

FCC-contacts / October 21st 2022

- News FCC / ECFA / IN2P3
- Debrief FCC-Lyon / Where in 2023 ?
- Tour de table
- Proposition d'organisation pour la mid-term review du feasibility study
- AOB / Calendrier des prochaines réunions

Discussion with the management

- **We met with Joachim Mnich (CERN, research director) on Tuesday, 29 Nov.**
 - ◆ **We were specific about the resources (or lack thereof) devoted to FCC PED**
 - With a possible impact on the PED deliverables
 - More importantly, with the real impact on the morale of people in the PED coordination group
 - ◆ **We urged him once more to create a specific FCC group in CERN/EP**
 - Be it only to send a strong signal that FCC is the flagship project in Europe
 - But also to give a home to the CERN users willing to work on FCC
 - ◆ **We asked him to encourage CERN/EP staffs and fellows to participate in FCC studies**
 - With specific suggestions of concrete incentives, rather than only words

- **Joachim promised to think about it**
 - ◆ **As he did last year, when Alain and I had very similar pleas**
 - He was adamant that the highest priority was to complete the upgrade work for HL-LHC
 - They are also assessing the luminosity actually needed to reach the HL-LHC goals

Increase willingness to participate to PED

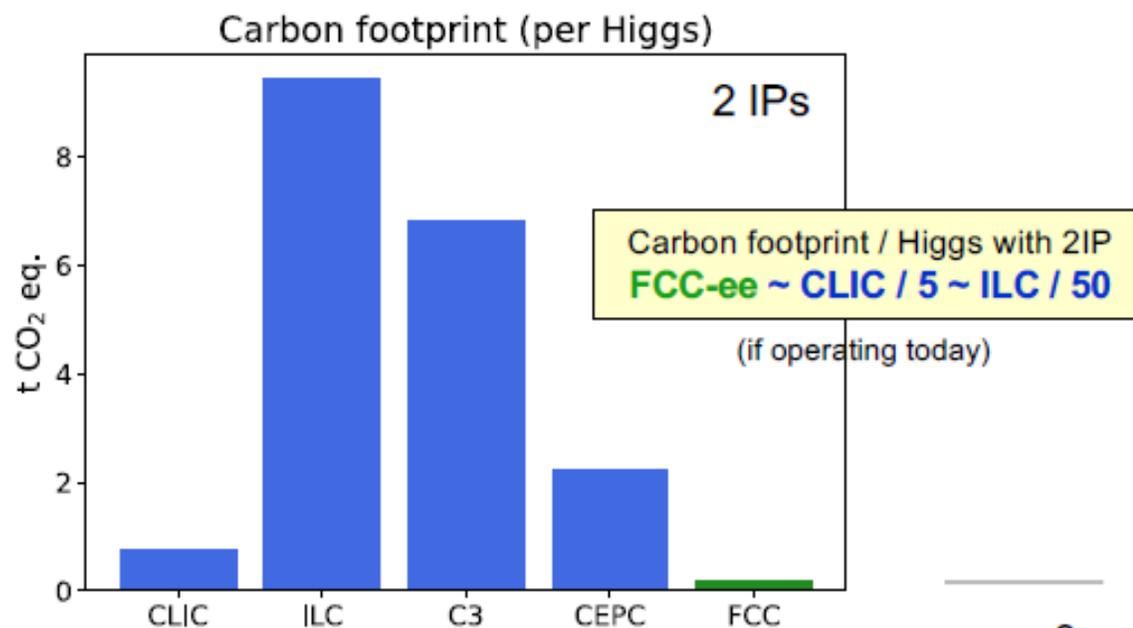
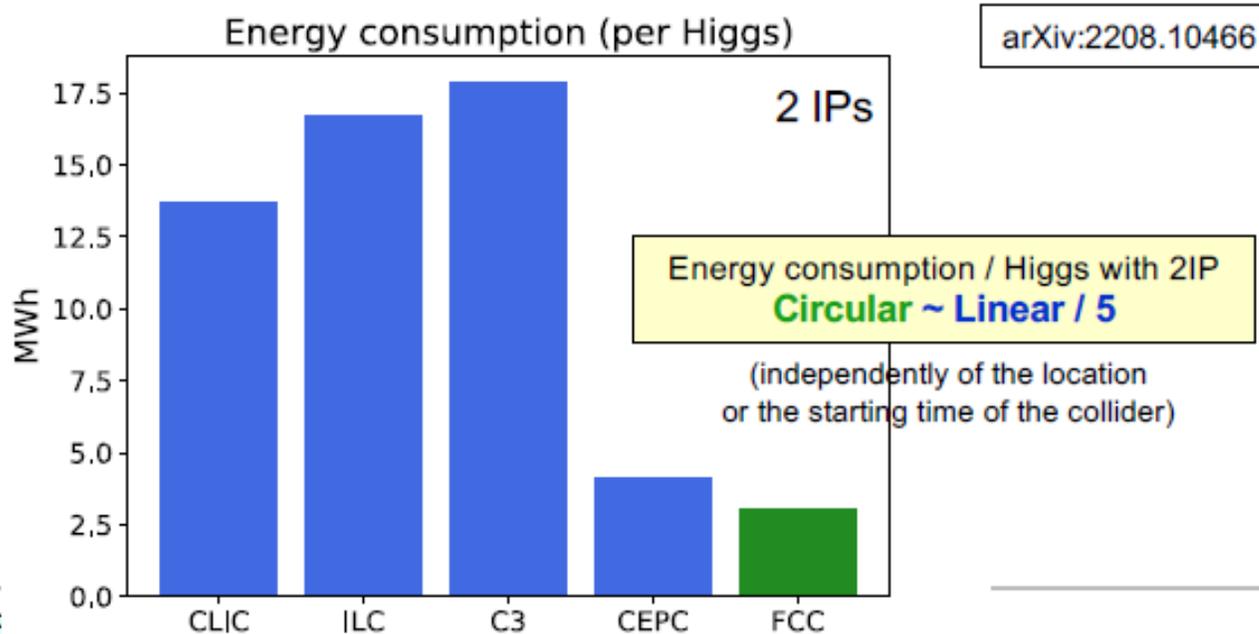
- We met with Ties Behnke (ILD) on Tuesday this week (13 Dec)
 - ◆ Ties (or another ILD colleague) will be part of the FCC PED Steering group
 - ◆ Resources allowing, possible contributions are already envisioned
 - Luminosity measurement and luminosity calorimeter in the interaction region
 - Estimate of the backgrounds in the TPC + Calo, especially at the Z pole (rate) and the top (SR)
 - Reduction of the calorimeter granularity, to account for the lower jet energies wrt ILC
 - Integration in the interaction region (MDI)
 - Ongoing participation in the software (key4hep, edm4hep, and detector simulation)

