FCC Feasibility Study Status

2nd FCC Italy – France Workshop, Venice, 4 November 2024

Michael Benedikt, Frank Zimmermann, CERN
on behalf of FCC collaboration & FCCIS DS team

photo: J. Wenninger

http://cern.ch/fcc

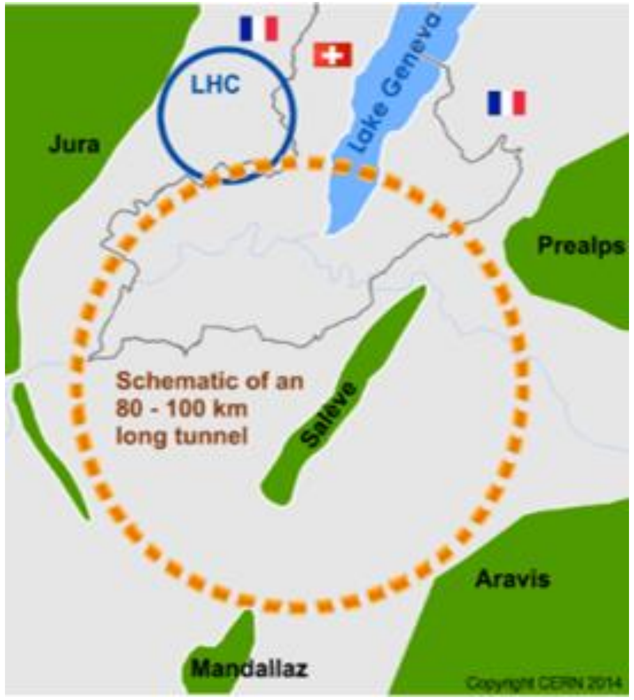
*Work supported by the **European Commission** under the **HORIZON 2020 projects EuroCirCol**, grant agreement 654305; **EASITrain,** grant agreement no. 764879; **iFAST**, grant agreement 101004730, **FCCIS**, grant agreement 951754; **E-JADE,** contract no. 645479; **EAJADE**, contract number 101086276; and by the Swiss **CHART** program*

FCC integrated program

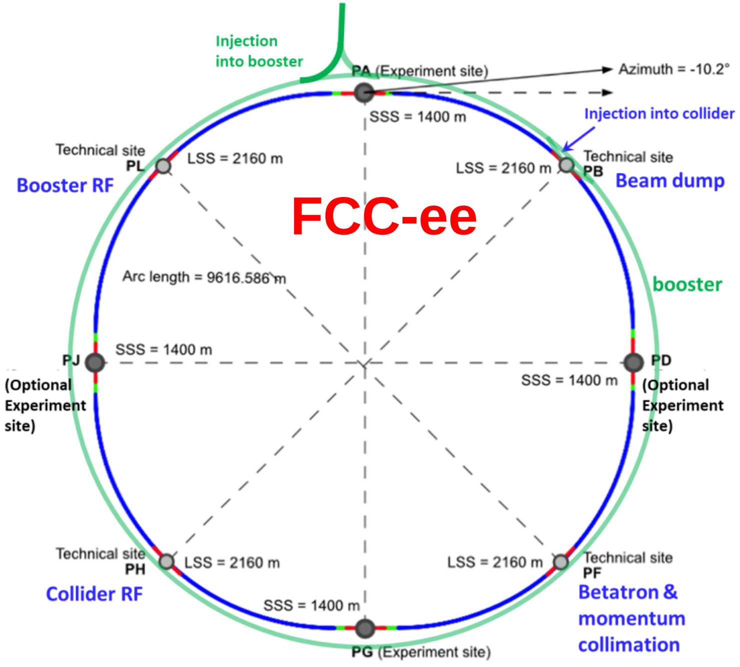
FUTURE CIRCULAR COLLIDER

comprehensive long-term program maximizing physics opportunities

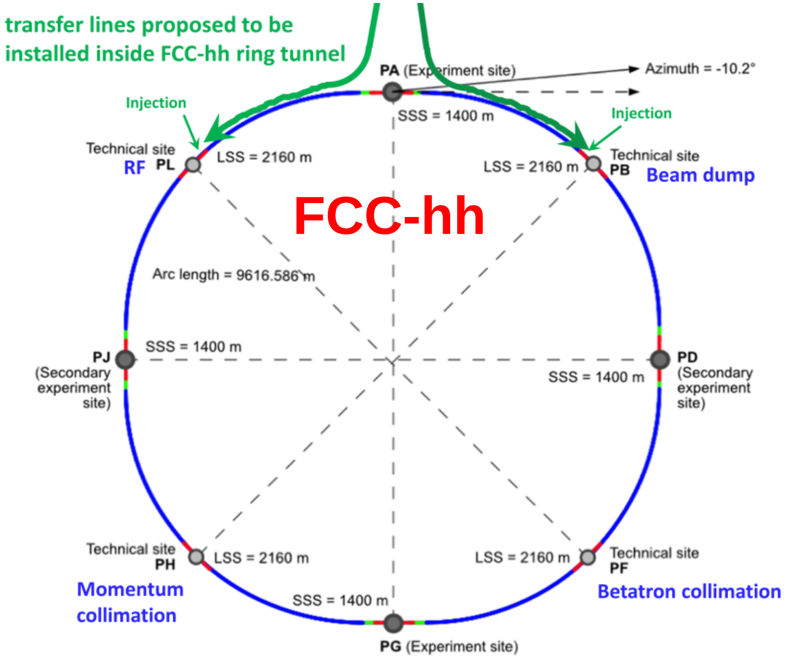
- **stage 1: FCC-ee (Z, W, H, $t\bar{t}$) as Higgs factory, electroweak & top factory at highest luminosities**
- **stage 2: FCC-hh (~100 TeV) as natural continuation at energy frontier, pp & AA collisions; e-h option**
- highly synergetic and complementary programme boosting the physics reach of both colliders
- common civil engineering and technical infrastructures, building on and reusing CERN's existing infrastructure
- FCC integrated project allows the start of a new, major facility at CERN within a few years of the end of HL-LHC



2020 - 2045



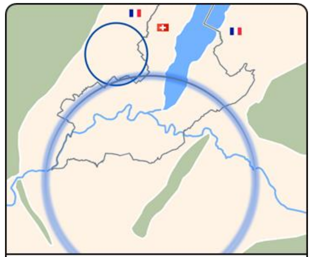
2045 - 2065

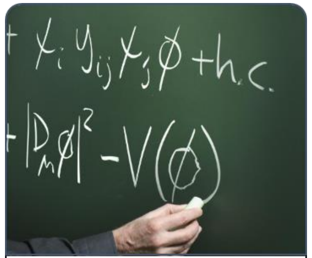


2070 -

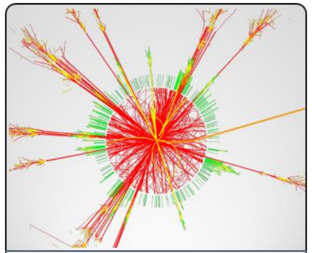
High-level goals of the FCC Feasibility Study

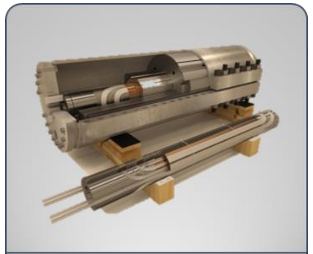
- together with the Host States, **optimisation of placement and layout of the ring,** and demonstration of the geological, technical, environmental and administrative feasibility of the tunnel and surface areas;
- **consolidation of the physics case** and detector concepts, optimisation of the **design of the colliders and their injector chains**, supported by targeted **R&D to develop the needed key technologies**;
- development of the technical infrastructure concepts and integration with territorial constraints and identification of opportunities for co-construction;
- elaboration of a **sustainable operational model for the colliders** and experiments in terms of human and financial resource needs, **environmental aspects and energy efficiency**;
- **identification of substantial resources** from outside CERN's budget for the implementation of the first stage of a possible future project;
- Final deliverable is a **Feasibility Study Report by March 2025.**


Infrastructures


Physics Cases

Collider Designs


Experiments


R&D Programs

Cost Estimates

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Feasibility Study Report for March 2025

Structure:Three Volumes

- ***Vol. 1:*** *Physics, Experiments and Detectors (~200 pages)*
- ***Vol. 2:*** *Accelerators, Technical Infrastructures, Safety Concepts (~400 pages)*
- ***Vol. 3:*** *Civil Engineering, Implementation & Sustainability (~200 pages)*

- - **Executive Summary of the FCC Feasibility Study: ~40 pages**

Input for Update of European Strategy for Particle Physics

to be prepared with Overleaf & published by EPJ (Springer-Nature) – FCCIS members

Overleaf — FUTURE CIRCULAR COLLIDER Innovation Study — EPJ.org your physics journal — SPRINGER NATURE

In addition:

a. Documentation on Cost Estimate – Funding Models

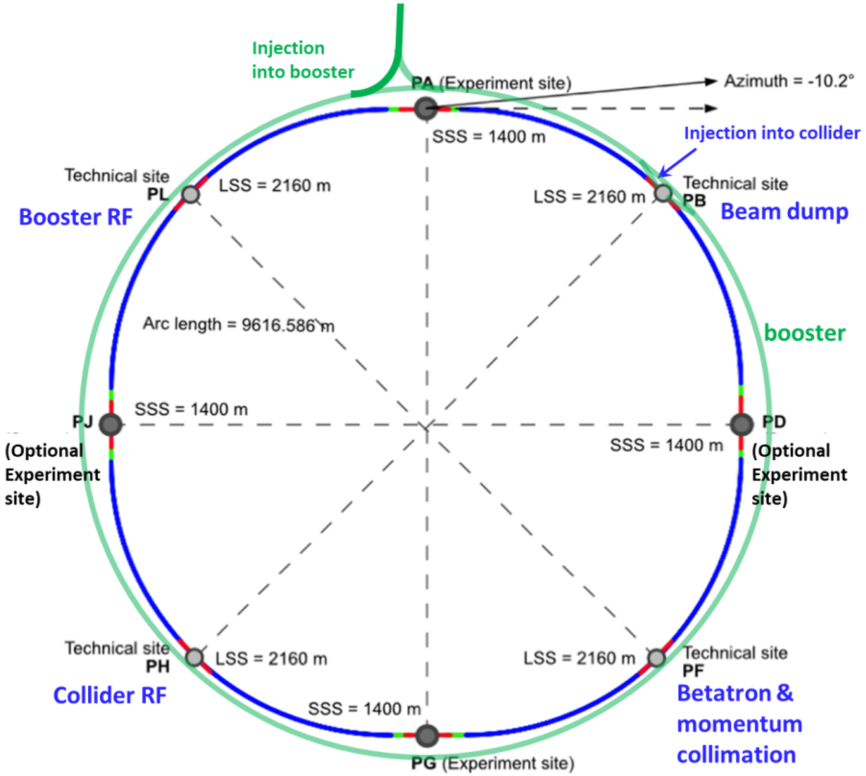
b. Environmental Report

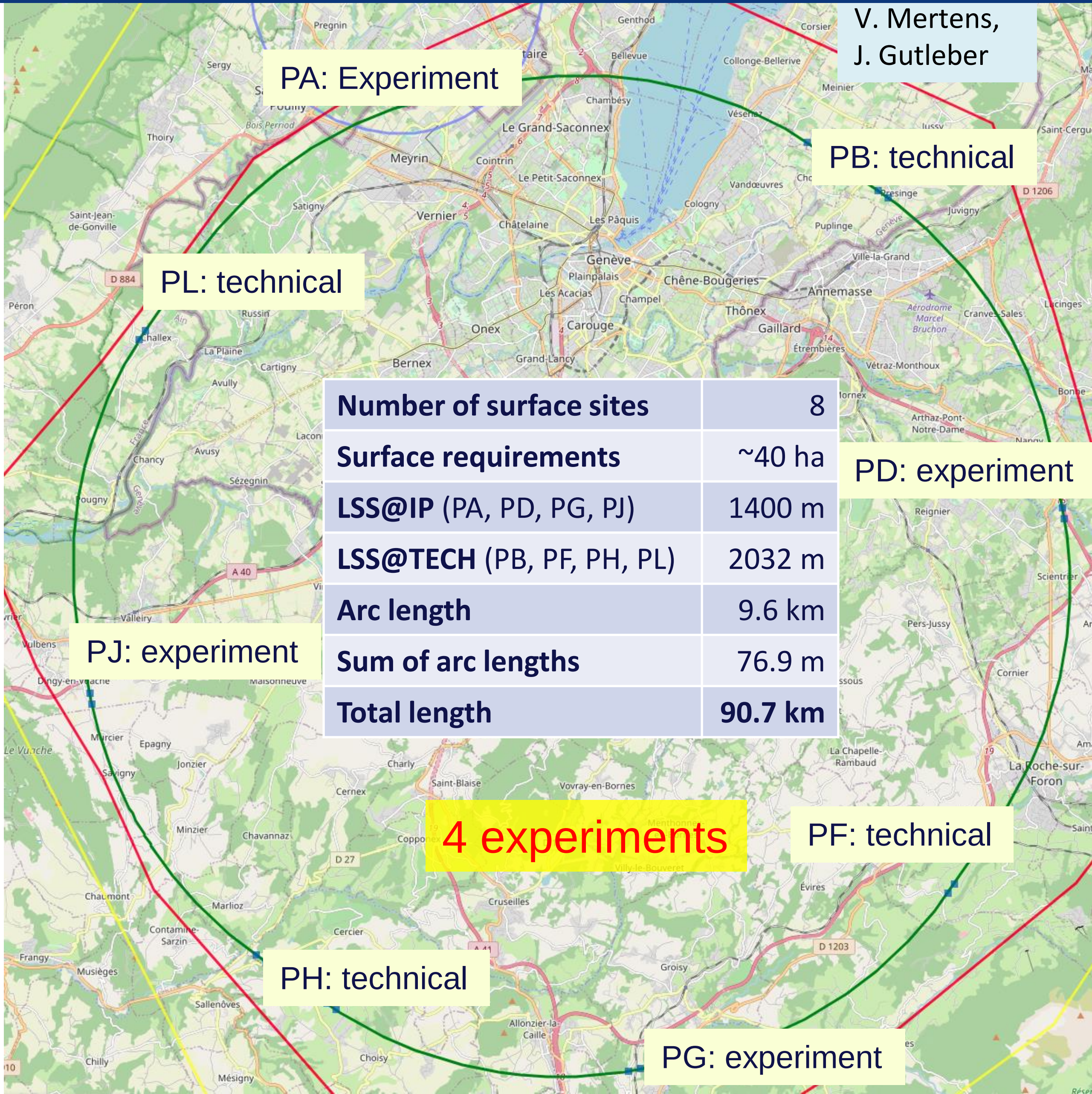
Reference layout and implementation: PA31 - 90.7 km

Layout chosen out of ~ 100 initial variants, based on **geology** and **surface constraints** (land availability, access to roads, etc.), **environment,** (protected zones), **infrastructure** (water, electricity, transport), **machine performance** etc.

“Avoid-reduce-compensate” principle of EU and French regulations

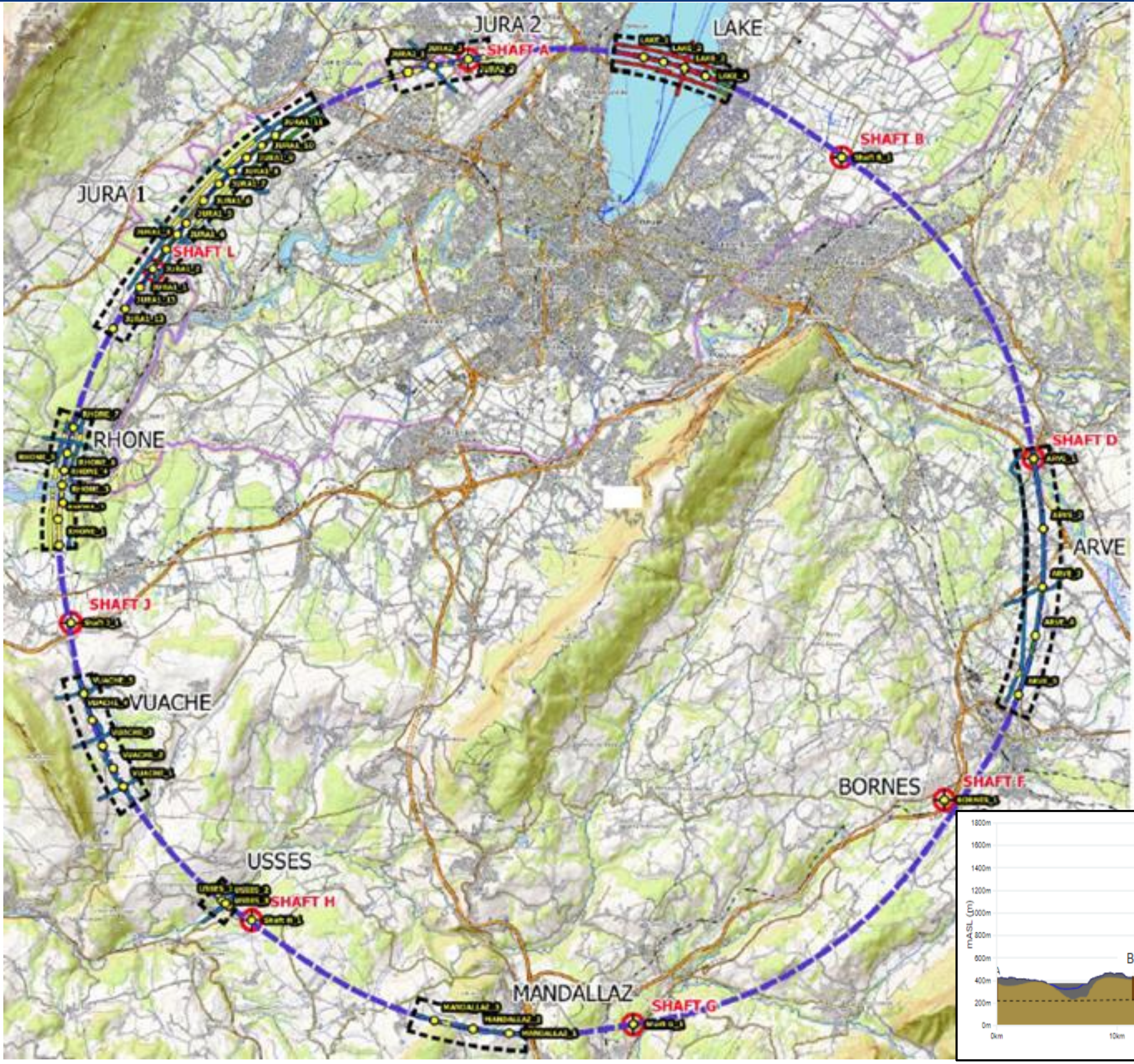
Overall lowest-risk baseline: 90.7 km ring, 8 surface points, 4-fold symmetry





Number of surface sites	8
Surface requirements	~40 ha
LSS@IP (PA, PD, PG, PJ)	1400 m
LSS@TECH (PB, PF, PH, PL)	2032 m
Arc length	9.6 km
Sum of arc lengths	76.9 m
Total length	**90.7 km**

First series of site investigations



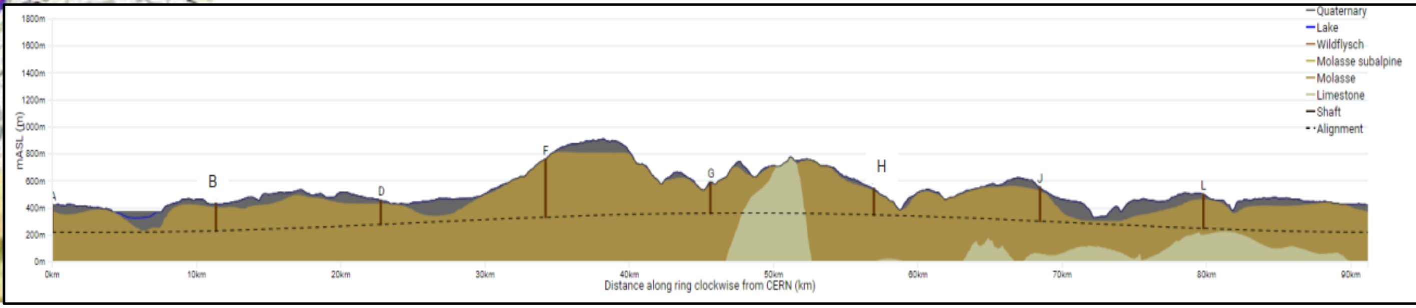
Site investigations to identify exact location of geological interfaces:

- Molasse layer vs moraines/limestone
- ~30 drillings and ~90 km seismic lines

→ **Vertical position and inclination of tunnel**

Sondage A89 (2007) incliné de 45° de 125 ml (surface plateforme estimée : 12 x 12 m soit environ 150 m²)

example of drilling works on a lake the lake



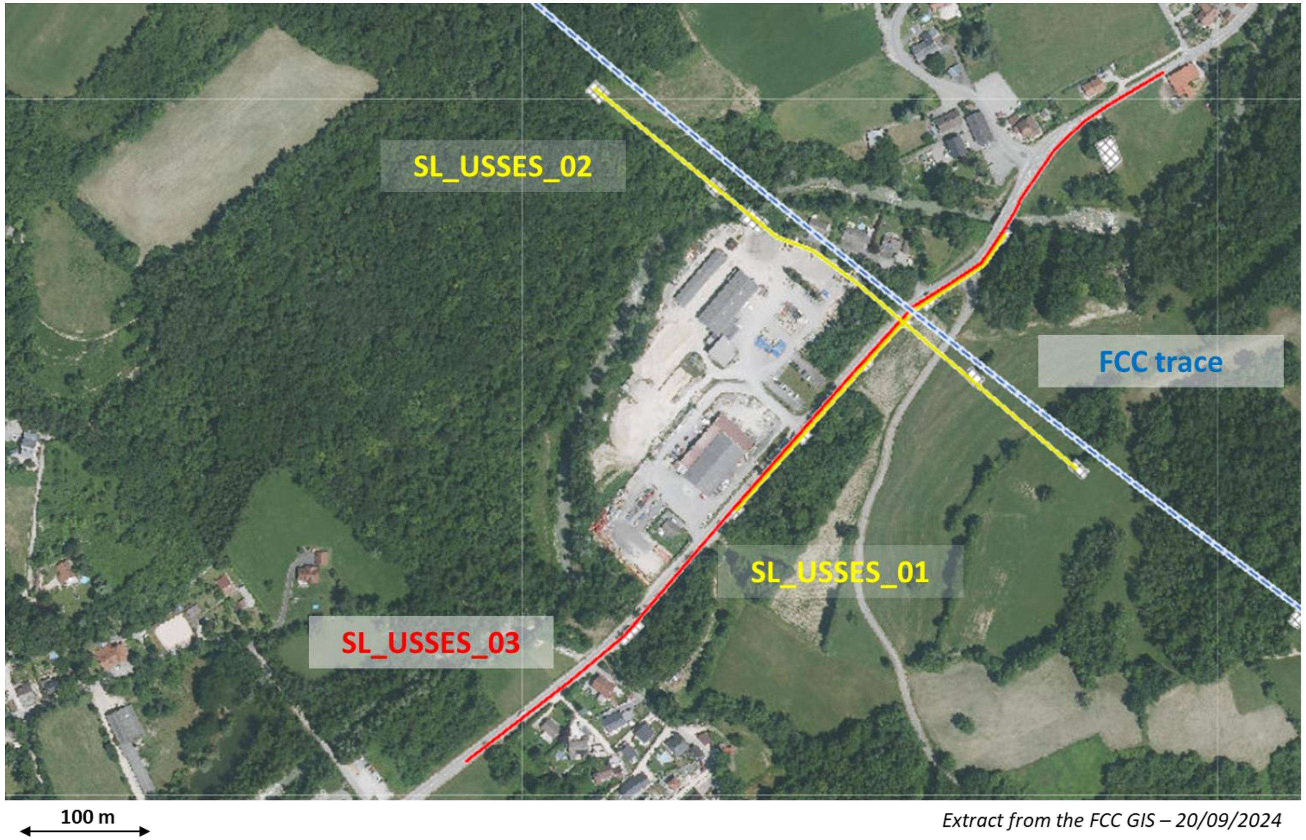
Start of site investigations – seismic investigations

First seismic line :

Seismic line SL_USSES_02 :
Acquisition date : 01/10/2024
Length : 480 meters
Method(s) : Explosive and Seismic gun
Geophones : 96 units (5 meters of spacing)
Shot points : 13 shot points in total

Second seismic line :

Seismic line SL_USSES_01 :
Acquisition date : 02/10/2024
Length : 300 meters
Method(s) : Weight drop
Geophones : 60 units (5 meters of spacing)
Shot points : 15 shot points in total



Extract from the FCC GIS – 20/09/2024

Status of site investigations – drilings

Drilling for first borehole has commenced on 14/10/2024

The drilling (USSES 2) is within the commune of Marlioz

The drill site is located within the storage yard of a private construction company (Besson).

