



**Physics Meeting
brief news 27 July 2020**

Our marching orders:



“Europe, together with its international partners, should investigate the technical and financial feasibility of a future hadron collider at CERN with a centre-of-mass energy of at least 100 TeV and with an electron-positron Higgs and electroweak factory as a possible first stage. Such a feasibility study of the colliders and related infrastructure should be established as a global endeavour and be completed on the timescale of the next Strategy update.”

- Every word and character counts: feasibility of the colliders (ee and hh) and related infrastructure.
- confirmed in meeting with DG on 14 July.
 - **FCC is the highest priority for Europe and its international partners → reach out!**

Feasibility study of FCC integrated program

Feasibility study to be delivered end 2025 as input for ESPP Update expected for 2026/2027:

- *Feasibility study of the 100 km tunnel (infrastructure aspects, administrative aspects, local authorities, environment, energy, etc.)*
- *High-risk site investigations included, to confirm principle feasibility*
- *Host-state related processes included to allow start of construction begin 2030.*
- *CDR+ for colliders and injectors, including key technologies.*
- *HFM intermediate milestones reached, according to long-term R&D plan.*
- *Physics and experiments CDR + for FCC integrated project.*
- *Financing concept and operation model.*

➤ For all these activities the sequential nature of implementation of the colliders and the overall timeline needs to be taken into account!

Reaching out – work to do!

The DG is working very hard (at her level) to engage CERN's international partners

On our side we need to do the bottom up part of the job in the experimental community a.k.a. 'the users'

- web site
- software framework, software
- simulation, reconstruction and analysis tools
- integrate contributors from all CERN member states and beyond
- establish detector requirements
- understand what detector R&D should be undertaken
- help generate proto collaborations which could produce LOIs by next strategy.

FCC-ee web site



The FCC-ee design study

Since 12/02/2014, the TLEP design study is part of the FCC design study as *Sleeping beauty* 

Home About FCC-ee and TLEP Organization Archive Events The FCCs Contact/join us Site map



FCC: Future Circular Collider Study

With the discovery of the Higgs boson at the LHC in 2012, coupled with the absence of other phenomena, the particle physics panorama has become, surprisingly perhaps, very open. While the Standard Model could appear as a complete theory, several undeniable observations tell us that there is more to the story. The nature of dark matter, the origin of the baryon asymmetry in the universe, the mysteries lying behind the very small neutrino masses are telling us to keep looking for answers. Are the required new phenomena to be found at higher energies, or have they escaped detection because of very small couplings? The FCCs will address these fundamental open issues of particle physics.

1 2 3

- FCC-ee current site based on CERN recommended Drupal technology, ver. 7
 - Drupal 7 decommissioned by last week of August 2020 (no accessibility after!)
- Current status (thanks to A Stano):
 - Migration of data completed
 - Migrated web site available at: <https://test-d8-fcc-ee.web.cern.ch/>
 - Modification access will be controlled by the same eGroup (DRUPAL-ADMINS-FCC-EE)
 - Instructions should be made available to allow your modifications
- Next steps
 - Identified person for taking over maintenance (M Chrzaszcz)
 - Need to organize handover

C. Helsens, G. Ganis

Building the software – common effort with other projects

Common Effort: Key4HEP / EDM4hep

[Inter-project activity to develop a common software framework](#)

- Meeting every Tuesday morning at 9h00
 - See <https://indico.cern.ch/category/11461/>
 - Good attendance and good coverage of different communities
 - Still too few contributors to make significant quick progress, but better than nothing
- Two fellows assigned 100% to the project
 - Valentin Volk, Placido Fernandez
- Dedicated GitHub project: <https://github.com/key4hep>

welcome new participants!

+ FCCSW group meetings -- Many achievements!

integration of algorithms (primary, secondary tertiary vertices, tracking)

FCC-ee backgrounds from MDI group and much more....

