

# World wide collaboration in Science

- CERN: from war to make science together
- From the Holocaust to start working together for science.
- Japan-Israel collaboration and how to share responsibilities.
- How Israelis and Palestinians can work together for Science.
- How Israelis and Pakistanis can work together for Science.
- Bringing South America into the big boys science.
- ATLAS: a conglomerate of different countries, cultures, and IT WORKS!!!
- Conclusions.

# CERN: from war to make science together

9 December 1949

At the end of the Second World War, European science was no longer world-class. Following the example of international organizations, a handful of visionary scientists imagined creating a European atomic physics laboratory. Raoul Dautry, Pierre Auger and Lew Kowarski in France, Edoardo Amaldi in Italy and Niels Bohr in Denmark were among these pioneers. Such a laboratory would not only unite European scientists but also allow them to share the increasing costs of nuclear physics facilities.

French physicist Louis de Broglie put forward the first official proposal for the creation of a European laboratory at the European Cultural Conference, which opened in Lausanne on 9 December 1949. A further push came at the fifth UNESCO General Conference, held in Florence in June 1950, where American physicist and Nobel laureate Isidor Rabi tabled a resolution authorizing UNESCO to "assist and encourage the formation of regional research laboratories in order to increase international scientific collaboration..."

- And the rest is history...but it was not so easy

# Being German at CERN was not easy in the early days

- Although Heisenberg played a very important political role in getting Germany as funding member of CERN, some younger generation German experimentalists were not too happy about his role (Gentner, Bothe).
- CERN open the way for German scientists and Engineers to become integrated into European Science.
- **First Germans to come to CERN (and other European institutions) had a very hard time to get accepted after the war.**
- Prof. Gentner, through his contacts in Paris during the war (he was in charge in getting the Cyclotron built by Joliot-Curie in operation, and managed to free Joliot-Curie and Langevin), had an important role in helping with this human integration.
- He was the director of the CERN 600MeV Synrocyclotron, and then Director of Research.

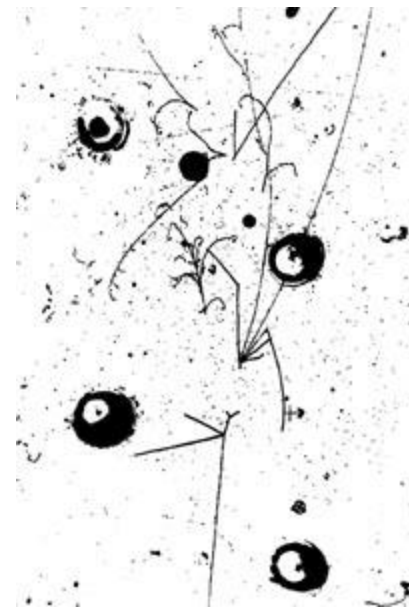


**Having well defined projects at the edge of technology allows people to concentrate on the end product and to forget about their prejudices.**

The CERN 600MeV (1957) and the 28GeV PS (1959) served not only to get German Physicists and Engineers to be integrated into CERN, but also to create a new school of German accelerator experts.

# But also CERN had many successes due to its 28GeV PS

- Observation on anti-deuteron
- Best measurement of  $g-2$  of the  $\mu$
- Development of the wire chamber and its later use in medical physics.
- Until early 70's, Quarks were a mathematical tool, but DIS ( $e^-P \rightarrow e^-X$ ) show the existence of point-like particles inside the proton.
- Discovery (1974) of neutral currents at Gargamelle, which gave credibility to the SM of electro-weak interactions, and its predictions of the existence of the W/Z bosons



# From the Holocaust to start working together for science

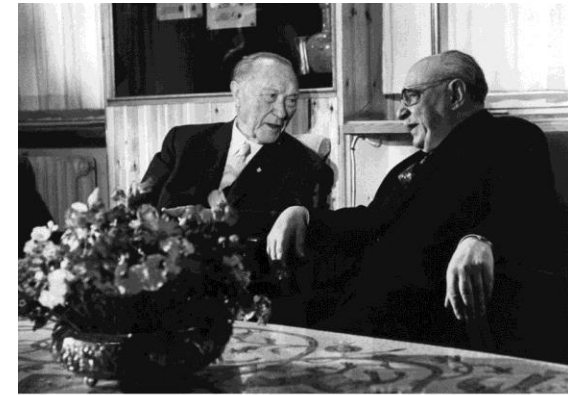
- Holocaust in the 50-60's were very present in both Israeli and German minds, but also political elements were part of the problems:
  - The 1952 Luxembourg Agreement on compensations was met with strong opposition in both Israeli and German parliaments:
    - In Israel it was called a “pact with the devil”=>**no cultural relations was included as part of the legislation.**
    - In Germany, Adenauer had to get the votes of the opposition to pass the legislation.
- But common search for knowledge is stronger than hate=>we are humans with common cultural and scientific interests.

# It happened in the CERN cafeteria

- First real discussion on how to do science together occurred at the CERN cafeteria in 1957:
  - Prof. Gentner (CERN Research Director) & Prof. de Shalit (chair of the Physics Dept., Weizmann Institute) met to discuss possible collaborations between Israeli and German scientists.
  - Main motivation:
    - For German scientists: to regain the respect of the international scientific community.
    - For the Israeli side: **scientists must cooperate, even beyond the scope of personal and national tragedies.**