Drilling Depth = 70m

Fully cored recovery

Drill time should be about 2 weeks

Equipped with Piezometer

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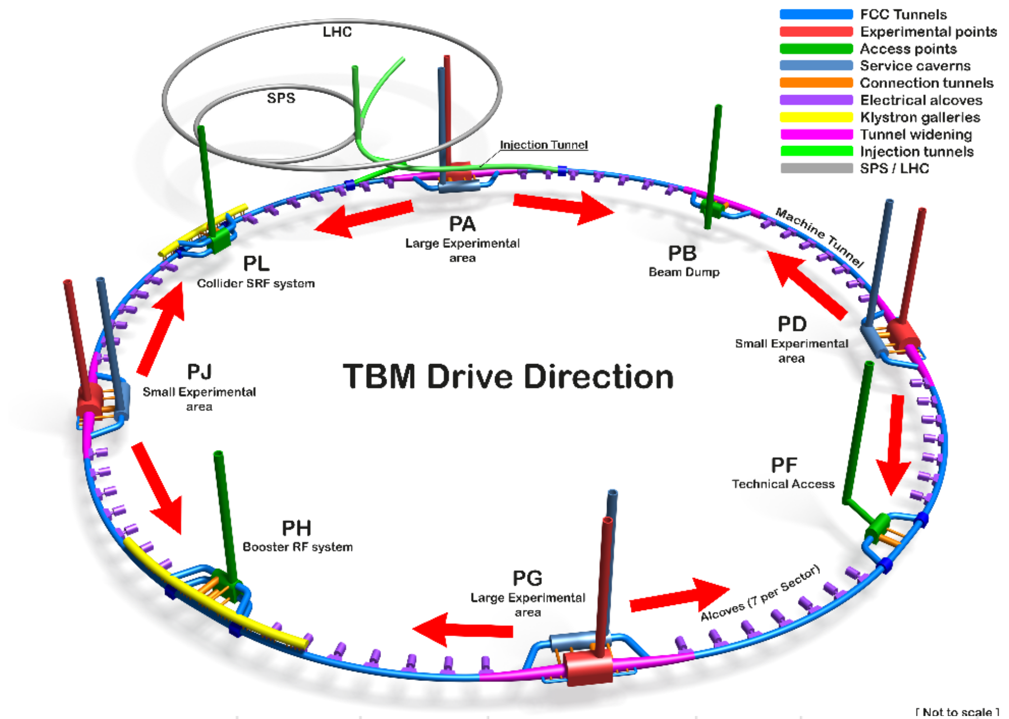
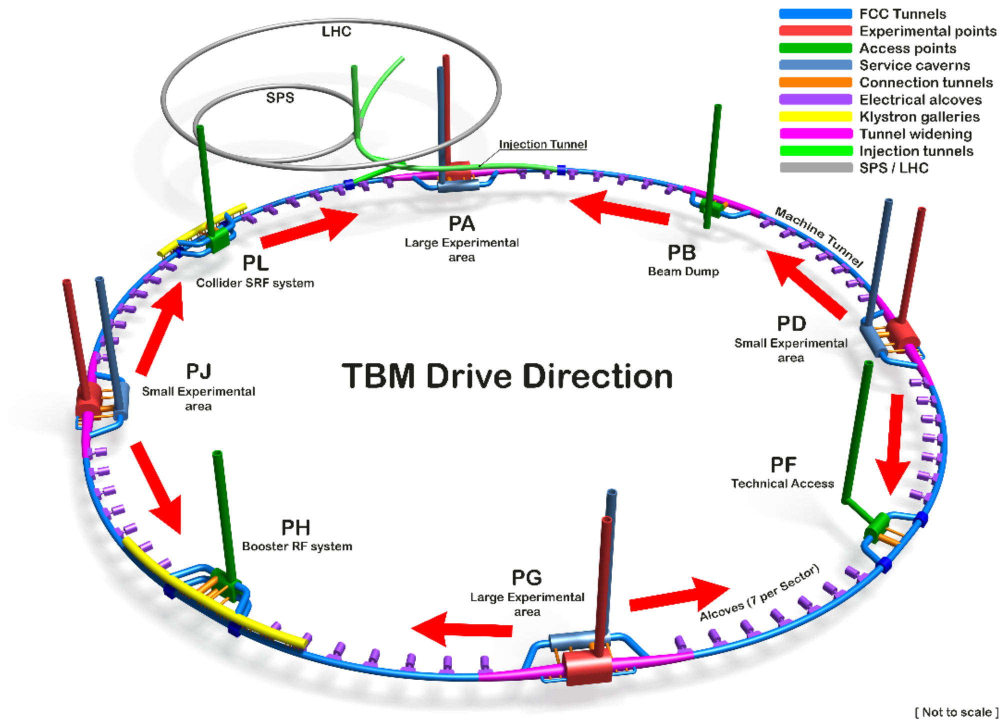
Studies on excavation strategy and material quantities

2 TBMs from each experimental point



	Limestone (m3)	Molasse (m3)	Moraine (m3)	Total (*in-situ*) (m3)	Total (*Bulk factor 1.3*) (m3)	%	Start Excavation	End Excavation
PA	-	1,315,336	62,721	1,378,058	1,791,475	22%	Jan-33	Jun-38
PB	-	137,379	10,473	147,852	192,207	2%	Jan-33	Jul-35
PD	-	1,248,824	24,925	1,273,749	1,655,874	20%	Jan-33	Jun-37
PF	-	165,213	-	165,213	214,777	3%	Jan-33	Apr-35
PG	141,175	1,193,094	30,829	1,365,098	1,774,628	22%	Jan-33	Jun-38
PH	-	304,083	7,482	311,565	405,034	5%	Jan-33	Dec-35
PJ	-	1,258,608	29,910	1,288,518	1,675,073	20%	Jan-33	Sep-37
PL	-	227,088	13,468	240,556	312,723	4%	Jan-33	Dec-35
Inj	-	122,329	-	122,329	159,028	2%	Jan-33	Jun-36
Total	**141,175**	**5,971,954**	**179,808**	**6,292,937**	**8,180,819**	**100%**		

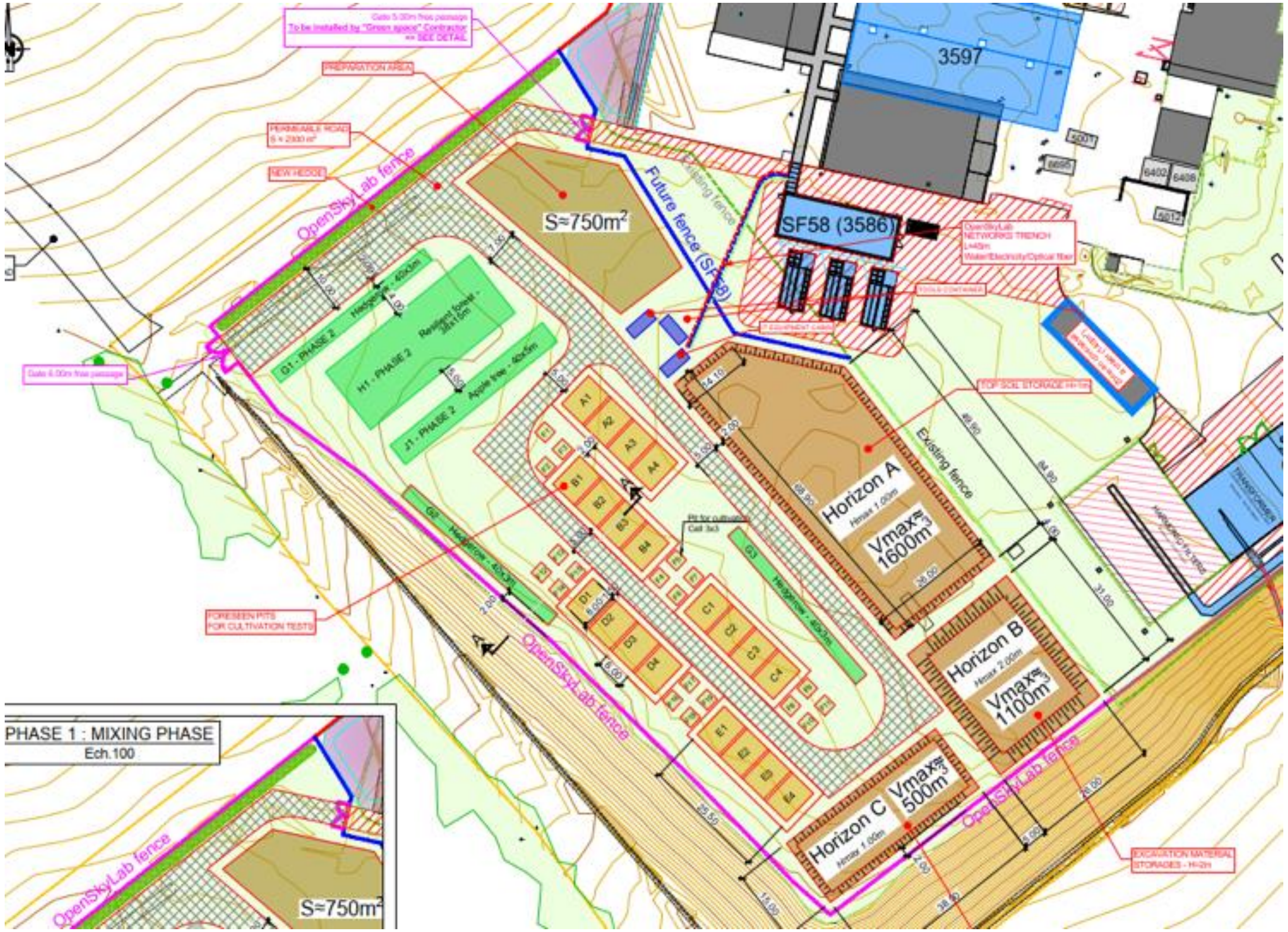
Alternative with no TBMs from PA



	Limestone (m3)	Molasse (m3)	Moraine (m3)	Total (*in-situ*) (m3)	Total (*Bulk factor 1.3*) (m3)	%	Start Excavation	End Excavation
PA	-	562,457	62,721	625,178	812,731	10%	Jan-33	Jun-38
PB	-	499,592	10,473	510,066	663,085	8%	Jan-33	Jul-35
PD	-	1,248,824	24,925	1,273,749	1,655,874	20%	Jan-33	Jun-37
PF	-	165,213	-	165,213	214,777	3%	Jan-33	Apr-35
PG	141,175	1,193,094	30,829	1,365,098	1,774,628	22%	Jan-33	Jun-38
PH	-	304,083	7,482	311,565	405,034	5%	Jan-33	Dec-35
PJ	-	1,258,608	29,910	1,288,518	1,675,073	20%	Jan-33	Sep-37
PL	-	617,754	13,468	631,222	820,589	10%	Jan-33	Dec-35
Inj	-	122,329	-	122,329	159,028	2%	Jan-33	Jun-36
Total	**141,175**	**5,971,954**	**179,808**	**6,292,937**	**8,180,819**	**100%**		

Development of excavation material re-use opportunities
OpenSkyLab: academic and industrial collaboration @LHC P5 CMS

- **Transformation of Molasse (FCC ~8 Mm^3 volume) into fertile soil for agricultural and other uses**
- **Materials: Molasse from the HL-LHC construction**
- **Duration: 4+ years (2024 -)**
- **Trials with 5 000 t molasse**
    - Soil fertilisation process (micro-organisms, mixing with fertile soil, etc.)
    - Development of ferilisation mix products
    - Development of quality managed processes
    - Experimental phase with scientific protocol and field monitoring and control system support



hepia Haute école du paysage, d'ingénierie et d'architecture de Genève · brgm Géosciences pour une Terre durable · EDAPHOS · BOKU UNIVERSITY · micro humus Ingénierie des sols · MONTAN UNIVERSITÄT LEOBEN · BECC EST 2018 · Csil · BG

OpenSkyLab status and progress

Environmental studies to document present status of potential FCC surface site areas