Coming up: extrapolation algorithm, geometry, tutorial (also in the Snowmass context)

Areas of work (non exhaustive summary)

- MC generators
 - Interfacing, testing
- MDI
 - Shared formats
 - GuineaPig++ integration
 - Overlay of MDI/signal events
- Detector concepts
 - IDEA DR Calo full simulation
 - IDEA Muon system full sim
 - Validation of LAr Ecal for FCC-ee
 - Enabling of CLD in FCCSW/k4h
- Validation/testing of Delphes cards
- Reconstruction
 - Tracking algorithms
 - Vertex reconstruction
 - ACTS integration
 - ML for calo reconstruction
- Identification
 - e, mu, tau, c, b tagging / ID
- Analysis tools
 - RDataFrame based analysis
- AoB
 - Distributed Computing
 - Porting to other OSs
 - ...

**People are getting in contact with us, mainly to ask questions on how to use the software
We need developers!!!**

Physics Performance group & conveners

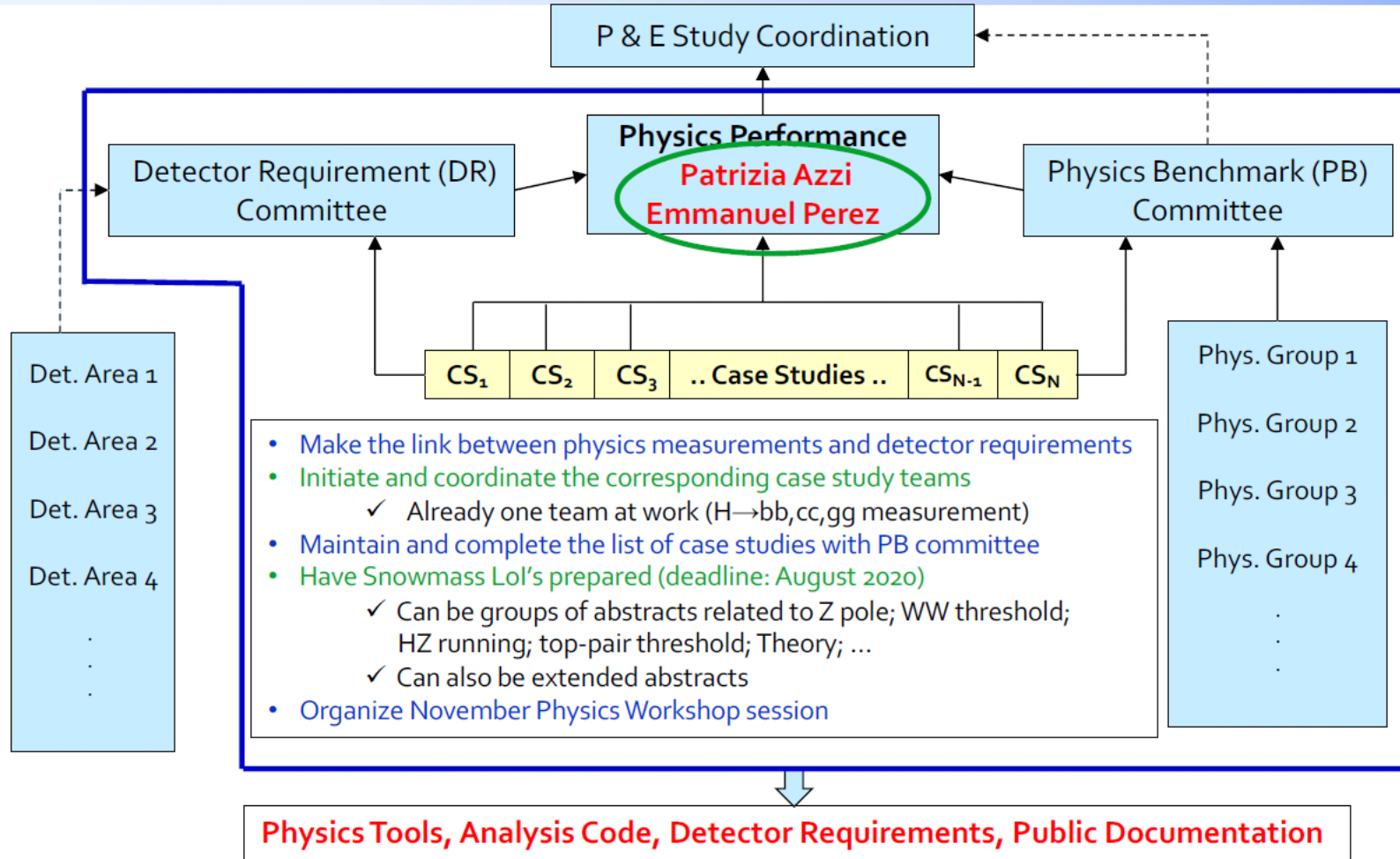
The FCC-ee PE&D SG approved a proposal for a Physics Performance group.

