# FCC-contacts – April 22nd

- News  from FCC, ICFA, Snowmass

- Detector concepts

# FCC news

- All nominated candidates for the FCC Scientific Advisory Committee have accepted their nomination
  - Very good list on the PED side:

    Andy Parker (Cambridge)
    Katri  Huitu (Helsinki)
    Belen Gavela (Madrid)
    Peter Krizan (Ljubljana)
    Roberto Tenchini (Pisa)

- A “FCC-ee IR Magnet” review was held at the beginning of last week
  - Draft Report from the reviewers is being proofread
    - The first and one of the most important recommendations in the current draft reads as follow

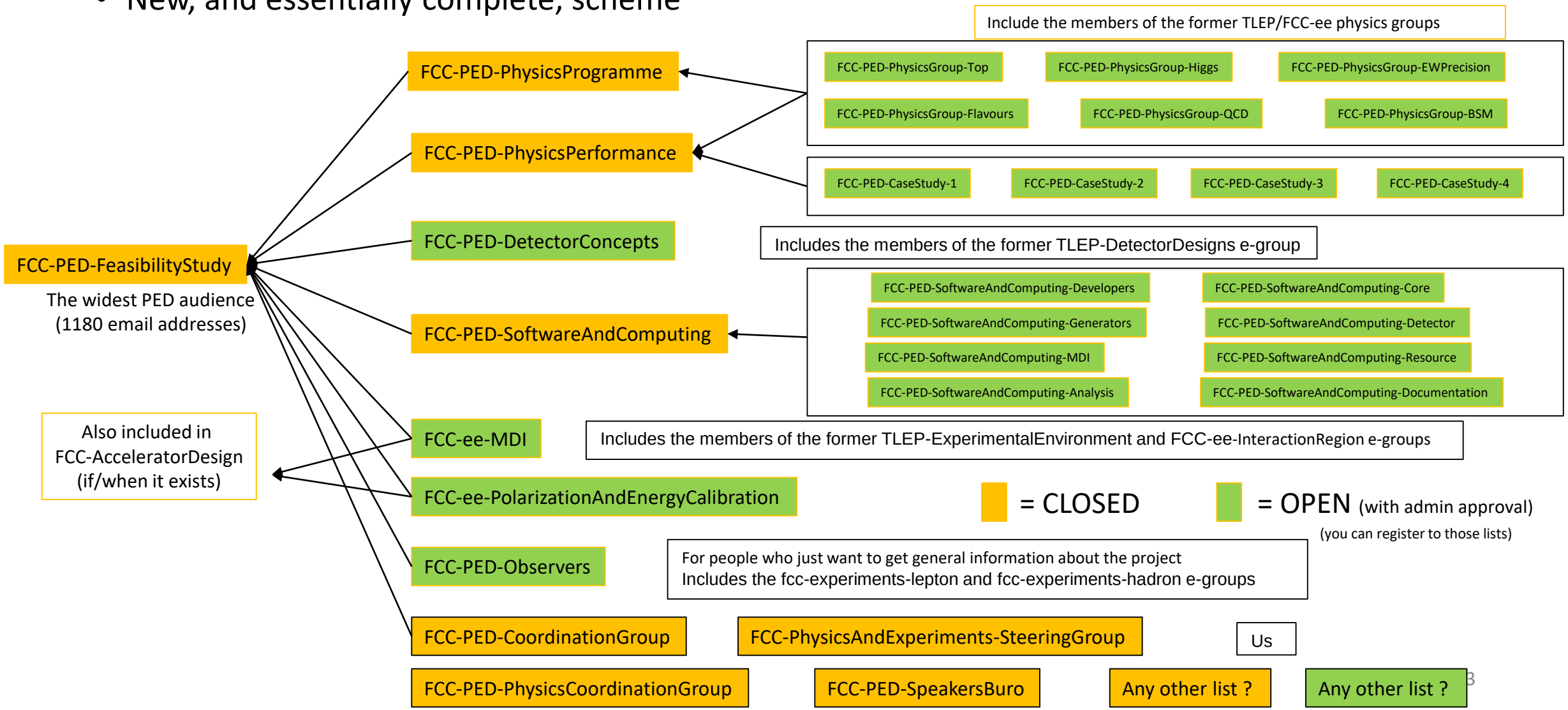
> *The feedback loop between detector and accelerator requires a more systematic approach.* ***Specify and document all boundary conditions and (magnetic, mechanical, …) couplings between the IR Magnet System and the Detector***

    - This task will be organized within the MDI group, where it belongs.

- Twelve abstracts submitted for ICHEP’22, https://agenda.infn.it/event/28874/
  - FCC PED Web page to be updated accordingly

# Mailing lists – a quasi-final update

- Mailing lists are ready to be used (for subscription and for communication)
  - New, and essentially complete, scheme



# Recent and forthcoming meetings

- A few kick-off meetings have already taken place !
  - Higgs physics group (performance, 28/03): https://indico.cern.ch/event/1142926
  - Physics Programme (flavours, 12/04): https://indico.cern.ch/event/1149567/
  - Detector Concepts (04/04): https://indico.cern.ch/event/1137809/
  - Software task force: https://indico.cern.ch/category/14370/
    - 10 restricted meetings from 14/10/21 to 17/02/22
      - A quasi-final draft report is circulating among the task force members
      - Mailing list structure is a preview of the proposed Software and Computing group structure
      - Long list of coordinators / conveners being built

# Recent and forthcoming meetings

- More kick-off meetings are scheduled
  - Physics Programme (focus on a given physics group)
    - Every second Tuesday of each month – next meeting on 10 May, 13:30-15:00 (BSM)
  - Topical physics mini-workshops
    - Precision mini-workshop (7-17 June): https://indico.cern.ch/e/fcee-wshop
    - BSM: proposed dates ?
    - Flavours: proposed dates 7-9 September
    - Higgs/EW: after ECFA workshop in October
  - Physics groups (with plans) during the FCC week (30.05 to 03.06)
  - Detector Concepts
    - Monthly meeting every first Monday of each month
    - Kick-off workshop (focus on optimization and benchmarking): 20-22 June

