RD_FCC
WP Acceleratore

Manuela Boscolo

5 Giugno 2025

FCC Week 2025

- https://indico.cern.ch/event/1408515/
  - Più di 600 partecipanti

Feasibility Study Report published on 31 March 2025

Structure:Three Volumes

- ***Vol. 1:*** *Physics, Experiments and Detectors*
- ***Vol. 2:*** *Accelerators, Technical Infrastructures, Safety Concepts*
- ***Vol. 3:*** *Civil Engineering, Implementation & Sustainability*

Input for the Update of European Strategy for Particle Physics

Three FSR volumes & other FCC-related input to 2025/26 European Strategy Update posted at https://indico.cern.ch/event/1534205/

prepared with Overleaf submitted for publication to EPJ (Springer-Nature) – FCCIS members

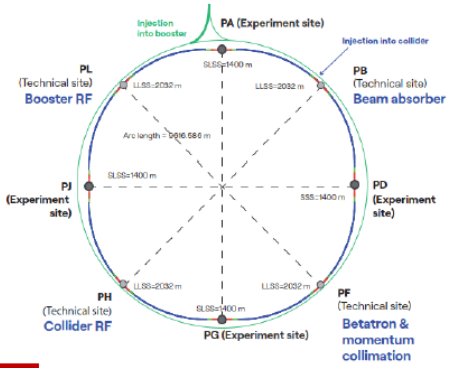
Stage 1: e^+e^- collider FCC-ee

Consolidated main parameters

parameter	Z	WW	H (ZH)	$t\bar{t}$
beam energy [GeV]	45.6	80	120	182.5
synchrotron radiation/beam [MW]	50	50	50	50
beam current [mA]	1294	135	26.8	5.1
number bunches / beam	11200	1852	300	64
total RF voltage 400/800 MHz [GV]	0.08 / 0	1.0 / 0	2.09 / 0	2.1 / 9.2
luminosity / IP [10^{34} cm^{-2}s^{-1}]	145	20	7.5	1.4
total integrated luminosity / IP / year [ab^{-1} / yr]	17	2.4	0.9	0.17
beam lifetime [min]	21	13	9	10

4 years 6 x 10^{12} Z LEP x 10^5 | 2 years > 10^8 WW LEP x 10^4 | 3 years > 2x10^6 H | 5 years 2 x 10^6 tt pairs

FCC-ee functional layout



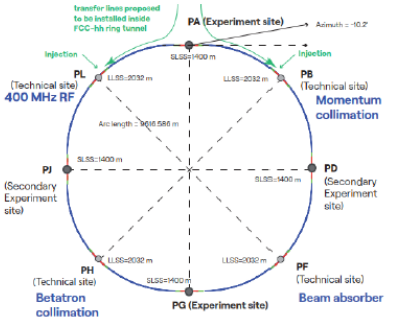
Stage 2: hadron collider FCC-hh

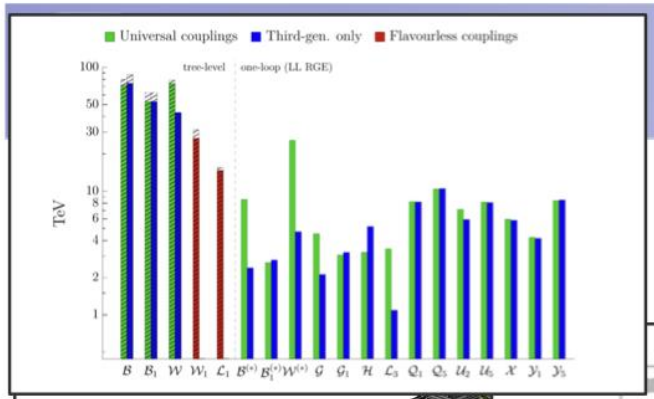
- Parameter optimization to lower electricity consumption (~max. consumption of FCC-ee)
- Magnetic field considered realistic with today's technologies (Nb_3Sn, ~14T, 1.9 K)