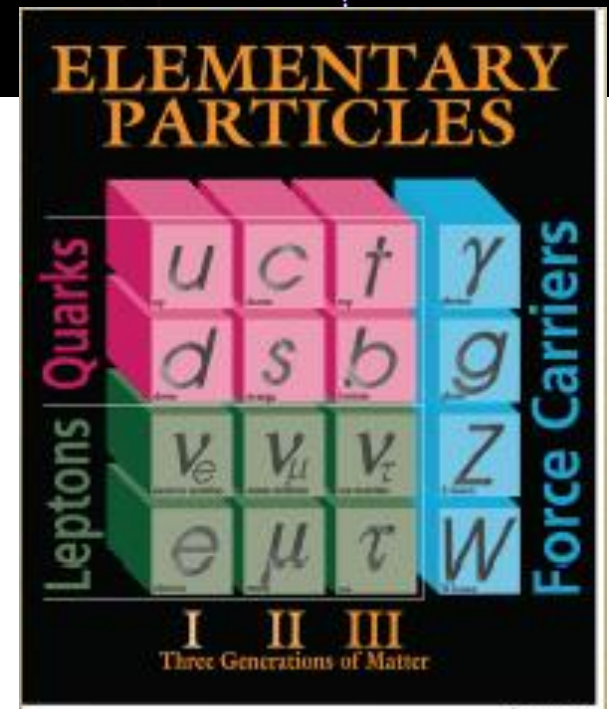
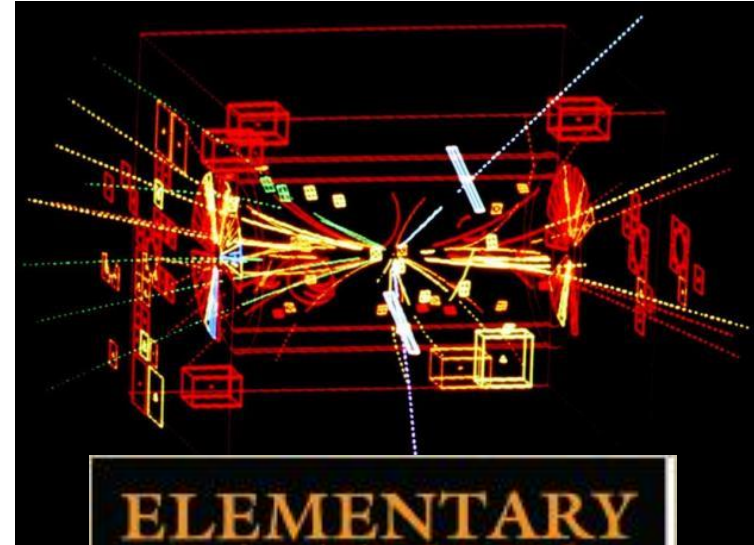
# Follow up from CERN Cafeteria

- To make it happened, one needs the highest levels: Adenauer and Ben-Gurion:
  - Adenauer was contacted by D. Heineman (co-founder of AEG); quoting Adenauer's memories: "As major of Cologne, I had many friends. Heineman and Prof. Kraus (both Jewish), were the only ones who helped me when I was remove from office".
  - Ben-Gurion was contacted by de Shalit and Aba Eben.
- In December 1959 an official delegation from the MPG, headed by Otto Hahn came for a 10 day visit to the Weizmann Institute and scientific exchange program started in 1962.
- Since 12 May 1965 Germany and Israel have established diplomatic relations.
- It took a long time for Israeli scientists to start collaborating with German scientists in common projects. I was the first Israeli to come to DESY to work in a common HEP Experiment and I could not understand how we can do science without each other.



