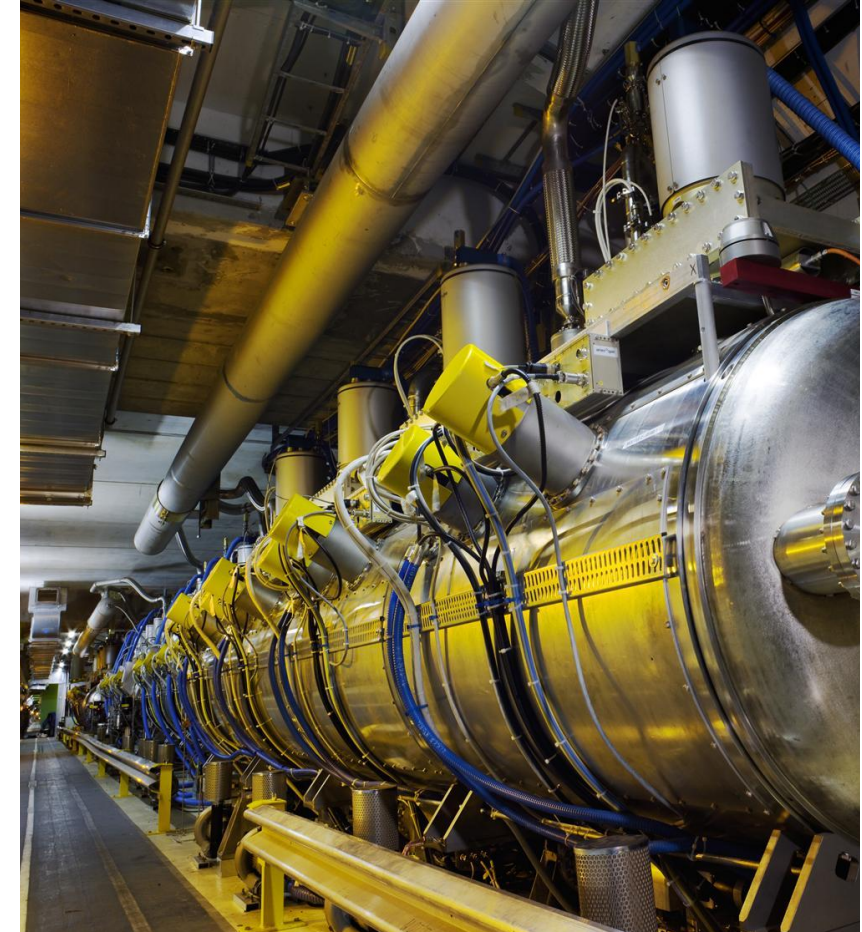
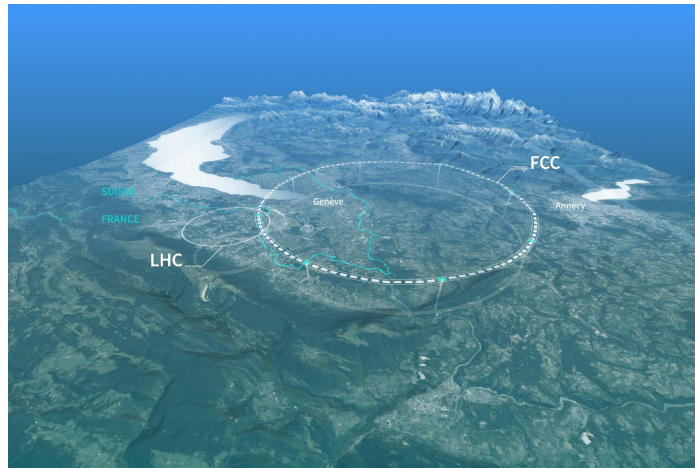
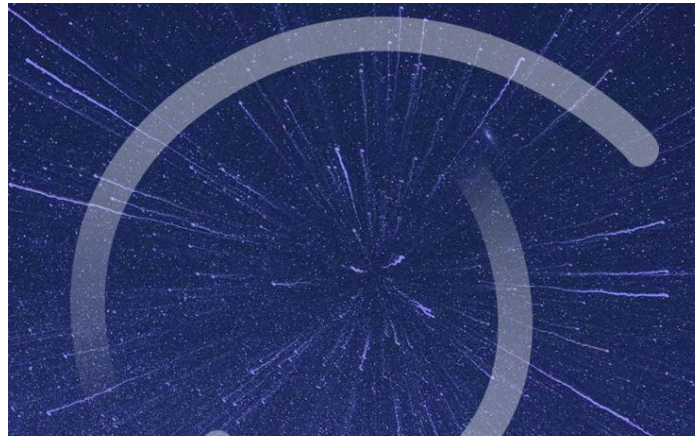
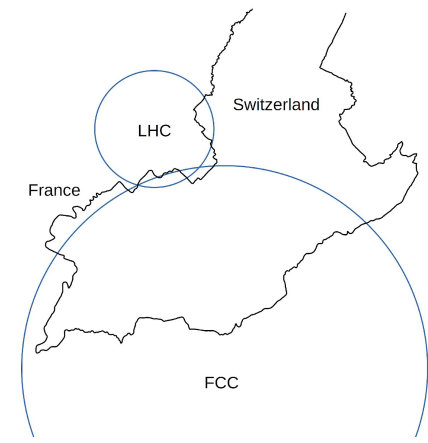
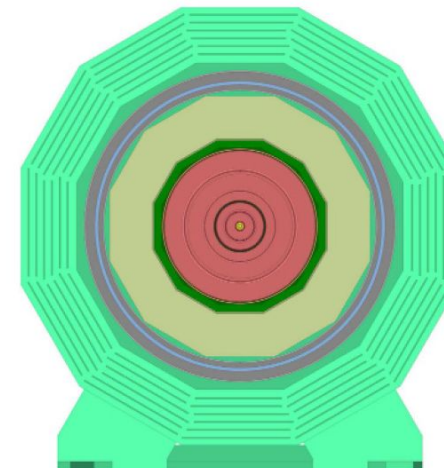
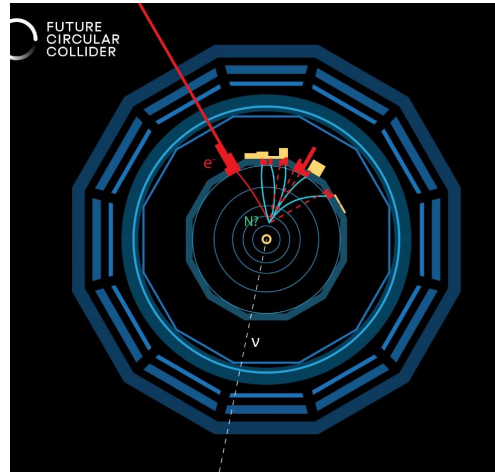


# Thoughts on roadmaps

Sarah Eno, U. Maryland

First annual US FCC  
workshop - BNL

26 April 2023

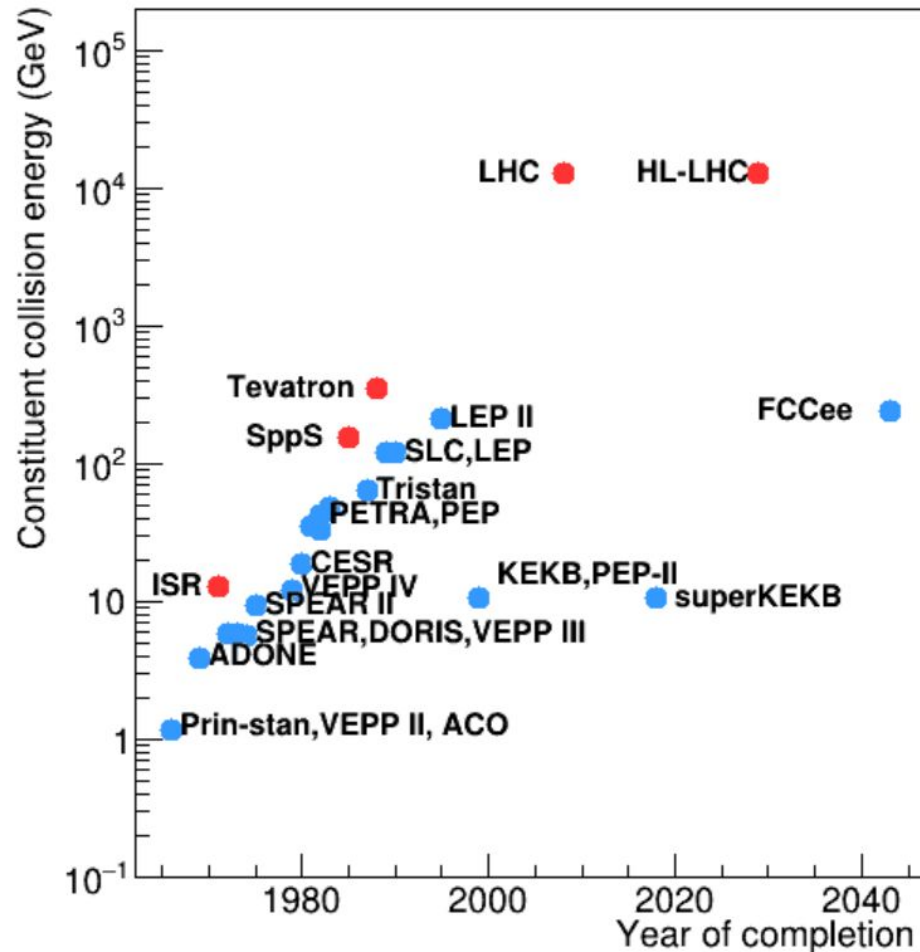


# Thank you to BNL

I cannot imagine a better host institution for this first USFCC workshop. The professionalism, meticulous planning, and warm welcome I am sure was felt by all.

