TECHNICAL INFRASTRUCTURE SUMMARY

K Hanke, FCC Week 2024, 14/06/2024

Day	Sunday	Monday		Tuesday					Wednesday					Thursday						Friday	Day
Time SFO	Front desk	Plenary	Board Room	Parallel 1	Parallel 2	Parallel 3	Parallel 4	Board Room	Plenary	Parallel 1	Parallel 2	Parallel 3	Board Room	Plenary	Parallel 1	Parallel 2	Parallel 3	Parallel 4	Board Room	Plenary	Time SFO
Room	Georgian	Colonial	Yorkshire	Elizabethan A	Elizabethan B	Elizabethan C	Elizabethan D	Yorkshire	Colonial	Elizabethan A	Elizabethan B	Elizabethan C	Yorkshire	Colonial	Elizabethan A	Elizabethan B	Elizabethan C	Elizabethan D	Yorkshire	Colonial	Room
08:00-08:30		Welcome coffee (Italian)		Welcome coffee (California East & West)					Welcome coffee (California East & West)					Welcome coffee (California East & West)						Welcome coffee	
08:30-09:00		1) Welcome remarks 2) CERN plans 3) A view from CERN Council 4+5) NSF and DOE Opening Remarks		Physics Case & Th. Calculations (i)	FCC-ee baseline design & optics, top-up	Safety				Detector Requirements (i)	Collective Effects	Sustainability and impact generation			Detector Requirements (ii)	FCC-ee code development and other themes		RF and Cryo	Governance meeting	Plenary session: summaries	08:30-09:00
09:00-09:30																					09:00-09:30
09:30-10:00																					09:30-10:00
10:00-10:30		Coffee break (Italian)		Coffee Break (California East & West)					Coffee Break (California East & West)					Coffee Break (California East & West)							10:00-10:30
10:30-11:00		1) Key Note 2) FCC FS status 3) FCC Collaboration status		Physics Case & Th. Calculations (ii)	Optics alternatives & lessons	Transport, logistic and Survey	Synergies and innovation			Software	FCC-ee optics correction & tuning	Sustainability and impact generation			Machine Detector Interface (ii)	FCC-hh design	Injection & instrumentation	Utilities		Coffee break	10:30-11:00
11:00-11:30																				Plenary session: summaries	11:00-11:30
11:30-12:00																					11:30-12:00
12:00-12:30				Lunch break (California East & West)				Governance meeting		Lunch break (California East & West)					Lunch break (California East & West)						12:00-12:30
12:30-13:00		Lunch break (California East & West)																			12:30-13:00
13:00-13:30																			Governance meeting		13:00-13:30
13:30-14:00				Detector Concepts (i)	FCC-ee injector incl. booster (i)	Civil Engineering	Directions for R&D			Machine Detector Interface (i)	SRF Technology (ii)	Magnets			EPOL (i)	high-field magnets for FCC-hh 1	Vacuum	AIML mini workshop			13:30-14:00
14:00-14:30		1) Implementation scenario 2) Civil Engineering 3) Accelerator status 4) Technologies & TI						Governance meeting													14:00-14:30
14:30-15:00																					14:30-15:00
15:00-15:30	Registration + as from 07:30am on Monday			Coffee Break (California East & West)					Coffee Break (California East & West)					Coffee Break (California East & West)							15:00-15:30
15:30-16:00		Coffee break (Italian room)		Detector Concepts (ii)	FCC-ee injector incl booster (ii)	Layout optimisation and services	SRF Technology (i)		Plenary: US Session						EPOL (ii)	high-field magnets for FCC-hh 2	Beam Intercepting devices	AIML mini workshop			15:30-16:00
16:00-16:30		1) Super KEKB status and plans 2) The Physics at FCC 3) Detectors requirements and benchmarks 4) Planning for upcoming workshops 5+6) US Plans FCC-PED, FCC-ACC	Governance meeting																		16:00-16:30
16:30-17:00																					16:30-17:00
17:00-17:30										vernance meeting		Early Career Researchers			Detector Requirements (iii)						17:00-17:30
17:30-18:00				Detector Concepts (iii)	FCC-ee injector incl. booster (iii)	Governance meeting															17:30-18:00
18:00-18:30																					18:00-18:30
18:30-19:00																					18:30-19:00
19:00-19:30		Welcome reception (Westin, St. Francis Heights)		Public event (Exploratorium) https://fccweek2024.web.cern.ch/PublicEvent.html													cocktail ian)				19:00-19:30
19:30-20:00																					19:30-20:00
20:00-20:30																					20:00-20:30
20:30-21:00																					20:30-21:00
21:00-21:30																					21:00-21:30
21:30 -22:30																					21:30 -22:30

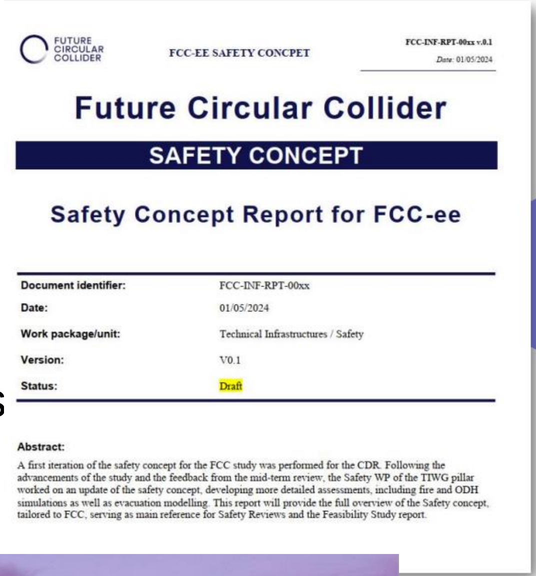
5 sessions
22 presentations

Safety

Safety Concept of the FCC

A Henriques, O Rios

Safety concept
Hazard registry
Safety systems: air management, transport, longitudinal compartments access control
Smoke extraction and life safety


FUTURE CIRCULAR COLLIDER
FCC-EE SAFETY CONCEPT
FCC-INF-RPT-00xx v.0.1
Date: 01/05/2024

Future Circular Collider

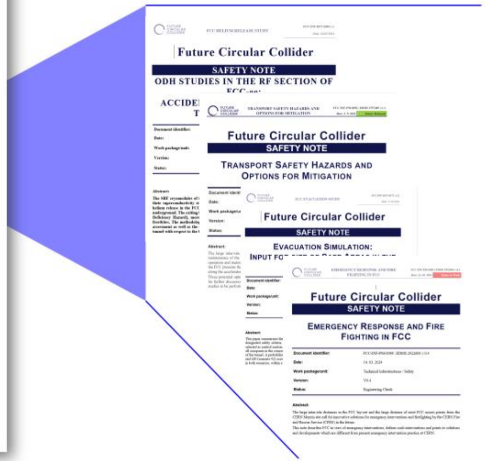
SAFETY CONCEPT

Safety Concept Report for FCC-ee

Document identifier:	FCC-INF-RPT-00xx
Date:	01/05/2024
Work package/unit:	Technical Infrastructures / Safety
Version:	V0.1
Status:	Draft

Abstract:
A first iteration of the safety concept for the FCC study was performed for the CDR. Following the advancements of the study and the feedback from the mid-term review, the Safety WP of the TIWG pillar worked on an update of the safety concept, developing more detailed assessments, including fire and ODH simulations as well as evacuation modelling. This report will provide the full overview of the Safety concept, tailored to FCC, serving as main reference for Safety Reviews and the Feasibility Study report.

