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SPEAKERS
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RS: We have more than 100 participants already after we started the broadcast. If everyone agrees, we can start. Welcome to the last plenary session of LHCP2020 online. You can see that I'm sharing the current group picture. I thank everyone for sending their picture yesterday. This is a link on the page of the last plenary session. We will still open for another week the possibility to send us the picture, if you wish. We will release the final group picture in a week or so. I let the floor to Jim that will introduce the poster prize and introduce the committee that decides the poster prize and I stop the sharing. Take care everyone.

JO: Thank you. We had two poster sessions on Thursday and Friday. We had a committee who graciously agreed to give their time to view the posters and get together last night to decide on the winners. I will share my screen and introduce the committee. Everyone can see, OK? There were 48 posters all together and recordings that go along with the posters. You can see them still available on Indico. The committee consisted of the chair, Monica Pepe-Altarelli, Fiete, Greg, Marjorie Shapiro and Chris Quigg. We thank them very much for their effort and willingness to volunteer for this project. Each winner will receive a grant of 500 euros cosponsored by CERN and the European Physics Journal C. We thank them as well to be sponsoring these nice prizes. I will introduce Monica, the chair, to announce the winners.

MP: Hello everybody. Not all my colleagues are connected. Some of them are still sleeping in Chicago. But it was a pleasure for us to view all these, to review all these posters and it was difficult to choose five of them. But anyhow we did it. The winners are: Konie Al-Khouri, from Université Paris-Saclay. She prepared the poster you can see on Measurement of the Standard Model Higgs boson produced in association with a vector boson and decaying to a pair of b-quarks in pp collisions at 13 TeV using the ATLAS detector. Congratulations Konie. The next winner is David Horak, from the Czech technical University in Prague, for a poster on the ALICE measurements of coherent Rho0 photo production in Pb-Pb conditions. The next winner is Joschka Knolle, from DESY, on Calibration of the luminosity measurement with the Van der Meer method in proton-proton collisions at the CMS experiment. And then we have: Claudio Andrea Manzari, a theorist from PSI, for a poster on Modified Lepton Couplings and the Cabibbo-Angle Anomaly. Finally: Emma Torro-Pastor, from University of Valencia and CSIC, for a poster on Exploring the lifetime frontier with the proposed MATHUSLA detector. So these are the winners. Congratulations again for your nice work.

JO: Thank you very much.

RS: Let me suggest that all the winners, the committee that is connected, the chairs, they will open their own cam ... so I have the grid vision and I can take the picture. But it's already something. Another one. Last one. Thank you so much. Now I give the floor to Tulika for the next part of the plenary session.

TB: Thank you Roberto. It's a pleasure to welcome you all to the session where we have a very subset of nice interesting talks. And to start off we will have a talk from Tamas Vami from Johns Hopkins University. Please go ahead and share your slides and start when you're ready. Just a word for the audience, please hold off your questions until the talk is over and at that point you should use the raised hands feature in Zoom and we will get to you in an order of time. If you, for whatever reason, can't use Zoom, please do put in a message or a question in the chat. Again this should be done after the talk. For those of you watching the web cast, you can use this order plenary for putting in your question. Tamas I will warn you three minutes before the end of your talk. Please go ahead and start.

TV: Thank you very much. My name is Tamas, I am the chair of the CMS young committee. As an introduction let me show you two plots with the demographics at LHC. On the left plot we see each collaboration in a different column. The colours mean that with the blue, it denotes the number of people who are in the junior category. So junior means either BSc, MSc or PhD students and post docs together. The green we have a senior. I wanted to show you that each collaboration is in this way. The other interesting plot to look at is the person in both categories. The experiments start in the rows and we see that the yellow or orange, which is the females in the juniors is always bigger than in the blue. Essentially like an average, you can say we have a 10% increase in females in the junior category.

In order to represent these demographics, young scientist committees were created by all the LHC experiments. The first one was created by ALICE in 2010. They have three junior representatives who are for two years. In 2013, the CMS young scientist committee was formed. We have about 20 members, with a chair, deputy and a secretary as coordinators of the team. The mandate is for one year and can be extended for another year. In 2014, LHCb's early career, gender and diversity office was formed. We have two members. They monitor this for two years. Finally, in 2017, the ATLAS early career scientist board was formed. They have seven members. They have this membership for two years and their chair is monthly rotating. They replace half of their members every year, so they have continuous change of people. The aim of these committees is to represent the interests of young scientists, to ensure the communication between the young scientists and management., to improve the recognition of work among the young scientists and to provide a forum to gather and discuss topics relevant to the young community.

From these four points, the first three are achieved somewhat differently by the four experiments. In ALICE, these three junior representatives vote in collaboration board and management board. In ATLAS, the committee meets a few times with management and they send out surveys to the young scientists to check the status of the co-lab racing. In CMS, the committee is ex-officio members on the board. We can attend but cannot vote. We have quarterly meetings. LHCb is non-voting membership at the CB and they have frequent meetings with the management and also send out surveys to the young scientists. The point D is ensured by several programmes, which can be organised either by

the individual committees or all together by the young scientist fora. I'm going to go through the programmes which are organised by the individual committees.

All the four experiments have some kind of introduction to their collaboration which we could call induction courses. These committees help the organisation of these induction courses. Then in ATLAS and CMS there are certain programmes in which we try to put together the juniors and seniors in an informal setting. We have meet and eat and lunches with the professors. There are events which are only organised for the juniors by the juniors. In ALICE there is the journal club. And in CMS we have dinner and drinks. You can open the floor to get feedback from the juniors about any complaints, if they have, which they wouldn't do in a formal environment.

In ALICE there is a junior diversity workshop, which is noted for, like it's an interactive version for diversity management and is connected to diversity. In ALICE at LHCb there are tutorials. These are organised by the experiments. But the young scientist committee has power in this case. So it's a shared event with ALICE and LHCb. Then the collaborations try to put forward the work of young scientists either in the form of talks or posters. This could happen by juniors, for juniors and so the format can be very different in the collaborations. That usually happened during the collaboration weeks. Then in ATLAS there was a workshop about grant writing. It's related to something bigger that I will mention a bit later. The CMS had an event. We were concerned on job matching for academia. We had several events where if somebody wants to go, this event is aimed at somebody who wants to stay in academia, so we tried to match people who are looking for post docs or PhD professors looking for candidates. In CMS we participated in the reflection group. The aim was to revise the spokesperson and procedures. This year we had a spokesperson in action.

85% who could vote voted. That can be considered a success, since in this change we allowed that all the post-docs could vote as well. So the accent is for organising these programmes all together or they can organise programmes with a yearly rotating basis. Then in the past, we met once a year. In the future we plan to meet twice a year. In order to discuss common issues, share tips and best practice and plan the common programmes. This year we decided to extend the portfolio of the common programmes with a series of soft skill workshops. Which I am going to detail here. We already have the first one on April 15. Then the topic was making the best out of working from home. That was something which is super relevant for the times of COVID. We had a presentation, so the general format of the event is that you have a presentation by an expert, which is followed by a round table discussion and in the end we have a Q&A session with all the participants. I bring, I wrote two plots here. So the top one is the career level distribution. You see that we had half of the participants were PhD students.

We decided that we opened it up, so like the original term was that this is for the juniors. But we opened it up to anybody. So you can see that we actually had 12% of seniors attending the event as well, which is kind of the same percentage as undergraduate students. The plot here is the distribution per experiment. So like from CMS, ATLAS, and the size of the experiment. So like other experiments

that we had at LHCb we had 37 people from other experiments. The rest of the workshop series was going to be based on today, on the next coming events day. We are concentrating on CV writing for academia and industry. Our idea was to have this kind of soft skills related workshops every three months. You can see there are some in April, June and the next one is going to be September. That is organised by the CERN alumni. They have a series of events called moving out of academia to something. And this year that something is MedTech. I put here the links for people, if you want to register for the upcoming events or see what happened in the past. Then after this alumni event there is our usual LHC career networking event.

In this career networking event we have presentations from LHC alumni. The idea is that we could get some insight into career opportunities outside of academia by meeting the alumni of LHC experiments on behalf of CERN. This is very similar . There are presentations, a round table discussion and you can also ask questions from the panellists. The range of fields are diverse. We get people from industry, finance, IT and so on. We have the next event on November 16. I put here the link for possible registration. The other event which is rotating on a yearly manner is this conversation over ice-cream. Here we have short presentations with both topics changing every year for the general audience. In the past we had ice-creams to attend the event. This year, we only have screens only. In 2018, we had dark matter, dark energy related topics. 2019, it was neutrino physics. This year it is going to be June 16. It's the future of particle physics. We have presenters from these experiments and also we plan to include some of this feature planning exercises as well. For the future, future plans include training for the working group conveners, since they are usually chosen from the physics analysis merit and not from previous leadership experience.

It would be nice to have some kind of leadership management education for the conveners. This we plan to have with professional trainers. Actually, ATLAS did it last year. We tried to have it done for all the other experiments. Then the other programme which is planned for the further future is the LHCb mentoring system. ATLAS had something similar. LHCb did a survey in 2019 in which they concluded that 70% of the people who did the survey didn't have a mentor. And those who had it, they all found it very useful. So the idea is to have a mentor from the other experiments and with this, we could offer this as an excellence programme, which means that we would limit the number of places and also the duration of the event. Summary: Despite the differences in the approaches of the committees, the goals are common. We would like to represent the interests of young scientists and proified a forum for the topics that are relevant to the young community at LHC. I should mention that in the past we had difficulties engaging the young community. However this is improving since we have all these events and there is an increased trust in the fora.

As I mentioned, we have several programmes upcoming from which just a reminder, we have the next version of this soft skills workshop on next Wednesday. Then we have the ice-cream event on June 16. The further plans include this working group convener training and LHC mentoring system. We created a new e-group where you can contact all of us. You can see it here: If you would like to reach us individually: Thanks a lot for your attention.

