

# Detector Concepts and MDI

## Overview

FCC Week

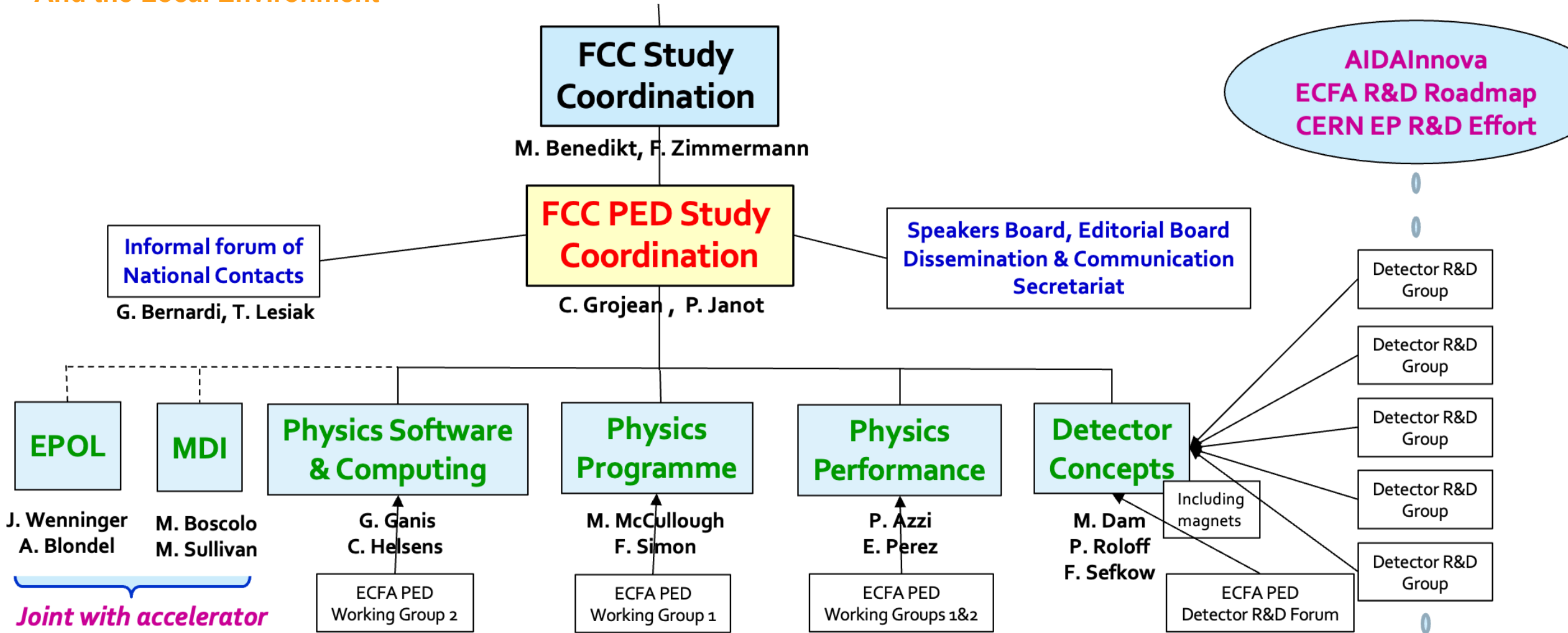
May 30, 2022

Felix Sefkow  
DESY



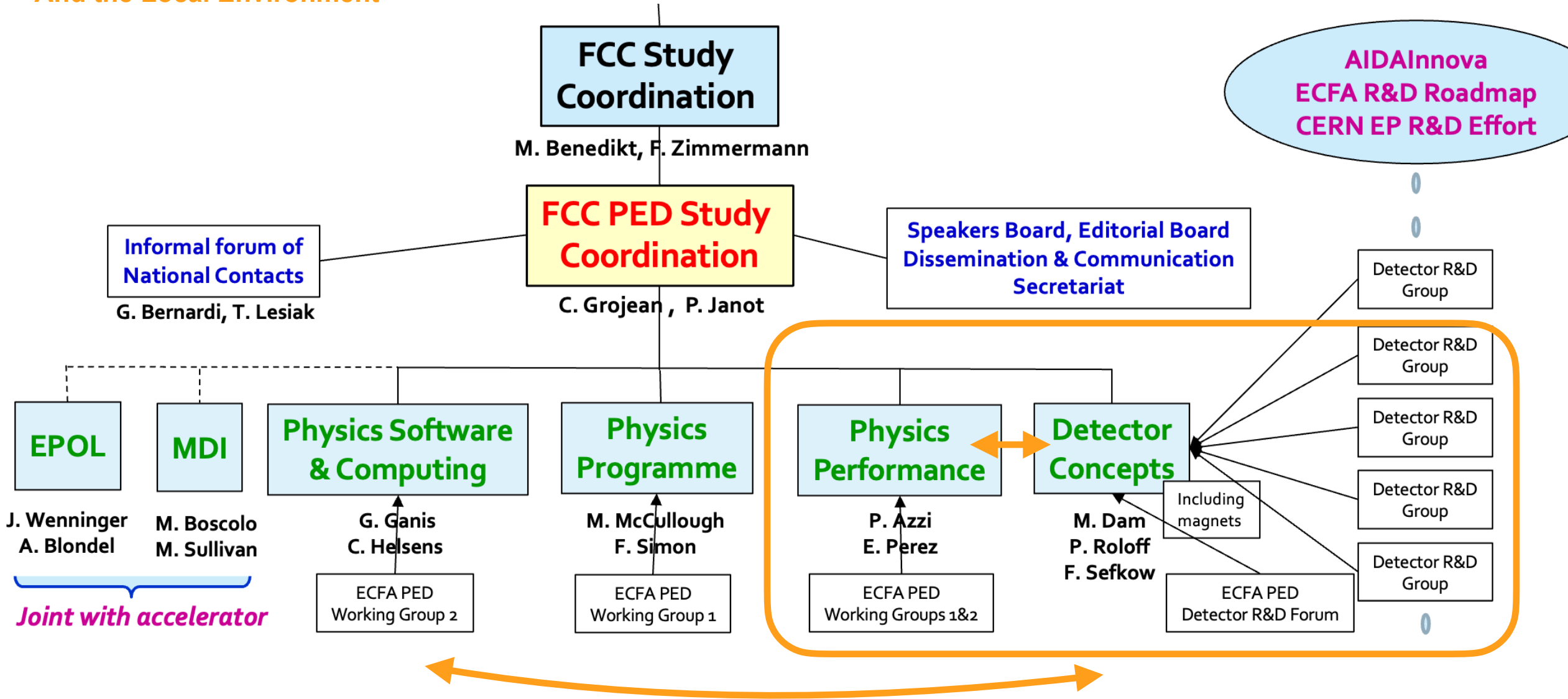
# Detector Concepts in the PED effort

## And the Local Environment



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# Detector Concepts Goals

## In the Feasibility Study and Beyond

**Primary goal of the detector branch is to demonstrate, as input to the next EPPSU, that detectors can be built that match the precision physics potential of the FCC**