Individual detailed reports

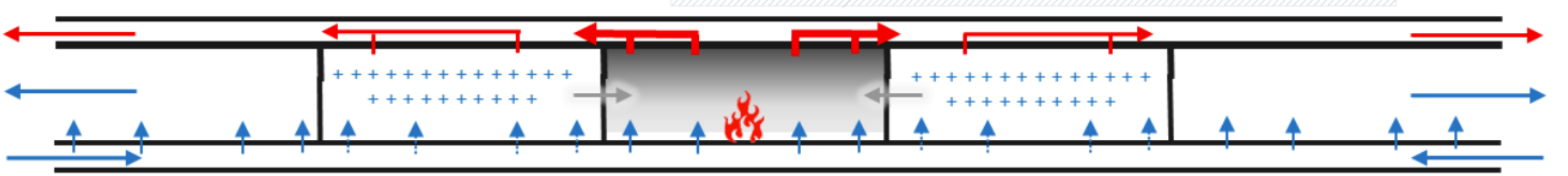


Safety

Personal Safety Systems

T Ladzinksi

Access control
Tracking
Fire detection
Compartments
Smoke extraction
Oxygen deficiency
Evacuation systems
Call points (rad hard!)
No showstoppers but many challenges



Safety

Radiological studies for FCC-ee

G Lavezarri

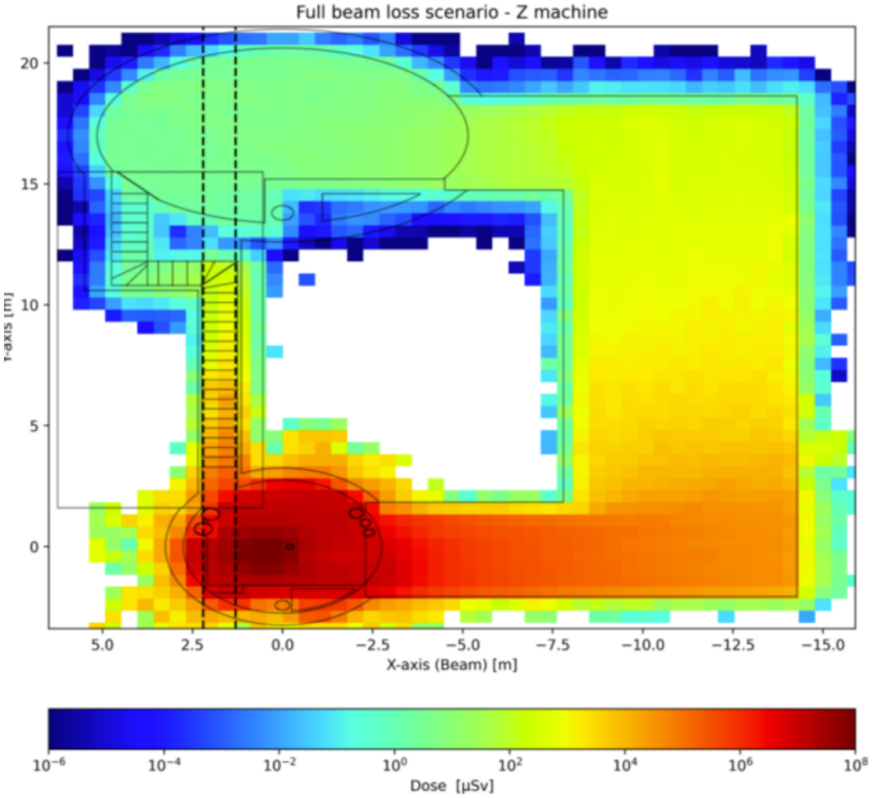
Radiological hazards overview

Prompt radiation levels in accessible areas

Residual dose rate

Activation studies

(air, water, material)

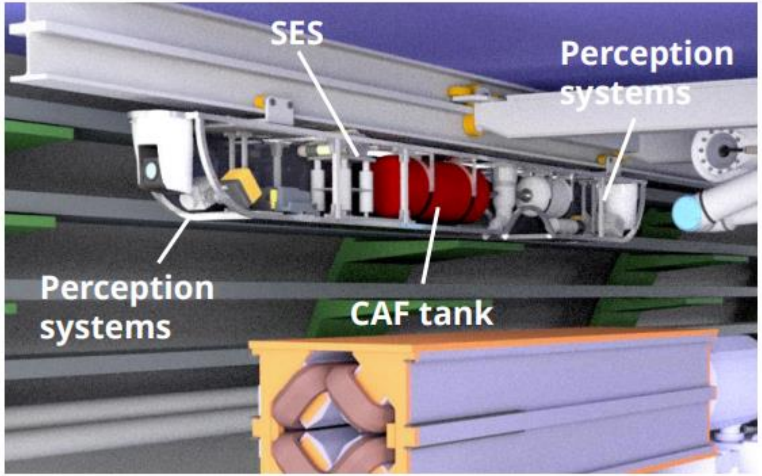


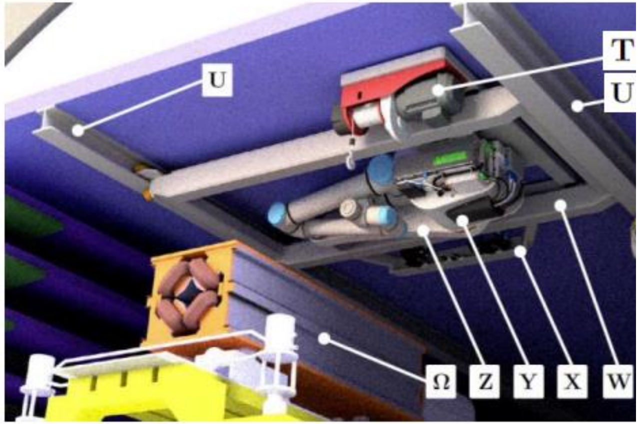
Safety

The FCC Robotic System for Safety and Availability

H Gamper

Review of robotic services at CERN and by category
The FCC robotic system
Maintenance / availability
Robots for Safety





Transport Logistics and Survey

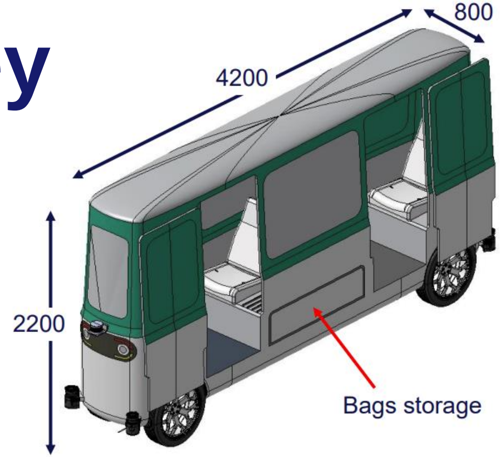
Personnel Transport

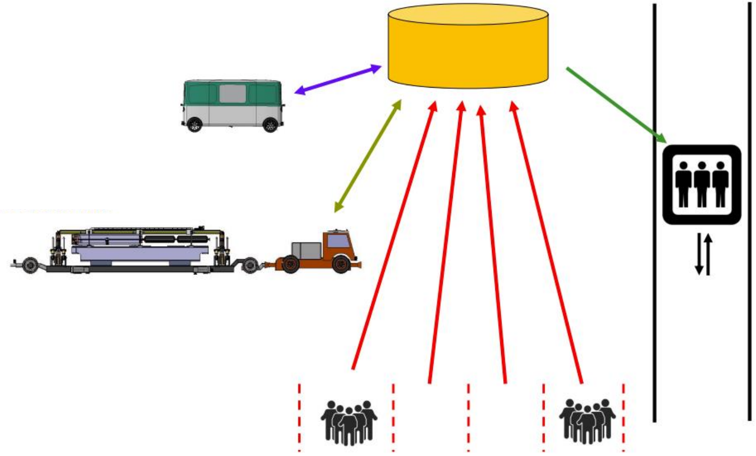
R Rinaldesi

Personnel Lifts

Vehicles for underground transport

Normal mode and evacuation mode





Centralized traffic management

- Symmetrical
- Overall dimensions: 4200 x 800 x 2200 mm (L x W x H)
- 4 seats maximum
- 4 bags (size equivalent to cabin luggage)
- Max speed: 30 km/h
- Battery driven; autonomy of 150-200 km
- Weight (fully loaded): 1500 kg
- Four steering wheels
- Line guidance
- Equipped with LIDAR sensors and laser scanners for autonomous driving

