

# CHIPP Roadmap Workshop 2020

## Young People Vision

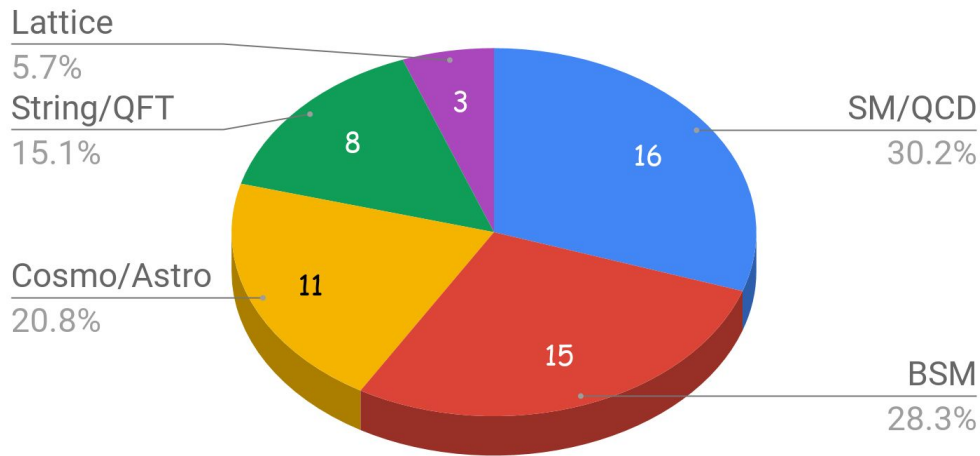
# Theory

Authors: **Xuan Chen** (Zurich), **Giulia Cusin** (Geneva), **Admir Greljo** (CERN/Bern)

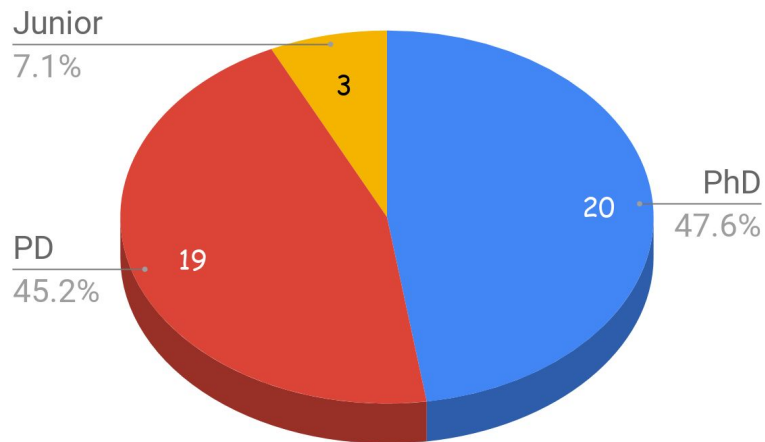
# Survey among young theorists in CH

- About 120 questionnaires sent to young theorists
- Research type: PhD students, Postdocs, Junior
- Swiss institutes: Basel, EPFL, ETH, Geneva, Zurich, Bern, PSI - uniform response

Response by subfield:

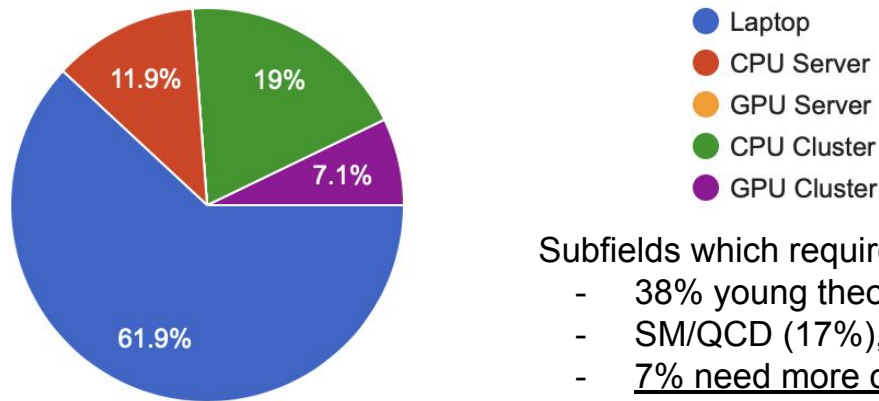


Research Type:



# Collaboration dynamics and resources

- 90% of publications are with  $< 6$  coauthors.
- Only 15% are members of big international collaborations.
- Majority of publications have at least  $\frac{1}{2}$  Swiss authors.
- $\frac{2}{3}$  think there are enough occasions to meet other Swiss theorists.
- Computing resource:



## Subfields which require intensive computing:

- 38% young theorists need external computing resources
- SM/QCD (17%), Cosmo/Astro (10%), BSM (7%), Lattice (5%)
- 7% need more computing resource (need 5k hours/month but only have 1k hours/month right now, need server level upgrade)
- Heavy computing users ( $>100k$  hours/month) all have access to CSCS

# The state of the research

- **Major developments / breakthroughs:**

Summary of the replies: SM precision calculations such as N3LO and muon g-2, Flavour model building, constraints on modified gravity, no major breakthrough

- **Main trends:**

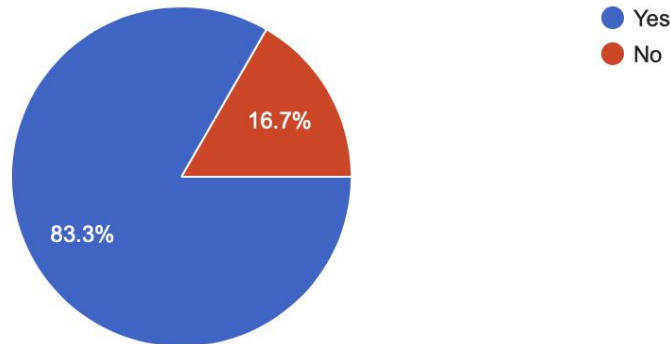
Precision calculations in QCD and flavour physics, EFT method in collider pheno and gravitational waves, flavour anomalies, H0 tension, origin of dark matter, neutrinos, quantum computing, machine learning, bootstrap method

- **Interplay with other fields:**

Only 1/4 thinks there is a **synergy** with other fields. Those fields are: non-HEP physics & mathematics.

Do you think Switzerland is at the forefront of your subfield?