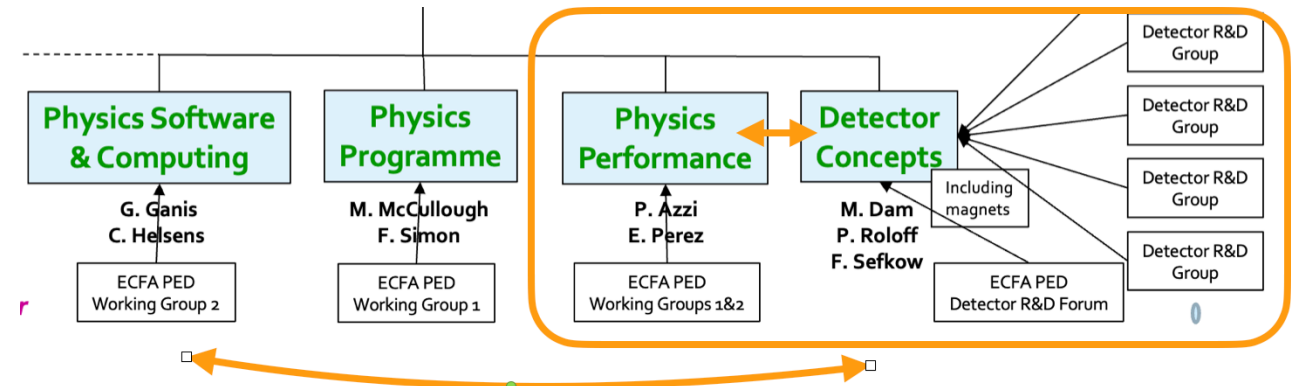
- The level of realism of such a demonstration, for the FCCee, should be comparable with other Higgs factory proposals

**The other main goal is to provide guidance for coherent detector R&D efforts to address the priority requirements of FCC experiments**

- And to support their funding requests

**Software is the underlying tissue connecting the PED branches**

- Detector model for performance evaluation and physics benchmarking
- Validation and proof of feasibility from R&D



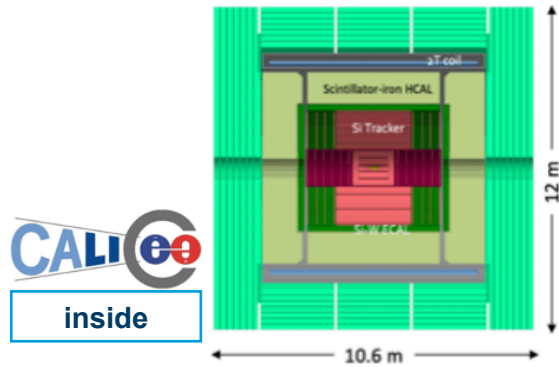
**Excellent connection and active communication between physics, physics performance, detector concepts and detector R&D are necessary**

- FCC Kick-off **Workshop** for Detector Concepts, Performance and Software
- Focus: Detector Optimisation and Benchmarking
  - plus selected R&D topics
- **Jun 22-23, CERN**
  - <https://indico.cern.ch/event/1165167/>

# Detector Concepts

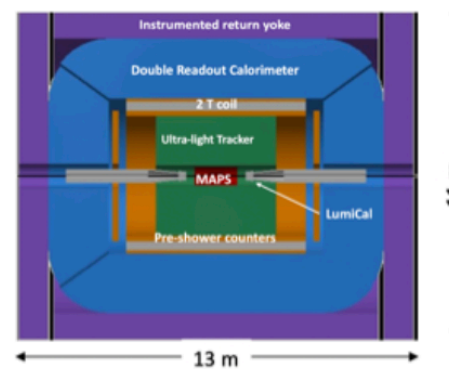
## In a Nutshell

CLD



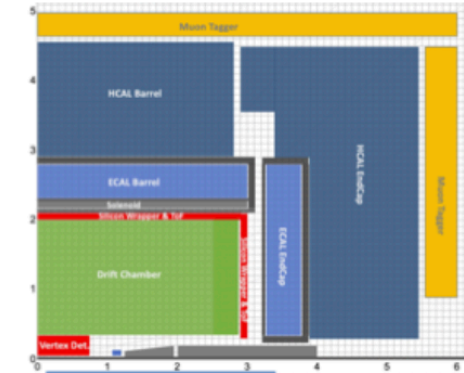
- Well established design
  - ILC -> CLIC detector -> CLD
- Engineering needed to make able to operate with continuous beam (no pulsing)
  - Cooling of Si-sensors & calorimeters
- Possible detector optimizations?
  - $\sigma_p/p$ ,  $\sigma_E/E$
  - PID ( $\mathcal{O}(10\text{ ps})$  timing and/or RICH)?
  - ...
- Robust software stack
  - Now ported (wrapped) to FCCSW