# FCC Week in Paris: https://indico.cern.ch/e/fccw2022

| Day | Monday | Tuesday | | | | Wednesday | | | Thursday | | | | Friday | Time |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Room | Plenary Campus Cordeliers | Parallel 1 Jussieu CICSU | Parallel 2 Jussieu CICSU | Parallel 3 Jussieu CICSU | Parrallel 4 Jussieu CICSU | Parallel 1 Campus Cordeliers | Parallel 2 Campus Cordeliers | Parallel 3 Réfectoire Cordeliers | Parallel 1 Campus Cordeliers | Parallel 2 Campus Cordeliers | Parallel 3 Campus Cordeliers | Parallel 4 Réfectoire Cordeliers | Plenary Campus Cordeliers | Room |
| Time | room 470 p. | room 80 p. | room 80 p. | room 80 p. | room 30 p. | room 155 p. | room 75 p. | room 100 p. | room 470 p. | room 155 p. | room 75 p. | room 100 p. | room 470 p. | Time |
| 09:00-09:30 | Plenary session | FCCee accelerator FCCIS WP2 | Phy Programme/ Performance | FCCIS WP4 Socio Econom | | FCC hh accelerator | PED: EPOL | FCCIS WP3 Placement | Reserve | PED/ACC: FCCee EPOL | RF Points for FCC-ee | Technology | Plenary session | 09:00-09:30 |
| 09:30-10:00 | | | | | | | | | | | | | | 09:30-10:00 |
| 10:00-10:30 | Chairperson | Chairperson | Chairperson | Chairperson | | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | 10:00-10:30 |
| 10:30-11:00 | *Coffee break* | *Coffee break* | | | | *Coffee break* | | | *Coffee break* | | | | *Coffee break* | 10:30-11:00 |
| 11:00-11:30 | Plenary session | FCCee accelerator FCCIS WP2 | Phy Programme/ Performance | SRF Directions for R&D | *Dialogue group CLOSED* | Technology | PED: Detector Concepts | Civil Engineering | Reserve | PED/ACC: FCCee MDI | Electricity and Cooling | Technology | Plenary session | 11:00-11:30 |
| 11:30-12:00 | | | | | | | | | | | | | | 11:30-12:00 |
| 12:00-12:30 | Chairperson | Chairperson | Chairperson | Chairperson | F. Eder | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | 12:00-12:30 |
| 12:30-13:00 | *Lunch break* | *Lunch break* | | | | *Lunch break* | | | *Lunch break* | | | | | 12:30-13:00 |
| 13:00-13:30 | | | | | | | | | | | | | | 13:00-13:30 |
| 13:30-14:00 | | | | | | | | | | | | | | 13:30-14:00 |
| 14:00-14:30 | Plenary session | FCCee injector FEB | Phy Programme/ Performance | Technology SRF | *SC meeting CLOSED* | FCCee accelerator | PED: Detector Concepts | FCCIS WP5 Collaboration | Reserve | PED/ACC: FCCee MDI | Transport & logistics, Safety | | | 14:00-14:30 |
| 14:30-15:00 | | | | | | | | | | | | | | 14:30-15:00 |
| 15:00-15:30 | Chairperson | Chairperson | Chairperson | Chairperson | F. Gianotti | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | Chairperson | | | 15:00-15:30 |
| 15:30-16:00 | *Coffee break* | *Coffee break* | | | | *Coffee break* | | | *Coffee break* | | | | | 15:30-16:00 |
| 16:00-16:30 | Plenary session | FCCee injector FEB | Phy Programme/ Performance | Technology SRF | *SC meeting CLOSED* | FCCee accelerator | TI Geodesy and survey | FCCIS WP5 Communication | **France special plenary session** (Campus Cordeliers, room 470 p.) | | | | | 16:00-16:30 |
| 16:30-17:00 | | | | | | | | | | | | | | 16:30-17:00 |
| 17:00-17:30 | Chairperson | Chairperson | Chairperson | Chairperson | F. Gianotti | Chairperson | Chairperson | Chairperson | Chairperson | | | | | 17:00-17:30 |
| 17:30-18:00 | | | | | | | | | **Poster session** (50 posters) **& drink** (Réfectoire Cordeliers) | | | | | 17:30-18:00 |
| 18:00-18:30 | *Welcome reception* (Réfectoire Cordeliers) | | | | | | | | | | | | | 18:00-18:30 |
| 18:30-19:00 | | | | | | | | | **Public event** (Réfectoire Cordeliers) | | | | | 18:30-19:00 |
| 19:00-19:30 | | | | | | | | | | | | | | 19:00-19:30 |
| 19:30-20:00 | | | | | | | | | | | | | | 19:30-20:00 |
| 20:00-20:30 | | | | | | *Conference Dinner* | | | *Cocktail* (Réfectoire Cordeliers) | | | | | 20:00-20:30 |
| 20:30-21:00 | | | | | | | | | | | | | | 20:30-21:00 |

**30 May – 3 June**


- PED summary
  - Speaker tbd
- Poster session ( + drink)
  - All plenary
  - Submit abstracts (deadline 6 May)
  - Ideal for young physicists
- Register !
  - 121 registrants
  - 82 on site (max 250)

# FCC Week in Paris: Plenary sessions on Monday

**Parallel sessions discussed later**

| | |
|---|---|
| 09h00: Welcome address CNRS, | U. Bassler, 10 mins |
| 09h10: Welcome address CEA, | P. Chomaz, 10 mins |
| 09h20: Welcome and introduction CERN, | F. Gianotti, 15 mins |
| 09h35: CERN Council's expectations on FCC Feasibility Study, | Eliezer Rabinovici, 15 mins |
| 09h50: Swiss vision for FCC FS, | Swiss Scientific Delegate, 15 mins |
| 10h05: French vision for FCC FS, | French Scientific Delegate, 15 mins |
| 10h50: View from EC, | J.E. Paquet, 30 mins |
| 11h20: Status of PED Studies, | C. Grojean, 40 mins |
| 12h00: FCC FS overview, | M. Benedikt, 30 mins |
| 14h00: Accelerator overview, | T. Raubenheimer/F. Zimmermann, 45 mins |
| 14h45: Physics/Experiments/Detectors overview: | |
| Physics Programme & Performance, | Frank/Matthew/Emmanuel/Patrizia (tbc), 10 mins |
| Detector Concepts and MDI, | Felix/Philipp/Mogens (tbc), 10 mins |
| Energy Calibration, | Alain/Jorg (tbc), 10 mins |
| Software and Computing, | Gerardo/Clément (tbc), 10 mins |
| 16h00: Snowmass perspective on future colliders, | I. Olvado, 45 mins |
| 16h45: High Field Magnet Programme, | A. Siemko, 45 mins |

# More meetings: ECFA Higgs/EW/top factory workshop

- WG1 and WG2: Physics Potential and Analysis (see recent mail from Juan)

20-22 April: First workshop of the Higgs/Top/EWK subgroup of WG1
https://indico.cern.ch/event/1132480/

4-5 May: First topical meeting on Reconstruction (WG2 activity)
https://indico.cern.ch/event/1124095/

6 May seminar: Higgs self-coupling (including LHC status+prospects)
https://indico.cern.ch/event/1143763/

- WG3: Detector working group
  - Mandate quasi-final draft available and discussed in the ECFA IAC
    - Provide and optimise the interplay between detector R&D and the physics potential realisation
  - Nominated conveners will soon be invited by K. Jakobs
  - Didier Contardo (CMS, FCC France) accepted to be part of the IAC

- First Higgs/EW/top factory workshop, 5-7 Oct 2022: https://indico.desy.de/event/33640/

# Recommendations from MEXT expert panel

- See official statement here: https://www.kek.jp/en/topics-en/202202251335/

1. The panel recognizes the academic significance of particle physics and the importance of the research activities, including that of a Higgs factory, and understands the value of international collaborative research. However, the panel found that it is still premature to proceed into the ILC Pre-lab phase, which is coupled with an expression of interest to host the ILC by Japan as desired by the research community proposing the project.

2. Given the increasing strain in the financial situation of the related countries, the panel recommends the ILC proponents to reflect upon this fact and to reevaluate the plan. They should reexamine the approach towards a Higgs factory in a global manner taking into account the progress in the various studies such as the Future Circular Collider (FCC) and ILC.

3. The panel recommends that the development work in the key technological issues for the next-generation accelerator should be carried out by further strengthening the international collaboration among institutes and laboratories, shelving the question of hosting the ILC.

4. For realizing a very large project such as the ILC, cultivating a framework where the related countries can exchange information on their situations and discuss required steps would be important.

5. The panel recommends that the research community should continue efforts to expand the broad support from various stakeholders in Japan and abroad by building up trust and mutual understanding through bi-directional communication with the people concerned.

In light of the panel's findings, KEK will make an effort to reexamine the path for realizing the ILC as a Higgs factory, taking into account the progress in various fronts including the FCC feasibility study. In this process, the interaction with the domestic and international research community as well as the opportunities in the exchange of information through ICFA will be crucial. Also, in collaboration with the IDT, KEK will propose a framework to ICFA to address some of the pressing accelerator R&D issues for the Pre-lab, where joint developments will be done by the participating laboratories on the selected subjects. KEK and the Japanese ILC community is committed to further advance important technological and engineering development in the accelerator area and to continue the effort for the realization of the ILC.

Furthermore, KEK, in collaboration with ILC-Japan, will establish a new organization that will centrally manage ILC communications activities. The new organization will strengthen activities to communicate the significance of the ILC to all parties involved, such as the general public, academia, or industry, focusing on communicating the importance to build an international laboratory for basic science, which will contribute greatly to the development of a new generation of scientists and advancement of knowledge, science and technology.

KEK endeavors to promote these activities for the realization of the ILC in the future, maintaining a relationship of trust with related organizations.

