FCC-contacts – July 21

- News
  - stratégie Européenne/Réaction (II), ILC-France, Snowmass
  - News de FCC-ee
  - Choix des case studies

  - NSIP / Dialog / input L. Vacavant
  - Workshop d'Annecy

- Tour de Table

- AOB

European Strategy : Comments

The ESPP is out and unanimously approved by the member states

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.

Cf next page for message on ILC

European Strategy : FCC-ee vs. ILC en France

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.

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

Réaction ILC-France ?

The Snowmass process

Long-term planning exercise for the particle-physics community.

- "Develop community long-term physics aspirations."
- "Communicate opportunities for discovery in particle-physics to broader community and to the (US) government."

(Young-Kee Kim, DPF Chair, Town-Hall Meeting, 2020 April APS meeting)

Physics-driven effort.

- Covers all areas of particle physics and facilitates cross-cutting.
- Develop overarching physics studies.

Global effort.

- Input from non-US community is essential.
- Input from recent international studies, for example HL-LHC, European Strategy Particle Physics Update (ESPPU), future colliders etc.

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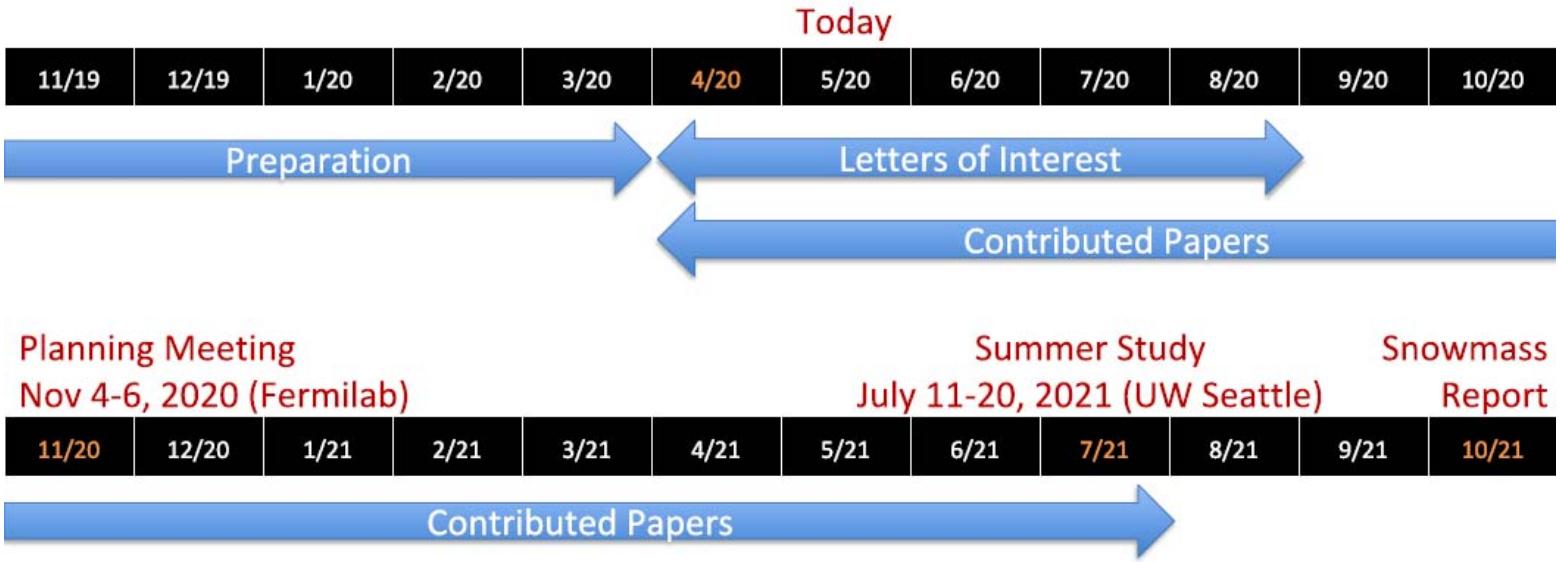