My special thanks to Marc-Andre and the program committee.

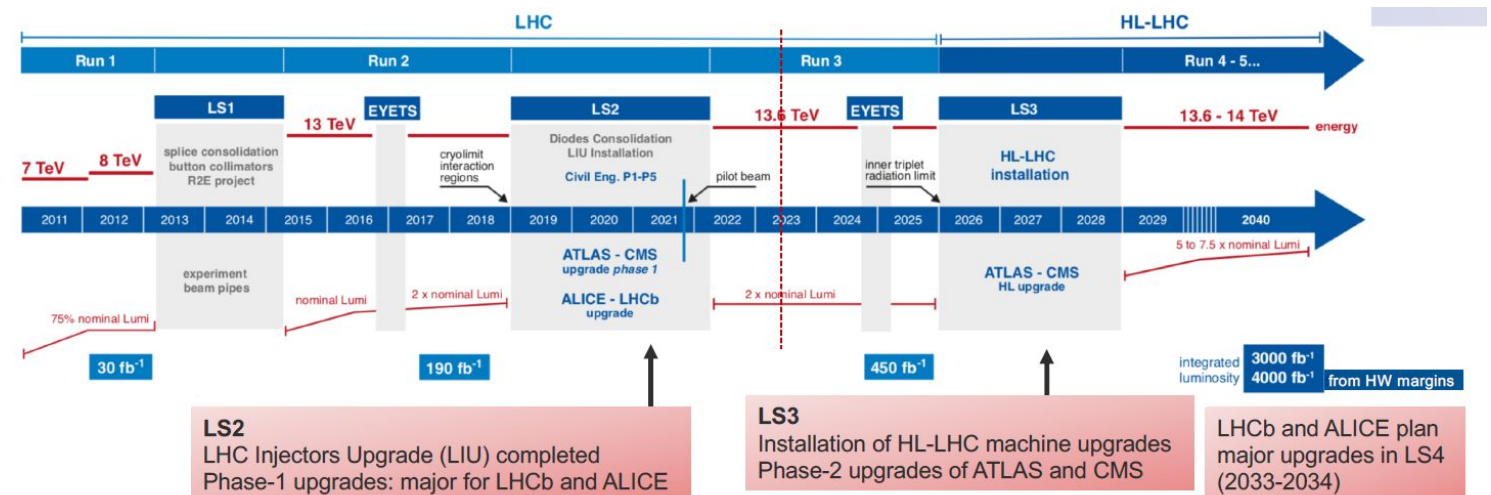
# Colliders



We know when the HL-LHC end date is. It is only 20 years in the future. It is essential for our field that we start a new machine very soon after its end. To my mind (and I hope to yours), that machine is FCC-ee.

It is to the H, W, and Z what KEKB, PEP-II, and superKEKB are to the b (and for the b itself, continues their impactful program).

It allows an exciting, perhaps revolutionary, physics program based on current accelerator technology in the 2040s while the accelerator technology for a new energy frontier via a muon collider and FCC-hh are being developed.





# You've heard about this exciting accelerator

## Relevant US Expertise

	ANL	BNL	FNAL	LANL	LBNL	JLab	SLAC	Universities
SRF cavities/CMs			■			■		Cornell, ODU ...
RF sources/modul.							■	
Copper RF linac	■			■			■	
IR magnets		■	■		■			FSU, TAMU, ...
Booster/MR magnets	■	■	■		■			
Beam Optics	■	■	■		■	■	■	Cornell, ...
Collimation		■	■				■	
Polarization		■	■			■		Cornell, UNM, ...
Instrumentation	■	■	■		■	■	■	Many
Infrastructure	■	■	■	■	■	■	■	

**Challenge:** the FCCee pre-CD2 phase 2024-2033 requires up to ~40FTEs/yr (Sci, Eng, Tech), that is **60-100 qualified people** - some of them don't exist, many involved on other projects/ops... other initiatives need the same type of people (ACE, MuColl, C3, GARD) → need a community-wide assessment and planning of the **accelerator workforce development** (expect P5/EPP to comment)

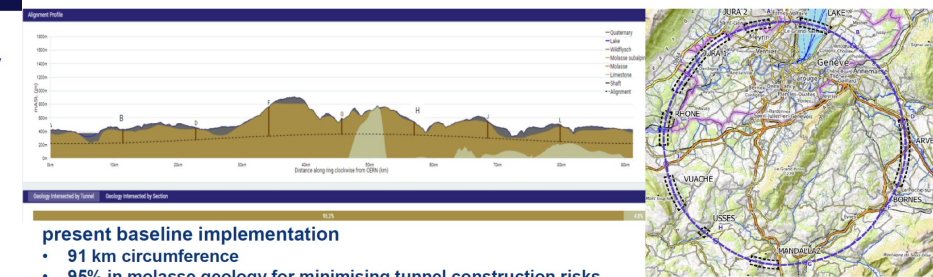


## Present US Engagement in FCC Accelerator

- Physics and detector studies (numerous US universities and labs)
- high-field magnet development (FNAL, LBNL, NHFML)
- SRF development (800 MHz 5-cell cavity prototype, JLAB)
- FCC-ee accelerator design: optics and collective effects (SLAC)
- FCC-ee machine detector interface (SLAC, BNL, JLAB)
- FCC-ee interaction-region magnet systems (BNL)
- FCC-ee polarisation and precise energy calibration (FNAL, BNL, Cornell, UNM)
- FCC-EIC collaborations (BNL, JLAB)
- FCC tunnel safety (FNAL)
- FCC civil engineering - surface building design (FNAL)
- SRF 800 MHz bulk Nb cavities with high Q<sub>0</sub> in preparation
- SRF cryomodule design –



## FCC implementation - footprint baseline



### present baseline implementation

- 91 km circumference
- 95% in molasse geology for minimising tunnel construction risks
- 8 surface sites with ~5 ha area each.

- site investigations planned for 2024 and 2025 in areas with uncertain geological conditions:
  - Limestone-molasse border, karstification, water pressure, moraine properties, water bearing layers, etc.
  - ~40-50 drillings, 100 km of seismic lines



Future Circular Collider Study  
Michael Benedikt  
US – FCC Workshop, 24.04.2023, BNL



## Mid-Term Review & Cost Review, autumn '23

Mid-term review report, supported by additional documentation on each deliverable, will be submitted to review committees and to Council and its subordinate bodies, as input for the review.

