FCC

US FCC Physics, Experiments and Detector efforts overview

September 9th, 2026

Valentina Cairo, Srini Rajagopalan
& the US-FCC Steering Committee

The FCC-ee in the US

https://us-fcc.web.cern.ch/mandate/

US Higgs Factory

Coordination Consortia

charged by DOE and NSF

Provide strategic direction and leadership for the US community to **engage, shape and thereby advance the development of physics, experiment and detector program at various Higgs Factories**

Ensure cooperation with our partners in the international program

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2026

European Strategy for Particle Physics Update process

US Higgs Factory

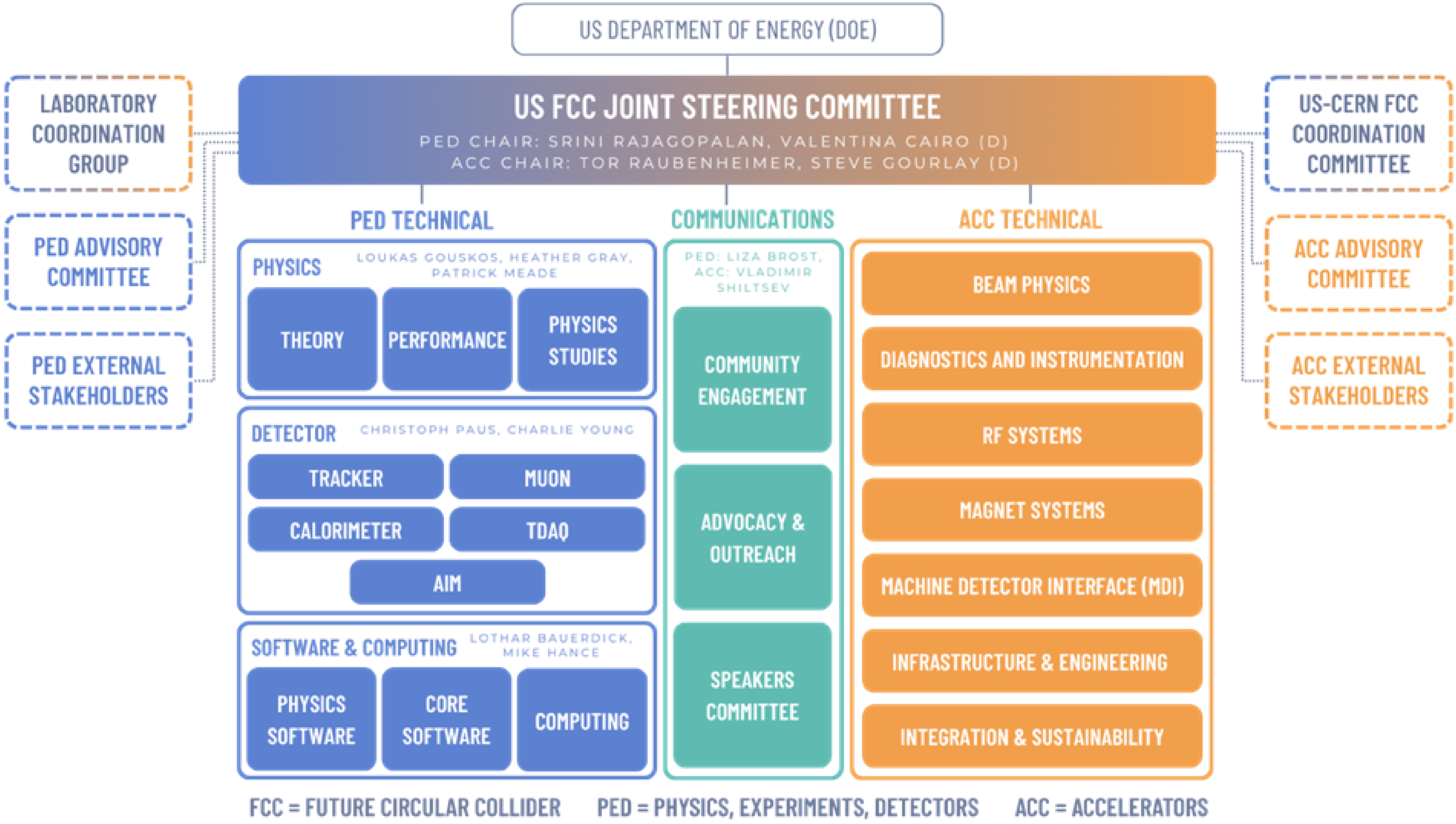
Circular Collider

Current US effort focused on defining strong international collaborations and unique areas of technological contribution to both **FCC accelerator and detectors**, including proposing detector concepts