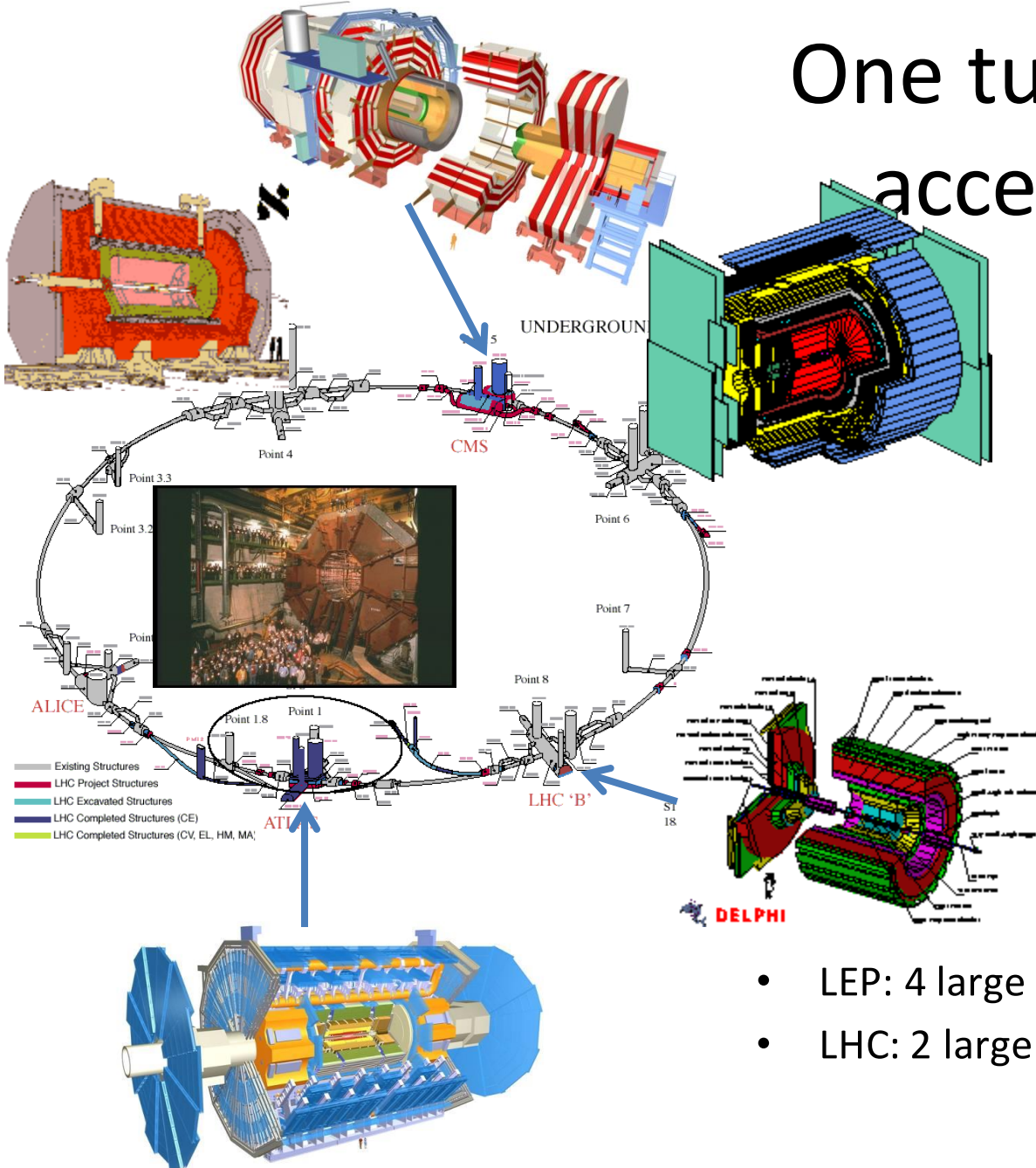
# Some more CERN success stories

- CERN constructed the first colliding p machine (ISR) that even surpassed its design luminosity.
- CERN constructed and operated the SPS, and converted into anti-proton (using stochastic cooling) proton collider, which lead to the discovery of the W and Z bosons in 1983.
- This lead to the SM of electro-weak interactions to become a reality.





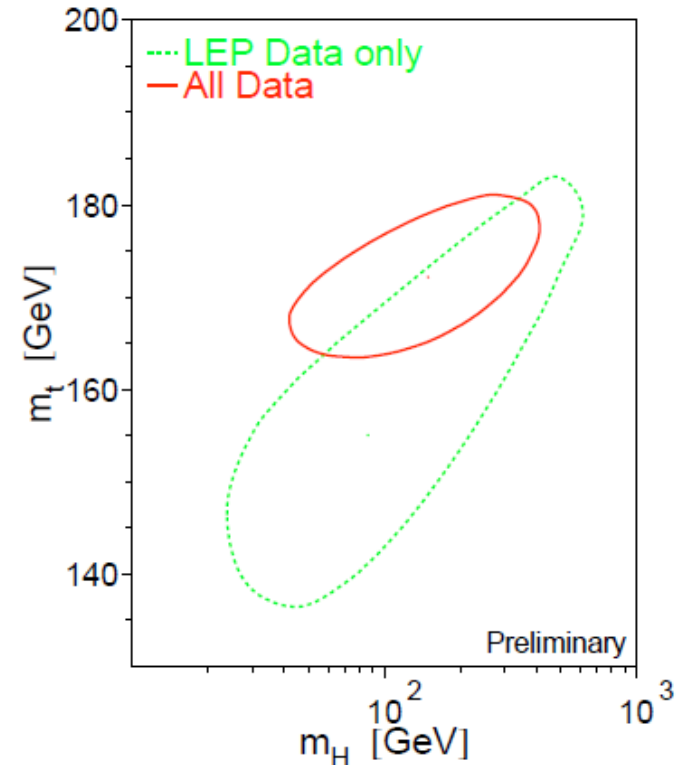
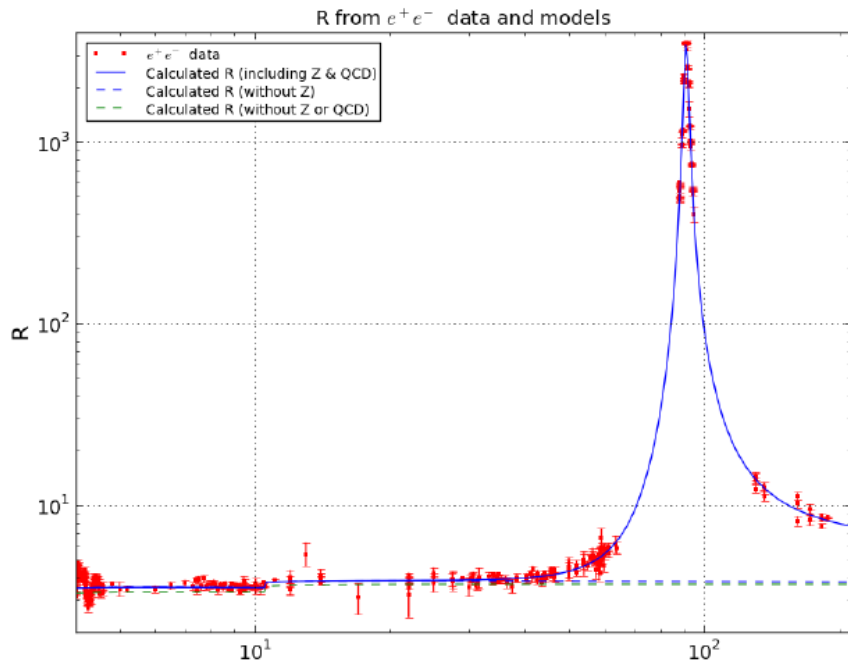
# One tunnel, two accelerators



With the LEP and then the LHC colliding rings, CERN became the center of World Experimental Particle Physics.

