



7th FCC PHYSICS WORKSHOP

January 29 - February 2, 2024.

ANNECY
Laboratoire d'Annecy
de Physique des Particules
(LAPP)

<https://indico.cern.ch/event/1307378/>



FCC - The Future Circular Collider - Innovative Physics
The FCC is a project of the European Organization for Nuclear Research
and the High Energy Physics Department of the Chinese Academy of Sciences
Programme scientifique international de physique des particules
et de la physique nucléaire



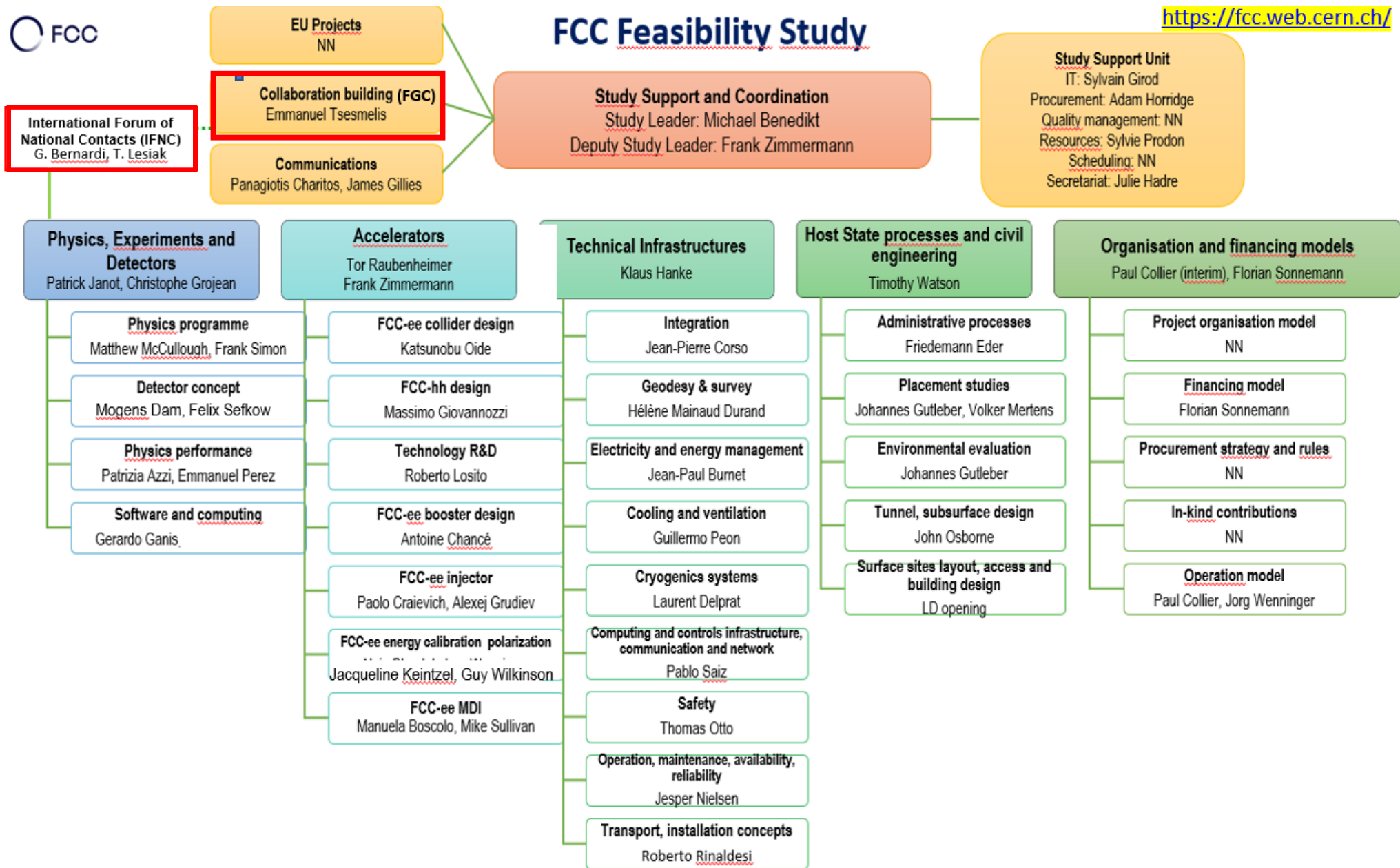
Plenary meeting of the

International Forum of National Contacts

Gregorio Bernardi, CNRS/IN2P3

- Introduction
- Goals of IFNC
- Report from Spain, India, France
- All reports

Enlarging the Collaboration → two approaches: **FGC** and **IFNC**



FCC Global Collaboration Working Group

- Engage with countries with **mature communities**, a **long-standing participation** in CERN's programmes and the **potential to contribute substantially** to the Organization's long-term scientific objectives, to facilitate opportunities for national participation in the FCC Feasibility Study.
 - **Priority Actions with Countries**
 - Strengthen existing collaborations with CERN MS, AMS, Observer States & NMS
 - Organise events / workshops in the **CERN MS & AMS**
 - Establish new FCC memberships of CERN institutional partners
 - Member States: **Bulgaria, Norway, Romania, Slovakia.**
 - Associate Member States in pre-stage to Membership: **Cyprus, Slovenia.**
 - Associate Member States: **Croatia, India, Lithuania, Ukraine.**
- **Work with national laboratories, institutes and universities** as well as **industry** in the MS, AMS and NMS - to carry out the following mandate:
 - Encourage an **expanded membership**.
 - Explore **opportunities** for future prospective participants.
 - Support new participants in **application process**.
 - Assist the new participants in defining **areas of collaboration**.
 - Conclude relevant **agreements**.
 - Facilitate the **integration** process.
 - Facilitate interest in **CERN non-core areas** - geology, geodesy, logistics, materials science.
 - Prepare the foundations for research and contributions by **industry**.
 - Liaise with **national contact persons** and **forums**.