The FCC-ee in the US

https://us-fcc.web.cern.ch/

Aspires to significant contributions to Physics, Experiments & Detectors (PED) as well as Accelerators (ACC).



Reminder of ongoing activities

PED
(ACC covered by Tor)

Cultivating unique US expertise with strong international collaborations

(*) partially or fully supported in FY 2026

Physics

AI detector optimization pipelines*
Development of Digitization framework for TDAQ*

Higgs, EWK, QCD physics, flavour tagging, particle identification, unique theory & experiment synergies
+...

Detectors

Muon Drift Tube & Micro-Rwell*
DR Crystal and Fiber Calo*
LAr design of turbine structures*
Strawtube*
MAPS*
Tracker Simulation*
Low Mass Mechanics*
+...

Software & Computing

Docs and Training support*
Core SW in Key4HEP*
MC Production*
Analysis Facilities
+...

Communication, Engagement, In- and Out-reach (shared with ACC)

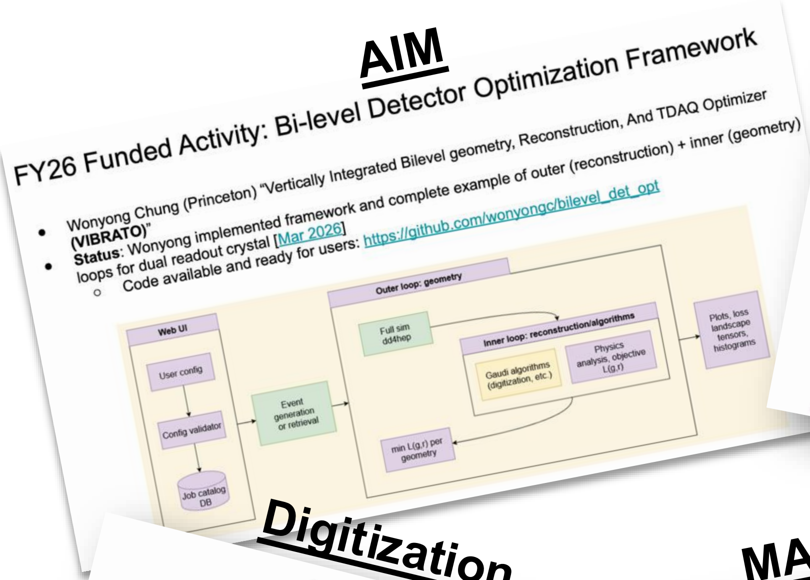
Some workshop/travel support*
Website development*

+...

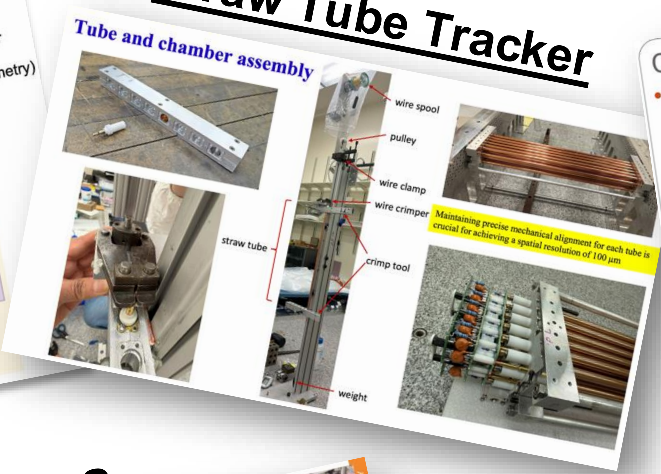
Reminder of ongoing activities

PED
(ACC covered by Tor)

