Future Circular Collider

— Physics, Experiment & Detectors —

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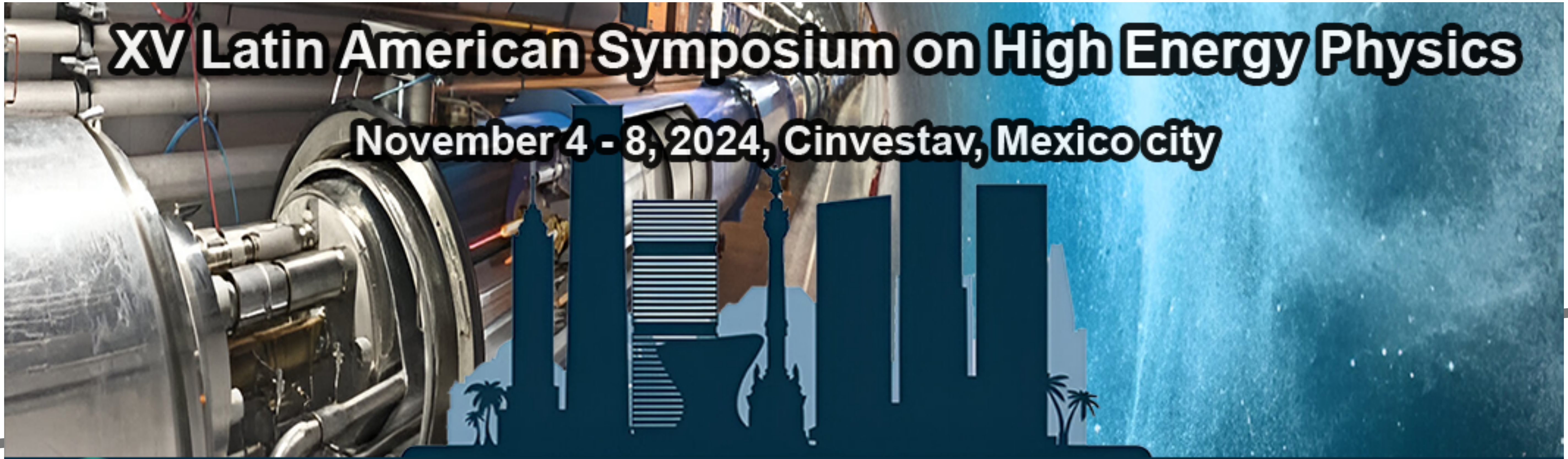


The launch of the feasibility study

"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."

— CERN council approved the Strategy and CERN management implemented it —

FCC Feasibility Study (FS) started in 2021 and will be completed in 2025.

Mid-term review in 2023.

Objectives of FCC feasibility study

- Demonstration of the **geological, technical, environmental and administrative feasibility** of the tunnel and surface areas and optimisation of placement and layout of the ring and related infrastructure.
- Pursuit, together with the Host States, of the preparatory **administrative processes** required for a potential project approval to identify and remove any showstopper.
- Optimisation of the design of the **colliders and their injector chains**, supported by R&D to develop the needed key technologies.
- Elaboration of a sustainable **operational model** for the colliders and experiments in terms of human and financial resource needs, as well as environmental aspects and energy efficiency.
- Development of a consolidated **cost estimate**, as well as the funding and organisational models needed to enable the project's technical design completion, implementation and operation.
- Identification of substantial **resources** from outside CERN's budget for the implementation of the first stage of a possible future project (**tunnel and FCC-ee**).
- Consolidation of the **physics case and detector concepts** for both colliders.

FCC Feasibility Organisation Chart

FCC Feasibility Study

EU Projects
NN

Collaboration building
Gregorio Bernardi, Tadeusz Lesiak, Emmanuel Tsesmelis,

Communications
Panagiotis Charitos, Arnaud Marsollier

Study Support and Coordination
Study Leader: Michael Benedikt
Deputy Study Leader: Frank Zimmermann

Study Support Unit
IT: Sylvain Girod
Procurement: Adam Horridge
Quality management: Beatriz Arias
Resources: Sylvie Prodon
Secretariat: Julie Hadre