Convened by Emmanuel Tsesmelis
(CERN International Relations)

Enlarging the Collaboration further

Two approaches, one globally-oriented (**FGC**), as just described, the other more PED oriented (**IFNC**),
→ facilitate opportunities for national participation in the Feasibility Study and enlarge the HEP community of FCC

International Forum of National Contacts (IFNC)

- **Physics groups in a country**, typically from LHC or Future Colliders groups can **join as new institution**
 - To study **R&D/ Detector concepts** for FCC
 - To expand the FCC Physics scope via the study of **physics case studies**
 - To improve the **theoretical calculations** to exploit the FCC physics potential
 - Help **forming a national FCC group**, with strong PED component, which can hold its national FCC meetings
 - Identify one or two **National Contacts** to exchange information between country situation and the FCC management, and to strengthen the national community → Orient the new efforts towards the FCC working groups
 - Exchange experience across countries (**IFNC meetings**)
 - Establish list of participating institutes and institute contacts (**IFIC**) inside each country, and identify their contribution.
- **Several initiatives, such as encouraging national or regional meetings, for instance**
 - Joint FCC France-Italy Workshop in Lyon in November 2022 **Joint FCC-France & Italy Workshop in Lyon** (140 participants)
 - First annual US-FCC Workshop at BNL in April 2023 **US FCC Workshop (24-26 April 2023)** → ~35 US institutes signed up for FCC (cf France, UK, Italy, ~13-20 institutes each)

**Enlargement of the FCC HEP community progressing → EoI for detectors in 2025,
→ Proto-collaborations after next ESPP**



FCC is here to stay, cf. DG's statements on 25/1: even if CEPC moves forward, FCC will remain CERN priority

- 1) Only a new European Strategy can modify the plans of a previous one, taking into account Europe's ambitions within the global context (e.g. P5/US support for an off-shore Higgs factory, CEPC in China, etc.)
- 2) Recommendation of 2020 European Strategy for future colliders:
"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."
Note: the Strategy does not state that a Higgs factory should be built in Europe. However, a Higgs factory is the highest priority for the European community → wherever it will be built, it should allow for significant participation from Europe
- 3) Furthermore, skipping FCC-ee and going directly to FCC-hh implies a long gap (>> 10 years) between the end of HL-LHC and beginning of next collider at CERN, for reasons of cost and of readiness of high-field magnet technology → risk to lose the community, in particular the young generations.
- 4) The only colliders that are technically mature enough to start operation in early 2040s are e^+e^- Higgs factories, and to be time-competitive with the CEPC (if approved), a circular Higgs factory is needed (much higher luminosity than linear colliders)



Should we change our plans ? **NO**

Should we accelerate our planning ? **YES**

→ CERN Directorate will discuss these matters with the CERN Council in the coming months

IFNC/national contacts must push towards increased participation rapidly. Feasibility Study is converging soon. We need to be ready to produce Lol for detectors and subdetectors for the European strategy update (2026)

International Forum of National Contacts

Possible evolution of the forum, now concentrated on the Feasibility study

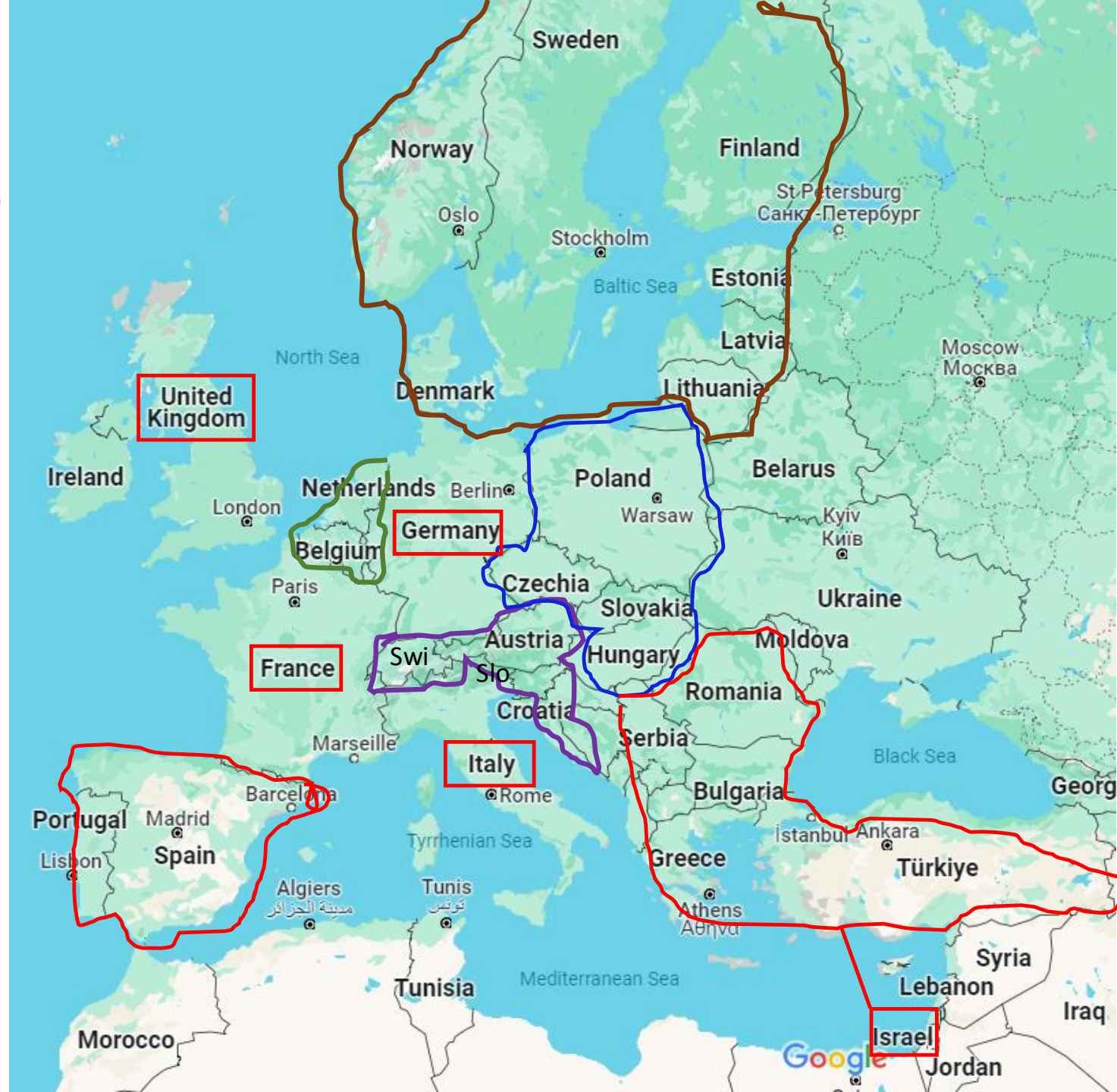
→ usefulness, for instance when EoI will be drafted, or when proto-collaborations will form.