Results of both general mid-term review and the cost review should indicate the main directions and areas of attention for the second part of the Feasibility Study

### Infrastructure & placement

- Preferred placement and progress with host states (territorial matters, initial states, dialogue, etc.)
- Updated civil engineering design (layout, cost, excavation)
- Preparations for site investigations

### Technical Infrastructure

- Requirements on large technical infrastructure systems
- System designs, layouts, resource needs, cost estimates

### Accelerator design FCC-ee and FCC-hh

- FCC-ee overall layout with injector
- Impact of operation sequence: Z, W, ZH, tτ vs start at ZH
- Comparison of the SPS as pre-booster with a 10-20 GeV linac
- Key technologies and status of technology R&D program
- FCC-hh overall layout & injection lines from LHC and SC-SPS

### Physics, experiments, detectors:

- Documentation of FCC-ee and FCC-hh physics cases
- Plans for improved theoretical calculations to reduce theoretical uncertainties towards matching FCC-ee statistical precision for the most important measurements.
- First documentation of main detector requirements to fully exploit the FCC-ee physics opportunities

### Organisation and financing:

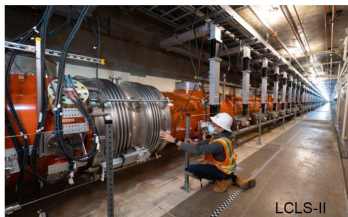
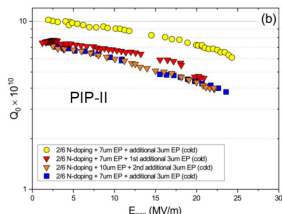
- Overall cost estimate & spending profile for stage 1 project

### Environmental impact, socio-economic impact:

- Initial state analysis, carbon footprint, management of excavated materials, etc.
- Socio-economic impact and sustainability studies

## High Q<sub>0</sub> SRF Systems – US expertise

- LCLS-II developed new N<sub>2</sub> doping approach → is operating cryomodules at 1.3 GHz with Q<sub>0</sub> = 2.7x10<sup>10</sup> at 16 MV/m
- PIP-II is developing high Q cavities at 650 MHz



- LCLS-II-HE will build 23 cryomodules with Q<sub>0</sub> = 2.7x10<sup>10</sup> and >21 MV/m

And seen that it is ripe for key impact by the US



# IR Magnets

- Challenging IR magnets embedded in the detector with 2.2 meter  $L^*$
- Similar requirements to Linear Colliders
- Small aperture with modest pole-tip field
- Design and requirements have significant impact on detectors



*BNL Direct Wind in Action Closeup View*

# You've heard about the exciting physics

## FCC is more than Higgs Factory

P. Gianiotti@PG-BNL

	$\sqrt{s}$	L/IP (cm <sup>2</sup> s <sup>-1</sup> )	Int L/IP/y (ab <sup>-1</sup> )	Comments
e <sup>+</sup> e <sup>-</sup> FCC-ee	~90 GeV 160 240 ~365	Z WW H top	182 x 10 <sup>34</sup> 22 19.4 7.3 0.16	2-4 experiments Total ~ 15 years of operation
pp FCC-hh	100 TeV	5 x 10 <sup>34</sup> 30	20-30	2+2 experiments Total ~ 25 years of operation
PbPb FCC-nh	$\sqrt{s_{NN}} = 39\text{TeV}$	3 x 10 <sup>29</sup>	100 nb <sup>-1</sup> /run	1 run = 1 month operation
ep FCC-eh	3.5 TeV	1.5 x 10 <sup>34</sup>	2 ab <sup>-1</sup>	60 GeV e <sup>-</sup> from ERL Concurrent operation with pp for ~ 20 years
e-Pb FCC-eP	$\sqrt{s_{NN}} = 2.2\text{ TeV}$	0.5 x 10 <sup>34</sup>	1 fb <sup>-1</sup>	60 GeV e <sup>-</sup> from ERL Concurrent operation with PbPb

A multi-stage facility with immense physics potential

(energy and intensity), operating until the end of the century.

- FCC-ee : highest luminosities at Z, W, ZH of all proposed Higgs and EW factories; indirect discovery potential up to ~ 70 TeV
- FCC-hh: direct exploration of next energy frontier (~ 10 LHC) and unparalleled measurements of low-rate and "heavy" Higgs couplings (ttH, HH)
- Also heavy-ion collisions and, possibly, ep/e-ion collisions
- Synergistic programme exploiting common civil engineering and technical infrastructure, building on and reusing CERN's existing infrastructure

- x 10-50 improvements on all EW observables
- up to x 10 improvement on Higgs coupling (model-indep.) measurements over HL-LHC
- x10 Belle II statistics for b, c,  $\tau$
- indirect discovery potential up to ~ 70 TeV
- direct discovery potential for feebly-interacting particles over 5-100 GeV mass range

LHC@15 reinforced the need for

- a TeraZ factory
- a MegaH factory
- a  $\sqrt{s} \sim 10$  TeV factory



FCC emerges  
as the natural project

FCC-ee will provide results in EW/Flavour/Higgs that will remain *state-of-the-art* well beyond FCC-hh

"FCC-ee+FCC-hh >> ILC+FCC-hh"

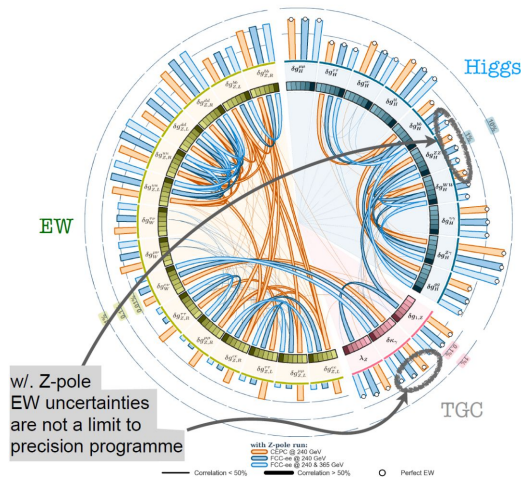
C. Grojean & P. Janot

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US FCC, April 24, 2023

## Impact of Z-pole on Higgs measurements

J. De Blas et al. 1907.04311

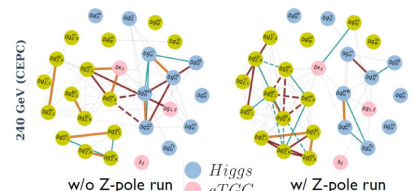


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Contamination EW/TGC/Higgs can be understood by looking at correlations

With Z-pole runs, only correlations between EW and TGC remain  
Z-pole runs at circular colliders isolate EW and Higgs sectors from each others



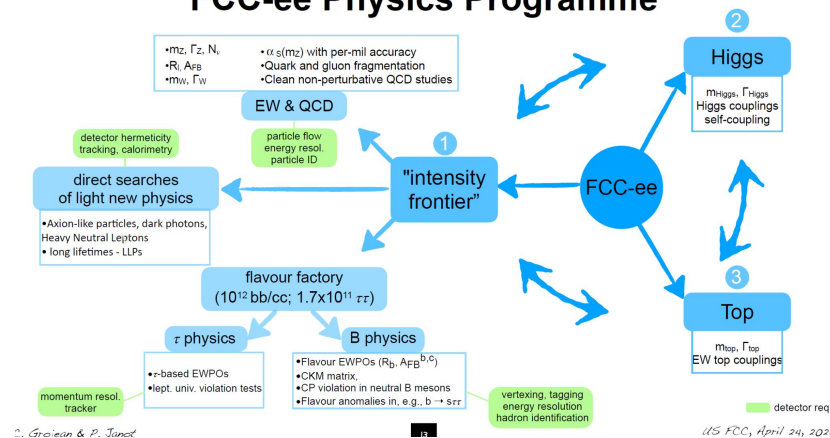
US FCC, April 24, 2023

## The alignment of stars towards FCC

P. Janot @ CERN-SPC

- **Discovery of a light Higgs boson –  $m_H = 125$  GeV, just above LEP limit**
  - ♦ Higgs boson can be produced at e<sup>+</sup>e<sup>-</sup> centre-of-mass energies accessible at circular colliders
- **Progress in e<sup>+</sup>e<sup>-</sup> circular collider technology (B factories)**
  - ♦ Makes it possible to exceed 10<sup>35</sup> cm<sup>-2</sup>s<sup>-1</sup> at the e<sup>+</sup>e<sup>-</sup> → ZH<sub>125</sub> cross section max. (~240 GeV)
- **No BSM physics found (yet) in the TeV range at LHC (+ ttH/HH sensitivity at HL-LHC)**
  - ♦ Greatly limits the physics potential of TeV-class e<sup>+</sup>e<sup>-</sup> linear colliders
  - ♦ Forces to think differently about BSM physics to explain the big open questions
    - Dark matter, Neutrinos, BAU, Flavour, Hierarchy problem, ...
  - ♦ Solutions to these open questions can be at even higher energy
    - Higgs compositeness is among the most popular avenues
  - ♦ But often include light and very-weakly-coupled structures
    - Axion-like particles, dark photons, heavy neutral leptons, long-lifetime particles

## FCC-ee Physics Programme



C. Grojean & P. Janot

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US FCC, April 24, 2023

And seen that it is ripe for key impact by the US



# You've heard about the exciting detectors

## Intra-Collider Synergies

### Current/near-future:

- ▶ Si-based Calorimetry: Calice & CMS HGCal
- ▶ Scintillator-tile-based calorimetry: CMS HGCal & EIC
- ▶ LGADs: HL LHC ATLAS & HL LHC CMS & EIC

### Future:

- ▶ MAPS: will be ubiquitous; low mass, high granularity, can include fast timing: HL LHC & EIC, FCC-ee, ILC, MuC
- ▶ Standard silicon tracking:
- ▶ Calorimetry: PF and Dual Readout, different materials and technologies: many commonalities among different colliders
- ▶ Gaseous detectors: applications in tracking, calorimetry, muon detection
- ▶ Radiation hardness: FCC-hh & MuC
- ▶ Many other synergies: ASICs, readout electronics, TDAQ, on-detector AI/ML

## FCC-ee Detector Requirements

### "Higgs Factory" Programme

- Momentum res. at  $p_T \sim 50$  GeV of  $\sigma_{p_T}/p_T \approx 10^{-3}$  commensurate with  $\mathcal{O}(10^{-3})$  beam energy spread
- Jet energy resolution of 30%/√E in multi-jet environment for Z/W separation
- Superior impact parameter resolution for c, b tagging

### Ultra Precise EW Programme & QCD

- Absolute normalisation (luminosity) to  $10^{-4}$
- Relative normalisation (e.g.  $\Gamma_{had}/\Gamma_l$ ) to  $10^{-5}$
- Momentum resolution "as good as we can get it"
- Multiple scattering limited
- Track angular resolution  $< 0.1$  mrad (BES from  $\mu\mu$ )
- Stability of B-field to  $10^{-6}$ ; stability of  $V_s$  meas.