TB: Thank you very much for this nice summary and for all the work that the committees are putting into this. So I open the floor now for questions. Please raise your hands in Zoom. Or put in a chat message. So maybe while I give people just a few minutes to think about their question, I could ask - so, I guess it's a two-pronged question, but if you were to think of, you know, any one of these efforts that you think hot most impact in improving the situation for young scientists, would you be able to pick one? Maybe it's tough. And or even it's related to the other, you could choose to answer that. Or is there a particular thing that you would like the not so young and senior people to do to improve the situation for the young scientists?

TV: The first part of the question I think the soft skill workshop was really a good choice. It's very successful. If you add up these numbers, we had around 300 people in the first workshop. For the second workshop since its upcoming, I can tell you that the numbers are around 480. So that's a really nice number for us. The number of registrants for this event is really high. This is very popular and also very helpful. This is one thing which we could do as a young scientist. Regarding the seniors, I mean, it's very nice that we can do all these events like meet the professors and so on. I think like in CMS we had this event, it is job matches. That was our first try. It was very successful. Maybe that's something which would be good in the future, if we had more participants from the seniors that would be improved.

TB: Thank you. I think I see another question, Giovanni, please go ahead.

GM: I have a quick curiosity, intrigued by your slide nine. I was trying to compare this success rate for the collaborations, for instance in LHCb there are more or less half of the people compared to ATLAS that attended these schemes. But in one of the slides you showed that the juniors there are maybe one fifth compared to others. Are you trying to reach out to the junior people in the various collaborations to understand why they cannot, could not join this workshop?

TV: Yeah, it is half a year advertising the event. In CMS we send it out to the whole collaboration. In ATLAS there was a newsletter. The way we tried to advertise it was different in each collaboration. I think that's why we had less people from ALICE this year. We hope it's going to be better for the next event on June 36789.

TB: Thank you again Tamash for this very nice talk and good work.

TV: Thank you.

TB: We will move on to the next talk. This will cover the outreach efforts at the LHC and it will be given by Despina. Please go ahead. Hello. Yes, go ahead and share your slides. Speak when you're ready. If I find that we are running late, I'll give you a three-minute warning.

DH: Can you see the slides?

TB: If you could do full screen that would be good. Yes. Perfect.

DH: Good afternoon. It is my pleasure to report on outreach activities on behalf of ALICE, ATLAS, CMS and LHCb. I would like to thank the organisers for this opportunity. First let me remind you why we do outreach. Of course, we want to inform the public and increase awareness and appreciation of science. (inaudible).

TB: We lost sound. Can you hear me? I cannot hear you anymore.

RS: I can confirm that I also do not hear Despina. We see you talking, but we cannot hear you.

…

TB: All right I think we should go ahead, if Eckhard is okay with this?

EE: Yes, of course.

TB: It's my pleasure to welcome the director of research and computer at CERN, Eckhard Elsen, to give the next talk. He's going to be talking about trends in particle physics. Please go ahead and share your slides and then start when you're ready. I'll give you an alert about five minutes before the end of your talk. Thanks.

EE: Thank you. Okay, first of all congratulations to the organisers of this conference. I think it's a real miracle to have run a whole week of conference with a new tool and a new format, quite adapted to this situation. I start my presentation just with a few disclaimers in the beginning. Because you know, when I agreed to give the talk on Saturday, the idea would actually be that I came back from Budapest reporting on the conclusions of the European strategy. Now we had several things intervening. I find myself in at least a triple sandwich position. First of all, the coronavirus hit and we are now finding, like everyone else, ourselves in the position between the lock down of CERN and the gradual restart. The second part is clearly LHCb is just have a new reg sculled release date in strategy in June council, in a different format. Due to COVID. Owing to the contents of my presentation, I'm between a full week of physics results and the summary talk which Andreas will give in a few minutes. I step back a whole lot speaking about things that many of you know clearly. But I would like to look back a little bit and just acknowledge the big successes the LHC had.

I think the picture that was shown earlier this week, ten years of experimental physics at the LHC, actually the LHC started earlier. But it's an extremely fruitful time for the experiments approaching a thousand publications, that's clearly a rich harvest. I would like to reflect a bit about the LHC. When it was launched, well actually, the precision tool came to an end. At least in larger parts of the community, the sentiment was oh, this is a hadron machine, it will do quick discoveries at the hard scale. And then we have to see what comes out of precision. So during those days, the discovery of SUSY was all on our minds, the access to the TeV scale was expected to quickly reveal the SUSY particles at least for those who were hoping for large couplings. I think it was the second, the discovery of the Higgs particle. You know the evidence was already quite strong

from indirect searches. But many people also said, well, it's the standard model particle. We know its coupling and they were well understood. Then there were precision physics tests around the standard model. Boson QCD because it's a hadron machine and electroweak particles and the whole thing would have been wrapped in a pack of about 300fb-1.

That was the thinking in larger parts of the community. We know the outcome. We have not discovered SUSY, so the couplings are not as strong as we had hoped for. The Higgs particle was found of course. We enjoy using it. And the precision tests of the standard model are ongoing. The discovery of the Higgs particle changed our lives considerably . It was as light as people started to anticipate. So a light x, a state to stabilise the metastable vacuum, in a position which is quite important for theoretical considerations. Immediately, it became clear that this would be the tool then to look for your physics in the various new couplings that the Higgs particle does undergo. So an industry of searches developed around the Higgs particle and exploring the coupling. You all know what came out of this, in fact you saw many results this week already, to that effect. The quick message of course was, the third coupling, OK you might be able to do with 300fb-1, but if you go to precision test we need an order of magnitude more.

That was the birth of the high luminosity LHC. This came quickly when the situation evolved in the earlier parts of this decade. Now, there is a new message, it's no longer that you simply crank up the trigger thresholds where the luminosity is increased. Can you do it with a standard detector? They already went through a phase one upgrade. But what became evident then when you go for the high luminosity you really want the detailed knowledge. In particular, when the luminosity was raised so much that you could not just simply assume that the underlying other events were simply background, described over the detector, even those could contain hard collisions. Because the multiplicity was so large. The need to separate all the vertices involved dimensions -- in fourth dimensions arose. This is a bold claim. First you need precision tracking near the vertices. That developed over the decade. The goal of also separating the vertices inside an elongated bunch is a fairly new idea. You know how far we have come with the plans for timing detectors, global timing detectors, that can separate these vertices also in a forced image.

Those were requirements that came. They were supported by a new industry that developed that you could do spectroscopy at the LHC. You can do MeV-scale precision physics viability at the multiTeV colliders. You can distinguish states at a few ten MeV. That's a tremendous achievement of the detectors. The other part that, at least for me, was a learning curve. Is that we knew that heavy ion physics would come up with complex events. My initial reaction was OK, you take a few of these events and then you understand the basic interactions. But it turned out to be much richer than what I really enjoyed with this part of physics now it comes with a much more quantitative assessment than was earlier anticipated. This is because we have so many tools at the LHC. It's not just a machine that you turn on and extract protons and lead ions. When you vary the beams and configure the events to properly report the event so you compare proper kinematics. With collisions in protone-led, proton, proton collisions you

have experimental handling in understanding the interactions. And also then model it with proper theories.

I think this is enormous progress on the experimental side and also on the theory side. So much richer programme that we originally anticipated. So, quickly as a reminder, already the previous edition of the European strategy identified the full exploitation of the LHC as the primary goal. Now formerly HL was approved in 2016 Council. The phase two upgrades of ATLAS and CMS were proposed and the cost envelope was acknowledged by funding agencies. In the meantime as you all know, the most technical design reports have been presented. And were used on the upgrades that were signed in most cases. Upgrade work is well under way. For example big contracts have been concluded. They were running for several years. But nevertheless, it's something that is in motion and will continue. And how could it be different once the two experiments had decided on a long-term programme. LHCb moved forward also and are now thinking of very ambitious programmes in the future. In fact, it is no secret, even before the European, the new European strategy was released the LHC is the flagship of that strategy and the operation of the LHC will extend far into the 20 30s in fact, I think.

Clearly until the end of the 30s. So the first stepping stone here is the ATLAS and CMS phase two upgrades that need to be completed to tackle the luminosity. You are also aware of the ALICE ITS. This is a new tracking detector, well they're just putting in a new tracking detector, the ITS2. But of course, as you study these detectors they recognise they could have flexible sensors, well, sensors arranged in a flexible shape around the beam, which gives better physics resolution at low momenta. It's an important ingredient. This is a stepping stone towards more ambitious upgrades that will come later. Of course, LHCb joined as well. Here it comes about mostly because of the competition with their two, and both experiments stepping up one notch at a time. We can expect a rich physics programme to continue also for many years. I'm convinced the LHC, with the high luminosity version, will give us very rich physics for many years to come. The new term schedule, and here I know you have to have schedules all along, I give my two cents into this. Let me remind you of the run three schedule as it stood end of November 2019, when there were two major decisions, namely to extend the LS2 by two months and possibly even three-and-a-half months to allow the installation of the second new small wheel of ATLAS.

And to delay the beginning of LS3 by one year, which is then meaning to start in 2025. When you look to the right side, you probably can't read the details, but this is the running period and the technical starts and the down times are restricted over the calendar years. So it was quite detailed and worked out to much precision . It was also clear that it would give us in excess of 200 in percent, which is important because we want to double the luminosity that has been integrated in the previous year. And then came something that hit the world. And of course, the physics programme is suffering from it. We entered lock down in the week ending 20th March. Basically went into the minimum mode in which the necessary services were maintained but otherwise CERN was empty. Some limited progress was possible in some countries which we are not immediately -- which were not immediately affected. Some limited progress on sub detectors

continued, at the time or resumed now, after some of the countries resumed the work. As you know, we all have been teleworking and my thanks to Tamash, I think I have to take the course and learn how to work from home.

