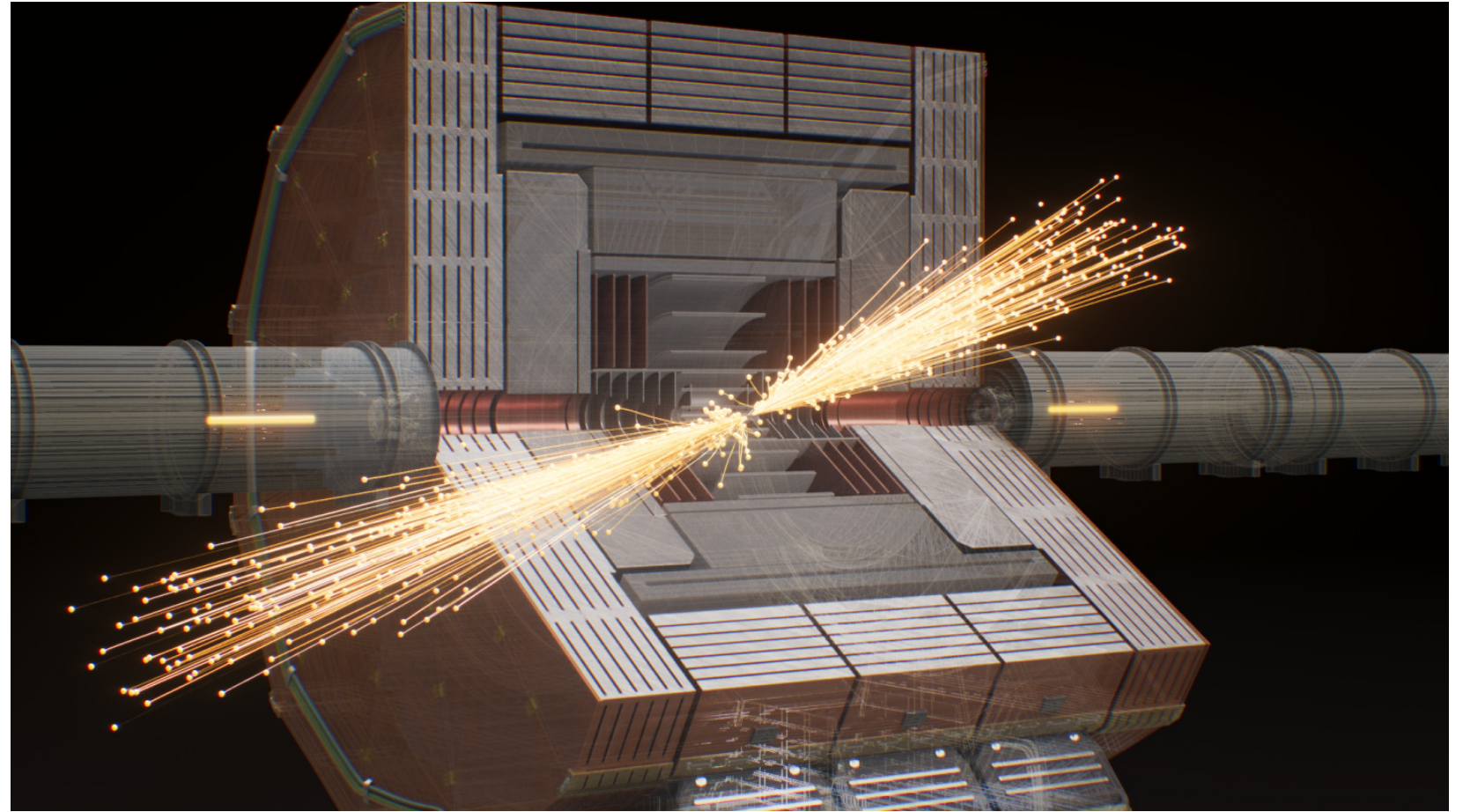


Future Collider Experiments

POF5 Meeting
August 26, 2025

Felix Sefkow
DESY



Key points

Timelines

Competence and Ambition

Detector R&D and Physics

Propose about 0.5 to one page - how much?

