FCC-contacts – January 15th

- News

- Programme du Workshop de Janvier

- Tour de Table

- AOB

FC: Organisation et projets

Futur collisionneur, physique prospective et R&T détecteurs:

- priorités ESPPU: usine à Higgs, collisionneur pp d'au moins 100 TeV
- choix de l'usine à Higgs non-tranché: ILC, FCC-ee, ...
- organisation se met en place (CERN, ECFA, nous) pour cela
  - prospectives nationales et déclinaison institut
  - R&T machines (cf. Jean-Luc)
  - prospectives physique/optimisation détecteurs, R&T détecteurs
- schéma global (présenté aux journées FCC-France), à affiner:
  - poursuite de la R&T ciblant ILC (CALICE/CMOS), synergie autres machines à encourager
  - propositions de R&T génériques (agnostique % machine) encouragées
  - pas de soutien à de la R&T ciblant FCC avant 2 ans (phase Exploratoire avant Focus&Consolidation)
  - nouveau MP FCC-Phys pour prospective physique & animation ciblant FCC et au-delà

Projets R&T détecteurs:

- CALICE (IJCLab, IP2I, LLR, LPC, LPNHE, Omega): calorimétrie ultra-granulaire
- CMOS (IPHC/IJCLab): capteurs pixels minces et granulaires
- NEW: DICE (CPPM, IPHC): pixels haut taux de comptages: hybrides (ASIC 65nm) et DepMAPS

Futurs collisionneurs:

SIMP, (CPVQ): physique prospective

FCC-Phys:	3 ETP CH [# {8 ch, 0 doc, 0 pdoc}]	G. Bernardi (LPNHE)

Budget indicatif 2021 FCC-Phys: 34 k€

INDE: les détecteurs innovants

CALICE:	7 ETP CH [# {10 ch, 1 doc, 1 pdoc}]	6 ETP IT [# {19}]	J-C. Brient (LLR)
CMOS:	2 ETP CH [# {4 ch, 1 doc, 0 pdoc}]	10 ETP IT [# {15}]	M. Winter (IJCLab)
DICE:	nouveau projet (CPPM+IPHC)		M. Barbero (CPPM)

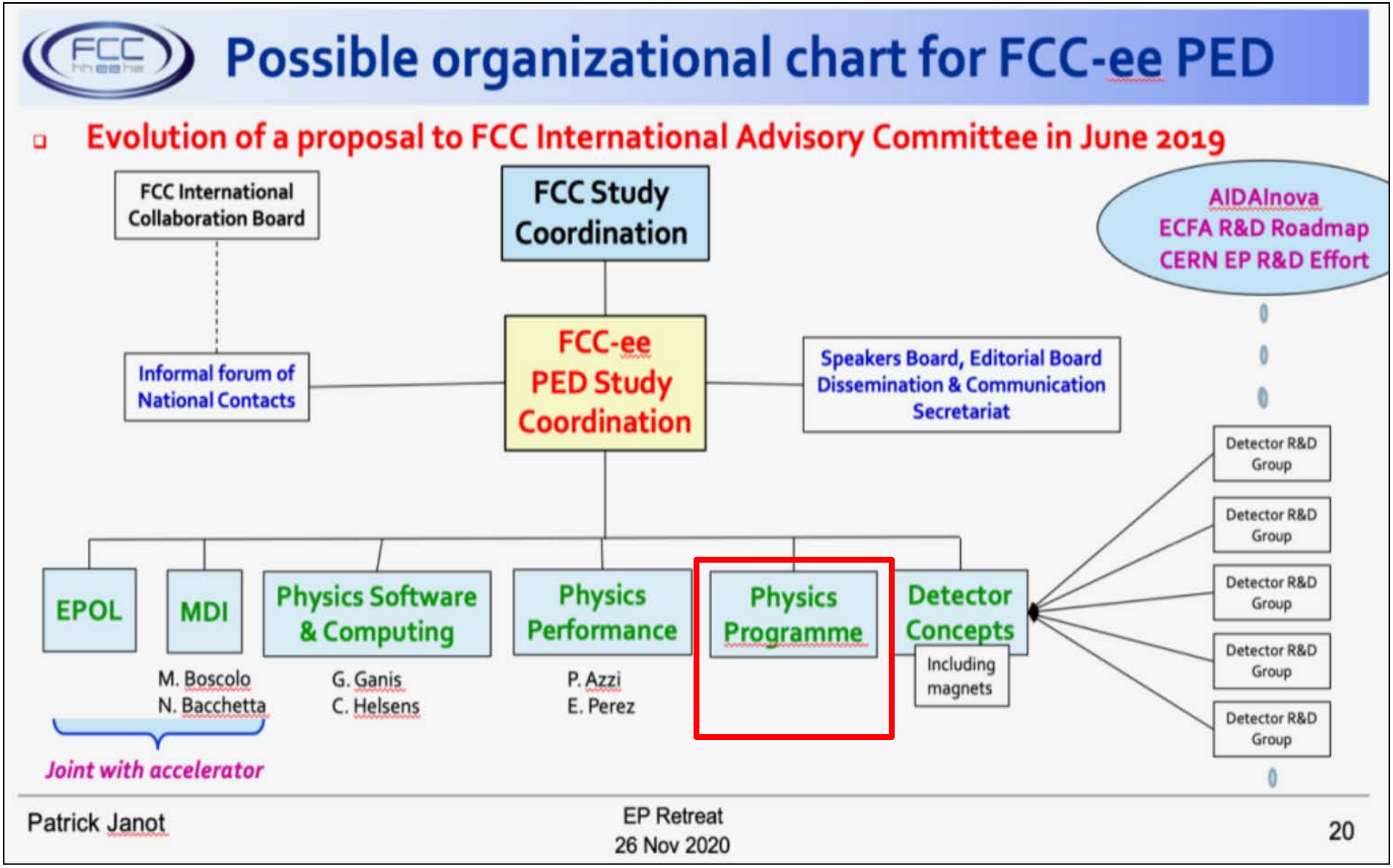
Budget indicatif 2021 CALICE: 220 k€

Budget indicatif 2021 CMOS: 124 k€

Budget indicatif 2021 DICE: 93 k€

Mentionnés 34 kE sur 55 demandés. Négociation en cours,

Physics programme organisation



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

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

Physics programme organisation (proposition Mangano et al.)

since there will be too many mtgs, and there is the risk that people will end up focusing on one, and loose the big picture. The proposal is to group topics as follows (boldface characters for the WG titles):

EW physics, covering:
-- precision EW at the Z peak and WW thresholds, including W mass
-- High energy EW: Diboson, difermion
-- precision theory calculations
-- Monte-Carlo generators and fitting formulae

Flavour physics:
- heavy quarks
- tau lepton

BSM:
- Bring all BSM-related topics under the same WG. In particular:
- indirect sensitivity, including model-specific global fits
- direct BSM searches, including Feebly interacting particles, LLPs, light DM, ...