IDEA



- Less established design
  - But still ~15y history: 4<sup>th</sup> Concept
- Developed by very active community
  - Prototype construction / test beam campaigns
  - Italy, Korea,...
- Is IDEA really two concepts? Or will it be?
  - w, w/o crystals
- Software under active development
  - Being ported to FCCSW

Noble Liquid ECAL based

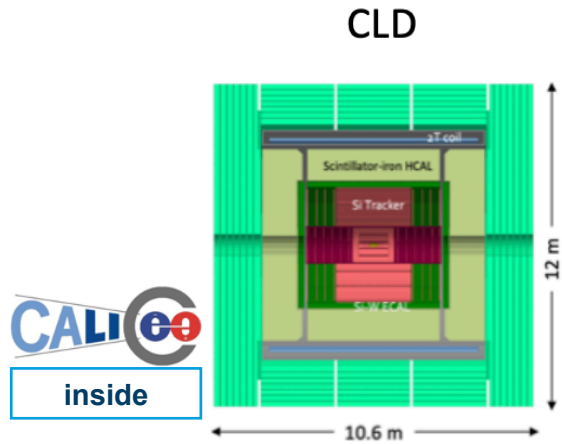


- A design in its infancy
- High granular Noble Liquid ECAL is the core
- Very active Noble Liquid R&D team
  - Readout electrodes, feed-throughs, electronics, light cryostat, ...
  - Software & performance studies
- Full simulation of ECAL available in FCCSW

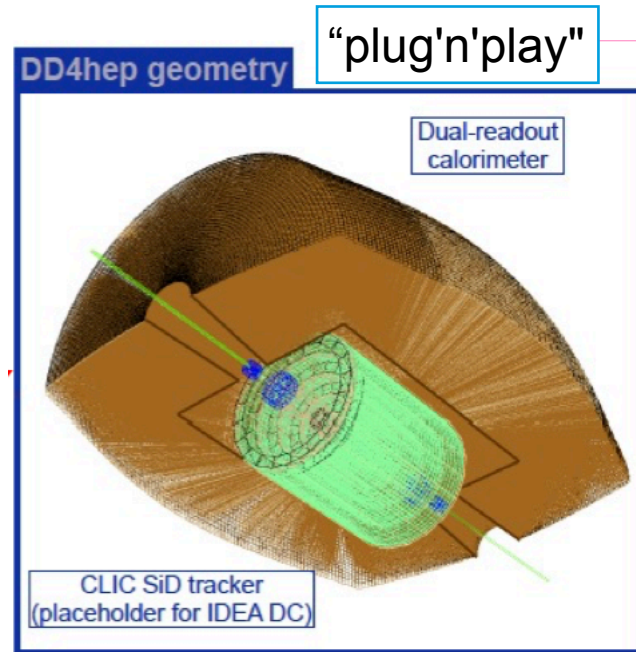
Mogens Dam

# Detector Concepts

## In a Nutshell



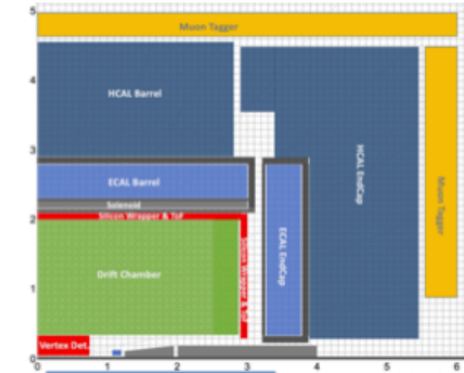
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Variants and permutations are possible (and sometimes reasonable), to streamline R&D efforts

## Noble Liquid ECAL based



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# Implementation of the ECFA Detector R&D Roadmap

Ongoing, invited by CERN Council

## European Strategy stresses importance of a strong focus on instrumentation

- Relevant R&D issues must be addressed **in time**
- Common R&D lines with near- and mid-term projects - exploit **synergies and stepping stones**

## Successful completion of High-Luminosity LHC must remain key focus

- start up the process now, but only gradually ramp-up
- larger involvement of many groups only after phase II construction completed

## Offer long-term perspectives for instrumentation physicists / engineers

## Two components

- Establishment of **R&D collaborations** anchored at CERN
- Implementation of General Strategic Recommendations

based on slides by  
P. Allport, K. Jakobs

see also talk at Plenary RRB <https://indico.cern.ch/event/1133070/timetable/>

# R&D Collaborations

Reloaded.