Patrizia Azzi and Emmanuel Perez have agreed to serve as coordinators -- WELCOME!

operation (see next slide)

- 1. Physics working groups (conveners) → establish list of BENCHMARK MEASUREMENTS**
 - each can correspond to several case studies
 - group case studies from different measurements for efficiency/consistency
 - will start with the Z (as in the run plan)
- 2. Case study teams establish DETECTOR REQUIREMENTS for optimizing measurement, and in particular matching exp. systematics with the expected statistical precision.**
 - one team already started: c vs b/g jets in Higgs (and Z) decays
- 3. This requires simulations of detector setup (fast sim or full sim as appropriate) with help/guidance from detector experts**

Hot News: Physics Performance coordinators



A first selection of Benchmark studies (mostly experimental, some theory)

has already been prepared.

A list of abstracts is here:

<https://www.overleaf.com/read/dyjpdszrqxhz>

it will be regularly updated

This was also submitted to the SNOWMASS process. <https://snowmass21.org/> as LOI

If you are interested in contributing this is a great way to start.

Now need to write up these as individual LOIs (or some grouping) by the end of August

A first list of benchmark studies

1. Towards an ultimate measurement of $R_\ell = \frac{\sigma(Z \rightarrow \text{hadrons})}{\sigma(Z \rightarrow \text{leptons})}$
2. Towards an ultimate measurement of the Z total width Γ_Z
3. Towards an ultimate measurement of the Z peak cross section
4. Direct determination of $\sin^2 \theta_{\text{eff}}^\ell$ and of $\alpha_{\text{QED}}(m_Z^2)$ from muon pair asymmetries
5. Determination of the QCD coupling constant $\alpha_S(m_Z^2)$
6. Tau Physics, Lepton Universality, and Lepton Flavour Violation
7. Tau exclusive branching ratios and polarization observables
8. Z-pole Electroweak observables with heavy quarks
9. Long lived particle searches
10. Measurement of the W mass
11. Measurement of the Higgs boson coupling to the c quark
12. Measurement of the ZH production cross section
13. Measurement of the Higgs boson mass - Part I
14. Measurement of the Higgs boson mass - Part II
15. Inferring the total Higgs boson decay width - Part I
16. Inferring the total Higgs boson decay width - Part II
17. Determination of the $HZ\gamma$ effective coupling
18. Electron Yukawa via s-channel $e^+e^- \rightarrow H$ production at the Higgs pole
19. Measurement of top properties at threshold and above
20. Search for FCNC in the top sector
21. Theory Needs for FCC-ee
22. Beyond MFV: constraints on RH charged currents and on dipole operators
23. Construction of CP-odd observables to probe CP-violating Higgs couplings
24. Combined fit of Higgs and top data

tera Z

WW

H fact

ee \rightarrow H

top

theory

This table presents the **statistical** errors for EWPOs, as given by the run plan.