- LEP: 4 large experiments
- LHC: 2 large + specialize Experiments

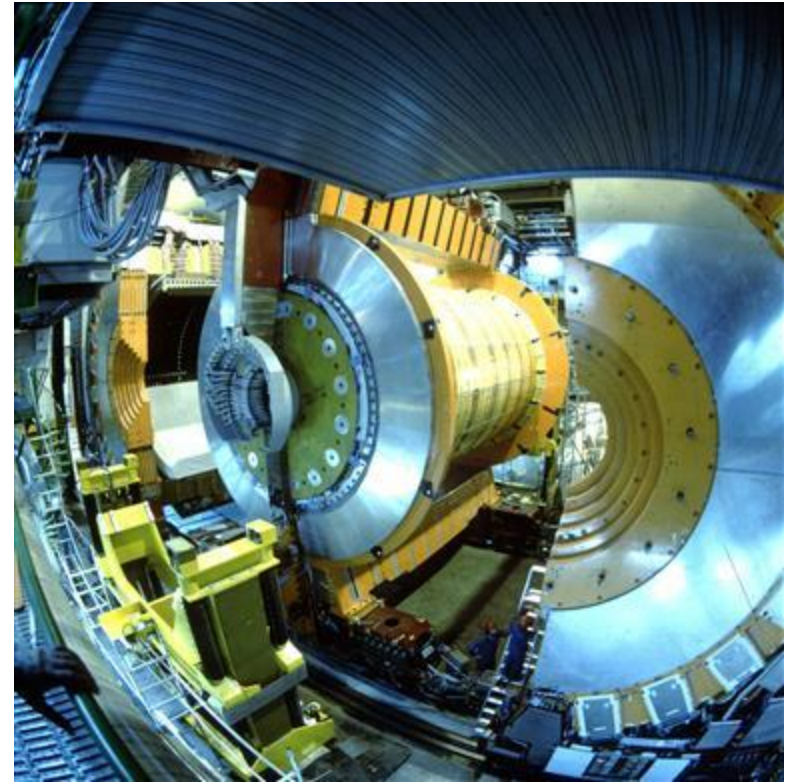
The LEP Experiments predicted the existence and the mass of the top quark, before it was found.



- The LEP Experiments proved the existence of the Electro-weak radiative corrections, due to the high accuracy measurements that they have performed.

# Japan-Israel collaboration and how to share responsibilities

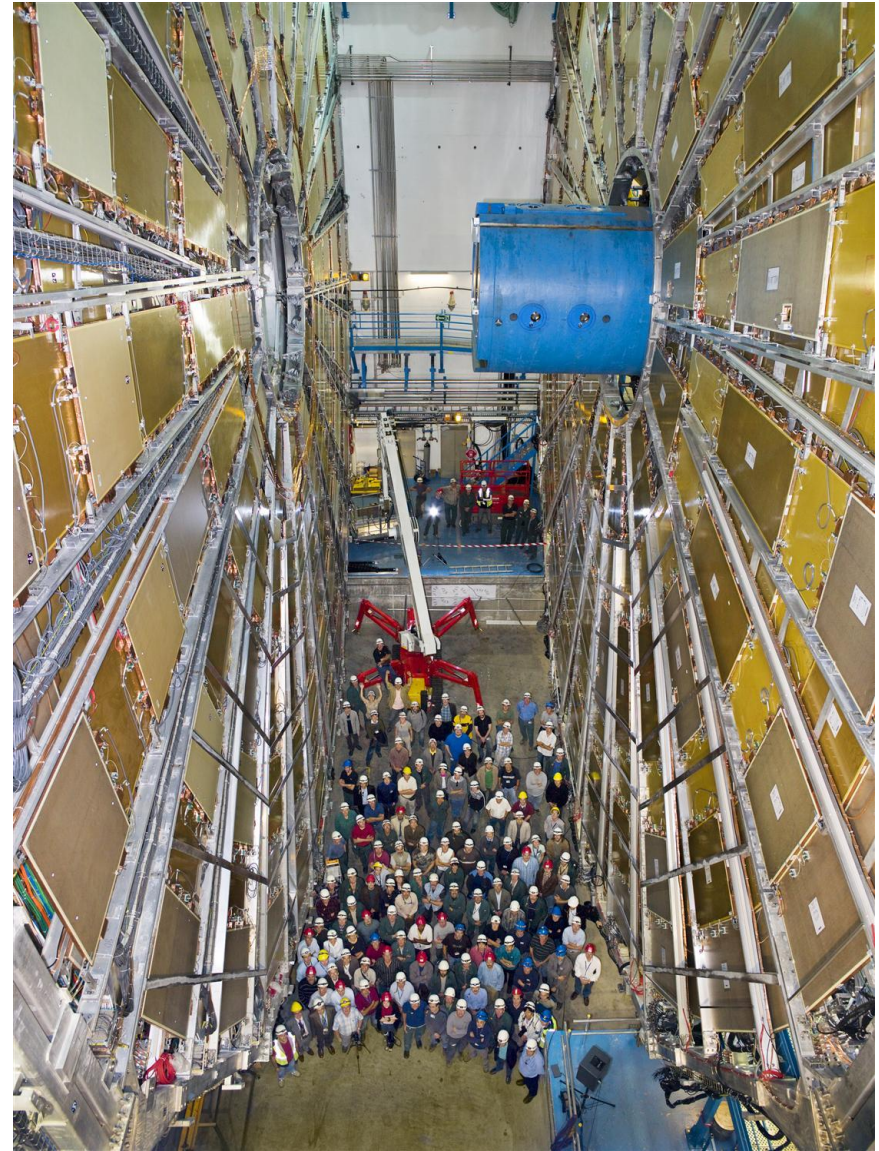
- Japanese and Israeli Physicists worked either together in the same experiment or in opposite ones at DESY.
- Although there was common appreciation, it was through more than 11 years of working together at CERN (OPAL in the LEP ring), that common thrust was achieved and the assurance that each side will keep to its responsibilities.
- This point was crucial for the 2 groups to decide to embark in a common project for the LHC:  
**The ATLAS End Cap  $\mu$  trigger.**



Mutual appreciation and responsibility is a crucial element for the success of a common scientific enterprise

# CERN knows how to provide recognition to outside contribution and participation in taking decisions

- The common project worked well, and both sides took their responsibilities.
- CERN first proposed to Israel to become the first paying Observer to the CERN Council.
- Japan followed a few years later with as similar model.
- **Contributing states should have a say (even if only during the coffee breaks) on the scientific program of the Institution.**



# How Israelis and Palestinians can work together for Science

- Although Israel became an Observer State to the CERN Council in 1991, Israeli participation in the CERN Summer Student Program, via its CERN contribution started only in 2002.
- In 2005 it was decided that this contribution could also be used to support Palestinian Summer Students.
- Being CERN a neutral ground, provides both sides an excellent opportunity to work and celebrate together without the feeling of motherhood.



To ensure a fruitful scientific and cultural collaboration, one should avoid the feeling that one side is being patronized. CERN being a neutral ground, is excellent example to be able to achieve this.