### Heavy Flavour Programme

- Superior impact parameter resolution: secondary vertices, tagging, identification, life-time meas.
- ECAL resolution at the few %/√E level for inv. mass of final states with  $\pi^0$ 's or  $\gamma$ 's
- Excellent  $\pi^0/\gamma$  separation and measurement for tau physics
- PID:  $K/\pi$  separation over wide momentum range for b and  $\tau$  physics

### Feebly Coupled Particles - LLPs

- Benchmark signature:  $Z \rightarrow \nu N$ , with N decaying late
- Sensitivity to far detached vertices (mm  $\rightarrow$  m)
  - Tracking: more layers, continuous tracking
  - Calorimetry: granularity, tracking capability
- Large decay lengths  $\Rightarrow$  extended detector volume
- Precise timing for velocity (mass) estimate
- Hermeticity

Courtesy M. Dam

April 24, 2023

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## US Participation to Detector Concepts

U.S. wide coordination body to drive the US FCC effort has been formed  
Strong existing involvement and strong interests in ramping up efforts to participate defining detector concepts for FCC

→ see dedicated talk later in this session and program throughout this week

### Solid State (A. Apresyan, C. Haber)

- Significant expertise in several Labs and institutes
- Pixel and strip design, fast timing and 4D concepts
- Low mass mechanics, power management
- Continuous beams puts demands low power, cooling

- Three thrust areas where U.S. must play a lead role leading to CDR:
  - Monolithic CMOS, 3D integration and LGAD based sensors
  - Mechanics and new low mass materials and fabrication techniques
  - Development of readout ASIC optimized for tracking & timing

- Beyond CMOS technologies, intelligent local & distributed systems

- Synergies with ongoing efforts in HL LHC upgrade & EIC with MAPS and timing

- 60 nm T2, 12" wafers, 3D WFOV, 0.55W/Kg/layer, 30m hit precision

- Collaborate with existing efforts and build on them prior to CDR:
  - Optimize position precision with low power/large wafer and quantify performance vs pitch and thickness in the range of 10 – 30  $\mu$ m
  - Implementation of precision timing: 4D tracking

- External internal cost/benefit analysis/feasibility studies

- U.S. groups have been deeply engaged for decades in Calorimetry

- Further investments will strengthen U.S. leadership and manufacturing in low-noise, high-resolution calorimetry suitable for particle flow algorithms

- Three thrust areas where U.S. has and continues to play key roles:
  1. Uniquely noble gas calorimeters
    - Prototype a high granularity LAr calorimeter test beam module with 1000 channels
    - High granularity (12.5 x 4 in) ASIC segmentation and readout (1st test with low level)
  2. High granularity Si-W sampling calorimeters
    - Prototype a Si-W calorimeter demonstrator with embedded large area MAPS readout at full rate
  3. Optical calorimeters: hybrid crystal and fiber dual-readout calorimeter
    - Prototype a hybrid SiC crystal and fiber dual-readout optical calorimeter test beam module
    - Investigate the use of fiber-based readout for PNA, SiC dual-SPM readout on-orbit to achieve superior BSM/HL readout
    - Develop a 3rd/4th generation precision timing LAr calorimeter

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- Develop a 3rd/4th generation precision timing LAr calorimeter

- Develop a 3rd/4th generation precision timing LAr calorimeter

### Gaseous Detectors (M. Hohlmann, B. Zhou)

- Significant expertise in U.S. built over past decades at the Tevatron/LHC experiments: 11 institutes with ~50 physicists have already expressed

- Three thrust areas identified as key areas of engagement for U.S.:
  - Develop robust, large-area muon/gaseous detectors with fast timing and high  $p_T$  in events from Z decay containing  $B_s$
  - Muons play a key role in precision measurement of Higgs as well as searches for  $h \rightarrow 2\gamma$  and a key benchmarking point
  - Create a US-based R&D facility for Micro Pattern Gas Detectors (MPGDs) at a
  - Develop services and infrastructure for these systems

- Develop and test the initial prototypes and electronics and establish facility by ~2028 (FCC approval) to lay the foundation for a significant

- Large Area (at low cost)

- Time resolution ( $< 1$  ns)

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### Particle ID (M. Artuso, S. Eno)

- Particle ID using time of flight, dE/dx, cluster counting is essential for flavor physics studies.

- Three thrust areas identified as key areas of engagement for U.S.:
  - Improve  $p_T$  resolution of secondary vertices, tagging, identification, life-time meas.
  - Excellent  $\pi^0/\gamma$  separation and measurement for tau physics
  - PID:  $K/\pi$  separation over wide momentum range for b and  $\tau$  physics

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### Trigger/DAQ (Z. Demiragli, J. Zhang)

- Significant expertise at U.S. institutes in trigger/DAQ through their efforts in LHC/HL-LHC

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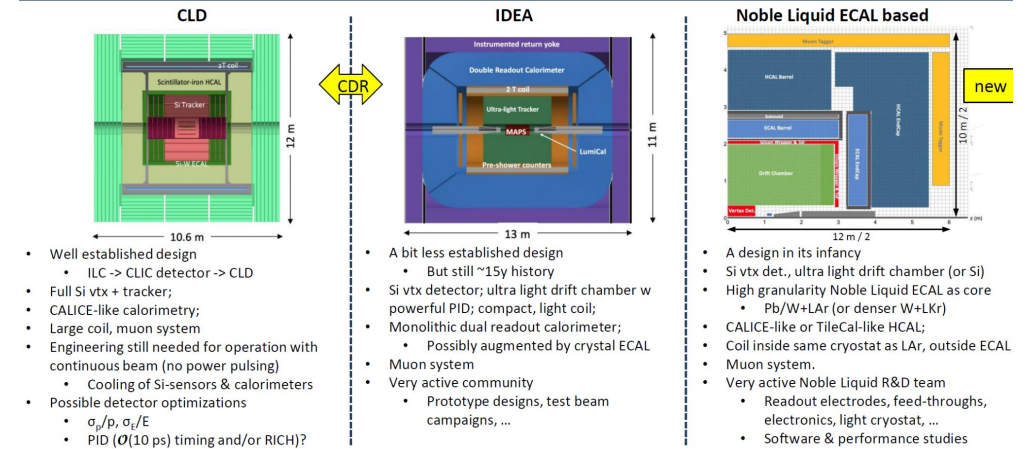
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## FCC-ee Proto Detectors – Overview