Physics, Experiments and Detectors
Patrick Janot, Christophe Grojean

- **Physics programme** – Matthew McCullough, Frank Simon
- **Detector concept** – Mogens Dam, Marc-André Pleier, Felix Sefkow
- **Physics performance** – Patrizia Azzi, Emmanuel Perez, Michele Selvaggi
- **Software and computing** – Gerardo Ganis, Brieuc François
- **EPOL** – Jacqueline Keintzel, Guy Wilkinson
- **MDI** – Manuela Boscolo, Fabrizio Palla

Accelerators
Tor Raubenheimer, Frank Zimmermann

- **FCC-ee accelerator design** – Christian Carli, Frank Zimmermann
- **FCC-ee technical implementation** – Jean-Paul Burnet, Tor Raubenheimer
- **FCC-ee injector** – Paolo Craievich, Alexej Grudiev
- **FCC transfer lines** – Wolfgang Bartmann
- **FCC-hh design** – Massimo Giovannozzi

Technical Infrastructures
Jean-Paul Burnet, Klaus Hanke

- **Integration** – Jean-Pierre Corso
- **Geodesy & survey** – Hélène Mainaud Durand
- **Electricity and energy management** – Jean-Paul Burnet
- **Cooling and ventilation** – Guillermo Peon
- **Cryogenics systems** – Laurent Delprat
- **Computing and controls infrastructure, communication and network** – Pablo Saiz
- **Safety** – Thomas Otto
- **Operation, maintenance, availability, reliability** – Jesper Nielsen
- **Transport, installation concepts** – Roberto Rinaldesi

Host State processes and civil engineering
Timothy Watson

- **Administrative processes** – Friedemann Eder
- **Placement studies** – Johannes Gutleber
- **Environmental evaluation** – Johannes Gutleber
- **Tunnel, subsurface design** – John Osborne
- **Surface sites layout, access and building design** – A. Mayoux

Organisation and financing models
Florian Sonnemann

- **Project organisation model** – NN
- **Financing model** – Florian Sonnemann
- **Procurement strategy and rules** – Anders Unnervik
- **In-kind contributions** – Anders Unnervik
- **Operation model** – Verena Kain

Many opportunities to engage.
Get in touch with the WG conveners!

Links:
- [FCC feasibility study]
- [Physics, Experiments and Detectors (PED)]