DESY Competences

Strategic goals

Timelines

Fundamental physics questions demand exploration with all available tools

Non-collider experiments and colliders beyond the LHC

Ongoing European Strategy Update: future flagship project at CERN

Timeline has uncertainties, but driven by finite lifetime of LHC accelerator and detectors and strong interest in community for a follow-up project not too much later

Expect approval in the first part of POF 5 and a general ramp-up of activities, given ATLAS and CMS upgrades largely completed by then

Competences and Ambition

**Ambition to maintain and evolve DESY's role as a German hub for future collider activities
remain in sync with momentum growth in the community**

DESY's competences

Physics case studies in close cooperation with theory; strong contributions to European strategy

Conceptual studies at full detector and full event level

**Complete lifecycle experience from R&D to key-ready systems - MT & MU
detector understanding - methods development - physics leadership**

Together with MT

software framework and integration

engineering integration of subsystems

Capitalise on infrastructure and know-how

test beam and its upgrade

DAF and equipment

Experience from large LHC tracker and calo upgrade projects

Detector R&D and Physics

DESY participates in Detector R&D Collaborations - and in corresponding German Verbundforschung

DRD3 (Silicon) and DRD6 (Calorimetry)

including horizontal activities in DRD7 (Electronics) and DRD8 (Mechanics)

**In POF5, work towards experimental CDRs and TDRs will start and intensify
will have to be substantiated by prototypes addressing system aspects**

e.g large tracker staves, calorimeter modules including cooling and services

timelines for different detector systems are different, calorimeters and large trackers must start early, vertex comes later

German institutes interested in ALLEGRO, CLD, ILD detector concepts

Detector R&D must be (more) strategically guided

engineering at system level, once application defined

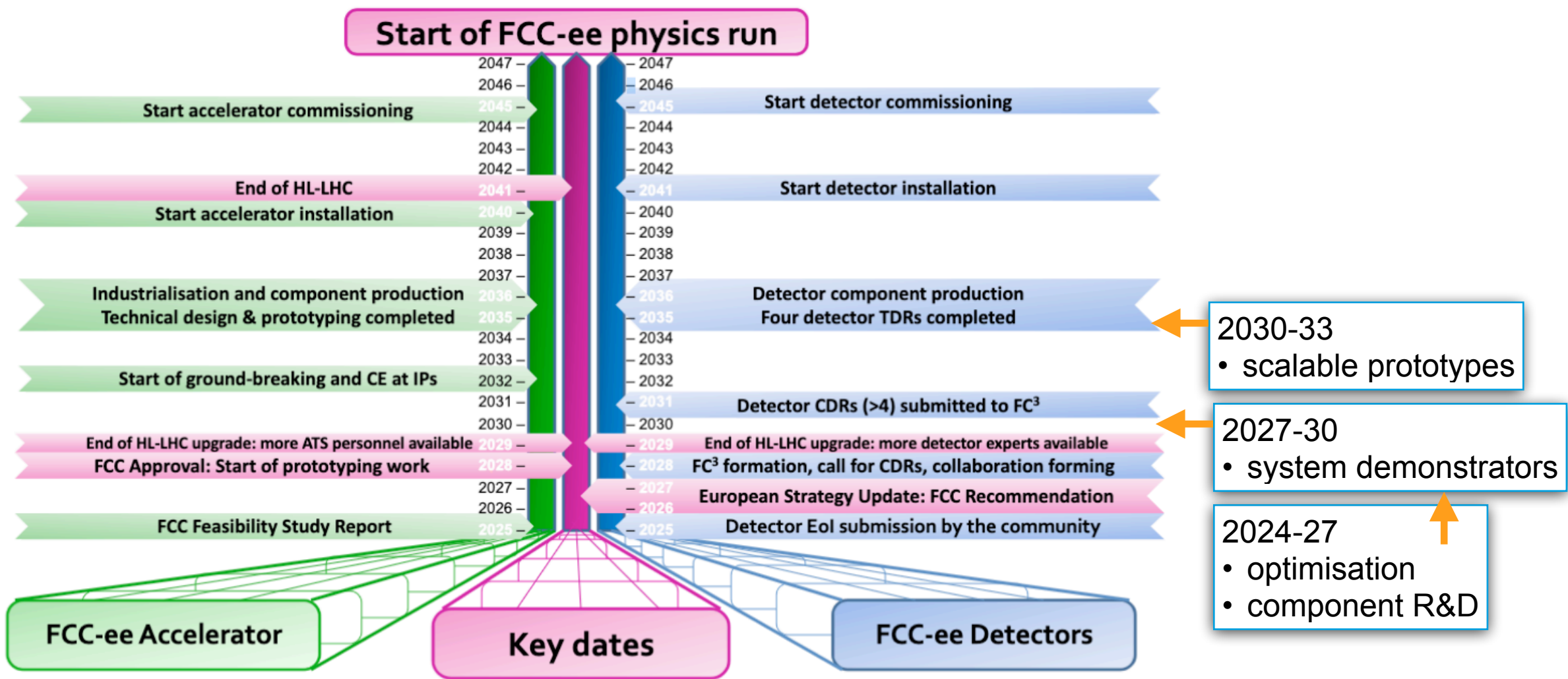
integration in overall detectorphysics performance impact of design choices