- Now let's review past year (countries grouped regionally), future work foreseen, local situation in terms of support

Reports from:

10 European regions (corresponding to ~30 countries)

- Spain+Portugal - France
- UK
- Italy
- Germany
- Belgium+Netherland
- Nordic+Baltic countries
- Switzerland+Austria+Slovenia+Croatia
- Poland+Czekia+Slovakia+Hungary
- Romania+Bulgaria+Serbia+Greece+Turkey+Israel
- +
 - India
 - Korea/Japan
 - Brazil/Argentina/Chile
 - US / Canada



FCC PED activities in India



India: 17 Institutions, 23 Faculty physicist + Postdocs and Students, generally also on CMS or Belle2

Now in the MoU preparation process/ several already signed, process converging

• TATA INSTITUTE OF FUNDAMENTAL RESEARCH,	MUMBAI	• GAGAN MOHANTY
• NATIONAL INSTITUTE OF SCIENCE EDUCATION AND RESEARCH,	BHUBANESWAR	• PROLAY MAL, SANJAY KUMAR SWAIN
• INDIAN INSTITUTE OF TECHNOLOGY,	BHUBANESWAR	• SEEMA BAHINIPATI
• INSTITUTE OF PHYSICS,	BHUBANESWAR	• ARUNA NAYAK
• BIRLA INSTITUTE OF TECHNOLOGY	MESRA, RANCHI	• RAM KRISHNA DEWANJEE
• INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE,	KOLKATA	• SOURAV ROY, SUNANDA BANERJEE
• INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH,	KOLKATA	• RITESH KUMAR SINGH
• SAHA INSTITUTE OF NUCLEAR PHYSICS,	KOLKATA	• SATYAKI BHATTACHARYA
• NATIONAL INSTITUTE OF TECHNOLOGY,	JALANDHAR	• SUNEEL DUTT
• PANJAB UNIVERSITY,	CHANDIGARH	• SUNIL BANSAL, VIPIN BHATNAGAR
• PUNJAB AGRICULTURAL UNIVERSITY,	LUDHIANA	• NITISH DHINGRA
• UNIVERSITY OF PETROLEUM AND ENERGY STUDIES,	DEHRADUN	• VIPIN GAUR, JASBIR SINGH
• INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH,	PUNE	• SEEMA SHARMA, SOURABH DUBE
• INDIAN INSTITUTE OF TECHNOLOGY,	GUWAHATI	• BIPUL BHUYAN
• INDIAN INSTITUTE OF TECHNOLOGY,	HYDERABAD	• SARANYA GHOSH
• INDIAN INSTITUTE OF TECHNOLOGY,	MADRAS	• JIM LIBBY
Recently, one new institution have been added to the list of interested	Indian Institutes	
• BN Mondal University	Bihar	Ashim Roy

FCC PED activities in Spain (1)

- **Future collider efforts centralized in the “Spanish Network on Future accelerators”:**
 - 12 institutes participating in this network, including the most relevant institutes of particle physics and technological centers for accelerator and detectors
 - Historical focus on:
 - ILC-related detector R&D: silicon tracking, CALICE
 - **FCC: MoU signed by several institutions, strong involvement in FCC-hh magnet/accelerator developments**
 - Many phenomenological/theoretical contributions from different Spanish groups, with a wide scope, focusing on both linear and circular scenarios, and also FCC-hh, not just FCC-ee
 - Current future collider PED experimental activities follow an ‘agnostic’ path, obviously moving slowly towards a larger FCC-ee weight:
 - People still doing studies in the ILC-LC context (IFIC, CIEMAT), others already focused on physics/phenomenology studies in an FCC-ee scenario (CIEMAT)
 - More FCC-ee weight expected in the future, in particular for detector-related studies (ILC→FCC-compatible transition)

FCC PED activities in Spain (2)

- **Specific projects and involvement in PED activities:**
 - Starting integration in Detector R&D (DRD) collaborations (several groups)
 - ‘Future collider’ IFIC-CIEMAT coordinated project approved and in operation: “From the LHC to the Higgs factory – physics & technology”. Responsible IPs for PED activities of the project: J. Alcaraz, M. Cepeda, M.C. Fouz, J. Fuster, M. Vos, A. Irles, V. Mitsou
- **General meeting of the Spanish Network planned for the 2nd half of 2024:**
 - Organizing the community to work with more coherent objectives regarding PED studies for future colliders: ECFA focus topics, ILD for FCC, formalize other joint PED and R&D activities, ...

FCC PED activities in Portugal

FCC PED activities in France

11 CNRS/IN2P3 Labs and 1 CEA Lab have an FCC group, with FCC-contact person:

APC-Paris (AP), CPPM-Marseille (CM), IJC Lab-Orsay (IO), IPHC-Strasbourg (IS),
IP2I-Lyon (IL), LAPP-Annecy (LA), LLR-X-Palaiseau (LX), LPC-Clermont (LC),
LPNHE-Paris (LP), LPSC-Grenoble (LG), L2IT-Toulouse (LT), IRFU/CEA-Saclay (IC)

Personpower went from 37 active members equiv. to 7.5 FTE in 2021 to 56/16.5 FTE in 2023 (not counting physicists on other FC projects now joining DRD's, but who could join FCC)

Activities can be grouped in PED topics:

- Higgs (AP,IO,LX), QCD (LP), Heavy Flavour (LC,IC), Electroweak (IS,LG), Top (LC), Software (IS)
- L.Argon Calorimetry (IO,AP,CM,LP), R&D Calice/FCC (LX,IL), CMOS (IS,IL,CM), Tracking (IL,IS,IC),
- EPOL (LP), MDI (LA)

Other projects are also being investigated (e.g. crystal calorimetry/GRAINITA)

France responsibilities for FCC-PED

- National contacts: Roy Aleksan / GB
- Heavy Flavour working group co-convener: Stephane Monteil
- EPOL co-convener: Alain Blondel
- Speakers Bureau: Suzanne Gascon-Shotkin
- IFNC co-convener : GB
- Responsibilities in related ECFA working groups
(e.g. Didier Contardo, Giovanni Marchiori, co-convener of WG3 of e⁺e⁻ Higgs/EW factory workshop)