Physics, Experiments, Detectors

- FCC Feasibility Study PED deliverables for mid-term report

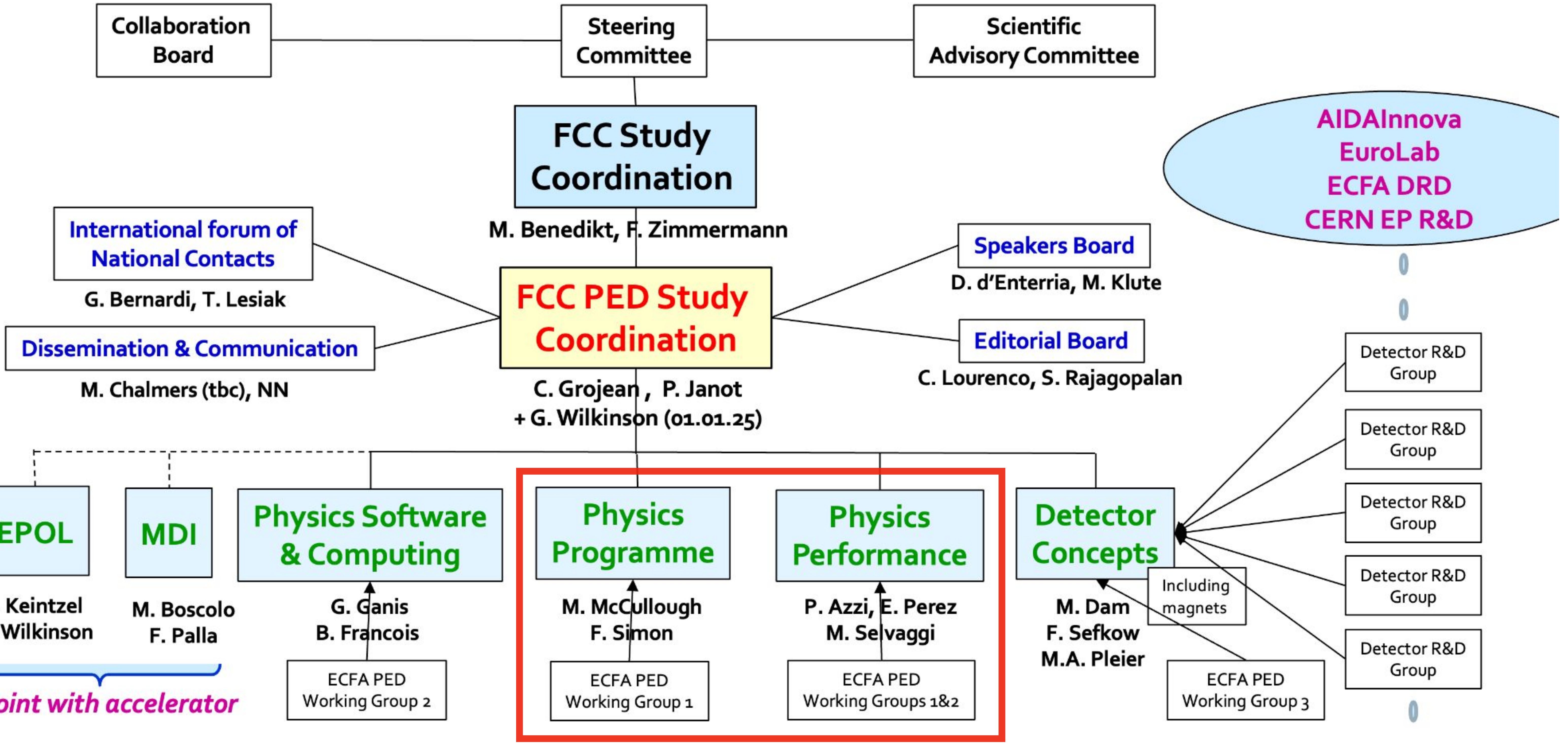
8. Physics & Experiments	C. Grojean, P. Janot, M. Mangano	8.1 Overview
		8.2. Documentation of the specificities of the FCC-ee and FCC-hh physics cases.
		8.3 Strategic plans for the improved theoretical calculations.
		8.4 FCC-ee Detector Requirements.

deliverables explicitly requested from SPC & Council

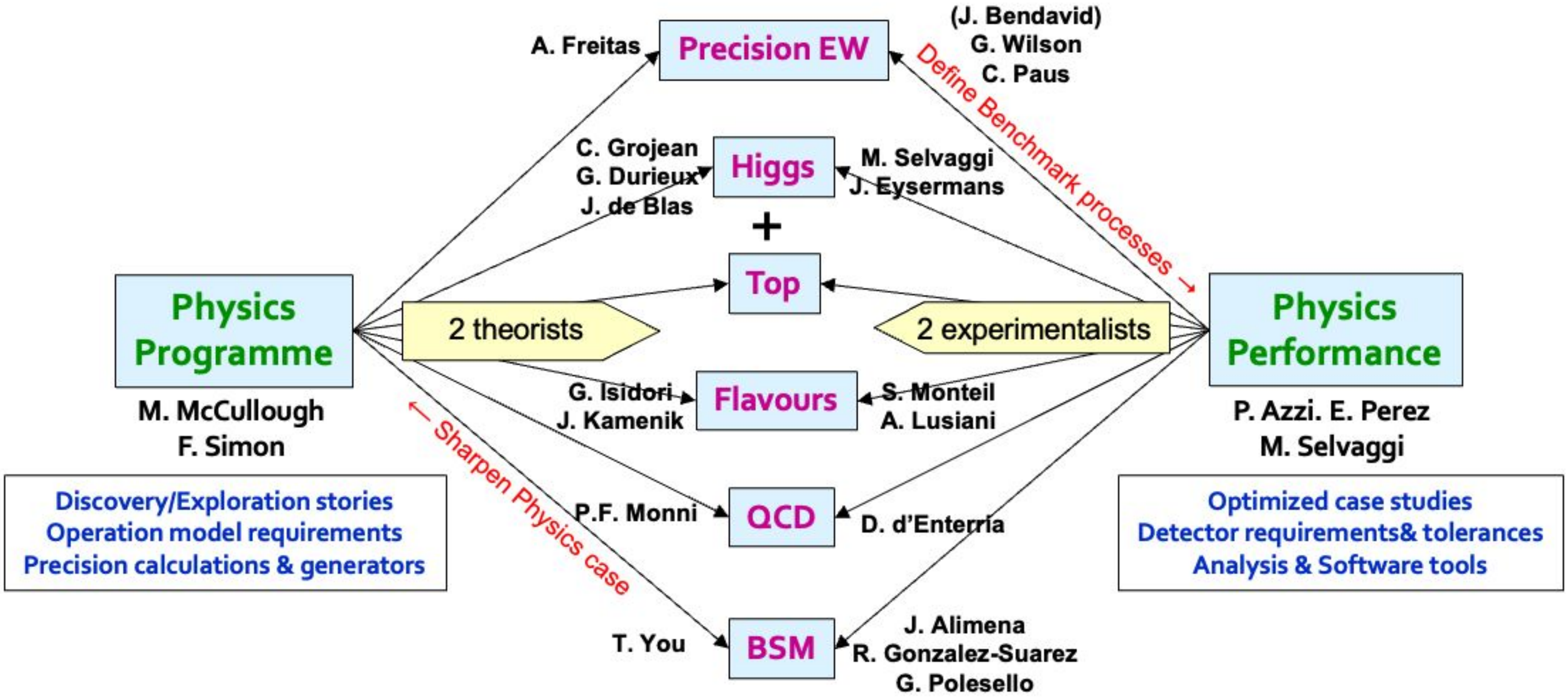
- Content of the mid-term PED chapter (60 pages were expected → 110 pages delivered)