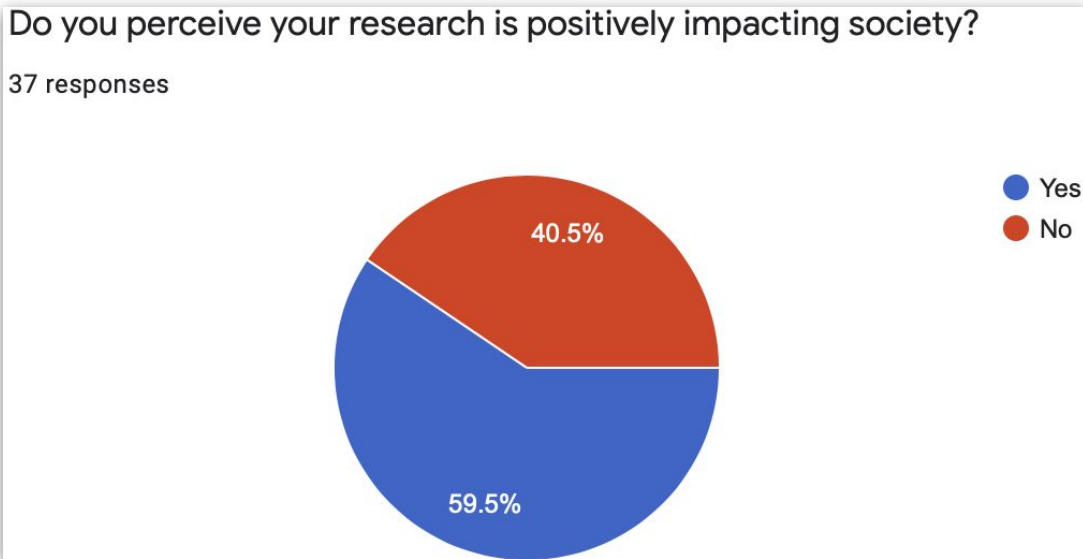
42 responses



- Only 17% involved in an **interdisciplinary** project.
- More than 40% think their research is benefiting from recent advancements in other fields.

# Outreach / Perception

- 56% of young theorists did not participate in any outreach event in the last 4 years.
- 78% would like to have more organised outreach activities.
- 41% do not think their research is positively impacting society (?!).



# Outlook for the future

How do you see HEP **evolving** globally in the next few years and more long term?

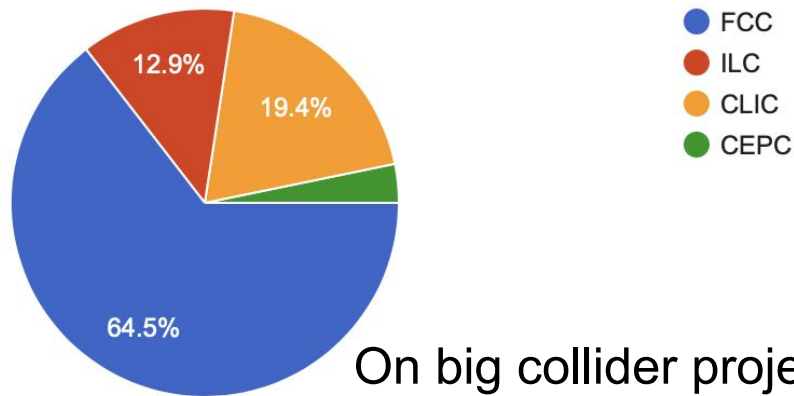
- Shift of directions. Migration from certain topics to others.
- 30% explicitly mention contraction.

"If there is no new collider, the field will be dead by 2050."

"I think the expansion/contraction depends a lot on whether NP is actually found or not."

Which one of the proposed big future collider projects do you think is a priority?

31 responses



On big collider projects

# Theory summary

- Switzerland is at the forefront of theoretical research.
- More and more diverse directions are trending / no clear single path forward.
- Overwhelming support for a strong experimental program / exploration needed.
- Some concerns about the overall perception of young theorists.





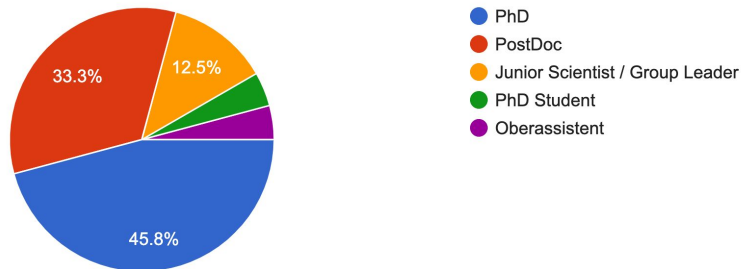
# Pillar 1

Authors: **Alessandro Calandri** (ETHZ, CMS), **Armin Fehr** (Bern, ATLAS),  
**Federico Leo Redi** (EPFL, LHCb), **Anna Soter** (ETHZ/PSI, Low energy),  
With the help and input of **Tatiana Pieloni** (EPFL, Accelerators)

# Pillar 1 Questionnaire

- We made a questionnaire similar as Theory group (thanks!)
- Sent out to 110 people, targeting PhD students, PostDocs and others  $\leq 45$
- List was public and questionnaire could be forwarded
- Small sample, LHC-dominated
- The opinions in this talk take into account ideas and community responses from this questionnaire
- Full results of questionnaire in agenda

What is your current status  
24 responses



24 respondees, from all Swiss institutes!