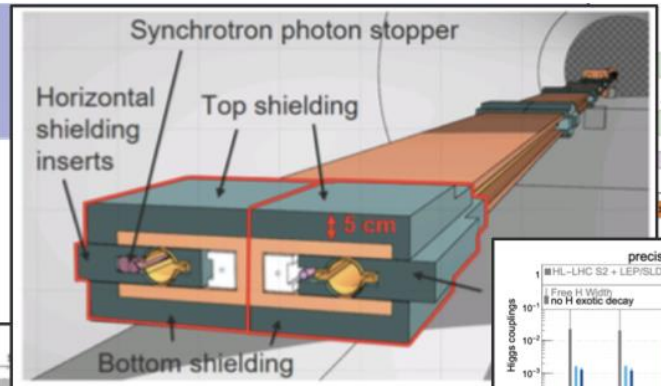
Main parameters FSR 2025

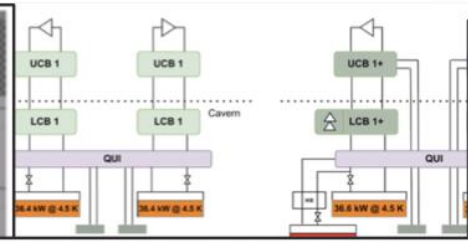
parameter	FCC-hh	FCC-hh CDR	HL-LHC
collision energy cms [TeV]	85	100	14
dipole field [T]	14	16	8.33
circumference [km]	90.7	97.8	26.7
beam current [A]	0.5	0.5	1.1
synchr. rad. per ring [kW]	1200	2400	7.3
peak luminos. [10^{34} cm^{-2}s^{-1}]	30	30	5 (lev.)
events/bunch crossing	1000	1000	132
stored energy/beam [GJ]	6.5	8.3	0.7
integr. luminosity / IP [fb^{-1}]	20000	20000	3000