- We met with Marc-André Meier (Atlas, BNL) on Tuesday last week (6 Dec)
 - ◆ 12+ staff physicists and 5+ post-docs
 - And one post-doc position offered in a mail sent to FCC-PED-FeasibilityStudy
 - ◆ Interests in physics, detectors, and interaction region magnets
 - ◆ Current physics interests (ATLAS biased) comprise
 - Higgs to charm, Higgs self coupling, flavour tagging (with ATLAS experience)
 - BSM Higgs decays, e.g., Higgs to invisible
 - ◆ Detector interests cover tracking, timing, noble liquid calorimeters
 - ◆ They do have people interested in software and in machine-detector interface (e.g., lumi)

- They are organizing a US-FCC workshop at BNL, April 24-28, 2023
 - ◆ Michelangelo and Tor are in the program committee

Energy consumption and carbon footprint @ 240 GeV

- Our first responsibility (as particle physicists) is to do the maximum of science From SPC talk
 - ◆ With the minimum energy consumption and the minimum environmental impact for our planet
 - Should become one of our top-level decision criteria for design, choice and optimization of a collider
- All Higgs factories have a “similar” physics outcome (ESU’20 and Snowmass’21)
 - ◆ Natural question: what is their energy consumption or carbon footprint for the same physics outcome?
 - Circular colliders have a much larger instantaneous luminosity and operate several detectors
 - FCC-ee is at CERN, where electricity is already almost carbon-free (and will be even more so in 2048)



Energy consumption and carbon footprint @ 240 GeV

□ We still want to (and must) improve and optimize these figures for FCC-ee

- ◆ Operate four detectors instead of two (unique to circular colliders)