- See also: https://physicsworld.com/a/panel-calls-on-physicists-to-shelve-notion-of-japan-hosting-the-international-linear-collider/

Panel calls on physicists to 'shelve' notion of Japan hosting the International Linear Collider

01 Mar 2022 Michael Banks

physicsworld

- Next step: FCC Coordination Group to contact KEK/ILC folks for collaboration with FCC FS

# ICFA Statement, 10 April 2022

- See https://icfa.hep.net/wp-content/uploads/ICFA_Statement_April2022_Final.pdf

**ICFA Statement Regarding Higgs Factory Development and the ILC**

The International Committee for Future Accelerators (ICFA) recently met to review global progress and plans in high-energy physics. ICFA reconfirms the international consensus on the importance of a Higgs Factory as the highest priority for realizing the scientific goals of particle physics. This view has only strengthened over time based on results from the world's particle physics facilities. Various design studies based on different technologies are in progress, including both circular colliders (FCC-ee and CEPC) and linear colliders (ILC and CLIC). ICFA follows with great attention the development of Higgs Factory proposals worldwide and recognizes the importance of advancing such concepts.

ICFA also reaffirms the importance of the regional planning activities that have recently been completed and those underway, which for decades have underpinned the global strategy for the field. Indeed, following the 2020 update to the European Strategy for Particle Physics, Europe is now undertaking a feasibility study for FCC. ICFA eagerly awaits the results of ongoing strategic planning activities in the U.S., China and elsewhere.

Concerning the International Linear Collider (ILC), ICFA reaffirms its position that the concept for the ILC is technically robust and has reached a level of maturity which supports its moving forward with the engineering design study toward its timely realization. Indeed, recent accelerator projects across the globe confirm the readiness of the foundational superconducting accelerator technology.

ICFA commits to continuing efforts within the International Development Team (IDT) over the next year to coordinate the global research community's activities toward further developing and realizing the ILC in Japan. In particular, the IDT will work to further strengthen international collaboration among institutes and laboratories, and to expand the broad support from various stakeholders. ICFA will monitor developments over the next year to assess availability of resources and progress in international discussions.

ICFA continues to encourage inter-governmental discussion between Japan and potential partner nations to advance international collaboration toward important research and development activities as well as coordination toward realization of an ILC.

- More inclusive than previously issued statements
  - Acknowledges the FCC feasibility study in Europe
  - "Eagerly awaits" the results of "strategic planning activities" in US, China and elsewhere
  - Supports moving forward with the engineering design study…. Commits to continuing effort with the IDT over the next year…
- Does not comment on the recent MEXT / KEK statement on ILC in Japan



Previous ICFA statements: https://icfa.hep.net/statements/

# Snowmass

- Agora on advanced colliders (yesterday) : https://indico.fnal.gov/event/53848/
- Snowmass white papers submitted on 15 March, in particular:



Future Circular Lepton Collider FCC-ee: Overview and Status

I. Agapov[1], M. Benedikt[2], A. Blondel[3], M. Boscolo[4], O. Brunner[2], M. Chamizo Llatas[5], T. Charles[6], D. Denisov[5], W. Fischer[5], E. Gianfelice-Wendt[7], J. Gutleber[2], P. Janot[2], M. Koratzinos[8], R. Losito[2], S. Nagaitsev[7,9], K. Oide[2,10], T. Raubenheimer[11], R. Rimmer[12], J. Seeman[11], D. Shatilov[2], V. Shiltsev[7], M. Sullivan[11], U. Wienands[13], F. Zimmermann[2]

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[5] *Brookhaven National Laboratory, Upton, N.Y., U.S.A.*
[6] *University of Liverpool, Liverpool L69 3BX, United Kingdom*
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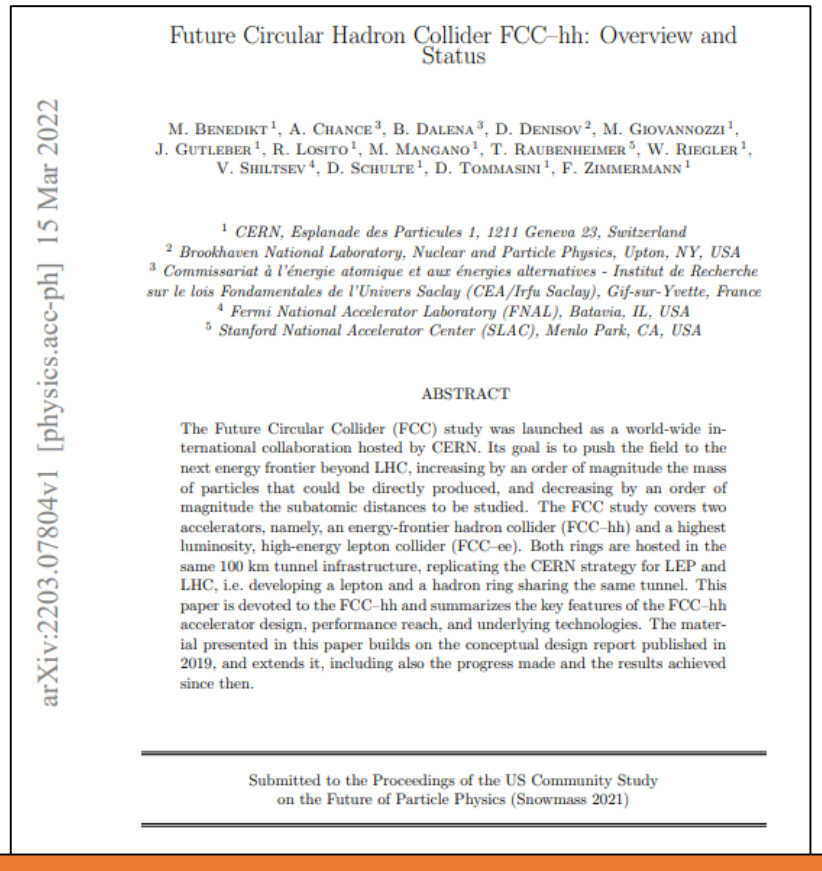
[8] *Massachusetts Institute of Technology, Cambridge, Massachusetts, U.S.A.*
[9] *University of Chicago, Chicago, Illinois, U.S.A.*
[10] *High Energy Accelerator Research Organization, Tsukuba, Ibaraki, Japan*
[11] *SLAC National Accelerator Laboratory, Stanford, California, U.S.A.*
[12] *Thomas Jefferson National Accelerator Facility, Newport News, Virginia, U.S.A.*
[13] *Argonne National Laboratory, Lemont, Illinois, U.S.A.*

ABSTRACT

The worldwide High Energy Physics community widely agrees that the next collider should be a Higgs factory. Acknowledging this priority, in 2021 CERN has launched the international Future Circular Collider (FCC) Feasibility Study (FS). The FCC Integrated Project foresees, in a first stage, a high-luminosity high-energy electron-positron collider, serving as Higgs, top and electroweak factory, and, in a second stage, an energy frontier hadron collider, with a centre-of-mass energy of at least 100 TeV. In this paper, we address a few key elements of the FCC-ee accelerator design, its performance reach, and underlying technologies, as requested by the Snowmass process. The Conceptual Design Report for the FCC, published in 2019, serves as our primary reference. We also summarize a few recent changes and improvements.

