

TECHNICAL INFRASTRUCTURE SUMMARY

K Hanke, FCC Week 2025, 23/05/2025

Day	Monday	Tuesday					Wednesday					Thursday					Friday	Day				
Time	Plenary	Parallel 1	Parallel 2	Parallel 3	Parallel 4	Board Room	Plenary	Parallel 1	Parallel 2	Parallel 3	Parallel 4	Board Room	Plenary	Parallel 1	Parallel 2	Parallel 3	Parallel 4	Board Room	Plenary	Time		
Room	Zeremoniensaal (472 p.)	Geheime Ratstube (146 p.)	Rittersaal (158 p.)	Trabantenstube (96 p.)	Künstlerzimmer (77 p.)	Radetzky Ap.1 (30 p.)	Zeremonienaal (500 p.)	Geheime Ratstube (146 p.)	Rittersaal (158 p.)	Trabantenstube (96 p.)	Künstlerzimmer (77 p.)	Radetzky Ap.1 (30 p.)	Geheime Ratstube (146 p.)	Rittersaal (158 p.)	Trabantenstube (96 p.)	Künstlerzimmer (77 p.)	Radetzky Ap.1 (30 p.)	Zeremoniensaal (472 p.)	Room			
08:00-08:30	Welcome coffee	Welcome coffee					Welcome coffee					Welcome coffee					Welcome coffee					
08:30-09:00	Opening session and key note	Physics Case and Theory calculations	Baseline Optics	Electricity & Energy Management	Environment (i)		Industry & Technology Day: Keynotes	Physics Performance & Detector Req.	FCC-ee Injector Overview	Magnets and power conversion	SRF - Directions for R&D		MDI	SRF - Technology (II)	Integration and Radiation	Synergies and Innovation (I)		Summaries	08:30-09:00			
09:00-09:30																			Summaries	09:00-09:30		
09:30-10:00																				Summaries	09:30-10:00	
10:00-10:30	Coffee break	Coffee Break					Coffee Break					Coffee break					Coffee break	10:00-10:30				
10:30-11:00	Lunch break	Physics Case and Theory calculations	Alternative Optics	RF Points and Cryogenics	Environment (ii)		Coffee Break	Software and Computing	FCC-ee INJ Linac and Damping Ring	Vacuum	SRF - Technology (I)		MDI	FCC-hh accelerator Optics baseline	Safety	Synergies and Innovation (ii)		Summaries	10:30-11:00			
11:00-11:30							The value of Big Science												Summaries	11:00-11:30		
11:30-12:00																				Summaries	11:30-12:00	
12:00-12:30		Lunch break					Scientific Advisory Committee	Lunch break					Lunch break					Closing remarks	12:00-12:30			
12:30-13:00	Lunch break	Lunch break					FCC-ES Steering Committee	Lunch break					Lunch break					Scientific Advisory Committee meeting		12:30-13:00		
13:00-13:30																						13:00-13:30
13:30-14:00			Detector concepts	Tuning and Operations	Civil Engineering (i)	Environment (iii)			WKO Industry session	Physics Performance & Detector Req.	FCC-ee INJ Booster and transfer lines	Injection & Instrumentation	SRF - Technology (II)		EPOL	FCC-hh High Field Magnets (I)	Cooling & Ventilation, Geodesy		Accelerator Technical Design: BID			13:30-14:00
14:00-14:30																				14:00-14:30		
14:30-15:00		Coffee Break					Coffee Break					Coffee break						14:30-15:00				
15:00-15:30	Coffee break	Detector concepts: Calorimetry and PID	Collective Effects	Civil Engineering (ii)			Large-scale infrastructure projects in Austria						EPOL	FCC-hh High Field Magnets (I)	Transport and Logistics	Accelerator Technical Design: MPS			15:00-15:30			
15:30-16:00																				15:30-16:00		
16:00-16:30																				16:00-16:30		
16:30-17:00	Physics, Experiments and Detector												Poster session	Detector concepts						16:30-17:00		
17:00-17:30			Early Career Researchers	International Collaboration Board																17:00-17:30		
17:30-18:00																				17:30-18:00		
18:00-18:30																				18:00-18:30		
18:30-19:00																						
19:00-19:30	Welcome reception	Public event: The Higgs Boson and Our Lives National Library					Social event: Concert Musikverein Vienna															
19:30-20:00																						
20:00-20:30																						
20:30-21:00																						
21:00-22:00																						

6 sessions
24 presentations



Safety

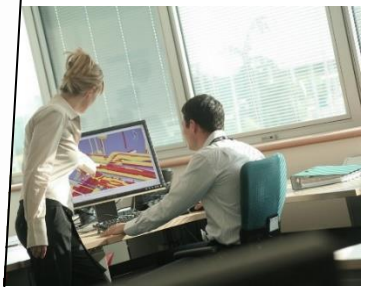
		
Wear Safety Glasses	Flammable	Hazardous
		
Toxic	Corrosive	Oxidising
		
Explosive	Gloves	Safety Glasses

**Future Circular Collider
Feasibility Study Report**

**Volume 2
Accelerators, Technical Infrastructure
and Safety**

March 31, 2025

Submitted to the European Physics Journal ST, a joint publication of EDP Sciences,
Springer Science+Business Media, and the Società Italiana di Fisica.