QCD (includes the dedicated precision theory calculations, Monte-Carlo generators, fitting formulae..)

Top (includes the dedicated precision theory calculations, Monte-Carlo generators, fitting formulae..)

Higgs, including ee->H, and including precision TH calculations, MCs and fitting formulae

Possible options include: i) absorb Higgs under EW physics, to make sure that EFT fits etc are covered within the same group, ii) move ee->H to a joint accelerator/experiment task force, ...

The different aspects covered by each WG could be handled by having several conveners with the more specific background (both on the TH and exp side), and one can imagine planning the WG mtgs to focus each time on a separate topic, depending on the needs and the available new material. The monthly physics mtgs, currently organized by Matthew&Patrizia, can be used to summarize the status of progress of the different WGs, and to show results that have reached maturity.

Tour de Table / Case studies / R&D / Stages

IRFU	Saclay
CPPM	Marseille
IJCLab	Orsay
IPHC	Strasbourg
IP2I	Lyon
LAPP	Annecy
LPC	Clermont
LLR	Palaiseau
LPNHE	Paris
LPSC	Grenoble
L2IT	Toulouse

Next meeting: Vendredi 12 Février 15h

Physics Benchmark studies

https://indico.cern.ch/event/951830 Snowmass LOI's
List of Benchmark case studies and abstracts in one file

Labo	Case study	titre	Total
CPPM			
IJC Lab			
IPHC	19	Top quark physics @ FCC-ee	
IP2I			
LAPP			
LLR	12 15	the total $e^+e^- \rightarrow ZH$ cross section σ_{HZ} the Higgs boson total decay width Γ_H	
LPNHE	5 5bis 11	Perspectives for high-precision $\alpha_S(m_Z^2)$ determinations FCC-ee High-precision αS(m2Z) from e+e− → hadrons data below the Z peak Higgs boson coupling measurements to charm quarks at FCC-ee	
LPC			
LPSC			
L2IT			
FCC-IN2P3			

Labo	Implication R&D
CEA	- TPC
CPPM	- Collab avec IP2I sur senseurs monolithiques actifs à pixels (MAPS):
IJC Lab	- GranuLar (~10 fois plus de cellules que le calo ATLAS) - Powder-O (fibres scintillantes immergées dans une poudre; version ‘solide’ de Liquid-O)
IPHC	- CMOS **(Picsel/C4PI)** : exploration de la techno 65 nm première soumission conjointe avec CERN (EP R&D WP1.2 et ALICE, oct. 20),
IP2I	- Calorimètre hadronique semi-numérique (SDHCAL)/détection de muons à chambres à plaques résistives en verre (GRPC): R&D depuis 2006 en grande partie transplantable au contexte FCC-ee [GG,IL,LM] - Senseurs monolithiques actifs à pixels (MAPS): Proposition de développement conjoint avec IPHC-C4PI, CPPM pour trajectographes, voire calorimètres à haute granularité [GB,DC,SG]
LAPP	- High granularity liquid argon calorimetry for a detector at a future circular electron-positron collider / Team: LAPP, IJClab, OMEGA
LLR	- high-granularity Si-based calorimeter (continuous operation, timing)
LPNHE	- Oriented towards Si sensors developments, for calorimetry and tracking (Calice & ITk involvement)
LPC	- Pixel detectors (if opportunities), Calorimetry
LPSC	
L2IT	

FCC-ee : Case studies Electroweak, QCD, HF, Taus

LOI repository
https://indico.cern.ch/event/951830/

1. Towards an ultimate measurement of $R_\ell = \frac{\sigma(\mathrm{Z}\to\mathrm{hadrons})}{\sigma(\mathrm{Z}\to\mathrm{leptons})}$
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 $\sin^2\theta^\ell_\mathrm{eff}$ and of $\alpha_\mathrm{QED}(m^2_\mathrm{Z})$ from muon pair asymmetries
5. Determination of the QCD coupling constant $\alpha_\mathrm{S}(m^2_\mathrm{Z})$
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

FCC-ee : Case studies, Higgs, Top, Theory, misc

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 HZγ effective coupling
18. Electron Yukawa via s-channel $e^+e^- \to H$ 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

European Strategy and new from Japan

Main points:

-- Higgs Factory is highest priority, loaction not specified, only FCC-ee and ILC mentioned
-- way towards high energies with FCC-hh is the long term plan, and it will be at CERN.
This is materialized by recommandation of strong R&D on High Field magnets
-- clear recommendation for the Technical and Financial Feasibility Study of FCCs
→ **go ahead towards TDR's for FCC-ee and hh**

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.

The timely realisation of the electron-positron ILC in Japan would be compatible with this strategy and, in that case, the European particle physics community would wish to collaborate.

FCC-ee et ILC peuvent travailler de manière plus rapprochée. Compatibilité.

https://www.kek.jp/en/topics-en/topic20200911-2/

In February 2020, KEK submitted an application to the Ministry of Education, Culture, Sports, Science and Technology (MEXT) for adoption of the ILC project as part of the "Fundamental Concept for Promoting Large Scientific Research Projects Roadmap"; however, in March, KEK withdrew the application in light of the subsequent international development of the project. On the occasion of the release of the "Roadmap 2020" draft, we sent the following notice to the press on September 8. As announced below, the ILC International Development Team was recently established with KEK as the host, and KEK will be vigorously promoting the ILC project under the new international project promotion framework.

Back to FCC : main goals

Overall goal

- Perform all necessary steps and studies to enable a definitive project decision by 2026, at the anticipated date for the next ESU, and a subsequent start of civil engineering construction by 2029.

This requires successful completion of the following four main activities

- Develop and establish a governance model for project construction and operation
- Develop and establish a financing strategy
- Prepare and successfully complete all required project preparatory and administrative processes with the host states (debat public, EIA, etc.)
- Perform site investigations to enable CE planning and to prepare CE tendering.

In parallel development preparation of TDRs and physics/ experiment studies

- Machine designs and main technology R&D lines
- Establish user communities, work towards proto-experiment collaborations by 2025.