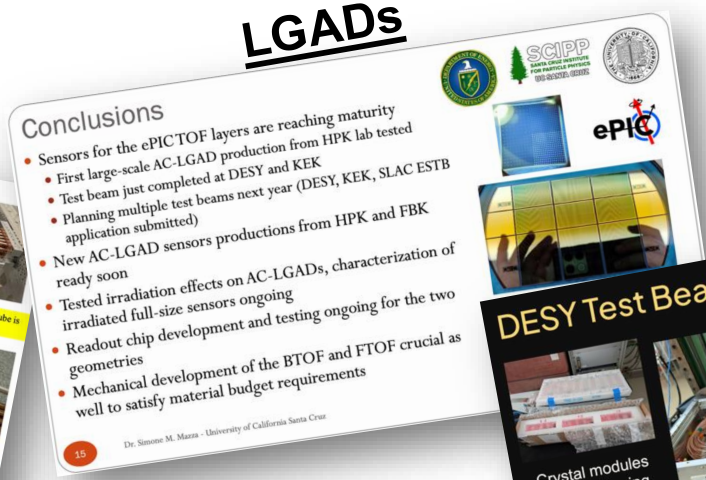
AIM



Straw Tube Tracker

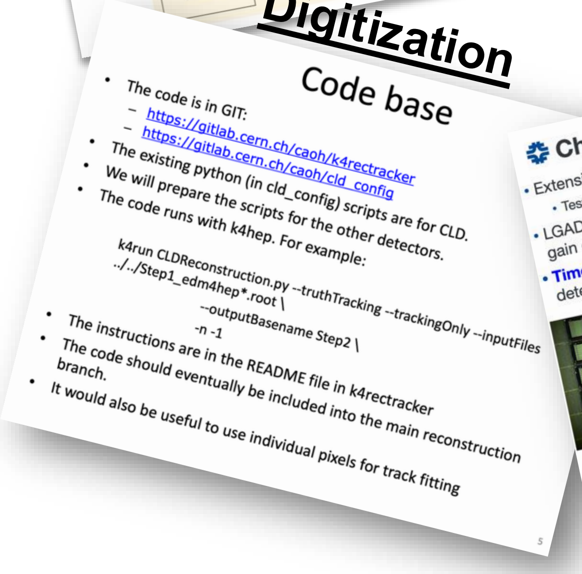


LGADs

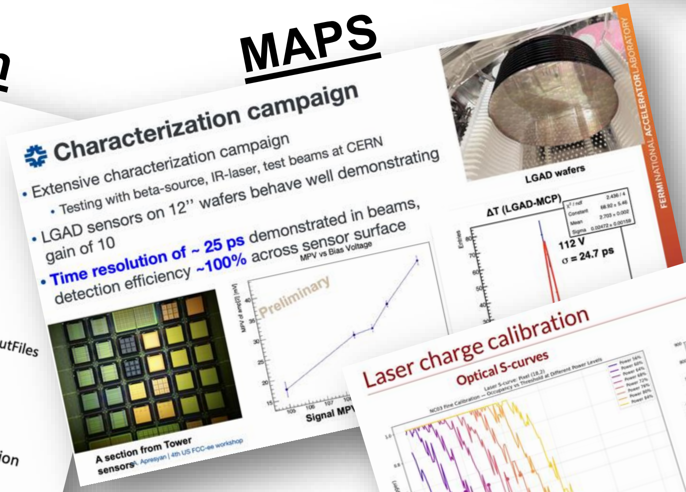


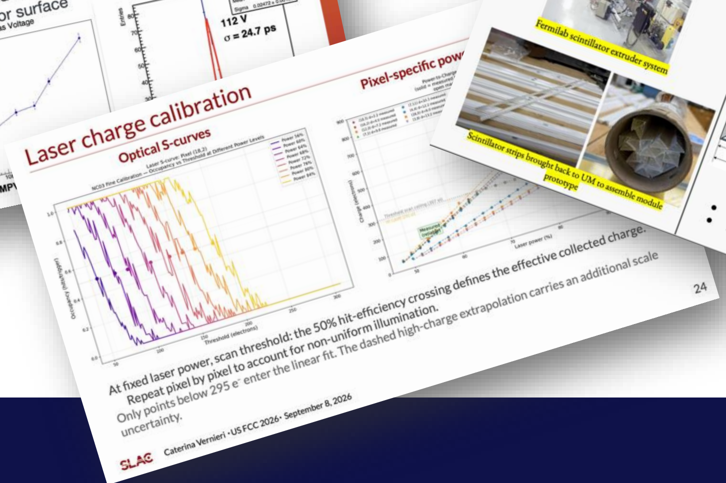
DR Calorimeter

Digitization

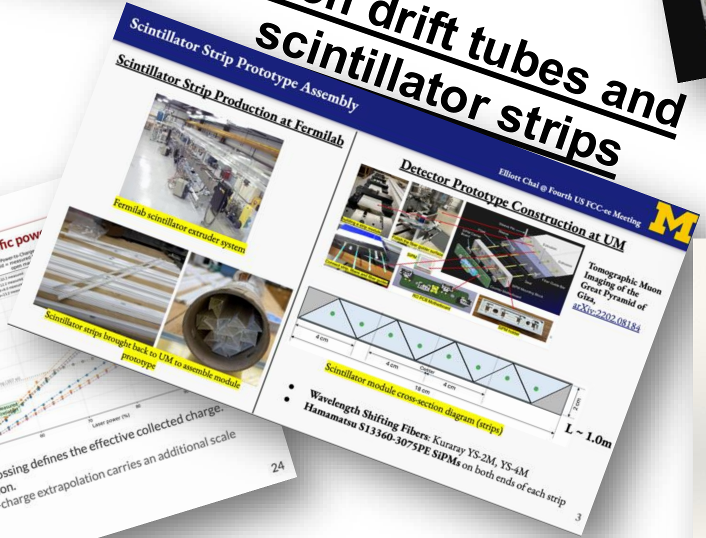


MAPS

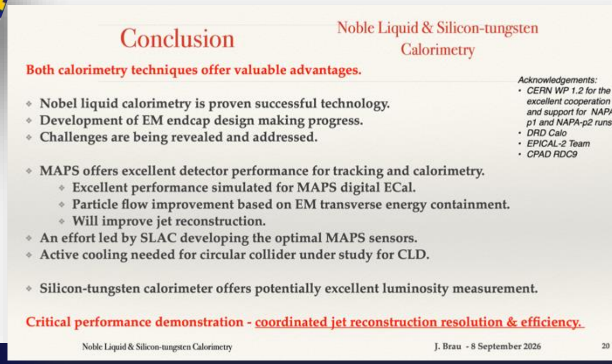




Muon drift tubes and scintillator strips

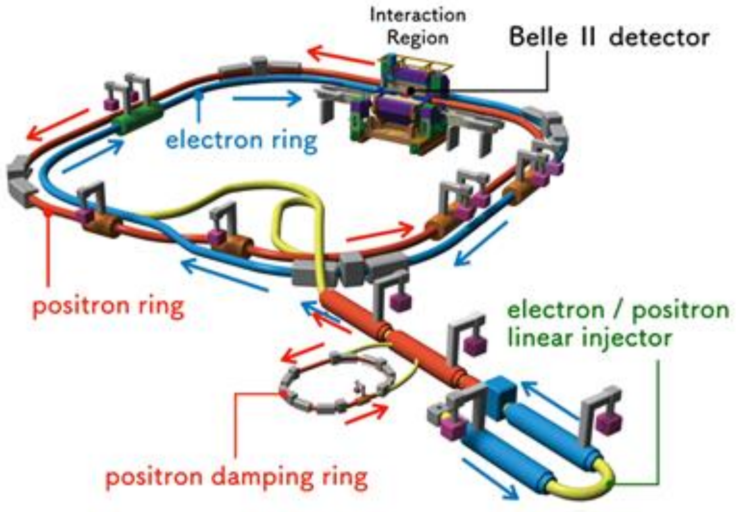


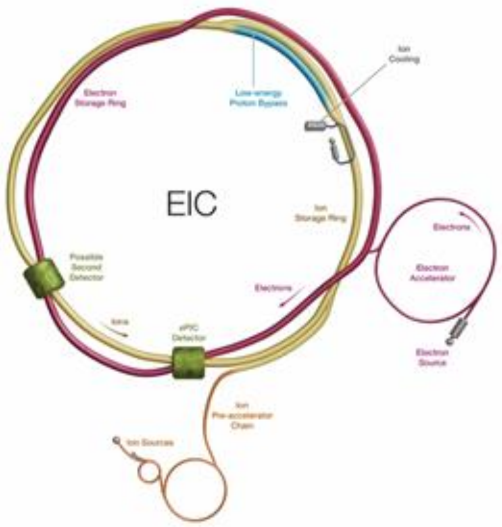
Noble Liquid and Silicon Tungsten Calorimetry



Synergies with other projects

- Synergies with other ongoing/future projects
  - SuperKEKB
    - e.g. luminosity
  - Electron-Ion Collider
    - e.g. MDI, tracking systems, etc
      - Recent US-FCC tracking meeting
        - https://indico.global/event/17982/
  - And more…
- Potential to establish strong long-term collaborations as in current times, e.g. HL-LHC and LBNF/DUNE





Today's International Context

From Srini's Introduction slides

Objectives of Physics, Experiments, Detectors

- ❖Continue developing the international high-energy physics community
- ❖Consolidation of the interaction region layout, detector integration and beam-background mitigation.
- ❖Optimized procedures for $\sqrt{s}$ calibration & possible monochromatic (125) operation.