Submitted to the Proceedings of the US Community Study
on the Future of Particle Physics (Snowmass 2021)





Future Circular Hadron Collider FCC–hh: Overview and Status

M. Benedikt[1], A. Chance[3], B. Dalena[3], D. Denisov[2], M. Giovannozzi[1], J. Gutleber[1], R. Losito[1], M. Mangano[1], T. Raubenheimer[5], W. Riegler[1], V. Shiltsev[4], D. Schulte[1], D. Tommasini[1], F. Zimmermann[1]

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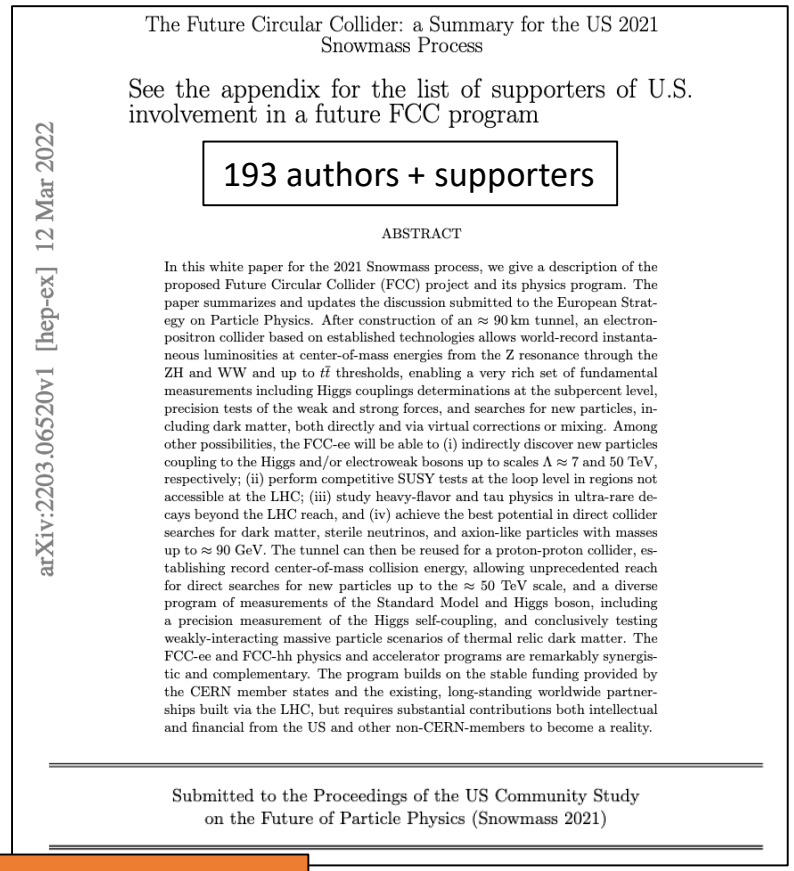
[4] *Fermi National Accelerator Laboratory (FNAL), Batavia, IL, USA*
[5] *Stanford National Accelerator Center (SLAC), Menlo Park, CA, USA*

ABSTRACT

The Future Circular Collider (FCC) study was launched as a world-wide international collaboration hosted by CERN. Its goal is to push the field to the next energy frontier beyond LHC, increasing by an order of magnitude the mass of particles that could be directly produced, and decreasing by an order of magnitude the subatomic distances to be studied. The FCC study covers two accelerators, namely, an energy-frontier hadron collider (FCC–hh) and a highest luminosity, high-energy lepton collider (FCC–ee). Both rings are hosted in the same 100 km tunnel infrastructure, replicating the CERN strategy for LEP and LHC, i.e. developing a lepton and a hadron ring sharing the same tunnel. This paper is devoted to the FCC–hh and summarizes the key features of the FCC–hh accelerator design, performance reach, and underlying technologies. The material presented in this paper builds on the conceptual design report published in 2019, and extends it, including also the progress made and the results achieved since then.

Submitted to the Proceedings of the US Community Study
on the Future of Particle Physics (Snowmass 2021)





The Future Circular Collider: a Summary for the US 2021 Snowmass Process

See the appendix for the list of supporters of U.S. involvement in a future FCC program

193 authors + supporters

ABSTRACT

In this white paper for the 2021 Snowmass process, we give a description of the proposed Future Circular Collider (FCC) project and its physics program. The paper summarizes and updates the discussion submitted to the European Strategy on Particle Physics. After construction of an ≈ 90 km tunnel, an electron-positron collider based on established technologies allows world-record instantaneous luminosities at center-of-mass energies from the Z resonance through the ZH and WW and up to $t\bar{t}$ thresholds, enabling a very rich set of fundamental measurements including Higgs couplings determinations at the subpercent level, precision tests of the weak and strong forces, and searches for new particles, including dark matter, both directly and via virtual corrections or mixing. Among other possibilities, the FCC-ee will be able to (i) indirectly discover new particles coupling to the Higgs and/or electroweak bosons up to scales $\Lambda \approx 7$ and 50 TeV, respectively; (ii) perform competitive SUSY tests at the loop level in regions not accessible at the LHC; (iii) study heavy-flavor and tau physics in ultra-rare decays beyond the LHC reach, and (iv) achieve the best potential in direct collider searches for dark matter, sterile neutrinos, and axion-like particles with masses up to ≈ 90 GeV. The tunnel can then be reused for a proton-proton collider, establishing record center-of-mass collision energy, allowing unprecedented reach for direct searches for new particles up to the ≈ 50 TeV scale, and a diverse program of measurements of the Standard Model and Higgs boson, including a precision measurement of the Higgs self-coupling, and conclusively testing weakly-interacting massive particle scenarios of thermal relic dark matter. The FCC-ee and FCC-hh physics and accelerator programs are remarkably synergistic and complementary. The program builds on the stable funding provided by the CERN member states and the existing, long-standing worldwide partnerships built via the LHC, but requires substantial contributions both intellectual and financial from the US and other non-CERN-members to become a reality.

Submitted to the Proceedings of the US Community Study
on the Future of Particle Physics (Snowmass 2021)

**final Snowmass meeting in Seattle**

https://indico.fnal.gov/event/22303/, Jul 17-26, 2022

## Energy Frontier Workshop

Mar 28, 2022, 10:00 AM → Apr 1, 2022, 6:30 PM

# Goal for the Energy Frontier Workshop

- Regroup after the submissions of the contributed papers.

- Start formulating vision for EF and TG reports
  - Contributed papers will serve as the basis of the discussions which will define TG and EF reports and formulate our vision for the EF.

- Timelines:

| | | | | | | |
|---|---|---|---|---|---|---|
| **3/15/22**<br><br>**Deadline Contributed Paper Submission** | **3/28/22-4/1/22**<br><br>**EF Workshop (Brown U.)** | **5/31/22**<br><br>**Prelim. Topical Group Reports** | **6/30/22**<br><br>**Prelim. Energy Frontier Report** | **7/17-26/22**<br><br>**Community Summer Study (UW-Seattle)** | **9/30/22**<br><br>**Final Reports** | **10/31/22**<br><br>**Snowmass Book & ArXiv docs** |

# Contributed Papers

- **122 Papers submitted so far to Energy Frontier**
  - **Thank you all!, your efforts are appreciated and are instrumental in defining the EF vision**
  - **Many thanks to Michael Peskin for his efforts in compiling them for the EF [tedious process!]**
  - **Thank you to all topical group conveners and liaisons in leading /organizing the studies.**
- Papers keep coming in, more are expected in coming days.
    - In few and specific cases we expect contributions in a few weeks time scale
  - Several contributions are focused on reach of a small set of processes, while many other contributions are compendia of several studies
- No. of submission is unevenly distributed between TG. In some cases this is by construction as TGs have decided to combine several studies in few comprehensive papers

| EF01 | EF02 | EF03 | EF04 | EF05 | EF06 | EF07 | EF08 | EF09 | EF10 | XFrontier/ General |
|---|---|---|---|---|---|---|---|---|---|---|
| 17 | 5 | 7 | 12 | 2 | 7 | 3 | 9 | 25 | 11 | 24 |
| Higgs + BSM | HF/Top | EW | QCD | QCDfw | HI | BSM | BSM | DarkMatter | | |

# Need for an e+e- Collider Forum at Snowmass

The international community is making great progress in the development of a strategy for e+e- colliders as the next major projects after the end of the LHC program.

To capture the interest for such linear and circular colliders in the US community, we have formed an **"e+e- Collider Forum"** led by the Snowmass

- **Energy Frontier (EF),**
- **Instrumentation Frontier (IF)**
- **Accelerator Frontier (AF)**.