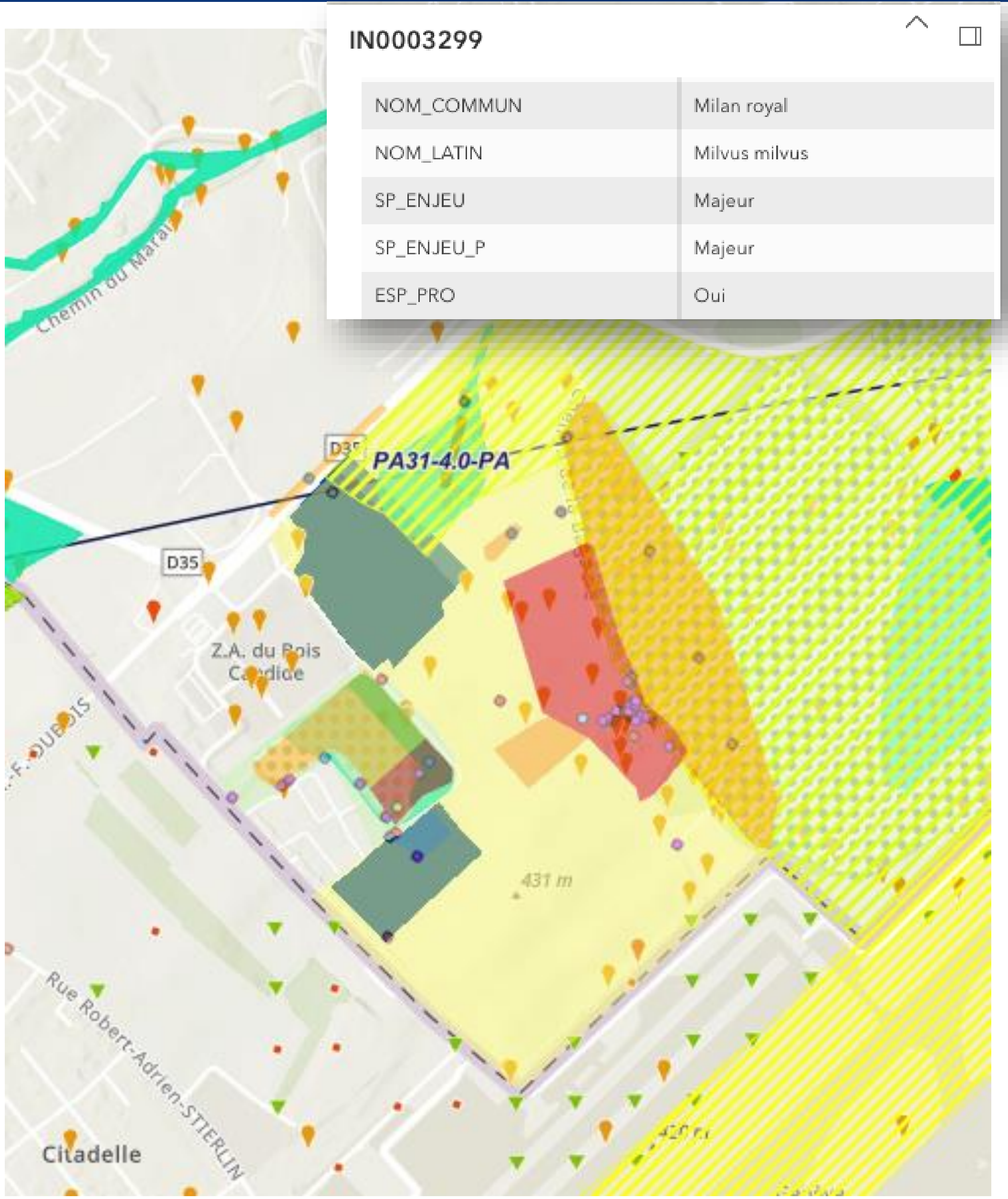
Short term goals for FCC Feasibility Study:

- Establish a state of the current environmental conditions at the surface site locations based on the actual situation, complementing the map and database investigations.
- Confirm the territorial feasibility in principle.
- Support the environmental impact studies for the geotechnical and geophysical investigations (i.e. boreholes and seismic lines).

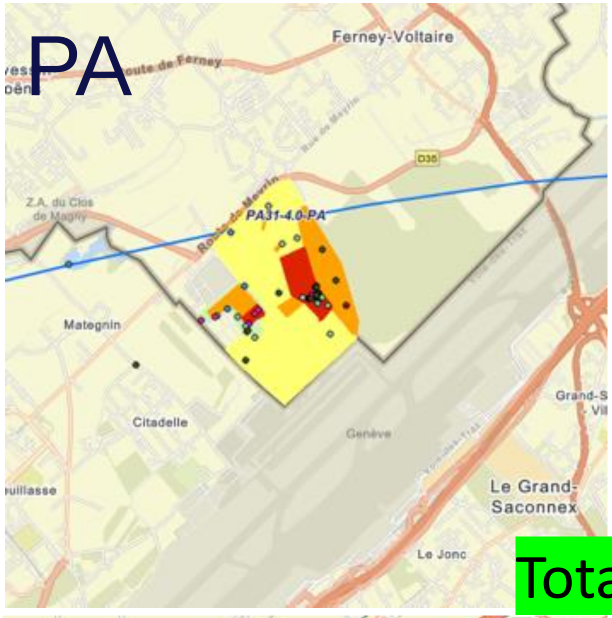
Long term goals <u>anticipating impact assessment works</u>:

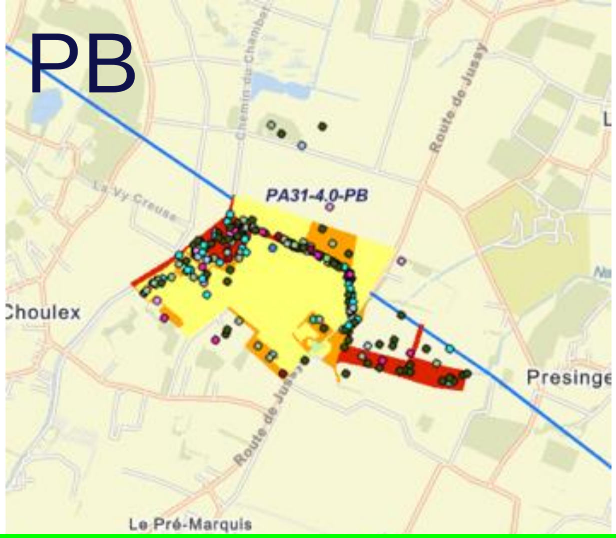
- **Comply with the regulatory reporting requirements** in the frame of the authorisation process.
- Identify and **document the environmental stakes exhaustively.**

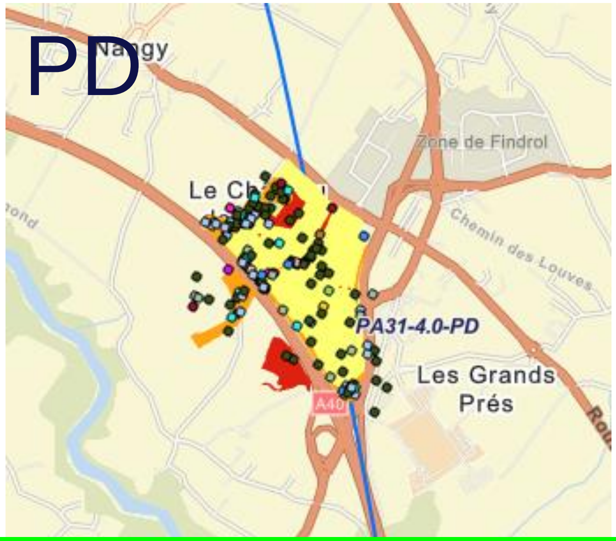
Definition of environmental strategy and guiding principles for Ecodesign to be considered by infrastructure and equipment designers in technical design phase.

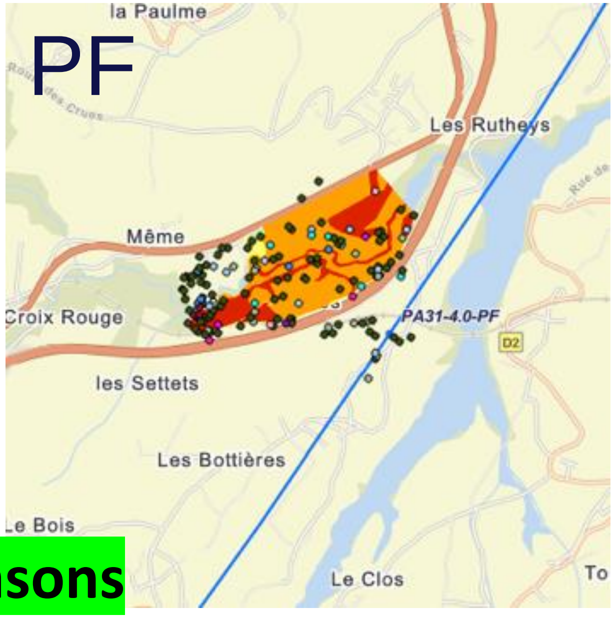


Environmental studies around surface areas

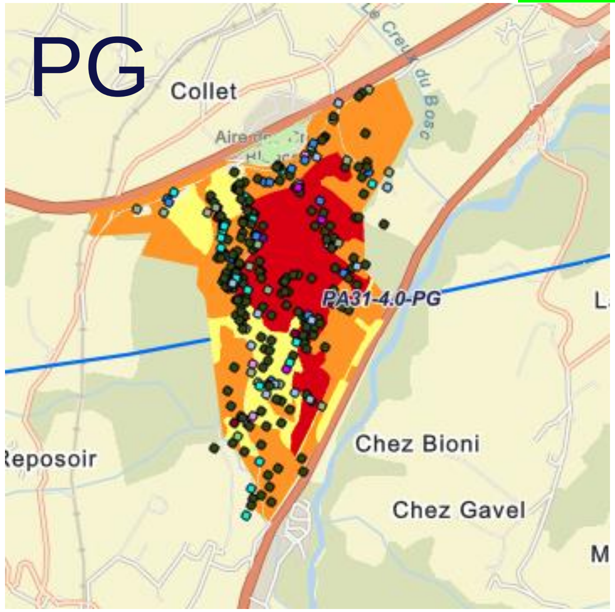


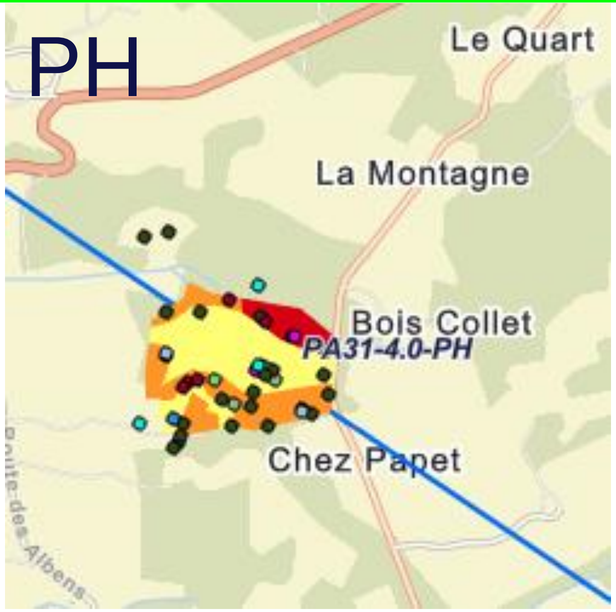


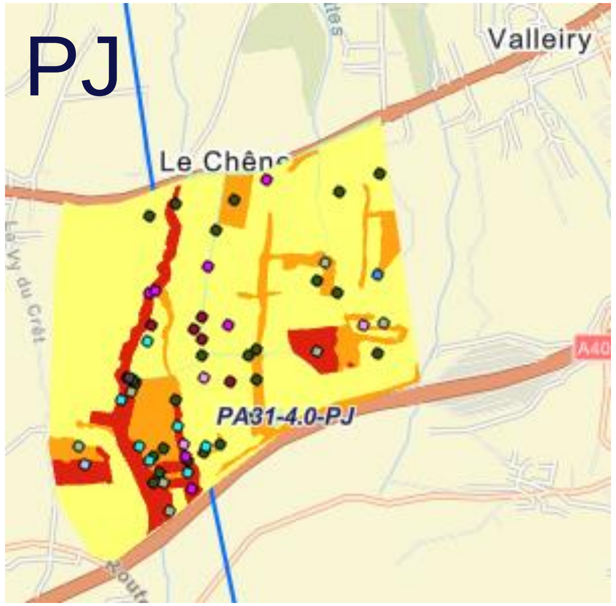


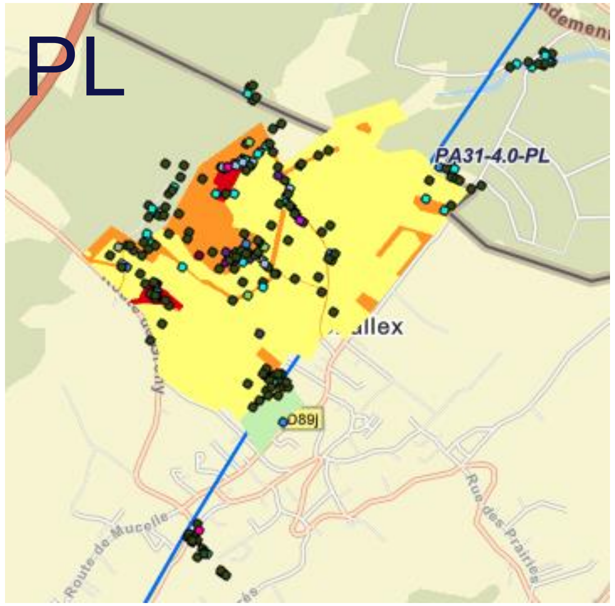


Total area investigated in 2023/24: **585 ha over 4 seasons**









Start of public information & engagement sessions

First public information and discussion meeting at the Science Gateway on the 24th April at CERN.