French institute interests per DRD as a function of systems for FCC-ee

- Muon hodoscope/tagger
 - **Micromegas** at IRFU, (**RPC** experience at IP2I but no specific project)
- Sampling calorimetry with fully embedded electronics
 - **ECAL** at IJCLab, LLR, LPNHE; **HCAL** at IP2I, **electronics** at Omega
- LNG calorimetry
 - **ECAL** at APC, CPPM, IJCLAB, LPNHE, Omega
- Optical calorimetry
 - **ECAL GRAiNita** at IJCLAB, LPC-CF, **Crystals** at IP2I
- Timing Layers
 - **MicroMegas** IRFU, LGAD LPNHE, **MCMOS** IPHC, IP2I, CPPM, **optical** CPPM, IP2I
- Tracking
 - **DCH** IJCLab, Ganil, LPSC; **TPC** IRFU; **MCMOS** CPPM, IPHC, IP2I, LPNHE

APC	Paris
CPPM	Marseille
IJC Lab	Orsay
IPHC	Strasbourg
IP2I	Lyon
LAPP	Annecy
LLR	Polytechnique
LPC	Clermont-Ferrand
LPNHE	Paris
LPSC	Grenoble
IRFU	Saclay

Example: DRD interest links to FCC-ee ALLEGRO concept

APC, CPPM, IJCLab, IPHC, IP2I, IRFU, LPNHE, LPSC, Omega

Muon Tagger

DRD1 - WP1 : Micromegas at IRFU

Liquid Noble Gas DRD6 - WP2 :
at IJCLab, APC, CPPM, LPNHE, Omega

Timing Layer DRD1 - WP5 : Picosec at IRFU

DRD1 - WP1 : MCMOS at APC, AMU, CPPM, IPHC, IP2I, IRFU

DRD3 - WP2 : LGAD at AMU, LPNHE

DRD4 - WP4.2 : nano MCP at IP2I; WP4.3 : materials at CPPM

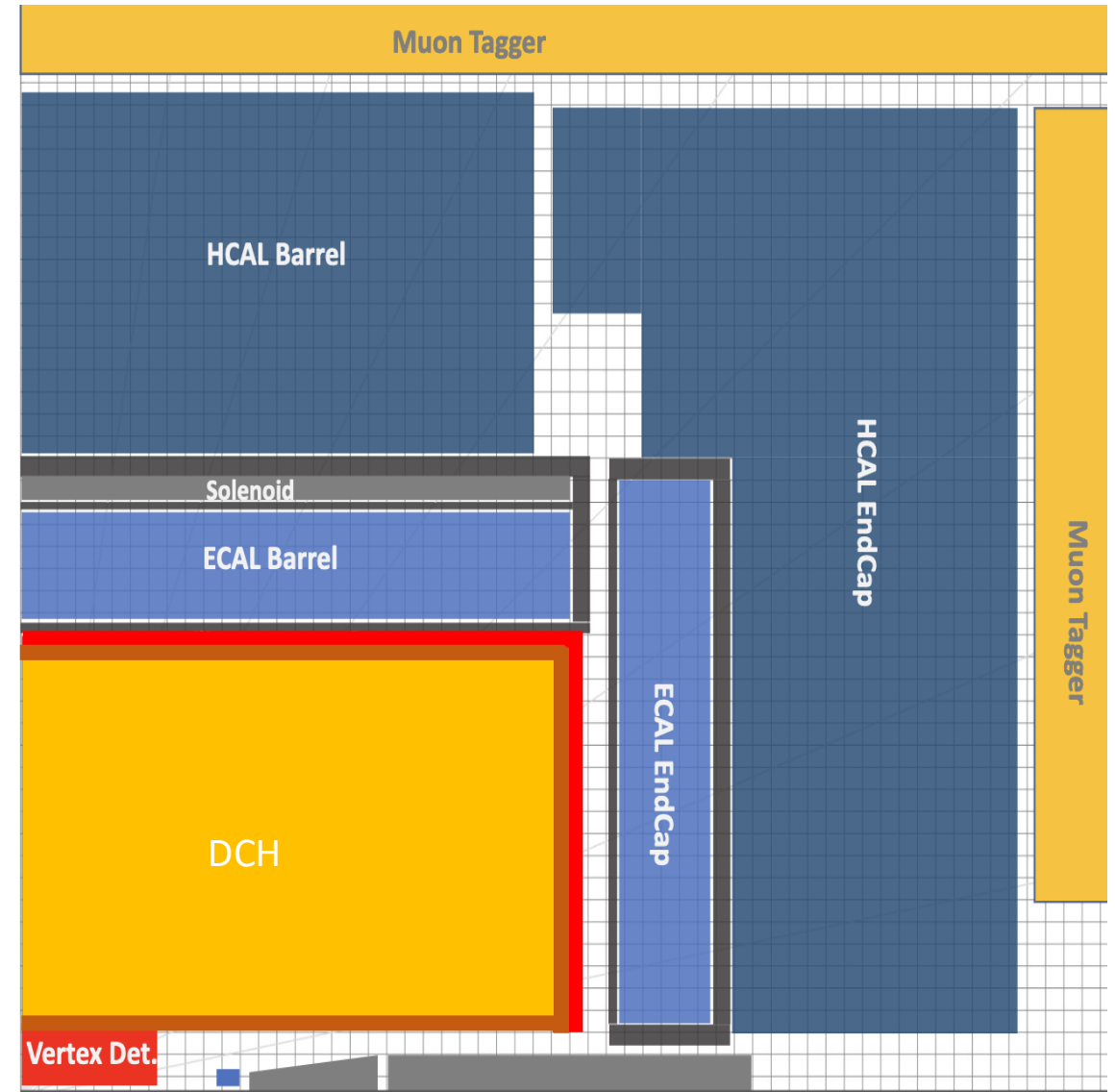
Drift or Time Projection Chamber

DRD1 - WP4: TPC IBF & MicroMegas readout at IRFU

DRD1 - WP4: DCH light wires & weaving at IJCLab, Ganil, LPSC

VD - Wrapper

DRD3 - WP1 : Monolithic CMOS
at APC, CPPM, IPHC, IP2I, LPNHE, IRFU



Strasbourg workshop (11/2023): first conclusions on detectors EoI's

- Numerous commitments to the ALLEGRO concept. Support from IN2P3
- We hope ILD will indeed make a proposal ILD' for FCC, possibly together with CLD. Need to identify in France physicist in charge of pushing this effort locally, which includes Calice calorimetry, and TPC if it can work.
- We would like to be in an expression of interest for a generic microvertex concept, and check which labs are interested to join.
- We are aiming at collaborating with Italian Labs on tracking (microvertex + drift chamber)
- We have other collaborative proposals: Crystal calorimetry or Grainita, which could possibly go into a separate detector concept dedicated to heavy flavour physics