From SPC talk

Energy consumption / Higgs with 4IP
Circular ~ Linear / 10

Carbon footprint / Higgs with 4IP
FCC-ee ~ CLIC / 10 ~ ILC / 100

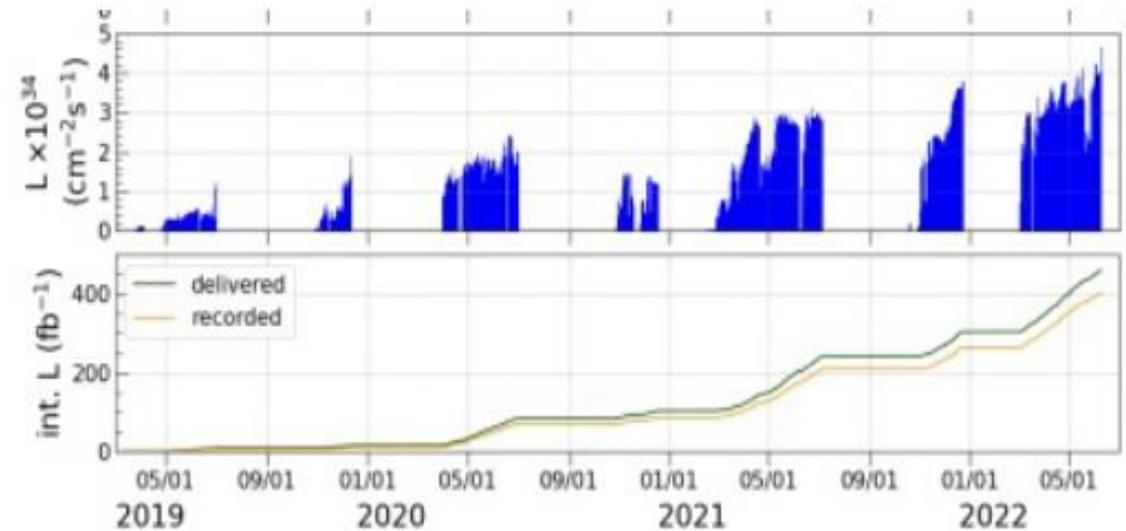
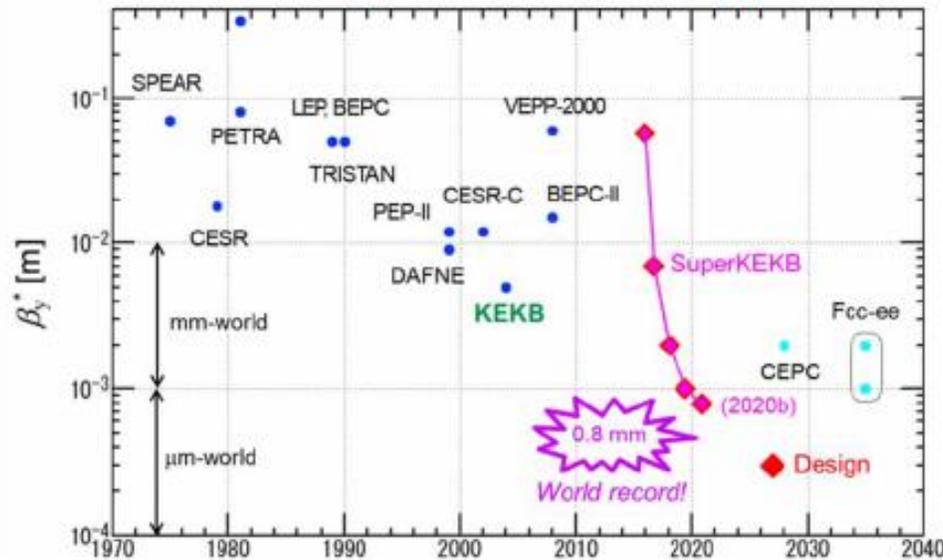
- **Would also maximise the science value for the investment (Part III of this presentation)**
- ◆ Further improve the specific luminosity (e.g., by decreasing β_y^*)
- ◆ Decrease the power demand for a given current (ongoing R&D)
 - e.g., High-Q cavities; HTS quadrupoles and sextupoles; Higher efficiency klystrons
- ◆ Operate the collider only when carbon-free energy is available
- ◆ Generalise heat recovery for neighbouring domestic heating
- ◆ Decreasing the current (i.e., the luminosity) by decreasing the RF power by a factor 5?
 - **Not a very good idea: Energy consumption & carbon footprint / Higgs increases by a factor 3**

SuperKEKB as a FCC-ee demonstrator

- Tested successfully FCC-ee-type “virtual crab waist collisions”

K. Oide, Phys. Rev. Accel. Beams 19, 111005)

- Run routinely with smallest β_y^* ever considered for FCC-ee: 1mm and 0.8mm



- World-record luminosity of $4.71 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$, and counting.

- e^+ production rate similar to FCC-ee: feasibility shown

From SPC talk (backup)

- ◆ Top-up injection with short beam lifetime (< 10 mins) demonstrated

SuperKEKB challenges

From SPC talk (backup)