Strategic Goal

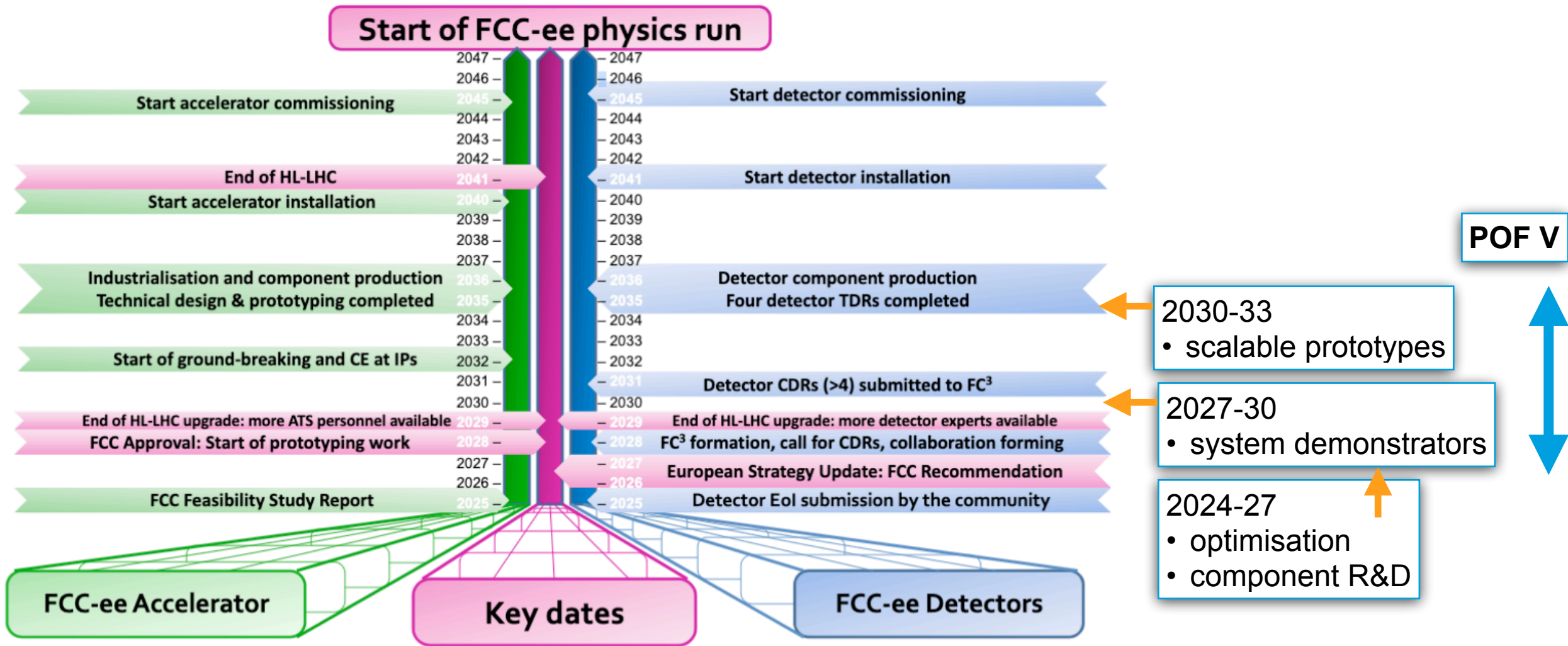
Together with German institutes prepare for a leading roles in future flagship project