The e+e- Collider Forum will help with the preparation of the Snowmass frontier reports and provide a path for further engagement in developing a strategy toward an e+/e- collider.

The intent of this Forum is to **promote dialogue** and **discuss differences and complementarities** between the various e+e- collider concepts, either linear or circular, from the accelerator, detector and physics perspectives, **in harmony with the rest of the wider international community.**

The discussions will be informed by the Agora on future collider events, contributed white paper, and works carried on within the topical groups.

The outcome of these discussions will be **summarized in a report** that will serve as input to the Snowmass frontier reports.

The Forum however will not replace or duplicate the work that is carried out in the various topical groups that oversee all physics studies and are ultimately responsible for the final reports. The Forum's activities will be carried out in close collaboration with the topical group convenors of the relevant frontiers.

The Coordinators of the Forum are:
AF: **Emilio Nanni** (SLAC), **John Power** (ANL),
IF: **Ulrich Heintz** (Brown), **Steve Wagner** (Colorado),
EF: **Maria Chamizo Llatas** (BNL), **Sridhara Dasu** (Wisconsin)

4:30 PM

### Forum mandate

**Speakers**: Alessandro Tricoli (BNL), Laura Reina (Florida State University), Meenakshi Narain (Brown University)

Tricoli_e+e-CollForu...

4:40 PM

### Circular e+e- collider physics + FCC-ee developments

Max 20m talk + Min 10m discussion

**Speaker**: stephane willocq (University of Massachusetts)

FCCee-Brown-2022-...

5:10 PM

### Linear e+e- collider physics + ILC developments

Max 20m talk + Min 10m discussion

**Speaker**: Michael Peskin (SLAC)

HiggsVarieties.png

ILC at Energy Fronti...

5:40 PM

### CCC developments + Justification for higher-energy + lumi choices

Max 10m talk + Min 10m discussion

**Speakers**: Caterina Vernieri (Fermi National Accelerator Laboratory), Caterina Vernieri (SLAC)

C3-forum-e+e-EFwo...

## ILC

a more realistic, but still optimistic, schedule is:

2023 - increased funding from Japan for final R&D issues
2024 - begin discussions on international cost sharing
2028 - begin tunnel construction, SRF cavity procurement
2039 - commissioning and first data

At this time, we are requesting funding only for the 250 GeV stage of the ILC.

ILC is the only Higgs factory proposal fully engaged with governments and negotiating funding. As of now, it is the only proposal with a path to first data before 2040.

## FCC

FCC

- **FCC-ee offers a compelling and extremely broad physics program**
  - Higgs, W, Z, top —> Model-independent Higgs couplings, big leap in EWPO, Flavor, QCD tests
  - Direct BSM searches + indirect searches via precision measurements
    unique sensitivity to feebly-interacting new particles w/ mass ~ $m_b - m_Z$ GeV
  - Sensitivity gains far beyond incremental, thanks to huge luminosities and control of beam parameters
    —> improvements by up to several orders of magnitude on key measurements and searches
  - Outstanding precision translates into sensitivity to high scales: $\Lambda_{\rm BSM} \gtrsim 7$ TeV for Higgs and $\Lambda_{\rm BSM} \gtrsim 50$ TeV for EW bosons
- Design of detectors, development of analysis ideas and new approaches, reduction of systematic uncertainties underway with *much room for innovation and improvement*
- **US can make key contributions to advance FCC-ee project in theory, experiment & accelerator areas —> FCC-ee provides wide range of exciting opportunities for the long-range US HEP program**
  - Working groups are starting to tackle some of the key challenges for the feasibility study report and welcome US contributions (several WGs are led by US physicists)
- Continuity of HEP at a laboratory (CERN) with an established track record and stable funding

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## C³

| Collider | NLC | CLIC | ILC | C³ | C³ |
|---|---|---|---|---|---|
| CM Energy [GeV] | 500 | 380 | 250 (500) | 250 | 550 |
| Luminosity [x$10^{34}$] | 0.6 | 1.5 | 1.35 | 1.3 | 2.4 |
| Gradient [MeV/m] | 37 | 72 | 31.5 | 70 | 120 |
| Effective Gradient [MeV/m] | 29 | 57 | 21 | 63 | 108 |
| Length [km] | 23.8 | 11.4 | 20.5 (31) | 8 | 8 |
| Num. Bunches per Train | 90 | 352 | 1312 | 133 | 75 |
| Train Rep. Rate [Hz] | 180 | 50 | 5 | 120 | 120 |
| Bunch Spacing [ns] | 1.4 | 0.5 | 369 | 5.26 | 3.5 |
| Bunch Charge [nC] | 1.36 | 0.83 | 3.2 | 1 | 1 |
| Crossing Angle [rad] | 0.020 | 0.0165 | 0.014 | 0.014 | 0.014 |
| Site Power [MW] | 121 | 168 | 125 | ~150 | ~175 |
| Design Maturity | CDR | CDR | TDR | pre-CDR | pre-CDR |

## Next: C³ Demonstration Facility

SLAC

- Minimum set of goals
  - **Demonstrate operation of fully engineered and operational cryomodule**
    - Simultaneous operations of at least 3 cryomodules
    - Demonstrate a cryomodule that is close to a production prototype
  - Demonstrate full operational gradient 120 MeV/m (and higher > 155 MeV/m) in single bunch mode
  - Work with industry to develop C-band source unit optimized for installation with Main Linac
- This demonstration directly benefits development of compact FELs for photon science
- The development of the other component of the accelerator complex - the sources, damping rings, and beam delivery system - is **synergistic with ILC and CLIC designs**

# Muon Collider Forum

Muon Collider Forum Report - a coherent vision for muon colliders and from the US/Snowmass Perspective

- Similar to a TG report but across frontiers - results are there for you to use already in EF
- Summary of contributions across frontiers, emphasizing the physics case as wel as what are the new results since 2013 across the frontiers.
- **Focus of the report is a 10 TeV 10/ab physics program**
  - IMCC had a particular staging concept of 3 then 10 TeV, but for Snowmass we're agnostic, and investigating 125 GeV or possibly O(1) TeV for top physics or other physics cases
- We also are planning on emphasizing the potential US role for R&D, siting for IMC or even a bold vision of a US program by the next Snowmass

## EF Recommendations on Muon Collider Program

It would be wise to focus on **how circumstances have changed in physics, technology, and studies** that have made a reexamination of the status of directed muon collider R&D appropriate in 2024+