France support for FCC-PED

- Funding for FCC-PED is 70k€ for 2024 (travel money), while R&D get separate funding (changing given the DRD reorganization, for instance ALLEGRO is receiving 15k€ for 2024)
- Accelerator activities receive separate funding, and several labs are very active (IO,LA) under Angeles Faus-Golfe responsibility

→ In 2024 our goal is to keep increasing the involvement, and getting focused on specific detector concepts

so far 5 Postdocs LHC-FCC assigned by IN2P3 in 2022-2024 (2 Atlas, 2 CMS, 1 LHCb)

6 Ph.D LHC-FCC starting in 2022-2024, first Ph.D LHC-FCC defended end 2023 (Ang Li)

Initiatives to recruit new people and to connect to other groups internationally

→ Funding for mixed Postdocs and Ph.D Students, recruitment quite successful.

→ Workshops open to international partners: FCC- France, Bilateral meetings: FCC France – Italy

→ Participation in ECFA workshops for R&D

French Comité interministériel for FCC / composition, goals

France, which would host the majority of the FCC on its soil (nearly 80%), must be able to assess all the components of the feasibility study. **Thus, an interministerial committee was formed.**

It is composed in particular of representatives of the

- Minister of higher education and research (MESR),
- Minister of the budget,
- Minister of public accounting and civil service,
- Minister of Europe and foreign affairs,
- Minister of ecological transition and territorial cohesion,
- Minister of the General Secretariat for Investment (SGPI),
- and of the Prefecture of the Auvergne-Rhône-Alpes Region,
- as well as qualified personalities and observers. A scientific personality is Astrid Lambrecht, solid state physicist

Chaired by the Director General of Research and Innovation of the MESR, this committee is in charge of assessing the feasibility study of the FCC carried out by CERN and of analyzing alternative or competing projects, in order to feed into the French position on this FCC project.

it will conduct an analysis of the data and documents provided by CERN concerning the FCC feasibility study as well as alternative scenarios to it. It will combine the French issues of such a project with its scientific, technical, socio-economic, financial and environmental impacts, taking care to anticipate the question of social acceptability and those of international partnerships.

The report will be delivered to the CERN council for its 2nd February special session

Convener: Gregorio Bernardi (APC Paris CNRS/IN2P3)

17:30 **Introduction + Reports on FCC-PED activities of Spain-Portugal-France**

Speaker: Gregorio Bernardi (APC Paris CNRS/IN2P3)

17:42 **Report from UK**

Speaker: Guy Wilkinson (University of Oxford (GB))

17:50 **Report from Belgium and Netherland [remote]**

Speaker: Wouter Waalewijn (NIKHEF)

17:55 **Report from Italy**

Speaker: Paolo Giacomelli (INFN Sezione di Bologna)

18:03 **Report from Switzerland, Slovenia, Croatia, Austria**

Speaker: Michele Weber (Universitaet Bern (CH))

18:10 **Report from Germany**

Speaker: Frank Simon (KIT - Karlsruhe Institute of Technology (DE))

18:18 **Report from Sweden, Norway, Danmark,Finland, Baltic countries [remote]**

Speaker: Rebeca Gonzalez Suarez (Uppsala University (SE))

18:25 **Report from Poland, Hungary, Slovakia, Czechia**

Speaker: Tadeusz Lesiak (Polish Academy of Sciences (PL))

18:33 **Report from Romania, Bulgaria, Serbia, Greece, Cyprus, Turkey, Israel**

Speaker: Calin Alexa (IFIN-HH (RO))

18:40 **Report from Korea (Japan) [remote]** ¶

Speaker: Hwi Dong Yoo (Yonsei University (KR))

18:48 **Report from Brazil (Argentina, Chile)**

Speaker: Patricia Rebello Teles (Brazilian Center for Physics Research - CBPF (BR))

18:55

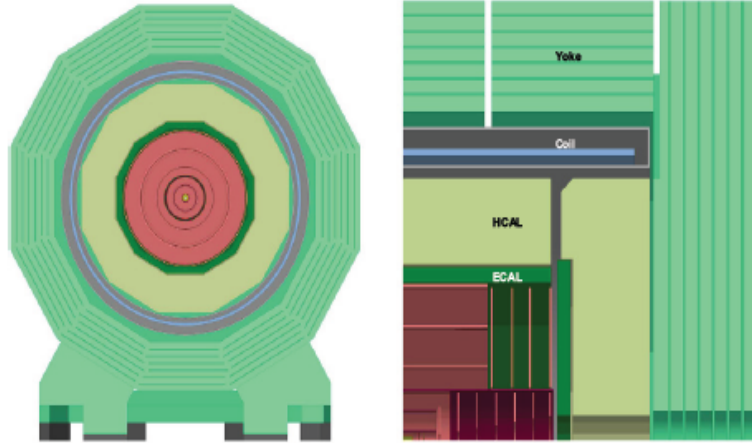
Report from US (Canada)

Speaker: Sarah Eno (University of Maryland (US))

Backup Slides

Detectors under Study

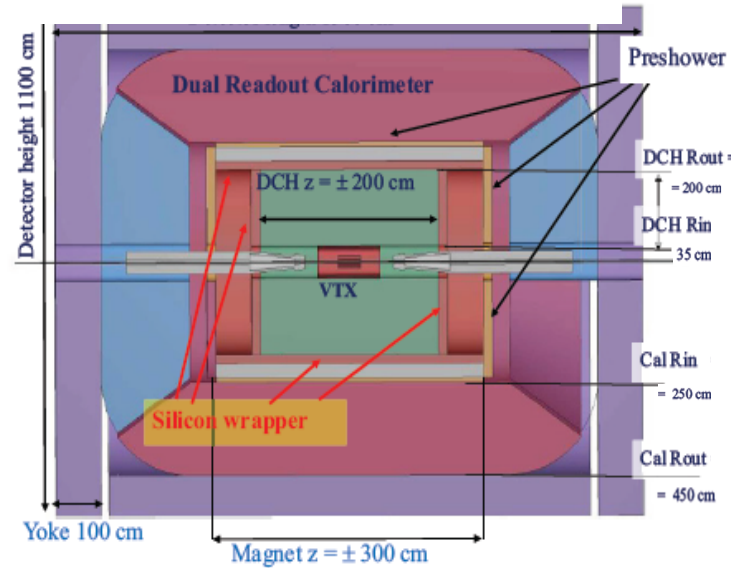
CLD



conceptually extended from the CLIC detector design

- full silicon tracker
- 2T magnetic field
- high granular silicon-tungsten ECAL
- high granular scintillator-steel HCAL
- instrumented steel-yoke with RPC for muon detection