Because it's really a chore in some sense. It's, of course, very good to also learn how to live without mode of operation. But it's been extremely successful. Analysis work has been unhindered. We have a flurry of physics results coming out of the LHC. This is excellent. And it really shows also that the video conference has been working. Also the development work has been continuing. The design of the mechanical structures, also the design of the ASICs, the specific application circuits that need now the key of the Redux systems that we designed for the upgrade that could be carried out. Of course, in the end, you have to submit a chip, but as we know, the testing of these verification of the circuitry can happen through simulation. There was very good progress and as we now begin the gradual restart logistics is a challenge. It's a bigger challenge than for the machine, for the accelerator complex because it's more or less one institute at CERN that has to administer this. There is no, there are no borders intervening. This is quite different to the experiments. Here just enumerate one or two points, namely the delivery of components from other institutes or companies even.

The production has been halted or the delivery chain is broken. You can't continue to build the detector if you don't have the electronics or if you don't have the detector subcomponents. Then also what we understand in our global arrangement of all the activities and applying the vision of the various responsibilities, we need the foreign experts available at the site. And this is impossible with the various travel restrictions, which are only slowly lifted. So I'm really pleased to see that at least in some cases, it was possible to have experienced technicians remotely controlled with a camera on the helmet and the expert sitting thousands of kilometres away overlooking the work. So that, it shows again that a little virus doesn't hold us back in the end. But it does require us to go quite unconventional avenues. So thanks for that. And I see the huge effort that is being made. It is very clear the first priority is to complete shutdown 2. These are the four experiments. They're all open and need to complete various work preparation or conclusion of the phase one upgrades and even preparation of phase two upgrades.

It's a considerable challenge for all of them. Without going into details, this is roughly how CERN anticipated the restart. On 18 May we call TO, the gradual restart with having something like 500 people new every week on site. Clearly it's starting with the highest priority work, but also with the contractors who need to be in place for the engineering and you name it. It's a gradual restart because we have to learn how to actually work with masks on, how to work even in the cafeteria when people would like to come back. I can tell you these days it does not feel the same to be in the cafeteria. But nevertheless, it works. People can get their lunch and also, we manage and learn to avoid being, to form a high density of people. It's a different way of working. It's slower. But we have to establish new practices. So the goal is by mid-September to have CERN all open. So at that time we can go back to the 7,000 users. This would not be the restriction. But I'm not convinced that all countries will allow their scientists to

come to CERN or whether there will be flights or you name it to come to CERN. This is why you see the shaded triangle at the bottom.

That the users will be back, but also remind you CERN at that time will probably not yet be the place where everyone likes to collide in the cafeteria with somebody else and have a chat. We still have to be respectful of the isolation criteria and social distancing. So, this is roughly the plan and now what is the impact on the schedule? I think early this week Miguel was explaining the effect on the accelerator. It is roughly a linear delay of three to four months, basically the time taken out by the lock down. This also gives them some time in the training of the dipole magnets. Remember all the dipole interconnects had been removed to allow the constillisation to take place. Now it takes time to train the magnet to take them to the highest energy and hopefully through several quenching cycles we will then reach the full field, so that we can operate at 14TeV or get as close as possible to that energy. As I explained already the delays for the experiments are less well predictable. So we have to be flexible with the schedule. But also there are opportunities to advance some of the activities.

So those activities that are most critical in time would be advanced. There is some activity that needs to take place for the CMS neutron shielding. That's an important part. Of course, if you look at the old schedule we had anticipated to have another extended year end technical stop for installation of the NSW-C of ATLAS. It would be most comforting if we could install the second small wheel during this shutdown still, so that we don't have to stop again. So from this sense, it all went well and keep fingers crossed, we could even gain some time that otherwise would be lost. What is the impact? We have not concluded yet. We will have a meeting on June 8 to assess this. Clearly LS2 will have to be extended. The machine is expected to be commissioned at the highest energy. With the, yeah we will continue with shorter interruptions for run three and LS3, the tile for that shut down will not be affected. Miraculously the integrated luminosity for run three will essentially be maintained, with the same stop date. These are very good messages for those planning PhD work. That schedule will not be affected. It should give us a very good harvest.

The luminosity in 2021 will be small or zero. That decision has not been taken. We rather see the highest energy and then the smoothest runner in the outer year. That is currently the status of the discussion and full optimization still needs to take place. We have to see, as you can understand, some of the components for installations are not yet ready. Plus, the uncertainty about the recovery of the COVID. OK, enough of COVID. Let's now quickly go through some other elements of the update of the European strategy of particle physics. This is a clear given LHC operation at the highest energy, which I mentioned. There is the fixed target programme. There's the isotope facility ISOLDE which is continuously upgraded, in-ToF and the decelerator programme. Most of the protons go into this direction of ISOLDE and the fixed target programme. It is critical, we have already decided before looking at the outcome of the strategy that the initial fix target programme will take place.

PS and SPS beams will be available in 21. Initial runs of the heavy ion programme for NA61, then the Kaon programme for NA62. The rather rich programme of COMPASS will start. We have a rich programme from the ebbing tron running of NA64. In addition also there will be initial feasibility studies for MU on E, this is elastic scheduling on electrons. Where the goal would be to support with experimental findings the situation of the T minus two measurements where you know there has been some discrepancy, that's too much, but deviations with respect to standard model which has been with us for quite a while. If the precision, the systematic precision can be reached, that would be a very interesting program and this will be studied. Approval of that experiment will come later. I mentioned already the isotope programme in ISOLDE. And AD proton decelerator. Further out, this is the recommendation of physics beyond collider study. You see that I'm careful not to pre-empt the outcome of the strategy, but they come forward with a follow up programme in fact a very ambitious programme for COMPASS plus plus or AMBER with the separated beam and the longer future.

I mention MUon E, ShiP is a beam dump experiment which has received already a lot of attention in earlier studies. So there has been CDR made available. It does require a beam dump facility. This is not a small feat. It is because of the radiation load it does require very careful planning, which has happened to some extent. But then also, quite some investment to install such a beam dump facility F it were to go forward it would clearly not be before LS3 because the resources are committed until that time. Then of course, one has to see whether it fits into the overall programme. With a future very large facility. I mention just for completeness, another professional that was prominent for the physics beyond collider which was the electron beam from the eSPS using an extended linear injector. The proton medium experiment, this would be external experiments for which CERN has already participated in some design studies already. So it's also interesting. Then of course, there's the neutrino platform, this is going forward since the earlier strategy of 2013. It really pioneered the liquid LarTPC technology. It's always a marvel but it's also a huge chamber.

It's something like six times six times six metres or larger. You feel dwarfed when you're standing inside. This is all filled with liquid argon. It's a big swimming pool already. This will be extended awe you know for the DUNE experiment to which contributes the cryo start detector. The success of this was a detector development as demonstrated with the single phase protoDUNE which showed that the lifetime of the electrons in the argon is very comfortable so that one can think of having large distances which of course comes about with considerable savings. So this is that part of the programme and now, I come to conclude quickly the update of the European strategies planned for the Council session in June. It will not be a big release of the strategy because honestly, I think we all share that sentiment, it doesn't fit into the time when the rest of the world is suffering from COVID to come forward with big, new plans and a big splash. I think we should take note of the Council click racings and then see how we translate . What we all know is that on the list is, here I quote the community input from Granada Town Hall meeting. There's clearly the interest in precision

Higgs physics just to complement the beautiful results we can expect from the LHC. There is an urgent need for accelerator technology.

Here I mention the high field magnets, so that one can accommodate the highest energies of proton machines. It is the recognition for the need of a future energy frontier machine, that you of course know about the hadron machine that would go to 100TeV or even beyond if the magnetic field can be increased. Then we have the enigma of the dark matter and that is nicely complimented by experimental professionals at the other end of the energy spectrum, namely for light axions could be carriers of the dark matter. It's quite an industry of experiments that are proposing to search for axions. These are of course searches that are often independent of the accelerator. They have come to quite some excellence already in the experimental set up. Now I come to conclude already and we'll give the floor then quickly to the summary of this conference and the beautiful result, which Andreas will conclude. I hope I could convince you with these qualitative statements at least a bit that the experimental programme of the LHC is extremely rich and in fact, it has developed enormously over the initial conception.

We have a long range experimental programme with a broad physics return. And this is clearly the energy frontier, where we will explore small ions, smaller couplings at the highest energy, but also the precision physics that comes about by mastering the experimental techniques in such a noisy and difficult environment. And my congratulations really go to the field in making this possible, which I had no talk possible ten years ago. I think that is a very good outlook for the strategy. I ticked off already the LHC and the vibrant physics programme beyond colliders, the details have been defined. And the wisdom on future facilities at the energy frontier, we offer here in a month's time. Thank you.

TB: Thank you very much for this very inspiring talk that showed us the breadth of the physics programme. So I now open the floor for questions. Please raise your hand in Zoom. Or chat. I guess maybe while I'm waiting, I can ask a question. So, I was wondering for you personally, is there any particular measurement or potential discovery that excites you most, if you look ahead to the next five or ten years, or a bit more of the LHC programme.

EE: I would love to have the dark matter enigma resolved. But OK this may be a subtlety when nature is cleverer than us. Actually when I look into the coming years, it's really the precision results where I expect measurements to come forward. Clearly for the muon production, the branching of the Higgs particle, I think we can count on getting some real measurements from the experiment. So addressing the second generation. So you know when I look at the developments in the experimental techniques, and maybe I should have emphasised even more the two developments - one is statistics. This is luminosity. The other part is having high resolution detectors and that is the inning newt of the detector builders. Then we should -- ingenuity. And the developments with machine learning are just breath taking. We should simply recognise they probably saved us years of running and collecting luminosity by improving the resolution

through these logarithms over the past years. In that sense it is very difficult to look very far in the future, because I don't know which surprises these analysis techniques hold in store for us. I'm not shy to expect a lot!