# Switzerland at the forefront of high-energy and high-intensity frontier

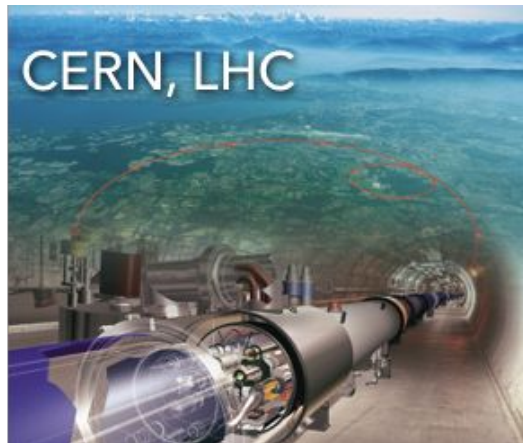
87% think we are at the forefront of our respective fields!

## High energy frontier

- Higgs physics
- B-physics
- Direct search for BSM physics
- Many more!

## Intensity and precision frontier

- Forbidden decays, (cLFV searches)
- Neutron EDM
- 5th forces and gravity of antimatter / exotic atoms



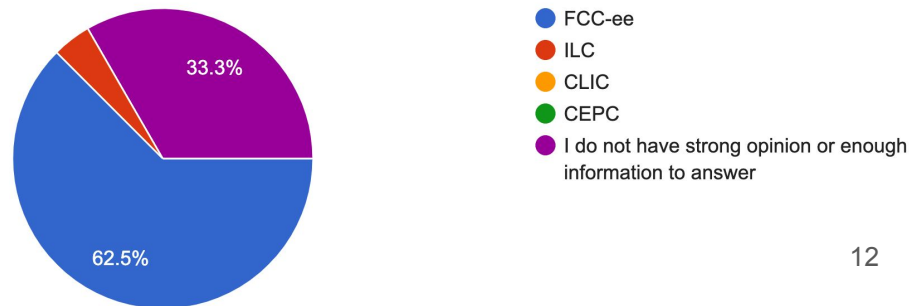


# Swiss involvements for the next decades - Large facilities

- **Fully harvest** capabilities of HL-LHC
- **Minimise time gap** between HL-LHC and next collider -> solution like FCC-ee -> FCC-hh is preferred
- Keeping **PSI** on the **forefront of intensity/precision** particle physics with diverse physics programs
- Examples for possible future new/expanded involvements:
  - CERN North Area experiments such as NA62 and Beam Dump facility
  - Profit from muon beam experience at SPS for muon collider research?

Which one of the proposed big future collider projects do you think is a priority?

24 responses



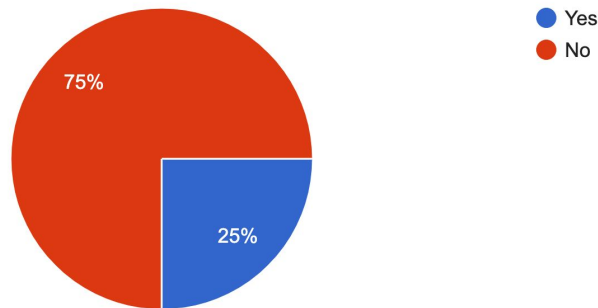
# Swiss involvements of the next decades - diversification

- Switzerland should be involved in more diverse experiments
  - Take part / strengthen involvement in more diverse small experiments looking for anomalies (antiproton physics, EDMs, flavor physics, intensity frontier...)
- Physics measurements and analyses
  - Strengthen the involvement in analysis (SM measurements, B-physics anomalies) and precision measurements, e.g. HH production beyond HL-LHC,...
  - New analysis techniques to cope with big data HL-LHC data and beyond
- Switzerland should be involved in more diverse developments
  - Keep Switzerland at forefront of ML Research for Physics analyses as a coordinated effort: push for ML-related activities in HEP within “traditional” physics analysis domain
  - Explore more opportunities for collaboration with industry (e.g Google, IBM, etc)?
  - In general: invest more in computing, strengthen collaboration in CSCS
  - More accent on detector R&D