IDEA



explicitly designed for FCC-ee/CepC

- silicon vertex
- low X_0 drift chamber
- drift-chamber silicon wrapper
- MPGD/magnet coil/lead preshower
- dual-readout calorimeter: lead-scintillating cerenkov fibers

ALLEGRO



explicitly designed for FCC-ee, recent concept, under development

- silicon vertex
- low X_0 drift chamber + silicon wrapper
- Thin Solenoid before the Calorimeter
- High Granularity Liquid Argon Calorimetry

But several other options, like **ILD'**, or Crystal Calorimetry in IDEA(active in US, Italy), are under study (similarly for tracking, muons and particle ID)

With potentially 4 experiments, many complementary options will be implemented

DRD interest links to FCC-ee CLD⁺ (w/ PID) concept

APC, CPPM, IJCLab, IPHC, IP2I, IRFU, LLR, LPNHE, Omega

Muon hodoscope (HCAL?)

DRD1 - WP1 : Micromegas at IRFU

Sandwich calorimeter
with fully embedded electronics

DRD6 - WP1 (DRD1- WP6) : AHCAL at Omega;
T-SDHCAL at IP2I, Omega

SiW-ECAL at IJCLab, LLR, LPNHE, Omega

Timing Layer DRD1 - WP5 : Picosec at IRFU

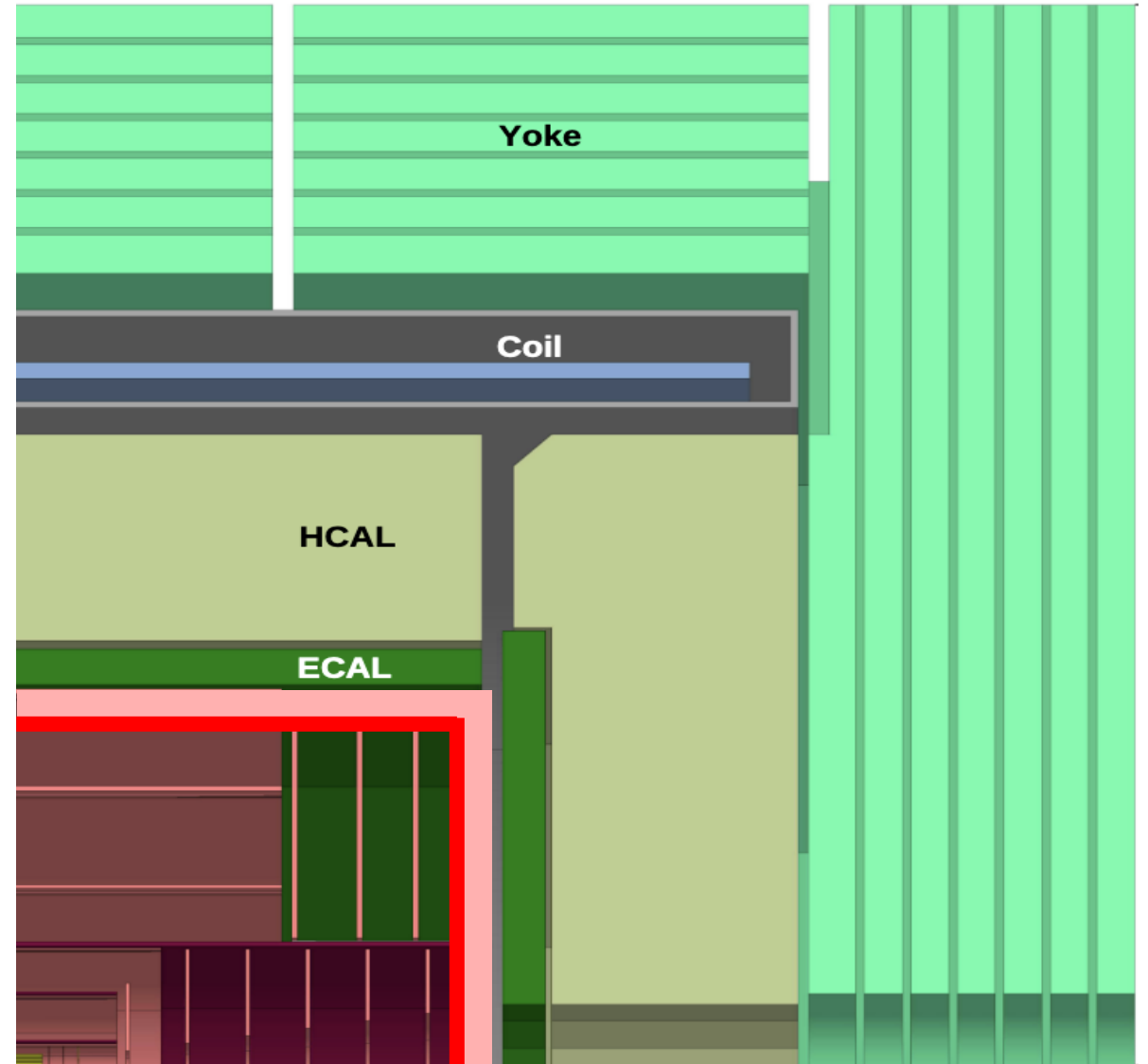
DRD1 - WP1 : MCMOS at APC, AMU, CPPM, IPHC, IP2I, IRFU

DRD3 - WP2 : LGAD at AMU, LPNHE

DRD4 - WP4.2 : nano MCP at IP2I; WP4.3 : materials at CPPM

Tracking (ECAL?)

DRD3 - WP1 : Monolithic CMOS
at APC, CPPM, IPHC, IP2I, LPNHE, IRFU



DRD links to FCC-ee ILD' concept

APC, CPPM, IJCLab, IPHC, IP2I, IRFU, LLR, LPNHE, Omega

Muon hodoscope (HCAL?)