TB: Thank you very much. Are there any other questions? Let's wait for a few seconds. I think everybody completely agrees with you here. I just see a question pop up. I'm allowing you to talk, could you please go ahead and introduce yourself and state your institution and then ask your question.

GB: Hi. I'm Gregorio Bernardi from Paris. I wanted to ask you, assuming that indeed things are going as you're planning with people coming back in September at CERN and so on, is the strategy still to release the European strategy around September? Or could it be delayed even further?

EE: I think, well, you saw I said the strategy would probably be released in June by Council. At least I hope. We have to see of course. The wisdom of Council, I don't want to pre-empt. But this is currently the plan. Remember, the Monday of this week was meant to be the release of the strategy in Budapest in a big meeting, the same time slot has been used for further discussion of the strategy. And honestly, I expect the deliberations to come forward in June. When I said it will not be the big splash, because you know, in June, we wouldn't be able to get together. We wouldn't be able to get on stage. It would be a no event in some sense at a time which is not right. And this is why I expect this release of the strategy to be, well, clearly an important message, and they may have a follow up conference or whatever to really appreciate the details of that strategy. What we have anticipated two years ago, also clearly is already overruled by the, a little virus I must say yeah.

GB: So I don't understand exactly, would the release of the document but no public statement? Or I don't understand?

EE: Exactly. It's the update of the strategy in Council which is counting. There will be a virtual Council meeting in the week starting 14th August, sorry of June, if that is a Monday. And during that week, I expect that to be released. I expect it. You know, you never know with the Council. They might decide otherwise.

GB: Okay thanks.

TB: Any other questions? I don't ...

EE: Maybe I can comment on the details, the Council in 2013 they produced a short, I don't know five pages, summary which is a really high level of the findings. And then, some longer document which goes into some more details about the elements of the strategy. So that has been prepared and should be released.

TB: Excellent, thank you very much. We look forward to that.

EE: Yes, we all do.

TB: All right, thank you again Eckhard. We will now move on. If you could please stop sharing and Despina we will try to go back to you hopefully the audio is fixed now.

DH: Can you hear me?

TB: Yes we can, excellent!

D: It was Zoom that was interrupted. Anyway. I will share the screen. Can you see the screen?

TB: Perfect. Yes we can.

DH: I'm sorry for the interruption. I was saying that I wanted first to remind you why we're doing outreach. Of course, we want to inform the public and increase awareness and appreciation of science. We want to tell taxpayers where their money goes. To inspire the youth, since they are the next generation of scientists. To motivate teachers and also to communicate our progress to the decision makers in order to ensure funding. We want to inform the media, also our fellow scientists. And since there are a lot of wrong facts and conspiracy theories on the web, we want to provide evidence-based information. Now to meet all these goals and to address the different audiences, we develop a lot of activities and resources. Of course, it is not possible in the limited time of this presentation to present everything, so what will follow is a personal selection. CERN as you know has a very broad outreach education and communications programme. The LHC experiments contribute to it and also participate in common activities.

Also each experiment has its own educational projects, produces material, both at CERN and also individual members, institutes and countries. Each experiment has an outreach coordinator or coordination group. At CERN, informal LOG meetings are held, normally every two months, to facilitate the exchange of mange, sharing of experiences and coordination. LHC experiments became part of EPPOG, which was later renamed IPPOG for international use soon after creation. Lately the IPPOG has been promoted, let's say it has become an international collaboration and the four big experiments are using their official members of this collaboration. Now the flagship activity of IPPOG and I could say for our community is the master classes in particle physics. That is a very successful programme. Last six weeks, normally every year in the period of February, March, April, in a nutshell this is a day of immersion in particle physics for high school students. And what happens is that they're invited to institutes or universities where they follow lectures. Then they analyse real data from an experiment leading to a measurement.

At the end of the day, they connect via video conference with other institutes and moderators in order to present their results and discuss and ask questions. Most master classes are done with the data from one of the four experiments of LHC. But lately other experiments such as Belle and Minerva have proposed exercise and particle therapy master classes are introduced to bring applications to the students. The programme has been growing over the years. And last year,

15,000 students and 1,000 teachers participated in master classes held in 54 countries. Going a step further, the LHC experiments have made the public data, together with the tools for their analysis and instructions, on the open data portal, you see the link here. Yesterday there was a nice presentation in the outreach session, so there you can find a lot of examples of what is in the open data portal. These programmes are mainly used by high school, by advanced high school and also university students. Of course, anybody interested can also participate. In passing, let me mention that there is other activity.

There is the LHC at home which is something else involving the public. This is volunteer computing. Individuals offer their idle times of their computers for simulations. This is another way of involving them. Oh. What has happened? OK. Now one of the main activities both for CERN and for the experiments is visits. CERN has more than ten visit sites. All LHC experiments are included. They all have a kind of visitor centre at the surface with exhibitions of the detectors, posters or videos. And also, they allow underground visits when it is possible, when there is no beam, which is of course, what particularly fascinates the public. A big event last year, maybe the major event of 2019 was the open days. During the weekend in September, more than 75,000 people visited CERN. All LHC experiments allowed underground visits. So many thousands of people had the opportunity to visit. In addition, at the LHC experiment site many more activities were organised. Here you can see some examples of simple experiments for children and adults. Building detectors out of cardboard or wooden blocks, proton cookies, music from cosmic craze. CERN also organises regularly other activities for children or the general public. And the way to participate in many of them, just as an example the researchers night in September. This is an activity for primary school children to introduce them to the concept of research. The international day of women and girls in science, this last year, on this occasion, many female physicists and engineers go to schools, both in France and Switzerland giving talks, discussing with the children the aim being to serve as role models in order against the stereotypes that science is for males only. A virtual visit, in order to reach remote audiences, who cannot come to CERN because it's too far or too expensive, virtual visits were introduced initially by ATLAS, then by CMS. Now they have been adopted by all experiments.

So each experiment has its own way of conducting the visits, either with fixed equipment in the control room or mobile devices or both. The goal is common for all of them - to allow remote audiences to see something of CERN and to interact with science and ask questions. So in the course of the years, many thousands of people have visited virtually from many, many countries. Going a step further, in order to reach audiences practically everywhere, occasionally live events are organised using various platforms. In the past, a series of Google hangouts were organised discussing various physics topics. In these last years the preferred method is Facebook lives. And in the last year, since LHC was stopped, Facebook lives were organised from the experiments with great help with the CERN audio visual service. So experts from the experiments talked about the upgrade, answered questions from the public and it's worth mentioning that the first ever 360 live from CERN, from the CMS last October received a Webby award from the academy of digital arts and sciences.

Every experiment has maintained a public website, where there is a wealth of information for the public and also, often there are updates about physics results on detector upgrades. Social media is broadly used since in this way we can reach audiences of different interests and ages. So all experiments have Facebook, Twitter, Instagram, which seems to be very popular these days. YouTube is also a powerful tool. All experiments have their YouTube channels. Just to mention that on the CERN YouTube channel three videos were posted lately explaining the Higgs discovery for the Lehman. CERN has a very interesting arts programme with visiting artists or resident artists. And in this context there is a lot of interaction between artists and scientists. With visits, interviews or mentorships. We also profit from this exchange. A nice example of using science and art combined is actions by the art and science across Italy, also cultural collisions from the origin network. These are mainly for school children. And they have seminars, visits, workshops by both scientists and artists. Then artistic creations by students inspired by art and exhibitions.

Also another example of actions by this origin network where all experiments are members, is outreach events during conferences as was the case in last year's LHCb in Puebla. There was one yesterday about other actions of origin. Going to find other new audiences. We've got music Festivals. So one case was sessions on physics of music and music of physics, organised by LHC physicists with great ... (inaudible) September music and unification of LHC data. Finally, big Festivals. Normally the organisers like to include something else in addition, so there was a first event at the WOMAD Festival of 2016. This stands for the world of music, art and dance. Where there was a physics pavilion with talks, experiments and so on, with great success. So after this, this formula to have a physics programme was adopted by other Festivals. And the feedback is very enthusiastic from the people who participate. So this is, since my time is over, this brings me to the end. As a conclusion, I would say that a lot of progress is happening these last years in outreach. We are reaching new audiences, thanks to the various online platforms and the fact that we got new venues.

Quite encouraging is the fact that the outreach activities are recognised by the collaborations. For instance, they count them as service work, similar to shifts. Also the fact that they're now included in physics conferences. Like the present one. But I think we can still do more. Let us all encourage our colleagues to participate. I would like to finish with there was an article in science emphasising the importance of outreach that the popularisation of science would provide an important antidote to overspecialisation. It would bring out clearly what is significant in current research and it would make science a more integral part of the culture of today. So thanks a lot for your attention.

TB: **Thank you very much Despina for this very nice summary and for the very important work that you yourself do in this area. Thank you for that. I'll open the floor now for questions. So feel free to raise your hands in Zoom or put a message in the chat. In the meantime, maybe I can ask - so, I know there is given that most people at least have limited time especially multitasking, is there any particular one or two kinds of outreach activities that you think would be most effective for them to do, so as to be able to reach out broadly or have some or the of impact?**

DH: You mean people, for individuals, what they should do?

TB: Yes.

DH: Well, I think everybody from the main initiatives, which exist, everybody should choose what is closer to their interests, to their abilities. I don't know if this is very general. But that's what I think.

TB: That's fine.

DH: For me the master class is a very important thing. It really reaches a big audience. And with not very much involvement, people can offer a lot to students. So I would really encourage the institutes who don't participate to consider participating.

TB: I second that. Because I myself was able to take advantage of that. I ran it with high school students. It was really wonderful.

DH: Normally it is appreciated.

TB: I see there is a question. Go ahead and introduce yourself.

I: Hi, I'm Indara from Boston University. I was wondering, I know there is a very useful page for the master class, but for some of these other activities that people are doing, is there a database where, if I'm interested in participating or in using some of these activities in an outreach event that I can easily go to and find?

