

Current PD/LDRD Initiatives for FCC-PED at BNL

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Current FCC-PED related Efforts at BNL

Building on LDRD efforts starting in FY23 (Feasibility Study Phase):

- LDRD “Advancement of Noble Liquid Detectors R&D for High Priority HEP Experiments in 2023 P5 Report”, PI: Hucheng Chen
- PD “FCC Center at BNL”, PI: S. Rajagopalan
- LDRD “Leading Discovery at a Future FCC-ee”, PIs: S. Rajagopalan, S. Dawson
- LDRD “Optical charge injection for calibration of liquid argon calorimeters”, PI: C. Rasmussen
- LDRD “An Integrated AI-Enabled Tracking Demonstrator for FCC-ee”, PI: S. Rajagopalan
- Accelerator/MDI-focused efforts are not discussed here

Noble Liquid Detectors R&D

Integral system design

- Architectural design of the full readout chain, including the critical interface and signal processing studies: *V. Radeka, S. Rescia, B. Yu, M. Zhao*
- Development of CFEB (Cold Front-End Board) and WFEB (Warm Front-End Board) in close collaboration with CERN and other international partners: *H. Chen, J. Fried, S. Gao*

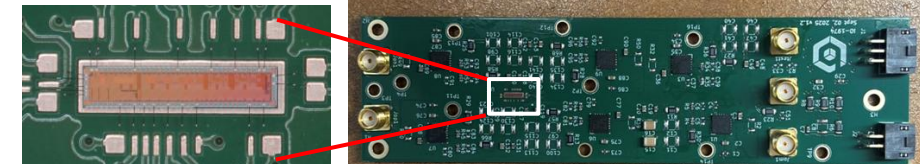
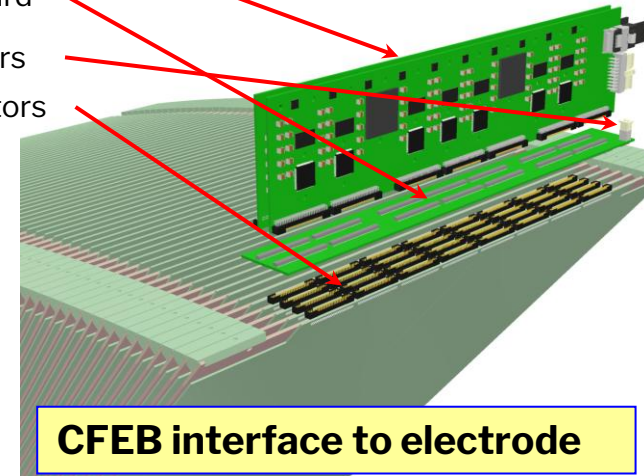
Cryogenic front-end ASIC

- Design of cryogenic front-end ASIC: *G. Deptuch, P. Mukim* with support from IO microelectronics group
- Characterization of the cryogenic front-end ASIC with PCB-based electrode: *N. Galice, S. Gao, L. Ke*

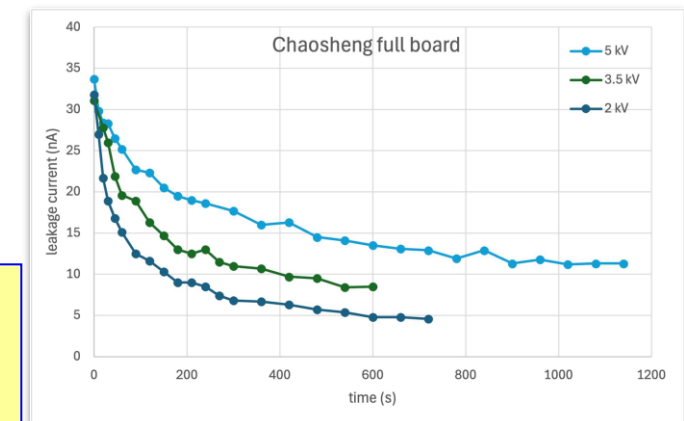
Simulation studies

- Use particle-flow to study the ultimate jet resolution: *C. Rasmussen, I. Veliscek*
- Use physics benchmark studies to further develop rudimentary simulation and reconstruction software: *D. Damazio, S. Singh, S. Snyder*
- Refine specifications of the front-end ASIC based on the requirements of ALLEGRO ECAL and DUNE FD3 photon detector: *S. Snyder, M. Zhao*