Transport Logistics and Survey

Fraunhofer IML

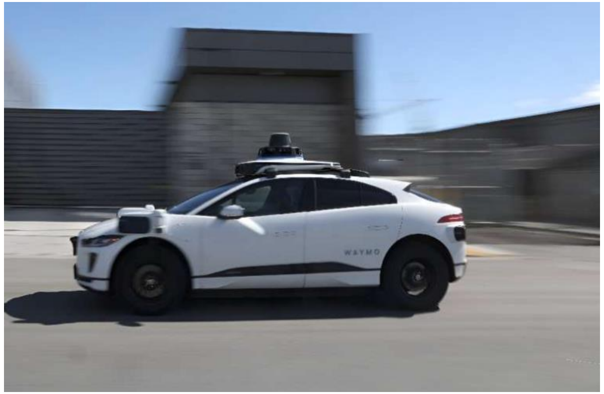
Update on magnet and people transport vehicles and logistics simulation study

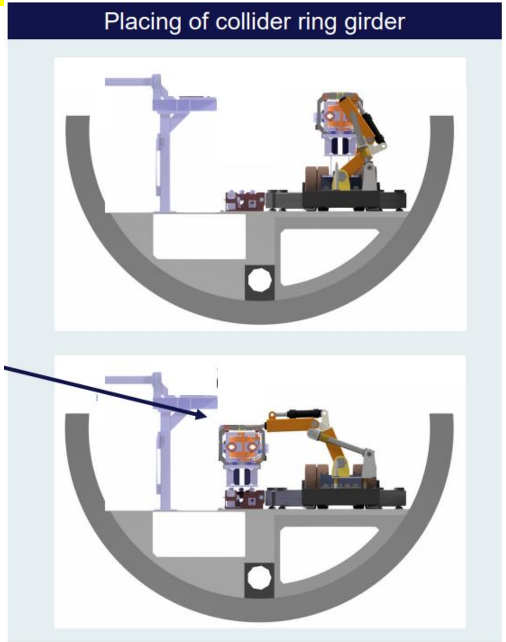
B O Müller

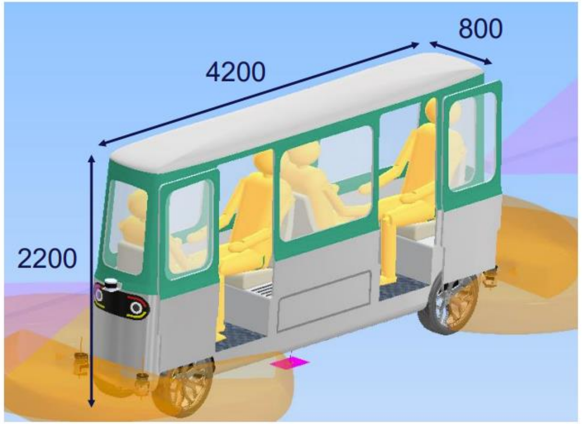
Autonomous personnel transport

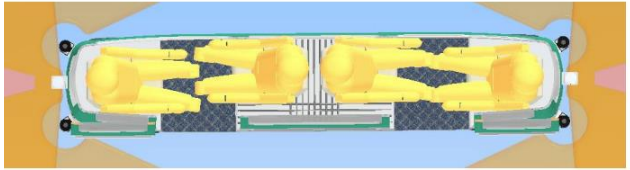
Magnet transport: 4 elliptical exp. shafts

Logistics simulation study









Transport Logistics and Survey

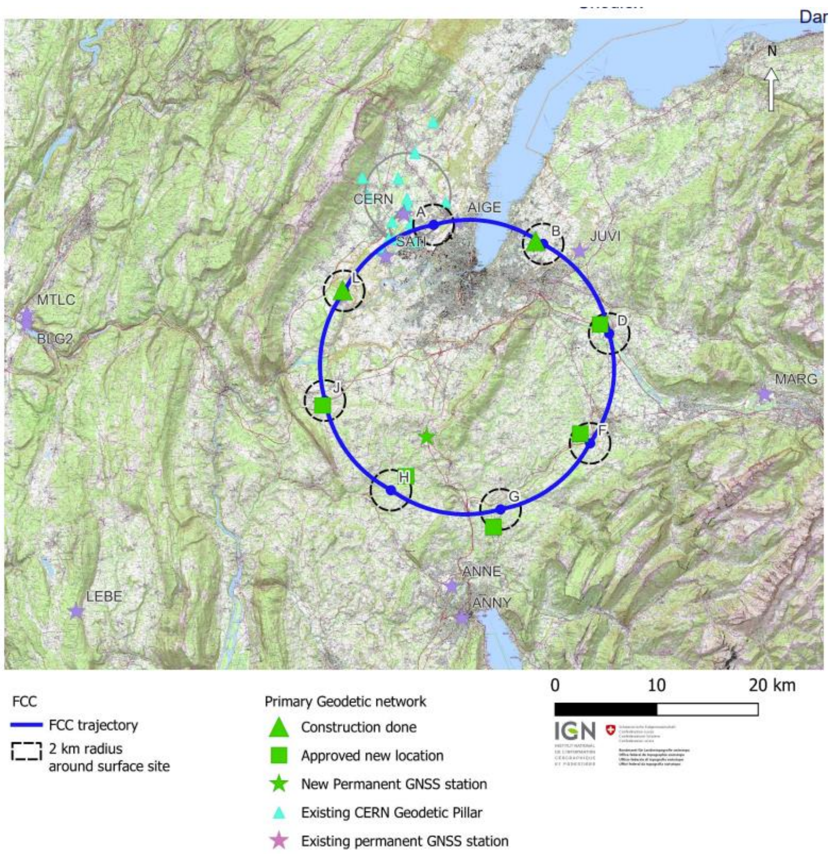
Geodesy Update

B Weyer

Establish the geodetic infrastructure for the Future Circular Collider

Objectives of the geodetic studies

- Define coordinate reference systems
- Establish the necessary geodetic reference frames
- Study the determination of a high-precision gravity field model for the FCC area



Transport Logistics and Survey

Optimised Installation Schedule

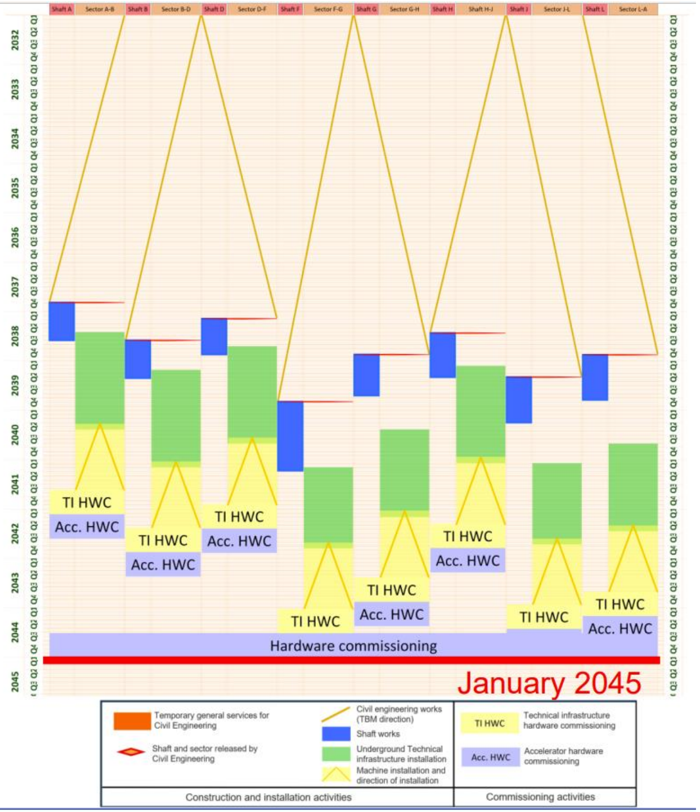
S A Fleury

Overall planning result

Taking into consideration all optimization proposal presented:

- **Overlapping of main block of installation activities**
- **Learning curve and team reinforcement**
- **Civil engineering input simulation**

➢ **Possible readiness for operation in January 2045 [-9.5 months] from the current baseline (with civil engineering start in 2032)**