Back-up

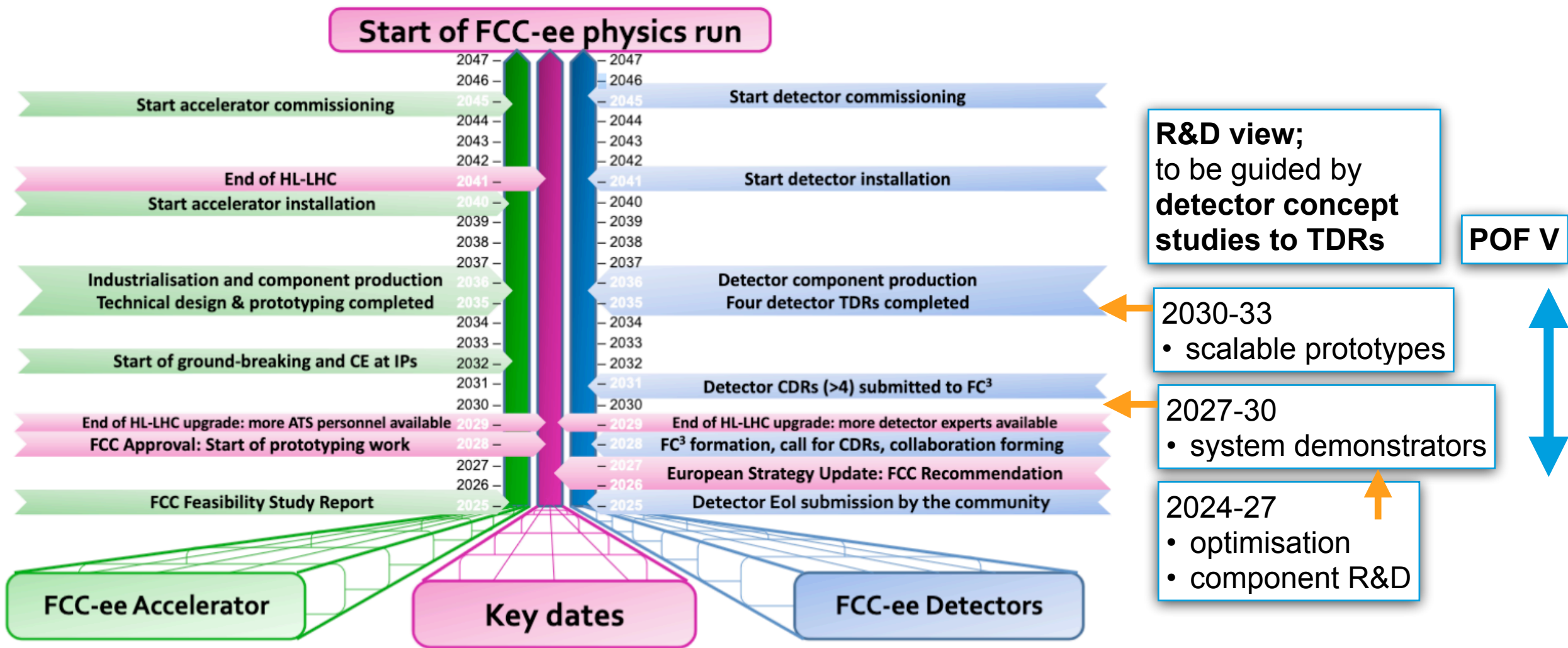
Timeline for the FCCee



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Timeline for the FCCee



Topics of Interest & Connections to DRDs

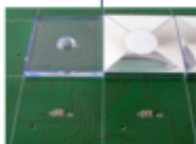
Silicon detector development is a strong focus of our interest

- Monolithic CMOS
- Novel sensors (ELAD, digital SiPM, ...)
- Software tool developments
- [Involvement in DRD3 \(Silicon\)](#)



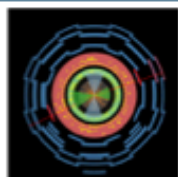
Calorimeter developments

- Highly granular SiPM on tile calorimeter
- [Involvement in DRD6 \(Calo\)](#)



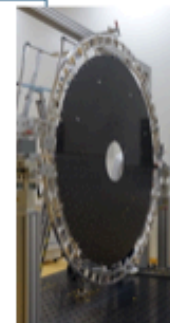
Data transfer

- Silicon photonics
- Advanced interconnects
- [Involvement in DRD7 \(Electronics\)](#)



Integration

- Detector integration center
- R&D on light weight mechanics, local cooling and cooling systems
- [Involvement in DRD8 \(Integration\)](#)



Cryogenic detectors

- Transition Edge Sensors
- Developments for axion/dark matter experiments
- [Involvement in DRD5 \(Quantum sensors\)](#)



Infrastructure

- Detector Assembly Facility
- Test beam

Cross topic goal: Build a demonstrator vertex detector based on CMOS technologies

shamelessly stolen from Katja & Moritz

Topics of Interest & Connections to DRDs

expect large area tracking effort to emerge after HL-LHC completion

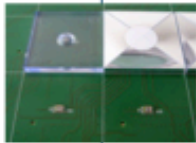
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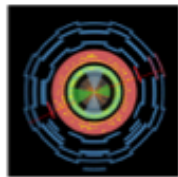
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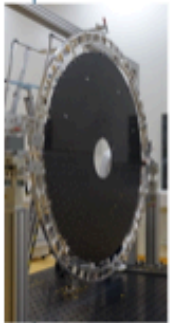
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Punchline