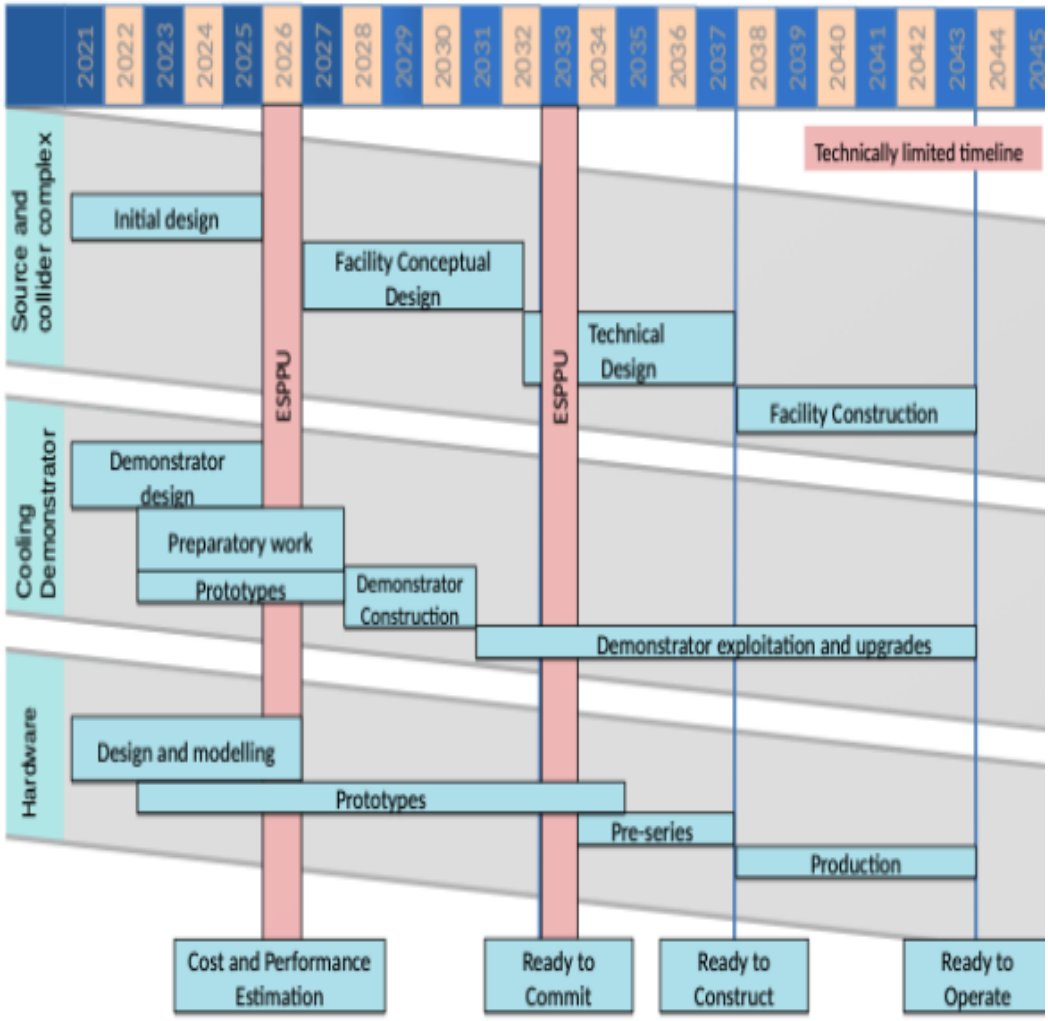



**Fig. 5.3:** A technically limited timeline for the muon collider R&D programme.

# EF Vision Building

- The EF-level report will need to **convey the EF vision** and summarise the details presented in TG reports in a **concise, simple and appealing way to a broad audience**
- Graphics, plots and tables help convey and summarise the EF vision
- We plan to have graphics, plots and tables with different levels of information and different target types of audience
- **We invite the EF community to provide suggestions and feedback on what information to provide and how**
- So far we (EF&TG convenors) have worked on the following proposals
  - 1) Introduce a small set of **Big Questions** that we want to address in greater detail in TG reports
  - 2) Graphics that links **Big Questions** to **Probes** and to **Signatures**
  - 3) A Table that summarises the f**ocus and reach of different collider options**

# A Project Ready to "Approve"


- **Is there a collider construction project ready to be presented for approval?**
  - Physics Case
  - Demonstrated Technical Design
  - Host organization
  - Cost Estimate
  - Plausible demonstration of funding
  - Understanding of how risk will be "shared"
- Until something like this exists, it is not likely a project can move forward in the US

**We have done a superb job of developing projects through the first two steps , as seen in this Agora series, but have not done so well at the remaining four tasks.**

# Towards a project


- **Given the ILC situation, there is no collider project that can be put forward as ready for approval**
- If collider physics is to continue, the field MUST have an international R&D program so we are ready to move forward
- **At least** two paths
  - **FCC-ee ➔ FCC-hh**
    - A very comprehensive, very long-term program, but with many challenges
      - FCC-ee operation, 2045-2060
        - For US contribution, funding needs may be matched with roll-off of spending on Long Baseline Neutrino
      - FCC-hh operation ~2070 – 2090++
  - **A linear collider followed by a muon collider** of 10 or preferably 20 TeV or a p-p collider of CM energy of several 10's of TeV
- **Other paths? Not too many, or none will reach a critical mass!**

# Snowmass 2021/22


- **We must make strong physics cases for near-term, i.e., the HL-LHC, and far term, i.e., new colliders**
  - We have to clearly identify the physics advantages of each and how they differ or overlap
- We should acknowledge the current situation of project readiness and also the demands on funding of ongoing projects which affects timing of new projects
- **The next big decision will be based on what CERN learns about the technical feasibility, siting issues, and cost of the large tunnel and FCC-ee**
  - We need to prepare an R&D program that can support it but also can pursue the most promising directions if it cannot go forward
- We might anticipate a decision point ~ 4years from now, well before the "natural" time for the next P5
  - **We should put in place now what is needed to be ready for that**

# Snowmass Community Summer Study (CSS)

- EF Goal for CSS meeting:
  - **Discuss all TG reports and finalize their contents**
    - Respond to all comments by the community
    - Review summary plots/tables
    - Review consistency
    - Converge on cross frontier discussions, if still pending
  - **Discuss EF Report and finalize its structure and contents**
    - Respond to all comments by the community
    - Review summary plots/tables [including those with cross-frontier information]
    - Vision/timeline [not priority] of studies, accelerator and detector R&D with AF and IF.
    - Comment on National and International Collaboration

- Assumption on attendees - 300 for EF plenary, 100 for each parallel
- Day 1: Introduction, setting the stage.
- Last 1.5 days: Summary, leap off for next phases (reports, DPF concerns, P5, etc.)
  - EF summary will be in general plenaries [opening & closing]
- Days 4 and 8 -- EF plenaries [plan for TG Summary: 30' ]
- other days (2,3, 5, 6, 7) -- parallels
  - TG Reports Summary Plots/tables (SP/T): Higgs, BSM, SM - top/QCD, HI
- Discussions

  1: EF/AF/TF - muon forum report comment/physics

  2: EF/AF/IF - - e+e- Forum report comment/physics

  3: About 2 or 5 hrs of dedicated discussions jointly with AF, IF, TF, CF, RF, NF, CompF

  4: Community engagement Fronteir will have one general meeting with all Frontiers

# Snowmass EF meeting / part of the agenda

**10:00 AM** → 11:00 AM **Topical Group Plenary Discussions (Close Captioned): Combined EFT Fits (EF04)**

10:00 AM **SMEFT fits for EW+Higgs** 20m

**Speakers**: Jiayin Gu (Fudan University), Jorge de Blas (University of Granada)

ees8.pdf

10:20 AM **SMEFT fits for CP-violating and four-fermion processes** 20m

**Speaker**: Yong Du (ITP CAS)

EFW-YongDu.pdf

10:40 AM **Discussion on global fits** 20m

**Speakers**: Alberto Belloni, Ayres Freitas (University of Pittsburgh), Junping Tian (University of Tokyo)

informal version of ...

**11:00 AM** → 12:00 PM **Topical Group Plenary Discussions (Close Captioned): Electroweak Physics (EF04)**

11:00 AM **Theory of quartic gauge-boson couplings in VBS** 15m

**Speaker**: Dieter Zeppenfeld (University of Karlsruhe)

Zeppenfeld-VBSthe...

11:15 AM **VBS and VVV studies at future colliders** 25m

**Speakers**: Aram Apyan (Fermi National Accelerator Laboratory), Aram Apyan (Brandeis University), Saptaparna Bhattacharya (Northwestern University), Saptaparna Bhattacharya (Northwestern University)

brown_snowmass_...

## Topical Group Plenary Discussions (Close Captioned): Higgs Physics (EF01+EF02)

1:00 PM **Theory Vision for Higgs (15+5)**
**Speaker**: Ian Low (Argonne National Laboratory)
Low_EF2022.pdf

1:20 PM **Higgs Couplings at a Muon Collider (15+5)**
**Speaker**: Zhen Liu (University of Minnesota)
MuCHiggs_EF_Brow...

1:40 PM **HL-LHC projections (25+5)**
**Speaker**: Saptaparna Bhattacharya (Northwestern University)
Snowmass_EF01_E...