Physics, Experiments, Detectors

Links: ○ Physics, Experiments and Detectors (PED)



Physics Programme and Performance



PED activities

Regular meetings organised by each PED WGs (one or twice a month on average):

- Physics Programme
- Physics Performance
  - Higgs physics
  - Top-quark physics
  - Flavour physics
  - QCD and gamma-gamma physics
  - BSM physics
  - FCC-hh ESPP 2025
- Detector Concepts
- Software and Computing
- Beam energy calibration, polarisation, monochromatisation

You are welcome to join, to participate, to get engaged.

Example of work ahead of us

- Development of a common software and the estimate of the computing needs
- Evaluation of the physics performance and requirements for detectors
- Conceptualisation of detectors capable of delivering these requirements
- Mitigation of the interaction region constraints on detectors and vice versa
- Design of methods and tools for centre-of-mass energy calibration, beam polarisation, and monochromatization
- Understanding and optimisation of the physics programme
- Exploration of the physics opportunities (incl. synergies FCC-ee/FCC-hh and incl. physics opportunities beyond colliders).
- Development of the theoretical tools and observables needed to meet the measurement targets

FCC-ee Run Plan

LEP1 data accumulated in **every 2 mn**. Exciting & diverse programme with different priorities every few years.
(order of the different stages still subject to discussion/optimisation)