Electricity and Energy Management

Chair: Nicolas Bellegarde

Mario Parodi, *New technologies for electrical transmission and distribution*

Santiago Hernán Suarez, *Integrating renewable energy and hydrogen storage into the FCC*

Charline Marcel, *Electrical grid and infrastructure update*

Hannah Dostmann, *Technical infrastructure availability: Challenges and opportunities from LHC to FCC-ee*

M. Parodi, M. Colmenero:

The problem of power quality

Data from PMUs (phasor measurement units), detected e.g. instabilities before black-out

Unified Power Flow Controllers for FCC

S. Hernan Suarez:

Renewable energy (solar, wind); hydrogen storage

Electricity and Energy Management

C. Marcel:

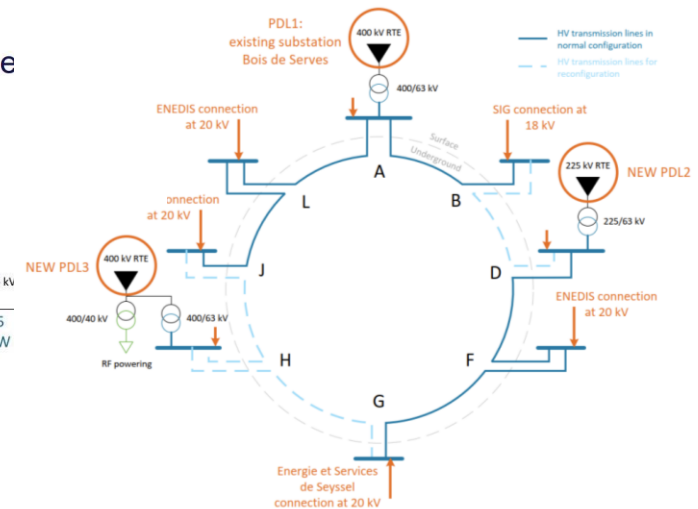
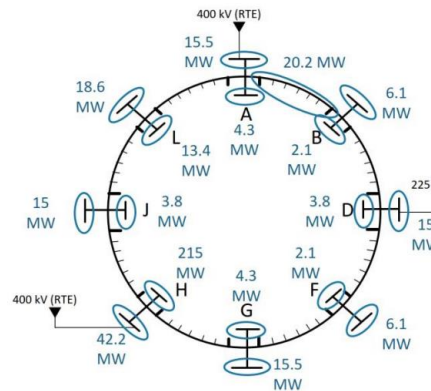
Concept of the electrical grid for FCC-ee

Energy consumption of the FCC-ee machine

Power demand by systems in MW:

	Z	W	H	t̄
Beam energy, GeV	45.6	80	120	182.5
Collider radiofrequency	146	146	146	146
Booster radiofrequency	2	2	2	2
Collider cryogenics	1.2	11.5	11.5	27.6
Booster cryogenics	0.35	0.8	1.5	7.4
Cooling and ventilation	25	26	28	33
Collider magnets	6	17	39	89
Booster magnets	1	3	5	11
4 experiments, PA, PD, PG, PJ	10	10	10	10
4 datacenters, PA, PD, PG, PJ	4	4	4	4
General services	26	26	26	26
Total power during beam operation	222	247	273	357