CFEB doublet
Summing board
HV connectors
Angled connectors



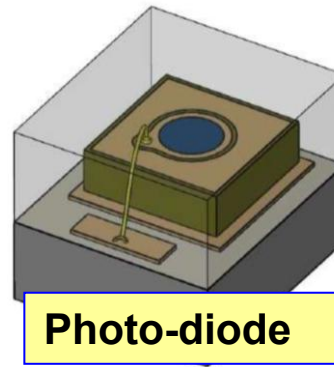
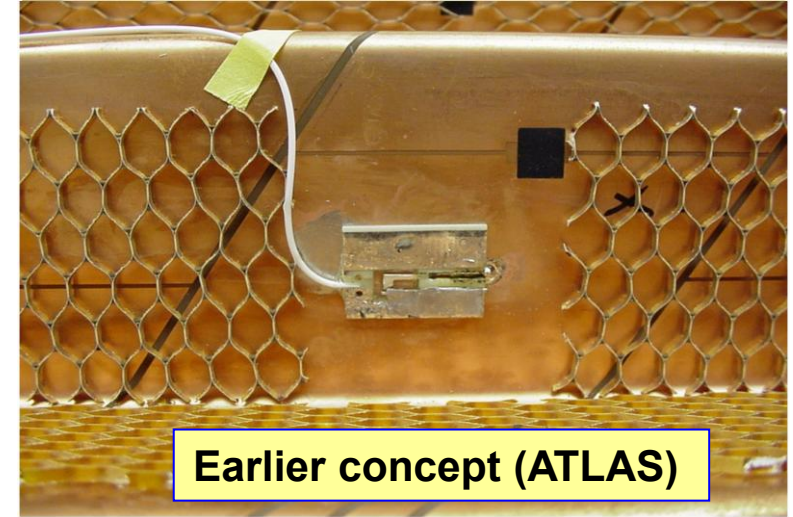
CHARMS250 wired bonded on the cold test board



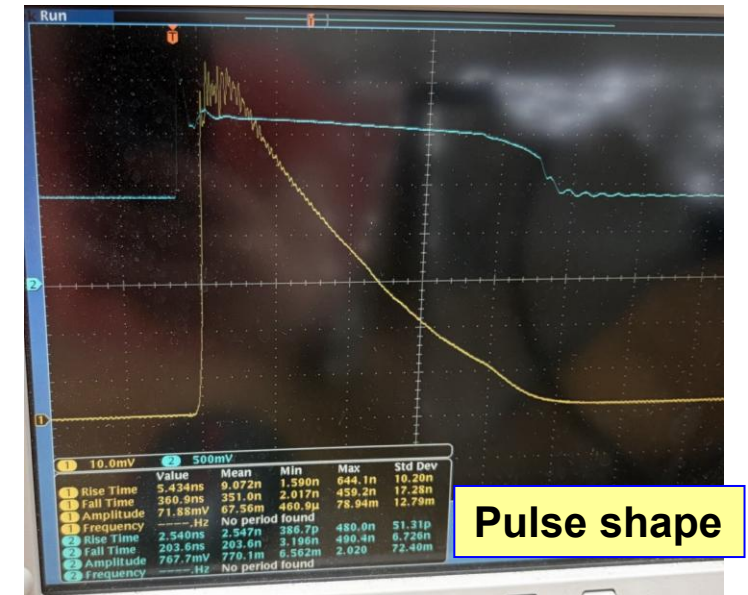
HV test of Section 1 electrode validated dielectric breakdown strength (5 kV @ 0.1 mm)