## Gap in communication and understanding the “big picture”

- **Not enough opportunities** to meet young researchers
- **Not enough information** on the big picture/future plans
- Personal feedbacks from survey:  
Many people **shied away from** filling out survey questions because of the **lack of information**

I know what is going on in other Swiss Pillar 1 institutes/groups  
24 responses

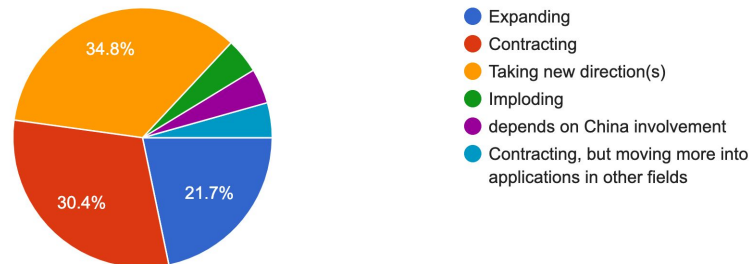


- 70% engaged in an outreach event in the last four years, 77% think **more** is needed
- Still 41% don't think their research is positively impacting society

# General opinions and concerns about the future

How do you see particle physics evolving globally in the next few years and more long term (expansion vs. contraction, possible new directions)?

23 responses



## Physics:

- Lack of clear experimental paths to new physics
- Potential gap between colliders: losing expertise
- *Reduction of scientific creativity linked to the inertia of big experiments*
- Too much focus on training on recent methods and theories instead of innovations
- There should be more accent on coming up with novel and diverse ways of searching for BSM

## Career:

- Hard to recognize personal contributions in large collaborations
- Temporary employment for years
- *Over-specialization on a narrow field*
- The danger of becoming complacent and no longer daring to try challenging new techniques as the complexity continues to grow

## Funding/accelerators:

- *Concern about the lack of perspective beyond HL-LHC, is there going to be a new accelerator and when?*
- Funding with lack of clear direction and in experiments that have long delays
- High risk, no fun - putting all money on one horse (LHC upgrade) no signal in return