# And they did celebrate together

This year, as before, Summer Students from all nationalities organized parties. The decision to organize our own party was taken during the Italian party. Besides showing that the reality is not what you see in the news, we wanted people in Europe to experience a different kind of party. With local music and food such as hummus, labane, pita bread and mahalabie for dessert that we made ourselves, the party was indeed different from all others. The party had more gimmicks such as writing all the signs in English from right to left, or a place where people could practice writing in Arabic and Hebrew, and a screen where we projected animation from Israel and Arab belly dancing

An Israeli-Palestinian Party might sound a bit strange, as people are used to hear of Israel versus Palestine most of the time. That is one of the reasons we, a few Summer Students, decided to throw a joint party on Wednesday, August 22. We wanted to show that despite the disputes between our governments, when it comes down to the people, we can easily get along. In some sense, just like with food for example, our cultures are quite similar.



# How Israelis and Pakistanis can work together for Science

- Scientists are used to work together independent of their cultural and religious backgrounds due to their motivation to improve our knowledge.
- It was not at all clear that this could be possible for groups of engineers and technicians, where this motivation is not necessarily present.
- With professor H. Hoorani from Pakistan we decided that it was worth a trial for one of the big projects of the ATLAS Experiment “the ATLAS Big Wheels”:
  - The chambers were constructed in Israel, Japan and China
  - The electronics was developed and build in Japan
  - The support structures (precise large Al structures) were designed in Russia and CERN and made in Israel.
  - The jigs and tooling were designed and made in Pakistan
- During 3 year 20 engineers and technicians from Pakistan worked together with 20 Engineers and technicians from Israel to put together the project.

# How Israelis and Pakistanis can work together at the edge of technology





# They can also have fun together



# And it also works

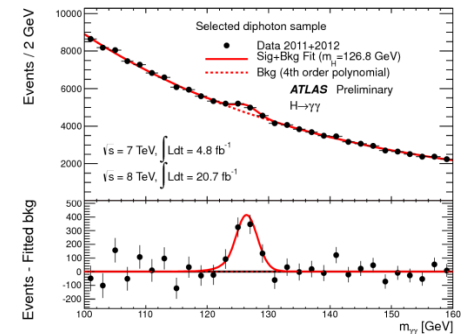
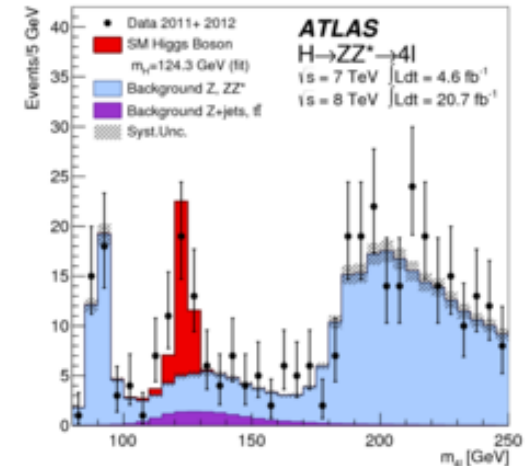
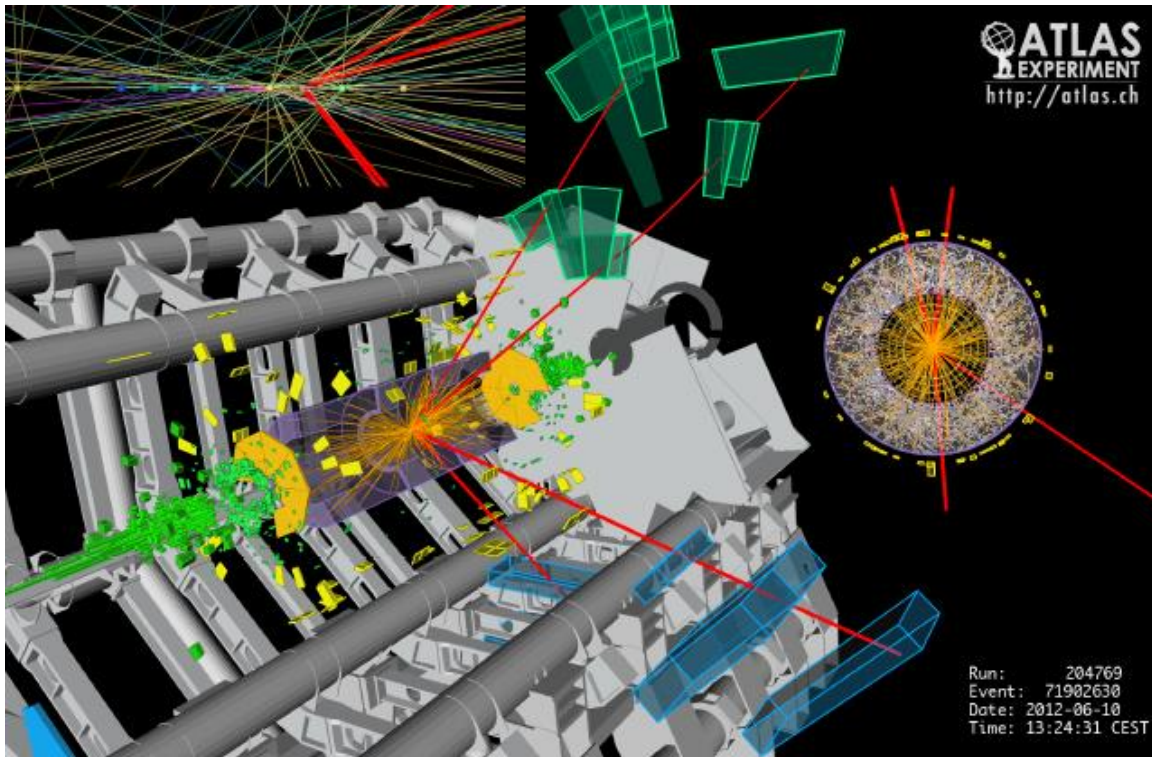
- It is not only the interest in finding the Higgs Boson that makes people work together.
- Having concrete projects at the edge of the technology, leads to new developments.
- CERN provides the possibility to construct such projects, at the edge of technology. This allows people to forget about their mutual prejudices, learn to respect each other and feel proud of their common achievement.