DH: Yeah, thanks for this question. Certainly the IPPOG is now updating its website. There there will be a database that has been created a long time ago and will be reviewed, where we try to put all the resources, events and so on. So I hope that this will be the best place to find this.

I: Thank you.

TB: Any other final questions? I don't see anything. Thank you again Despina. And we will now move on to our next talk. So in LHCb tradition we typically have a keynote talk that covers physics or science topics that are complementary to what we discuss here in our conference. This year, given the current situation we are very glad to have the chair of the CERN against COVID-19 taskforce, Beniamino Di Girolamo to give this talk. Please go ahead and start sharing your slides. I will give you a five minute alert before the end of your talk.

BD: Thanks a lot. I hope you hear me well.

TB: Yes, we hear you well. We are waiting to see your slides.

BD: Yeah. Let me share my screen.

TB: We see them great.

BD: So I'm here today and I'm very glad for being invited for this talk by the organiser and especially Bruno, who has been a friend for many years. Your decision on having this conference online was quite bold. I see that it takes place very well. It's very G very happy to be here. So, in fact, CERN has decided (inaudible) on 26 March to start this taskforce . This was established to collect and coordinate ideas that we were already starting to receive from our community, from the scientific community of course, over 17,000 people worldwide. But also from individuals, people from society that were asking if CERN could help in giving ideas. We decided to put together this taskforce to collect these ideas to see what we could do. Of course, in a humble way, drawing on our expertise and facilities that we have at CERN and in member state countries and we see how we could contribute to society. Essential message is CERN is here, present to help society and researchers in other fields at this difficult time. A task force was put together. Here are just a few members of the taskforce: They come from all over the CERN specialties.

They have expertise and of course, from the experiments, from each of the four major experiments. As I said the taskforce is as a multidisciplinary composition. This is a very good element. It's a key element in fact that has enabled us to receive the ideas, to see how we could contribute to this idea that we received. So several colleagues that are not officially in the taskforce have been extremely active. We count that beyond the population of the task force around 150-200 people have been active. In working with us. And this has allowed enormous acceleration of initiatives, finding short routes to results, making emergency decisions for immediate help to the neighbours, but also really society around us, but then larger initiatives that are in support of researchers. Also in unexplored territories like ventilators. I will tell you today a bit about all this work that we have done. In fact we received about 300 mail exchanges. We got initiatives proposed, some were duplication of others. In essence so medical applications. You will see something about ventilators and coatings. Mainly for PPE and sanitising.

But also the logistic support and also to you will see a big chapter on how to materialise PPE. So masks for example, to increase the amount of pressures. Last up, a large variety of initiatives in computing and data analysis. As you can imagine, this was based on the folding@home run on the CERN platforms but also on the general adoption of the platform for open data for good science. Let me go through the ventilators. HEV is the high energy physics immunity ventilator. It's the best low cost ion ventilator. Starting from a core group in the LHCb experiments but joined immediately by at CERN, but joined by the other universities, Liverpool, Rio de Janeiro, Manchester, Krakow, so there was really a big group of people working on this. The idea of course was stimulated by the emergency, by the fact that ventilators is something that was in short supply in countries and also looking at the future for countries that are in the low income settings for helping them to get some inexpensive ventilators that are easy to manufacture. So three prot types were built. You can see in the picture, this is one of the prototypes. It has a touch screen.

You can see in the middle this buffer that is one of the main features of this ventilator. I will tell you near the time to run effects, but this buffer allows us to

precisely monitor and refine the pressure output, so this can be regulated in a very precise way for the patients. It supports various types of ventilation that are similar to the ones that are available in conventional ventilators, but this is much safer. You can see the number of components is not very large. Then there is this print board that is essentially a microcontroller, a microcomputer which allows the human to interface with the machine and also to have all the controls that are needed for this very high availability kind of application. As you can see, the timeline has been impressive. So the first idea started, the first work started on March 27 by the end of April, this was finished. And now we are in a situation in which essentially we are looking at the market. We are looking at the possibility of investment patterns to bring this to the next steps. So the prototyping has been completed. We also gained support for organisation and to put in with the WHO, which we have been discussing extensively in several fields to the mechanical ventilator milano.

This came from initiative of, from the global argon gone dark matter collaboration. In this difficult time started with under 60 collaborators, nine companies. So industrial partners immediately in the game. And to obtain the emergency use authorisation from the food and drug administration on May 1. Also in this case, impressive timeline. It was tested ten days after with COVID patients. On May 1 the authorisation from the FDA. We have been also supporting, especially for mechanical components a very simple approach. This is very easy to operate. It's essentially a bag, like the ones they use on the ambulance so that they are typically manipulated manually to ventilate patients. But in this case there is a two-step motor. This is an extremely low cost object. Nonetheless, it supports a lot of modes of ventilation. That is very promising for places where resources are very low because this is very simple and cheap. Here it comes. Now this was an emergency, now we are looking at this moment. At this moment we have a lot of usage on masks everywhere.

And we have got the requests from several institutions and from people to see how we could reuse masks. So one big chapter is the UV light disinfection. This is UV so it's quite energetic UV light. This is not something new. We know that UV light can essentially necratise cells. This is essentially what we are looking for. As I said UV light is not something new. You see here a bus in Shanghai that is completely sanitised by UV lamps. For this reason, CMS have had the development of boxes in which there are several America row vapour based lamps. These boxes are made to be used for conventional tools and masks, whatever you want. But also, we developed together with a company, a small box in which essentially you can recognise one of these such masks that are so frequently seen nowadays around. This is something that could be developed and we just received at CERN and we will exploit it for doing some tests to see if this can become the tool that is cheap and readily available but can make masks reusable. Of course, we also looked at the irradiation at different doses. The idea is the same as how to reuse essentially PPE. Having them sanitised in this way.

We also looked at the 3D printed masks. These are masks that are built with a 3D printer. There were several October that allowed essentially to put several types of filters. It can arrive at even the FFP2 kind of filtration standards and it's completely washable. There has been some development by the same group to

have a washable and biodegradable filter that would make this mask to be completely reusable. 3D printing is very slow. We are now moved to building with a 3D printer where we can inject sill crone. And essentially now we are looking for possible partners because there is quite some interest for this approach. OK now another point on the use of masks is coating. There is a coating for UV light treatment. This component is called liquid glass. It's essentially still a crone dioxide solution in water. This makes a very thin coating, that is by an aerosol spray into this solution. And it protects you from droplets. The results are the possibility to add an antiviral agent in the matrix to allow even further protection. This is a very interesting object.

It's a material that's not make the mask to be stiffer. It's very flexible. It's breathable. We are looking into this kind of thing to see again in the field of reusing the protection that we would have to wear every day. Another chapter has been the production of sanitiser. According to the WHO recipe that has been produced at CERN in the chemical lap. We have produced 10,000 litres to date. And 6,000 have been donated to the local community. You can see already, a rare picture of a military truck on the CERN site loading 10,000 litres of this solution. Then we have had a very interesting phase in which we started to produce these face shields. Face shields that are in three types. The type one is completely manually built. The second type is by injection. Type three is also completely manual, that is adapted to the elements. It has been developed in CMS. This became a factory for the face shield type one. We produced 15,000 shields in quite little time. An impressive increase in the rate of production per day. We passed from 50 per day to a thousand per day. And more than 10,000 shields have been donated and some are reserved for CERN usage for the restart.

I finish with the areas of computing. Computing has been very important for fighting COVID. We have received a request from researchers outside of high energy physics for this. Of course, you can imagine being contributed with great results. When we started we were positioned to under 60 out of 160,000 teams worldwide. We are now 31, but for sure in this moment while I speak, we have increased this. We were fifth in May. Out of more than 250,000 teams. This has been a great contribution. For this, we deployed 15,000 together with others with the experiments. Then we started to have in the sense that they were not able to feed the cube for processes fast enough. That's why CERN stepped up with the high energy physics maps to deploy data management and in this way, give the possibility for it to be more effective in feeding the computing course put available.

It has been a very popular tool. We know it's another resource at CERN. It's part of the open data portal. We have a really an increase in requests for data from a variety of research, you will see in a moment some examples. And looking for example on binder, a popular notebook execution framework, nowadays it shows 815 different zenodo-based flows. That is a big success. They are all connected to COVID. Example of data set, we go from medical type of application, biological, but also about the standardisation, and the passport logistics. This is something that has been quite interesting. We are in discussion now with WHO because the programme is studying the supply chain disruption, because of the COVID. They also will be with data. They are open access data initiatives. So initiatives

concerning the health, concerning biological aspects and also concerning socio-economic aspects to see how the COVID has impacted in several fields of our life. So here are just two examples. WHO with health emergency and disaster risk management. We are looking at the support on data architecture for risk analysis and supply chain management.

And the university Bocconi on the right, you see the first example of data aggregation from date why from several sources to build a map of the problems, in this case in Italy. But this will be standard worldwide and to see how the effect of the COVID is on socio-economic aspects. Here you see examples also of the biological simulation. This is a biodynamo. This is based at CERN and on the right you see some simulation done by CERN department colleagues. These are two examples. There are many. It's one of the aspects of this work. So what is the long-term impact? Well we have based a lot of relations with organisations, both in high energy physics and outside, with the WHO, with biological labs. So this has strengthened even more our collaborations and our community seeing us as a reference, especially for open data, open science. We have learned a lot. And since these are being shared with the other organisations, as I said, especially WHO given also our closeness in Geneva, but also with the world economic forum. Now beyond the emergency, the taskforce has allowed CERN to provide help in this emergency.