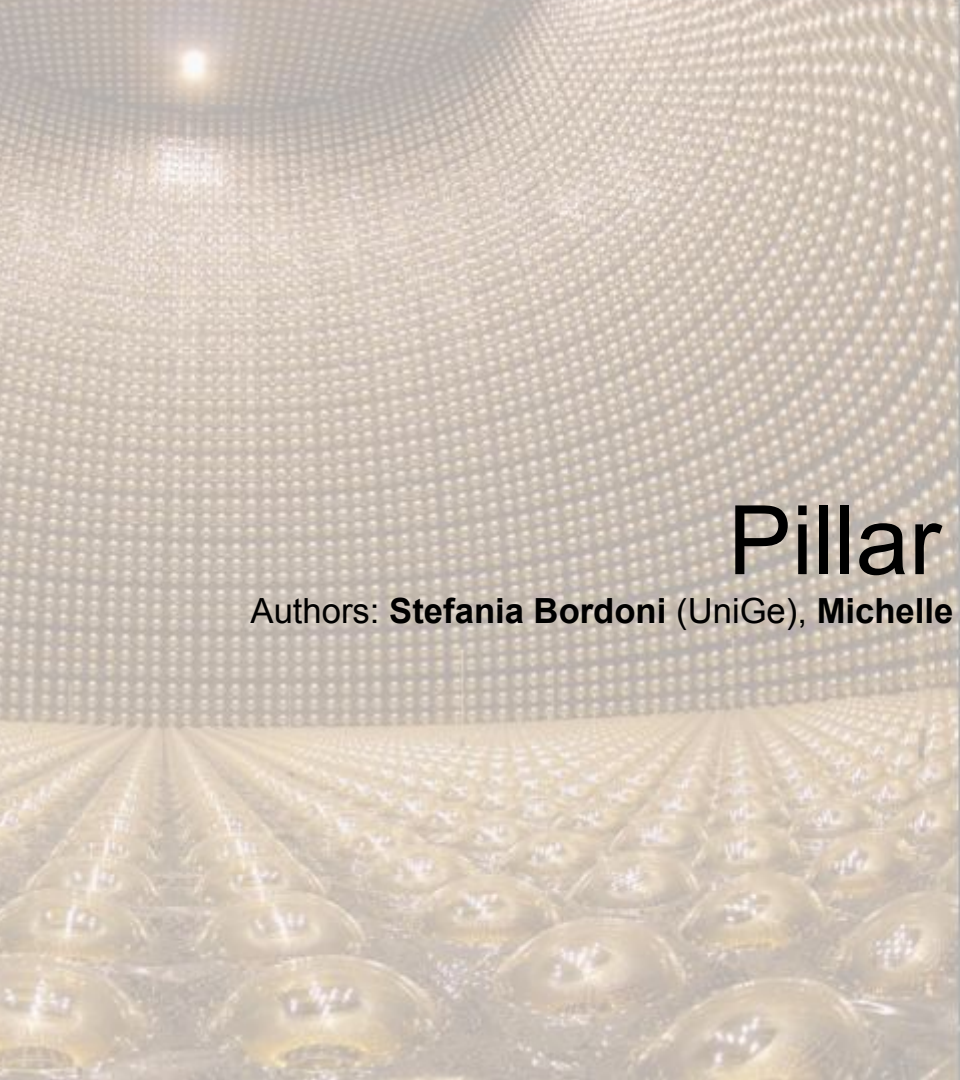
## Society:

- Losing support / interest from the general public based on oversimplified or false knowledge
- *Climate change and sustainability is an increasing question, and will be a serious issue in building a new<sub>15</sub> collider*

## Pillar 1 summary

- Switzerland at **forefront**, positive inertia
- Possibly no new high-energy experiments for many years generates concerns
- Young community tends to be segregated by experiments
- Trend of **diversification** should continue





# Pillar 2 & 3

Authors: **Stefania Bordoni** (UniGe), **Michelle Galloway** (UZH), **Francesco Lucarelli** (UniGe)

# How we proceeded

- Direct interviews (informal chat) with young researchers from several institutes
  - Astroparticle: UniGe
  - Neutrinos: UniGe, Bern, ETHZ
  - Dark Matter: UZH, ETHZ
- Audience reached:
  - Astroparticle: ~8 people (75% PhD, 25% post-doc)
  - Neutrinos (LBN): ~15 people (60% PhD , 40% post-doc)
  - DarkMatter: ~ 10 people

# Present Swiss landscape

- Swiss contributions at forefront of large collaborations:
  - CTA and IceCube DAMPE, POLAR
  - Neutrino accelerator long and short baseline exp (T2K /HK, DUNE, MicroBooNE)
  - Neutrinoless double beta decay (GERDA, LEGEND, XENON, DARWIN)
  - Dark matter (XENON, DARWIN, DAMIC, ArDM, DarkSide and GERDA, LEGEND)