- ❖Finalizing common software/analysis framework and developing common computing architecture.
- ❖Realistic studies of exp. systematic uncertainties for some EW precision measurements & consolidation of pertaining requirements on colliders, detectors and theory.
- ❖Engagement of theory community to address theory challenges
- ❖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.
- ❖Engaging the early career researchers and the next-generation scientists.

Fourth U.S. FCC Week 11

Given today's funding realities and priorities, how do we not only sustain but grow the expertise and collaboration needed to move science forward?

What can we do in the US to make the FCC a reality?

FY 2027

Developed a bottom-up proposal request for FY 2027. Worked with the L1/L2 coordinators and the community (email sent out to whole US-FCC community to collect ideas).
Prioritization will be based on:

- Why US? (local expertise, leverage infrastructure, maintain leadership and engagement)
- Why now? Importance of engaging in the proposed R&D in FY 2027 rather than later.
- What is the impact if not done now?

Two additional points are considered:

- **Uniqueness of activity:** US uniquely positioned to deliver; international FCC relies on US.
- **FCC & AI:** Explicitly spell out connections with AI.

This process allows the US HFCC to develop the case to seek appropriate funding through multiple funding streams

Prioritization process is ongoing

△ High ◯ Medium ▽ Low

Today we present the full US-FCC potential that is in our strategic interest to pursue in FY27.
This is based on existing or growing expertise and collaborations.

Our goal is to identify the highest priorities to fit within the available funding

Request for FY27 support

PED

Executive Summary of what we believe is crucial for PED. Total cost ~3M USD (breakdown below + travels)

Physics (~250k USD)

Larger scope studies: Higgs & Z pole physics

Z pole focused studies: Impact of Magnetic field & Impact of bunch spacing structure

Digitization & TDAQ

Detectors (~2000k USD)

AIM
TDAQ
Muon
Calorimeter
Tracker

Software & Computing (~320k USD)

Physics software
Core software
Computing

Communication, Engagement, In- and Out-reach (~50k USD)

"Work"-workshop

Poster prize at US-FCC workshop in the form of travel grant for 1 domestic conference

Physics Studies

Magnet studies: Compare 2, 3 & 4 T configurations at the Z pole; O(month) effort, synergies with Detector

Beam structure: Compare continuous beam vs. 25 ns bunch spacing using Z-pole measurements; O(month) effort, synergies with Detector & Acc