FCC program, and next steps

- **FCC-ee offers a huge physics program** with
  - ➡ Higgs and top measurements with > 10^6 events each in short (3-5y) runs
  - ➡ Unique possibilities
    - Electron Yukawa coupling
    - TeraZ + beam energy calibration
    - keV and ppm precision on EWPOs at Z resonance and WW threshold
    - $\alpha_{QED}(m_Z)$, $\alpha_S(m_Z)$, $\sin^2\theta_W^{eff}$ and $G\tau$
    - Searches for LLPs and rare phenomena (LFV, LNF, light scalars, ...)
    - Flavor physics program with 10^{12} Bs and 10^{11} τ's
    - Offering sensitivity to new physics at scales of 10 to 70 TeV

- Main challenge is to imagine/optimize detector to match statistical power and to sharpen the theory calculations

FCC-ee : Next steps

The detector R&D roadmap will be studied under the supervision of ECFA so that CERN-EP detector R&D will be re-assessed

- intensify our efforts to enlarge and support the experimental community
  ➔ French FCC contacts

- development of detector concepts matching the requirements
  ➔ involve our technical teams, once constraints better known

- intensify theoretical developments esp. precision calculations
  ➔ French FCC contacts : G. Cacciapaglia, B. Fuks

- physics studies (benchmark case studies towards detector requirements)
  ➔ all of us, cf new structure, Physics Performance

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 Volkl, Placido Fernandez
- Dedicated GitHub project: https://github.com/key4hep

+ 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)

C. Helsens, G. Ganis

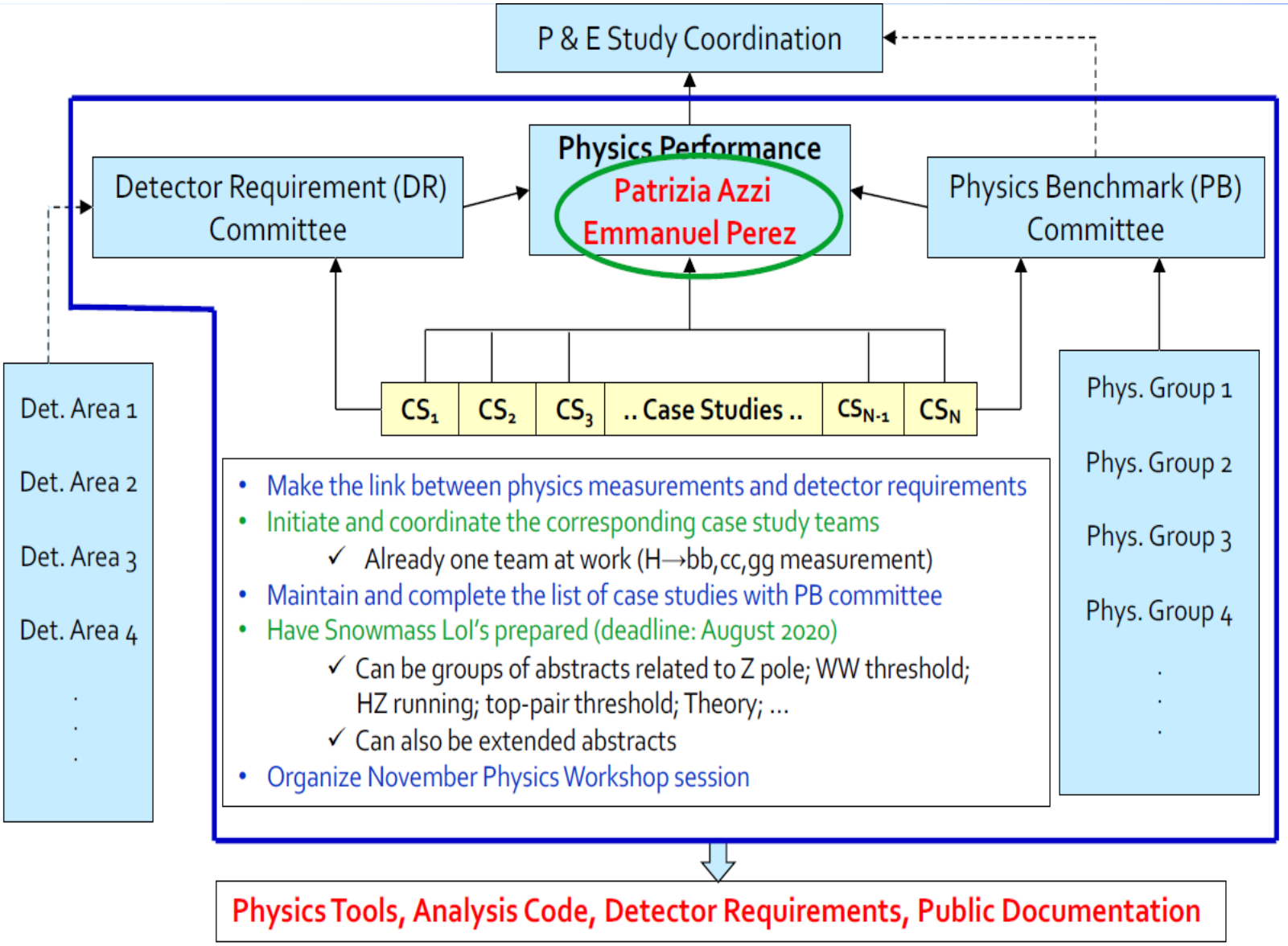
FCC-software : Next steps

- 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
  - ...

C. Helsens, G. Ganis

Physics Performance group

- For a year, the highest priority of the FCC Physics & Experiments activity
  - Will be to start and coordinate the work on the process and tools ("Case Studies")
    - By which detector requirements can be established from a set of benchmark measurements
- We need a re-organization of the physics group coordination
  - To generate a sustained creative atmosphere and ensure a more efficient focus
  - To channel the efforts in a common working environment
    - Towards the proposal and development of benchmark measurements
      - ➔ Physics groups will be actively involved
    - Towards the development of simulation and analysis tools
      - ➔ Software proponents should be associated
    - For the delivery of documentation and a consistent set of inputs to the next CDR
      - ➔ Detector proponents should be associated
- We propose to create a "Physics Performance (PP) Group" to this aim
  - With two motivated coordinators based at CERN, available for ~0.8 FTE at least
  - With an ad-interim mandate (to be reviewed in a year)


P & E Study Coordination
Physics Performance
Patrizia Azzi
Emmanuel Perez
Detector Requirement (DR) Committee
Physics Benchmark (PB) Committee
Det. Area 1
Det. Area 2
Det. Area 3
Det. Area 4
CS1
CS2
CS3
.. Case Studies ..
CSN-1
CSN
Phys. Group 1
Phys. Group 2
Phys. Group 3
Phys. Group 4
• Make the link between physics measurements and detector requirements
• Initiate and coordinate the corresponding case study teams
✓ Already one team at work (H→bb,cc,gg measurement)
• Maintain and complete the list of case studies with PB committee
• Have Snowmass LoI's prepared (deadline: August 2020)
✓ Can be groups of abstracts related to Z pole; WW threshold; HZ running; top-pair threshold; Theory; ...
✓ Can also be extended abstracts
• Organize November Physics Workshop session
Physics Tools, Analysis Code, Detector Requirements, Public Documentation

Case studies and Physics groups

CS_i = i^{th} case study team

- Development
  - Establishes milestones and analysis strategy
  - Develops analysis code
  - Develops necessary physics tools
    - ➔ If they exist, start from already existing tools / code
  - Propose and implement new ideas

- In an iterative process, brings case study to conclusions
  - Documents and maintains code
  - Delivers detector requirements
  - Produces public documentation (prep
  - Delivers input for the Physics CDR