Maintain and evolve DESY's position as a German hub for future collider activities

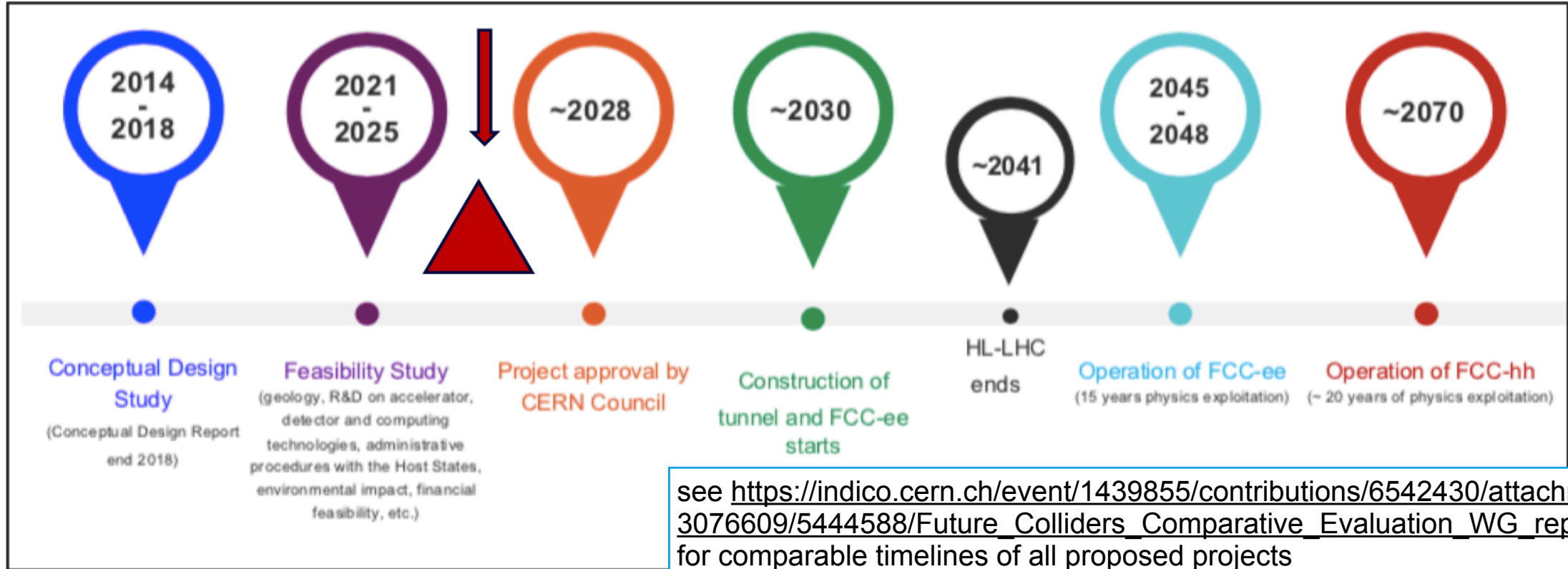
- in sync with momentum growth in the community

Capitalise on DESY strengths in

- **physics** and link to **theory**
- overall **detector concepts** and optimisation
- **software** frameworks and **integration**
- **detector technology** competences and **infrastructure**

Develop leading role of DESY and German institutes in CERN's future flagship project

FCC Timeline as an Example



20 years to develop, prototype, build and install detectors

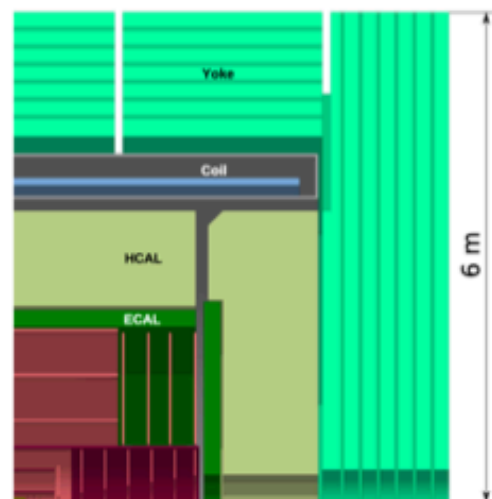
- not all in the last moment
- LHC experience teaches us: time to start
- next phase already includes CERN contribution to detector concepts