- **Design luminosity was too optimistic**
 - ◆ Twice larger than simulated for ideal case w/o impedance and w/o errors
 - By contrast, FCC-ee luminosity projections are not guessed. They are simulated, with impedance and errors
- **Sudden beam losses, presently avoided by bunch currents significantly lower than design**
 - ◆ Such losses did not occur in previous machines (PEP-II and KEKB), even at much higher currents
 - Reason not yet identified, but seems specific to SuperKEKB (Feedback noise? Dust? ...?)
- **Overlap of solenoid field and final focus quadrupole field**
 - ◆ Aberration tentatively corrected (maybe not successfully?) by skew sextupoles
 - By contrast, FCC-ee design perfectly separates the solenoid and final quads
- **Big emittance blow-up in the injection line (by factors 10-100 from Linac to collider)**
 - ◆ This transport line is inherited from TRISTAN and KEKB, which did not require low emittance
 - By contrast, FCC-ee will have a new transport line, with new magnets, and w/o sharp bends
- **Vertical emittance still 3-5 times too large and β_y^* still 3-4 times larger than design**
 - ◆ Progress are slow down by the limited IR aperture and the large emittance of the injected beam

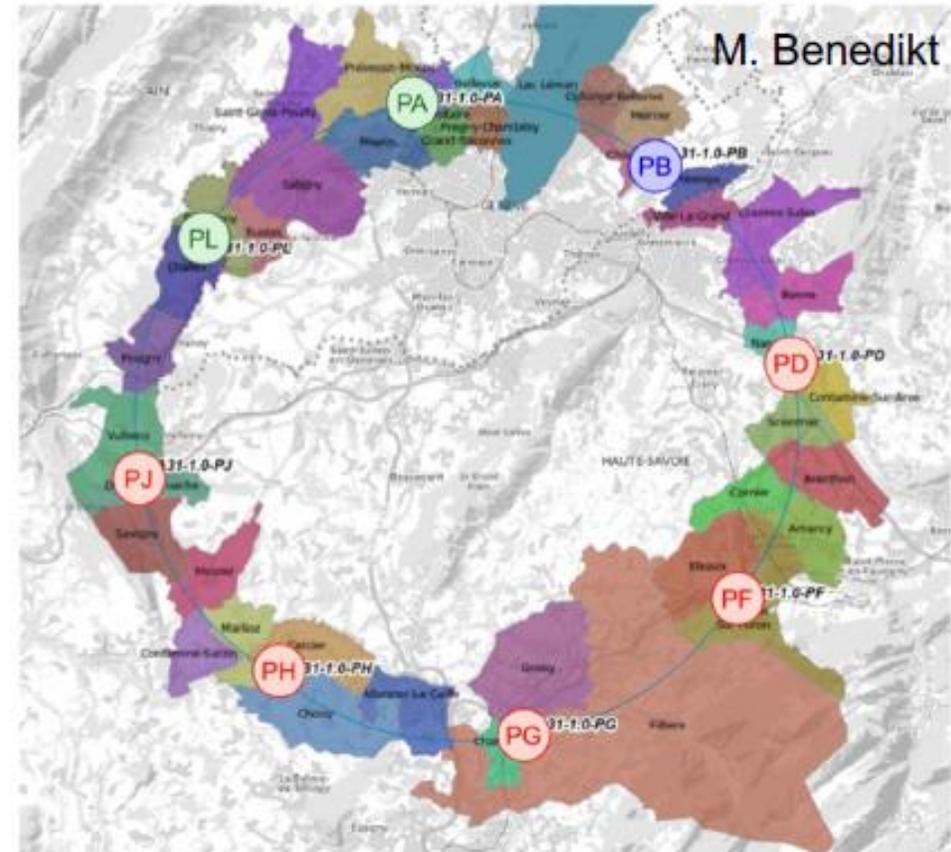
Lessons learnt towards FCC-ee

FCC is becoming very concrete !



FCC placement working hypothesis PA31-1.0/2.x/3.0

1. **PA** – Ferney Voltaire (FR) – site scientifique
2. **PB** – Choulex/Presinge (CH) – site technique
3. **PD** – Nangy (FR) – technique (P1), scientifique (P2)
4. **PF** – Etaux/La Roche-sur-Foron (FR) - technique
5. **PG** – Charvonnex/Groisy (FR) - scientifique
6. **PH** – Cercier/Marlioz (FR) – technique, RF
7. **PJ** – Vulbens/Dingy en Vuache (FR)
- technique (P1), scientifique (P2)
8. **PL** – Challex (FR) – technique, RF



FCC is becoming very concrete !