# Projects at the edge of technology allow to make new developments

- It is very hard to make new developments without a clear applicable goal.
- CERN, by providing projects for basic research, that are at the edge of the technological possible, allows to improve/develop technologies and test them in a real environment.
- With experiments that include 100M single detector elements that operate with ~1% failure, this is tremendous test for developments:
  - In this common work, this included developing new reliable procedures for welding.
  - Develop highly reliable fiber-optics connectors and adapters.
  - Develop highly reliable optical transmitters.
  - Many other software and hardware applications (to be discussed in the next presentations)

But from a Physicists point of view, the discovery of the Higgs Particle was the dream becoming a reality

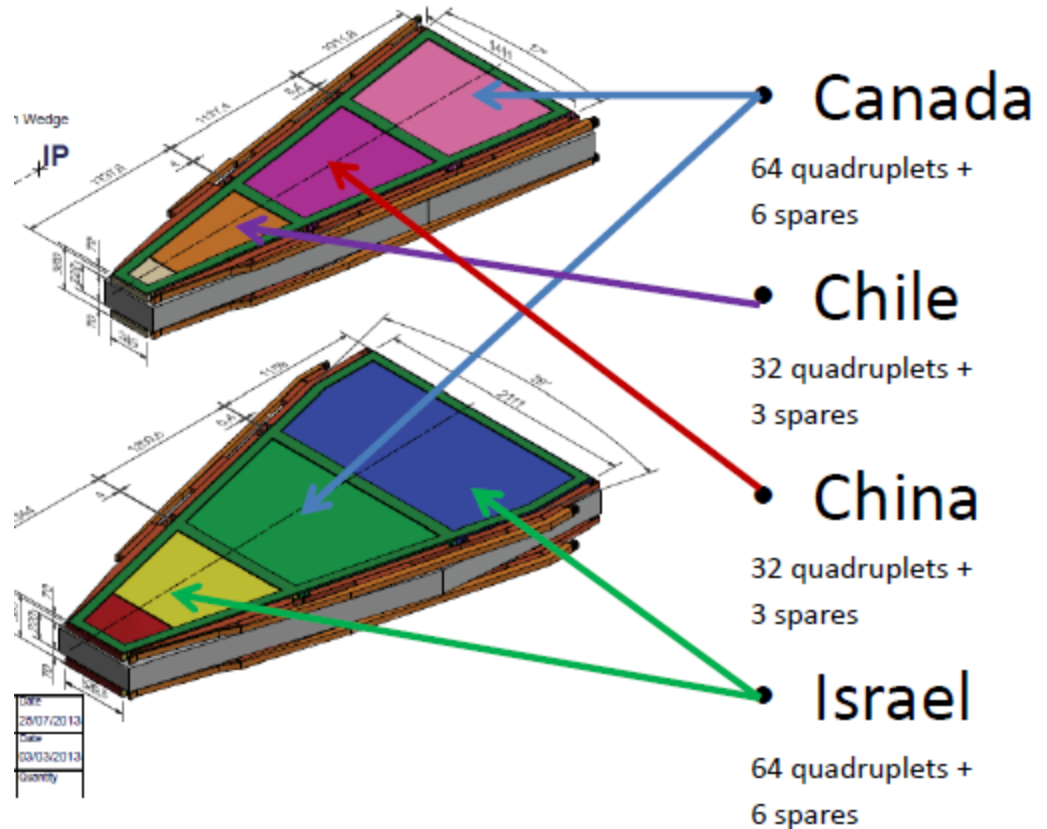
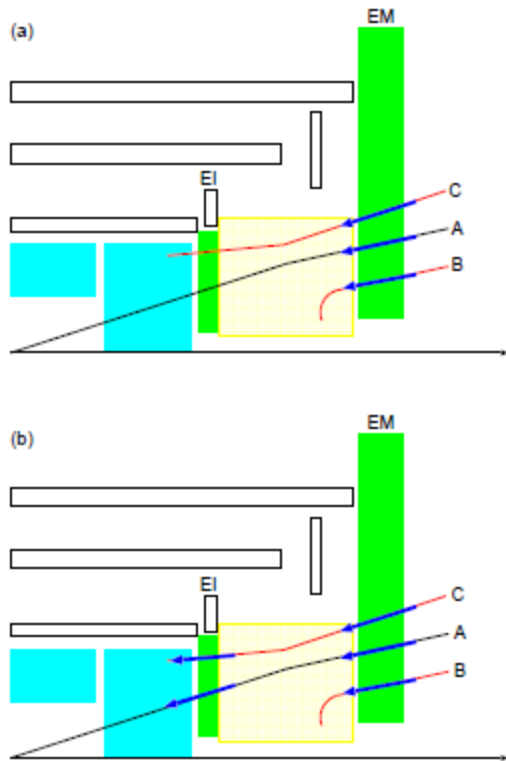


- Quarks and Leptons were shown to be point-like ( $<10^{-19}\text{m}$ ), but they acquire their mass through the Brout Englert Higgs mechanism.

# Bringing South America into the big boys science

- There are a number of South American groups involved in Experimental Particle Physics.
- These groups have been involved in many experiments at FNAL, BNL and CERN with good success, but mainly based on individual contacts.
- Most of the hardware contributions have been based on electronics developments, or in the construction of scintillator detectors.
- No real effort has been made to collaborate between local groups, to produce a central component of an Experiment.

# The Trigger is a crucial part of the LHC Experiments



- By joining forces between the Universidad Federico Santa Maria and the Pontificia Universidad Catolica de Chile; Chile will be able to construct a critical component of the ATLAS Upgrade.

# Working together allows to get funding and sharing of responsibilities

- To make an impact in large HEP Experiments, it is crucial for local groups to collaborate in common projects.
- It is only by making a common effort that the groups of a small country can acquire the credibility to be a main player in a crucial component of a large experiment.