Load mapping of the machine

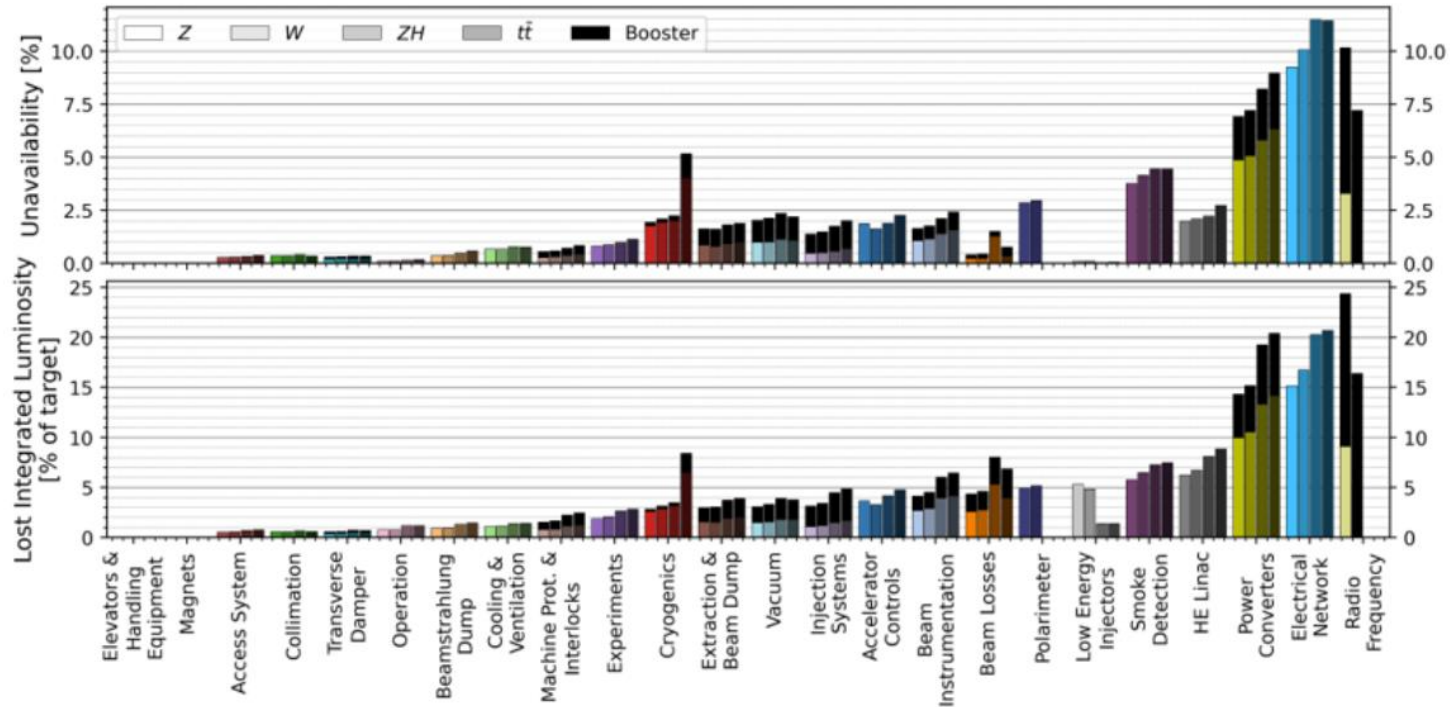


Electrical infrastructure layout
Secured network concept

Electricity and Energy Management

H. Dostmann, availability

- electrical system, cryogenics, cooling & ventilation;
- data based on experience, along with mitigation measures



RF Points and Cryogenics

Chair: Frank Gerigk

Fani Valchkova, Mark Timmins, *Integration of RF points for FCC-ee*

Davide Aguglia, *Powering of RF for FCC-ee*

Anita Petrovic, *FCC-ee cryogenics status update from FSR*

Laurent Delprat, *FCC-hh cryogenics update for 1.9 K and 4.5 K options*

F. Valchkova, M. Timmins: updated integration of PH, PL, based on new cryostat design

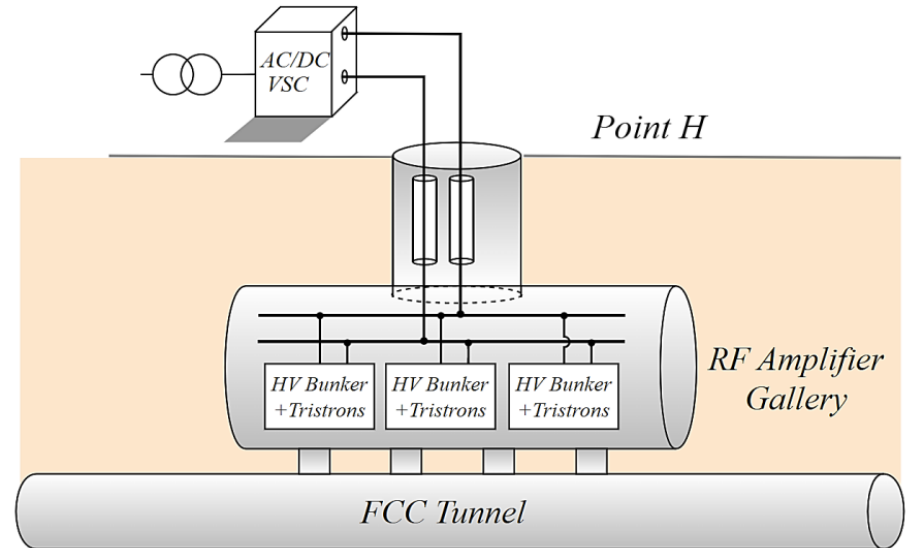
RF Points and Cryogenics

D. Aguglia, powering of the RF

- new baseline Tristron
- Modular Multilevel Converter MMC
- existing facilities feature high availability and efficiency
- available technology, centralized powering scheme seems to be the best

Powering concept baseline:

1. Centralized powering
2. Use of switching power converter

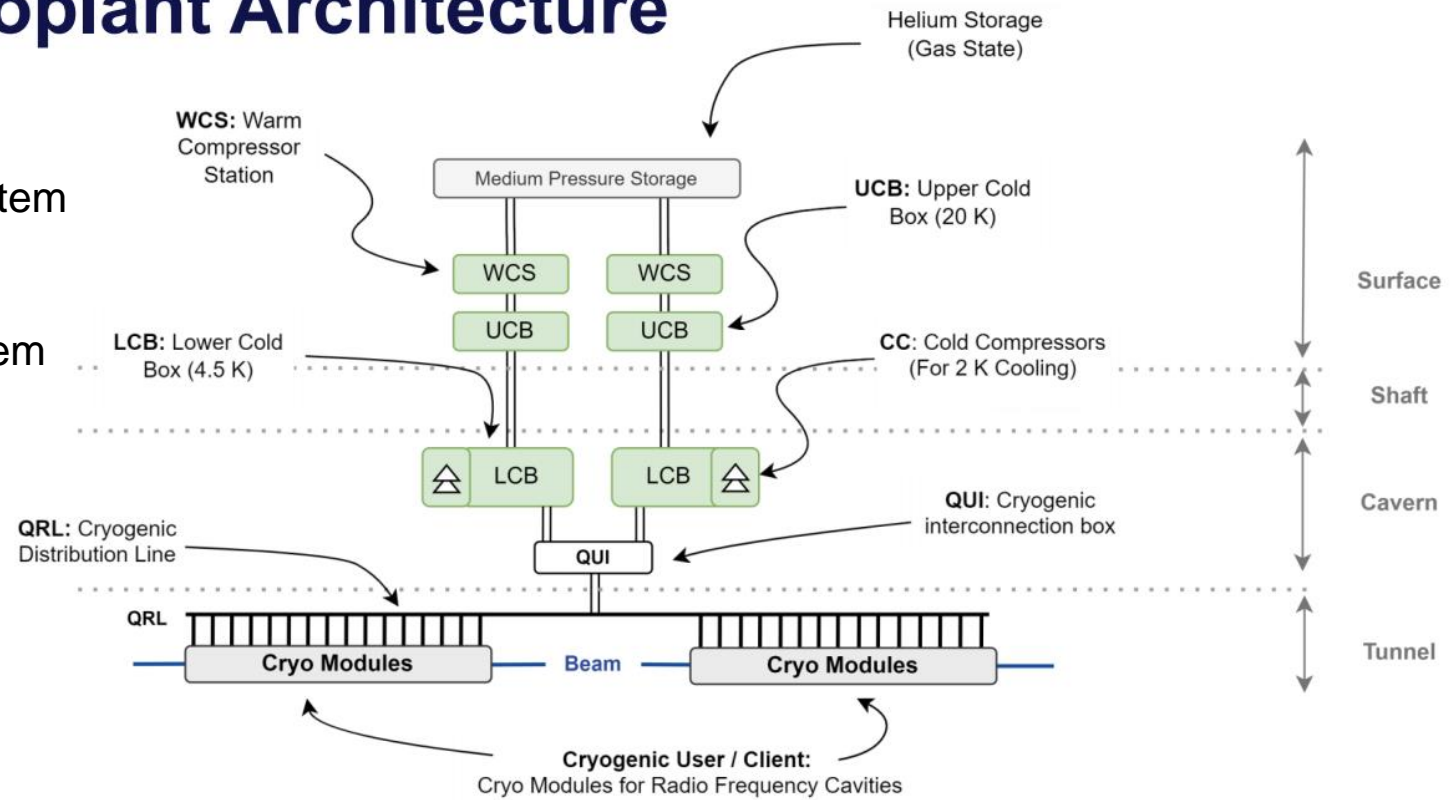


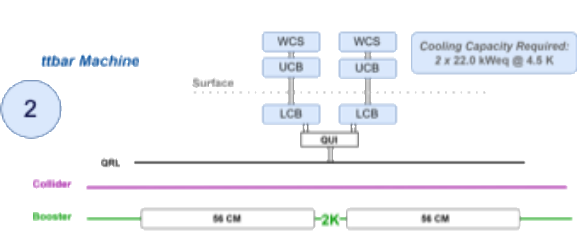
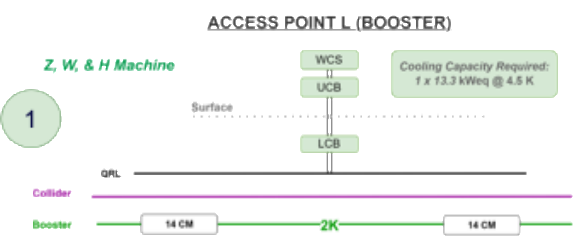
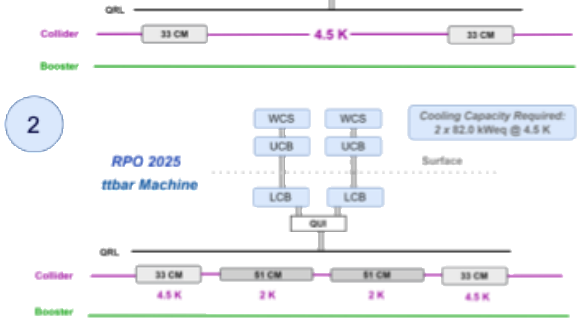
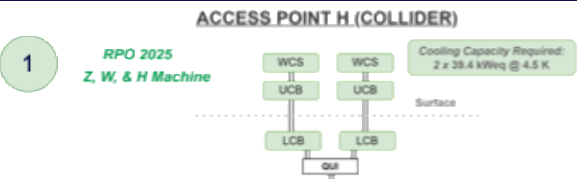
RF Points and Cryogenics