Full simulation studies:
- Higgs: Z coupling & charm
- Z pole: R_b
- Start with fast simulation → full simulation comparison

O(year) effort, cross-institute collaboration, synergies with Software & Computing

Physics studies to inform the Integration of Silicon Tracking, Calorimetry, Timing, and Particle ID:
- Detector integration: Assess physics impact of silicon tracking, calorimetry, timing & PID
- 5D Particle Flow: Integrate tracking + fast timing + dual-readout calorimetry
- Particle ID: Study RICH + silicon timing layer integration
- Physics benchmarks: Focused, but not limited to, **Higgs → ss**

O(year) effort, cross-institute collaboration, synergies with Detector, Software & Computing, Theory

Realistic silicon-tracker digitization + TDAQ design in Key4hep:
- Sensor-level simulation (charge generation, Lorentz drift, diffusion, front-end threshold/timing effects) providing the data stream needed to evaluate streaming readout, data-volume reduction and real-time FPGA/GPU tracking.
- Determines sensor geometries and bandwidth requirements against beam-induced backgrounds.

O(year) effort, synerigies with Detector, Software & Computing

- Leverages unique and longstanding US experise (e.g. Full simulation, Higgs couplings to light particles, etc core US expertise already during Snowmass).
- Timely to inform reference design phase, in line with international priorities
- Builds longterm impact
- Cross-institute collaborations
- Exp-Th-Acc synergies
- High return on investment

Detector Studies

AIM:
- Detector optimization framework
- Agentic detector optimization

TDAQ:
- TDAQ digitization framework
- Rad-hard Si-photons data link

MUON:
- Drift tube and scintillators

Calorimeter:
- Dual-readout simulation
- DR ECAL testbeam (CalVision)
- DR HCAL testbeam
- Thermal management of LAr cold electronics
- Endcap LAr calorimeter design
- Simulation for Si-W luminometer
- Digital ECAL with MAPS

Tracker:
- MAPS development
- Straw tube
- Beam background simulation
- Lightweight supports
- Carbon fiber wires
- Development for PID using a fast-timing Tracker Wrapper
- dN/dx front-end electronics

- Builds on established US leadership and expertise in detector R&D, leveraging existing facilities, university/lab capabilities, and industry partnerships
- Sustains ongoing efforts while developing innovative technologies critical to future detector design, with strong opportunities for US-led collaboration and long-lead development
- N.B. The CalVision project depended on DOE R&D Programme, now being reduced because the scope is considered targeted to FCC, i.e. not generic enough

Software & Computing Studies

Physics Software:
- Agentic AI for FCC Workflows; O(year) effort
- AI driven documentation & Knowledge Surfaces; O(month) effort

Core Software:
- Geometry & Thread safety; O(year) effort
- Key4HEP configuration; O(year) effort

Computing:
- Distributed Data Science & Open Science Grid; O(month) effort
- Computing Hardware

General:
- Workshops, hands-on sessions, training events; See “Communications” request

- Continued priorities from FY26
- Longstanding US expertise
- Time-critical activities especially in support of physics studies

Communications Activities

Workshops

- Organize a work-oriented hands-on workshop, favour early career participation by sponsoring their fee

Timely to keep community engaged, train and motivate early career scientists (more during Panel discussion on Thursday)

Prize for poster session at US-FCC Workshop

- Prize consist in travel support to a domestic conference to present work

A multi-prong approach

No new project likely to start before ~2030 in the US → The sum of what we would like to support is ~3M USD, so funding FCC requires a multi-prong approach

- **Traditional DOE support**
  - ***The check is in the mail*** for 0.5 M for PED for FY 2027

- **LDRD/PD support from the National Labs (see dedicated discussion later in the week)**
  - BNL, FNAL, SLAC, ANL and LBNL; BNL, FNAL & SLAC already have established LDRDs/PDs
  - We have been discussing with respective laboratory management to seek additional LDRDs/PD

- **University funding**
  - Must explore possibilities; potentially to obtain matching contributions from Universities (travel support to help community engagement?).