FCC-ee CDR: <https://link.springer.com/article/10.1140/epist/e2019-900045-4>

April 24, 2023

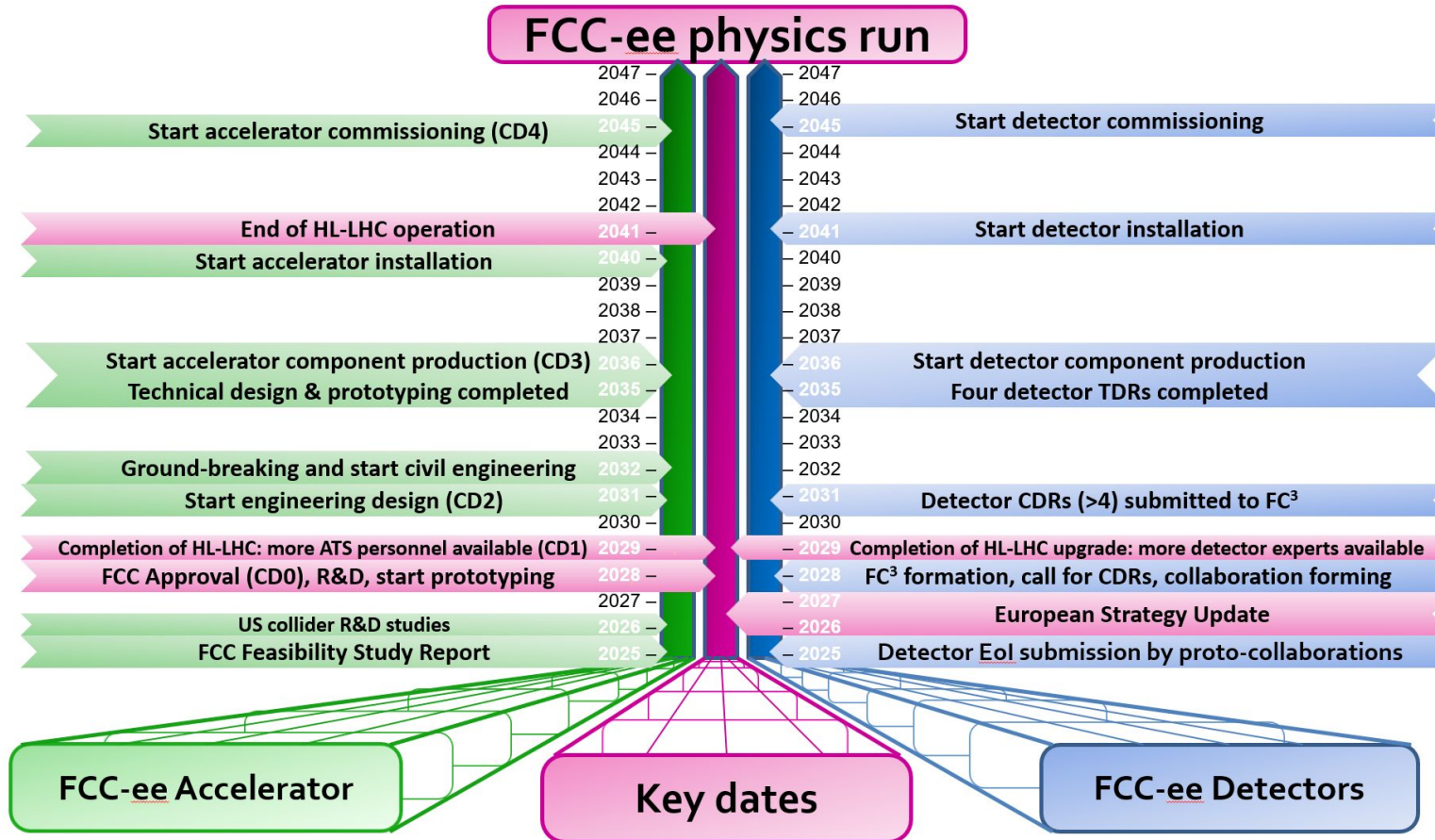
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And seen that it is ripe for key impact by the US

Sarah Eno USFCC workshop

# Time is short



An aggressive but feasible timeline. But for this to happen, we need to push!

- 2028 formulation of collaborations. That's five years from now!!
- 2031 detector CDR's (4!) that's eight years from now
- 2041 installation (18 years)
- CD0 in 2028???
- CD1 at time of CDR?



# What are the next steps forward?

- sign up on US-FCC and FCC mailing lists
- Become an official FCC institution by signing an MOU (okay, I haven't done that yet)
- Get familiar with the existing documentation and structures
- Start to participate in some aspect as your current commitments allow. Even one meeting a month is enough to prepare for a bigger impact later.
- Try to send somebody from your group either to the winter "PED" meeting or to the June "FCC" meeting (which has strong accelerator-community attendance) or our new annual USFCC meeting..
- Think bold. Bored of what you are doing? Now is the opportunity to make a change. Why not think about drift chambers? cherenkov counters? doing flavour physics? doing precision measurements of the W, top, or Z mass? It can be fun to explore these things with undergrads. There are a few years here where you can get up to speed to make a course change
- Form a community to help ourselves make an impact despite our limited resources
- **and above all, get ready for a lot of fun!!**

# sign up usfcc and FCC

← → ↻ e-groups.cern.ch/e-groups/EgroupsSearch.do

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☐ Only groups I own or manage ☐ Only groups I am on | Page Size:

+ Create new static group + Create new dynamic group Show groups for one member Manage groups for one member

E-groups						
Goto 1-12						
	Name	Type	Topic	Description	Status	Owner
✉	<a href="#">us-fcc</a>	Static		US FCC mailing list	Active	srini.rajagopalan@cern.ch
✉	<a href="#">us-fcc-admins</a>	Static		US FCC mailing list admins	Active	srini.rajagopalan@cern.ch
✉	<a href="#">us-fcc-asics-readout</a>	Static		US FCC asics readout	Active	Sarah.Eno@cern.ch
✉	<a href="#">us-fcc-calorimetry</a>	Static		US FCC calorimetry	Active	Sarah.Eno@cern.ch
✉	<a href="#">us-fcc-coordination</a>	Static	FCC	US FCC Coordination Team mailing list	Active	srini.rajagopalan@cern.ch
✉	<a href="#">us-fcc-gas-muons</a>	Static	FCC	US FCC gaseous detectors and muons	Active	Sarah.Eno@cern.ch
✉	<a href="#">us-fcc-gas-quantum</a>	Static		US FCC quantum	Active	Sarah.Eno@cern.ch
✉	<a href="#">us-fcc-particleID</a>	Static		US FCC particle ID	Active	Sarah.Eno@cern.ch
✉	<a href="#">us-fcc-software-computing</a>	Static	FCC	U.S. FCC-ee Software Computing RD	Active	Oliver.Gutsche@cern.ch
✉	<a href="#">us-fcc-software-computing-admin</a>	Static	FCC	Admin group for us-fcc-software-computing	Active	Oliver.Gutsche@cern.ch
✉	<a href="#">us-fcc-solid-state</a>	Static		US FCC solid state	Active	Sarah.Eno@cern.ch
✉	<a href="#">us-fcc-trigger-daq</a>	Static		US FCC trigger daq	Active	Sarah.Eno@cern.ch

The cms x Inbox (7) x Status of x Universal x My Drive x eno\_joa x Melfest x Search C x e-groups x Single to x screen s x

← → ↻ fcc-ped.web.cern.ch/content/single-top-quark-production-probe-anomalous-tagamma-and-tqz-couplings-fcc-ee

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CERN Accelerating science

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HOME ABOUT FCC-EE AND TLEP ORGANIZATION ARCHIVE EVENTS THE FCCS

CONTACT/JOIN US FCC WORLDWIDE SEARCH

Join FCC Collaboration

Join us

Production as a probe of anomalous  $\gamma\gamma$  and  $tqZ$  couplings at the FCC-ee

arXiv:1703.02030 [hep-ph] Phys. Lett. B 775, 25 (2017)

H. Khanpour  
S. Katibi  
M. K. Yanehsari  
M.M. Najafabadi  
29/03/2017 - 12:00

Submitter  
H. Khanpour

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4/11/2023 8:50 AM File folder  
4/5/2023 2:44 PM File folder