DRD1 - WP1 : MicroMegas at IRFU

Sandwich calorimeter
with fully embedded electronics

DRD6 - WP1 : AHCAL at Omega;

T-SDHCAL at IP2I, Omega also DRD1 - WP6

SiW-ECAL at IJCLab, LLR, LPNHE, Omega

Timing Layer DRD1 - WP5 : Picosec at IRFU

DRD1 - WP1 : MCMOS at APC, AMU, CPPM, IPHC, IP2I, IRFU

DRD3 - WP2 : LGAD at AMU, LPNHE

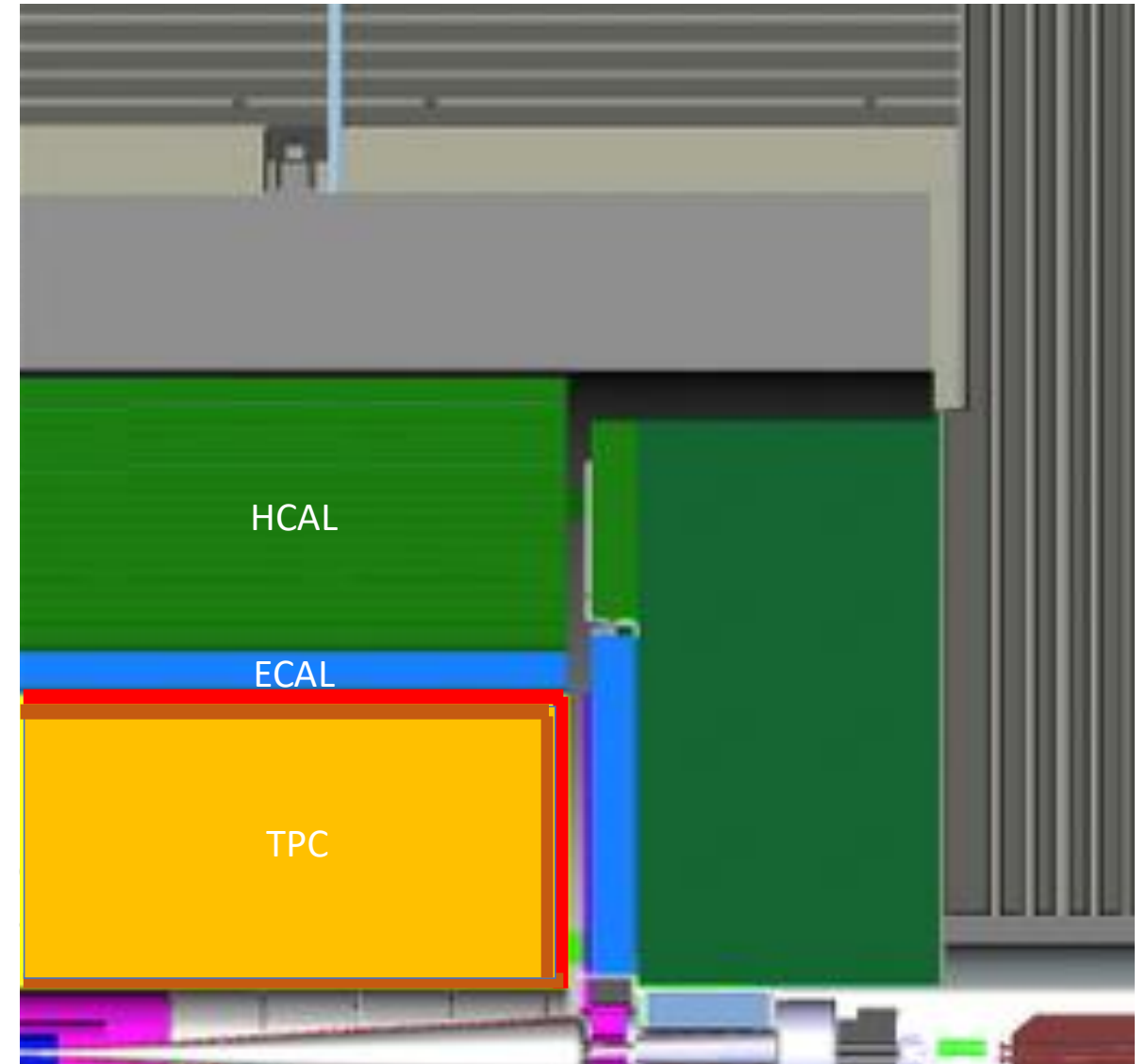
DRD4 - WP4.2 : nano MCP at IP2I; WP4.3 : materials at CPPM

Time Projection Chambers

DRD1 – WP4: IBF & MicroMegas readout at IRFU

VD - Wrapper – (ECAL?)