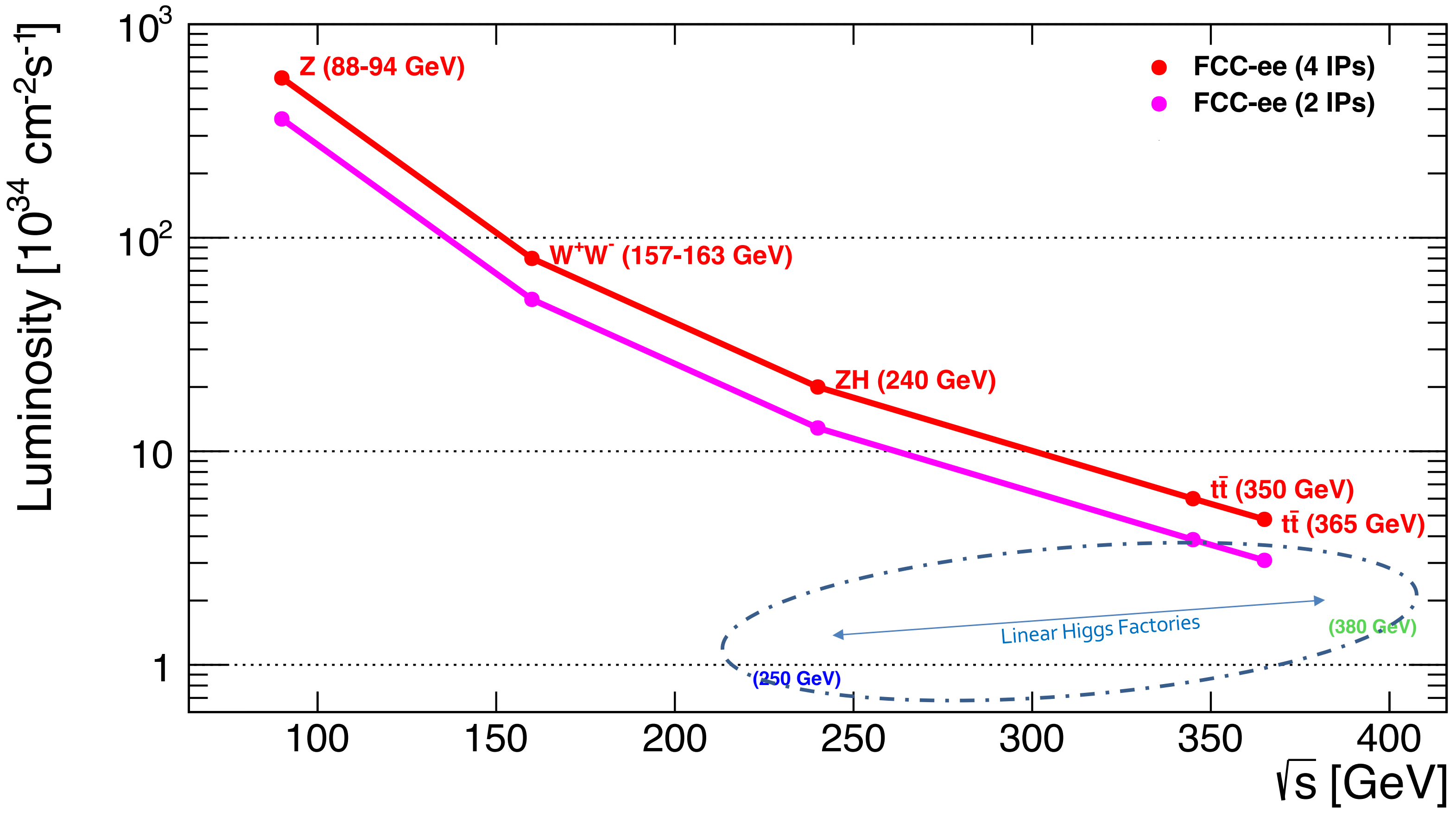
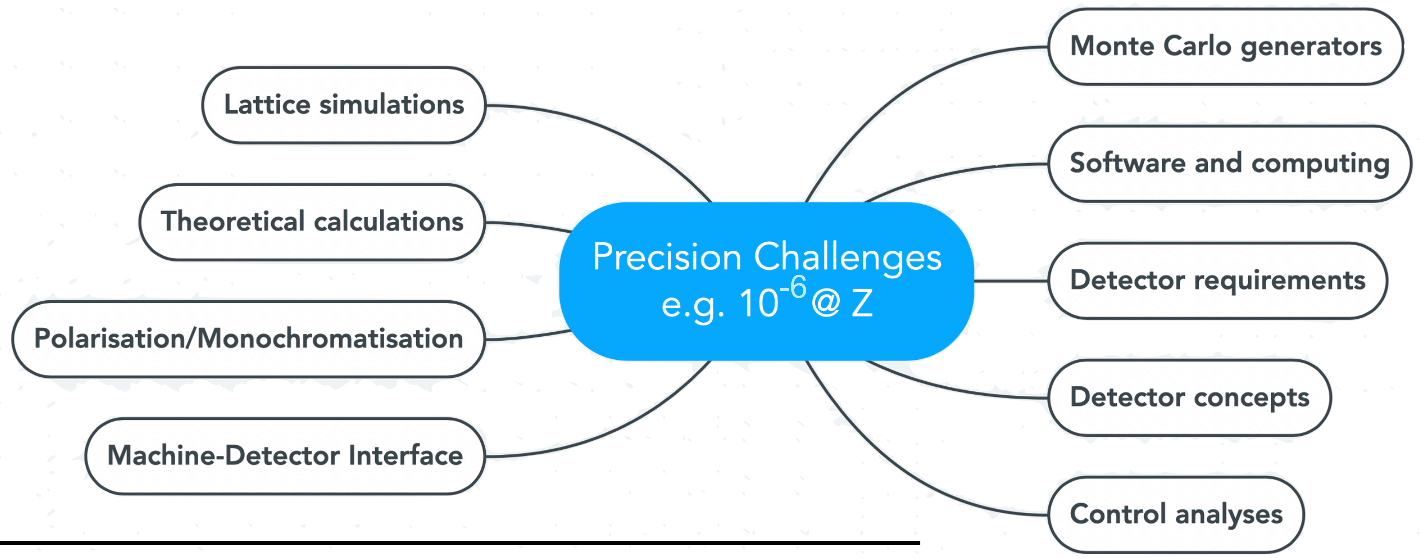