5:53 PM 4/19/2023



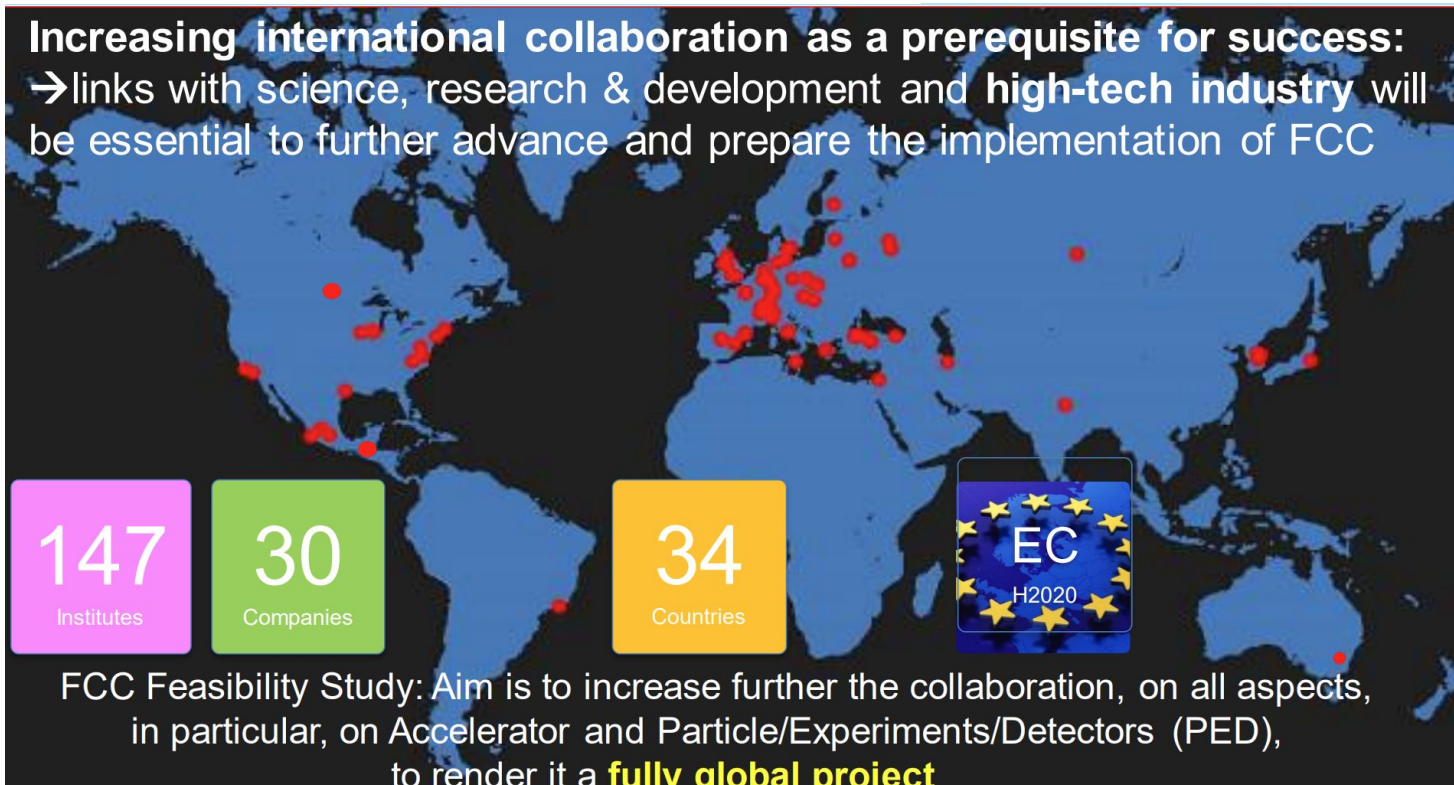
# MOU

## Step 1: Sign the Memorandum of Understanding

- Identify the organisation's legal authorised representative for the signature
- Download the [FCC MoU TEMPLATE](#) or the [FCC MoU for Companies Template](#)
- Put the legally authorised signatory's name and function in the template
- Print the document twice (one side printing)
- Have both copies signed by the legally authorised representative
- Send the two signed copies by postal mail to **CERN - [FCC Study Office](#) - P.O. Box M22110 - 1211 Geneva 23, Switzerland**

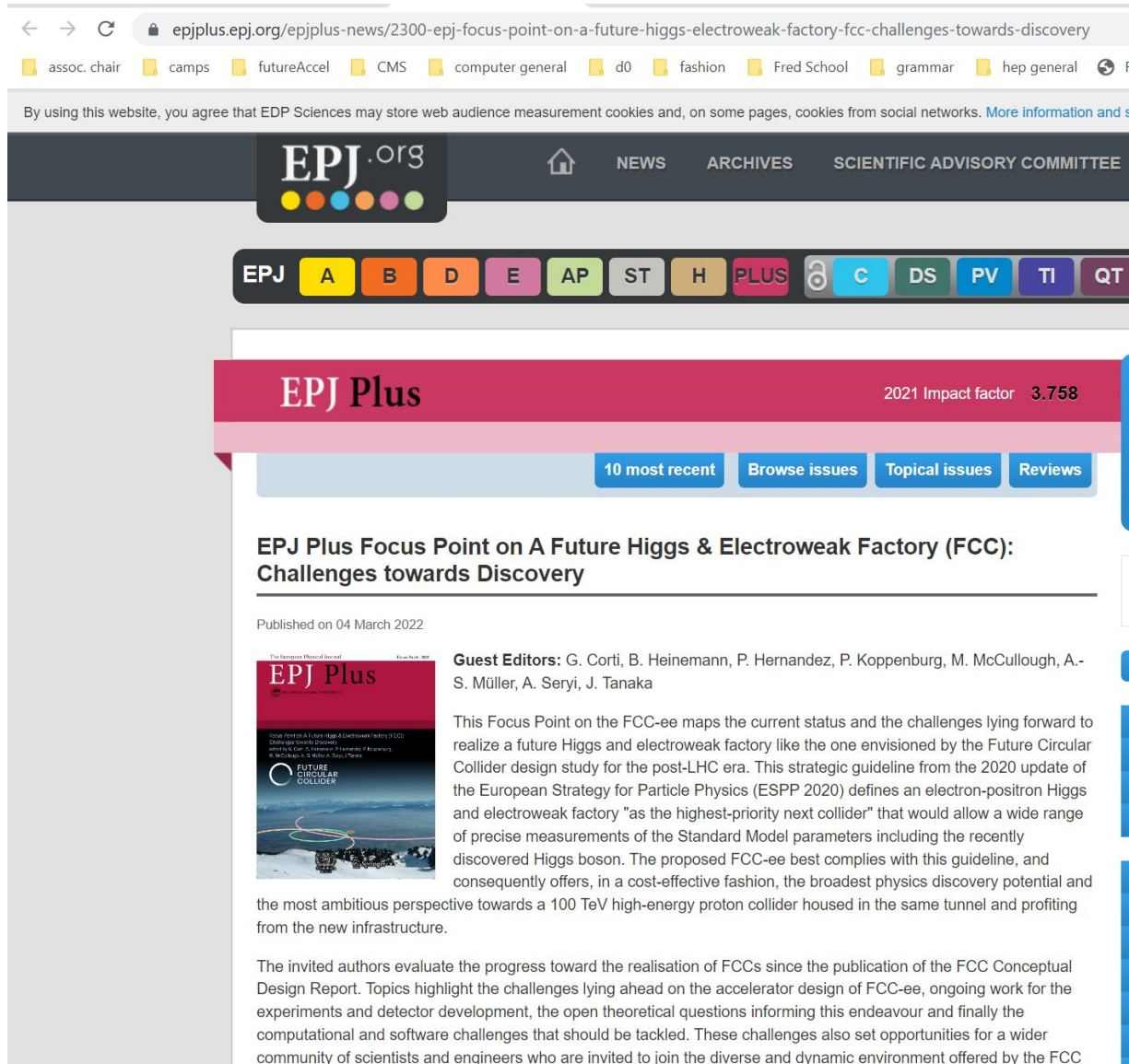
[https://twiki.cern.ch/twiki/pub/FCC/FCCMoU/FCC-2109140000-CERN\\_FCCMoUTemplate\\_V0200.pdf](https://twiki.cern.ch/twiki/pub/FCC/FCCMoU/FCC-2109140000-CERN_FCCMoUTemplate_V0200.pdf)

**Increasing international collaboration as a prerequisite for success:**  
→ links with science, research & development and **high-tech industry** will be essential to further advance and prepare the implementation of FCC



# existing documentation

perhaps a nice place to start?



The screenshot shows the EPJ Plus website. At the top, there's a navigation bar with the EPJ.org logo and links to NEWS, ARCHIVES, and SCIENTIFIC ADVISORY COMMITTEE. Below this is a row of colored buttons labeled EPJ, A, B, D, E, AP, ST, H, PLUS, C, DS, PV, TI, and QT. A pink banner displays 'EPJ Plus' and '2021 Impact factor 3.758'. Below the banner are buttons for '10 most recent', 'Browse issues', 'Topical issues', and 'Reviews'. The main article is titled 'EPJ Plus Focus Point on A Future Higgs & Electroweak Factory (FCC): Challenges towards Discovery', published on 04 March 2022. It features a thumbnail image of a particle detector and lists guest editors: G. Corti, B. Heinemann, P. Hernandez, P. Koppenburg, M. McCullough, A.-S. Müller, A. Seryi, and J. Tanaka. The article text discusses the FCC-ee as a next-generation collider, highlighting its potential for precise measurements of the Standard Model parameters and its role in the broader context of high-energy physics research.