First meetings with communes concerned in France and Switzerland
(Recipients of letters dated 11 and 20 October 2022)

France : 31 communes

Suisse : 10 communes

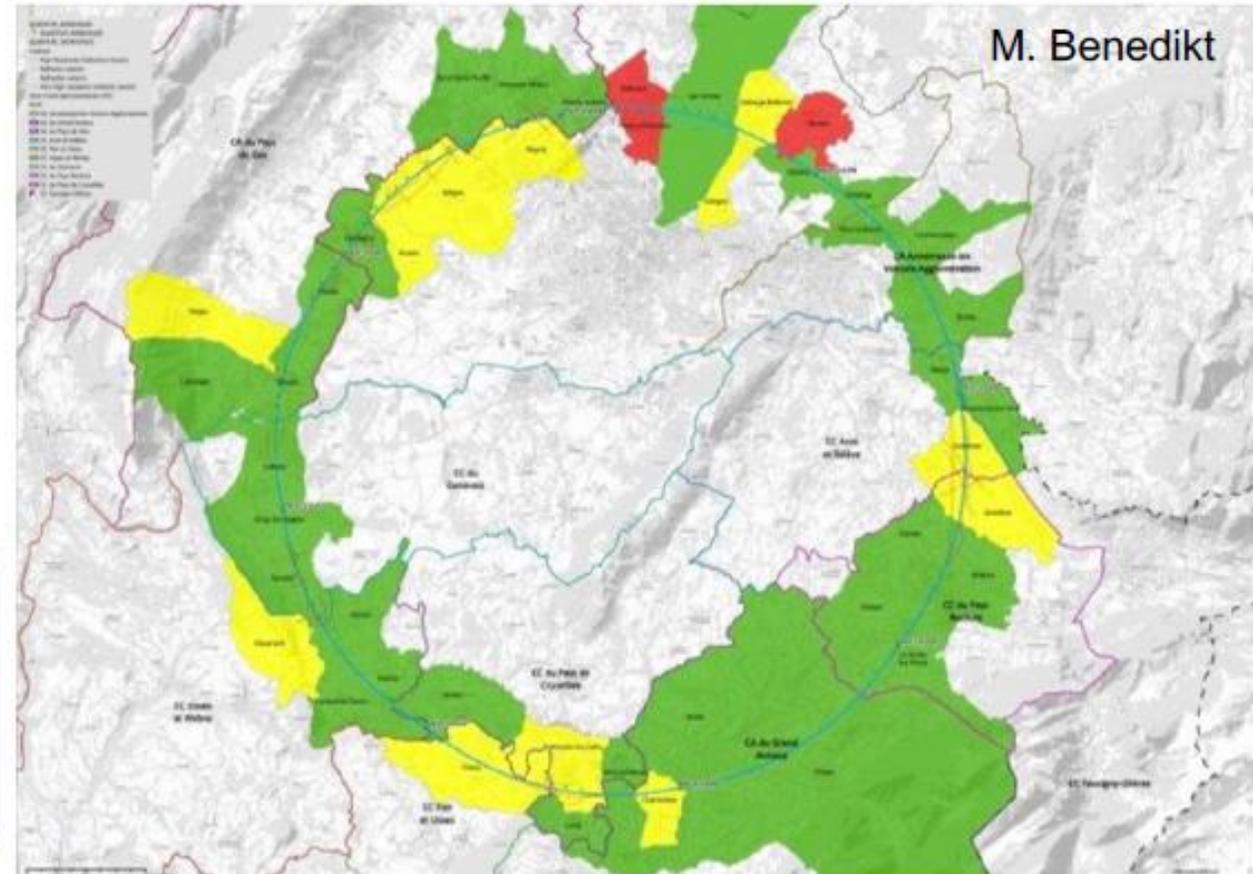
Légende

Commune :

Rencontrée

Rendez-vous proposé / programmé

Contactée – sans réponse



FCC-IS workshop, 5-9 Dec., [link](#)

- **First FCC General Meeting on Monday, to be repeated every ~4 months**
 - ◆ **With presentations providing an overview the entirety of the feasibility study**
 - **Feedback (in particular in comparison with our monthly PED general meetings) ?**
- **First meeting of the Scientific Advisory Committee (SAC), chair A. Parker**
 - ◆ **Composition: R. Bartolini, B. Gavela, K. Huitu, P. Krizan, P. Lebrun, P. McIntosh, M. Minty, A. Parker, K. Shibata, R. Tenchini (+ M. Benedikt and F. Zimmermann)**
 - **Underlined names will review the PED part of the mid-term review report (Editor: A. Parker)**
 - **Skeleton for the document available in February/March 2023. Andy will enquire with SPC chair on the document length.**
 - ◆ **Topics of discussion mostly referred to the FCC-ee physics case presentation**
 - **Energy consumption and carbon footprint : absolute rather than relative ?**
 - **Number of IPs: 2 or 4 ? (Larger community vs. communication with politicians)**
 - **Sequence of energy thresholds: Starting with the Higgs or the Z ? (Z running not appealing for the youngsters)**
 - **Increase of the overall duration? (Must not appear as a threat to FCC-hh)**
 - **Stress that FCC-ee is a "door" to FCC-hh. (Mind the comment from Montgomery)**
 - **Increase of luminosity: lifetime will be the limitation (*)**
- **(*) Highlight of the week (imho): FCC-ee optics design from scratch by Pantaleo Raimondi**
 - ◆ **Much larger momentum acceptance & dynamic aperture, hence larger lifetime**