## **Follow the successful model of R&D collaborations for the LHC**

- funding in place since ~1986, R&D collaborations established in 1990
- Aim at few large DRD collaborations, to keep it manageable

## **Take full account of existing, successful and well managed R&D coll.**

- Integrate with CERN EP R&D, AIDAinnova, CALICE,...

## **Community-driven approach, supported by ECFA Roadmap Task Forces**

- call for proposals, moderate process, timeline 1-2 years

## **Reasonably dimensioned review process (ECFA and CERN)**

- addressing needs of future experiments is important criterion
- worldwide perspective

## **ECFA Higgs factory study WG 3 established: MC Fouz, G.Marchiori, FS**

- as a forum for the interplay between physics and detector studies and R&D efforts
- This is also relying on functional FCC detector concepts



# Detector Concept Sessions

This Week Wednesday

Overview and updates  
Selected topics, avoiding duplication  
with Liverpool workshop

11:00	PE&D (until 12:30) (Bilsky PASQUIER)
11:00	Detector Concepts Overview - <a href="#">Mogens Dam (University of Copenhagen (DK))</a> (Bilsky PASQUIER)
11:30	The CLD Detector Concept - <a href="#">Andre Sailer (CERN)</a> (Bilsky PASQUIER)
11:50	The IDEA detector concept - <a href="#">Paolo Giacomelli (Universita e INFN, Bologna (IT))</a> (Bilsky PASQUIER)
12:10	LAr based detector concept - <a href="#">Martin Aleksa (CERN)</a> (Bilsky PASQUIER)

New study  
CMOS R&D and its performance impact

14:00	PE&D (until 15:30) (Bilsky Pasquier)	
14:00	Summary of GranuLAr workshop in Paris - <a href="#">Nicolas Morange (Université Paris-Saclay (FR))</a> (Bilsky Pasquier)	
14:22	TOWARD A VERTEX DETECTOR CONCEPT EXPLOITING THE EVOLUTION OF CMOS PIXEL SENSORS AND THEIR SERVICES - <a href="#">Dr Auguste Guillaume Besson (Centre National de la Recherche Scientifique (FR))</a> (Bilsky Pasquier)	
14:44	R&D for lumionometers at e+e- colliders - <a href="#">Wolfgang Friedrich Lohmann (Deutsches Elektronen-Synchrotron (DE))</a> (Bilsky Pasquier)	
15:06	The Grainite calorimeter project - <a href="#">Jacques Lefrancois (Université Paris-Saclay (FR))</a> (Bilsky Pasquier)	

New idea

# Detector Concepts: the D in MDI

## MDI Session on Thursday

11:00	<b>FCC-ee accelerators</b> (until 12:30) (FARABOEUF)	
11:00	MDI overview - <a href="#">Manuela Boscolo (INFN e Laboratori Nazionali di Frascati (IT))</a> (FARABOEUF)	
11:20	Luminosity calorimeter - <a href="#">Mogens Dam (University of Copenhagen (DK))</a> (FARABOEUF)	
11:40	IR chamber & Calculations - <a href="#">Francesco Franesini</a> (FARABOEUF)	
12:00	Modelling process for vibrations estimations - <a href="#">Stanislas Grabon (Centre National de la Recherche Scientifique (FR))</a> (FARABOEUF)	
12:15	Machine Detector Interface Alignment System Update and challenges - <a href="#">Leonard Watrelot (CNAM - Conservatoire National des Arts et Métiers (FR))</a> (FARABOEUF)	