The meeting was organised for the **local community of our Host States, France and Switzerland**, in the Science Gateway.

The **"Progress of the feasibility study of the Future FCC circular collider"** was followed by a discussion with the participants.

La Roche-sur-Foron - Haute Savoie international fare April 27 to May 6

Unveiling the science of tomorrow: FCC Study takes centre stage at La Roche-sur-Foron exhibition

The Future Circular Collider team discussed the project's status and aspirations with a large number of attendees

15 MAY, 2024 | By Zoe Nikolaidou

CERN's participation in the **International Fair of Haute-Savoie/Mont Blanc**, enhanced by the valuable help of volunteers from the FCC team, resulted in meaningful **discussions with more than 2000 members of the local community** on topics ranging from the required technological advancements to sustainability measures.

On 15 May, RTS (Radio Télévision Suisse) broadcasted a special program celebrating CERN's 70th anniversary and hosted at CERN's Science Gateway.

The event featured a comprehensive look at **CERN's illustrious history, groundbreaking achievements, and future ambitions**, including the prominently featured Future Circular Collider (FCC) project with **study experts interacting with the audience.**

Commission Nationale de Debat Public (CNDP) mission and public information meetings

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The CNDP, created in 1995, is an **independent French authority that ensures public participation in the definition and decision process of major projects in France,** impacting the environment by providing a neutral and transparent framework for discussions between decision-makers and citizens.

On July 2, 2024, the **CERN DG requested the CNDP to undertake an advisory mission** on public participation for the FCC. On July 3, the president of the CNDP appointed two guarantors to:

- **Assist CERN in preparing the first information meetings** on the ongoing studies in the region.
- **Provide non-binding advice to CERN** on the next steps for **public participation regarding the FCC**.

RÉPUBLIQUE FRANÇAISE
Commission nationale
du débat public

Décision n° 2023 / 109 / CERN / 1 du 3 juillet 2024 relative au projet FCC de futur collisionneur circulaire d'accélérateur de particules du CERN (74)

La Commission nationale du débat public,

Vu le code de l'environnement en ses articles L.121-1 et suivants ;
Vu le courrier du 2 juillet 2024 et le dossier annexé de Mme Fabiola GIANOTTI, représentant le CERN, sollicitant une mission de conseil afin de préparer la saisine à venir sur le projet FCC de futur collisionneur circulaire d'accélérateur de particules du CERN et d'accompagner les premières démarches d'information du public menées par le maître d'ouvrage ;

Après en avoir délibéré,

Décide :

Article 1er
Mme Brigitte FARGEVIEILLE et M. Jonas FROSSARD sont désignés pour assurer une mission de conseil relative à la préparation de la saisine à venir sur le projet FCC d'accélérateur de particules du CERN et à l'accompagnement des premières démarches d'information du public menées par le maître d'ouvrage.

Article 2
A l'issue de leur mission, Mme Brigitte FARGEVIEILLE et M. Jonas FROSSARD, produiront un bilan de leur mission relative à la préparation de la saisine à venir sur le projet d'accélérateur de particules du CERN et à l'accompagnement des premières démarches d'information du public menées par le maître d'ouvrage.

Article 3
La présente décision sera publiée au *Journal officiel* de la République française.

Fait le 3 juillet 2024

Le Président
Signature numérique de Marc PAPINUTTI marc.papinutti
Date : 2024.07.03 16:30:58 +02'00'

Le président
M. Papinutti

CNDP decision for the Advisory Mission

FCC-ee main machine parameters

FUTURE CIRCULAR COLLIDER

Parameter	Z	WW	H (ZH)	ttbar
beam energy [GeV]	45.6	80	120	182.5
beam current [mA]	1270	137	26.7	4.9
number bunches/beam	11200	1780	440	60
bunch intensity [10^{11}]	2.14	1.45	1.15	1.55
SR energy loss / turn [GeV]	0.0394	0.374	1.89	10.4
total RF voltage 400/800 MHz [GV]	0.120/0	1.0/0	2.1/0	2.1/9.4
long. damping time [turns]	1158	215	64	18
horizontal beta* [m]	0.11	0.2	0.24	1.0
vertical beta* [mm]	0.7	1.0	1.0	1.6
horizontal geometric emittance [nm]	0.71	2.17	0.71	1.59
vertical geom. emittance [pm]	1.9	2.2	1.4	1.6
vertical rms IP spot size [nm]	36	47	40	51
beam-beam parameter ξ_x / ξ_y	0.002/0.0973	0.013/0.128	0.010/0.088	0.073/0.134
rms bunch length with SR / BS [mm]	5.6 / 15.5	3.5 / 5.4	3.4 / 4.7	1.8 / 2.2
luminosity per IP [10^{34} cm^{-2}s^{-1}]	140	20	≥5.0	1.25
total integrated luminosity / IP / year [ab^{-1}/yr]	17	2.4	0.6	0.15
beam lifetime rad Bhabha + BS [min]	15	12	12	11
	4 years 5 x 10^{12} Z LEP x 10^5	2 years > 10^8 WW LEP x 10^4	3 years 2 x 10^6 H	5 years 2 x 10^6 tt pairs

Design and parameters to maximise luminosity at all working points:

- allow for 50 MW synchrotron radiation per beam.
- Independent vacuum systems for electrons and positrons
- full energy booster ring with top-up injection, collider permanent in collision mode

- ❑ x 10-50 improvements on all EW observables
- ❑ up to x 10 improvement on Higgs coupling (model-indep.) measurements over HL-LHC
- ❑ x10 Belle II statistics for b, c, τ
- ❑ indirect discovery potential up to ~ 70 TeV
- ❑ direct discovery potential for feebly-interacting particles over 5-100 GeV mass range

Up to 4 interaction points → robustness, statistics, possibility of specialised detectors to maximise physics output

F. Gianotti

Optimisation for operation: 400 MHz SRF and beam switchyard

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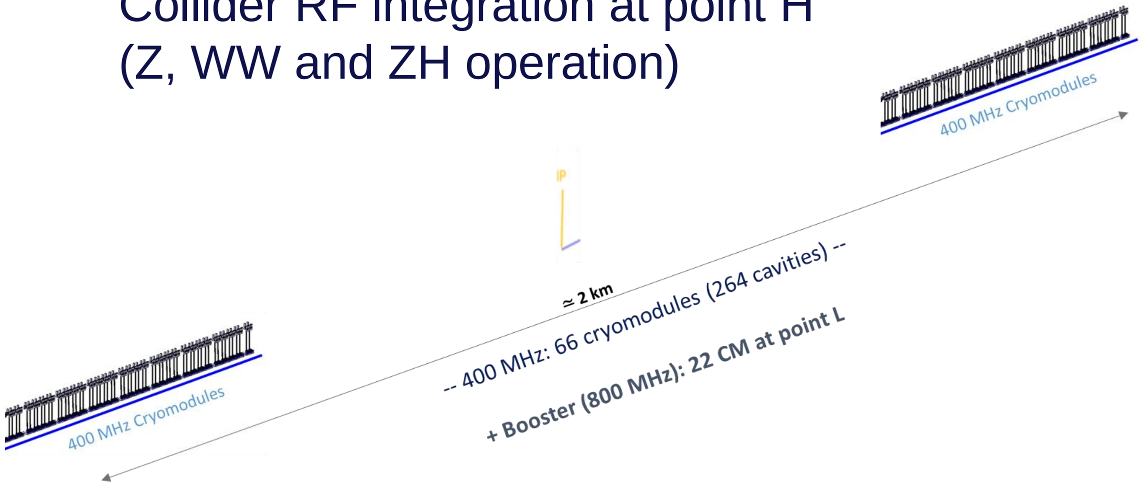
Beam switching between (Z, W) and ZH operation

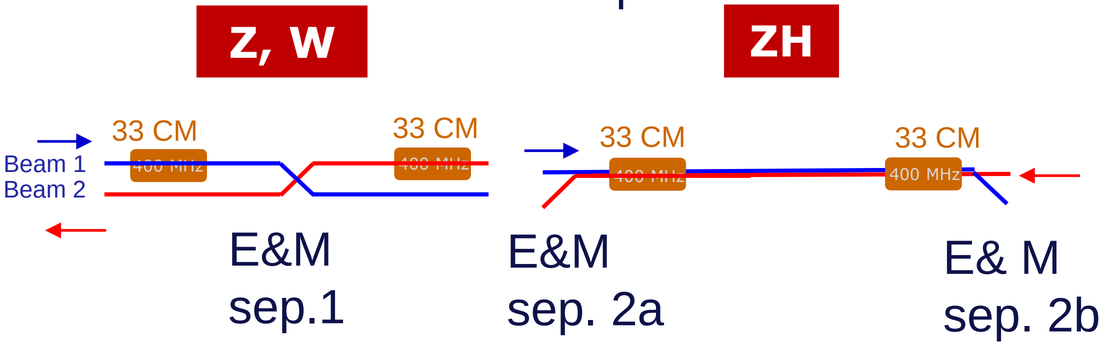
- 2-cell 400 MHz cavities for all three working points, identical configuration
- ES separators + magnetic field for switching beams
- Allows quasi "instantaneous" switching between Z, W, ZH

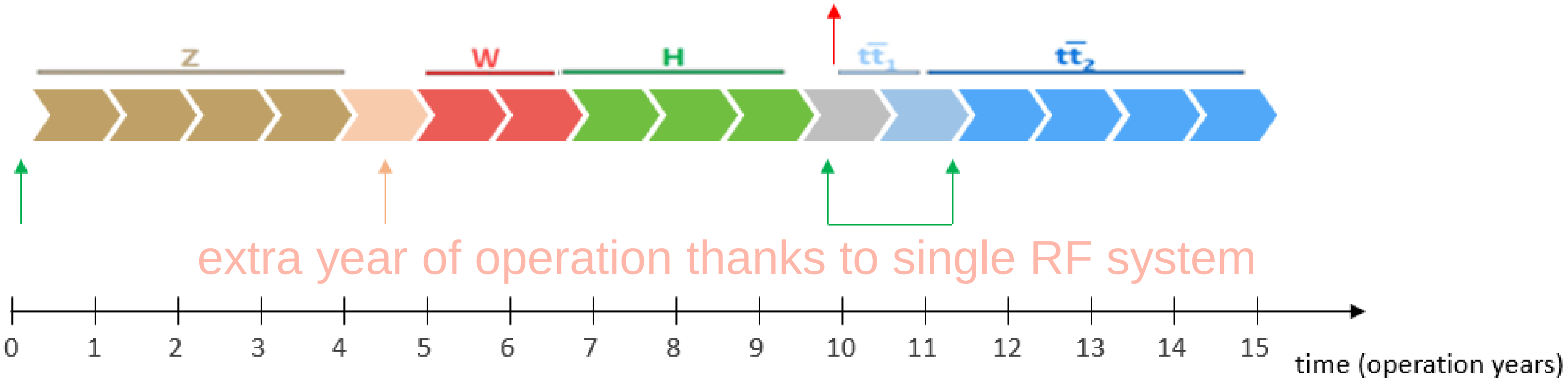
	Energy (GeV)	Current (mA)	RF voltage (GV)
Z	45.6	1280	0.08
W	80	135	1
H	120	26.7	2.08
ttb	182.5	5	11.67

Collider RF integration at point H
(Z, WW and ZH operation)



Beam crossing and combination
at RF section in point H



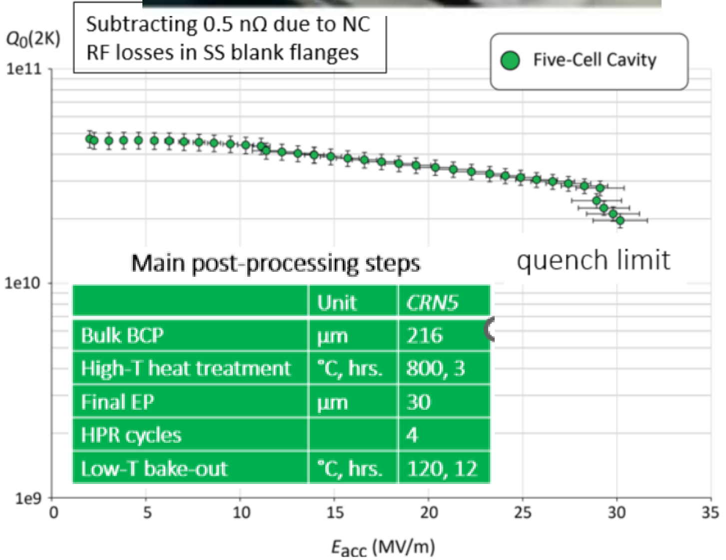


RF R&D activities

RF system R&D is key for increasing energy efficiency of FCC-ee

- Nb on Cu 400 MHz cavities (KEK as R&D partner), seamless cavity production, coating techniques
- Bulk Nb 800 MHz cavities, surface treatment techniques
- RF power source R&D in synergy with HL-LHC.