- Reports strategy and results in Physi

Physics groups and physics groups conveners

- Physics groups (See previous mandates in https://fcc-ee.web.cern.ch/content/wg[#X]-exp, with [#X] = 1 to
  - They are part and parcel of the Physics Performance group organization
  - They participate actively in the case study activities
    - ➔ Physics group members can be CS team contact or member (and vice-v
  - They help establishing and improving the case study strategy
  - They propose new case studies and check their potential and feasibility

- Physics group conveners
  - They are the backbone of the Physics Benchmark Committee
  - They deepen the existing physics case (did we forget anything?)
  - They discuss and evaluate new ideas with the Phenomenology group
  - We start with the existing conveners (when they have not disappeared)
    - ➔ We need to foresee more/new conveners & think of additional physics
  - Conveners need to be hired in the international community (ECFA role?)
    - ➔ In order to increase participation to the study across the board

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 → H D. d'Enterria

QCD and γγ 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

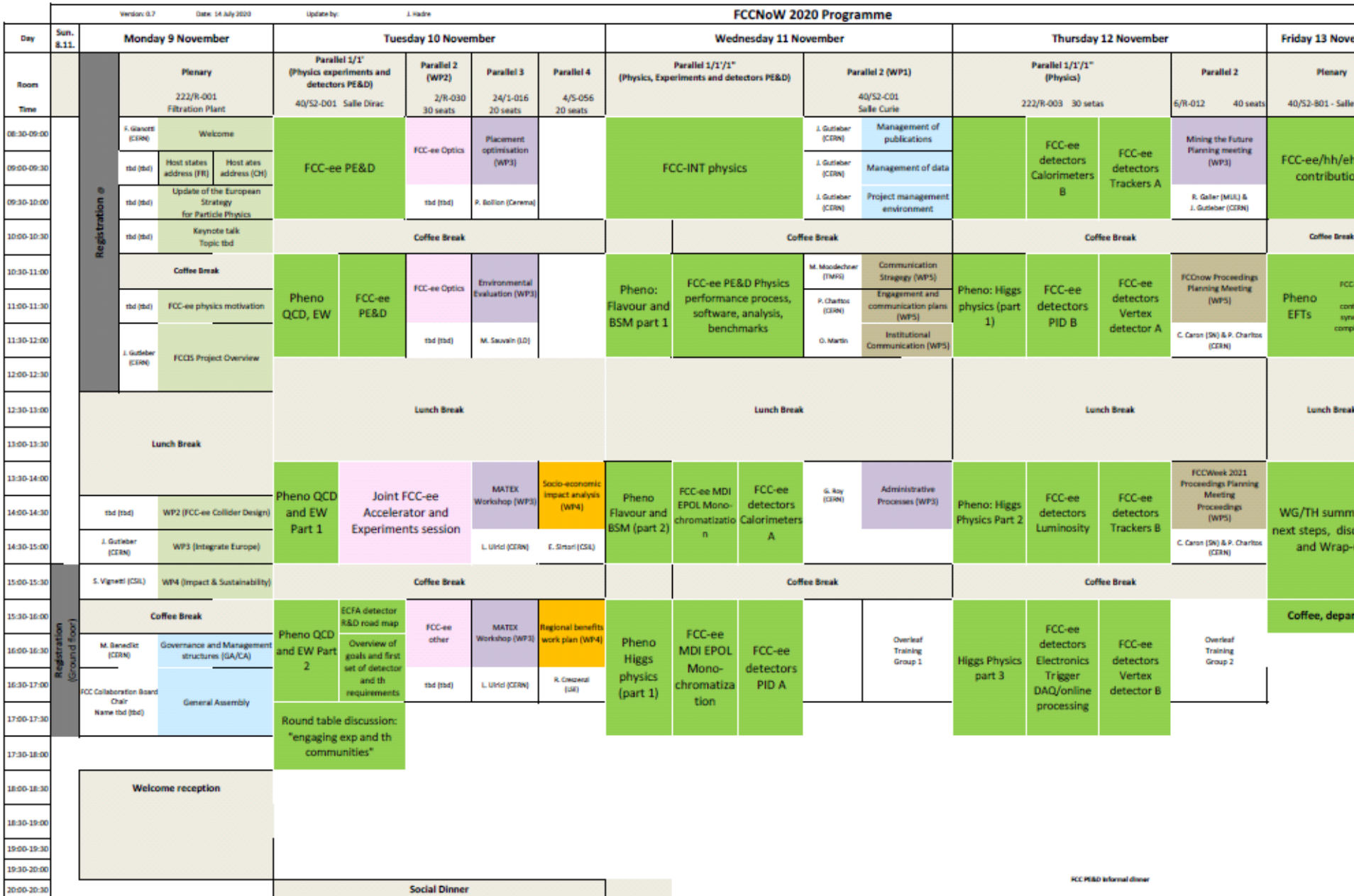
- By 15 September, we would like to receive
  - Your proposals of new physics groups *ex: tau physics, Long Lived Particles, (+FCC-hh)*
  - Your nominations for physics group conveners
    - ➔ Current conveners who want to continue should of course let us know
      Some have already said they could not continue as conveners
    - ➔ Most urgent part of the mandate will be to enlarge international participation

NSIP / Dialog (old slide, où en es t-on ?)

- Possibilité de demander des missions pour les collègues engagés ou s'engageant à au moins 10% de FTE d'ici Septembre 2020.
- Mieux vas ne pas demander pour ceux qui promettent pour 2021 (ils iront aux meetings FCC sur le budget de leur équipe principale).
- Possibilité de demander une gratification de stage (3 ou 4 mois = 1800 ou 2400 E) pour stagiaire M1 ou M2
- Pas de demande de poste cette année
- Pas de demande d'argent R&D cette année
- Possibilité de proposer des thèses conjointes LHC-FCC

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

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



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

Snowmass Contacts

- **Memorandum sent to Snowmass by FCC Physics Coordination**
  - **See following link**

ttps://www.snowmass21.org/docs/files/summaries/EF/SNOWMASS21-EF-RF-TF-IF-CompF-TOPIC0-003.pdf

  - **Snowmass contacts**
    - Overall contact: Markus Klute, plus Alain Blondel, Patrick Janot and Michelangelo Mangano
    - Energy Frontier: Patrizia Azzi and Gregorio Bernardi (FCC-ee), Michele Selvaggi (FCC-hh), Christophe Grojean (Phenomenology)
    - Frontiers in Rare Processes and Precision Measurements: Stéphane Monteil (b and c physics) and Mogens Dam (τ physics)
    - Theory Frontier: Matthew McCullough
    - Instrumentation Frontier: Mogens Dam and Franco Bedeschi
    - Computational Frontier: Luc Poggioli

    Software support can be obtained from the FCC software group (see C. Helsens and G. Ganis in [14]) who will be happy to integrate software contributions.