Optical charge injection for calibration of liquid argon calorimeters

- Develop a package to optically inject calibration pulses into noble liquid calorimeters
- Enable cross talk studies without introducing new ground loops
- Based on avalanche diode C30737MH



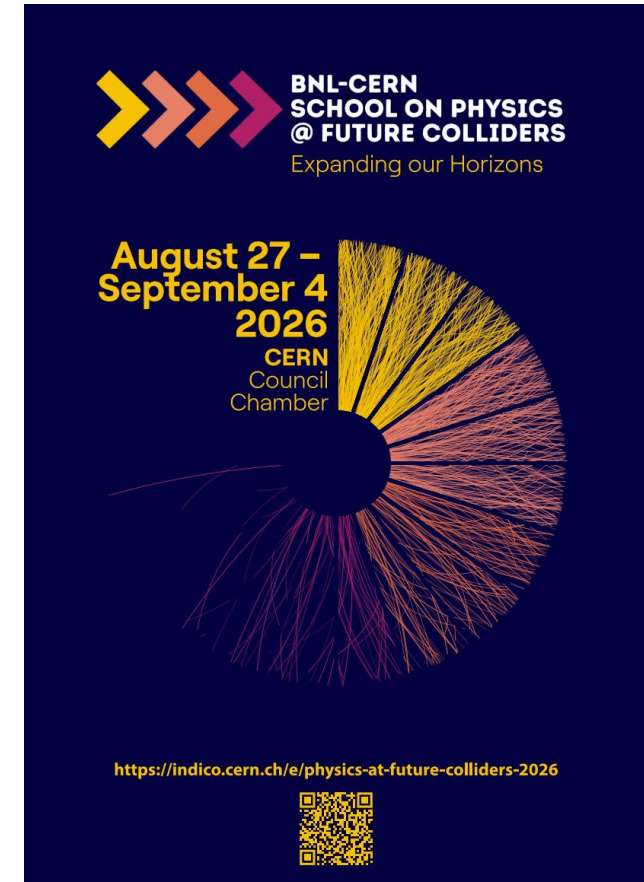
Team: S. Gao, M. Kris, C. Rasmussen



U.S. FCC Center at BNL

Scope of the U.S. FCC Center at BNL:

- Support for an FCC-ee Theory Center
 - Details see dedicated slide
- Engaging community through supporting workshops and hosting visitors
 - Inaugural school on [Physics at Future Colliders](#) →
 - Various workshops/schools sponsored or hosted at BNL
- Creation of a national U.S. FCC Analysis Facility
 - Details see dedicated slide
- Launching an FCC Silicon MAPS Facility at BNL
 - Started collaboration on MAPS R&D for tracking detectors (synergy with ALICE-ITS3/ALICE3 and EIC-ePIC detectors)
 - Development to complete design of ALMIRA prototype by early 2027 to prepare for the engineering run submission
- Administrative and Program Office support



BNL FCC-ee Theory Center

We have expertise in precision electroweak computations, QCD and QED corrections and effective field theories

SMEFT beyond LO at FCC-ee
(ZH, Z-pole, H decays)

Asteriadis, Dawson, Giardino, Szafron · [arXiv:2406.03557](#)

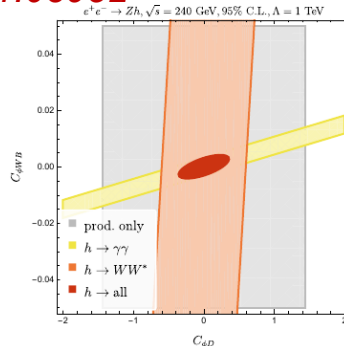
Asteriadis, Dawson, Giardino, Szafron · [arXiv:2409.11466](#)

Dawson, Forslund, Giardino · [arXiv:2411.08952](#)