It represents the real potential of FCC-ee

Systematics are ‘just a start’ and next challenge will be to -- design detectors and analysis and --improve calculations/simulations

so that systematics $\approx \leq$ statistics

One common mistake in all the previous studies was to underestimate the ability of a real group of collaborators to exploit real data to reduce systematics

Table 5: Measurement of selected EWPOs at FCC-ee, compared with present precision. The systematic uncertainties are initial estimates, aim is to improve down to statistical errors. This set of measurements, together with those of the Higgs properties, achieves indirect sensitivity to new physics up to a scale Λ of 70 TeV in a description with dim 6 operators, and possibly much higher in specific new physics (non-decoupling) models.

| Observable | present value \pm error | FCC-ee Stat. | FCC-ee Syst. | Comment and leading exp. error |
|---|---------------------------|--------------|--------------|---|
| m_Z (keV) | 91186700 ± 2200 | 4 | 100 | From Z line shape scan Beam energy calibration |
| Γ_Z (keV) | 2495200 ± 2300 | 4 | 25 | From Z line shape scan Beam energy calibration |
| R_Z^e ($\times 10^3$) | 20767 ± 25 | 0.06 | 0.2-1 | ratio of hadrons to leptons acceptance for leptons |
| $\alpha_s(m_Z^2)$ ($\times 10^4$) | 1196 ± 30 | 0.1 | 0.4-1.6 | from R_Z^e above |
| R_b ($\times 10^6$) | 216290 ± 660 | 0.3 | <60 | ratio of bb to hadrons stat. extrapol. from SLD |
| σ_{had}^0 ($\times 10^3$) (nb) | 41541 ± 37 | 0.1 | 4 | peak hadronic cross section luminosity measurement |
| N_ν ($\times 10^3$) | 2996 ± 7 | 0.005 | 1 | Z peak cross sections Luminosity measurement |
| $\sin^2 \theta_W^{\text{eff}}$ ($\times 10^6$) | 231480 ± 160 | 2 | 2.4 | from $A_{\text{FB}}^{\text{pole}}$ at Z peak Beam energy calibration |
| $1/\alpha_{\text{QED}}(m_Z^2)$ ($\times 10^4$) | 128952 ± 14 | 3 | small | from $A_{\text{FB}}^{\text{pole}}$ off peak QED&EW errors dominate |
| $A_{\text{FB},0}^b$ ($\times 10^4$) | 992 ± 16 | 0.02 | 1-3 | b-quark asymmetry at Z pole from jet charge |
| $A_{\text{FB}}^{\text{pol},\tau}$ ($\times 10^4$) | 1498 ± 49 | 0.15 | <2 | τ polarization asymmetry τ decay physics |
| m_W (MeV) | 80350 ± 15 | 0.25 | 0.3 | From WW threshold scan Beam energy calibration |
| Γ_W (MeV) | 2085 ± 42 | 1.2 | 0.3 | From WW threshold scan Beam energy calibration |
| $\alpha_s(m_W^2)$ ($\times 10^4$) | 1170 ± 420 | 3 | small | from R_Z^W |
| N_ν ($\times 10^3$) | 2920 ± 50 | 0.8 | small | ratio of invis. to leptonic in radiative Z returns |
| m_{top} (MeV/ c^2) | 172740 ± 500 | 17 | small | From tt threshold scan QCD errors dominate |
| Γ_{top} (MeV/ c^2) | 1410 ± 190 | 45 | small | From tt threshold scan QCD errors dominate |
| $\lambda_{\text{top}}/\lambda_{\text{top}}^{\text{SM}}$ | 1.2 ± 0.3 | 0.10 | small | From tt threshold scan QCD errors dominate |
| ttZ couplings | $\pm 30\%$ | 0.5 – 1.5% | small | From $\sqrt{s} = 365$ GeV run |

Physics groups

□ Current/Previous organization (not all conveners are active)