Cryoplant Architecture

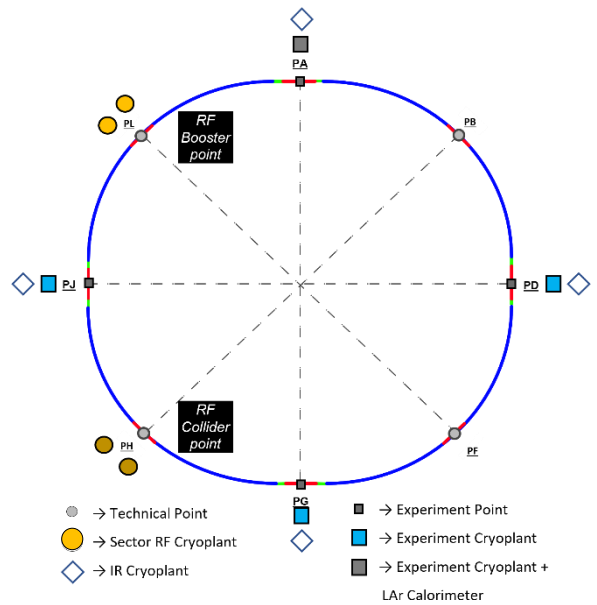
A. Petrovic, cryo system for FCC-ee

L. Delprat, cryo system for FCC-hh baseline 1.9 K

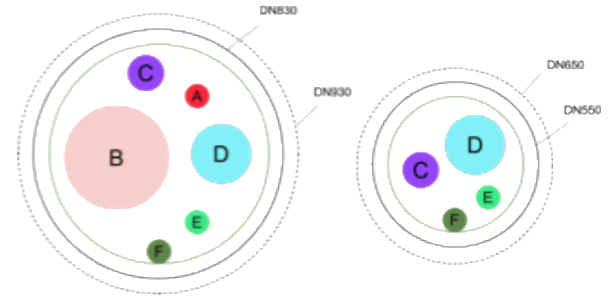




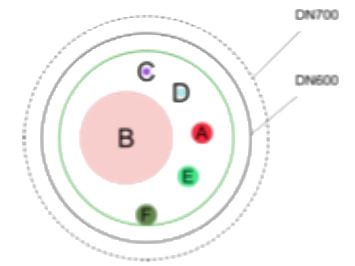
FCC-ee @ ttbar



FCC-ee collider cryogenic system layout for $t\bar{t}$ operation



PH (Collider)



PL (Booster)

YEARLY ELECTRICAL ENERGY CONSUM. FOR CRYO (PH + PL)	Z, W, & H	ttbar
Full Power [MW]	20.25	45.77
Eco Mode [MW]	7.64	12.87
Electrical Energy / year with ECO MODE [GWh]	138.05	298.31
Electrical Energy / year FULL MODE [GWh]	177.41	400.96

Total He Mass: PH + PL	Z, W, & H	ttbar
CM He Mass Total [t]	9.20	19.43
Distribution He Mass [t]	5.01	6.04
Cryoplant He Mass [t]	3.20	7.22
Total He Mass [t]	17.40	32.69
# Medium Pressure Storage Tanks	26	47