This is a model of working that for sure we remain part of the CERN culture. We can learn from what has happened, how we reacted and be prepared to respond better in future. The landscape is changing. There is a worldwide response to this emergency that has been outstanding. And I think input from all parts of research, not only high energy physics, of course. So concluding, we responded, at CERN, with this task force joining a worldwide effort to the scientific community. We are sure that we will get this not forgotten. We had a variety of ideas that are so high and also so high quality that we implemented many but we have still some in the pipeline to be implemented. Certainly this emergency has increased our contact with society and also research in other fields. And of course, I have deep gratitude for all the members of the taskforce and colleagues, we are about 150-200 persons working on this. Because this really was important to make this a success. So we did our best. But we will continue. The emergency is not over. And we are still in operation.

TB: Thank you very much for this really excellent summary and also for all of the important work that everybody is doing in this area. It's really impressive to see that. So I open the floor now for questions. Please raise your hands in Zoom or put a message in the chat window. I can see, I mean you talked of several important projects, I was wondering if there was one in particular that you thought was most challenging to undertake and then what people are doing to overcome the challenges.

BD: The ventilator certainly has been a challenge. Because clearly, we have expertise at CERN in controlling these ventilators, need really good levels of controls and are very precise. We are also experts in population, so this was certainly a good aspect. Now going from a prototype, to arrive to the patient is extremely challenging. It has to meet standards that are not easy to meet and certainly not

what we do every day. So it is for these reasons that we've been liaising with the WHO and seeking their expertise and we are looking for an industrial partner in the medical field so that could bring this to solution. So this has been probably the most challenging of the projects we have been doing, yeah.

TB: Thank you. Questions from the audience? Or from the panellists, if you're a panellist and you have a question, just speak up. You cannot probably raise your hands. Again I would like to thank you again for everything you're doing and for your wonderful talk and now I give the mic to Giovanni to introduce the next speakers.

BD: Thanks a lot.

GM: Yes, thank you very much. We now are into the final hour of this long but exciting conference. Before just going to the presentation, let me say it was a pleasure from me to help organise the conference, although not in the form it was initially foreseen. I hope that you enjoyed it despite the glitches we had and to see many of you in person next year in Paris. Now let me virtually pass the microphone to Andreas from CERN, who will give his personal view of the experimental highlights of the conference.

AH: Thank you very much. I hope everyone can hear me and to see my slides. Can you just confirm?

GM: Yes, I can see you and see your slides.

AH: Very good. I will stop the video so there's more band width for the talk. Thank you very much for inviting me for this. This is not an actual summary, but it will be selected highlights. Because there was so much material shown during the week. This conference was pioneering. It was the first virtual of the large HEP conferences. This was a very rich show case of first rate research under quite difficult circumstances. I think everyone agreed during this week that it was a very important conference. We have huge thanks as many people said to the organisers for bringing the community together in quite a short notice. Now we are celebrating ten years of physics and technological prowess. Among the results of this was a page from the CERN courier in March this year. Among the main results is that we know that the Higgs Boson exists. There is so far no proof of physics beyond the standard model up to the TeV scale. There have been numerous discoveries in the standard model involving rare processes, flavour, spectroscopy, high density strong matter. Accelerators, detectors and computing and analysis performed beyond expectations and l has prompted prodigious progress in particle theory.

If you think back, remembering back in 2008, there was this headline, after the 10th September, CERN experiment, the machine switched on New York big bang and it works. It was all correct apart from how it works. Which took a year more to get it really running. Then at 7TeV in 2010. These were the first candidate collision events. We didn't know that we had collisions. We had to look at the detector timing to make sure we had events in the detector. This is a nice display of the first one from CMS. On the right you see a high multiplicity collision event.

The first year gave rise already to quite interesting, with only 35pb-1, very interesting first paper. The first paper on the left on the charge particle multiplicity. On the bottom the production cross-section of bb production . This was important to do to actually make sure that the physics potential they were hoping for can be achieved. This is indeed the case. Then we had a very first surge of only a few hundred inverse nanobans. This is a sensitivity that is very low. Then came the bang from CMS. That shows for the first time the interesting feature of collectivity in pp collisions.

You have a far range nearby correlations spectrum here. Later, a similar collective effect was seen already in the control room in ATLAS to see the jet quenching. So one jet basically removed energy and so you had the large symmetry in the events. After announcing run two, the LHC experiments now have the richest hadron collision data of the same pull ever recorded. The LHC is an everything factory. We have about eight million Higgs Bosons produced. Top quarks, Z Bosons, W Bosons and bottom quarks. This gives huge potential for physics. This week witnessed this huge potential. Now a very important groan of any of the analysis results, we have seen this year, is of course the axion detector understanding and the reconstruction performance. I think these applications to reconstruction are probably the most interesting of the ones we have seen for modern machine learning in particular the deep networks. But most importantly, of all, is the meticulous calibration of the algorithm ams with the data. This allows us to make high precision measurements.

Here you see examples of jet energy calibration in CMS. B jet tagging calibration and Kaon PID efficiency in LHCb. Very important also is the presized luminosity measurement. For many people this was a surprise that we were able to measure it a percent level using the separation scans, the luminosity in all our experiments. Now there has been a harvest of cross-section measurements which confirms the predictive power of the standard model, this type of stairways talks have been shown in many talks, plots have been shown in many talks. This is a beautiful example from CMS. It shows also that there has been huge progress on the theoretical calculation. There has been a revolution, this is the state-of-the-art next leading order, corrections are included. We have heard this week that it's going towards the fruit fly of particle advisics. This is really amazing. One of the first experimental highlights this week was the observation of triBoson production by CMS. You see here the various modes, the combination is now more than 5.7 Sigma. This travels a collection of several interesting diagrams.

In particular you have here the triple edge coupling, and the Higgs production all together contributing to this important process. This is a beautiful event displayed of a five lepton event in CMS. This is a very pure event. Somewhere here at about 12fentobarns we expect top production to occur, a spectacular massive state of 700TeV. This exists in the standard model. ATLAS has reported first evidence for this production with a significance of 4.4 Sigma and cross-section of 24 plus seven minus six. You see here the bdt output of this analysis. You see in grey, the ttW contribution, which is one of the important backgrounds here, which has been fitted in this analysis and found to be 60% higher than predicted in the standard model. This is consistent with other

ATLAS analysis as well. This has been seen as well. This is an event display for top candidate events. You have a direct channel here, seven jets of which four have been b-teched. I would recall that hadron colliders as was said also, enable high precision measurements. We have many examples already. We have precise W and top mass measurements.

We have very, very precision on WZ cross-sections, top cross-section, flavour measurements. And so this is another example of a pre-sized measurement. There has been a long standing 2.7 lepton. It was driven by an L3 result which is high in Tau and low in mu. This was something we wanted to test. Can you not just use a W decay inclusive one. You have a trigger. You have to trigger these events. Then you get additional systematics. ATLAS used tt bar events, where you can probe the other W. You can cancel systematic uncertainties there. You take the lifetime of the momentum to discriminate between prompt and delayed muons. And this finds a value consistent with the standard model and twice more precise than the lep measurements. I would like to come to the LHC magnum opus, still the Higgs Boson. The discovery allows us to access new sectors of the standard model. We have Yukawa couplings and the Higgs potential where we want to look into self-coupling. Run one provided the discovery and the couplings to Bosons and run two provided the proof and measurement of Higgs couplings to the third generation.

This is really a big thing. These couplings here, between elementary particles, are a new form of interaction. It's not a gauge force. It is non-universal. It's a bit like gravity almost. And it is driving the fate of the universe. If you think about if the electron had a mass of the muon think what happens. You can find the answer in this beautiful paper here. The experiments have continued with the full run through data sample to look into these couplings. Measurements already from ATLAS and CMS on the Higgs 2bb channel. It has in this channel a full data set observed with ZH production and strong evidence for WH. The cross-section is in agreement with the standard model. We have here this beautiful shoulder from the Higgs to bb decay. It looks very interesting analysis into hard jets, recalling against the Higgs and the Higgs decaying to (inaudible) these was where there was a substructure in one event. It's interesting to look at a high pt where you have a mixture of several production modes. And there is sensitivity to new physics in this area. You see a beautiful event here.

What you have here on the right side the jet and on the left the substructure of Higgs to bb candidate. And this is a striking example of the power of our detectors and it is exploited in many high masses, and the analysis by combining presize measured in a dense environment. So, of course, the experiments continue to probe these properties here as an example in the four lepton channel. I cannot look enough at these Higgs mass peaks we see in the four lepton channel. You see here two examples of measurements of the differential cross-section measurement of the Higgs. In good agreement so far with the standard model expectation. And measurements from simplified template cross-sections constrained on effective theory parameters by ATLAS. Looking into the coupling, of course, a big and important question is to understand whether there is CP violation in these couplings. We know that they have to look for additional CP violating phenomena beyond the standard model. This is a very

interesting area to look, particularly the coupling which is so big. A great channel to look into is the TTH channel.

This is a peak here from CMS, which alone T this alone allows us to observe this mode with 6.6 standard deviations. Boning experiments have looked into this channel to see if there are CP odd contributions to the CP even. This can be by a mixing angle alpha here. Can you see it's constrained from alpha on this angle. It's compatible with zero. There's an upper limit on 43 and a full CP contribution is excluded by 3.9 Sigma from this analysis. There are also other ways to study the coupling, by looking into the detailed kinematic properties of the tt bar production here. An example from CMS which looked into TT bar production and measured it looking into the mass of the lepton reaction. These diagrams give constraints that allow it to restrain the coupling. Here it has been measured by CMS to be patying with about 20 to 30% uncertainty, which is compatible and competitive with the direct measurement. It's a very interesting indirect test. Of course, the experiments continue to look into rare decays of the Higgs. Second generation first results, preliminary of the full data set have been shown before.