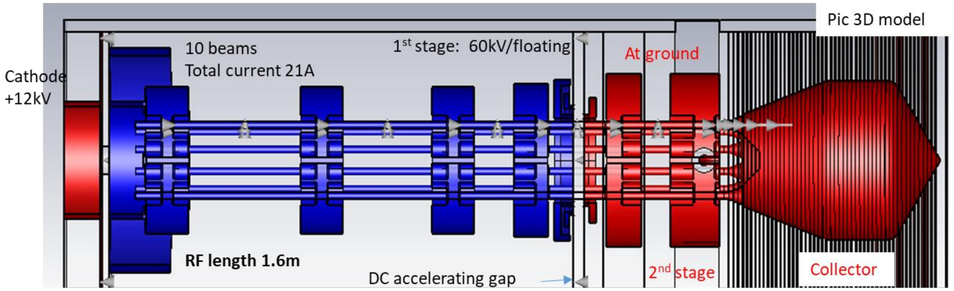
5-cell 800 MHz cavity development collaboration with JLAB

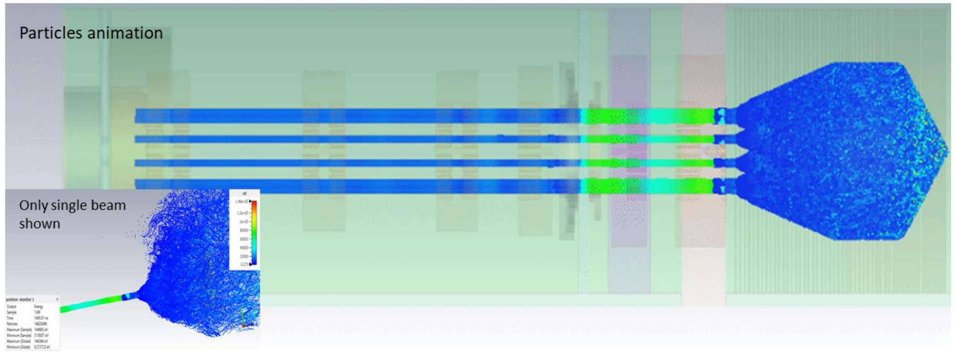


	Unit	CRN5
Bulk BCP	µm	216
High-T heat treatment	°C, hrs.	800, 3
Final EP	µm	30
HPR cycles		4
Low-T bake-out	°C, hrs.	120, 12

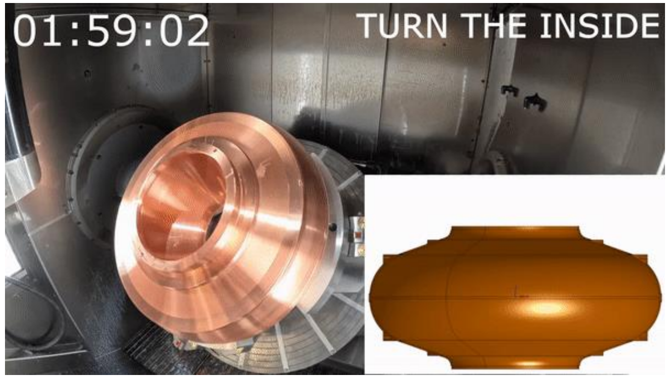
high-efficiency klystron R&D

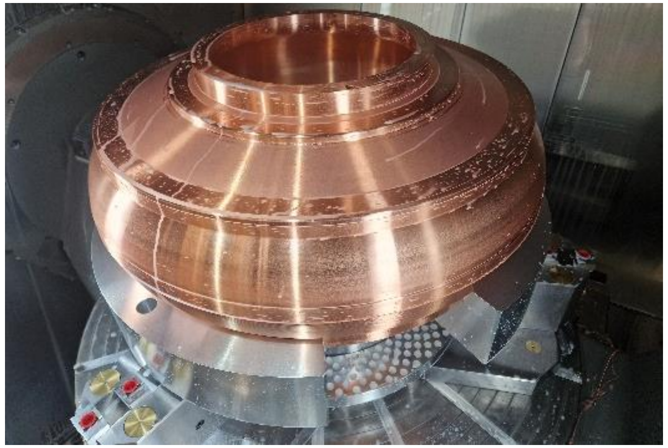
Novel two-stage MBK klystron: CW, 400MHz, 1.28MW.





400 MHz monoblock prototype





Interaction region mock up at INFN-LNF (Frascati)

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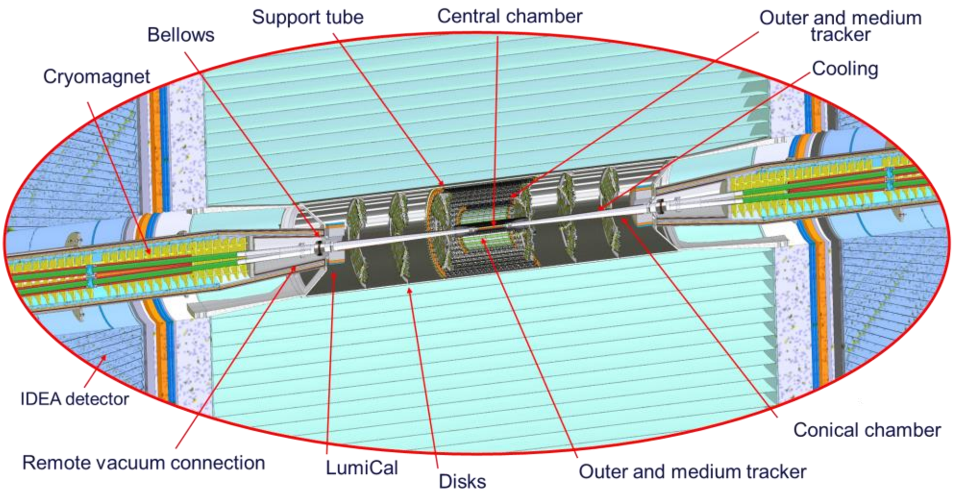
INFN-LNF, CERN and INFN-Pisa collaboration

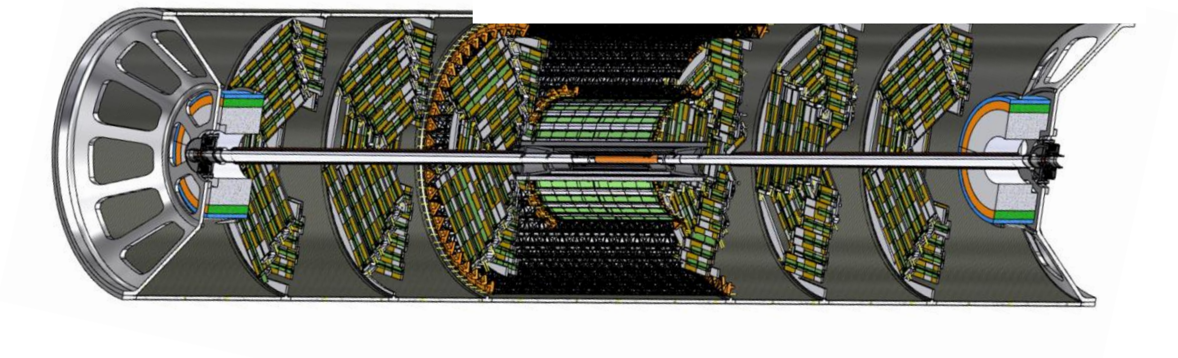
Assembly & test lab in Frascati

B. 5/a Serv. ing. mecc. (SIM) div.acc.

- Central chamber with paraffin cooling **in production** – **Tests starting end of Oct.**
  Conical chamber(s) with water cooling **~ to be ordered** – **Delivery end of the year**
- Vertex mechanical structure Carbon fibre foils **arriving**
- Vertex air cooling tunnel – **orders placed – assembled Q1 2025**
- Support tube - **orders expected Q1-2025**
- Bellows **~ design almost finished, to be ordered**
- Integration & overall assembly **Q4-2025**