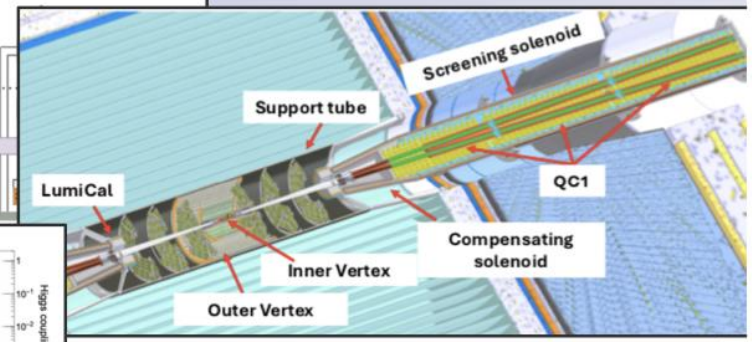
FCC-hh functional layout

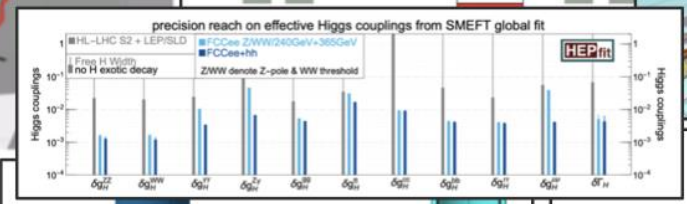


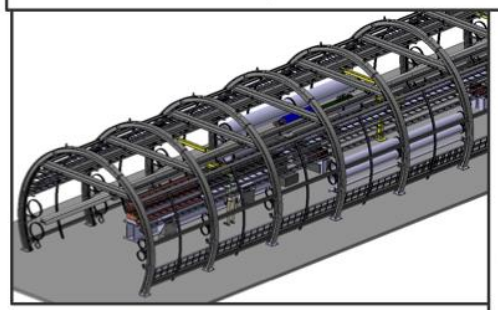


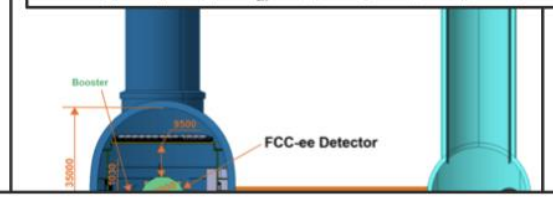


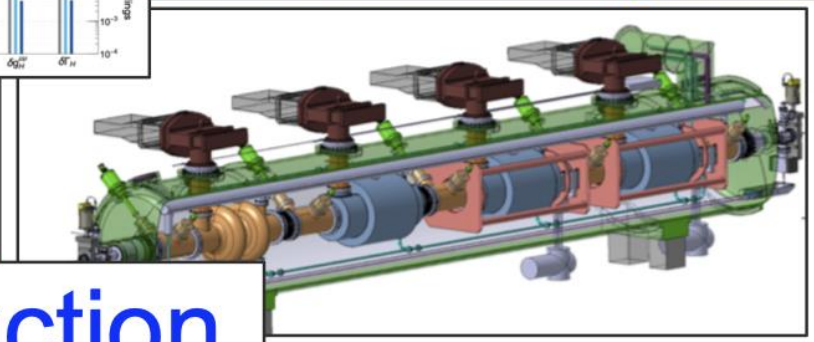








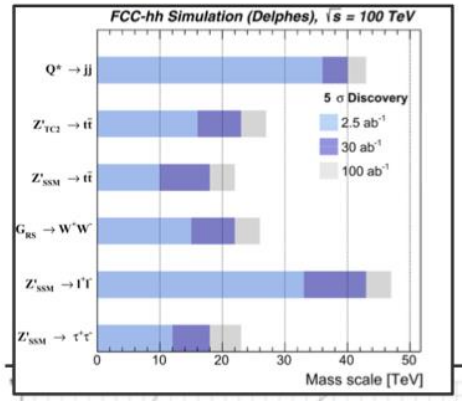


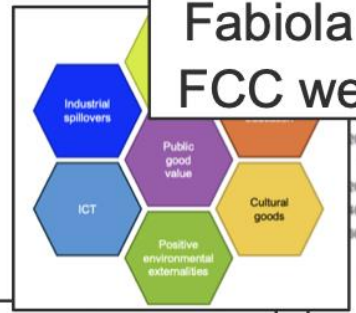


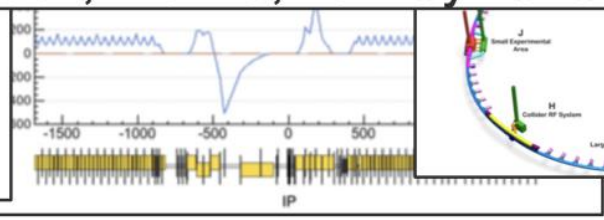
Welcome and introduction

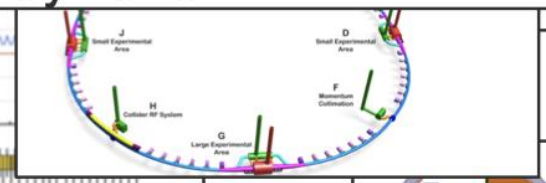
Fabiola Gianotti (CERN)