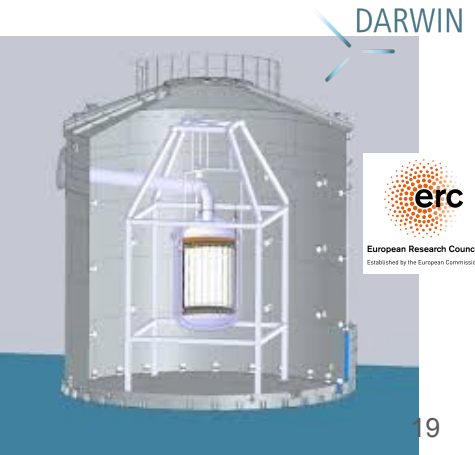
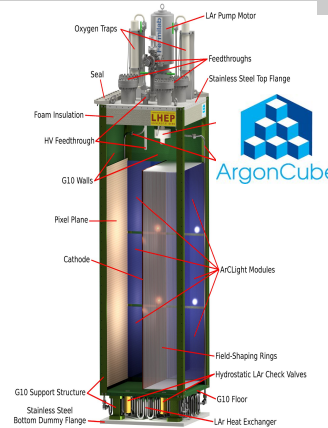
T2K (2020)



XENON 1T (2019)



IceCube (2018)



# International context

## Swiss contributions at forefront of large collaborations

- **Astroparticles:**
  - Small sector in Switzerland compared to other fields
  - Involvement in a large variety of collaborations carried out by small groups
  - Visibilities in collaborations not always well established
- **Neutrinos and Dark matter:**
  - Actively working on both detector R&D and analysis for leading measurements
  - Well established roles: convenership of detector and analysis groups from young post-doc

# Synergies

- With other fields:

- Mainly with the computing field to support the use of big data and machine learning developments : knowledge transfer and increase of efficiency
- Tentative to establish synergies with the medical diagnostic field. Goal: apply expertise on photodetectors (CTA) to develop medical instrumentations

- With Swiss Institutions

- CERN: detector developments and testing (w or w/o beams)
- PSI: calibration source development (Xenon-based experiments)
- Swiss observatories: devices testing

- With Industry

- Mutual feedback for detector devices: photosensors (Hamamatsu, CAEN, FBK), cryogenics valves, low light-level sensors ([SENSE](#))
- Shared interests among youngsters for software and analysis, currently not really developed: potential benefit for research and for career moving (both sides)

# Impact on education and society

- Large involvements to outreach events (Nuit de la Science, Open days, Dark matter days, Master classes, WIT events)
- Detectors donated/exhibited in Museum for education
- Involvement in social projects like [GENERA](#), about gender in physics and female under-representation
- Involvement in teaching and education of young students (short, long internships)



The XENON1T time projection chamber  
*Science Exploratorium, UZH*  
(opening Nov. 2020)

# Vision for the future (1/2)

- Well established Swiss participation to have forefront collaborations in neutrino, dark matter and foreseen to remain for the next few years
- Important results achieved in astroparticle physics regardless the size of the groups. Will for a development of the sector in Switzerland
- All three fields are getting more and more interesting in the short time scale!

## Vision for the future (2/2)

- A weak collaboration between CH-institutes working on same/similar topic is generally reported with a wish to have it improved in the next years
  - Stronger impact and visibility of the Swiss contributions
  - Swiss-internal networking to enlarge the chances for a continuous career in Switzerland
- Limited choice of lectures during the University and PhD (astroparticles)
- Short events/workshops to educate and share group knowledge might help young researchers (not only in astroparticles)



# Summary for discussions

- We are at the forefront of our respective fields, but young people are not convinced they research positively impact the society / or do not see the big picture
- Too little connection between different fields in Switzerland - no knowledge about other projects. CHIPP level organization for social networking - boost innovation, enhance interdisciplinary projects, startup companies...? (Poster + Pizza events)
- Training possibilities in different fields / towards industry? Many PhD students/young postdocs are specialized in a narrow field.
- Sustainability / connection to society?
- + Topics in the individual talks:

# Common items

# Common items of Pillar 3(shared with other pillars, groups)

- Relation to industry:
  - Well established connections e.g to medical industry. Possible collaboration with e.g Google, NVIDIA, IBM (all have R&D in Switzerland) in data sciences/big data? Also consider working together with swiss data science groups
- Sustainability:
  - We always discuss about reducing the power consumption, what about also considering installing e.g solar panels to at least produce the power for offices etc? What about compensating the CO2 that we produce in running our accelerators in development cooperation projects?
  - Guidelines on work related travel
- Do you have something about early career planning?
  - Train Early Career Scientists to diversify their knowledge
  - Raise awareness
  - Help/motivate Early Career Scientists to learn local language and out-of-field training -> Helping in step to industry