Bellafronte, Dawson, Del Pio, Forslund,
Giardino · [arXiv:2508.14966](#)

Bellafronte, Dawson, Del Pio, Forslund,
Giardino · [arXiv:2601.09599](#)

Bellafronte, Dawson, Del Pio, Forslund,
Giardino · [arXiv:2605.18679](#)



QED initial state radiation at NNLO
and mass effects

Schnubel & Szafron · [arXiv:2509.09618](#)

Schnubel, Schoenleber, Szafron · [arXiv:2604.02859](#)

We also organize events and hosts visitors working on FCC-ee physics:

LoopFest XXIV May 27–29, 2026 · Hosted at BNL
Special session on technical calculations for FCC-ee
(J. Reuter, A. Freitas, F. Ucci, M. Forslund, ...)

Visitors (2026):

Amin Aboubrahim, “Leveraging the FCC-ee capabilities to study the invisible decay of a dark photon”

Wolfgang Kilian, “Electroweak Interactions at the LHC and Beyond: Studies and Simulations”

Marvin Schnubel, “The Fate of Ultra-Collinear Modes in On-Shell Massive Sudakov Form Factors”

+ several virtual talks on precision computations, SMEFT, and future colliders

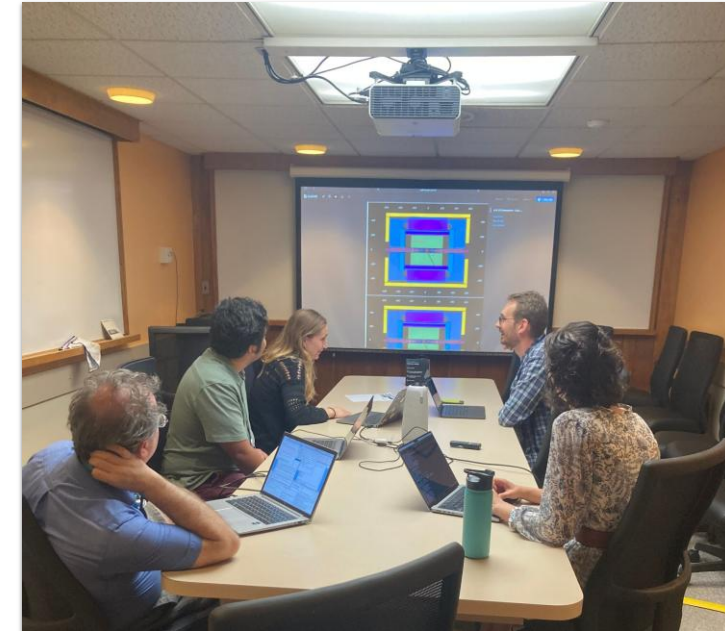
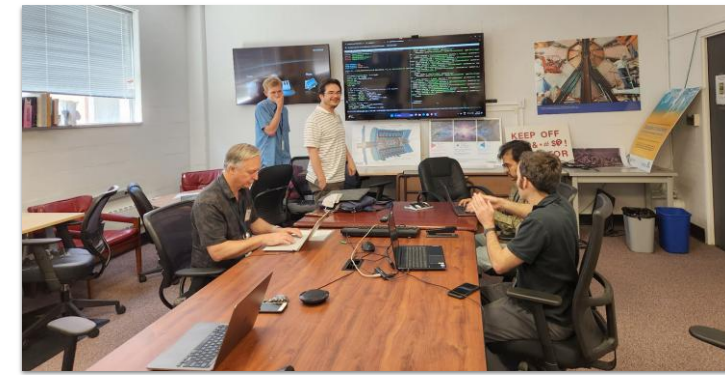
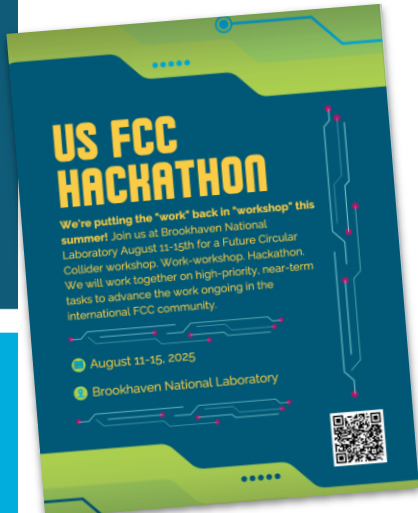
US FCC Hackathon 2025

We put the "work" back in "workshop" this summer!

