Noble Liquid Calorimetry as the Basis of a Third e^+e^- Collider Detector Concept

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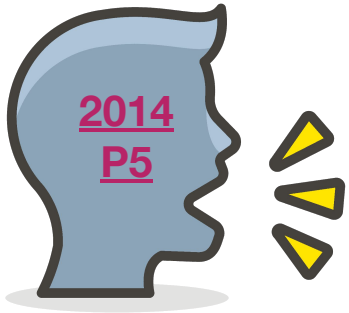
June 27th, 2023

P5 Virtual Town Hall, Virginia Tech

Brookhaven National Laboratory

Towards a future Higgs Factory



Snowmass reports. We distilled those essential inputs into five intertwined science Drivers for the field:

- **Use the Higgs boson as a new tool for discovery**
- **Pursue the physics associated with neutrino mass**
- **Identify the new physics of dark matter**
- **Understand cosmic acceleration: dark energy and inflation**
- **Explore the unknown: new particles, interactions, and physical principles.**

From the 2021 Snowmass Energy Frontier report: "the EF supports a fast start for construction of an e^+e^- Higgs factory (linear or circular) ... **The realization of a Higgs factory will require an immediate, vigorous and targeted detector R&D program.**"

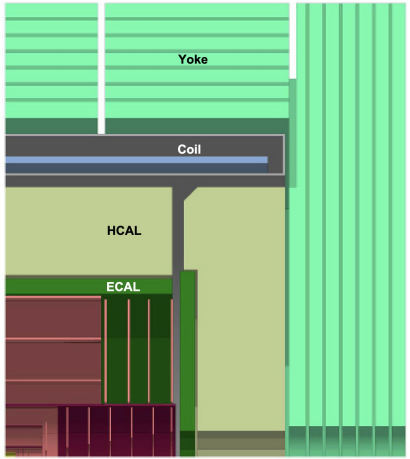
See Patricia Azzi's CERN seminar for more details

Higgs Factory Detector Requirements

- **Higgs:**
  - Momentum resolution
  - Jet energy resolution (W/Z separation)
  - Impact parameter resolution / particle ID for b,c-tagging
- **Precision QCD, Electroweak:**
  - Luminosity determination
  - Momentum resolution
- **Heavy Flavor:**
  - Impact parameter resolution
  - ECAL resolution
  - π^0/γ separation, particle ID
- **BSM:**
  - Displaced tracking
  - Detector volume
  - Hermeticity

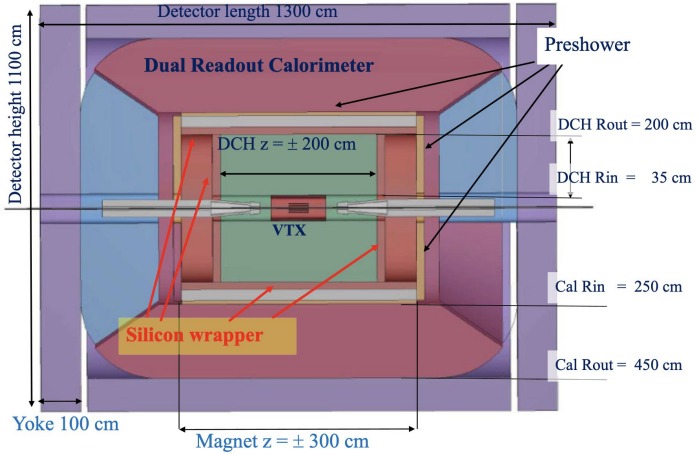
FCC-ee baseline:
4 detectors

Detector concepts for the FCC-ee



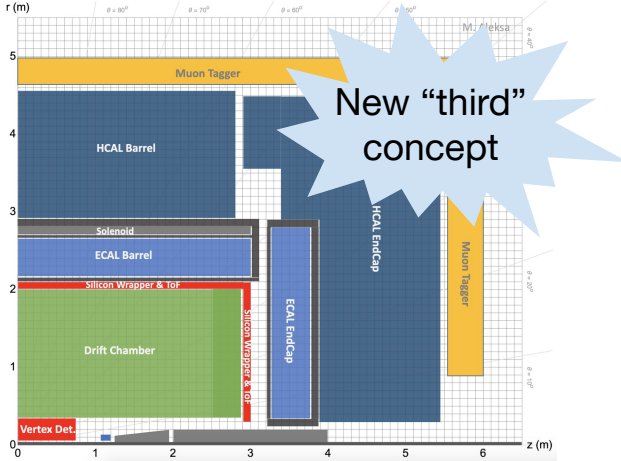
CLD: FCC-ee CDR

- Full Silicon vertex detector + tracker
- CALICE-like calorimetry
- Large coil, muon system