# Backup

# Pillar 1

# Desired Accelerator research (for Tatiana)

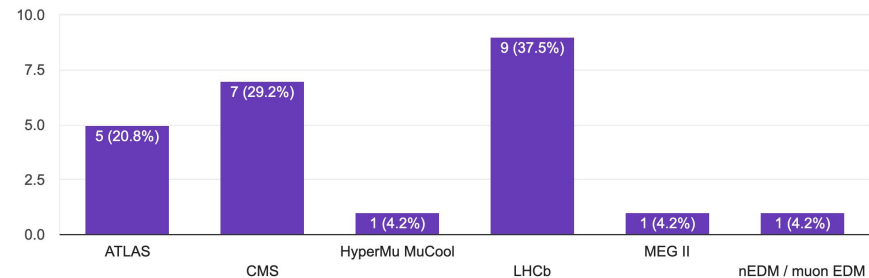
- Stronger involvement in Muon Collider? SpS facility as catalyst
- Question on High-temperature superconducting magnets:
  - If they deem to be fulfilling requirements, is this technology in general cheaper than classic cold superconducting magnets? Would this reduce the price tag of FCC-hh significantly?
-

Questions that can be solved in near future:

- Does “common” BSM physics (e.g SUSY) exist
- Higgs couplings
- Upper limits for cLFV decays
- Lepton flavour universality
- Flavour anomalies
- 
- Not benefitting enough from
  - AI/Machine learning (4 mentions)
  - Computing/GPUs (2 mentions)
  - Modern silicon chip technology and post p
  - Optical magnetometry

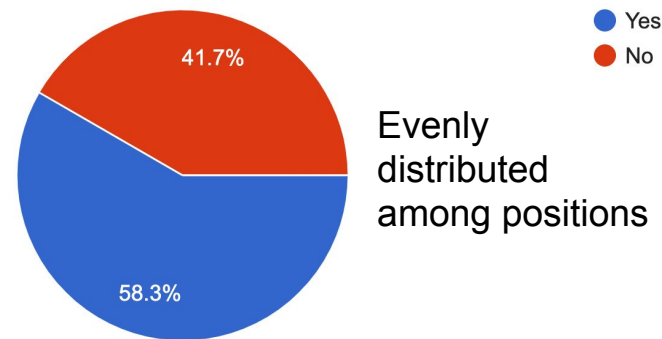
Which experiment(s) are you currently working on?

24 responses



Do you perceive your research is positively impacting society?

24 responses



# Future of our field (physics)

## New directions of our field:

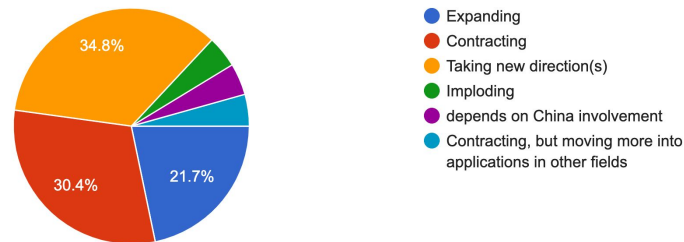
- Small-medium sized experiments
- Gravitational waves, high-precision laser spectroscopy
- More interdisciplinary, novel detection methodology

If you were to bring a new research direction to Switzerland, what would it be?

- Sensors (?)
- molecular EDM searches using Proctactinium at CERN
- Emphasis on computing (not ML)
- ML for unknown patterns
- Kaon physics
- R&D on advanced post-processing technologies (?)

How do you see particle physics evolving globally in the next few years and more long term (expansion vs. contraction, possible new directions)?

23 responses



How important do you think are issues of sustainability for particle physics?

23 responses