Transport Logistics and Survey

The Availability Challenge: Opportunities within the FCC-ee

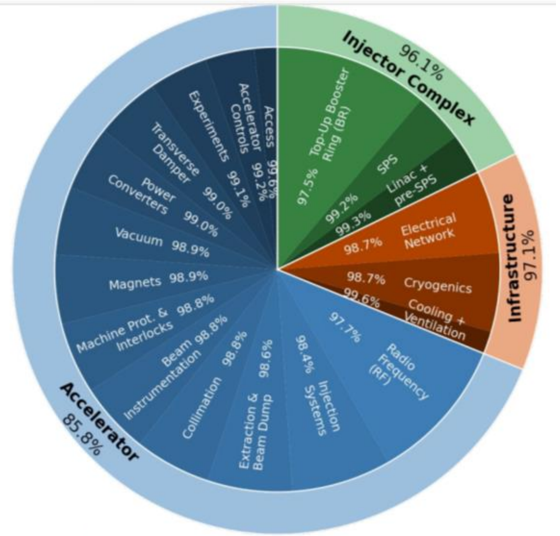
Operation Cycle

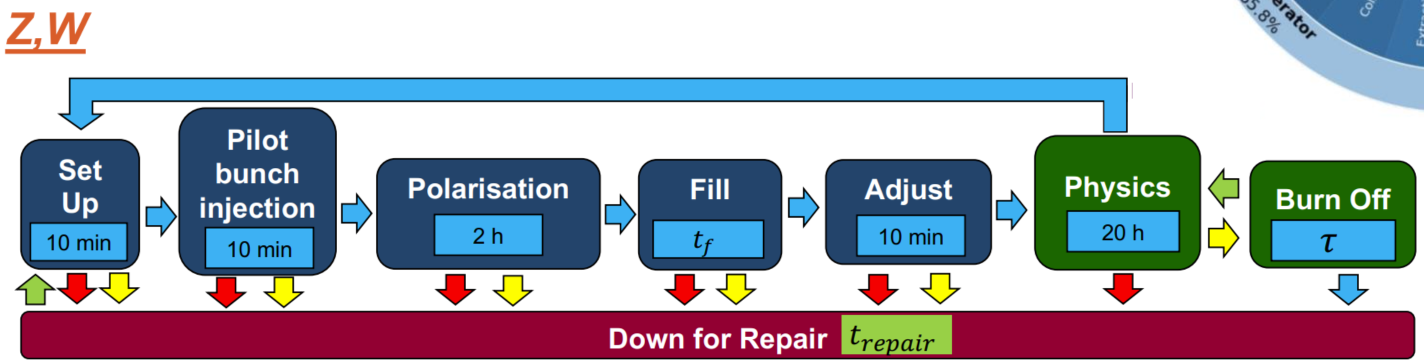
J Heron

Availability targets

Operations model

Detailed simulations available for RF system





Layout optimisation and services

Update of Integration tunnel and arcs, straight sections

F Valchkova

Updated tunnel straight section ***BASELINE***

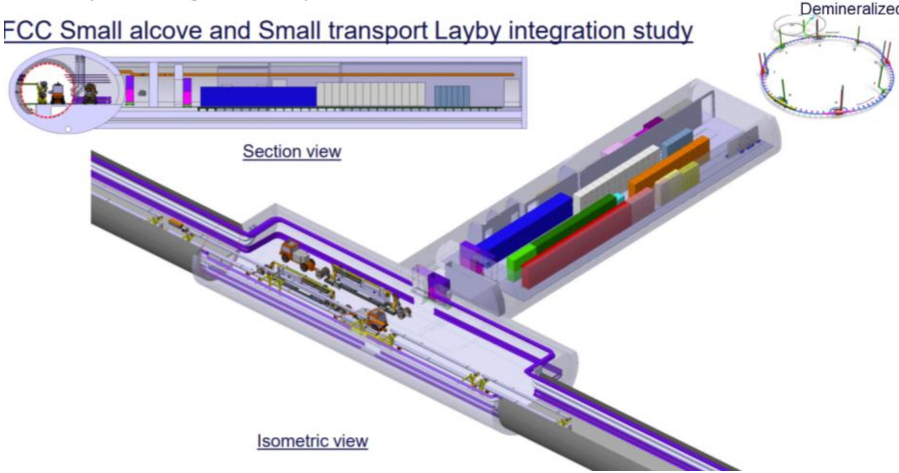
Experimental caverns for ee and hh

Beamstrahlung dump

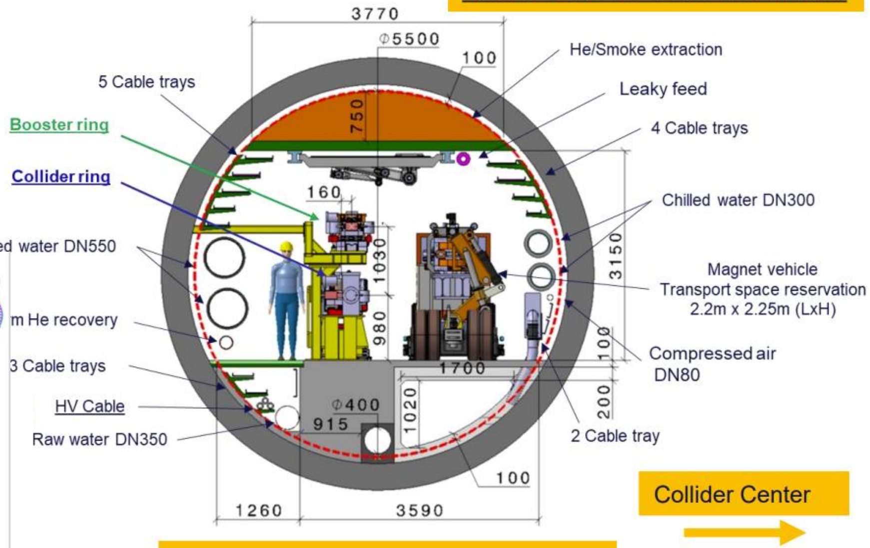
Alcove and transport layby areas

Everything compatible with hh!

FCC Small alcove and Small transport Layby integration study



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

Layout optimisation and services

New technologies for electrical transmission and distribution in FCC

C Marcel

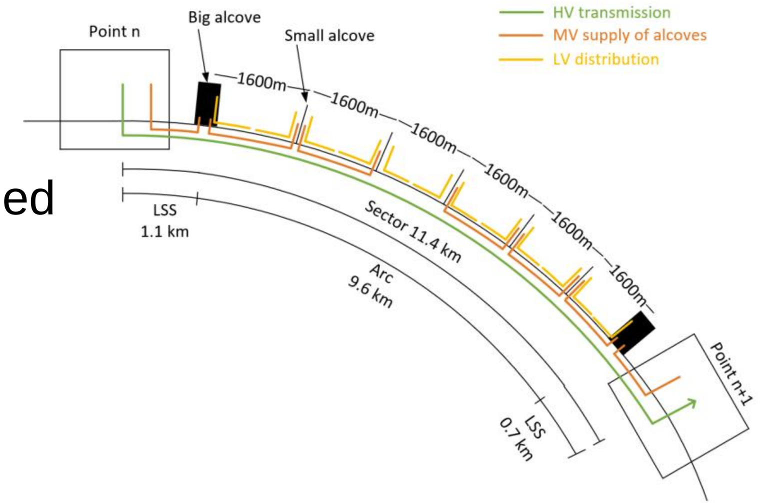
Present cabling concept

Results in a number of cable trays; to be optimized (integration issue and heat evacuation)