Indico: <https://indico.cern.ch/event/1564836>

Work-workshop by the numbers:

- 39 registered participants (30 in-person at BNL)
- 6 work packages: 'Pandora PFlow for ALLEGRO', "Digitization in noble liquid calorimetry", "HFCC Integration/Detector Concepts Design Challenge", "CalVision", "Tools for drift chamber design", "Theory Challenges"
- 15 hours of dedicated work-work time
 - [Summarized in 15 final presentations](#) by participants
- Two motivational talks and one tutorial



U.S. Analysis Facility for FCC-ee

- **BNL Analysis Facility includes:**
 - 100 CPUs allocated for batch processing (with opportunistic access to thousands)
 - >10 NVidia L40S GPU for ML and vectorized computing
 - ~100 TBs of common disk space for sharing datasets
- Planning to grow it larger this year with more CPU and disk storage!
- [Instructions](#) to access these resources are available
- Two paths for access, full SCDF account or light weight federated account
 - People who want to get full SCDF account: please follow the process and request account
 - For federated access, Looking for volunteers to stress test the system
- Please contact Haider (sabidi@cern.ch) if any help is needed!

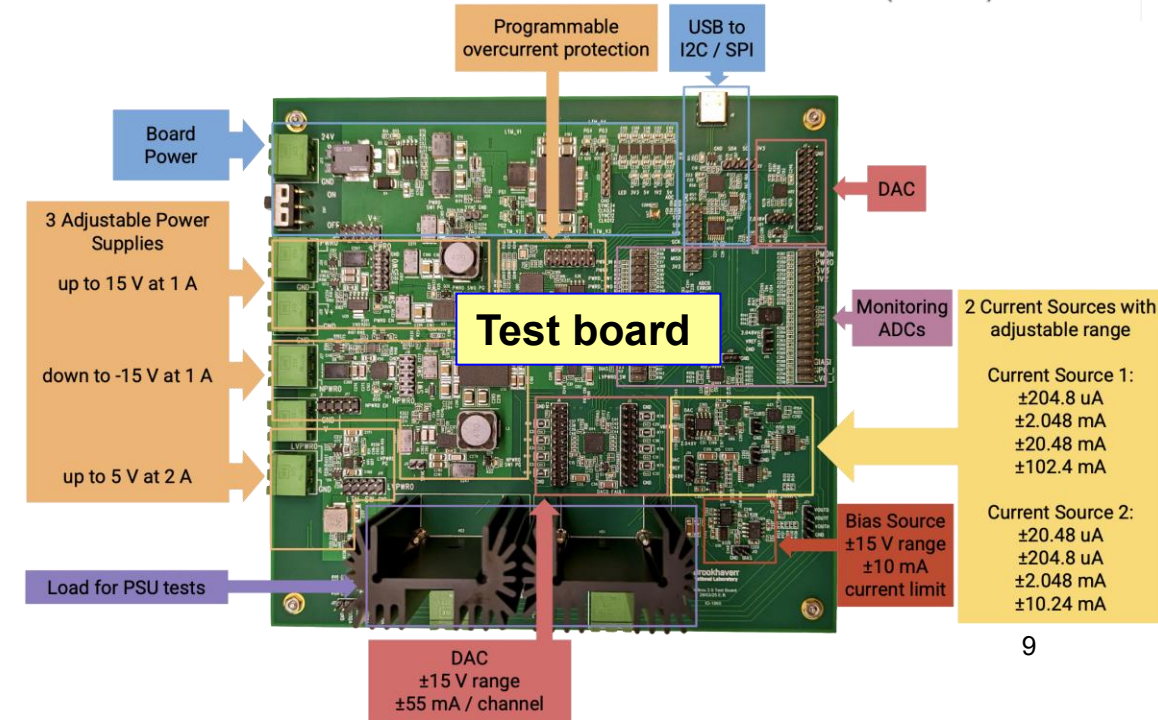
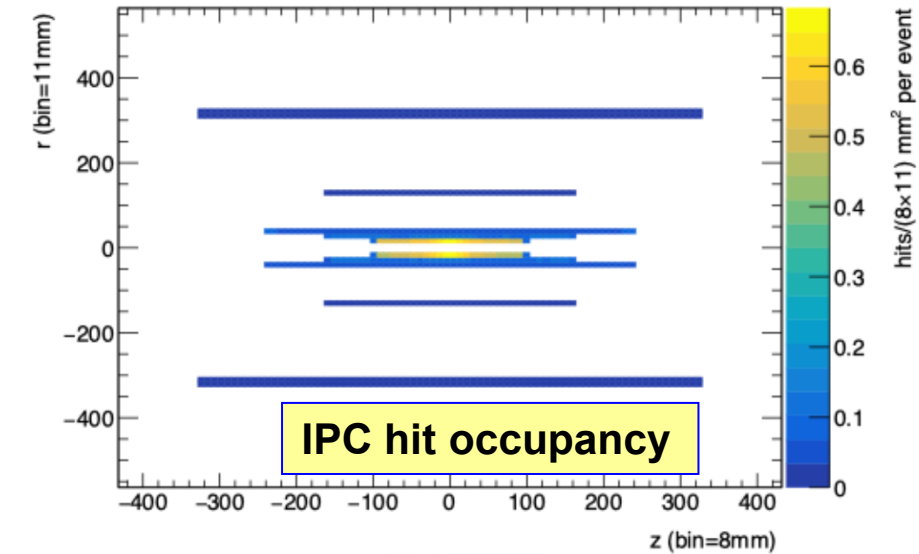
Access Type	Institution	Features	Account Type
Full SDCC Access	BNL Users	SSH, Jupyter, Condor (CPU/GPU), Storage	SDCC Account