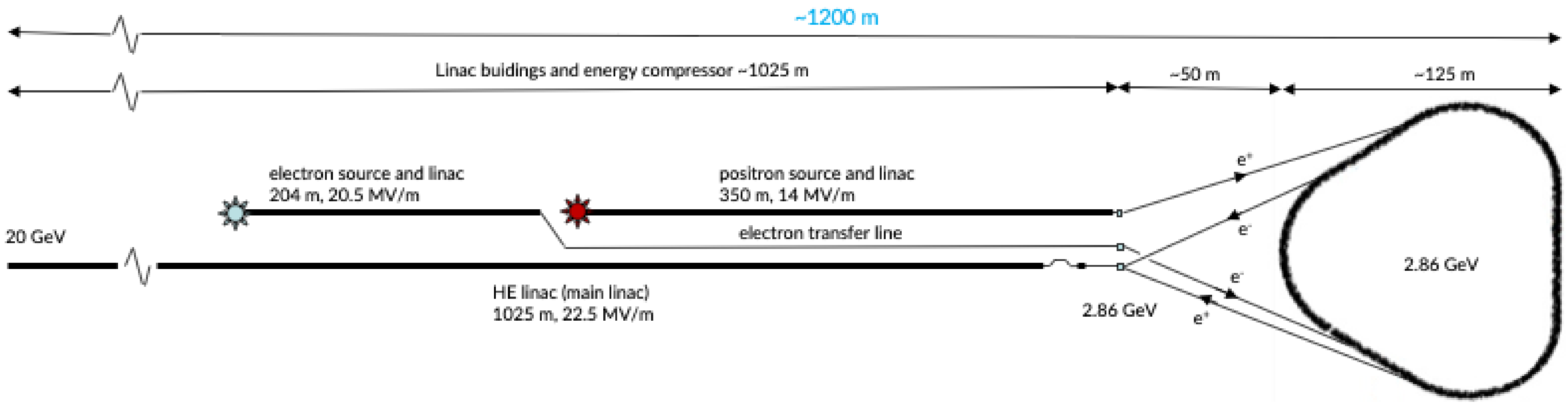


M. Boscolo,
F. Fransesini,
F. Palla



Optimized injector concept and parameters

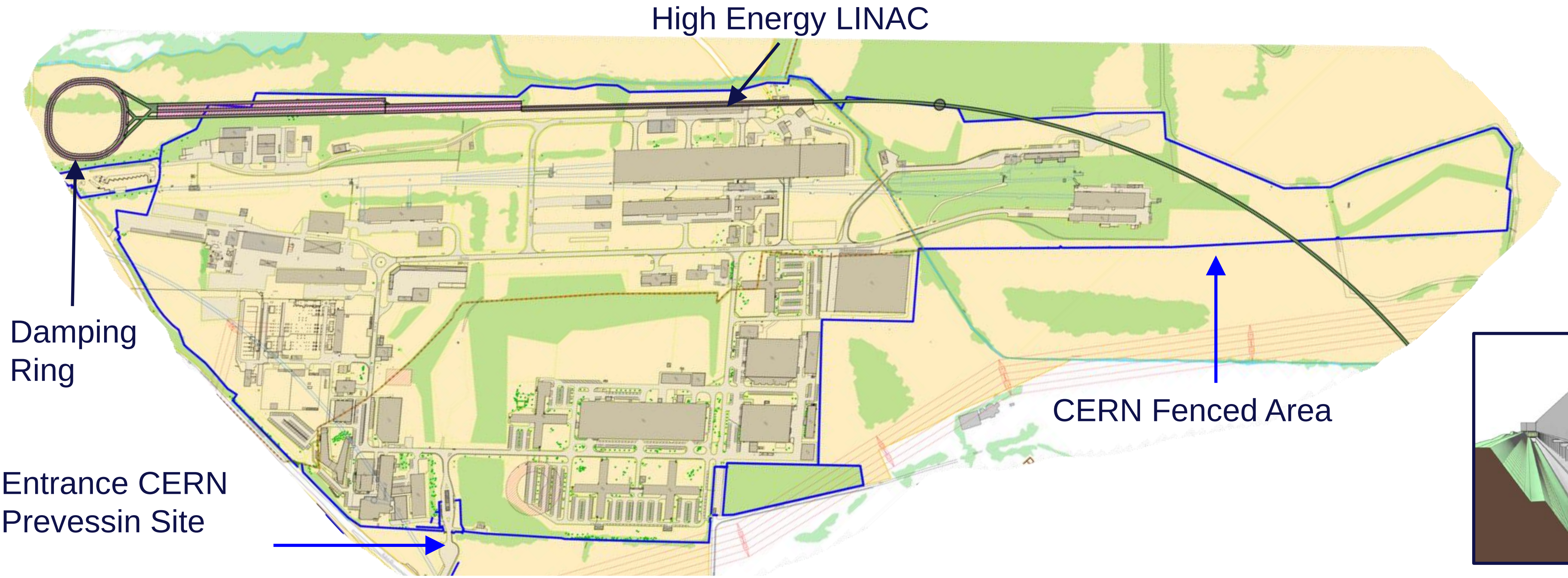
- **Mid-term review recommendations to reduce gradients and repetition rate → new linac optimization in terms of cost and power density**

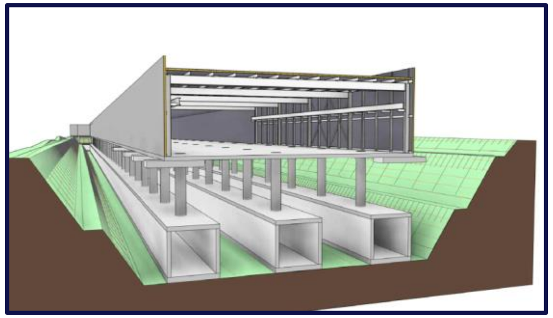


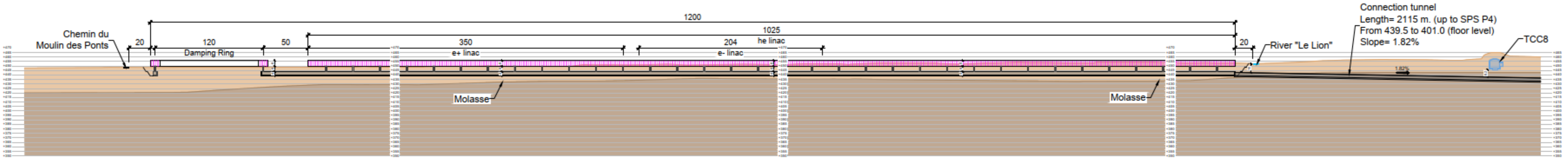
- Overall power consumption (for linacs) is reduced by **more than a factor 3** by means of:
  - new accelerating structures with higher shunt impedance;
  - lower gradient (29.5 MV/m → 22.5/20.5 MV/m);
  - lower repetition rate (200/400 Hz → 100 Hz).
- Repetition rate of **100 Hz with 4 bunches** per rf pulse
- New layout: **Damping Ring at higher energy 2.86 GeV**, no common linac with 2x repetition rate.

Optimised injector implementation at Prevessin site

- Good integration with existing CERN Prevessin Site and strongly reduced visibility from outside.
- Ideal connection to existing experimental halls.
- Good conditions for construction.







LONGITUDINAL PROFILE

Other FCC-ee science applications under study

→ **Workshop on "Other Science Opportunities at the FCC-ee"**
28-29 November at CERN, https://indico.cern.ch/event/1454873/

for example:

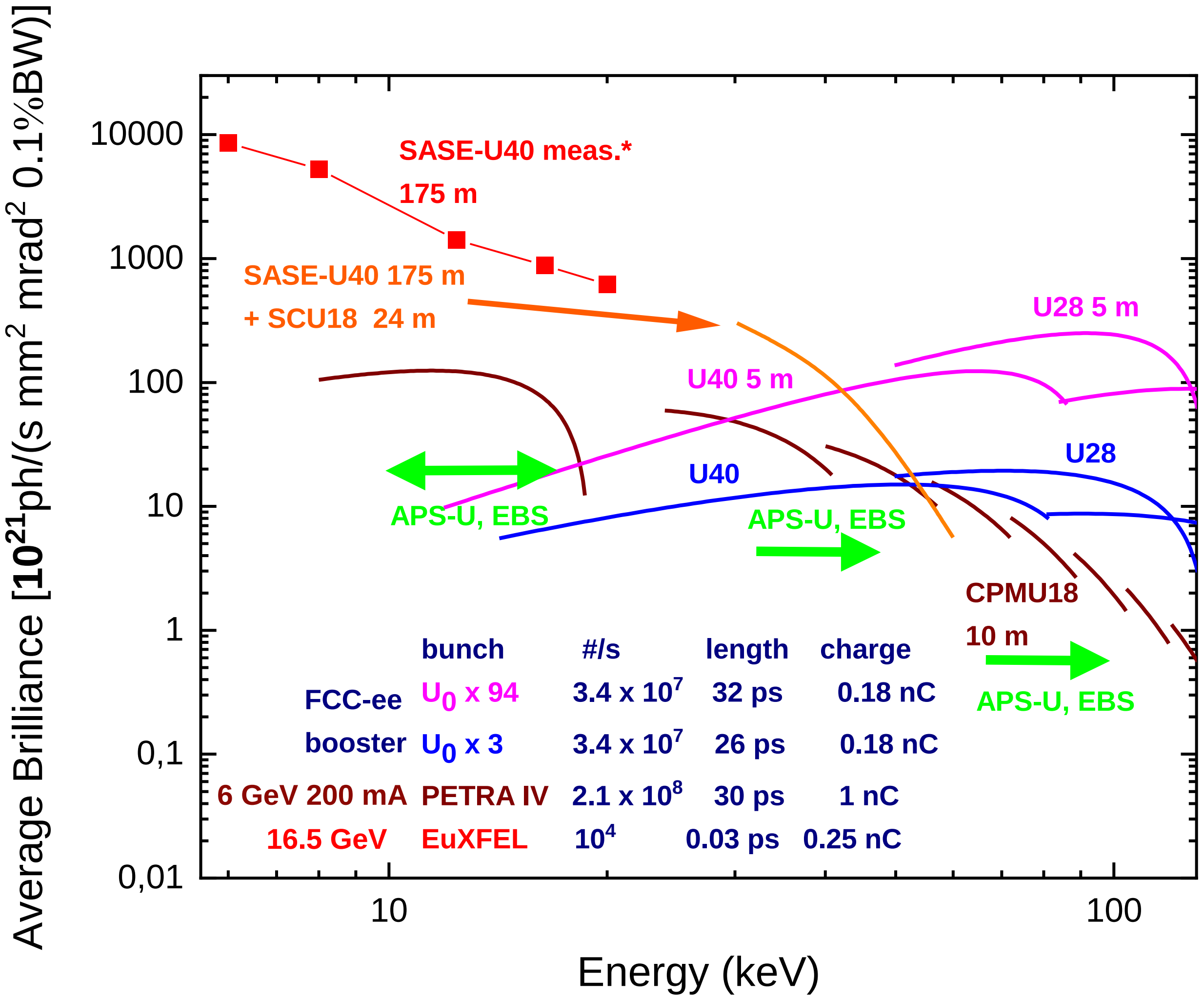
FCC-ee booster as diffraction limited storage ring with coherent synchrotron radiation down to 0.1 Å

FCC-ee injector as the world's **ultimate positron source** for material studies and paving a path towards the first **Bose-Einstein condensation of Ps** (511-keV gamma-ray laser)

using beamstrahlung for **radionuclide production**

e^- beam driven **neutron source**

etc.



FCC-hh main machine parameters

parameter	FCC-hh	HL-LHC	LHC
collision energy cms [TeV]	81 - 115	14	
dipole field [T]	14 - 20	8.33	
circumference [km]	90.7	26.7	
arc length [km]	76.9	22.5	
beam current [A]	0.5	1.1	0.58
bunch intensity [10^{11}]	1	2.2	1.15
bunch spacing [ns]	25	25	
synchr. rad. power / ring [kW]	1020 - 4250	7.3	3.6
SR power / length [W/m/ap.]	13 - 54	0.33	0.17
long. emit. damping time [h]	0.77 – 0.26	12.9	
peak luminosity [10^{34} $cm^{-2}s^{-1}$]	~30	5 (lev.)	1
events/bunch crossing	~1000	132	27
stored energy/beam [GJ]	6.1 - 8.9	0.7	0.36
Integrated luminosity/main IP [fb^{-1}]	20000	3000	300

With FCC-hh after FCC-ee: significant amount of time for high-field magnet R&D, aiming at highest possible collision energies

- Target field range for cryo-magnet R&D

Formidable challenges:
- ❑ high-field superconducting magnets: 14 - 20 T
- ❑ power load in arcs from synchrotron radiation: 4 MW → cryogenics, vacuum
- ❑ stored beam energy: ~ 9 GJ → machine protection
- ❑ pile-up in the detectors: ~1000 events/xing
- ❑ optimization of energy consumption: → R&D on cryo, HTS, beam current, …

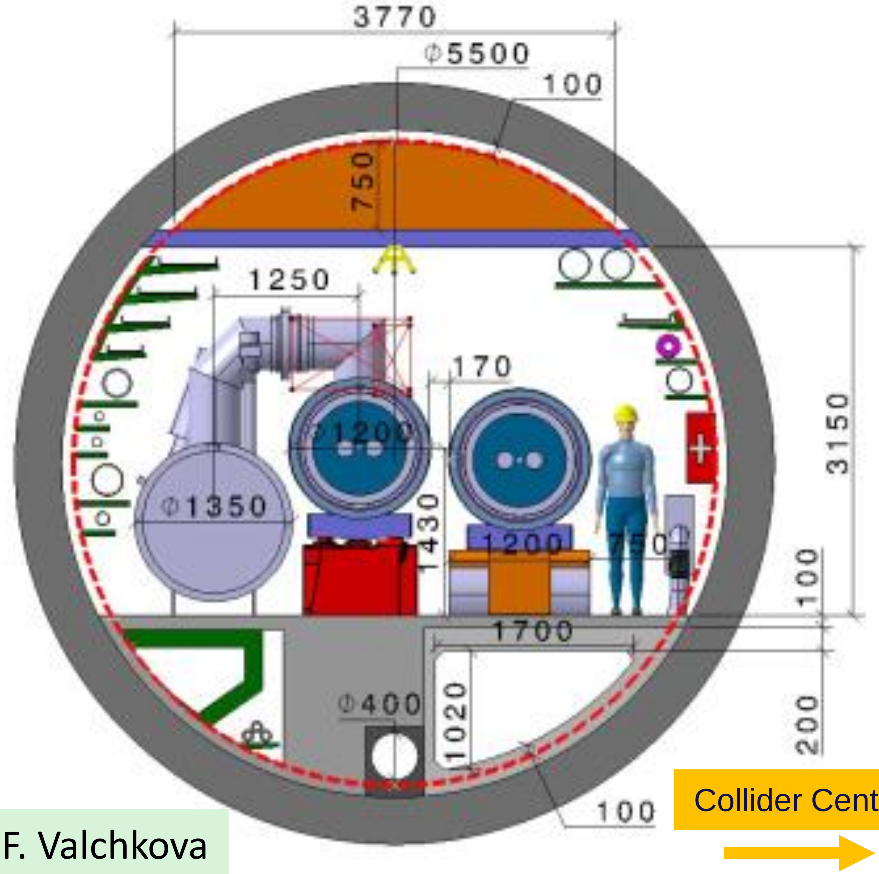
Formidable physics reach, including:
- ❑ Direct discovery potential up to ~ 40 TeV
- ❑ Measurement of Higgs self to ~ 5% and ttH to ~ 1%
- ❑ High-precision and model-indep (with FCC-ee input) measurements of rare Higgs decays ($\gamma\gamma$, $Z\gamma$, μμ)
- ❑ Final word about WIMP dark matter