IDEA: FCC-ee CDR

- Silicon vertex detector, ultra light drift chamber
- Monolithic dual readout calorimeter
  - Possibly augmented by crystal ECAL
- Muon system



Martin Aleksa's slides at FCC Week 2022

- Tracker:
  - Silicon vertex detector, ultra light drift chamber (or Si) **(?)**
- **High granularity Noble Liquid ECAL**
- CALICE-like or TileCal-like HCAL **(?)**
- Muon system **(?)**

Reference: Michael Benedikt, FCC Week 2023

Timeline to FCC-ee

- 2025: FCC Feasibility Study Report, **Collect detector Expressions of Interest**
- 2026-7: European Strategy update

5 years from now

- **2028: Formation of four collaborations**
- 2029: Completion of HL-LHC upgrade

8 years from now

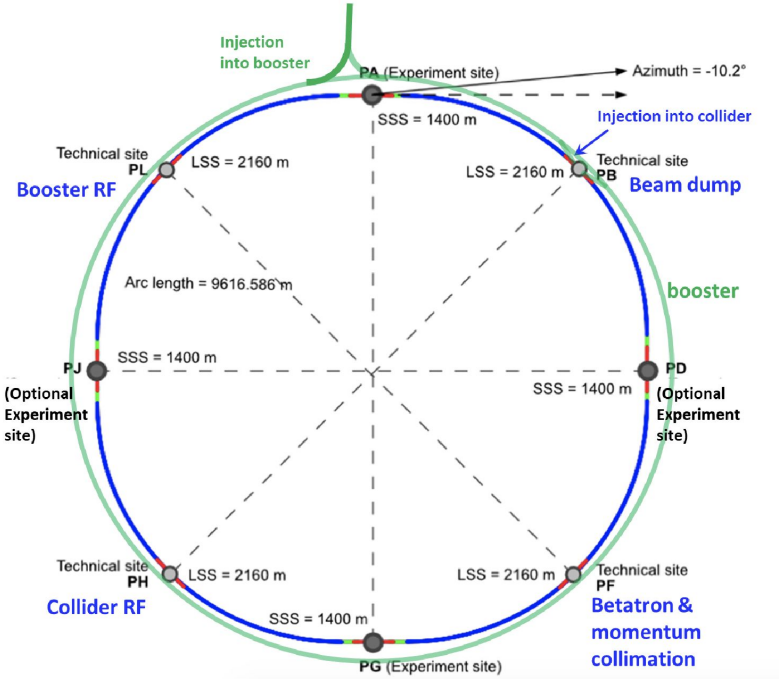
- **2031: Submit four detector CDRs**
- **2035: Four detector TDRs**

< 20 years from now

- **2041: Start detector installation**
- Early 2040s: end of HL-LHC operations
- **2045: Start detector commissioning**
- **2048: FCC operations**

Conclusions

- **“Third” detector concept for the FCC is a great opportunity for new ideas and contributions**
  - Especially for young people
- **Next meeting on “third” detector concept on July 6th**
  - Vote on a better name :)
  - n.b. Meeting series primarily focused on calorimeter so far - can add more general meetings when new people join



FCC-ee baseline, June 2023

BACKUP

Abstract

In 2019, the FCC CDR presented two complementary and mature detector designs (CLD and IDEA) for the FCC-ee. Since then, a new detector concept for future e+e- colliders, built around a noble-liquid electromagnetic calorimeter, has emerged. At this early stage, the technologies for the rest of the detector have yet to be decided. This “third” detector offers a unique opportunity for newcomers, and especially for early-career scientists, to influence the design of a detector concept, build international partnerships, and to assume major roles in its design and construction phases.