FCC mid-term review - technical deliverables:

FCC Scientific Advisory Committee acts as reviewing body

M. Benedikt

- 5/6 December 2022 First SAC meeting, full day of overview presentation of FCC FC and ½ day closed session with study management, working methodology of SAC
- March 2023 SAC meeting to discuss detailed planning for submission of individual deliverables and responsibilities inside SAC
- 5 – 9 June 2023 FCCW Presentations of major part of deliverables, interaction with study management
- End September 2023 All deliverables available in final form for SAC.
- Begin October 2023 SAC mid-term review meeting with all deliverables, interaction with FCC management and launch of SAC review report preparation
- End October 2023 SAC report available for SPC

6th FCC Physics Workshop

- Krakow, Jan. 23-27, 2023: <https://indico.cern.ch/event/1176398/>
- Jagiellonian University, 5 mn walk from the city centre, 10 mn walk from Wawel Castle
- 20-30 mn to airport by taxi, 45 mn to airport by public transport
- Registration fees: ~ 200 EUR, incl.: day-long coffee breaks, lunches, conf. dinner
- Expected # participants: 150-200 (Liverpool had 642 registrants - remote)
- All coordinators and physics group conveners are supposed to go. And that they should invite as many people as possible! We'll make sure that everyone who is interested could give a talk.

— Main Goals —

- prepare Mid-Term Report and Full Feasibility Study Report
- monitor progress
- strengthen the FCC PED community
- strengthen FCC physics case

Program outline

- In-person meeting
- Plenary only (possibility of one day of parallel sessions will be discussed in the SPC)
- Monday morning to Friday afternoon
- Two evening sessions (8pm-10pm)
- Excursion and dinner: Thursday afternoon/evening:
 - 3pm-4pm buses departs
 - 4pm-7pm excursion
 - 7-10pm dinner
 - 10pm-11pm bus back
- Sessions (FCC-ee & FCC-hh)
 - Precision incl. EW, Higgs, QCD, Flavour
 - BSM
 - Detectors
 - EPOL
 - MDI
 - Software
 - Complementarity studies

New IN2P3 / Journée Projets

SMPP: le modèle standard (et au-delà?) de la physique des particules

ATLAS: 87 ETP CH [# {67 ch, 32 doc, 9 pdoc}] 58 ETP IT [# {116}] L.Serin (IJCLab)

CMS: 46 ETP CH [# {38 ch, 17 doc, 7 pdoc}] 32 ETP IT [# {60}] D.Contardo (IP2I)

FCC-Phys: 3 ETP CH [# {15 ch, 1 doc, 0 pdoc}] G. Bernardi (APC)

INDE: les détecteurs innovants

CALICE: 5 ETP CH [# {11 ch, 1 doc, 0 pdoc}] 4 ETP IT [# {22}] J-C. Brient (LLR)

CMOS: 3 ETP CH [# {4 ch, 0 doc, 1 pdoc}] 8 ETP IT [# {20}] M. Winter (IJCLab)

DICE: 1 ETP CH [# {2 ch, 1 doc, 0 pdoc}] 3 ETP IT [# {11}] M. Barbero (CPPM)

LHCb-CALO2: P. Robbe (IJCLab)

PCle400: 0 ETP CH [# {0 ch, 0 doc, 0 pdoc}] 4 ETP IT [# {15}] JP. Cachemiche (CPPM)