F. Gianotti

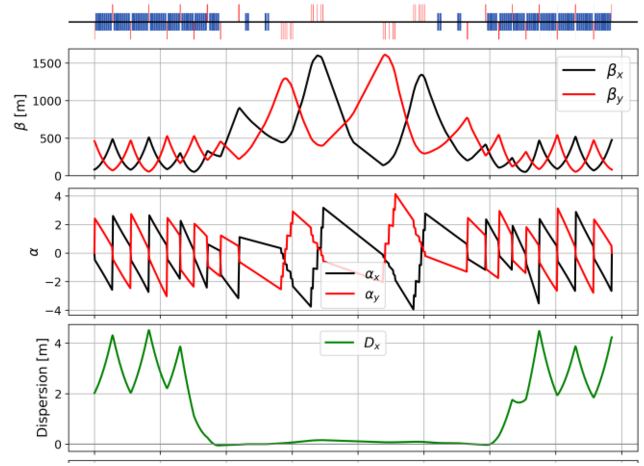
Key activities on FCC-hh: cryo magnet system, optics design

Optics design activities:

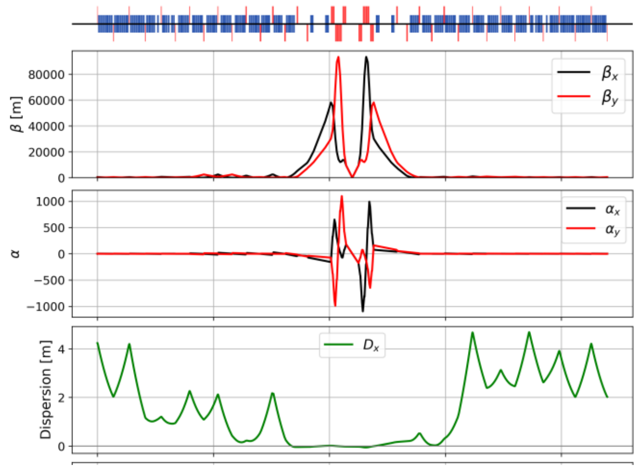
- adaptation to new layout and geometry
- shrink β collimation & extraction by ~30%
- optics optimisation (filling factor etc.)



F. Valchkova



betatron collimation straight



experimental straight

M. Giovannozzi. G. Perez, T. Risselada

High-field cryo-magnet system design

- Conceptual study of cryogenics concept and temperature layout for LTS and HTS based magnets, in view of electrical consumption.
- Update of integration study for the ongoing HFM designs and scaling to preliminary HTS design.

  → **Confirmation of tunnel diameter!**
- HFM R&D (LTS and HTS) on technology and magnet design, aiming also at bridging the TRL gap between HTS and Nb_3Sn.

FUTURE CIRCULAR COLLIDER

Status of FCC global collaboration

Increasing international collaboration as a prerequisite for success:
→links with **science, research & development** and **high-tech industry** will be essential to further advance and prepare the implementation of FCC

FCC Feasibility Study:
Aim is to increase further the collaboration, on all aspects, in particular on Accelerator and Particle/Experiments/Detectors

141 Institutes

32 countries + CERN

FUTURE CIRCULAR COLLIDER *Feasibility Study*

FCC Week 2024 - San Francisco – 10 to 14 June

449 participants, 50 public sessions, 216 oral presentations, 32 posters
US efforts getting organized, towards completing the FS by March 2025

Progress on international collaboration

Joint Statement of Intent between The United States of America and The European Organization for Nuclear Research concerning Future Planning for Large Research Infrastructure Facilities, Advanced Scientific Computing, and Open Science

The United States and CERN intend to:

- Enhance collaboration in future planning activities for large-scale, resource-intensive facilities with the goal of providing a sustainable and responsible pathway for the peaceful use of future accelerator technologies;
- Continue to collaborate in the feasibility study of the Future Circular Collider Higgs Factory (FCC-ee), the proposed major research facility planned to be hosted in Europe by CERN with international participation, with the intent of strengthening the global scientific enterprise and providing a clear pathway for future activities in open and trusted research environments; and
- Discuss potential collaboration on pilot projects on incorporating new analytics techniques and tools such as artificial intelligence (AI) into particle physics research at scale.

Should the CERN Member States determine the FCC-ee is likely to be CERN's next world-leading research facility following the high-luminosity Large Hadron Collider, the United States intends to collaborate on its construction and physics exploitation, subject to appropriate domestic approvals.

26 April 2024

White House Office of Science and Technology Policy Principal Deputy U.S. Chief Technology Officer Deirdre Mulligan signed for the United States while Director-General Fabiola Gianotti signed for CERN.

FUTURE CIRCULAR COLLIDER

EU Competitiveness Report

edited by Mario Draghi, and officially handed over to Ursula von der Leyen in September 2024

"One of CERN's most promising current projects, with significant scientific potential, is the construction of the Future Circular Collider (FCC): a 90-km ring designed initially for an electron collider and later for a hadron collider..

Refinancing CERN and ensuring its continued global leadership in frontier research should be regarded as a top EU priority*, given the objective of maintaining European prominence in this critical area of fundamental research, which is expected to generate significant business spillovers in the coming years."*

https://commission.europa.eu/topics/strengthening-european-competitiveness/eu-competitiveness-looking-ahead_en

Supporting statements at CERN’s 70 anniversary

“….No European country alone could have built the world’s largest particle collider. CERN has become a global hub because it rallied Europe and this is even more crucial today.

I am proud that we have financed the feasibility study for CERN’s Future Circular Collider (FCC). This could preserve Europe's scientific edge and could push the boundaries of human knowledge even further. *And as the global science race is on, I want Europe to switch gears. To do so, European unity is our greatest asset. ….”*

Ursula von der Leyen, President of the European Commiss*ion*

FCC Main Goals for Coming Years

- **Upcoming milestone for FCC is the completion of the Feasibility Study by March 2025 as input for the Update of the ESPP.**
- **The following pre-TDR phase should prepare for a possible project approval by 2027-2028 and enable the subsequent start of CE design contract:**
  - Updated cost and schedule studies
  - specifications to enable CE tender design by mid 2027
  - refined input for environmental evaluation and project authorisation process
  - requires overall integration study and designs based on technical pre-design of accelerators, technical infrastructure and detectors
- **Possible start of CE construction would then be 2032-33:**
  - CE groundbreaking
  - TDR to enable prototyping, industrialization towards component production
- **Strong international collaboration is essential for success!**

FUTURE CIRCULAR COLLIDER

FCC Week 2025 - Vienna

Event Overview

- **Venue**: **Hofburg Palace**, a historical and cultural landmark in **Vienna, Austria**.
- **Dates**: **Monday 19 to Friday 23 May 2025**
- **Presentation of the Feasibility Study Report and review of its findings and opportunities for future R&D projects**
- **Please save the date and join us in Vienna**

Spare slides

FUTURE CIRCULAR COLLIDER

Pre-TDR phase from April 2025 until end 2027

Main goal is to provide all relevant information to Council to allow taking a decision on the project **by end of 2027 or early 2028**

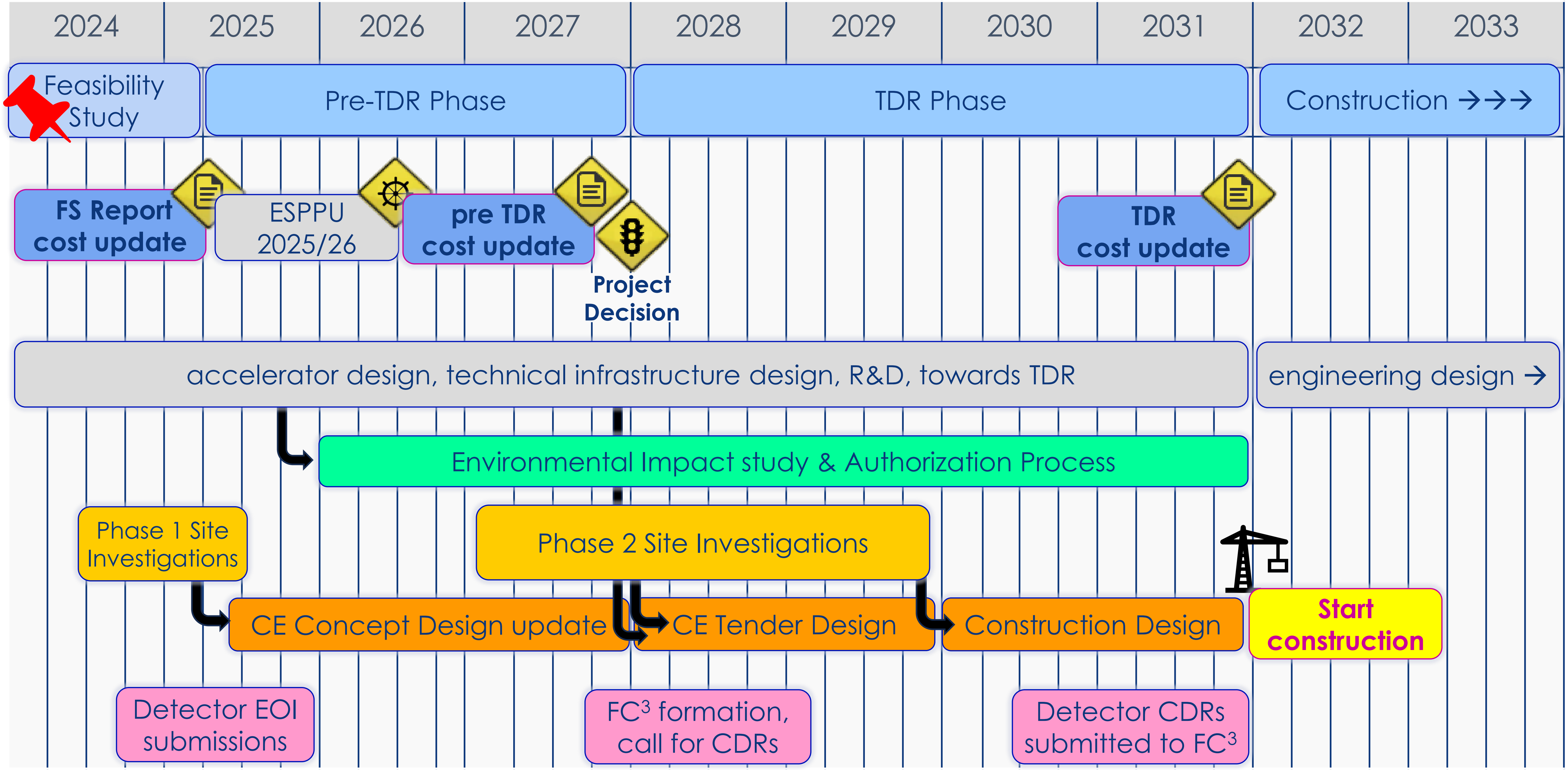
- Further develop the civil engineering and the technical design of all major systems and components, so as to provide a **more detailed cost estimate** with reduced uncertainties
- Continuation of **technical R&D activities**
- Work with host states on **regional implementation development** and **authorization process definition to enable launch of environmental impact study in 2026**
- Continuation of site investigations and perform an **overall integration study to specify requirements of technical infrastructure, accelerators and detectors**

→ **Provision of input for civil engineering design if the project goes ahead.**

→ Work with international partners to define roles and work packages

Resources for pre-TDR phase allocated, not yet approved by CERN Council.

Possible time line till start of construction



Construction and installation planning

Baseline collider schedule

- Q1 2033, Start of CE construction work
- Q2 2041, Completion of last lot of CE construction
- Q2 2043, Overall completion of TI installation
- Q4 2044, Accelerator installation completed
- Q4 2045, HW commissioning completed
- Q1 2046, First beams
- Q1 2048, Start of nominal operation
- Q3 2041 – Q3 2044, Experiment installation
- Q1 2046, Start beam commissioning