# And it works



And it even works

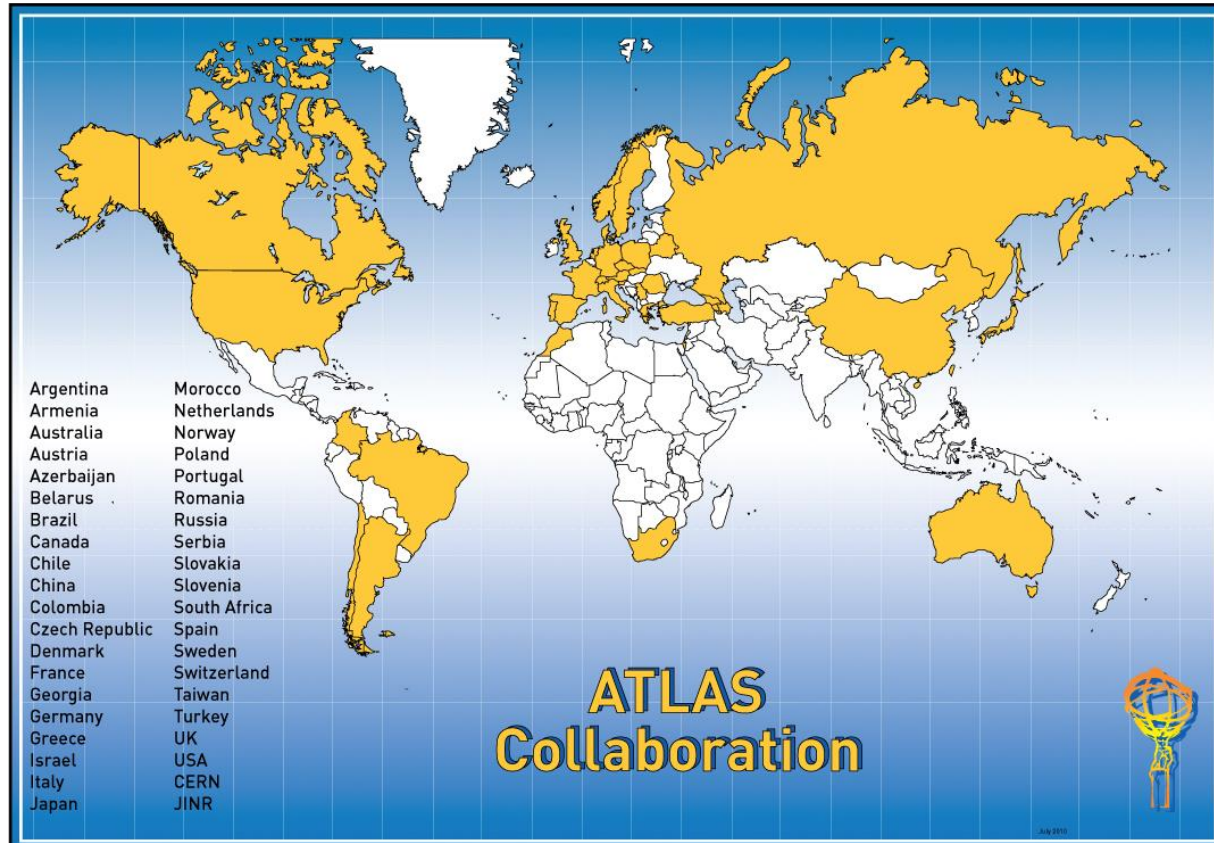
First 2 detectors of the project were completed last week in Chile

And

Even new methods for processing honeycomb were developed.

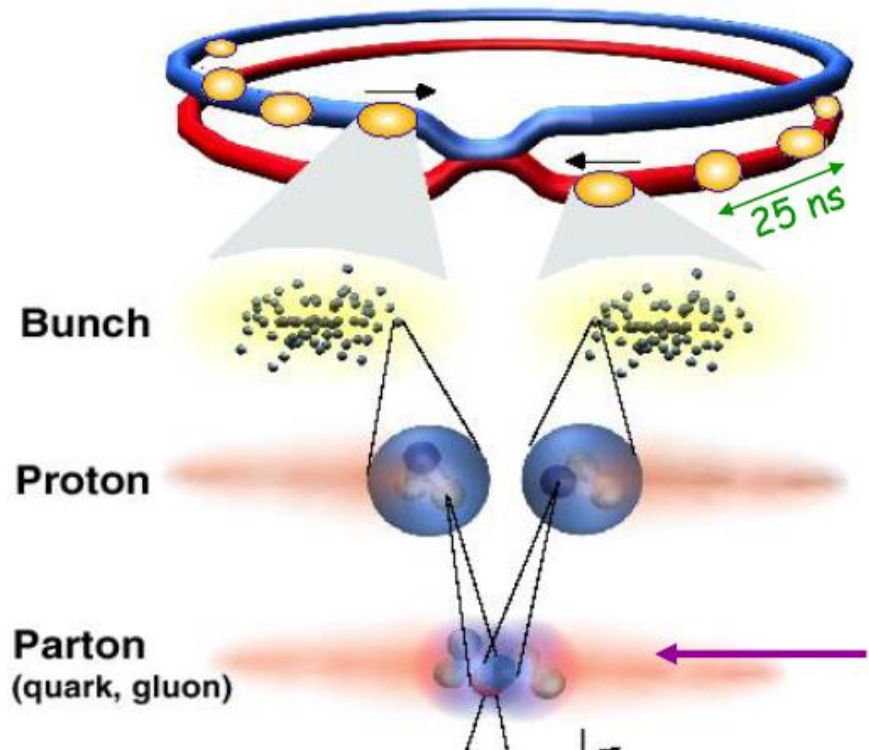
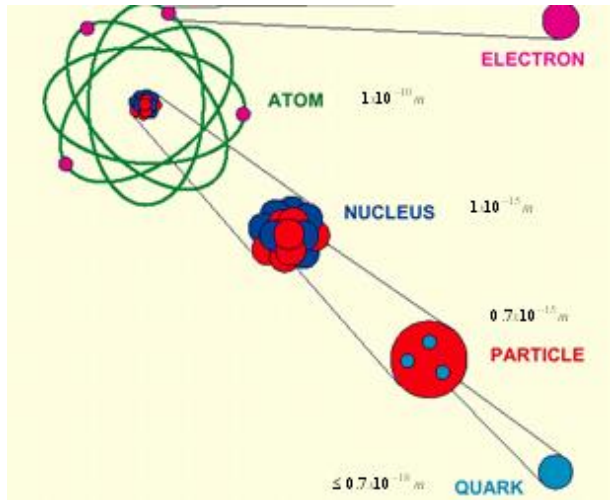