Federated Access	CERN / Fermilab / SLAC	Jupyter with terminal and Condor access	Federated Identity

An Integrated AI-enabled tracking demonstrator for FCC-ee

Work packages:

- 1: **Simulation**: hit rates, occupancy for physics + BIB (ddsim)
Dataflow, buffer depth, read-out frames on chip (PixESL)
- 2: **Hardware demonstrator**: Build test stand with tracker module + “on detector electronics” (CaRIBOu v2.0) + “off detector electronics” (FELIX), operated in streaming mode
- 3: **AI in the readout**: Deploy AI models on FELIX for data compression/reduction in the readout stream.
Develop FELIX as a user-friendly platform for AI deployment

Team: *H. Abidi, N. Agaras, E. Buschmann, H. Chen, A. Li, A. Malige, S. Rajagopalan, C. Rasmussen, P. Sharma*



Analysis expertise and interests at BNL

- [H to invisible decays](#) – contact: *K. Assamagan, S. Snyder*
- [H self couplings](#) – contact: *L. Brost, A. Tishelman-Charny*
- [Model-independent ZH production cross section, Higgs Boson Mass with Natural-Width Precision](#) – contact: *A. Li*
- [Detector variations, H branching fractions to cc and ss](#) – contact: *A. Sciandra, I. Veliscek*
- [Precision Measurements of Higgs Hadronic Decay Modes](#) – contact: *G. Iakovidis*
- BSM: Higgs + dark sector at the Z-pole/higher $\sqrt{s}$ – contact: *L. Brost, A. Tishelman-Charny*

Conclusions

A vibrant FCC-ee
program is being
pursued at BNL
together with partner
institutes.
Come join us!