2:10 PM **Higgs physics at FCC-ee (15+5)**
**Speaker**: Christophe Grojean (DESY and Humboldt University)
Grojean_Snowmass...

2:30 PM **The Higgs and BSM physics at linear e+e- colliders (15+5)**
**Speaker**: Jenny List (DESY)
jlist_snowmass_efw...

## Discussions: Muon Collider Forum

**Conveners**: Derun Li (LBNL), Diktys Stratakis (Fermi National Accelerator Laboratory), Fabio Maltoni, Fabio Maltoni (Ur
Kevin Black, Patrick Meade (Stony Brook), Patrick Meade (Stony Brook University), Sergo Jindariani (FNAL)

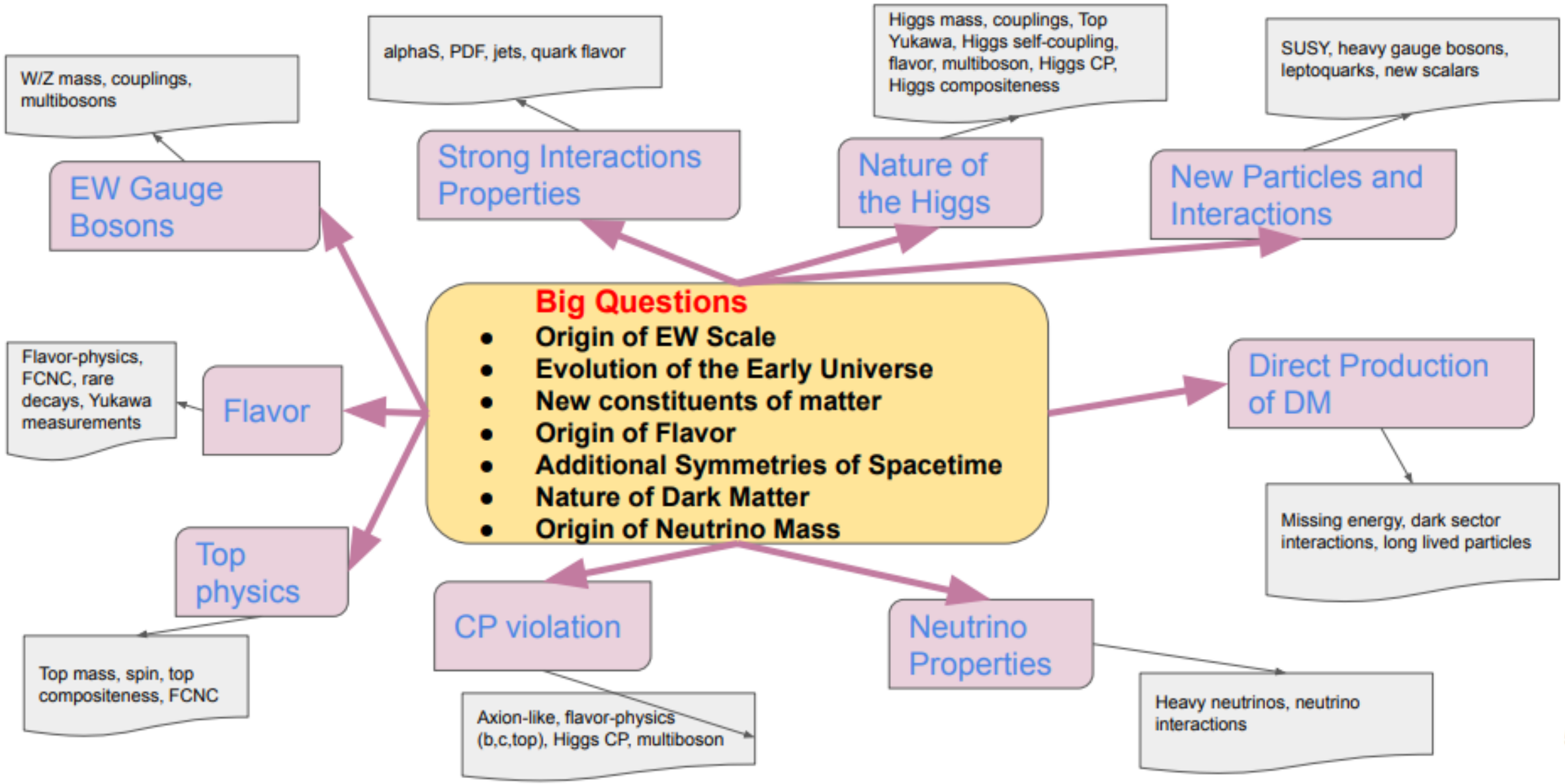
4:30 PM **Muon Collider Forum: News**
muonforumEFnews....

4:35 PM **Muon Collider physics highlights from the White Papers**
**Speaker**: Fabio Maltoni (Universite' catholique de Louvain)
Muon highlights.pdf

4:50 PM **Muon Collider: Accelerator plans, technology readiness, R&D path**
**Speaker**: Mark Palmer (Brookhaven National Laboratory)
MC_Accelerator_Pal...

5:05 PM **Muon Collider: Discussion of US plans and involvement**

# Examples of Signatures



# Focus and Reach of Colliders

Example of signatures that can be studied at various colliders
By no means exhaustive, to be expanded

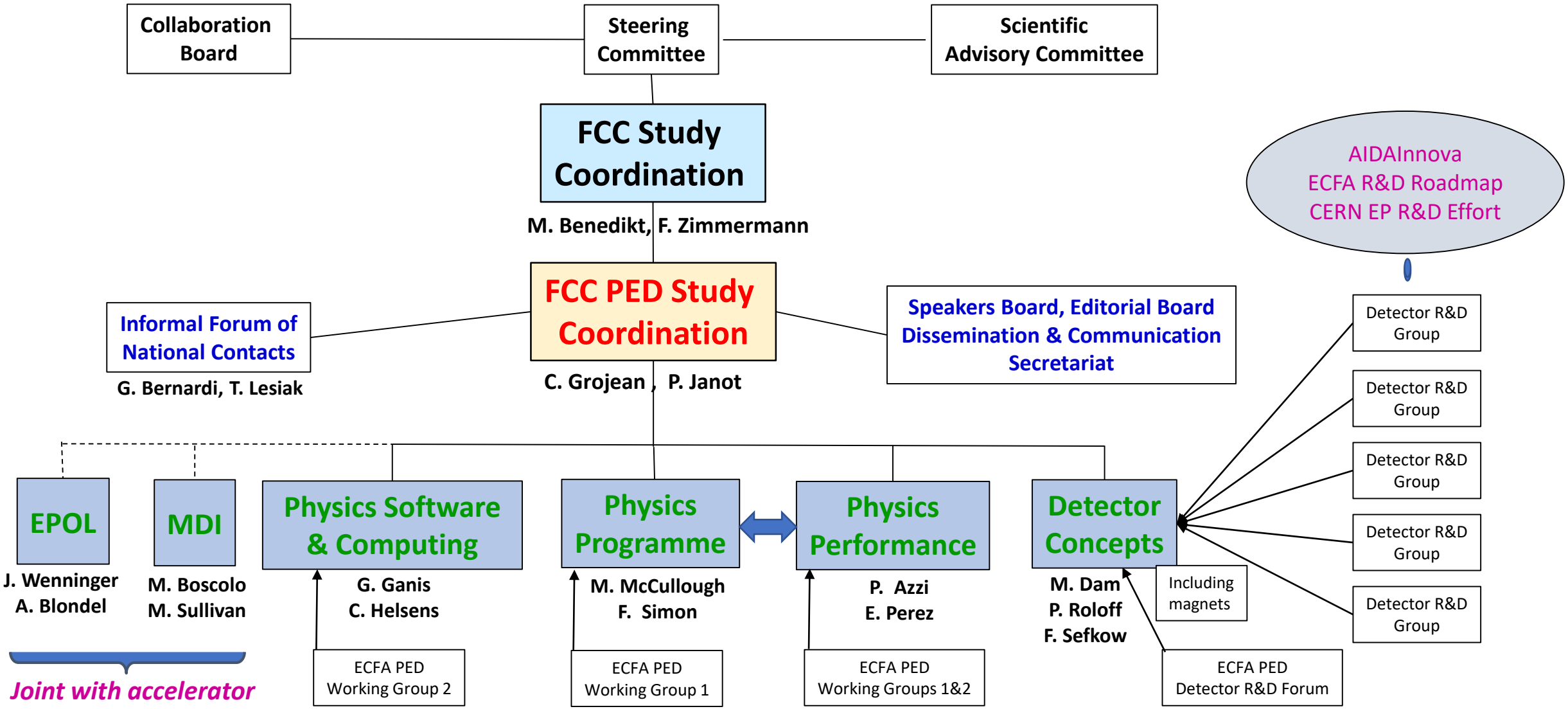
| Example of Signatures | HL-LHC | e+e- | | hh | muon collider | Low Energy Experiments | Neutrino Experiments |
|---|---|---|---|---|---|---|---|
| | | linear | circular | | | | |
| Multi-Higgs production | *ADD CHECK MARKS* | | | | | | |
| Higgs coupling to light quarks | | | | | | | |
| Higgs coupling to top | | | | | | | |
| Higgs coupling to gauge bosons | | | | | | | |
| Higgs coupling to leptons | | | | | | | |
| Additional light scalars | | | | | | | |
| Additional heavy scalars | | | | | | | |
| Higgs to long lived particles | | | | | | | |
| Top-quark production | | | | | | | |
| Rare top-quark decays | | | | | | | |
| Top-quark EW couplings | | | | | | | |
| … | | | | | | | |