  - **Task of Snowmass contacts**
    - **Understand what happens at SNOWMASS21 in your track, and inform regularly the FCC physics coordination group.**
    - **Inform and sensitize the Snowmass working groups of the pertinent elements concerning FCC, get FCC members invited to the Snowmass working groups, welcome individual Snowmass group members to work with us.**
    - **As opportunities or questions arise, call for FCC community action.**

Objectif principal : impliquer la communauté américaine dans FCC-ee
Et faire mettre en relief le potentiel supérieur de FCC-ee par rapport à ILC

Software news

- **Good news! Clément Helsens to work with for one more year**
  - In his role of FCC Software co-coordinator (with Gerardo Ganis)
    - "To put the software project in the right state to be used for TDR work"
- **Highest priority item (from Software Coordinator's mandate)**

Summer/Fall 2019: Have a first prototype of software stack usable for FCC-ee physics simulation, with (for example) the beam pipe, a vertex detector, and tracking/vertexing algorithms.

  - Add also b/c tagging algorithm(s) with tracks
    - Based on vertex position, track impact parameters, vertex mass, …
      - ➔ This item will be developed on tracks obtained with Fast Simulation

        Ongoing integration of latest DELPHES will make it possible
      - ➔ And ultimately need the full simulation of a tracker
  - Clément & Gerardo are developing a plan to get it done ASAP
    - Including a plan to get people working on the project

- **MC Generator integration ongoing: please contact Clément and Gerardo**

Case Studies

- A number of case studies have been proposed last year
  - To define detector requirements and benchmarks for detector R&D
    - See https://docs.google.com/document/d/1obwT_QMM0S1LfmRR698fnwoIR_nBwyiVzxN8bjBDb4E
  - Summary of basic needs and name of contact persons are still missing for a number of case studies
    - See https://docs.google.com/spreadsheets/d/1ja0UQC-20NHzYq3FktoIpYuNfLM-oGffA0D4PrVJh9E
  - Everybody is welcome / encouraged to
    - Consult the list
    - Manifest their interest
    - Propose new items
- Obvious synergies with software effort
- Possible synergies with Snowmass 2020-2021
  - Once an entry has a contact person, Letters of Interest (LoI's) can be written
    - After consulting with Snowmass contact persons

Summary of FCC-Phys activities in the French Labs

R. Aleksan, J. Andrea, G. Bernardi, A. Besson, V. Boudry S. Gascon, T. Guillemin,
F. Malek, S. Monteil, N. Morange, S. Muanza, L. Poggioli, R. Salerno, J. Stark

IRFU	Saclay
CPPM	Marseille
IJCLab	Orsay
IPHC	Strasbourg
IP2I	Lyon
LAPP	Annecy
LPC	Clermont
LLR	Palaiseau
LPNHE	Paris
LPSC	Grenoble
L2IT	Toulouse

People involved

Activities, Goals

Physics interest

Algorithms interest,
subdetector interest

Future R& D ?

Previous Lab involvement
in Future Collider R&D

Summary of FCC-Phys activities in the French Labs Conclusions

Physicists involved :

- About 30 permanent physicists involved on FCC (including those by the end of 2020)
- Potential for ~15 more, soon after (2021)
- Large technical teams in all the labs.
- Numbers are significant, % of involvement has to grow, taking into account HL-LHC.

  (Reminder: Accelerator R&D/personpower not covered in this talk)

Wide Physics interest :

- Higgs, Electroweak, Top, Heavy Flavour, QCD, BSM

Algorithms interest,

- b-tagging, particle-ID, Tracking and Calorimeter reconstruction, Particle Flow

Subdetector interest

- Microvertex, P-ID, Tracker, Calorimeter

Future R&D ?

- Exploit current expertise on MicroVertex, Tracking (TPC), and Calorimetry (Calice) ?
  ➔ See round table at 6PM:

  Can FCC(-France) benefit from the ILC(-France) expertise ?

Some General Messages from this Workshop

The French FCC community is in an «Exploration» phase (2019-2021)

- The IN2P3 and IRFU physicists working or starting to work on FCC are getting numerous. Sharing time with Run3/HL-LHC is a challenge but also an opportunity to increase our knowledge
- Expand the current effort to build strong links with the theoretical community which is motivated and very needed for the physics which can be achieved at FCC-ee
- Further refine the detector requirements, mostly through simulation, fast and detailed.
  ➔ need to get more involved in the FCC software effort
- Work on the conceptual development of detectors, along the CLD & IDEA models but also beyond, in particular since the project would benefit a lot from 4 detectors.

The Round table (which included 2 ILC-France, 3 FCC-France + D. Bortoletto, P. Giacomelli and C. Helsens) **"***Can FCC(-France) benefit from the ILC(-France) expertise* **" was successful and constructive**

- Build on acquired expertise. From ILC R&D, develop a few strong lines of R&D
- Try to develop new ideas and also work on generic R&D at this stage
- Collaborate closely between all the ee projects

The Future may arrive faster than we think !

- The «Focus & Consolidation» phases are around the corner: (~2022)
- We may have to soon focus on only a few options to get a strong French contribution
- The size of the community will shape the French contributions: how many (sub-)detectors ?
- Proto experiments/collaborations are expected by 2025/26

Next Steps for FCC(-France)

- **Snowmass** effort begins in the USA
  - US DOE committment to FCC was a very important input to ESPP.
  - Snowmass is a good opportunity to put forward new efforts for FCC

- **Approval of the FCC-Innovation Study**
  ➔ strong motivation to deepen FCC physics and detector studies right away.

- **FCC-IS kick-off meeting @ CERN 9-13 November 2020**
- **4th FCC Physics workshop @ CERN 9-13 November 2020**
  For FCC-ee emphasis on:
  - precision measurements and calculations.
  - BSM aspects of precision, flavour (τ,b), and direct search program
  - flavour program
  - detector requirements from benchmark studies, and new ideas

- **Next FCC-France workshop @ Annecy**, **December or January 2021**
  will cover Accelerator, Detector and Physics (exp&theory)

- **FCC General Meeting @ Paris, April 2021 (following Brussels in 2019)**

Participation/Thanks/Lessons from an online workshop

- 138 Registered participants, thanks to all participants !
- Good attendance to all six sessions (from 50 to 90, stable during the sessions)
- Questions and Round Table were useful to build a link while we are far away from each other
- Hope to see you all soon in person at the next FCC events, including at the next FCC France workshop in Annecy
- Thank you to all speakers, chair and round table members for their nice presentations, and ideas.
- Thanks to IN2P3/CNRS and IRFU/CEA for their support
- Special thanks to our Foreign colleagues for enriching the workshop

General comments

- More opinions ?
- Next workshop, December or January ?