Backup

Reference Design Phase (2026-2028)

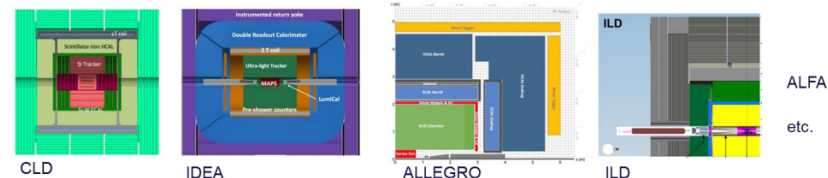
FCC has entered its Reference Design Phase to provide the CERN Council all the technical elements for an informed decision in 2028.

Reference Design Phase (RDP) objectives

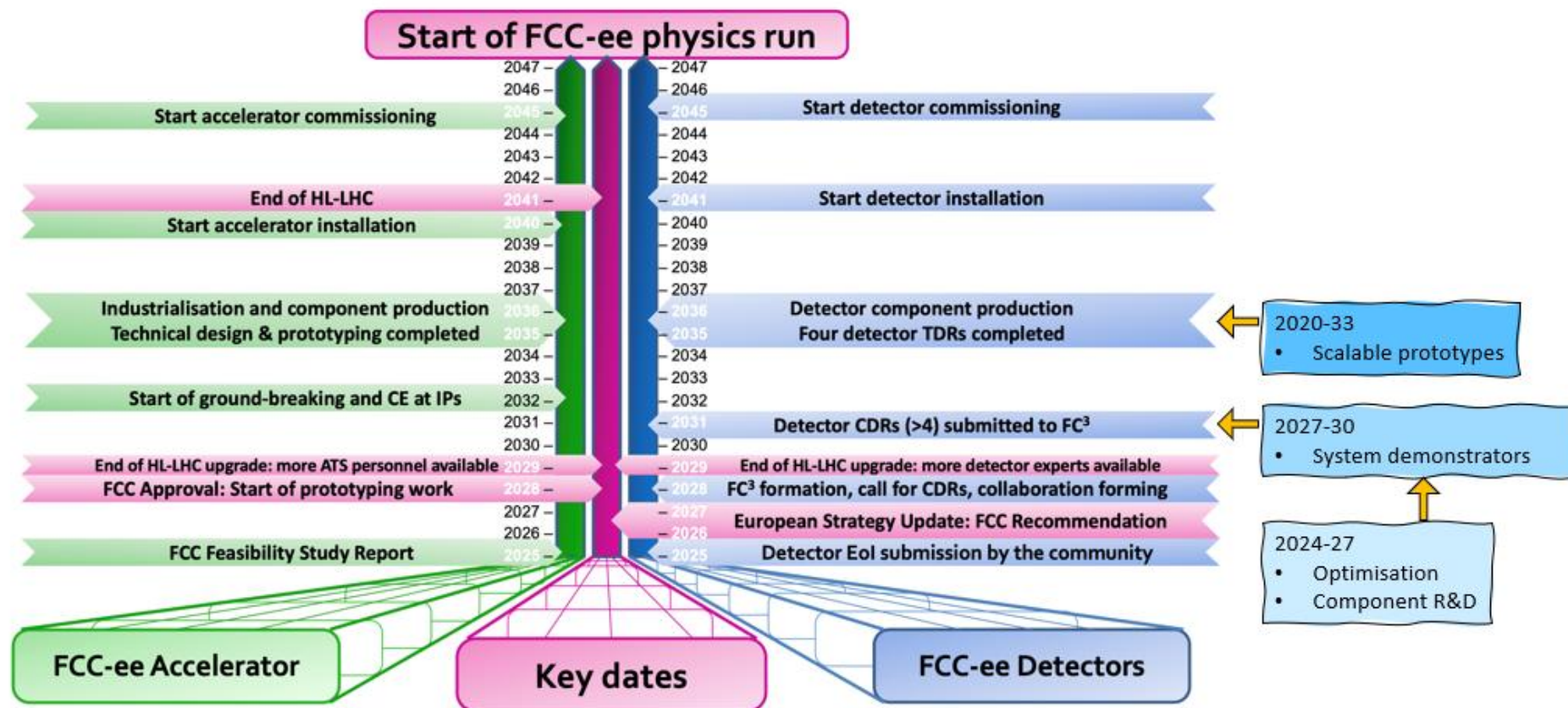
- Increase maturity of technical design (incl. recommendations from feasibility study reviews)
- Overall project integration and requirements on civil engineering sufficiently detailed to enable subsequent launch of civil engineering tender design in case of project approval
- Overall project design sufficiently detailed to allow advancing with environmental impact and evaluation as core parts of project authorisation processes in Host States
- Reducing project risks via:
 - **Integrated planning across all domains and interface management**
 - **Prototyping of critical systems**
 - **Build up cost / performance contingency by design optimization**
 - **Civil engineering refinement**
 - **Close coordination with Host States on territorial implementation aspects**
 - **Reinforcing collaboration as basis for global support for the project**