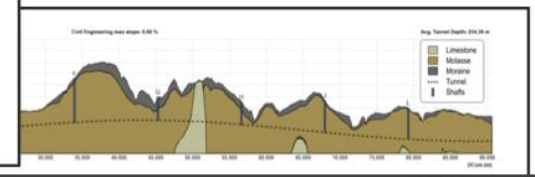
FCC week, Vienna, 19 May 2025

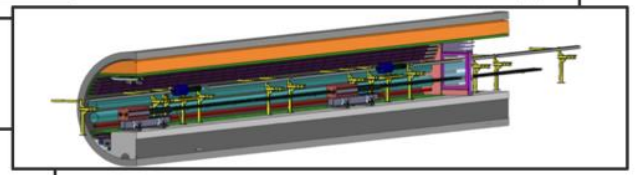


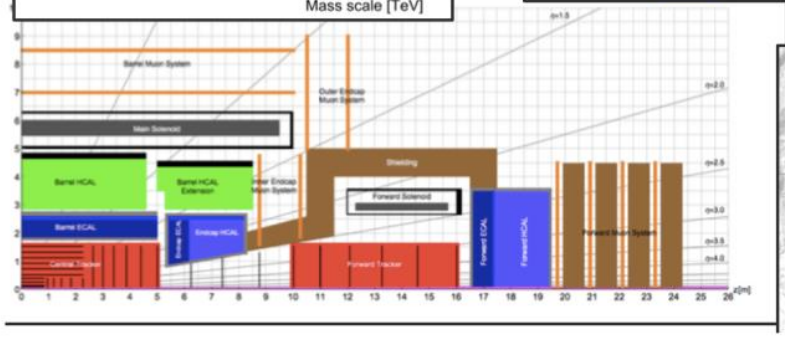


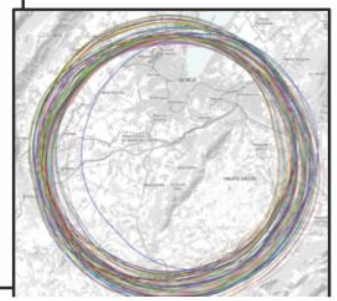


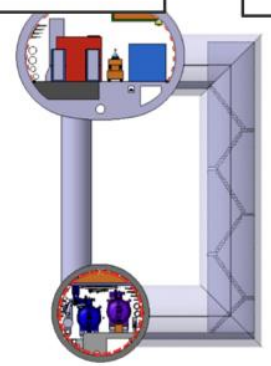


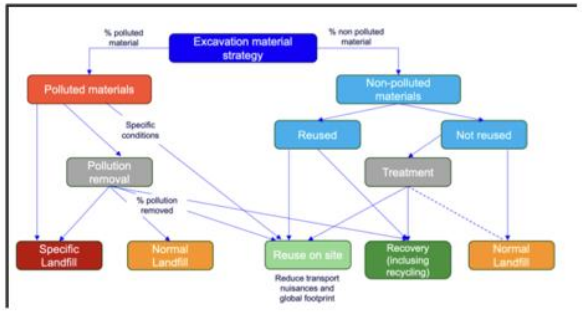












Fabiola Gianotti

The FCC Feasibility Study has been successfully completed

(work on the financial feasibility of the project will be concluded this Summer)

Over less than 5 years, an **extraordinary collective effort** by the FCC community, involving some 1500 contributors, has delivered this milestone, expertly coordinated by a dedicated and highly effective FCC Coordination Group.

The breadth and depth of the results are remarkable — **achievements of this scale and quality are unprecedented for a project at this stage of development.**

Although the report will still undergo review by several committees, **no showstopper has been identified** across the full range of areas covered in the Report.

This is a crucial outcome for the project's future and **a major milestone for the field of high-energy physics**.

We now look ahead and prepare for the **next phase**.

Building a viable financial path

Updated project cost for FCC-ee up to and including operation at ZH and 4 experiments
t-tbar upgrade requires additional 1.3 BCHF

Domain	Cost [MCHF]
Civil engineering	6160
Technical infrastructures	2840
Injectors and transfer lines	590
Booster and collider	4140
CERN contribution to four experiments	290
FCC-ee total	**14 020**
+ Four experiments (non-CERN part)	1300
FCC-ee total, including four experiments	**15 320**

Funding of FCC (and any other major future collider project) will come from two main sources:

- ❑ CERN Budget (i.e. revenues from Member and Associate Member States): would cover more than 50% of FCC investment cost
- ❑ External contributions:
  - additional voluntary contributions (in-cash or in-kind) from Member and Associate Member States
  - contributions from non-Member States
  - exploring possible contributions from the European Union in the next Multiannual Financial Framework (MFF 2028-2034)
  - exploring possible contributions of private donors (→ in Dec 2024, Council approved "*Policy for fundraising from private donors for scientific activities at CERN*")

Several funding models developed, based on different assumptions (e.g. constant or slightly increased CERN Budget)
→ final report will be submitted to Council and its subordinate bodies in August

The next milestones

Jun-Jul 2025: review of Feasibility Study Report by Cost Review Panel and FCC Scientific Advisory Committee