Physics and Experiment Studies coordination

A. Blondel, P. Janot (EXP), C. Grojean, M. McCullough, M. Mangano, J. Ellis (TH)

EW Physics with Z's and W's
J. Alcaraz, P. Azzurri, E. Locci
A. Freitas

Higgs properties
M. Klute, K. Peters
C. Grojean

Top quark physics
P. Azzi, F. Blekman

$ee \rightarrow H$
D. d'Enterria

QCD and $\gamma\gamma$ physics
D. d'Enterria
P. Skands

Flavours physics
S. Monteil
J. Kamenik

New physics
M. Pierini, C. Rogan
M. McCullough

Global Analysis
Synergies
J. De Blas

Precision Calculations
A. Freitas, J. Gluza
S. Heinemeyer

◆ By 15 September, we would like to receive

- Your proposals of new physics groups *ex: tau physics, Long Lived Particles, (+FCC-hh)*
- Your nominations for physics group conveners
 - Current conveners who want to continue should of course let us know
Some have already said they could not continue as conveners
 - Most urgent part of the mandate will be to enlarge international participation

National FCC-groups

Progress continuing:

- FRANCE and ITALY: are well established already. Contact (G. Bernardi, R. Aleksan)(F. Bedeschi)
- UK: lots of progress. Contacts in all HEP groups and at the two STFC lab sites (RAL and DL).

First meeting in September. (Christos Leonidopoulos Guy Wilkinson)

- Poland: (T. Lesiak) planning FCC information day at Epiphany conference in January.
- Spain: starting within a national 'future colliders' structure (Juan Alcaraz)
- CH well in the road map, CHARD for accelerator (e+ source)

discussions on towards effort FCC funding. CH unambiguously supported FCC-INT project.

- Begium and Netherlands (just starting, contact Freya Blekman)
- Contacts with Germany, USA, Austria, Estonia etc.. have been initiated – to be followed.

more?

If you are interested contact the above or let us know!