Physics, Experiments, Detectors - objectives

- Continue developing the **international high-energy physics community**
- Consolidation of the **interaction region layout, detector integration, and beam-background** mitigation
- Optimised **procedures for $\sqrt{s}$ calibration & possible monochromatic operation at $\sqrt{s} = 125$ GeV**
- Finalising common **software/analysis framework** and developing **common computing architecture**
- Realistic studies of **experimental systematic uncertainties** for some **EW precision** measurements and consolidation of the **pertaining requirements** on collider, detectors, and theory
- **Engagement of theory community** to address theory challenge and nurture the young generation
- Proposal for staging implementation and improvements of the **staged/descoped FCC-ee**
- **Prepare to answer call for (at least 4) documented EoI's for FCC-ee experiments end 2028**



Timescale towards FCC-ee



Get involved in Detector Concepts!

Group name	Email	Signup	Indico
Calorimetry	FCC-PED-DetectorConcepts-Calorimetry@cern.ch	click	click
Luminometry	FCC-PED-DetectorConcepts-Luminometry@cern.ch	click	click
Magnet	FCC-PED-DetectorConcepts-Magnet@cern.ch	click	click
Muon	FCC-PED-DetectorConcepts-Muon@cern.ch	click	click
TDAQ	FCC-PED-DetectorConcepts-TDAQ@cern.ch	click	click
Tracker & PID	FCC-PED-DetectorConcepts-Tracker@cern.ch	click	click
AGORA	FCC-PED-DetectorConcepts-AGORA@cern.ch	click	click
ALFA	FCC-PED-DetectorConcepts-ALFA@cern.ch	click	click
ALLEGRO	FCC-PED-DetectorConcepts-ALLEGRO@cern.ch	click	click
CLD	FCC-PED-DetectorConcepts-CLD@cern.ch	click	click
IDEA	FCC-PED-DetectorConcepts-IDEA@cern.ch	click	click
ILD	FCC-PED-DetectorConcepts-ILD@cern.ch	click	click

- Signing up to any of the above e-groups adds you to the overall "FCC-PED-DetectorConcepts@cern.ch" e-group as well
- Indico categories are available for [Detector Subsystems](#) and [Concept Studies](#)
- See indico meeting [calendar](#) for upcoming meetings

Concept Studies

[AGORA](#)

[ALFA](#)

[ALLEGRO](#)

[CLD](#)

[IDEA](#)

[ILD](#)

Detector Subsystems

[Calorimetry](#)

[Luminometry](#)

[Magnet](#)

[Muon](#)

[TDAQ](#)

[Tracker & PID](#)