8-9 Sep 2025: review of Feasibility Study Report and funding model report by Scientific Policy Committee and Finance Committee

6-7 Nov 2025: review of both reports by Council

Other relevant milestones for all projects:

23-27 Jun 2025: ESPP Open Symposium

1-5 Dec 2025: ESPP drafting session

Jan 2026: ESPP draft document submitted to Council

29 May 2026: ESPP decision making by the Council

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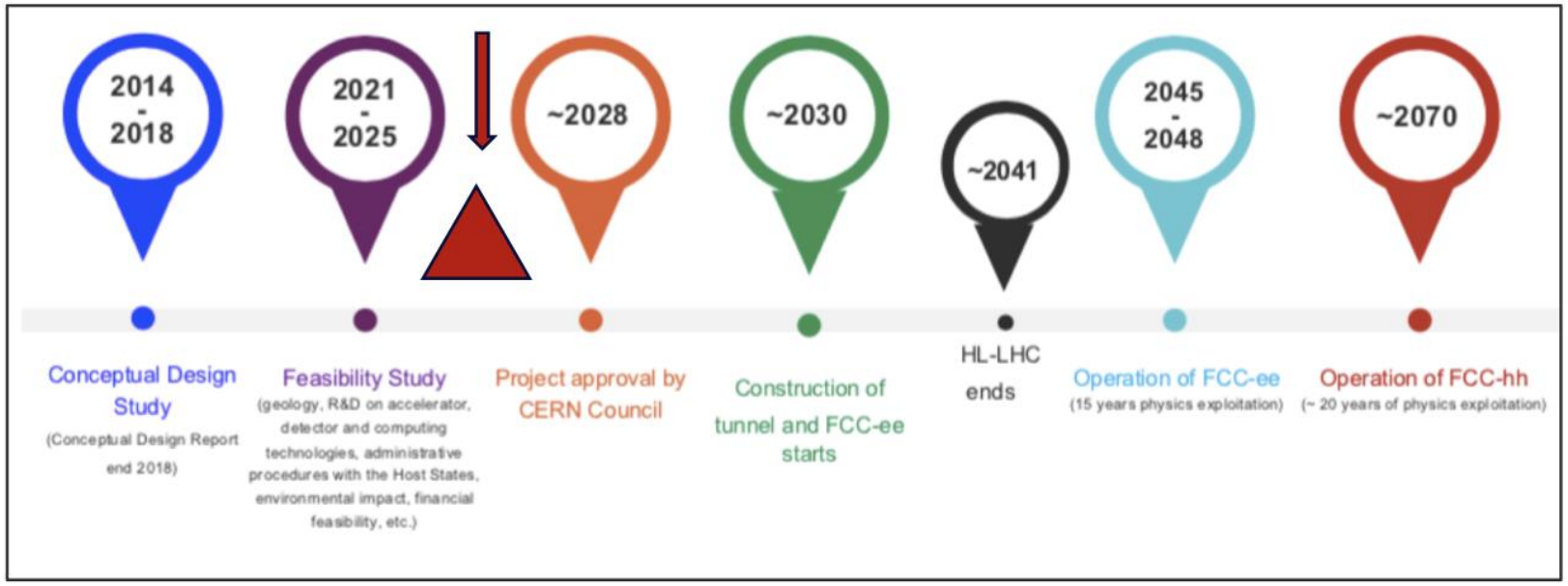
Preparing for the Next Phase: from Feasibility to Decision



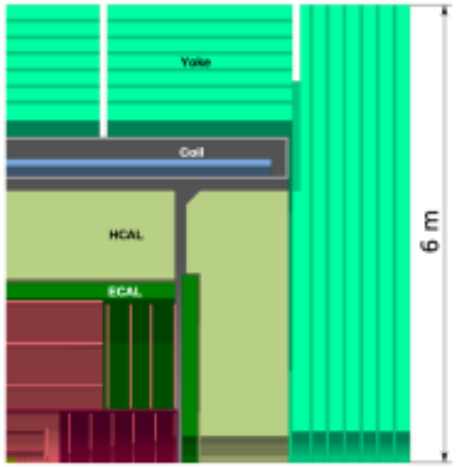
The next phase of the study ("pre-TDR") will position the project for a decision by CERN Council around 2028.