Timelines are uncertain and tend to slip

- earlier milestones and decisions less affected than end dates

FCC-ee Detector Concepts

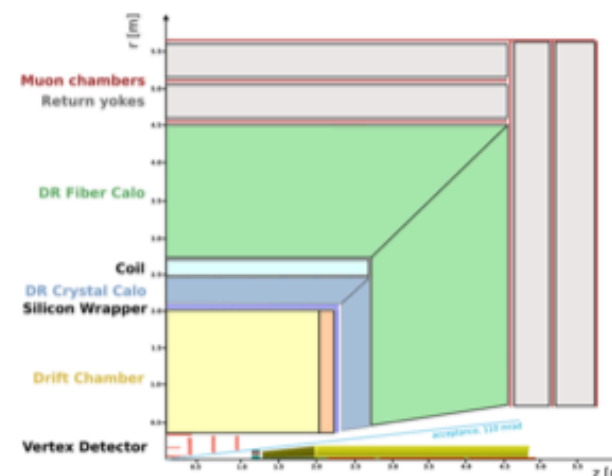
CLD



- Well established design
 - ILC → CLIC detector → CLD
- Full Si VXD + tracker
- CALICE-like calorimetry – very high granularity
- Coil outside calorimetry, muon system
- Possible detector optimizations
 - Improved σ_p/p , σ_E/E
 - PID: precise timing and RICH

[arXiv:1911.12230](https://arxiv.org/abs/1911.12230)

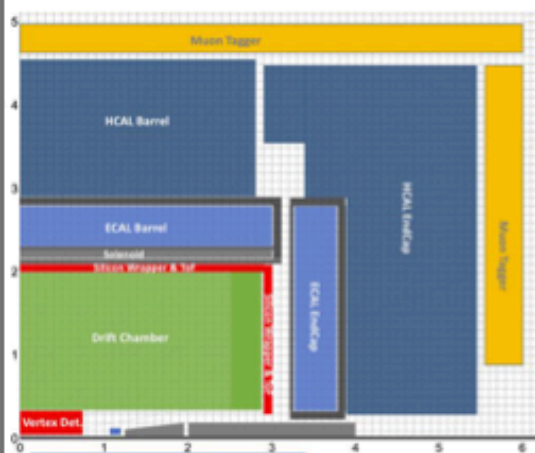
IDEA



- Design developed specifically for FCC-ee and CEPC
- Si VXD; ultra-light drift chamber with powerful PID
- Crystal ECAL w. dual readout
- Compact, light coil;
- Dual readout fibre calorimeter
- Muon system

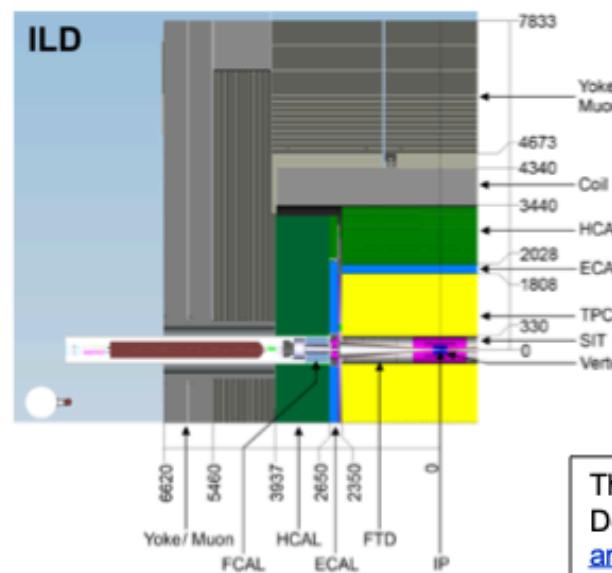
<https://doi.org/10.48550/arXiv.2502.21223>

Allegro



- Still in early design phase
- Design centred around High granularity **Noble Liquid ECAL**
 - Pb+LAr (or denser W+LKr)
- Si VXD
- Tracker: Drift chamber, straws, or Si
- Steel-scintillator HCAL
- Coil outside ECAL in same cryostat
- Muon system

[Eur.Phys.J.Plus 136 \(2021\) 10, 1066, arXiv:2109.00391](https://arxiv.org/abs/2109.00391)