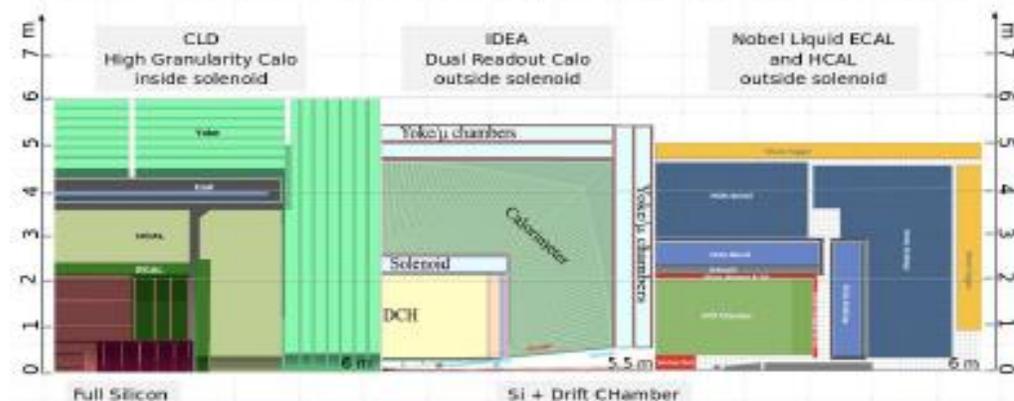


SMPP/CPVQ: FCC-Phys

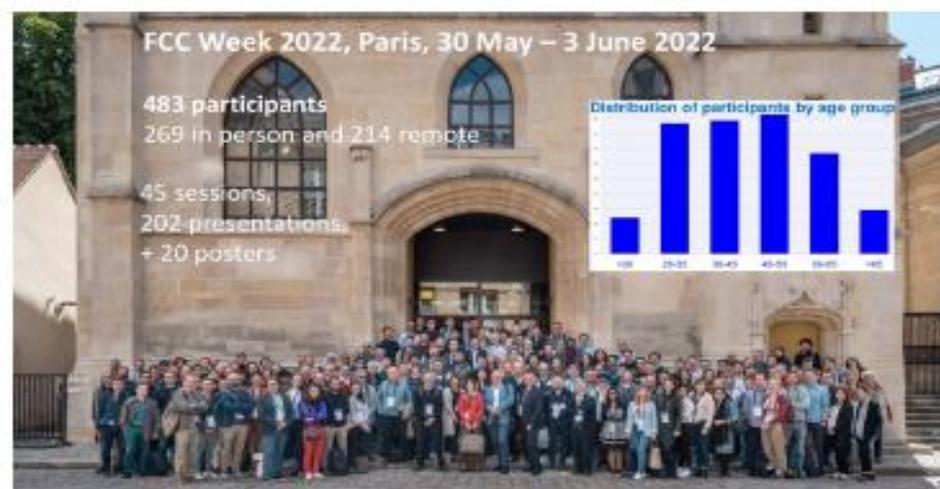
Objectifs du MP:

- organiser la contribution IN2P3 à l'étude de faisabilité FCC
 - rapport à mi-parcours en 2023 !
 - dûe pour 2025, en préalable à l'EPPSU
- sur les aspects PED (Physics/Experiments/Detectors)
 - définition des 'requirements' de physique
 - proposition de concepts de détecteurs globaux
 - études des performances
- accompagner
 - l'émergence de nouvelles R&D
 - et le repositionnement d'autres
 - interactions vers les théoriciens et les experts machine

Current FCC-ee Detector Concepts implemented in simulation



Tracker radius at $r = 2\text{m}$ somehow driven by 2T maximum field at Z-peak energy
 Calorimeter 22 X/X₀, 7 λ, depth driven by absorber (ex. HGC W/ECAL, DR Cu, NL W/ECAL)



Situation:

- intérêt croissant pour cette activité à l'IN2P3:
 - passage de 37 membres actifs (7,5 ETPT) en 2021 à 52 (15,4 ETPT)
- workshop FR annuel (cette année conjoint avec IT), jamboree de physique au printemps, réunion mensuelle des contacts
- toujours limité cependant par la simultanéité avec les Upgrades LHC
- il manque quelques personnes investies plus fortement (>50%) pour faire la différence
- nouveau:** postdocs mixtes IN2P3 LHC/FCC

Demandes ressources financières

	CRACOVIE Phys wkshop	LONDRES FCC-week	FCC-France	FCC-meet CERN	ECFA FC wkshop	stages & FCC-FR & info.	TOTAL (k€) TOT	(k€) TOT-stages	rounded (k€) TOT-stages
COÛT VOYAGE	1500	1800	300	500	1000				
APC+FCC-FR	3000	3600	1200	3000	2000	6000	18,8	18,8	19
CPPM	1500		600	500	1000		3,6	3,6	4
IJC Lab	1500	3600	900	1000	1000		8	8	8
IPHC	1500	1800	900	3000	1000	2000	10,2	10,2	10
IP2I	3000	5400	1500	1000	2000	4800	17,7	12,9	13
LAPP	1500	1800	600		1000		4,9	4,9	5
LLR	1500	3600	1200		1000	1800	9,1	7,3	7
LPC	1500	1800	900	1000	2000		7,2	7,2	7
LPNHE	1500	1800	300	1000	1000		5,6	5,6	6
LPSC	1500	0	600	500	1000	1800	5,4	3,6	4
L2IT							0	0	0
TOTAL-2023							90,5	82,1	83

Budget indicatif 2023:

	Fonctionnement	+ M&O	Physique	Jouvenances
ATLAS + CMS	230 k€	1.3 M€	550 k€	7.1 M€ (dont 1M€ CDD)
FCC-Phys			60 k€	

Demandes ressources humaines

En 2022: 3 Postdocs LHC-FCC attribués:

IPHC : CMS / FCC (tracking for FCC)



LLR : CMS / FCC (Calice for FCC)

➔ Louis Porteles started 1/11/2022

APC : ATLAS / FCC (L.Argon simulation for FCC)

➔ Tong Li started 15/9/2022

Demandes 2023

IP2I : PostDoc CMS / FCC

LPC : Postdoc LHCb / FCC

LPSC : PostDoc/Etudiant ATLAS / FCC

APC : Etudiant ATLAS / FCC

Qui essaye de prendre un étudiant en thèse en 2023 ?? En stage ?? ANR ??