- **Timeline**: **April 2025 – December 2027**
- **Preliminary budget envelope**: **~150 MCHF** (allocation for 2026–2027 subject to Council decision in November 2025)
- **Main objective**: **further development of main components**; deliver a consolidated **cost estimate with significantly reduced uncertainty** (aim: Class 2, +5–20% for main components)

- **Key deliverables**:
  -- detailed R&D and engineering design for technical systems and civil infrastructure
  -- full integration study to support cost estimation and implementation planning

FCC-ee Detector Concepts

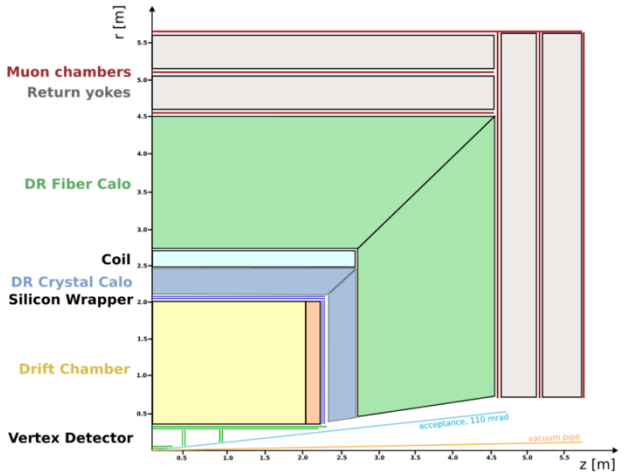
CLD



- Well established design
  - ILC -> CLIC detector -> CLD
- Full Si VTX + 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

IDEA



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

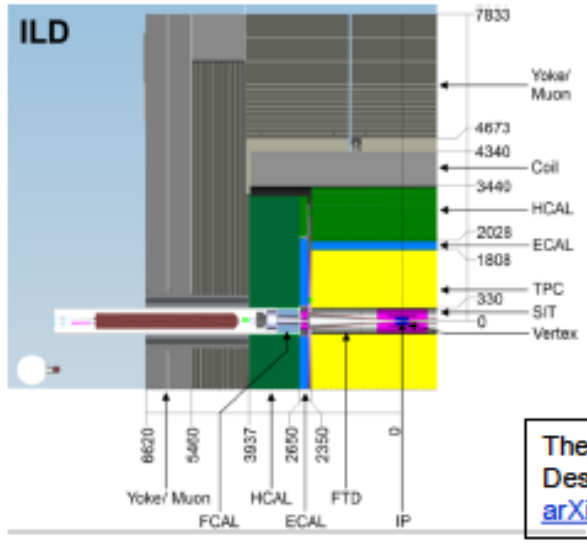
https://doi.org/10.48550/arXiv.2502.21223

Allegro

- Still in early design phase
- Design centred around High granularity **Noble Liquid ECAL**
  - Pb+LAr (or denser W+LKr)
- Si VTX detector
- 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

ILD



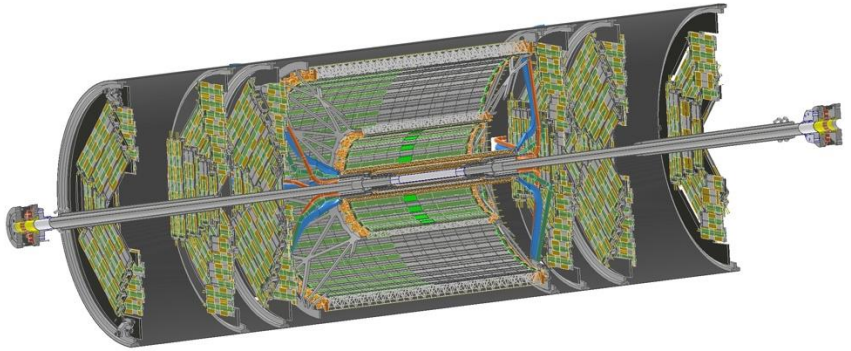
- Designed originally for operation at the ILC
- Together with SiD, ancestor of CLD.
- Main difference and signature element:
  - Large-volume time projection chamber (TPC)