Energy Frontier Workshop - Open Questions and New Ideas

20 juil. 2020 à 10:00 → 22 juil. 2020 à 17:00 US/Eastern

Workshop Goals — *Alessandro Tricoli et al.* — 10:30 - 11:00

European Strategy Group report — *Halina Abramowicz* — 11:00 - 11:30

Monte Carlo Task Force activities and plans — *John Stupak* — 11:30 - 12:00

Break — 12:00 - 13:30

Early Career Scientist Chat — *Amber Roepe et al.* — 12:15 - 13:15

CepC - Open Questions and New Ideas — *Manqi Ruan* — 13:30 - 13:55

FCC-ee - Open Questions and New Ideas — *Markus Klute* — 13:55 - 14:20

ILC - Open Questions and New Ideas — *Michael Peskin* — 14:20 - 14:45

CLIC - Open Questions and New Ideas — *Aidan Robson* — 14:45 - 15:10

Future Hadron Colliders - Open Questions and New Ideas — *Heather Gray* — 15:10 - 15:35

Future Electro-Proton and Electron-Hadron Colliders - Open Questions and New Ideas — *Nestor Armesto*

Higgs physics - Open Questions and New Ideas — *Hitoshi Murayama* — 10:00 - 10:30

Electroweak Physics - Open Questions and New Ideas — *Jorge de Blas* — 10:30 - 11:00

Strong Interactions - Open Questions and New Ideas — *Thomas Gehrmann* — 11:00 - 11:30

BSM Physics - Open Questions and New Ideas — *Marcela Carena* — 11:30 - 12:00

Break — 12:00 - 13:28

Zoom link for EF01-04 parallel sessio (auto-captioning with otter.ai)

Zoom link for EF08-10 parallel sessio (with auto-captioning using otter.ai)

Zoom link for EF05-07 parallel sessi — 13:29 - 13:30

Precision QCD Physics Input to European Strat... — *Gavin Salam*

LLP benchmarks Introduction — *Brian Shuve*

Forward QCD facility: brainstorming session — *Maria Vittoria Garz...*

Discussion — 13:50 - 14:00

LLP benchmarks Discussion

FCC Main Goals (2020-2026)

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.

Conclusion

- **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
- Ambitious program aiming for significant progress in understanding of nature
- Main challenge is to imagine/optimize detector to match statistical power and to sharpen the theory calculations
- Last but not least: an essential springboard towards 100 TeV pp collisions