← → ↺ epjplus.epj.org/epjplus-news/2300-epj-focus-point-on-a-future-higgs-electroweak-factory-fcc-challenges-towards-discovery

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EPJ A B D E AP ST H PLUS C DS PV TI QT

EPJ Plus 2021 Impact factor 3.758

10 most recent Browse issues Topical issues Reviews

**EPJ Plus Focus Point on A Future Higgs & Electroweak Factory (FCC): Challenges towards Discovery**

Published on 04 March 2022

**Guest Editors:** G. Corti, B. Heinemann, P. Hernandez, P. Koppenburg, M. McCullough, A.-S. Müller, A. Seryi, J. Tanaka

This Focus Point on the FCC-ee maps the current status and the challenges lying forward to realize a future Higgs and electroweak factory like the one envisioned by the Future Circular Collider design study for the post-LHC era. This strategic guideline from the 2020 update of the European Strategy for Particle Physics (ESPP 2020) defines an electron-positron Higgs and electroweak factory "as the highest-priority next collider" that would allow a wide range of precise measurements of the Standard Model parameters including the recently discovered Higgs boson. The proposed FCC-ee best complies with this guideline, and consequently offers, in a cost-effective fashion, the broadest physics discovery potential and the most ambitious perspective towards a 100 TeV high-energy proton collider housed in the same tunnel and profiting from the new infrastructure.

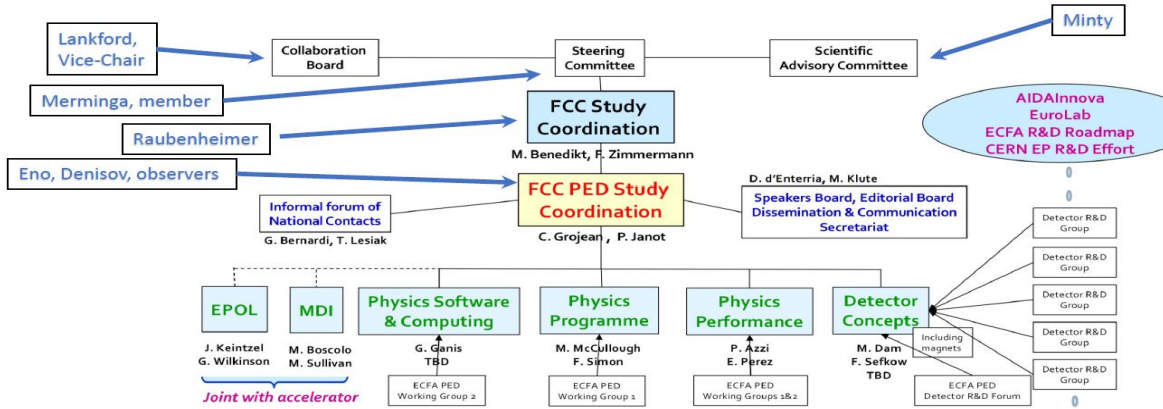
The invited authors evaluate the progress toward the realisation of FCCs since the publication of the FCC Conceptual Design Report. Topics highlight the challenges lying ahead on the accelerator design of FCC-ee, ongoing work for the experiments and detector development, the open theoretical questions informing this endeavour and finally the computational and software challenges that should be tackled. These challenges also set opportunities for a wider community of scientists and engineers who are invited to join the diverse and dynamic environment offered by the FCC

Some other literature

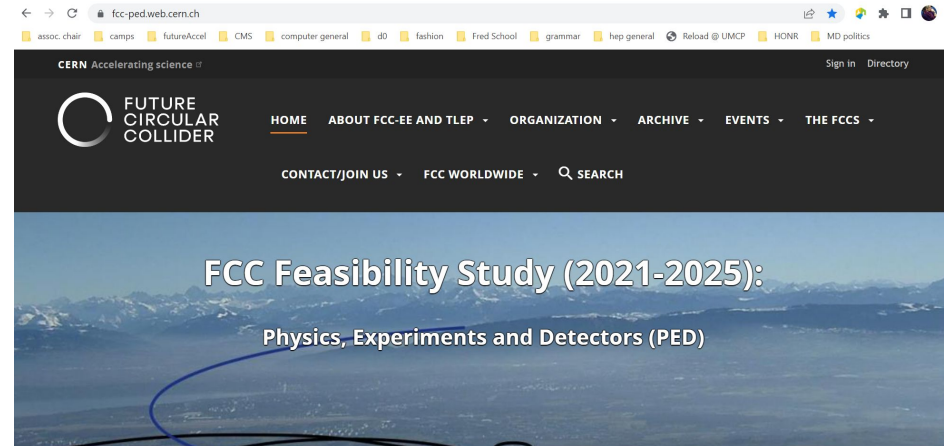
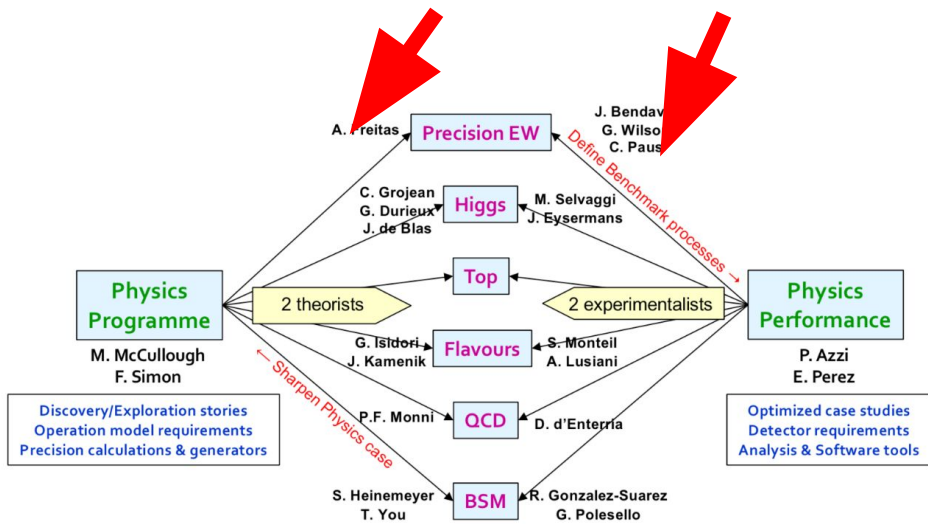
- Snowmass white paper  
<https://arxiv.org/abs/2203.06520>
- FCCee CDR  
<https://link.springer.com/article/10.1140/epjst/e2019-900045-4>
- Detector Challenges at FCC-ee  
<https://fcc-ee-conference.web.cern.ch/database/conference/960/presentation/1036/>
- Particle identification at FCC-ee  
<https://link.springer.com/article/10.1140/epjp/s13360-021-01810-4>
- FCC-ee: Your Questions Answered  
<https://arxiv.org/abs/1906.02693>



# existing structures



We hope to announce more US names soon



## Stay aware

## The FCC-ee in a few words

## Next events

- FCC PED meetings
- Physics performance meetings
- FCC-ee monthly physics meetings past and upcoming meetings
- FCC conferences and

The idea of a large circular  $e^+e^-$  collider as Higgs Factory came from a conjunction of circumstances: i) the need of a large tunnel for the continuation of the high energy exploration after the LHC; ii) the new 'nano-beams' designs proposed for the 'super B factories'; iii) and of course the discovery of the Higgs boson with a mass that could have been reached (with efforts) at LEP1. The idea of such a machine as a first step toward a 100TeV pp collider was submitted to the ESPSP2013/13 and led to the FCC study, launched in 2014. The study concluded in its FCC-int submission to the ESPSP2020 that the "*The most effective and economical approach to theoretically explore the mass spectrum in modern particle*

Higgs physics  
Higgs Performance meeting  
Tue, 18/04/2023 - 13:30

LHCb Upgrade

<http://cern.ch/fcc> photo: J. Wenninger 15

**FCC feasibility study organization -**

**Approved by the CERN Council September 2021**

**FCC Study M. Benedikt**

Study support and coordination	
Study leader	Study support and coordination
study/collaboration secretariat	study support unit
EU projects	collaboration building E. Tsesmelis
Communications J. Gillies (local com.)	