Overview and updates on Lumi-Calo, beam pipe, vibrations and alignment

IR Magnets backgrounds

14:00	<b>FCC-ee accelerators</b> (until 15:30) (FARABOEUF)
14:00	IR Magnet concepts - <a href="#">m Koratzinos (Massachusetts Inst. of Technology (US))</a> (FARABOEUF)
14:20	IR Magnet review - <a href="#">John Seeman</a> (FARABOEUF)
14:35	Machine induced backgrounds in the FCC-ee MDI region and Beamstrahlung radiation - <a href="#">Andrea Ciarma (CERN)</a> (FARABOEUF)
14:55	Synchrotron radiation background studies - <a href="#">Kevin Daniel Joel Andre (CERN)</a> (FARABOEUF)
15:10	Challenges for instrumented beamstrahlung - <a href="#">Marco Calviani (CERN)</a> (FARABOEUF)

# The FCC-hh Detector

Also Part of the Feasibility Study!

An a longer timescale - but proof-of-concept is indispensable

- to demonstrate feasibility
- to guide some long-term R&D
- **CDR almost ready**

## Conceptual design of an experiment at the FCC-hh, a future 100 TeV hadron collider

Editors: M. Mangano and W. Riegler

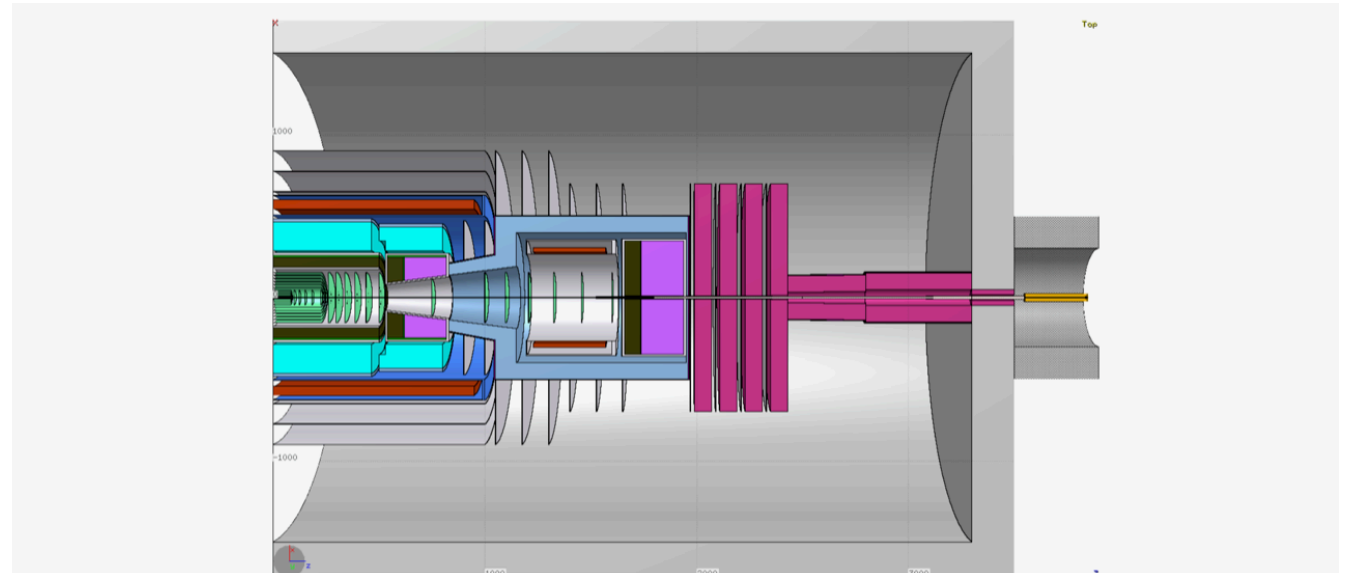


Fig. 3.3: Detector layout: top view at beam height. The  $x$  axis is in the horizontal plane, pointing outside the ring;  $y$  axis is up (opposite to gravity) and  $z$  axis is along the beam. The origin of the right-handed coordinate system corresponds to the nominal collision point.

# Back-up