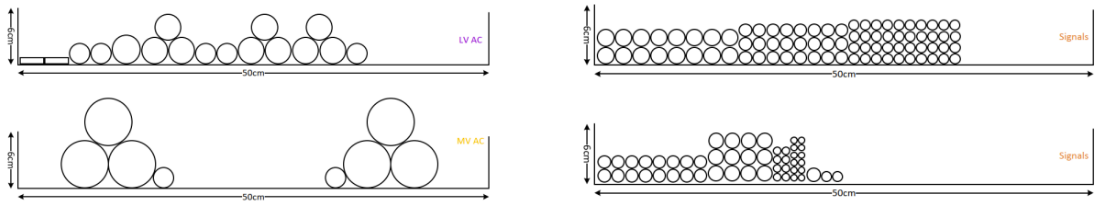
Best guess inventory

7 vs 14 alcoves

Optimization also for the surface sites



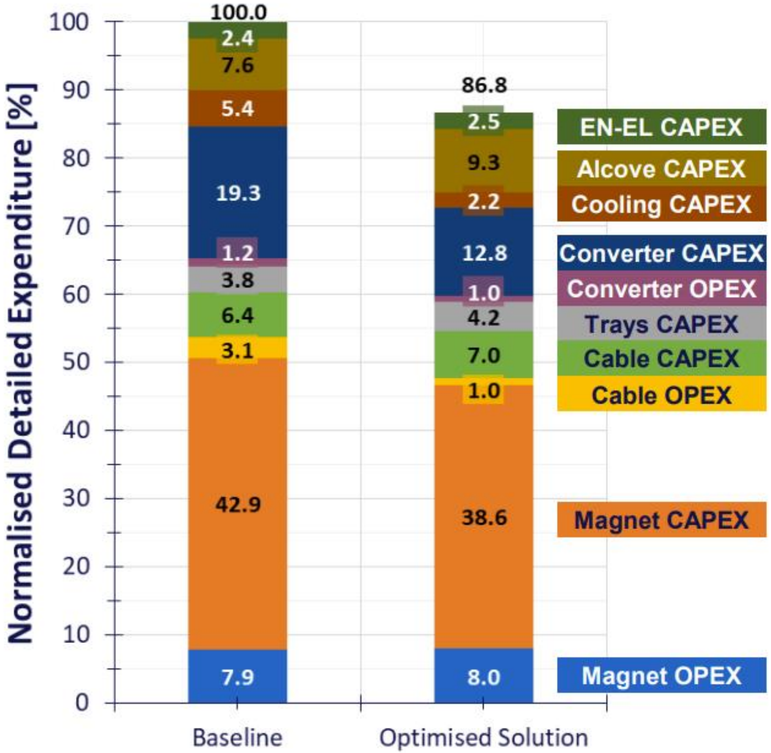
With the currently known cable needs:



Layout optimisation and services

Global Optimisation

B Wicki



The Global Model found an optimised solution by considering **Capital** and **Operational Expenditures**.

Preliminary global optimisation results shows that:

- **≥9 alcoves** per arc seems to be optimal
- **Bigger cable Trays** needed.
- Booster Quadrupole powered from Big Alcoves.
- Collider Dipole, Quadrupole and Corrector in aluminium coil.

What's next :

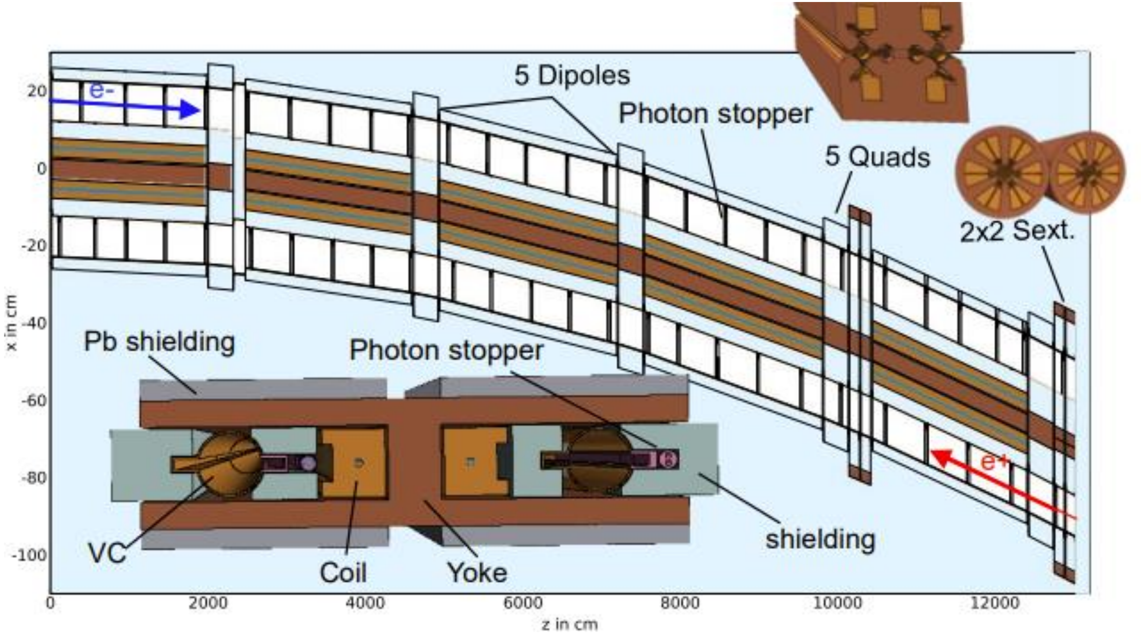
- Booster Magnet model with TE-MSC.
- Assessing certainty.
- Refining certain submodels.
- Fixing Optics parameters.
- Radiation Protection
- ...

Layout optimisation and services

Radiation environment in the FCC-ee arcs

B Humann

Update on radiation studies; SR potential showstopper but now mitigated
Integrated shielding (Pb vs W)
Promising reduction of the rad. levels but further optimization required



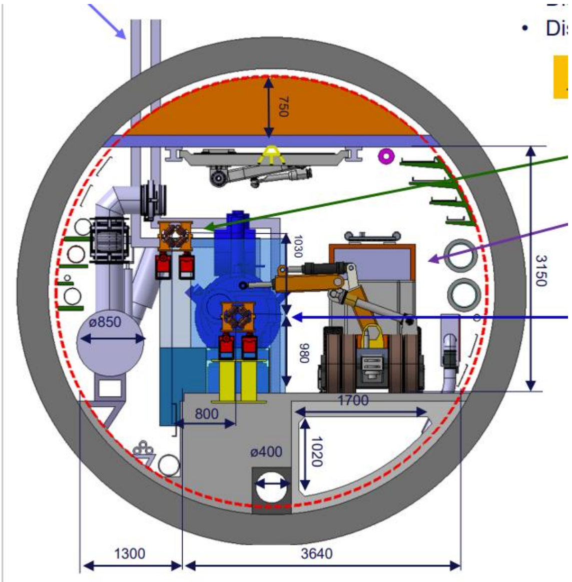
RF and Cryogenics

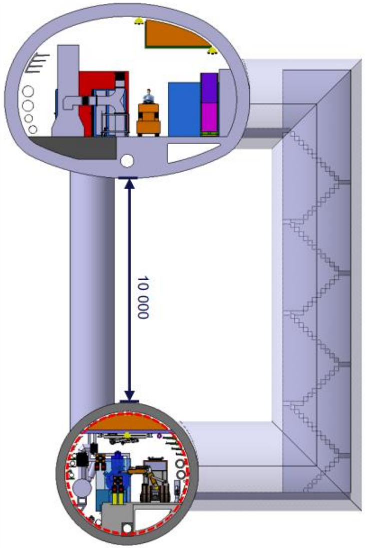
RF General Layout and integration

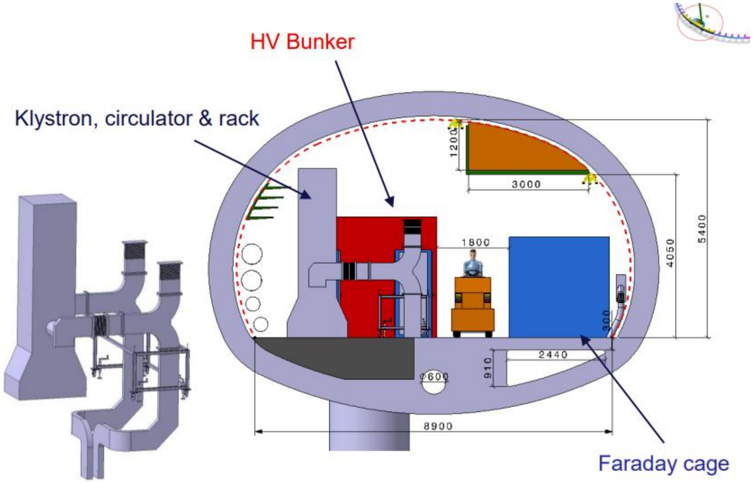
F Valchkova

PL (Booster RF) and PH (collider RF)