DRD3 - WP1 : Monolithic CMOS
at APC, CPPM, IPHC, IP2I, LPNHE



DRD interest links to FCC-ee IDEA⁺ w/ crystal ECAL concept

APC, CPPM, IJCLab, IPHC, IP2I, IRFU, LPNHE, LPSC

Muon Tagger

DRD1 - WP1 : Micromegas at IRFU

ECAL

DRD6 - WP3 : GRAINITA at IJCLAB, LPC-CF

DRD6 - WG materials : at CPPM, IJCLab, ILM, IP2I, IRFU

DRD6 - WG Photodetectors : at IRFU, IJCLab

Timing Layer with crystals

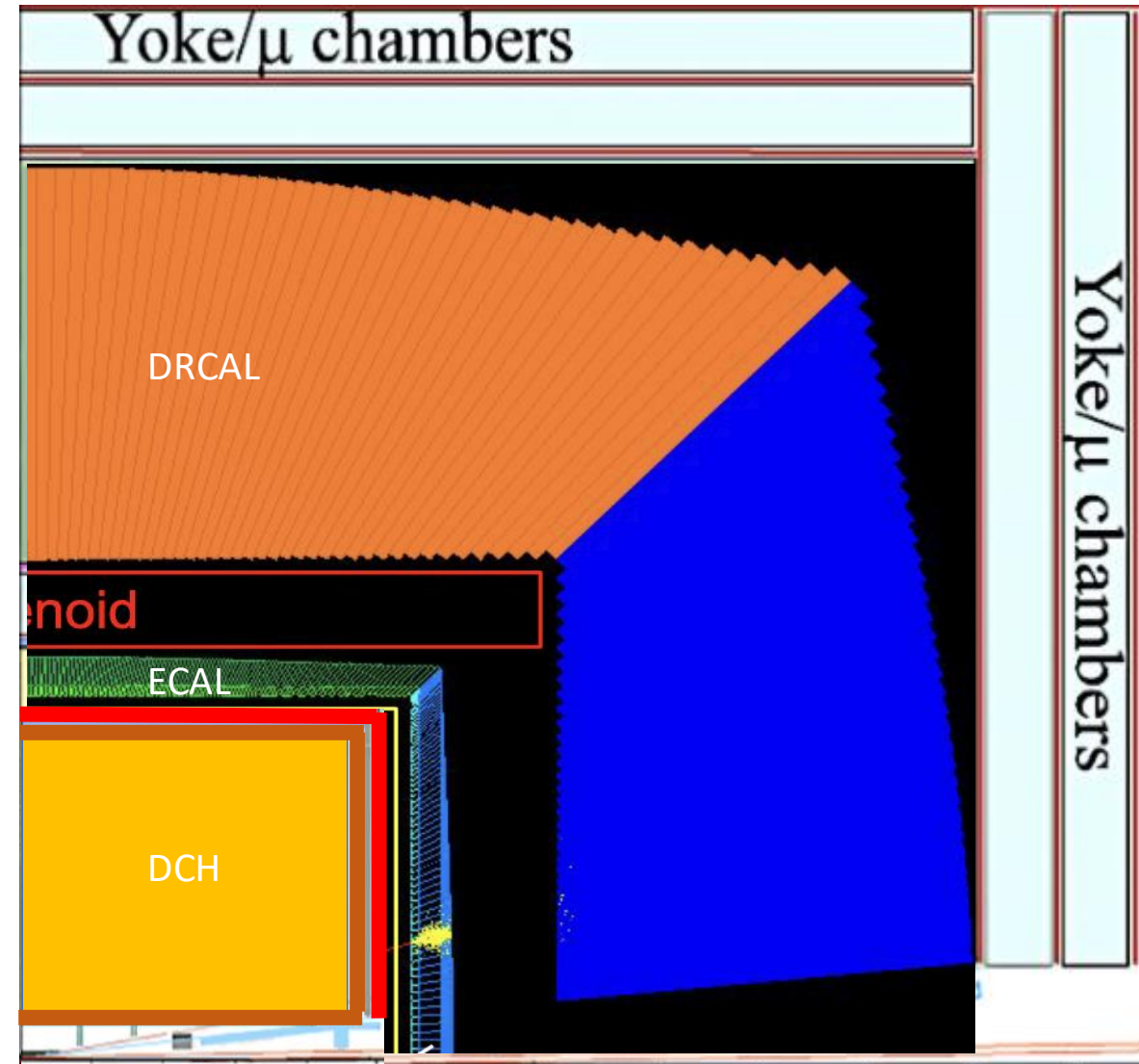
DRD4 - WP4.2 : nano MCP at IP2I; WP4.3 : materials at CPPM ?

Drift Chamber

DRD1 - WP4: DCH light wires & weaving at IJCLab, Ganil, LPSC

VD, Wrapper

DRD3 - WP1 : Monolithic CMOS
at APC, CPPM, IPHC, IP2I, LPNHE, IRFU



Comité interministériel pour FCC / Questions (1)

- Impacts scientifiques

- o Intérêt scientifique / solidité du « science case » (au-delà du modèle standard)
- o Besoins des futurs utilisateurs
- o Perception scientifique des projets alternatifs ou concurrents
- o Rôle de l'IA

- Impacts technologiques (équipements)

- o Maturité technologique, verrous
- o Savoir-faire des laboratoires et industriels français
- o Programme de R&D à visée sobriété énergétique
- o Mutualisations avec d'autres infrastructures de recherche
- o Bénéfices/retombées envisagés pour d'autres applications

- Impacts économiques

- o Maîtrise des coûts et du planning
- o Retombées économiques et industrielles pour la France
- o Perspectives de développement d'écosystèmes d'innovation territoriaux

- Impacts sociaux

- o Création d'emplois
- o Mobilité
- o Acceptabilité, opposants
- o Nuisances pour les riverains pendant les travaux
- o Cas des huit sites en surface

Comité interministériel pour FCC / Questions (2)

- Impacts internationaux

- o Position Suisse (autre pays hôte)
- o Position pays membres
- o Position US, Japon, Chine (qui ont des accords avec le CERN et représentent environ 20% des utilisateurs du CERN)
- o Partenariats
- o Concurrence internationale du FCC
- o Situation géopolitique
- o Évolution de la gouvernance et du modèle économique

- Impacts environnementaux

- o Respect et préservation de la biodiversité des milieux concernés
- o Perturbation des strates géologiques
- o Conception durable des installations et respect des normes sociales et environnementales
- o Optimisation énergétique
- o Empreinte carbone

- Impacts foncier et juridique

- o Prise en considération des caractéristiques des localités aux alentours des accès au tunnel (identité paysagère et architecturale, activité économique, transports etc.)
- o Procédures réglementaires

1) **Physics** : best overall physics potential of all proposed future colliders; matches the vision of the 2020 European Strategy: “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.”

- ❑ FCC-ee : ultra-precise measurements of the Higgs boson, indirect exploration of next energy scale (~ x10 LHC)
- ❑ FCC-hh : only machine able to explore next energy frontier directly (~ x10 LHC)
- ❑ Also provides heavy-ion collisions and, possibly, ep/e-ion collisions
- ❑ 4 collision points → robustness; specialized experiments for maximum physics output

2) Timeline

- ❑ FCC-ee technology is “mature” → construction can start in the early 2030s and physics a few years after the end of HL-LHC operation (currently 2048, earlier if more resources available) → This would keep the community, in particular the young people, engaged and motivated.
- ❑ FCC-ee before FCC-hh would also allow:
 - cost of the (more expensive) FCC-hh machine to be spread over more years
 - 20 years of R&D work towards affordable magnets providing the highest achievable field (high-T superconductors!)
 - optimization of overall investment : FCC-hh will reuse same civil engineering and large part of FCC-ee technical infrastructure

3) It's the only facility **commensurate to the size of the CERN community** (4 major experiments)

Is it feasible? Isn't it too ambitious?

- Ongoing Feasibility Study showing spectacular progress
- FCC is big, audacious project, but so were LEP and LHC when first conceived → they were successfully built and performed far beyond expectation → demonstration of capability of our community to deliver on very ambitious projects
- FCC is best project for future of CERN (for above reasons) → we have to work to make it happen

Start of FCC-ee physics run