# The ATLAS Collaboration



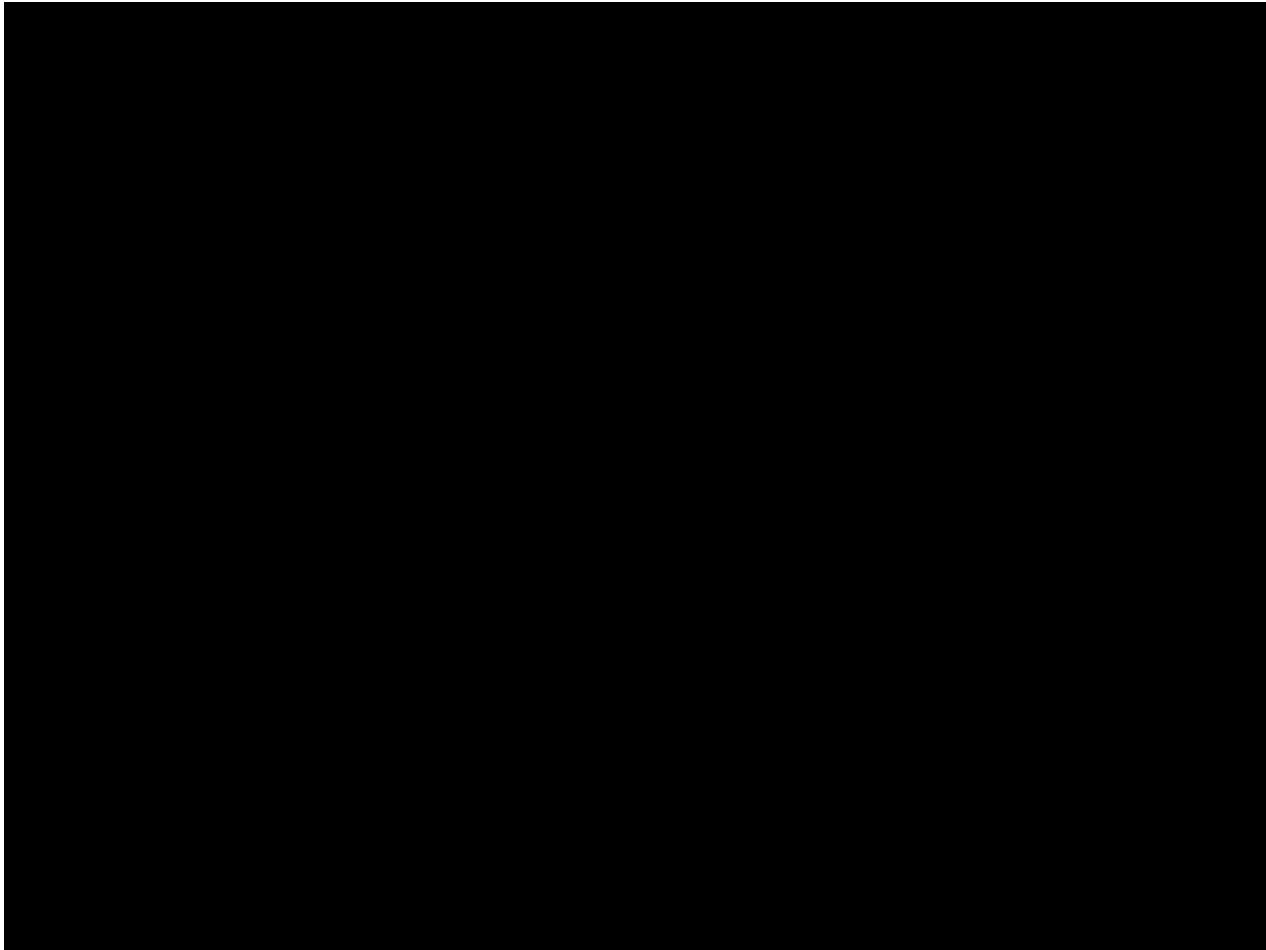
- 3,000 Physicists from around the world working together to make one of the most complex experiments in humankind

# Why so complex?



- Interesting collisions are  $1/10,000,000,000,000$  but we need to measure them all.

How do we measure them?



# Collaboration between people from different cultures allows to make it into a reality

- Many scientist talk about making science together,
- A few DO IT, and it is very satisfying to oneself to see that you have accomplished something that it works.
- In ATLAS, through common work and using know-how from different people, we have been able to make a detector compose of 100,000,000 individual elements operational at the 99% level.

# Conclusions

- Having well defined projects at the edge of technology allows people to concentrate on the end product and to forget about their prejudices.
- CERN provides the possibility to materialize such projects, at the edge of technology. This allows people to learn to respect each other and feel proud of their common achievement.
- CERN, by providing projects for basic research, that are at the edge of the technological possible, allows to improve/develop technologies and test them in a real environment
- Mutual appreciation and responsibility is a crucial element for the success of a common scientific enterprise.
- To ensure a fruitful scientific and cultural collaboration, one should avoid the feeling that one side is being patronized. CERN is excellent example on how to achieve this by being in neutral grounds.
- Contributing states should have a say (even if only during the coffee breaks) on the scientific program of the Institution to which they are contributing.
- To make an impact in large HEP Experiments, it is crucial for local groups to collaborate among themselves in common projects.