FCC-IS kick-off meeting and 4th Physics workshop

9-13 November <https://indico.cern.ch/event/932973/>

You can register already and let us know if you wish to present something

Overall Program

| Version: 0.7 | | Date: 14 July 2020 | | Update by: J. Haidre | | FCCNoW 2020 Programme | | | | | | | | | | | | | | | |
|--------------|--|--|--|---|--|--|---|------------------------------------|--------------------------------------|--|---|--|--|--|--|------------------------------------|--|---|---|-------------|-------------|
| Day | Sun. 8.11. | Monday 9 November | | | Tuesday 10 November | | | | Wednesday 11 November | | | | Thursday 12 November | | | Friday 13 November | Time | | | | |
| Room | | Plenary 222/R-001 Filtration Plant | | | Parallel 1/1' (Physics experiments and detectors PE&D) 40/S2-D01 Salle Dirac | | Parallel 2 (WP2) 2/R-030 30 seats | Parallel 3 24/1-016 20 seats | Parallel 4 4/S-056 20 seats | Parallel 1/1'/1'' (Physics, Experiments and detectors PE&D) | | Parallel 2 (WP1) 40/S2-C01 Salle Curie | | Parallel 1/1'/1'' (Physics) 222/R-003 30 seats | | Parallel 2 6/R-012 40 seats | Plenary 40/S2-901 - Salle Bohr | Room | | | |
| Time | | | | | | | | | | | | | | | | | Time | | | | |
| 08:30-09:00 | Registration @ | J. Gaiser (CERN) | Welcome | | | FCC-ee PE&D | | FCC-ee Optics | Placement optimisation (WP3) | FCC-INT physics | | J. Gutleber (CERN) | Management of publications | | FCC-ee detectors Calorimeters B | FCC-ee detectors Trackers A | Mining the Future Planning meeting (WP1) | FCC-ee/hh/eh new contributions | 08:30-09:00 | | |
| 09:00-09:30 | | tbd (tbd) | Host status address (FR) | Host site address (CH) | | | | | | | | J. Gutleber (CERN) | Management of data | | | | E. Geler (MUL) & J. Gutleber (CERN) | | 09:00-09:30 | | |
| 09:30-10:00 | | tbd (tbd) | Update of the European Strategy for Particle Physics | | | | | tbd (tbd) | P. Bollen (CERN) | | | J. Gutleber (CERN) | Project management environment | | | | | | | 09:30-10:00 | |
| 10:00-10:30 | | tbd (tbd) | Keynote talk Topic tbd | | | | | Coffee Break | | | | Coffee Break | | Coffee Break | | Coffee Break | | | Coffee Break | 10:00-10:30 | |
| 10:30-11:00 | | Coffee Break | | | Pheno QCD, EW | FCC-ee PE&D | FCC-ee Optics | Environmental Evaluation (WP3) | Pheno: Flavour and BSM part 1 | | FCC-ee PE&D Physics performance process, software, analysis, benchmarks | M. Moedcheher (TMS) | Communication Strategy (WPS) | Pheno: Higgs physics (part 1) | FCC-ee detectors PID B | FCC-ee detectors Vertex detector A | FCCWeek Proceedings Planning Meeting (WPS) | Pheno EFTs | FCC-ee/hh/eh new contributions, synergies and complementarity | 10:30-11:00 | |
| 11:00-11:30 | | tbd (tbd) | FCC-ee physics motivation | | | | | | | | | P. Charlot (CERN) | Engagement and communication plans (WPS) | | | | C. Caron (SN) & A. Charlot (CERN) | | | 11:00-11:30 | |
| 11:30-12:00 | | J. Gutleber (CERN) | FCCIS Project Overview | | | | | tbd (tbd) | M. Savvin (IO) | | | O. Martin | Institutional Communication (WPS) | | | | | | | 11:30-12:00 | |
| 12:00-12:30 | | Lunch Break | | | | | | | | | | | Lunch Break | | Lunch Break | | Lunch Break | | | Lunch Break | 12:00-12:30 |
| 13:00-13:30 | | Lunch Break | | | | | | | | | | | Lunch Break | | Lunch Break | | Lunch Break | | | Lunch Break | 13:00-13:30 |
| 13:30-14:00 | | Lunch Break | | | Pheno QCD and EW Part 1 | Joint FCC-ee Accelerator and Experiments session | | MATEX Workshop (WP3) | Socio-economic impact analysis (WP4) | Pheno Flavour and BSM (part 2) | FCC-ee MDI EPOL Monochromatization | FCC-ee detectors Calorimeters A | G. Roy (CERN) | Administrative Processes (WPS) | Pheno: Higgs Physics Part 2 | FCC-ee detectors Luminosity | FCC-ee detectors Trackers B | FCCWeek 2021 Proceedings Planning Meeting Proceedings (WPS) | WG/TH summaries, next steps, discussion and Wrap-up | | 13:30-14:00 |
| 14:00-14:30 | tbd (tbd) | WP2 (FCC-ee Collider Design) | | | | | L. Ulmer (CERN) | E. Sirtan (CERN) | | | | | | | | | | | | 14:00-14:30 | |
| 14:30-15:00 | J. Gutleber (CERN) | WP3 (Integrate Europe) | | | | | Coffee Break | | | | Coffee Break | | Coffee Break | | Coffee Break | | | | 14:30-15:00 | | |
| 15:00-15:30 | S. Vignati (CERN) | WP4 (Impact & Sustainability) | | | | | Coffee Break | | | | Coffee Break | | Coffee Break | | Coffee Break | | | | 15:00-15:30 | | |
| 15:30-16:00 | Coffee Break | | | Pheno QCD and EW Part 2 | ECFA detector R&D road map | FCC-ee other | MATEX Workshop (WP3) | Regional benefits work plan (WP4) | Pheno Higgs physics (part 1) | FCC-ee MDI EPOL Monochromatization | FCC-ee detectors PID A | Overleaf Training Group 1 | | Higgs Physics part 3 | FCC-ee detectors Electronics Trigger DAQ/online processing | FCC-ee detectors Vertex detector B | Overleaf Training Group 2 | Coffee, departure | | 15:30-16:00 | |
| 16:00-16:30 | M. Benedetti (CERN) | Governance and Management structures (GA/GA) | | | Overview of goals and first set of detector and th requirements | | tbd (tbd) | L. Ulmer (CERN) | A. Gonzalez (IO) | | | | | | | | | | | 16:00-16:30 | |
| 16:30-17:00 | FCC Collaboration Board Chair Name tbd (tbd) | | | General Assembly | | | | | | | | | | | | | | | | 16:30-17:00 | |
| 17:00-17:30 | | | | Round table discussion: "engaging exp and th communities" | | | | | | | | | | | | | | | | 17:00-17:30 | |
| 17:30-18:00 | | | | | | | | | | | | | | | | | | | | 17:30-18:00 | |
| 18:00-18:30 | Welcome reception | | | | | | | | | | | | | | | | | | | 18:00-18:30 | |
| 18:30-19:00 | | | | | | | | | | | | | | | | | | | | 18:30-19:00 | |
| 19:00-19:30 | | | | | | | | | | | | | | | | | | | | 19:00-19:30 | |
| 19:30-20:00 | | | | | | | | | | | | | | | | | | | | 19:30-20:00 | |
| 20:00-20:30 | | | | Social Dinner | | | | | | | | | | | | | | | | 20:00-20:30 | |