R&D Détecteurs pour Futures machines

Stratégie machines et R&D détecteurs associées:

- priorités ESPPU: usine à Higgs (FCC-ee, ILC, ...), collisionneur pp d'au moins 100 TeV
- organisation se met en place (CERN, ECFA, IN2P3) pour cela
 - perspectives nationales et déclinaison institut (2022)
 - R&T machines (portefeuille A&T)
 - perspectives physique/optimisation détecteurs (ECFA WG1&2), et R&T détecteurs (ECFA Roadmap puis WG3) et PED pour FCC-FS

Notre organisation:

- schéma global (présenté aux journées FCC-France 01/2021), à affiner:
 - propositions de R&T génériques (agnostique % machine) encouragées: e.g. GRAINITA (portefeuille A&T)
 - poursuite des études sur la synergie avec autres machines pour la R&T ciblant historiquement ILC (CALICE/CMOS)
 - pas de soutien fort à de la R&T ciblant FCC avant 1-2 ans (phase Exploratoire précédant la phase de Focus&Consolidation)
 - MP FCC-Phys pour prospective physique & animation autour de FCC / Higgs Factories
- implication forte dans l'implémentation de la Roadmap R&D Détecteurs ECFA
 - Didier Contardo, co-chair du ECFA Detector Panel, coordination nationale pour les EoI pour les futurs DRDT

PID and Photon	DRDT 4.1 Enhance the timing resolution and spectral range of photon detectors
	DRDT 4.2 Develop photosensors for extreme environments
	DRDT 4.3 Develop RICH and imaging detectors with low mass and high resolution timing
	DRDT 4.4 Develop compact high performance time-of-flight detectors
Quantum	DRDT 5.1 Promote the development of advanced quantum sensing technologies
	DRDT 5.2 Investigate and adapt state-of-the-art developments in quantum technologies to particle physics
	DRDT 5.3 Establish the necessary frameworks and mechanisms to allow exploration of emerging technologies
	DRDT 5.4 Develop and provide advanced enabling capabilities and infrastructure
Calorimetry	DRDT 6.1 Develop radiation-hard calorimeters with enhanced electromagnetic energy and timing resolution
	DRDT 6.2 Develop high-granular calorimeters with multi-dimensional readout for optimised use of particle flow methods
	DRDT 6.3 Develop calorimeters for extreme radiation, rate and pile-up environments
Electronics	DRDT 7.1 Advance technologies to deal with greatly increased data density
	DRDT 7.2 Develop technologies for increased intelligence on the detector
	DRDT 7.3 Develop technologies in support of 4D- and 5D-techniques
	DRDT 7.4 Develop novel technologies to cope with extreme environments and required longevity
	DRDT 7.5 Evaluate and adapt to emerging electronics and data processing technologies

Évolution en cours des principaux MP:

- redéfinition des périmètres des projets pixels (orthogonalité, adhérence à la Roadmap ECFA):
 - les projets CMOS et DICE s'arrêtent fin 2022
 - proposition de nouveaux projets: GRAM (A. Besson) et DEPHY (M. Barbero)
- le projet CALICE a fait l'objet d'une revue approfondie cet automne
 - stratégie à définir dans les prochains mois

<https://indico.in2p3.fr/event/27968/>

Feedback ?

FCC France workshop en 2023 ?

- 2 options principales:
 - a) Refaire France-Italie en 2023 (et donc plutôt en Italie cette fois-ci)
 - b) Alternner une année France-Italie, une année France toute seule, et donc France (seule) en 2023 et Italie en 2024 en format France-Italie

En 2023 à l'automne il y aura la mid-term review donc l'option b) pourrait se retrouver favorisée, d'autant qu'en 2025 on serait alors de nouveau "France seule", et ceci marcherait bien car il y aura aussi la final review du FCC FS à la fin 2025.

Volontaires pour organiser FCC France en France en 2023 (Octobre ou Novembre) ?

Tour de table (cf **slides** sur l'agenda)

APC
CPPM
IJC Lab
IPHC
IP2I
LAPP
LLR
LPC
LPNHE
LPSC
L2IT