- **AI-focussed funding**
  - Plan to document AI-specific activities for FCC into a white paper and submit for consideration
    - Building on the general AI white paper 2602.17582

- **Explore private foundations support?**

In summary

The Future Circular Collider has the potential to become a unique driver in our fundamental understanding of nature, its physics reach will advance the state-of-the-art in an unprecedented way

Interplay between **accelerator, detector design**, **algorithms and analysis techniques** is of paramount importance to achieve the FCC physics goals

Leveraging longstanding US expertise and **maintaining timely and strong US involvement** ensures a **leading role in shaping the FCC** design and physics reach while providing a **training platform** for the next generation of scientists

Particle Physics programs of CERN and the US are interdependent to the mutual benefit of both

Following the HL-LHC legacy, the Future Circular Collider will push open a new window onto the laws of nature…

Relative view point, by F. Cairo

We are getting ready to discover ***what we know*** and also ***what we did not know*** we were missing

We have a **unique opportunity to drive it as a community** and shape technologies, theories, and the scientific vision of the future

EXTRA SLIDES

EU Strategy Update for Particle Physics

European Strategy Update

https://europeanstrategyupdate.web.cern.ch/

*Aim: develop a **visionary and concrete plan** that greatly advances human knowledge in fundamental physics through the **realisation of the next flagship project at CERN**. This plan should attract and value **international collaboration.** → **European Strategy Group concluded its deliberations and recommendations are available***

A. The electron–positron Future Circular Collider (FCC-ee) is recommended as the preferred option for the next flagship collider at CERN. ~15 billion CHF over ~12 years, civil engineering for tunnel about 1/3

Broadest high-precision particle physics programme

- Outstanding discovery potential through the Higgs, electroweak, flavour and top sectors, as well as advances in QCD. Its technical feasibility is demonstrated via the FCC feasibility study, Scope and costs are well defined, plausible funding models exist

B. A descoped FCC-ee is the preferred alternative option for the next flagship collider at CERN. No top-quark run, 2 interaction regions and experiments, decreasing the radiofrequency system power. Cost reduction ~15%

FCC-ee would pave the way towards a hadron collider reusing tunnel and infrastructure → direct discovery reach beyond the 10 TeV parton energy scale, in line with the community's ambition for exploration at the highest achievable energy.

The Future Circular Collider in a nutshell

https://home.cern/science/accelerators/future-circular-collider/

The future collider would be built in a circular underground tunnel some 91 kilometres in circumference located at a depth of between 180 and 400 metres beneath the French departments of Haute-Savoie and Ain and the Swiss canton of Geneva.

90.7 km	**200 m average depth**
4(2) detectors	**Decades of scientific research**

A project with an integrated 2-stage program

Stage 1: **FCC-ee** (Z, W, H, tt) as electroweak, Higgs & top factory at highest luminosity
Stage 2: **FCC-hh** (~100 TeV) as natural continuation at energy frontier, pp & AA collisions; e-h option

HL-LHC **HL-LHC ends**

FCC civil construction **FCC-ee starts** **FCC-ee** **FCC-ee** **FCC-hh starts** **FCC-hh**

~2030 **2040** **2050** **2060** **~2070** **…**

FCC Timeline

The Future Circular Collider in a nutshell

The future collider would be built in a circular underground tunnel some 91 kilometres in circumference located at a depth of between 180 and 400 metres beneath the French departments of Haute-Savoie and Ain and the Swiss canton of Geneva.

Timeline

2021-2025	Feasibility Study
2026-2027	Update of the European Strategy for Particle Physics
2028	Expected decision whether or not to build the FCC
Early 2030s	Construction start
2038-2046	Installation phase
Late 2040s	Start-up of FCC

90.7 kilometres

The circumference of the accelerator ring is a key parameter for determining the energies at which particles can be collided. Its proposed location was chosen after careful consideration to minimise the impact on the surrounding countryside and villages.

200 metres average depth

The FCC tunnel would be primarily embedded in the molasse of the Geneva Basin, spanning parts of France and Switzerland and including a section beneath Lake Geneva. The tunnel would be accessible from eight surface points, one in Switzerland and seven in France.