This is a new analysis from ATLAS looking into Z gamma. It's a bit similar to gamma gamma, but it has a different loop induced diagram. It has a low branch. Of course, sensitive to new physics which is different to that in Higgs 2 gamma gamma. There is a little success here, 2.2 Sigma with a mu of two and 50% uncertainty. This is a candidate event. We have the Z to muons and the fault here and very clean events. Then the Higgs as a probe of dark matter. If dark matter is massive, it could or should couple to the Higgs Boson. And the Higgs Boson could be the part to hold the sector. As we have heard before this morning. So invisible Higgs decays can be probed through associated production, associated with vector Boson fusions, this is the most powerful one. It has been looked at by ATLAS with the full run two data set. Here is an example of the at higher mass one would expect excesses of events if there is an invisible Higgs decay. This sets the upper limit of 130% for these decays. It can be translated into an interesting constraint into the cross-section to compare it and show the complement argonity of these direct searches at low mass as you can see here.

It is clear that the Brout-Englert-Higgs mechanism is real. If you look at the couplings here from CMS compared to the part cut masses, it is clear that we have a non-universal coupling. The scalier sector is directly connected with profound connections related to naturalness, vacuum, stability, energy and flavour. The Higgs Boson discovery gives a tool to study the sector, requiring a broad experimental programme that will extend over decades. We have learned in Higgs Boson MoD rates high energy longitudinal vector Boson scatterings. These are exploding and breaking unitarity. You get a minus sign which MoD rates this contribution if the Higgs is not too heavy, which is the case. This is the mechanism we need to test. The experiments look at vector Boson electroweak qqvv production. You see here the jets. Here we have a coupling. You need to add other electroweak processes to this. We have to separate this from strong productionment the history here is that electroweak production has not been observed during run.

So we have heard this week beautiful new measurements from CMS of these processes. With these types of couplings observed with 5.8 standard deviations. Here using the full run two data samples. There's evidence for 4 Sigma found with nice success here. Run two has seen the observation of electroweak qqvv production and as I showed you triBoson production, probing Higgs moderation requires higher mass studies, so this is physics we will do in run three. Eventually we need to isolate the longitudinal polarised components. This is really physics of the high (inaudible) more theoretical work needed for precise predictions of these complex processes. We see the deficiencies we currently have. This is a new analysis, VBF electroweak plus Z production. You see the control regions and signal regions. Control regions are used to correct the results here. To get a nice prediction here. From the start we would like a good description of these processes. These are very complicated processes. Now I want to switch gears and move to flavour physics and spectroscopy.

This is the detector. This is the natural colour. As the photograph was done. The success of the standard model flavour sector is since a long of discomfort for beyond the standard model physics. As are the anomalies, a source of excitement. I would like to start this section with a bit of bread and butter physics which is very important. So the CKM gives four parameters. These are four out of the 19 standard model parameters Westminster needs to know this with the best precision. LHCb has greatly contributed already to metrology particularly through a large set of gamma measurements, really an industry in LHCb of these measurements. This is a fantastic achievement that they have produced on gamma. Now LHCb contributes to them directly and there is long standing tension between exclusive and inclusive results. You see on the left: There is a big tension between the two. This is a hampering progress in this area. This is the first time this has been measured. They used another approach to estimate the recoil. It can determine the neutrino which we cannot. They used the novel approach to not suffer from this additional neutrino.

But it needs some theoretical input to get out of the measurement of the recoil shape to the vcb measurement. There are two results and both are currently compatible with the exclusive and inclusive determinations. This is not enough now to distinguish the two. But this is certainly a very important and interesting input. Very few have had new measurements of time dependent Bs system. It's not only the golden channel but it's platin. New CMS results using 2017/18 data. This has been combined with run one. This plot here shows the results, which are so far available. This is the new CMS result. This is the combination of the LHCb results and ATLAS results. There is some tension which we have to understand before moving on. Another very important topic is rare decays overall. We have seen in many theories talk, huge statistics we have at the LHC to all experiments. We need to look for any type of rare decays. Because these are suppressed decays, their loop amplitudes very often and it can make measurable differences here. LHC has looked for it using the 2011/12 data set. There is more to come.

They found an upper limit of: There is room for looking for new physics here. I have to mention the status of anomalies. I want to be brief on this. We have the RD star anomalies. The remaining tension in overall analysis: 3.1 Sigma in this

channel. Then the interesting RK star and RK ratio. Experimentally these are double ratios. Here we have LHCb driving the physics so far. There's new results from LHCb shown: What is measured a double ratio. The result is: This comes with the observation of this model. There has been a new result on angular analysis: This global fit gives overall a discrepancy with this particular model of 3.3 Sigma. Here I think there is only one firm conclusion, which is clear that we need more data in particular for these R ratios which are very interesting. They don't have any uncertain, theoretical uncertainty. Every year, we enjoy additional new states, strong states. We had these ones this year: Beautiful peak, very significant. It shows that the X isn't quite normal in this stage. We have several indications already of this. LHCb had a new observation: In this mass spectrum, LHCb finds these interesting peaks. Two very significant ones. And two smaller ones which need more data to see if they're significant.

So very significant states here. A little show here not understood currently. More data is needed to understand whether this is significant. I move to heavy ion physics, high density strong matter and the physics of strong electromagnetic fields. I want to start with the seminal beautiful plot from ALICE. This is rich in physics. What is shown is the science of the system, you move from left to right, larger to larger systems. The hadron over pythia multiplicity. You see a rise, you see a low, but the rise is steeper, the stranger the particles R. You have recombination quite a sense of strangeness. Now the question is, is it possible to understand the behaviour of large systems from par ton re-scattering in the small systems? There are interesting theoretical models which allow the quantitative description we heard about. True collectivity in small systems has been established. All the experiments have done multiple measurements. This parameter has been measured in many details and this is a beautiful platform. The small system collectivity was revealed from ion techniques in proton physics. The theoretical analysis of the pre-flow data show that the sheer viscosity of the Palace master classes is ten times lower than for any other form of matter. This is an almost perfect fluid.

Hard probes: We understood the suppression of strongly interacting probes in lead, lead collisions. This is uniformly observed. It is one consistent with one for colourless particles, in this case Z and W. Also for photons. That's very interesting. These colourless particles can be used as probes to understand the nuclear PDFs but also momentum references in jet quenching analysis. Now what is jet quenching? I found it interesting. There has been a lot learned since the initial discovery of jet quenching in 2010. So you see the plot from CMS. It shows the amount of particles compared to the data r of a particle compared to the jet access. The amount of high energy particles are reduced. The energy effect in the picture is the energy goes out of the cone. I want to show the new result of quarkonium physics. There's an interesting combination in suppression. The colour screening at high temperature, even the very narrow CC bar states are measured at high temperatures. This is the colour screening which we see here at high PT. For high production. But at low PT, in fact they can be regenerated by recombination of the heavy QQ bar.

The recombination cancels the disassociation from the melting process. This is an interesting phenomenon. We can see the J size is small. This is a very

beautiful plot which was shown already before. This doesn't play a role here, but why it plays a role here. The high statistics in the data allows the experiments to look for new probes. CMS has done this beautiful evidence: When I saw this first, it's impressive, I thought why is that interesting? The top decays so fast. It's before it has any chance to create. There is a nice theoretical paper which shows that if you look at the top mass, if you had enough statistics, you can derive from the top mass, from the deformation of the top mass information on the time structure of the plasma classes. That's very interesting to look at. They have measured the cross-section of the ratio of united neutron production. We see here again, the size of the system that there is a smooth transition across colliding systems again. Very similar production mechanism for these particles. This is interesting for cosmic ray studies and antimatter studies in the universe. It has shown a low PT united neutron production cross-section.

Where they used their detector as an absorber to measure the cross-section. This is a beautiful idea to do. Video conference showed you that the heavy ion inclusions so if the heavy ion passes by close by, there's no strong interaction. Here the heavy ions produce, that's huge. These field strengths we can observe are rare events of this type. ATLAS has looked into more data. And made first measurements of the differential cross-section and looked into the mass spectrum which it could look at and have constrained limits on axion-like particles. Now searches for new physics, this continues exploiting the detectors in new ingenious ways, not always envisioned by the designers, but possible thanks to the system redundancy. So any new detector developer you have to build redundant detectors. You see a beautiful example of an event. The three jet structures of the boost which was reconstructed in this case. There is big IPPOG proximity by using deep networks with the tagging of substructure components in other types of heavy hadrons, heavy Bosons. And the top quarks.

You see here a spectrum measured in@r artillery not seeing excess and setting a limit on some Z prime model. Similar in spite of this from CMS: By fitting the individual masses and the overall mass. All of this gives 30% better sensitivity. Overall this gave very sensitive limits. I would like SUSY supersymmetry to show maybe less typical one, which is analysis looking for R parity violation here. You have a three lepton resonance. ATLAS looked for resonances in the three lepton stage and did not find one here. In another on the right: Many B quarks. ATLAS looked at events with us to nine jets and five B quarks. If you want to have the overall picture: Now, I would move to the dark sector briefly. And long lived particle searches. There have been a number of new experiments around LHC and SPS proposed. And some of them approved to look for long lived neutral particles. These could be heavy neutral leptons, sterile neutrinos, dark photons, dark scalars, axion like particles. You see them here on the right. You see pictures of the civil engineering work in the tunnel about 480 metres upstream.

I want to show analysis on the left: The dark photon is the portal between the sectors. It mixes with the standard model photon. This mixing we have seen on the top before. This fantastic analysis, these are uncertainties. This is a huge statistics. The grey areas are the known resonances. LHCb is looking for tiny resonances around this spectrum. But cannot find it. Setting impressive limits. We heard at noon that the dark matter searches at the LHCb can be done either

directly through recoil of this type here. You can look at it through the Z prime mediated production, which would decay directly into resonances. These two are complimentary. We have to do both of them in the experiments. It's very important. On the left we have an example of the exclusion ranges for the quark coupling here. You see here a translation of this type of limits from CMS using these assumptions on the coupling here. This gives a strong constraint from the searches here and a smaller constraint from the recoil searches. It's important that we continue with these searches.