Integration and Radiation

Chair: Sonia Bartolome

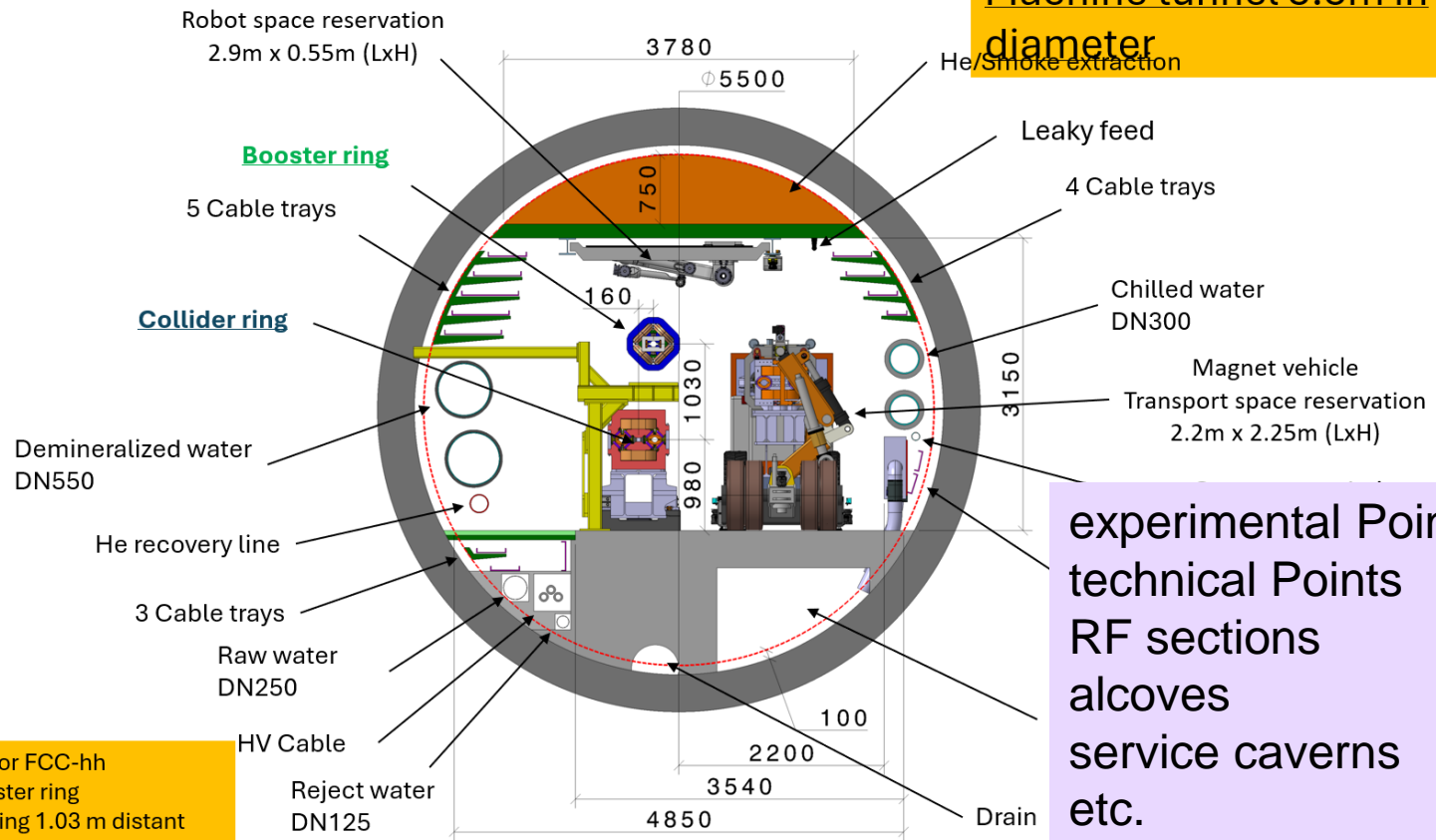
Fani Valchkova, *Integration update*

Federico Carra, Audrey Piccini, *Arc half-cell mock-up status*

Barbara Humann, *Radiation environment in the FCC-ee arcs*

Integration of FCC-ee machine elements (regular arc)

Machine tunnel 5.5m in diameter

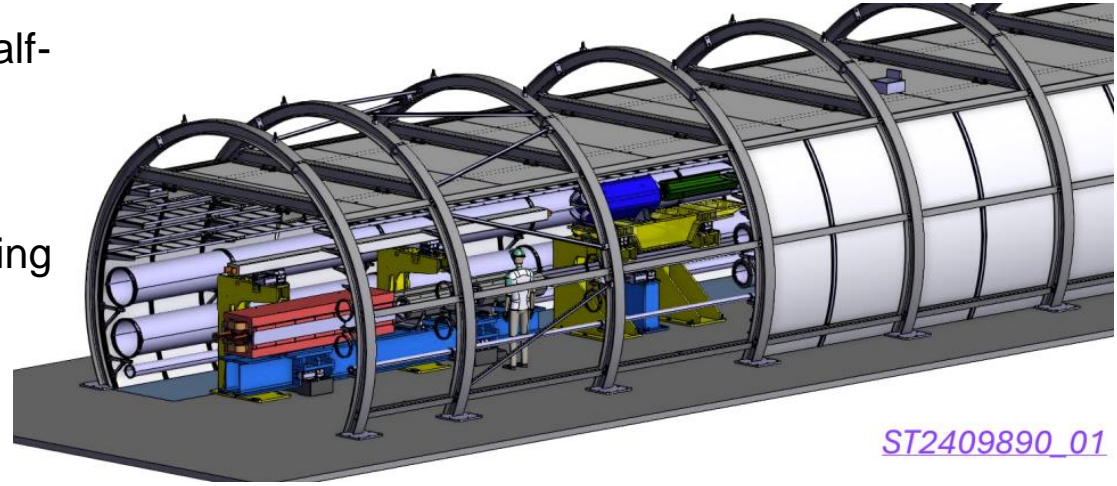


Main cross section as for FCC-hh
Main ring below of booster ring
Main ring and booster ring 1.03 m distant

experimental Points
technical Points
RF sections
alcoves
service caverns
etc.

F. Carra, A. Piccini, status of arc half-cell mock-up

- arc represents 85% of the machine
- installation at CERN in an existing building
- preparatory works ongoing



[ST2409890_01](#)





Courtesy Y. Grislain

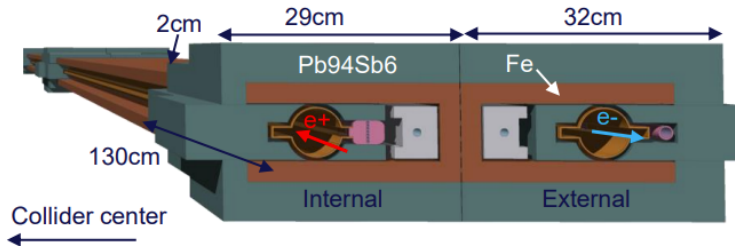
B. Humann

radiation environment in the FCC-ee arcs


- challenges: dissipated power, ionizing dose, radiation to electronics

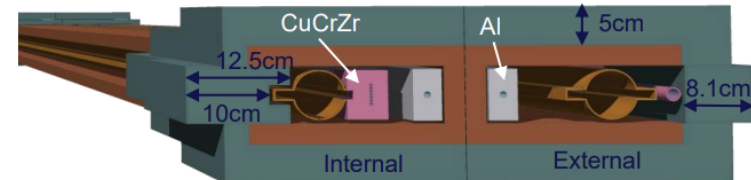
Feasibility Study Report (FSR):