Fig. to be updated: new optics design (May 2024) gives 50% more lumi @ 240 GeV.

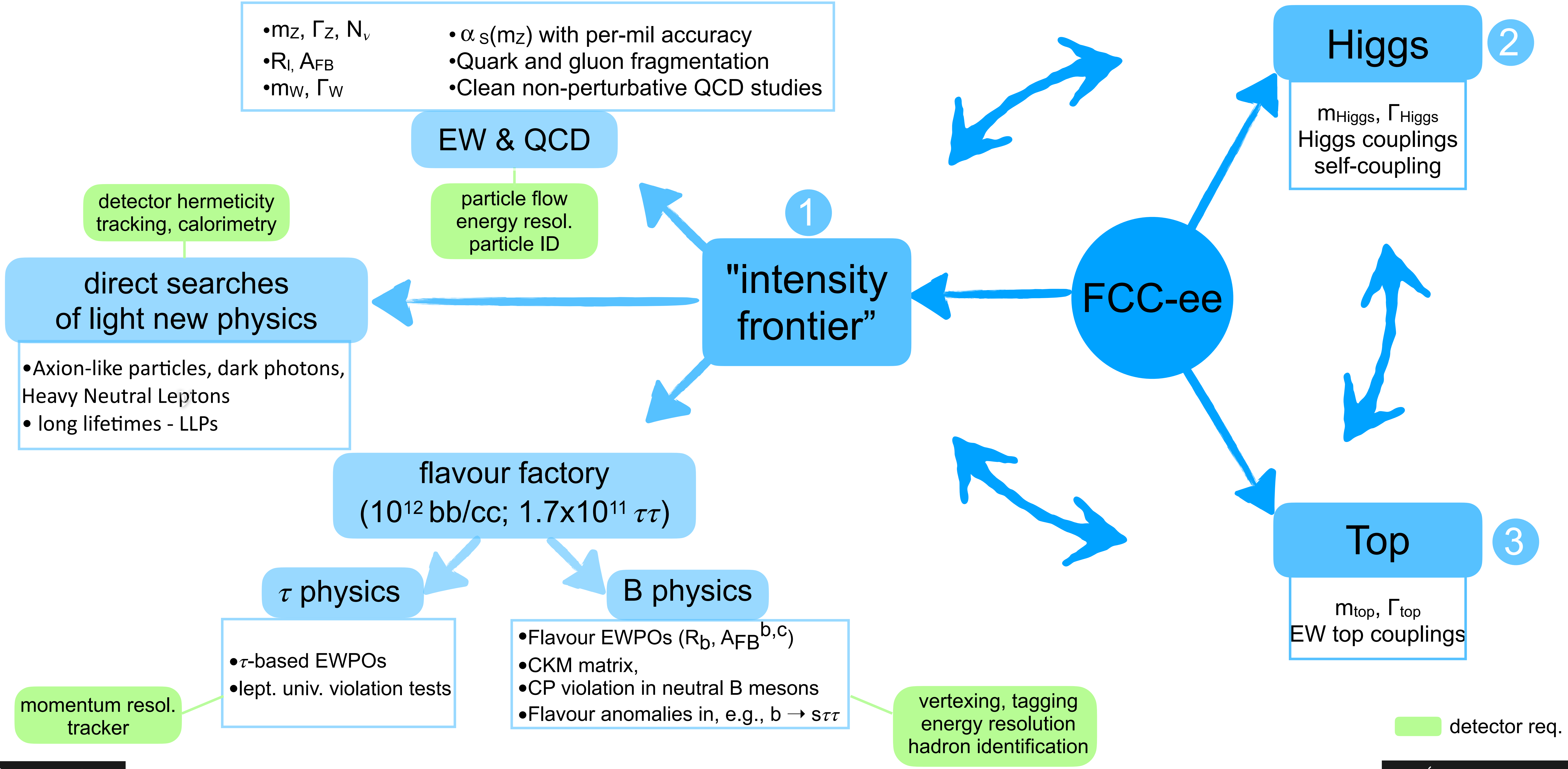
— Superb statistics achieved in only 15 years —