2020 Strategy Statements

Guide through the statements

2 statements on **Major developments from the 2013 Strategy**
a) Focus on successful completion of HL-LHC upgrade remains a priority
b) Continued support for long-baseline experiments in Japan and US and the Neutrino Platform

3 statements on **General considerations for the 2020 update**
a) Preserve the leading role of CERN for success of European PP community
b) Strengthen the European PP ecosystem of research centres
c) Acknowledge the global nature of PP research

2 statements on **High-priority future initiatives**
a) Higgs factory as the highest-priority next collider and investigation of the technical and financial feasibility of a future hadron collider at CERN
b) Vigorous R&D on innovative accelerator technologies

4 statements on **Other essential scientific activities**
a) Support for high-impact, financially implementable, experimental initiatives world-wide
b) Acknowledge the essential role of theory
c) Support for instrumentation R&D
d) Support for computing and software infrastructure

2 statements on **Synergies with neighbouring fields**
a) Nuclear physics - cooperation with NuPECC
b) Astroparticle - cooperation with APPEC

3 statements on **Organisational issues**
a) Global collaboration on projects in and out of Europe
b) Relations with European Commission
c) Open science

4 statements on **Environmental and societal impact**
a) Mitigate environmental impact of particle physics
b) Investment in next generation of researchers
c) Knowledge and technology transfer
d) Cultural heritage: public engagement, education and communication

Letters for itemizing the statements are introduced for identification, do not imply prioritization

See also:

Deliberation Document

on the 2020 update of the European Strategy for Particle Physics

European Strategy : Introductory statements

In the coming decade, the LHC, including its high-luminosity upgrade, will remain the world's primary tool for exploring the high-energy frontier. Given the unique nature of the Higgs boson, there are compelling scientific arguments for a new electron-positron collider operating as a "Higgs factory". Such a collider would produce copious Higgs bosons in a very clean environment, would make dramatic progress in mapping the diverse interactions of the Higgs boson with other particles and would form an essential part of a research programme that includes exploration of the flavour puzzle and the neutrino sector.

The exploration of significantly higher energies than the LHC will make it possible to study the production of Higgs boson pairs and thus to explore the particle's interaction with itself, which is key to understanding the fabric of the universe. Further, through the exploration of a new realm of energies, discoveries will be made and the answers to existing mysteries, such as the nature of dark matter, may be found. The particle physics community is ready to take the next step towards even higher energies and smaller scales. The vision is to prepare a Higgs factory, followed by a future hadron collider with sensitivity to energy scales an order of magnitude higher than those of the LHC, while addressing the associated technical and environmental challenges.

European Strategy : High Priority Future Initiatives

An electron-positron Higgs factory is the highest-priority next collider. For the longer term, the European particle physics community has the ambition to operate a proton-proton collider at the highest achievable energy. Accomplishing these compelling goals will require innovation and cutting-edge technology:

the particle physics community should ramp up its R&D effort focused
· on advanced accelerator technologies, in particular that for high-field superconducting magnets, including high-temperature superconductors;

· 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.

The timely realisation of the electron-positron International Linear Collider (ILC) in Japan would be compatible with this strategy and, in that case, the European particle physics community would wish to collaborate.

The European particle physics community must intensify accelerator R&D and sustain it with adequate resources. A roadmap should prioritise the technology, taking into account synergies with international partners and other communities such as photon and neutron sources, fusion energy and industry. Deliverables for this decade should be defined in a timely fashion and coordinated among CERN and national laboratories and institutes.

Design par FCC-France d'un nouveau détecteur pour FCC-ee ?

FCC detector technology R&D

Need a senior physicist **1) to review and possibly propose adaptation of EP detector R&D to better focus on FCC-ee; and 2) to imagine new detectors to be studied for very specific FCC-ee physics measurements.**

The following is certainly not included right now in the EP detector R&D plan.

-1- Precision knowledge and stability of magnetic field in the experiments, control and monitoring at 10^{-6} level (including all magnetic elements such as compensating solenoids).

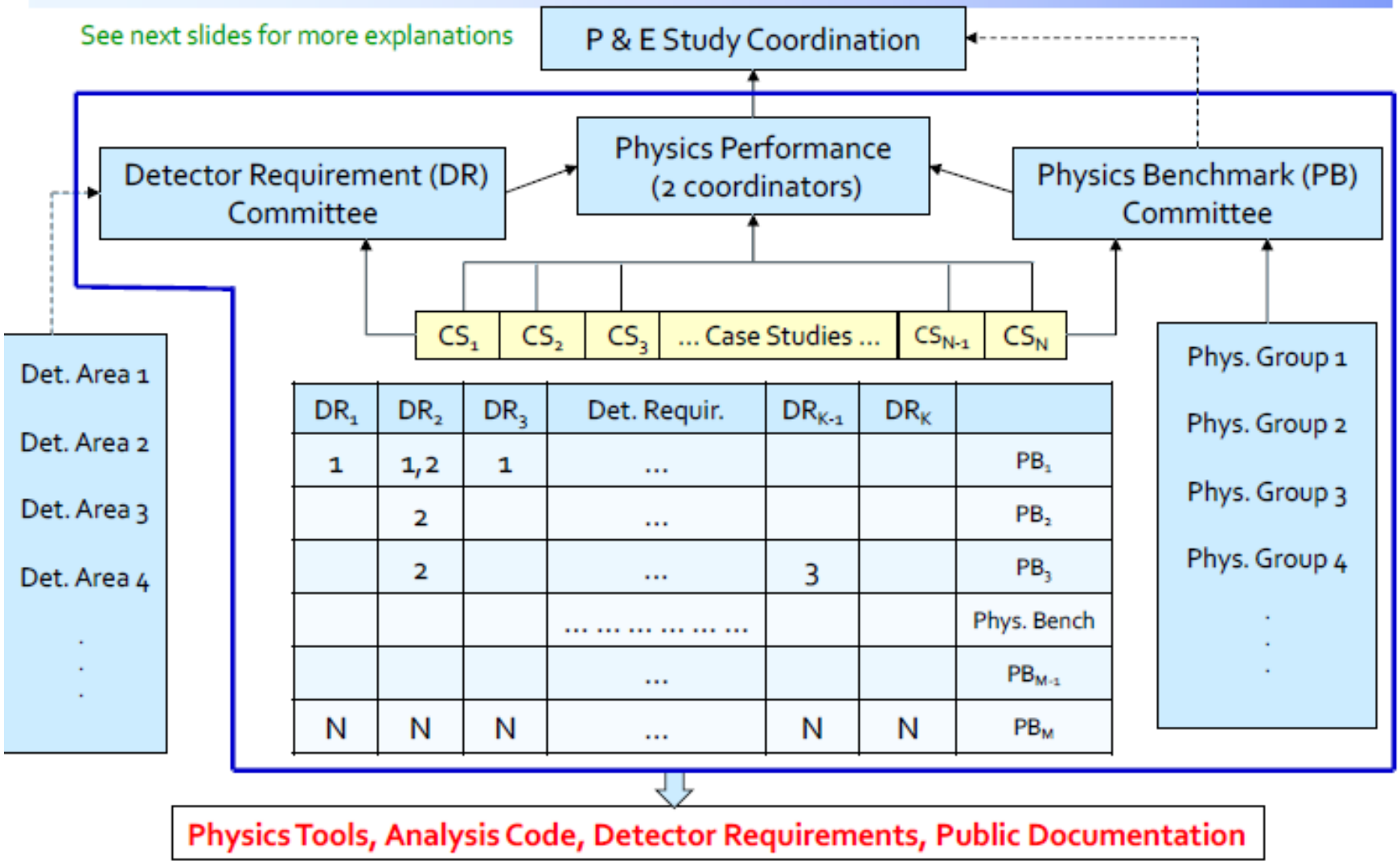
Supervision Matthias Mentink EP
+ 1 fellow