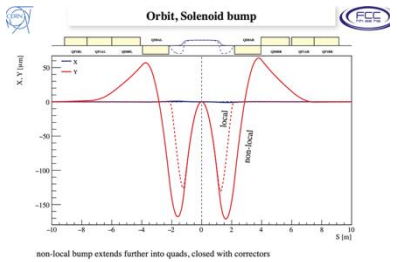
The International Linear Collider Technical Design Report - Volume 4: Detectors
arXiv:1306.6329

Attività in corso nell'INFN WP Acceleratori

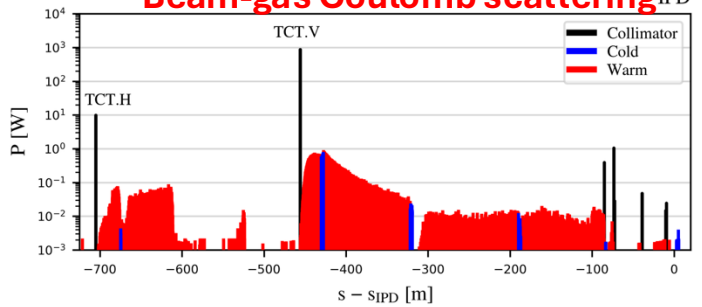
FCC-ee

- **MACHINE DETECTOR INTERFACE & REGIONE INTERAZIONE** (Frascati, Pisa)
  - Progettazione meccanica regione interazione
  - Simulazione fondi macchina (Beam-gas, iniezione, halo beam, Touschek, beam-beam)
  - Collimazione
  - Ottica regione di interazione per compensazione solenoide



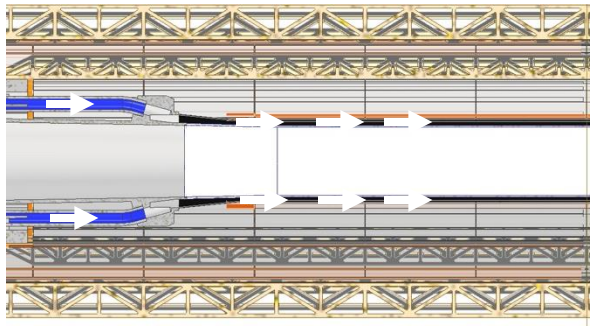


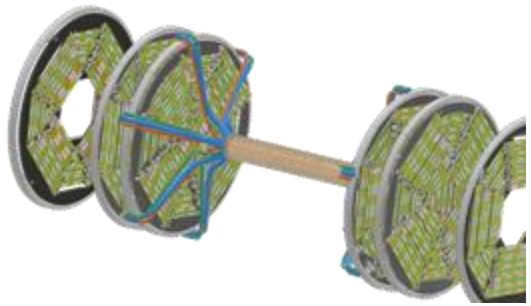
Beam-gas Coulomb scatteringIPD



Estimated lifetime*: 41 min
> 10 h in a fully conditioned machine

- **FCC-ee IR MOCKUP** (Frascati, Pisa) – Progetto speciale
  - Misure raffreddamento camera centrale in corso
  - Integrazione con rivelatore e servizi
  - Tunnel del vento a Pisa