in each detector:
10^5 Z/sec, 10^4 W/hour,
1500 Higgs/day, 1500 top/day

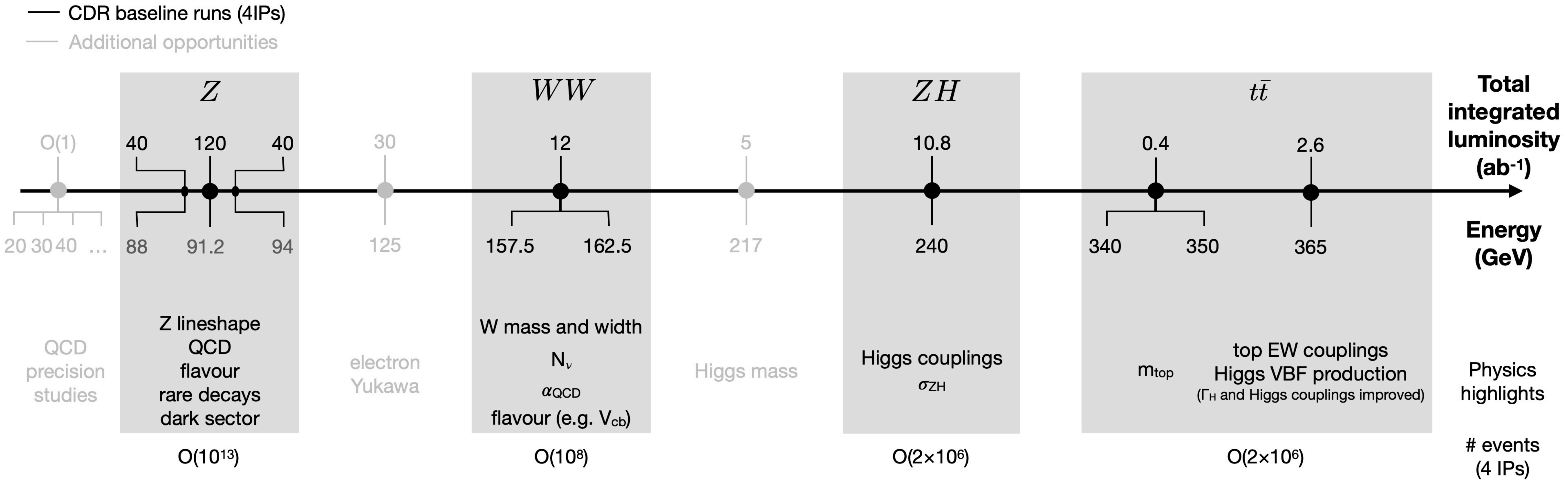


Working point	Z, years 1-2	Z, later	WW, years 1-2	WW, later	ZH	$t\bar{t}$	
$\sqrt{s}$ (GeV)	88, 91, 94		157, 163		240	340–350	365
Lumi/IP ($10^{34}\,\text{cm}^{-2}\text{s}^{-1}$)	70	140	10	20	5.0	0.75	1.20
Lumi/year (ab^{-1})	34	68	4.8	9.6	2.4	0.36	0.58
Run time (year)	2	2	2	–	3	1	4
Number of events	6×10^{12} Z		2.4×10^{8} WW		1.45×10^{6} ZH + 45k WW $\to$ H	1.9×10^{6} $t\bar{t}$ +330k ZH +80k WW $\to$ H	

FCC-ee Physics Programme



Collider Programme (and beyond)



- **Opportunities** beyond the baseline plan (√s below Z, 125GeV, 217GeV; larger integrated lumi…)
- **Opportunities** to exploit FCC facility differently (to be studied more carefully):
  - using the electrons from the injectors for beam-dump experiments,
  - extracting electron beams from the booster,
  - reusing the synchrotron radiation photons.