# Communicating in FCC

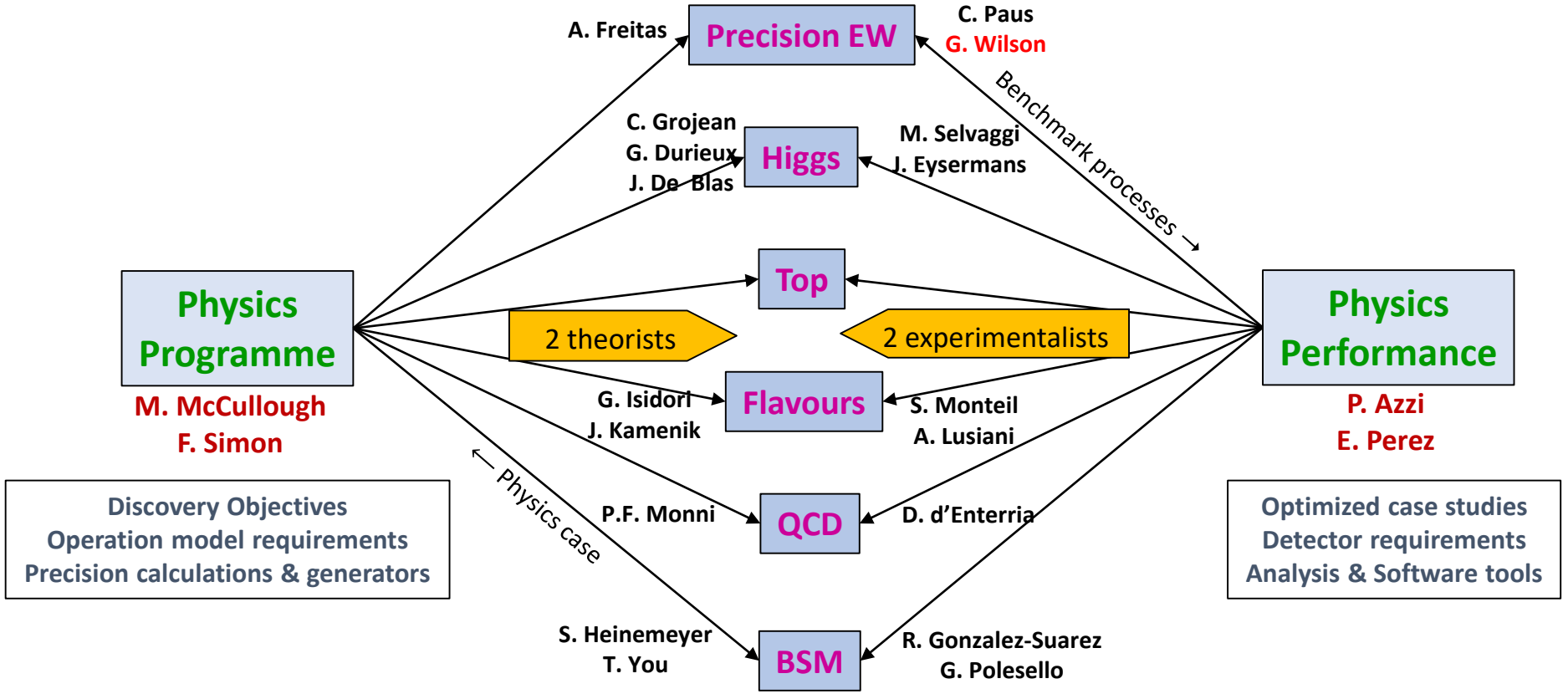
- A few examples
  - Use FCC-PED-FeasibilityStudy when you want to reach all in the PED Feasibility Study
  - Use FCC-PED-PhysicsProgramme for Physics Programme meetings
    - And maybe FCC-PED-FeasibilityStudy for the first of these meetings
      - Similar comment for DetectorConcepts, PhysicsPerformance, SoftwareAndComputing, …
  - If you want to reach only (some of) the conveners
    - FCC-PED-CoordinationGroup : all the work-package conveners
      - FCC-PED-CoordinationGroup-admin : the FCC PED coordinators
      - FCC-PED-DetectorConcepts-admin : the Detector Concepts coordinators

        Similar for PhysicsProgramme, PhysicsPerformance, SoftwareAndComputing, …
    - FCC-PED-PhysicsCoordinationGroup : all the physics group conveners
      - FCC-PED-PhysicsGroup-Higgs-admin : the Higgs Physics Group conveners
  - Etc…

# PED Organisation & conveners



# Joint Physics groups



# Mid-term review (mid-2023)

FUTURE CIRCULAR COLLIDER

M. Benedikt

## Context:

**Mid-term review requested by CERN Council**

**From council document on FCC Feasibility Study:**

***- A committee including external experts will be established to review the cost of the first-stage project (the tunnel and the FCC-ee collider) by mid-2023; a second cost review will take place at the end of the Feasibility Study in 2025;***

- **to allow better understanding of progress and evolution of feasibility study**
- **Anticipation of the direction towards Strategy Update in 2026/27**
- **Potential date: mid 2023**
  - Integrated in FCC Week 2023
- **Proposal by Greek delegate:**
  - presentation of review draft proposal to SPC/scientific council delegates to receive feedback BEFORE presentation to CERN Council.
  - Presentation of proposal to Council at June 2022 meeting (~1 year prior to review)
- **Review committee not yet discussed, perhaps SAC?**

# Follow-up from previous coordination meeting

- (Good!) News from Host States
  - Nov'21: Préfet de region becomes official French representative with CERN & Switzerland
    - To facilitate the execution of the FCC Feasibility Study
  - Dec'21: Swiss Federal Council will draw up a federal sectoral plan
    - To facilitate administrative procedures for FCC planning in the event of its implementation
  - 14 Feb' 22: First French information meeting about the FCC
    - Préfet de Région + deputés, sénateurs, communauté de communes, … in Ain & Haute Savoie
  - 24 Feb' 22: Symbolic ceremony and joint declaration
    - CERN DG, Préfet de Région, Swiss Ambassador, Representative of Canton de Genève
  - In short: very fast political evolution towards FCC planning in France and Switzerland
    - More meetings will follow
    - Michael Benedikt will be present in all meetings and will report to the FCC Coordination Group
      - And we will report here in turn