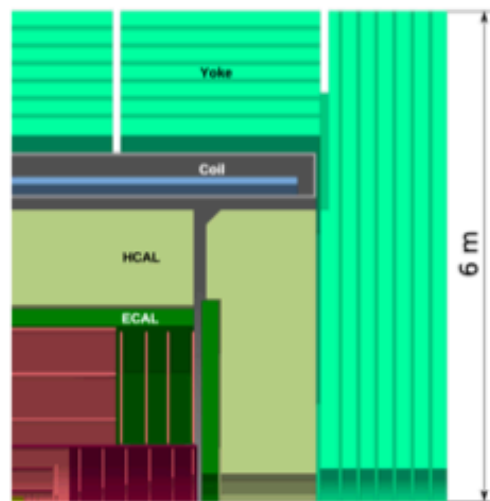


- Designed originally for operation at the ILC
- Together with SiD, ancestor of CLD.
- Main difference and signature element:
 - Large-volume time projection chamber (TPC)

The International Linear Collider Technical Design Report - Volume 4: Detectors
[arXiv:1306.6329](https://arxiv.org/abs/1306.6329)

Any Future Higgs Factory Detector Concepts

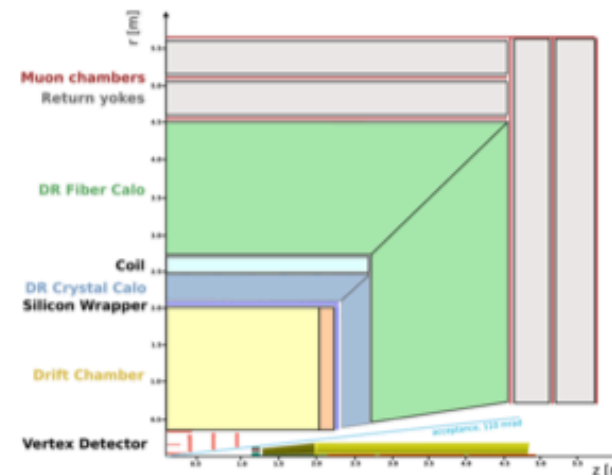
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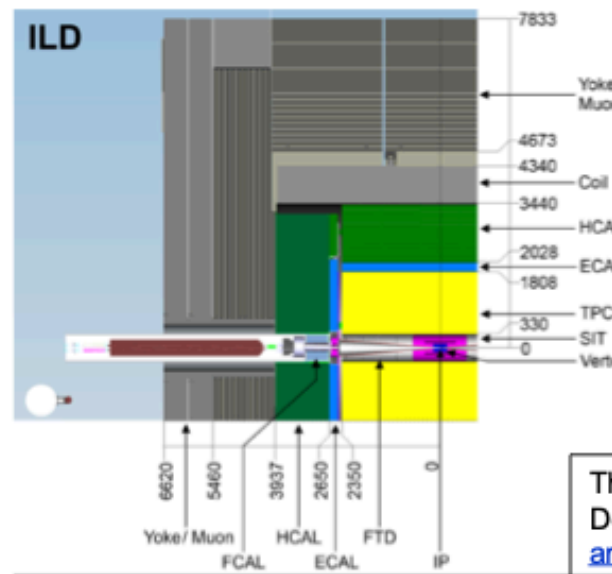
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German Community and DESY