- Shielding enclosing the VC with 5mm gap for bakeout but in contact with photon stopper ($\Delta y = 3\text{cm}$)
-  Complex shape around VC
-  Efficient shielding due to close location of shielding
- Weight:** ~400kg/shielding
(Total weight: ~10kt for the full machine)



Current conceptual design:

- Enlargement of photon stoppers ($\Delta y = 6.3\text{cm}$)
-  Removal of shielding next to busbars
- Updated busbar dimensions
- Volume of plates on top and bottom as well as lateral extension identical
- Weight:** ~340kg/shielding



Safety

Chair: Benoit Delille

Andre Henriques, *Review of the safety concept - pre-TDR roadmap*

Giacomo Lavezzari, *Radiation protection studies for the FCC*

Oriol Rios, *Reviewed fire safety concept and future studies*

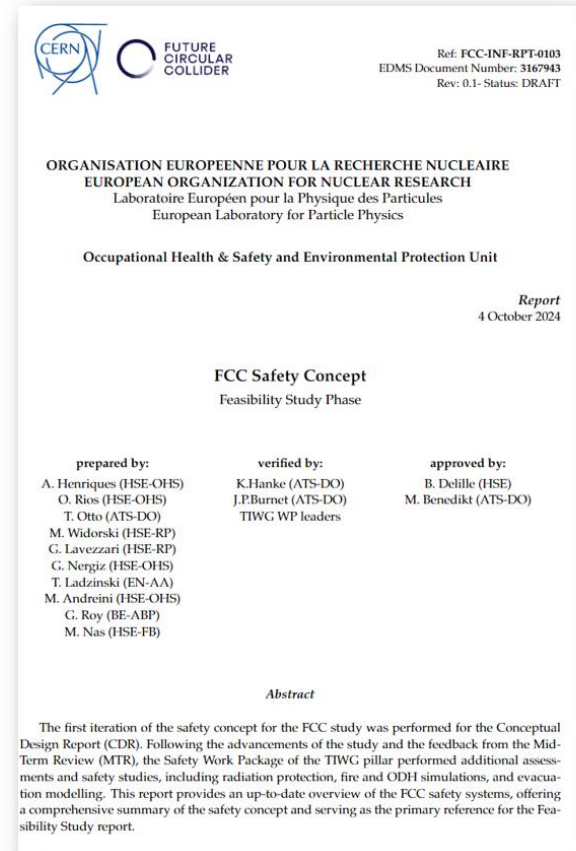
Guven Nergiz, *ODH simulations: benchmark and access conditions to RF sector*

Marc Nas & Hannes Gamper, *FRS intervention: use of robotics*

Safety concept

Review

- By experts experienced in large research / industrial infrastructures
- From 'notified body', experienced in pre-construction authorization processes
- External (expert) review of our studies and assumptions
- Outcome:
 - Generic statement on the validity of the concept (showstoppers Y/N)
 - List of TODOs – basis for the pre-TDR work description



Cooling and Ventilation, Geodesy

Chair: Ingo Ruehl

Inigo Martin Melero, *Cooling update*

Inigo Martin Melero, *Ventilation update*

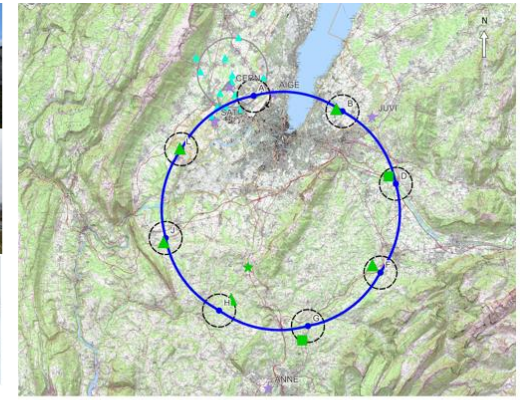
Armin Hafner (NTNU), *Heat recovery perspectives with CO₂*

Benjamin Weyer, *Geodesy update*

Geodesy

Implementation of the primary surface geodetic network

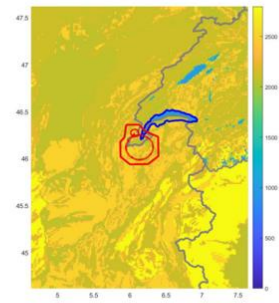
- IGN and Swisstopo are densifying their national geodetic network. 7 out of 9 geodetic pillars built



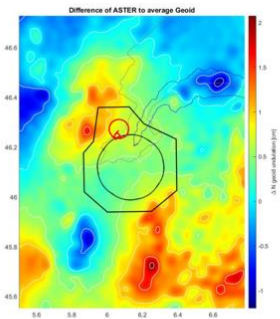
Progress made in collaboration with ETHZ and HEIG-Vd

- Delivery of report: Database of methodologies, instruments and auxiliary data for gravity field determination
- Computation of a local geoid model using Groops toolkit. Investigation on the effect of digital terrain model and topographic density variations
- Development of a gravity field closed-loop