I want to move to the next steps now. This is a beautiful picture of civil engineering in CMS. This is a bit of a busy slide. The upgrades during LS2, of course, the aim is to improve the run three physics and prepare for the LHC. We have heard from the accelerators that there is an upgrade with the new Liac4. Booster upgrades. This is for improved beam brightness and reliability. In addition there's the very important consolidation of the diode boxes. And the dipoles that can add additional co LHC imator. This could make it 0.7. All the civil engineering work as well. On the detector side in particular ALICE and LHCb have a huge upgrade programme. It's fantastic what they can do after this update. ALICE they will have triggerless readouts. They have a new pixel inner tracker, using monolithic detectors. LHCb the main theme is to maintain under these conditions the performance of the detector. And so this requires an update of our systems. And the very important feature is the 40 megahertz of the trigger.

Which can be a much more sophisticated trigger than Brexit ATLAS, their main theme is refine the trigger selection in preparation for run three. But for the high luminosity LHC. There is a granular level one trigger. This is explored by powerful level one trigger boards. That allows a much more powerful level one triggers. The famous new small wheel improves the fake muon rejection at the trigger level. CMS has started to do the upgrades. The new pixel has been put in during run two, one trigger, the PPS system and HCAL electronic. They're finalising the upgrade components too. Run three will be a Graham heater for ALICE and LHCb. For ATLAS and CMS the LS2 upgrades prepare for the game changing high luminosity LHCb. We have heard, of course, that we had the talk just before that this week that much of this work is affected by the necessary COVID-19 measures. And in addition to the restrictions at CERN, the international experiments depend on the situation at production sites and the travel of experts. There will be delays. It's clear.

The reassessment of schedule will be performed over the summer. But people are coming back and you see with their personal protective equipment working at social distances and doing very good and important work already. One quick thing before I close, we have heard, he confirmed that the additional time that is needed by the experiments will be used by the accelerator to do magnet training. I wanted to re-emphasise that photon TeV is better than 13. Not only is there additional search power for very heavy particles but also for already known visits, very important physics, we have a 20% larger cross-section. That gives 20% more luminosity. Of course the high luminosity LHC will be a monumental upgrade. The construction phases for phase two have already started for CMS and ATLAS. I have no time to summarise this. I wanted to show you this CMS

picture to recall the challenge we are dealing with in these very, very busy environments. But also, the great stuff this spring. We're in the luminosity here. We will be moving up here. And the physics will be really different.

We will have 190 million Higgs Bosons produced. And 120,000 biHiggs produced. Among many other beautiful results, there is the full suite of new and incense particle searches, which is an utterly creative field as we heard today in the talk. Further progress in theoretical calculation and modelling is critical for exploiting the physics of run 3 and the HL-LHC. Then SMEFT, the theorists and experimentalists are moving it to a coherent beyond standard model interpretation framework of measurements and searches. This is a fantastic development. I would like to point out the importance of outreach as we have heard in the talk just before, for particle physics, so I would really wish all of us, all of you, to go and speak to policy makers, your colleagues at university labs, to students and to the public about this exciting and important science. A decade after the start, the LHC and its experiments have exceeded all the performance promises and transformed particle physics. We have discovered many new tools, the Higgs Boson is a tool, to approach the big questions, the nature of dark matter and energy, hierarchy of the scales and the stability of the sector.

Matter antimatter asymmetry in the universe, strong CP problem, to which unfortunately so far we don't have direct experimental probes. But there has been huge progress on the answerable questions. This is something which I copied from two years ago . It was a very nice way to formulate it through measurements. This is very important. So we live in data driven times. Experiment must guide us to the next stage and the LHC and its experiments represent the flagship of particle physics at the energy frontier for at least a decade or two to come. I want to finish by pointing out as we've heard just before that this unprecedented COVID-19 crisis hit our society very hard with human suffering and huge societal as well as economic challenges. In this situation, when we are extremely grateful to Giovanni, Robertry and everyone who contributed to this organisation of this beautiful conference as well as CERN for allowing this important conference with many fascinating talks and posters to happen. I have here virtual spring flowers which I would like to give to the organisers. So thank you very much for your attention.

GM: Thank you very much for accepting our invitation to be at this talk and such an inspiring presentation. We have a selection of beautiful results and a glimpse at the future ones that we might expect. Thanks also personally for your kind final words. When we decided to cancel the Paris conference, but the LHC collaborations and CERN asked us to consider a full online conference, we were hesitant at first. Then we worked on the project enthusiastically and tried to make it a success. We had a large team of committed people, as you will hear in the concluding remarks by the international co-chairs of the conference, to whom I hand over the microphone. I thank you again. I give the microphone to Bruno for the final talk.

BM: Thank you very much. I will try to share my slide. Full screen. Is this full screen? Thank you, it was difficult bringing such a very simple talk after the very

impressive review and very inspiring review by Andreas. Of course, it's my honour and privilege to chair this conference, together with my co-chair Tulika, whom you've seen chairing this session. Last year it was the seventh edition of LHCP. There is this give us a kid till she's seven and we'll have her for life, meaning after seven a kid is meant to have acquired her or his personality and this was very much the case for LHCP. We have been very active preparing for Paris with all the local teams. While we've had to work exclusively from preparing this conference we had in Puebla to Paris for this year. In passing, Dave who replaced me as the chair of this conference. We expected a smooth ride. But of course, well you know, that all hell broke loose and the virus invaded earth. We had of course, such a conference was very secondary with people in danger, people alone in their homes. We were a bit hesitant what to do facing this situation.

But the collaboration we acted on very early encouraged us very strongly for this online version which we did actually now. In doing so, the Paris conference will be shifted to next year. 2021 with the dates 7-12 June. I will have more on that at the very end of my talk. As well we shifted all our agenda. Taipei in Taiwan will welcome us in 2022. A very exciting setting and conference as well. Shifting the whole preparation process, shift as well the selection process for 2023, which should take place the year after Asia, will be hosted in Europe. And the process for selection will take next year in Paris. What about the online LHCP? Well you understood that we had to face a challenge with time zones. It was very clear that with all the material we had to show, keeping the same format in one week, we tried to compact it as much as possible during the day. But it was very colourful that people in the US West Coast would have to get up very, very early and people in Asia would have to go to bed very, very late. The only other option would have been to reduce the number of hours per day and stretch over two weeks.

We decided to keep it like it is because we wanted to be a very specific moment and a very dense conference as usual. We were very aware of the problem with the time zones. All I can say is many thanks to the early birds for getting up so early. And many thanks to the late birds for going to bed so late. Then we had to decide on the practical organisation and we went for the Zoom-based format. There were webinars for the sessions. And the posters with the videos, Zoom rooms. We also tried to add a little bit of lively communication channels and so on, which you experienced. So the attendance we expected initially for Paris in person was between 350-400 people. For this conference. But of course, with the online conference we had 1300 registered. Which is a whole different matter! 1300 people coming from 56 different countries. In fact it is a big success. On the right you can see one of the statistics we have, we have a lot of statistics this is just one example of the generational registered participants. You see that we have almost 30% female attendance. Which I think is pretty good for, of course it shows that we have a long road ahead towards the 50% balance.

As well, the peak attendance was for a plenary session, 700 people on Zoom and almost 400 on web cast. For parallel, we had 150 people in a single session and transecting over all sessions the maximum was 500 at the same time. This would not have been possible without all of you, would take the time for very, very

sincere thank you. First for the speakers and poster presenters. We had very absolutely fantastic talks and I know very well that some of you had a hard time preparing the talks at home, confined, not always in an easy environment. So this is really amazing and for the experimental talks, of course, all the teams who made the same level and quantity of analysis as the usual years. We would like to thank the conveners of the parallel session who set up all the sessions. Very efficiently. And all the people who chaired plenaries, special thanks to the jury of the poster prize. They worked very fast and very late yesterday to come up with the list of winners which we saw today. For the next thank you, I think we have representatives and each time we ask them to open their camera, so you can see who they are and have applause in your mind at least.

For the programme committee, of course, developed the programme for all the original version, we also had to adapt it quickly to the online version, because we reshuffled quite a bit of the programme to make it denser, etc. So represented by the chairs: Gautier and Pierre. Will you please open your cameras so we can see you. Well, if they are not available or able to open their cameras. I move on. Many thanks also to the IAC, initial advisory committee, who was very helpful. Always helpful. We had to react very quickly for this very special edition and they helped us in a number of views. The chairs are Jim and Aleandro. Again, we would like them to open their cameras, if possible. Then of course, we have scientific secretaries. They helped a lot in all the communication and with the conference, Yasmine and Zaida. Our conference secretaries, from CERN Connie and Dawn who were helpful. Of course, all these organisations would have been completely impossible without the technical support from CERN/IT that was provided by these fantastic times.

Thomas and Jonathan. They really supported us with incredible organisation and assistance. Coming to the local organisers, of course, completely delocalised. The local team is Paris. In person conference is shifted to next year. They very kindly accepted to take the load of all the organisation of this year's online event. The whole team, doing the social media, proceedings, and the team was led by those two people who have communicated with, who helped you in many ways, Giovanni and Roberto, who were delocalised, on all fronts, 24/24. For those, if I can, a special feature on your behalf. [Clapping] I hope you hear that. And of course, a very, very big thank you to all of you. Again, I'm very aware that the situation is very diverse and not easy for some of you in these strange and difficult times. You've helped us by participating, by asking questions, by showing up and in all the sessions. So many thanks. What about the future for speakers and presenters in the next few days, please don't forget the proceedings which will be published in the proceedings of science. And well, of course, we very much hope to see you all, I hope as many as possible, from you all in person in Paris next year. Again the date is 7-12 June.

It's the campus of the university and the other two are well known features that I will be happy to have in Paris. So this is the end. There is this very nice group photo, virtual group photo that the organisers have built for you. I think now it's time to unmute all your microphones, if you would like to say goodbye. This is time to say goodbye. Goodbye to all. Thank you again. And see you next year.

END OF TRANSCRIPT