-2- Study and design a possible set of geometry systems to ensure required alignments and fiducials for precision measurements (such as luminosity measurement at low angles or dilepton/diphoton cross sections at large angles, or the tau lepton lifetime)

need to find one supervising engineer + 1 fellow and possibly a tech student

-3- Other aspects of technology R&D are already included in AIDA-innovation or in EP R&D plan
3.1 Liquid Argon calorimeter for FCC-ee detector (Martin Aleksa)
3.2 Development of silicon vertex detectors (Paula Collins)
3.3 CALICE detector (with CLIC group) -- cost reduction
3.4 Dual readout detector (Roberto Ferrari)
3.5 Particle identification detectors (Guy Wilkinson) – but this one needs to be reinforced.

Proposed structure for the PP group



Physics Benchmark and Detector Requirement Committees

Physics Benchmark Committee

- It advises PP coordination by providing input to the process
  - Generates (and updates) a list of FCC-ee physics benchmark measurements
  - Produces an up-to-date a list of case studies (and the corresponding matrix)
    - ➔ Stemming from the benchmark measurements and the anticipated detector requirements addressed by each case study

      [Each cell of the matrix contains one or several case study]
  - Establishes a case-study priority ordering, based on practical considerations

- For each case study, it defines deliverables
  - Detector requirements
  - Physics tools and Analysis code
  - Documentation

- Composition (ad interim)
  - Physics Performance coordinators [chairs]
  - Present Physics Group conveners
  - P&E chairs ex-officio

Detector Requirement Committee

- It oversees the case study process to completion
  - Coordinates development of common physics tools and analysis code
  - Ensures public code availability (analysis and tools) in the common FCC fra
  - Provides technical help when needed
  - Keeps physics tool and analysis code documentation up-to-date
  - Supervises the public documentation (preprints and web)

- It reports to Physics Performance coordination
  - Physics tools development status
  - Detector requirements from each case study
  - Improvements of benchmark measurements
  - Get feedback from the Physics Benchmark Committee (iterative process)

- Composition (at interim)
  - Physics Performance coordinators [chairs]
  - Case Studies contacts and detector area contacts
  - Software coordinators ex-officio

Physics Performance Coordinators

The FCC Physics Performance Project coordination is responsible for the following aspects (in essentially chronological order), with help and input from the FCC Physics, Experiments, and Detectors Steering Group.

- Deliver, document, and maintain, with input from the physics group conveners, a prioritized list of representative FCC-ee physics benchmark measurements; their ultimate statistical uncertainties (assuming full acceptance, and with the standard centre-of-mass energies and luminosities for one experiment); and their limiting systematic uncertainties.

- For each benchmark measurement, propose one or several case study(ies) aimed at delivering requirements for systematic uncertainties to be reduced and match – if possible – the statistical limit. Case studies will be initially focused on establishing the tools needed; review already existing tools either from the first phase of the FCC-ee design study or from other (hadron or lepton) collider efforts; and, together with the "Detector Design" and the "Software" group, develop and implement the corresponding software in FCCSW.

- Gather a growing team of developers and, as needed, case study contacts, in view of (i) delivering operation, detector, and theory specifications required by FCC benchmark measurements; and (ii) support and encourage a worldwide consortium of scientific contributors who can reliably commit resources to the development of the FCC-ee science project in the coming decade.

- With high priority (no later than Spring 2021), deliver a first working case study prototype, with its physics tools, analysis code, detector requirement, and corresponding documentation.

- Progressively, have all ongoing benchmark measurements and case studies documented, both on a user-friendly web interface in the development phase; and in a preprint/publication upon completion, in view of compiling a set of consistent inputs for the Physics CDR.

11 Measurement of the Higgs boson coupling to the c quark

The SM Higgs boson is expected to decay to $c\bar{c}$ with a branching ratio of about 3%. This decay will be extremely difficult to isolate and measure at LHC, but is directly accessible at FCC-ee if an efficient c-tagging algorithm, able to disentangle $c\bar{c}$ decays from other copious hadronic Higgs boson decays ($b\bar{b}$ and gg, and to a lesser extent, ZZ* and WW*) with high purity, can be designed. An ideal (100% efficient and 100% pure) tagging algorithm would yield a measurement of $\sigma_{ZH} \times BR(H \to c\bar{c})$ with a precision better than 1%.

Starting from the related experience developed at LHC and other e^+e^- collider projects, and with the help of the latest machine-learning technologies, such an algorithm will be developed, first with fast simulation, and then in the full context of the constraints from the interaction region and detector layout. The impact of the interaction-region and detector design (beam pipe radius, vertexing, vertex mass determination, tracker material, ...) on the precision $\sigma_{ZH} \times BR(H \to c\bar{c})$ measurement will be studied. As a by-product, similar studies for the $H \to b\bar{b}$ and $H \to gg$ decays will be conducted as well. The need for calibration data at the Z pole will be estimated (frequency, number of events).

- ➡ Measurement of charm quark Yukawa coupling (b and gluon)
- ➡ Starting from LHC and lepton collider experience and using DNN
- ➡ First studies with fastSim (Delphes) and later with fullSim taking constraints of interaction region and detector layout into account as well as available calibration data
- ➡ Goal: understand/optimize performance with modern detector, 1cm radius beam pipe and very clean experimental environment. Find best compromise between granularity and low mass detector, use of PID. Add analysis at Z (10^{12} bb events!) to understand self –calibration and systematics.

Physics Performance Coordinators

Patrizia Azzi
Emmanuel Perez

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The Physics Group conveners are the backbone of the Physics Benchmark committee

Physics groups: Nominations wanted !