Physics, experiments and detectors P. Janot, G. Salam	Accelerators T. Raubenheimer, F. Zimmermann	Techn. coordination techn. infrastructure K. Hanke	Host State processes and civil engineering T. Watson (1 Nov. '21)	Organisation and financing models P. Collier (interim)
physics programme M. McCullough, F. Simon	ee design K. Oide, A. Chance	Electricity distribution J.-P. Burnet	administrative processes F. Eder, J. Gutleber	project organisation model NN
detector concepts M. Dam, NN	hh design M. Giovannozzi	cooling & ventilation G. Peon	placement studies J. Gutleber, V. Mertens	financing model F. Sonnemann
physics performance P. Azzi, E. Perez	technology R&D R. Losito	integration, installation, transport, logistics, JP Corso, C Colloca, C Prasse	environmental evaluation J. Gutleber	procurement strategy and rules NN
software and computing G. Ganis, C. Helsens	ee injector P. Craievich, A. Grudiev	general safety, access, radiation protection, T. Otto	tunnel, subsurface design J. Osborne	in-kind contributions NN
ee MDI M. Boscolo, NN		Computing, controls, communication, networks D. Duellmann	surface buildings design NN	operation model P. Collier & J. Wenninger
ee energy calibration & polarization (EPOL) J. Wenninger?, A. Blondel		geodesy & survey H. Mainaud Durand, A. Wieser	surface sites layout and access NN	
		Cryogenics systems L.P. Delprat		



# attend an FCC general meeting

indico.cern.ch/event/1202105/

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Europe/London English (Un)

## FUTURE CIRCULAR COLLIDER FCC Week 2023


Jun 5 – 9, 2023  
Millennium Gloucester Hotel London Kensington  
Europe/London timezone

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- Overview
- Programme at a glance
- Timetable
- Call for Abstracts
- Contribution List
- Registration
- Participant List
- CERN lightweight account application
- Organizing Committee
- Scientific Programme Committee
- Entering the UK
- Venue and accommodation
- Payment of fee
- Data privacy
- Contact

The ninth edition of the Future Circular Collider (FCC) Conference will take place in London, United Kingdom from 5 to 9 June 2023. The meeting brings together the international scientific community pursuing a feasibility study for a visionary post-LHC research infrastructure at CERN and is organized with the support of the EU-funded H2020 FCCIS project.

Leading experts from academia and industry will review the recent progress en route to the completion of the feasibility study in 2025 and set the near-term goals for the coming years. The physics opportunities opened by the FCC integrated programme as well as the status of key technology R&D programmes will be discussed along with the technological opportunities on offer for building new collaborative projects. The meeting is an excellent opportunity to reinforce the bonds between the FCC collaborating institutes and to draft the work plans for the submission of the FCC mid-term review to the CERN's Council



<https://cern.ch/fccweek2023>

indico.cern.ch/event/1176398/


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Europe/Warsaw English

## FUTURE CIRCULAR COLLIDER 6th FCC Physics Workshop

Jan 22 – 27, 2023  
Europe/Warsaw timezone

Enter your search term



**Welcome to the 6th FCC Physics workshop in Kraków!**

If you want to remain up-to-date on the FCC physics and experiments activities, please register to the following mailing list:

<https://e-groups.cern.ch/e-groups/EgroupsSubscription.do?egroupName=FCC-PED-Observers>

If you plan to participate in the FCC PED Feasibility Study, you can register to specific working groups here:

<https://fcc-ped.web.cern.ch/>, then click on "Contact/Join us", "Join us", "Subscribe to mailing lists"

**Previous Editions:**

2017: <https://indico.cern.ch/event/550509/>  
2018: <https://indico.cern.ch/event/618254/>  
2020: <https://indico.cern.ch/event/838435/>  
2021 : <https://indico.cern.ch/event/932973/>  
2022 : <https://indico.cern.ch/event/1066234/>

- Overview
- Timetable
- Payments
- Venue
  - Traveling to Poland
  - Directions in Krakow
- Hotels
- Program Committee
- Contribution List
- Registration
- Participant List
- Dinner

And next year's annual USFCC meeting

# meetings

← → ↺

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📁 MD politics

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📶 Parent category

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FCC (Future Circular Collider) Study

👤 Managers

👤 fcc-indico-admin

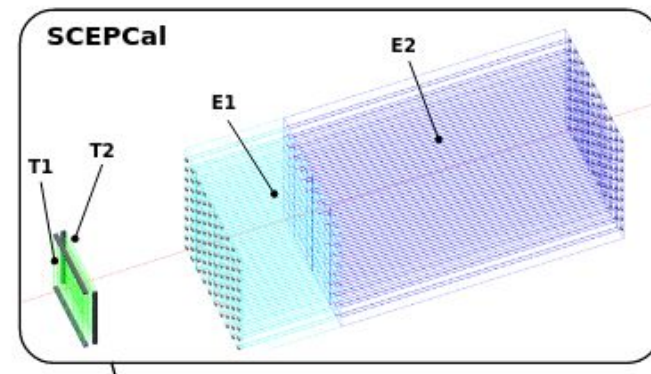
Study support and coordination (incl. EU projects)	767 events	➡
Physics, Experiments and Detectors	1,184 events	➡
Accelerators	1,081 events	➡
Technical Infrastructures	312 events	➡
Host States Implementation	348 events	🛡️ ➡
Civil Engineering	144 events	➡
Organisation and financing models	44 events	➡
Conferences and Workshops	43 events	➡



# think bold

For CMS, I do radiation damage in plastic scintillators. There is no need for that at FCCee. So working with colleagues at a variety of institutions, I've pivoted to dual readout calorimetry.

You have a year or so before work gets serious. Think about trying something new. That's why we got into physics, right?



# work collaboratively

We are all very busy. We are operating our detectors for the current run, analyzing last and this run's data, and building for HL-LHC. Who has time to do even a little for FCC-ee?

We have been here before. We know the solution. We can do it if we work together.

USCMS meeting Princeton 2004

## Letter from Tevatron Groups

A group of 9 University faculty on D0/CDF and CMS wrote to Mike, asking that he strongly support the LPC during the coming 3 years (2004,2005,2006) because we saw no other way we could possibly maintain the level of manpower we need on the Tevatron experiments while insuring we will be ready to do physics on Day 1 on the new energy frontier machine (LHC).

“Sold” LPC as a way to ensure a smooth transition between Tevatron/LHC and to maintain manpower on the Tevatron experiments as LHC turn-on becomes imminent. As a way to allow postdocs to work on both experiments at the same time.

Similar process occurred in ATLAS

## Letter

Dear Colleagues:

I am writing to respond to your letter concerning the LHC Physics Center at Fermilab. In that letter you expressed interest in the development of such a center and stated how important it would be for U.S. university groups to take full part in research with the CMS data sample.

Both Fermilab and the leadership of the US-CMS research program have also expressed support for the LHC Physics Center (LPC). One goal of the center is the one you articulated, that is, to make it possible for U.S. physicists working on CMS to be innovative leaders in LHC physics. The other is that Fermilab remain an intellectual center for collider physics in the LHC era. I think that both of these goals serve the larger purpose of advancing particle physics in the U.S.

A broad group of the involved parties recognizes the need of a transition period in which physicists will share effort between CDF or D0 and one of the LHC experiments. This sharing will make it possible to sustain the needed effort to operate CDF and D0 effectively, at the same time that it brings a lot of experience from the Tevatron program to the LHC. At our Annual Program Review, both CDF and D0 said that they are moving to make it easier for scientists to be an active member of their collaborations while sharing time with CMS or ATLAS. P.K. Williams expressed to me his encouragement of the LHC Physics Center here as an effective way of sharing university physicists between CDF or D0 and CMS.

I want to make the LHC Physics Center into one of the leading centers in the world for producing particle physics results, and am ready to commit resources to that end. In planning this startup we will work closely with you and with leadership of the US-CMS research program to make sure that we are establishing an institution that serves all of the interested parties well.



# US FCC

Work with us to advocate for what we need to succeed

## The US FCC Coordination Team

Solid State	Artur Apresyan (Fermilab), Carl Haber (LBNL)
Gaseous Detectors	Marcus Hohlmann (FIT), Bing Zhou (Michigan)
Calorimeter	Hucheng Chen (BNL), Chris Tully (Princeton)
Particle ID	Marina Artuso (Syracuse), Sarah Eno (Maryland)
Readout/ASICs	Julia Gonski (Columbia), Jim Hirschauer (Fermilab)
Trigger/DAQ	Zeynep Demiragli (Boston), Jinlong Zhang (ANL)
Software/Computing	Heather Gray (Berkeley), Oliver Gutsche (Fermilab)
Quantum	Marcel Demarteau (ORNL), Cristian Pena (Fermilab), Si Xie (CalTech)
Advisers	Karl Jakobs (ECFA), Andy Lankford (ILC)
ex-officio	Abid Patwa (DOE), Helmut Marsiske (DOE), Jonathan Asaadi (CPAD)
Chair	Srini Rajagopalan (BNL)

# Thank you

- My sincere thanks to everybody for taking the time to come to this workshop
- I know how stretched we all are, time-wise, financially, etc
- I see this meeting as a key investment in our future, something that will be celebrated 20 years in the future, at FCC-ee turn-on, as the beginning of strong US participation in a new machine.
- But more than that, you are going to be glad you came here, because this is the start of a whole lot of fun!