Baseline layout for the different operation phases





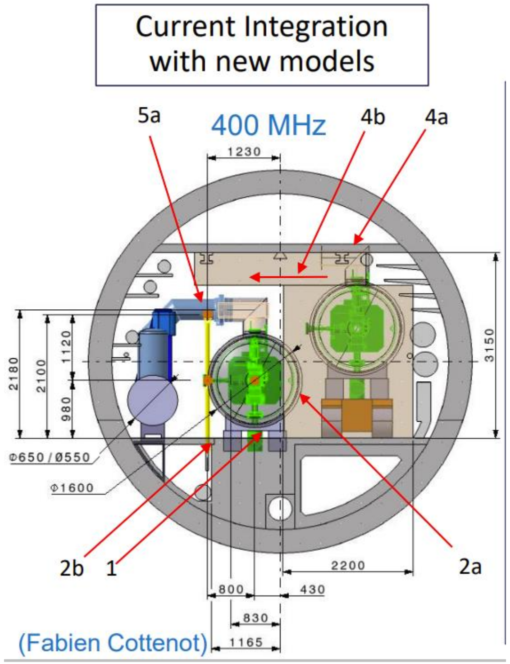


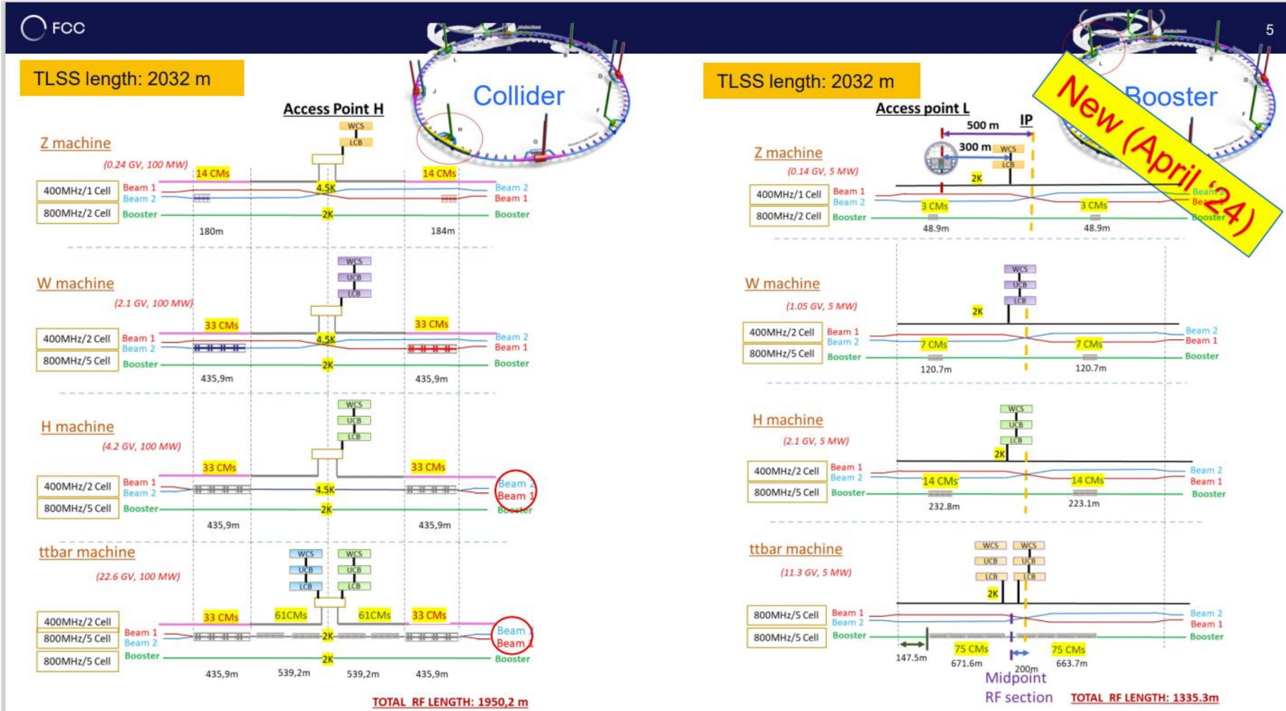
RF and Cryogenics

Update of RF layout and cryomodules

V Parma

Updated integration with real cryostat design





RF and Cryogenics

Parametric studies on FCC-ee cryogenic design

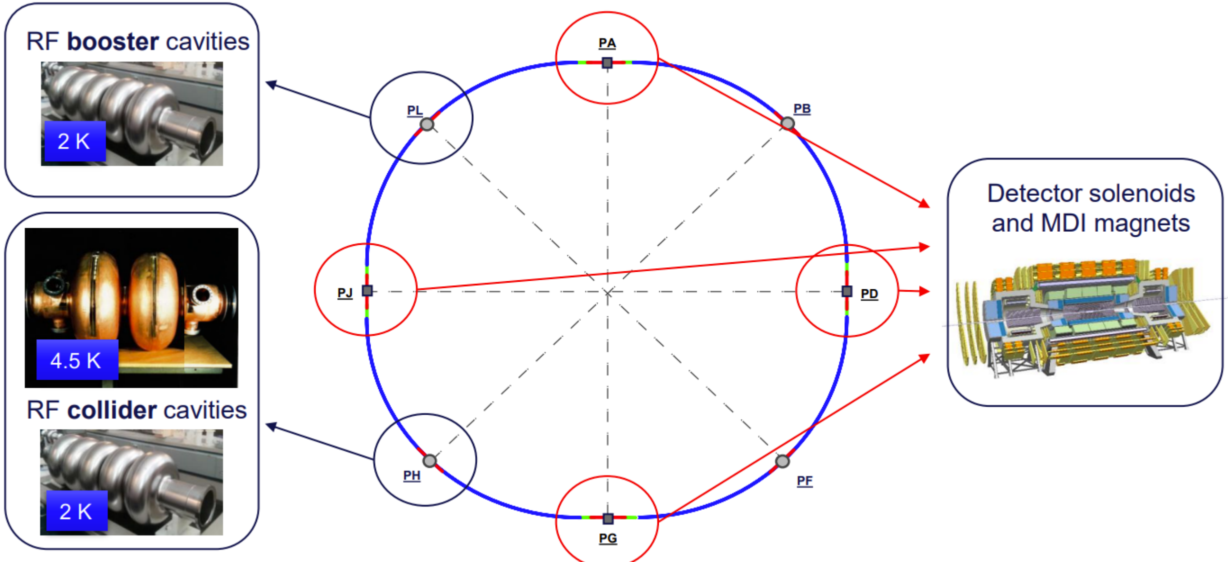
B Naydenov Popov

System architecture, optimization and sensitivity study

Alternative scenarios

He recovery

Cold compressors



Compound cryogenic distribution line incl. ScHe supply and VLP return)