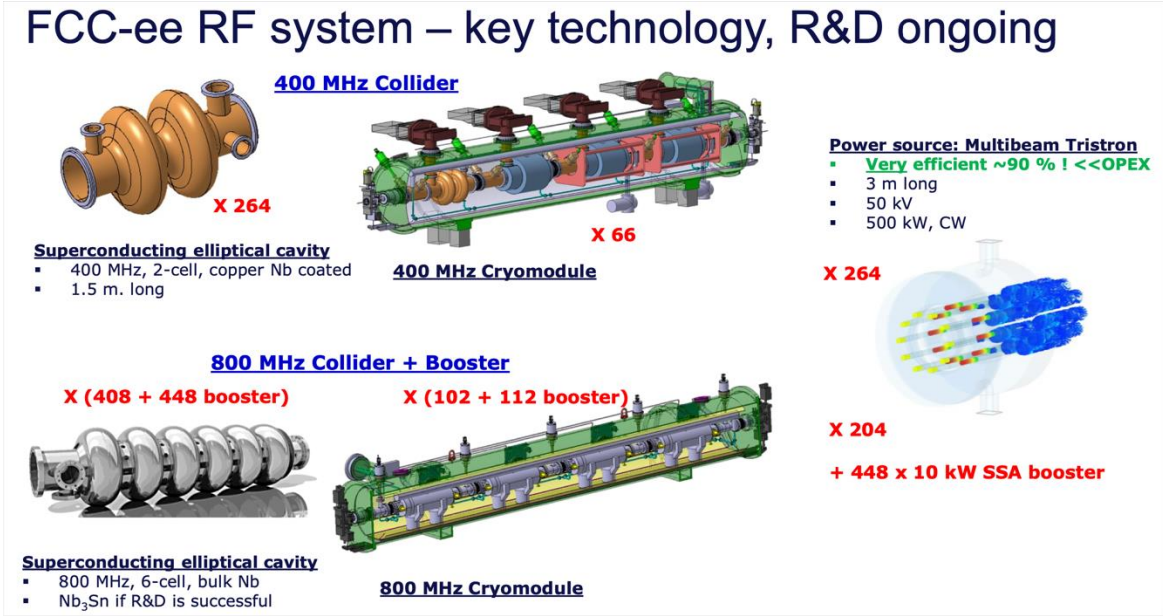


Documento riassuntivo per FS: DOI: 10.17181/w4kws-rne05: link

Attività in corso nell'INFN WP Acceleratori

FCC-ee

- Cavita' RF (Legnaro) – Progetto speciale



Michael Benedikt

- EFFETTI COLLETTIVI (Roma1, Frascati)
- Magneti HTS per archi di FCC-ee (Milano)
- Solenoide IDEA in HTS (Milano)
- Sorgente positroni: targhetta a cristalli e dinamica di fascio (Ferrara, Milano)

Attività in corso nell'INFN WP Acceleratori

FCC-hh

- Dipoli ad alto campo (Genova, Milano)
- Dinamica nonlineare (Bologna)

Partecipazione a Fondi Esterni e Progetti EU

- IFAST – LNL
- FCCIS – MDI ed effetti collettivi (LNF) *terminato nel dicembre 2024*
- Partecipazione al DRD8 per FCC-ee MDI
- PRIN – Ferrara sui cristalli

Anagrafica (da confermare)

	FTE	progetto esterno sinergico	Totale per calcolo metabolismo
LNF			
Manuela Boscolo			
Giacomo Broggi			
Sergio Cantarella			
Andrea Ciarma			
Enrico Di Pasquale			
Francesco Fransesini			
Giulia Nigrelli			
Ruggero Ricci			
Mikhail Zobov			
INFN-ROMA1			
Mauro Migliorati			
INFN-Milano			
Alberto Bacci			
Lorenzo Balconi			
Enrico Beneduce			
Simone Busatto			
Ilya Drebot			
Marcello Rossetti Conti			
Francesco Mariani			
Lucio Rossi			
Massimo Sorbi			
Samuele Mariotto			
Stefano Sorti			
Marco Statera			
LNL			
Cristian Pira			
Giorgio Keppel			
Fabrizio Stivanello			
Gaia Guindani			
Giacomo Mastrotto			
Alessandro Salmaso			
Dorothea Fonnesu			
INFN-Genova			
Stefania Farinon			
Riccardo Musenich			
INFN-Pisa			
Gherardo Ammirabile			
Fabrizio Palla			
INFN-Perugia			
Giorgio Baldinelli			
Cristiano Turrioni			
INFN-Ferrara			
Laura Bandiera			
Nicola Canale			
Gianfranco Paternò			
Alexei Sytov			