Lateral density maps UNB



Primary Geodetic network
 ▲ Construction done
 ■ Approved new location
 ★ New Permanent GNSS station
 ▲ Existing CERN Geodetic Pillar
 ★ Existing permanent GNSS station



Swiss Accelerator
Research and
Technology

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Landestopografie swisstopo
Office fédéral de topographie swisstopo
Ufficio federale di topografia sviztopo
Uffiz federal da topografia sviztopo



INSTITUT NATIONAL
DE L'INFORMATION
GÉOGRAPHIQUE
ET FORÊSTIÈRE



Transport and Logistics

Chair: Benedikt Müller / FIML

Damien Lafarge, *Transport concept (personal and material)*

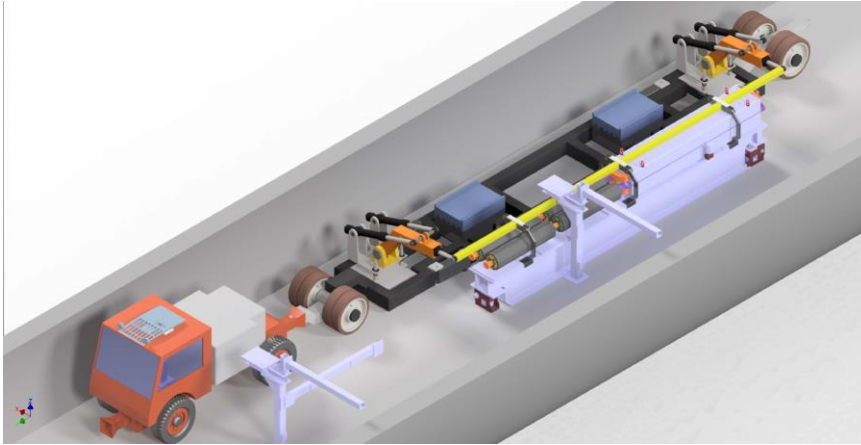
Hannes Gamper, *Robotics update*

Milosz Zielinski, *Magnet production*

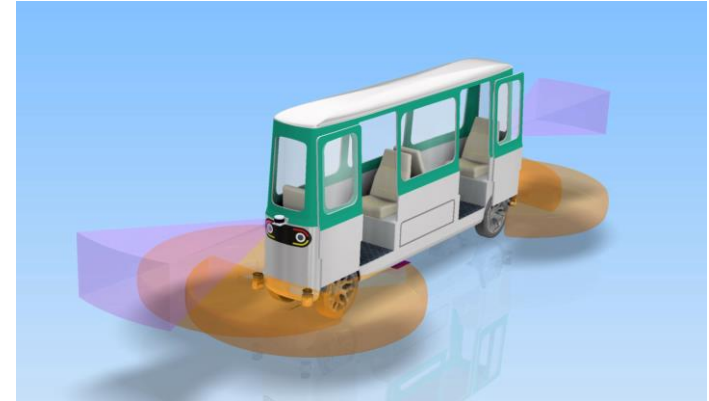
Sarah Fleury, *Installation schedule*



Transport and Logistics



Transport and installation of a quadrupole with two sextupoles and the supporting girder (QSS unit)



- max speed 30 km/h
- autonomous driving
- driveway width is 2.2 m

H. Gamper, robotics update



Maintenance



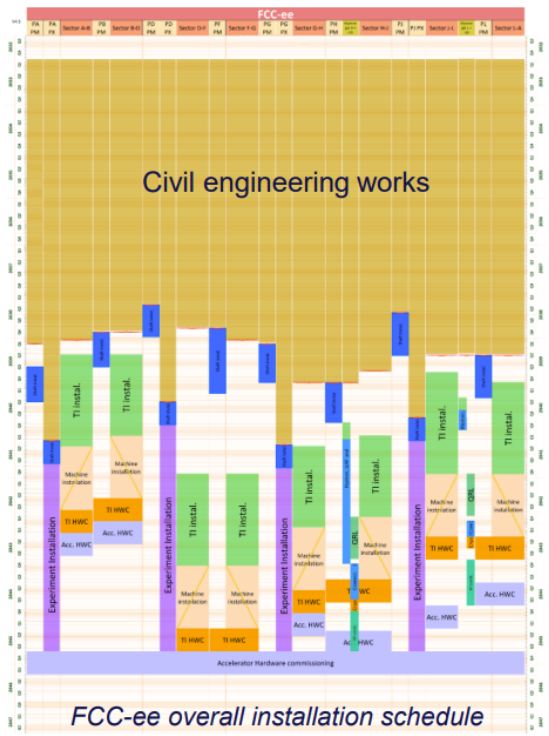
Search and Rescue



Machine Automation and Control

S. Fleury, updated installation schedule

Overall installation schedule FCC-ee



- Civil engineering excavation is scheduled to begin in January 2033. The first technical shaft will be released in 2038, with the last area expected in 2041.
- These initial technical shaft releases will be the starting point for technical infrastructure installation.
- The installation of radio frequency systems at Point H and Point L is not on the project's critical path and will therefore not impact the overall schedule.
- Total duration for installation including hardware commissioning: **2038-2046, 8 years.**
- Readiness for operation in **April 2046.**



**Big thanks to the chairpersons and speakers
of the infrastructure sessions**