Subcooling heat exchanger

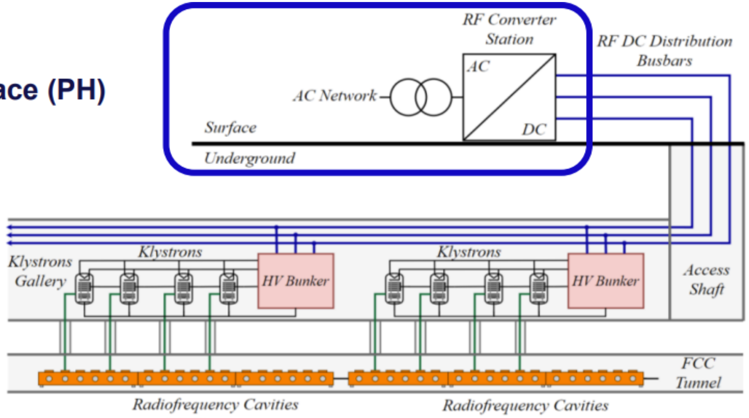
RF and Cryogenics

Powering of the FCC-ee RF System

M Colmenero Moratalla

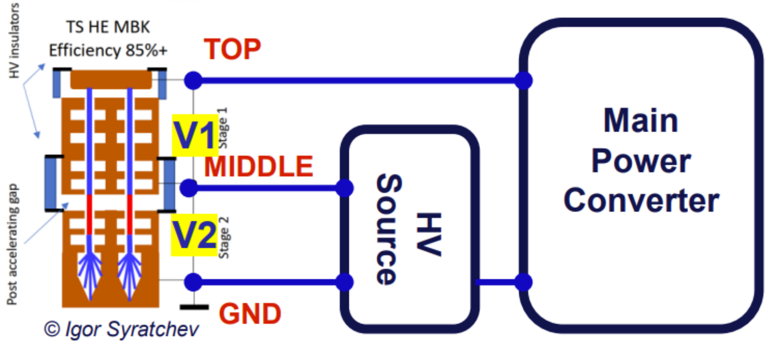
FCC-ee RF Powering Strategy

- **Single Power Converter situated on the surface (PH)**
  - 150 MW rated power / 34 kV on AC side
  - Directly supplied from the 400 kV Network
  - **Robust to network perturbations**
- **Single Busbar Scheme:** Klystrons connected in parallel to the same busbar



Requires new protection and control strategies

- **Three-wire distribution scheme → Two-Stage High-Efficiency Klystrons**
  - **Stage 2 (V2) voltage fixed by a low power HV converter (I middle = 0)**
  - **Stage 1 (V1+V2) voltage fixed by the main power converter**

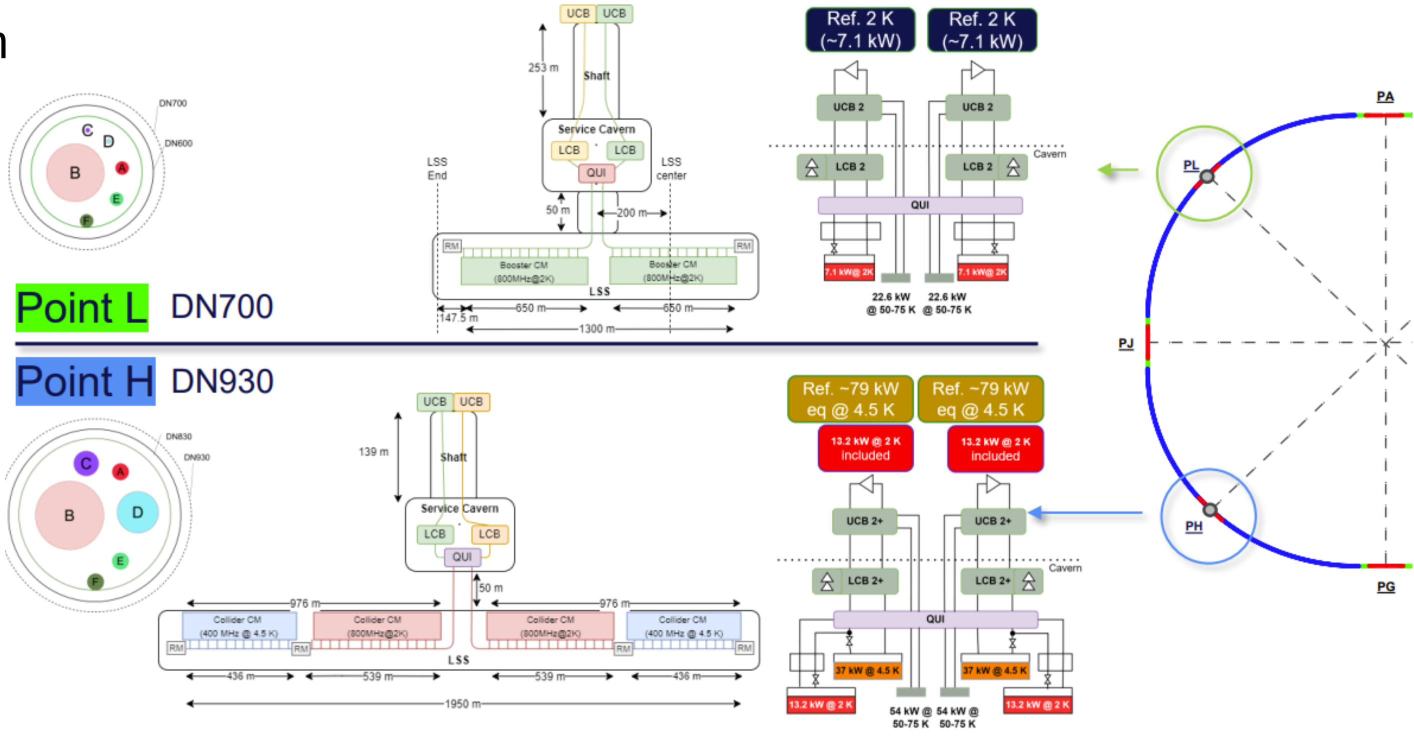


Utilities

Status of the FCC cryogenics feasibility study

L Delprat

Layout of the system
Surface areas
Operation modes
Factor 3 larger than state of the art



Utilities

Cooling of the FCC-ee and FCC-hh: update and sustainability aspects

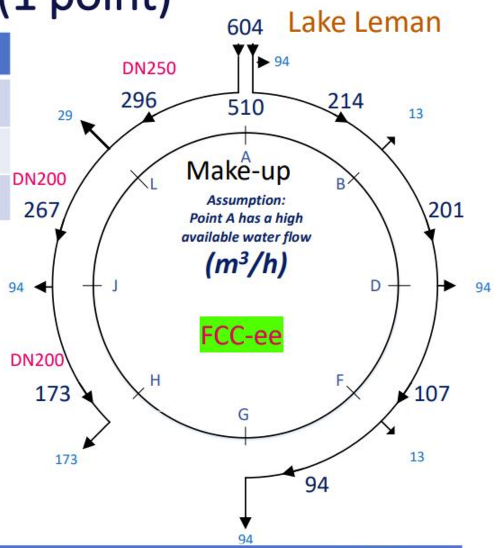
G Peon

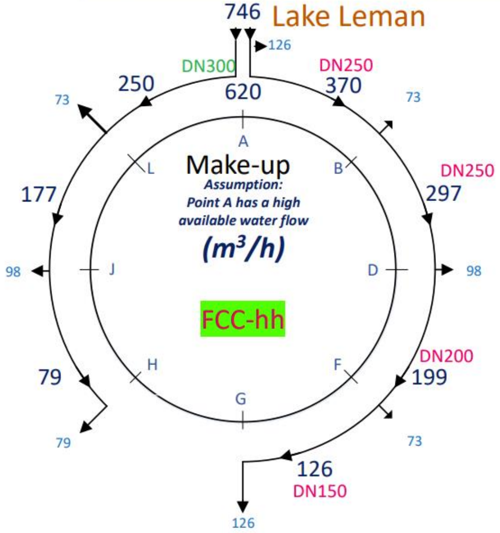
Single water supply
Reduce make-up and reject water

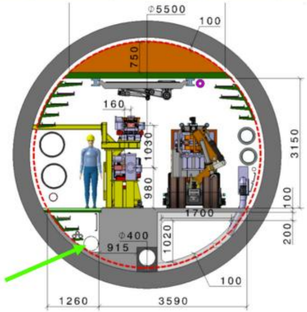
Make up and reject water needs (1 point)

WATER NEEDS FOR FCC-ee, *Considering Blowdown Recycling* (m^3/h)

Point	A	B	D	F	G	H	J	L
Make-up	94	13	94	13	94	173	94	29
Reject water	11	2	11	2	11	21	11	3







WATER NEEDS FOR FCC-hh, *Considering Blowdown Recycling* (m^3/h)

Point	A	B	D	F	G	H	J	L
Make-up	126	73	98	73	126	79	98	73
Reject water	15	9	12	9	15	10	12	9