Physics dinner

**Experiments and detectors
Program Advisory Committee**

| name | institute | sent | answ Y/N |
|------------------------------------|-----------------------|-------------|-----------------|
| Greg Bernardi | FCC-IN2P3 | Y | Y |
| Aleksan | FCC-CEA | Y | Y |
| Rainer Wallny | CHIPP | Y | Y |
| Franco Bedeschi | FCC-INFN | Y | Y |
| Christos Leonidopoulos | FCC-UK | Y | Y |
| Tadeusz Lesiak | FCC-PL | Y | Y |
| Beate Heinemann | DESY | Y | Y |
| Felix Sefkow | AIDA | Y | Y |
| Paolo Giacomelli | AIDA | Y | Y |
| Christian Joram | CERN-EP | Y | Y |
| Jorgen D'Hondt | ECFA | Y | Y |
| Joel Butler | DPF + Fermilab | Y | Y |
| Young Kee Kim | DPF, Chicago | Y | Y |
| Sarah Eno | Maryland | Y | Y |
| Dmitri Denisov | Brookhaven | Y | Y |
| Maria Chamizo | BNL | Y | Y |
| Frank Simon | Munich MPI | Y | Y |
| Yuriy Tikhonov | BINP | Y | |
| Jochen Schieck | Vienna | Y | Y |
| Paula Eerola | Helsinki | Y | Y |
| David Milstead | Stockholm | Y | Y |
| Richard Brenner | Uppsala | Y | |
| Farid Ould-Sada | Oslo | Y | |
| Anna Lipniacka | Bergen | Y | Y |
| Jorge Fernandez de Troconiz | Spain | Y | |
| Mario Kadastik | Estonia | Y | |
| Stan Bentvelsen | NIKHEF | Y | |