- **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)

Black = exp.
White = 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 → H D. d'Enterria
QCD and γγ physics D. d'Enterria P. Skands	Flavours physics S. Monteil J. Kamenik	New physics M. Pierini, C. Rogan M. McCullough, S. Heinemeyer	Global Analysis Synergies J. De Blas	Precision Calculations J. Gluza, A. Freitas

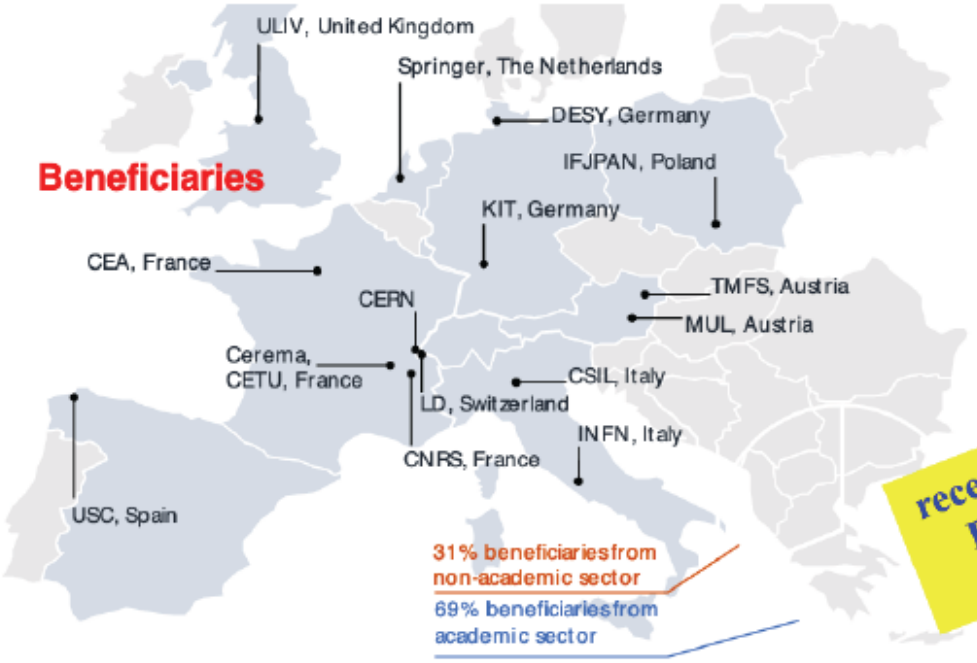
- **By 15 September, we would like to receive**
  - Your proposals of new physics groups (tau, LLP, ...)
  - Your nominations (including self) for physics group conveners
    - ➔ Current conveners who want to continue should of course let us know
      Some have already said they could not continue as conveners
    - ➔ Most urgent part of the mandate will be to enlarge international participation

Deadline extended until 15 October

Possible creation of LLP and tau groups

H2020 FCC Innovation study 2020-2024

Beneficiaries



Partners

- D.R.R.T. (F)
- Etat de Geneve (CH)
- DOE (US)
- BINP (Ru)
- U Oxford (UK)

recently accepted for funding by the European Commission with the highest achievable score

Design optimisation, construction planning, environmental impact assessment, management of excavation materials, user community building and public engagement, socio-economic impact,…

Preparatory work with Host States

General secretariat of the region Auvergne-Rhône-Alpes and notified body "Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement" CEREMA

Working group with representatives of federation, canton and state of Geneva and representation of Switzerland at the international organisations and consultancy companies

- Administrative processes for project preparatory phase developed.
- First review of tunnel placement performed.
- Requirements for urbanistic, environmental, economic impact, land acquisition and construction permit related processes defined.
- **Ongoing: common optimization of collider tunnel and surface site infrastructure implementation.**

FCC-IS Kick-Off Meeting (9-13 Nov)

- **Monday Morning Plenary Session – see https://indico.cern.ch/event/923801/**

Day	Monday 9 November			
Room	Registration	Plenary		
Time		(Chair: Joachim Mnich, tbc)		
08:45-09:00		Jorgen d'Hondt (tbc)	Welcome	
09:00-09:30		tbd	Host states address (FR)	Host states address (CH)
09:30-10:00		U. Bassler (tbc)	Update of the European Strategy for Particle Physics	
10:00-10:30		F. Gianotti	CERN vision and goals until next strategy	
10:30-11:00		Coffee Break		
11:00-11:30		C. Grojean	FCC-ee physics motivation	
11:30		M. Benedikt	FCCIS Project Overview	

Experiment & Detector session co

SESSION Alain, Patrick	present timing (indicative)	conveners
FCC-ee Physics performance session	Wedesday 11-12:30	Patrizia Azzi Emmanuel Perez
MDI, Polarization, Monochromatization	Tuesday 13:30-15:00 Wednesday 14-15:30 Wednesday 16-17:30	Nicola Bacchetta Manuela Boscolo Angeles Faus Golfe Jorg Wenninger
FCC-ee detectors: calorimeters	Wednesday 14-15:30 Thursday 11-13:00	Martin Aleksa Franco bedeschi
FCC-ee detectors: PID	Wednesday 16-18:00 Thursday 9-10:30	Guy Wilkinson Stéphane Monteil
FCC-ee detectors: Vertex detector	Thursday 9-10:30 Thursday 16-17:30	Auguste Besson Paula Collins Andeas W. Jung
FCC-ee detectors: Tracker	Thursday 11-13:00 Thursday 14:00-15:30	F. Grancagnolo Dominik Dannheim Bernhard Ketzer
FCC-ee detectors Luminosity monitor	Thursday 14-15:30	Mogens Dam xx
FCC-ee TDAQ, Electronics	Thursday 16-17:30	Christos Leonidopoulos Richard Brenner Niko Neufeld, Beat Jost

Name

BEDESCHI, Franco

BESSON, Auguste

GRANCAGNOLO, Francesco

ALEKSA, Martin (EP-ADO-AM)

AZZI, Patrizia (EP-UCM)

BACCHETTA, Nicola (EP-UCM)

BLONDEL, Alain (EP-UGC)

BRENNER, Richard (EP-UAT)

COLLINS, Paula (EP-LBD)

DAM, Mogens (EP-UAT)

DANNHEIM, Dominik (EP-DT-TP)

FAUS-GOLFE, Angeles (EP-UC3)

JANOT, Patrick (EP-CMG)

JOST, Beat (EP-LBC)

JUNG, Andreas (EP-UCM)

KETZER, Bernhard (EP-UFT)

LEONIDOPOULOS, Christos (EP-UAT)

MONTEIL, Stephane (EP-ULB)

NEUFELD, Niko (EP-LBC)

PEREZ, Emmanuel Francois (EP-CMG-OS)

WENNINGER, Jorg (BE-OP-LHC)

WILKINSON, Guy (EP-ULB)

FCC-ee : Evolution dans les différents pays

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)

- **Germany**: Transforming their ILC allianz into a future ee machines allianz (F. Simon)

- **Spain**: starting within a national 'future colliders' structure (Juan Alcaraz)

- **Poland**: (T. Lesiak) planning FCC information day at Epiphany conference in January.

- **Switzerland** well in the road map, CHARD for accelerator (e+ source) discussions on towards effort FCC funding. CH unambiguously supported FCC-INT project.

- **Belgium** and **Netherlands** (just starting, contact Freya Blekman)

- **CERN: creation of EP/FCC group is commissioned to EP dep. head (Contact: P. Janot)**

- Contacts **USA, Austria, Estonia** etc.. have been initiated – to be followed.