4 detectors

Using different detector technologies would ensure a broad scientific harvest as well as systematic cross-checks of results. International collaborations would build on CERN's existing technical and organisational infrastructure, while expanding it to meet the specific requirements of the FCC programme.

Decades of scientific research

An infrastructure designed to support decades of scientific research, reinforcing Europe's leadership in particle physics throughout the 21st century and beyond.

https://home.cern/science/accelerators/future-circular-collider/

2026 European Strategy Update: FCC-ee descoped - Summary

Other alternative options

A descoped FCC-ee (to improve the financial feasibility)

- Descoping scenarios include:
  - removing the top-quark run -1.26 BCHF
  - constructing two rather than four interaction regions and experiments - 0.80 BCHF
  - decreasing RF system power (50 MW → 30 MW) - 0.35 BCHF
- These measures would reduce the construction cost by approximately 15%.
- **Although this would have a significant impact on the breadth of the physics programme and the precision achieved, the descoped FCC-ee would still provide a very strong physics programme and a viable path towards high energies, compared to the alternative collider options.**
- *The luminosity for the descoped FCC-ee would be (M. Benedikt, F. Zimmermann):*
  L(FCC-ee) x 3/5 x 2/4 x 1.2 = L(FCC-ee) x 0.36
- Should additional resources become available, these descoping scenarios would be reversible.

K. Jakobs, US HFCC Meeting, 5th February 2026 26

FCC-ee

M. Benedikt, Venice Symposium 2025

FCC 24 June 2025

FCC-ee main parameters and operation plan

parameter	Z	WW	H (ZH)	$t\bar{t}$	
Collision energy $\sqrt{s}$ [GeV]	88, 91, 94	157, 163	240	340-350	365
synchrotron radiation/beam [MW]	50	50	50	50	50
beam current [mA]	1294	135	26.8	6.0	5.1
number bunches / beam	11200	1852	300	70	64
total RF voltage 400 / 800 MHz [GV]	0.08 / 0	1.0 / 0	2.1 / 0	2.1 / 7.4	2.1 / 9.2
luminosity / IP [10^{34} cm^{-2}s^{-1}]	144	20	7.5	1.8	1.4
luminosity / year [ab^{-1}]	68	9.6	3.6	0.83	0.67
run time (including lumi ramp-up) [years]	4	2	3	1	4
total integrated luminosity [ab^{-1}]	205	19.2	10.8	0.4	2.7
total number of events	$6\ 10^{12}$ Z	$2.4\ 10^{8}$ WW (incl. WW at higher $\sqrt{s}$)	$2.2\ 10^{6}$ ZH 65k WW → H	$2\ 10^{6}\ t\bar{t}$ + 370k ZH + 92k WW → H	

HFCC-PED Funding Allocation for FY26

US HFCC (PED) is able to support a wide range of activities, albeit at minimal funding levels

Group	Description
AIM	Lead developer of AI detector optimization pipelines
TDAQ	Development of Digitization framework
Muons	Muon Drift Tubes
	Micro-Rwell
Calo	DR Crystal and Fiber Calo
	LAr design of turbine structures
S&C	Docs and Training support
	Core SW in Key4HEP
	MC Production
Tracker	Strawtube
	MAPS
	Tracker Simulation
	Low Mass Mechanics

Cultivating unique US expertise with strong international collaborations

ACC

(*) partially or fully supported in FY 2026

RF Systems

Leverage expertise in bulk Nb SRF technology, recent SRF CM fabrication, & RF power sources

→ 800 MHz Superconducting RF Cryomodule*
800 MHz+ high efficiency RF Sources

Beam Physics

Leverage beam-physics modelling using DOE complex supercomputing capabilities

Model FCC and SuperKEKB*

Machine Detector interface

Leverage expertise from e+/e- and EIC

Luminosity measurement systematics*
IR cryostat engineering*
Expect future work on IR magnets

Magnet and Diagnostic Technologies

Leverage HFM expertise and consider applications of HTS and Nb3Sn

Leverage expertise in diagnostics from synchrotron radiation sources