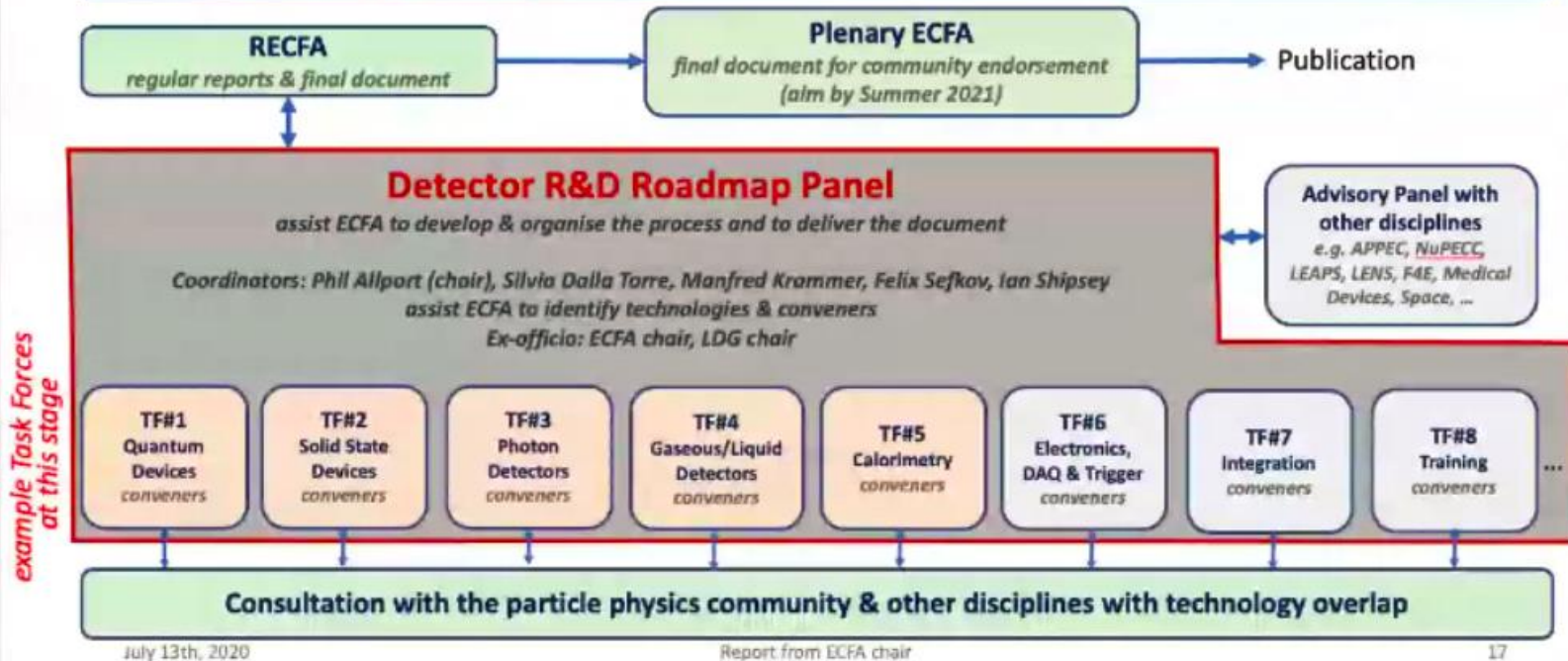
We are now in consultation with ECFA

ECFA

European Committee for Future Accelerators

ECFA & Strategy

Organization to structure the consultation with the community



Exp + Detectors Parallel session conveners

MDI EPOL and Monochromatization : Bacchetta, Boscolo, Faus, Wenninger

PID : Guy Wilkinson, Stéphane Monteil

Luminosity : Mogens Dam

Calorimeters : Franco Bedeschi, Martin Aleksa (will find CALICE person)

Vertex detector : Paula Collins (TBC), Auguste Besson

Tracker : Franco Grancagnolo + **Need another convener (seeking proposal)**

TDAQ Online Processing Christos Leonidopoulos + **Need another convener (seeking proposal)**

Of course structure is ‘detector-based’, rather than ‘technology-based’

They will be happy to be contacted.

SUMMARY

With all its careful writing the strategy gives CERN and its international partners an unambiguous mandate:

Financial and technical feasibility study of the FCC colliders and infrastructure.

Software, Web, Physics performance group... will be growing in the next months to provide tools to trigger newcomers to contribute, and establish the FCC physics case and detector requirements (and check they work). CERN will lead the way, Physics groups to restart.

National groups are steadily being formed and seeking their own visibility/resources.
➔ See the given contacts to contribute.

Mark the 4th Physics workshop in your calendars

Time to go into high gear!