Reject: DN125 in sector AB

Utilities

Ventilation strategy for the FCC

I Martin Melero

Update on ventilation for technical and experimental points, and for the tunnel

Operational vs emergency modes

- Regulation and conditioning of air (mainly temperature, humidity) when machines are running and when workers access facilities

- Transfer of part of the thermal load produced in the machines and racks to the air renewed by ventilation

- Extraction of smoke or helium in case of emergency and creation of safe conditions in compartments

Utilities

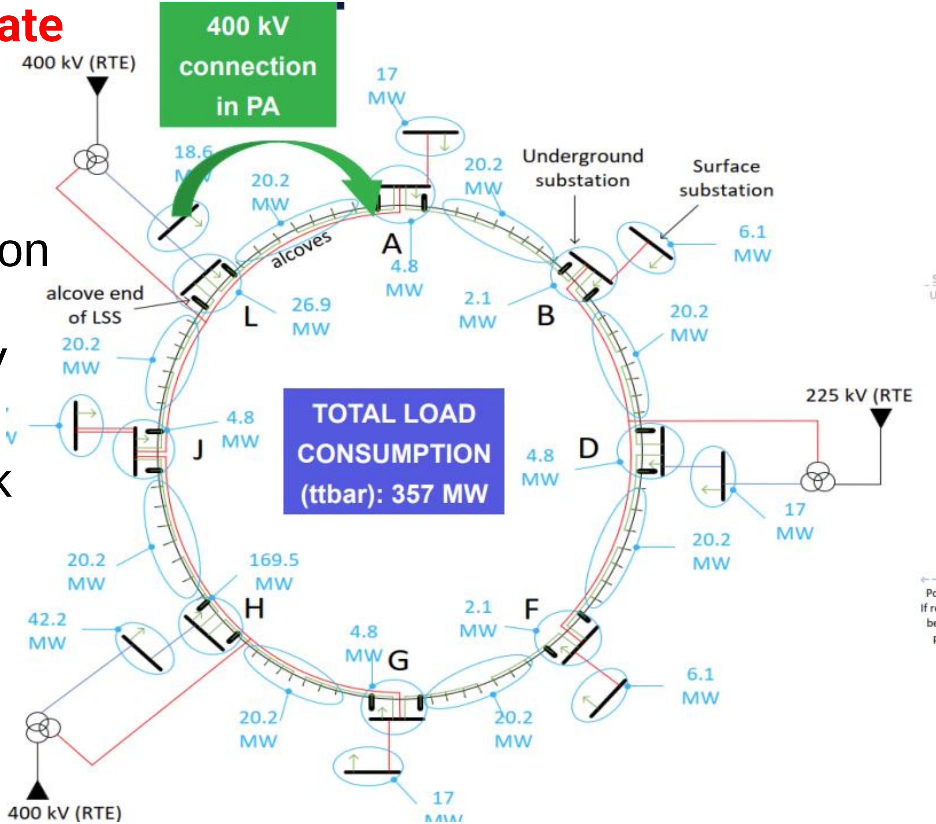
FCC electrical grid and infrastructure: update

M Parodi

Open points from 2023 FCC week

- Definition of the High Voltage transmission level
- Launch of the feasibility study for the HV cable in the tunnel
- Launch the study of the secured network
- Definition of the main operational scenarios

Operational vs degraded modes



Utilities

DC Networks for the Powering of the FC

M Colmenero Moratalla

DC powering advantages vs challenges

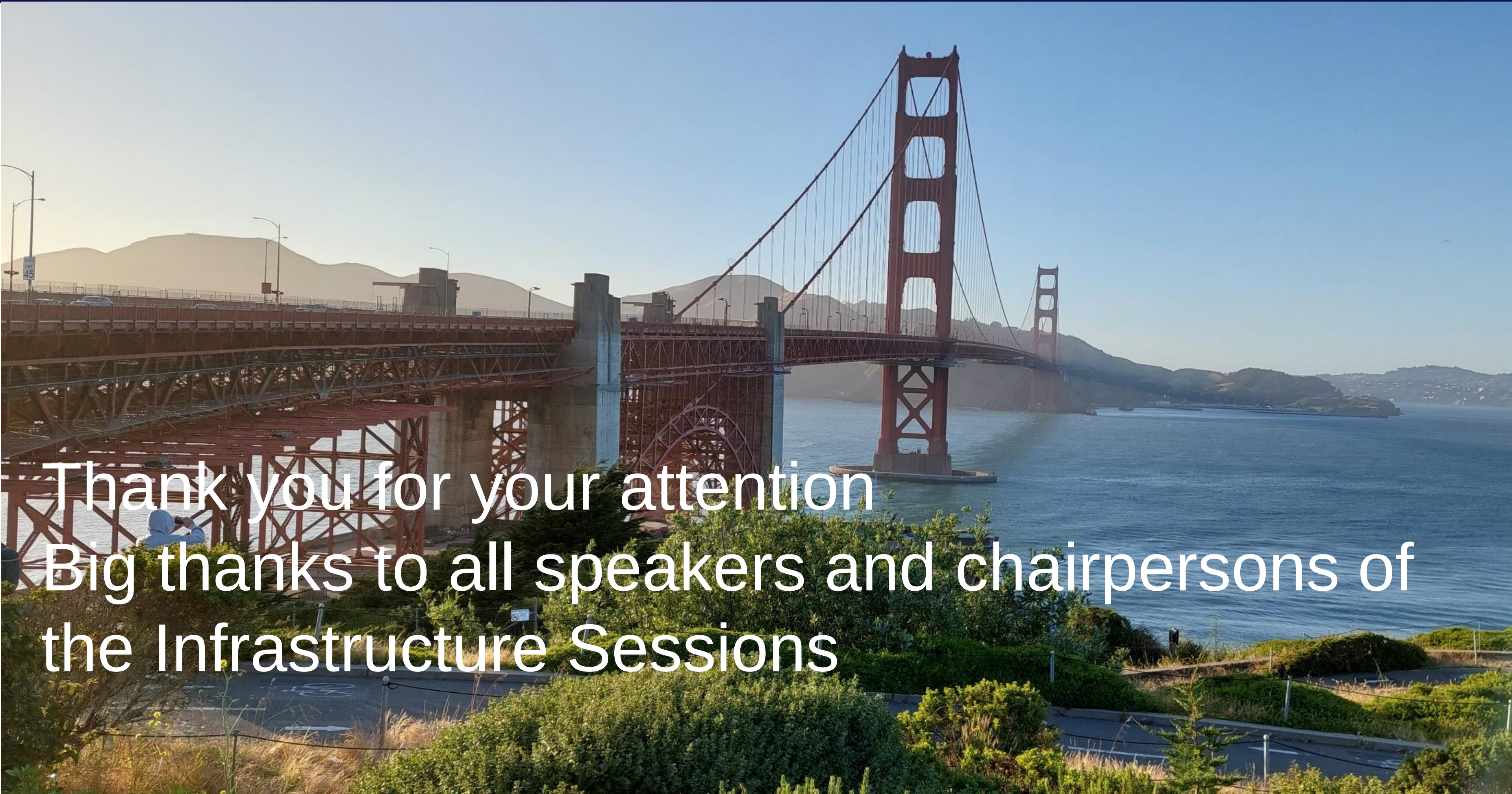
- **Local Distribution in DC**

Powering Solution	Advantages	Challenges	Roadmap
Purely AC	Extensive expertise Simplicity	Need of compensating equipment DC loads are not optimized	Better definition of FCC load characteristics CAPEX/OPEX including compensation
Purely DC	Modularity Controllability	High complexity High cost	Abandoned
Mixed AC/DC	Optimization for loads DC to compensate AC	Grouping of DC loads Standardization	Technological feasibility CAPEX/OPEX estimation

- **DC for transmission**

Powering Solution	Advantages	Challenges	Roadmap
Purely AC	Extensive expertise Simplicity	Need of compensating equipment	Addition of FACTS to models CAPEX/OPEX including compensation
Purely DC	Lower cost of cable Robust to network perturbations Controllability	Higher complexity	CAPEX/OPEX estimation

Work in more detailed models for taking a final decision



Thank you for your attention

Big thanks to all speakers and chairpersons of the Infrastructure Sessions