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

- development of detector concepts matching the requirements

- intensify theoretical developments esp. precision calculations

➔ French FCC contacts (tbc) : G. Cacciapaglia, B. Fuks

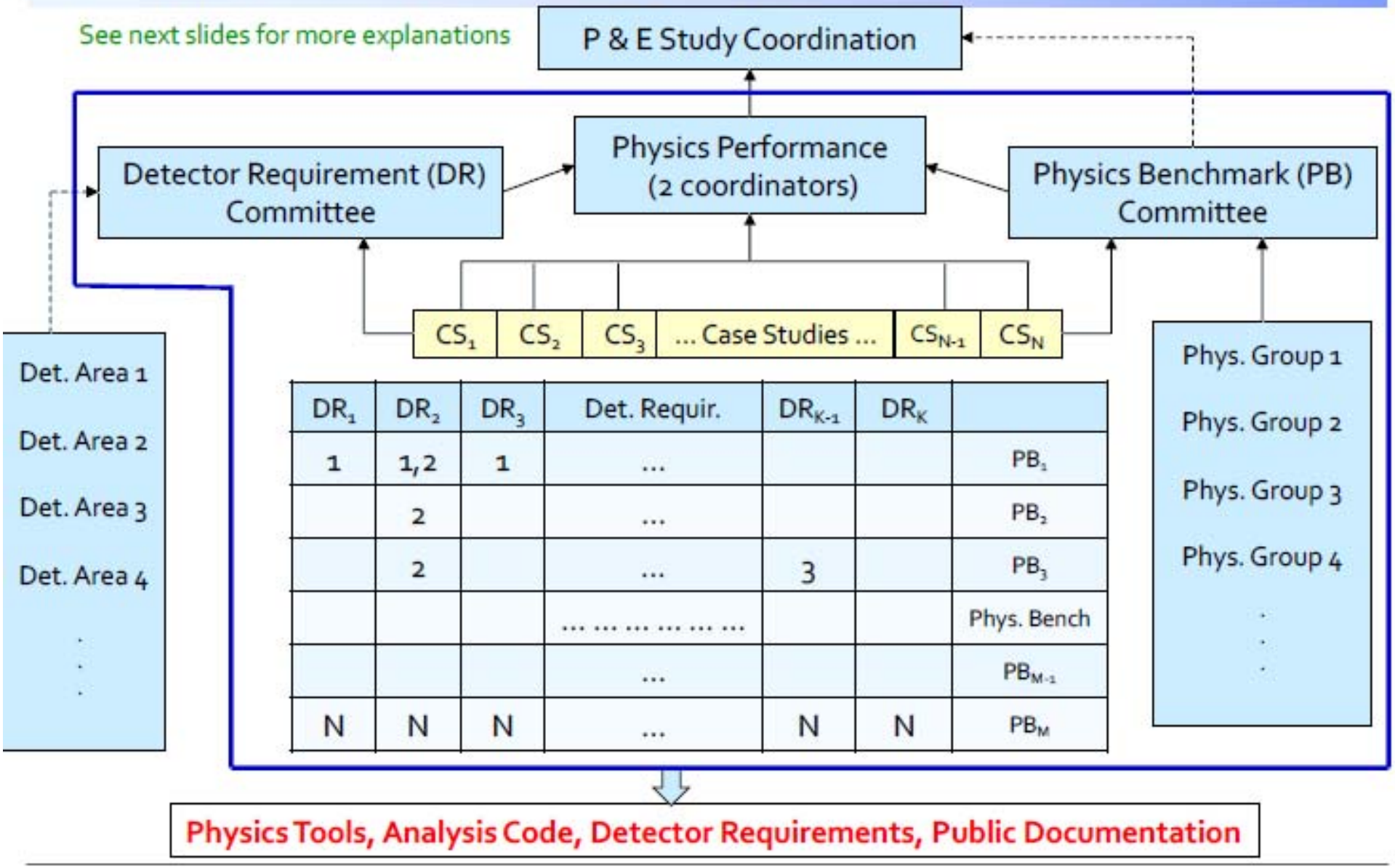
- physics studies (benchmark case studies towards detector requirements)

➔ new structure

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)

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.

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Patrizia Azzi

Emmanuel Perez

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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

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

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, Top, Theory, misc

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

FCC-ee : Case studies Higgs

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 $e^+e^- \rightarrow H$ production at the Higgs pole

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.

FCC-ee : en France

- Organisation du master-projet à l'IN2P3
- Réunion ressources avec Laurent
- Date du workshop d'Annecy

Cadrage général pour 2020 pour les visites d'équipes "Particules & Hadronique"

Cadre: Après une première visite l'an dernier, je souhaite discuter essentiellement avec les équipes de leur projet scientifique à disons 5 ans.

Processus:

1. ces jours-ci: discussion si besoin du cadrage entre le responsable d'équipe (RE) et le DAS
2. organisation/poursuite par le RE de la discussion dans l'équipe sur le projet scientifique à 5 ans
3. envoi du projet scientifique ou de son ébauche au DAS si possible pendant l'été
4. envoi du projet scientifique et des autres informations au DAS avant le 15 septembre
5. visite d'équipe en septembre-octobre, dans la mesure du possible (vu la compression du calendrier et les EAP, je ne pourrai pas me rendre dans tous les labos, et il n'est pas certain que je puisse accommoder tout cela en visio non plus, on fera au mieux)

Projet scientifique:

Il s'agit de présenter le projet scientifique de l'équipe pour les cinq prochaines années, ainsi que l'évolution ultérieure envisagée. Le format du document est libre (mais 5 pages maximum de texte). Le format demandé aux équipes par l'HCERES peut servir d'exemple, en particulier l'analyse SWOT peut être intéressante, par contre la partie scientifique devra être plus étoffée. Si besoin, expliciter l'articulation avec les discussions en cours dans le cadre des prospectives.

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

Workshop Annecy

Avec le retour progressif en présentiel nous pourrions confirmer la date de Décembre pour le prochain workshop FCC-France, avec une partie accélérateur comme on l'avait mentionné il y a un certain temps.

Le LAPP a confirmé sa disponibilité du :

mercredi 9/12 13h au vendredi 11/12 13h00

ceci permettrai un déplacement sur 3 jours

il y aurait aussi une connection on-line.

Tour de Table

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

Next meeting: Jeudi 17 Septembre, 10H