Survey in 2024

Main interest in silicon detectors (vertex and large area) and calorimetry

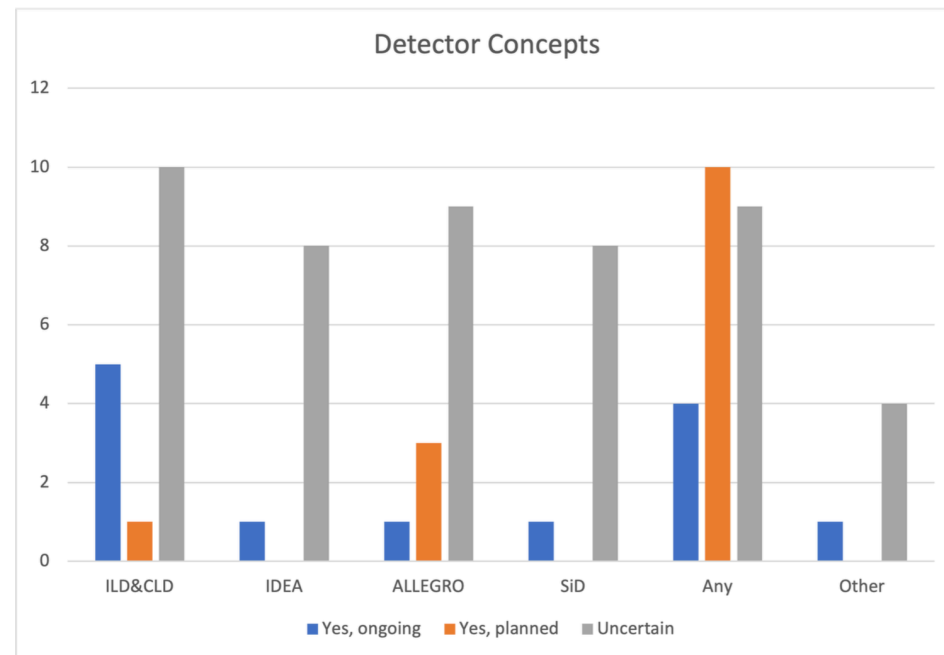
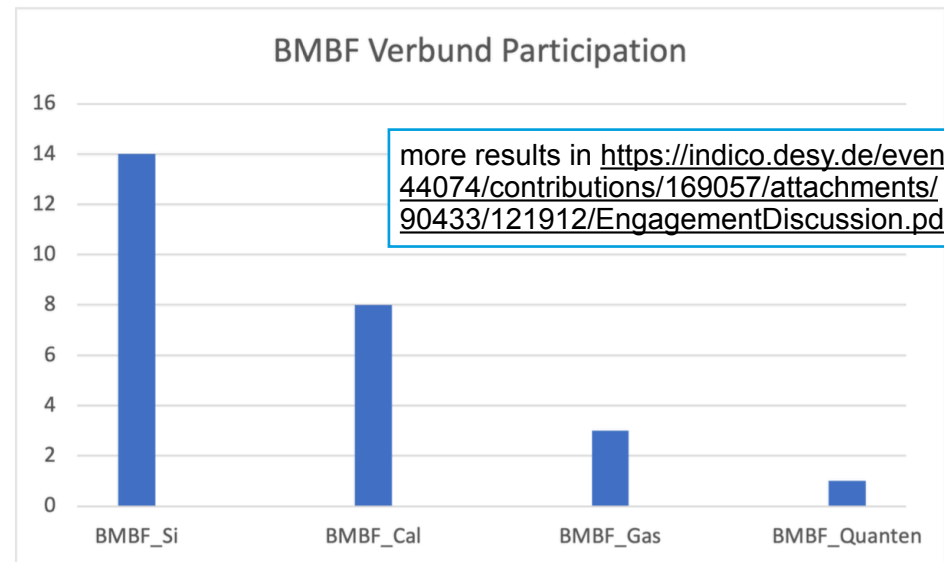
- best way to position oneself in future projects is success in ongoing ones
- DESY and German universities well aligned
- DESY technology focus also includes advanced electronics & mechanics
 - see detector platform view

Interest in several detector concepts

- CLD/ILD, ALLEGRO

See also submitted **Expressions of Interest** (concepts and sub-detectors)

<https://indico.cern.ch/event/1529896/>



DESY Key Competences in Detector Concepts

25 years of experience in leading and supporting physics and detector efforts worldwide

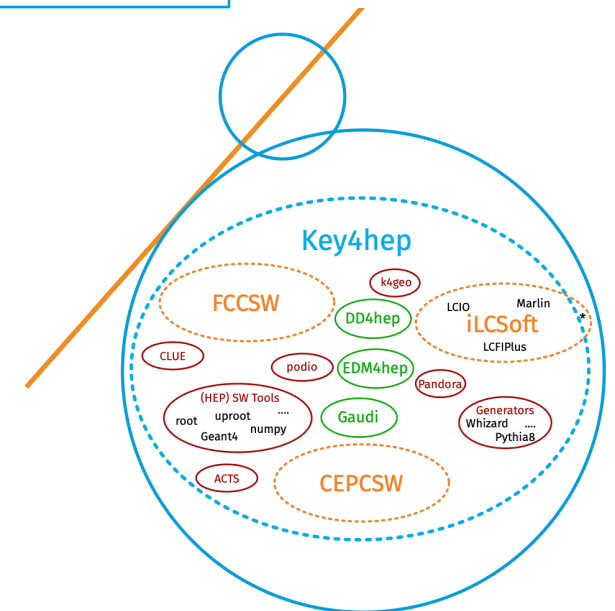
DESY strengths

- strong links with **theory**; phenomenology and generator competences
- **physics** case studies as key to strategic contributions
- physics driven detector **optimisation**
- **software** frameworks, sub-detector s/w integration and high-level reconstruction; **Machine Learning** in simulation & reconstruction
 - key to community integration
 - see computing platform view
- detector integration including **MDI**
- detector **engineering** and test beam **support**

Lifetime competences

- detector understanding → methods development → physics leadership

Jenny's talk



Key4hep contains the experiment specific software components of all major Higgs factory proposals