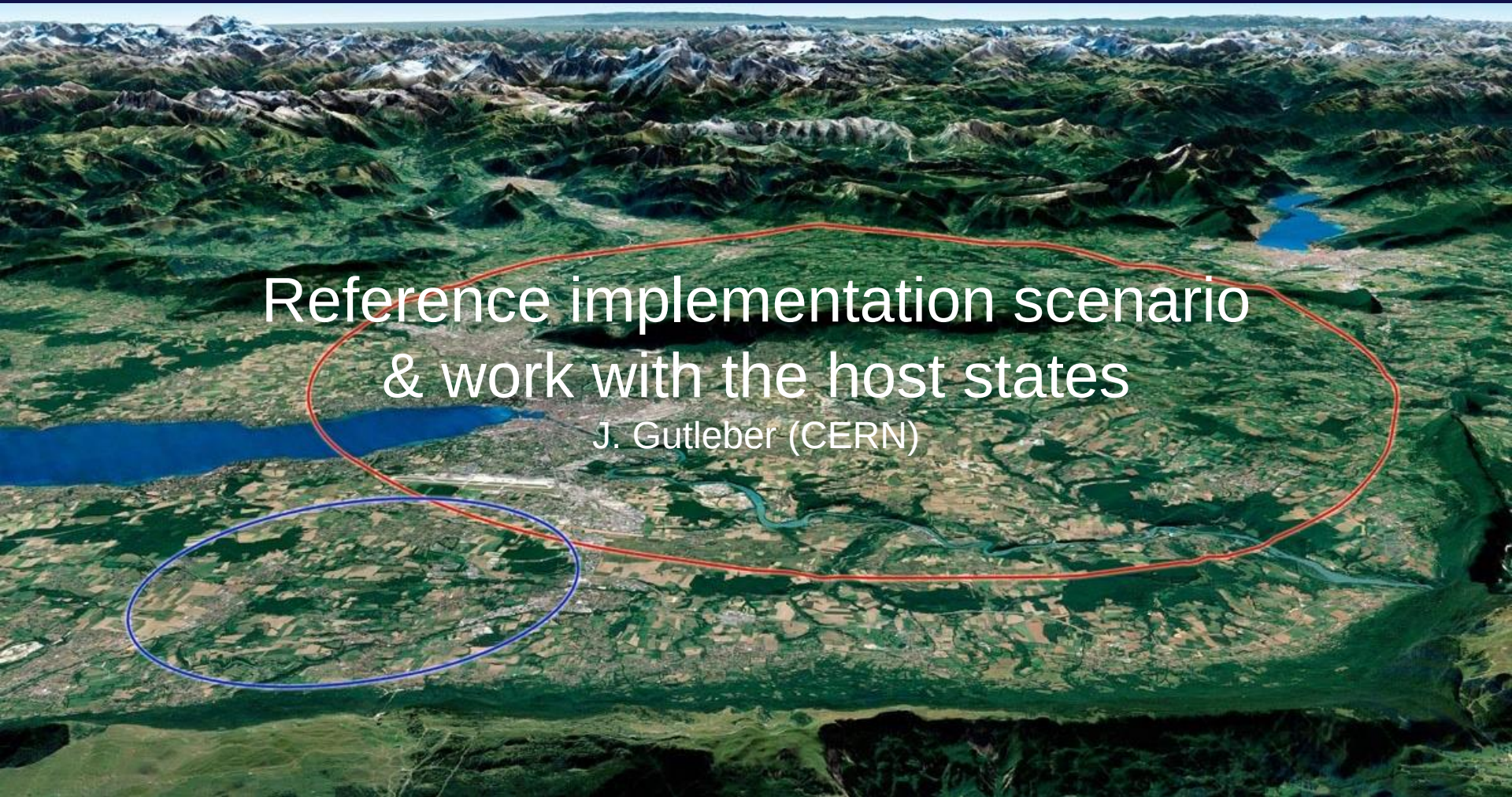

Reference implementation scenario & work with the host states

J. Gutleber (CERN)

Collaborative work of almost 120 people over several years

Laurent Aleazzi, DT Genève
Sophie Auchapt, McKinsey
Frédéric Bachmann, DT OCEau Genève
Austin Ball, CERN
Charles Barre, Egis
Wolfgang Bartmann, CERN
Fanny Battle, McKinsey
Michael Benedikt, CERN
Amandine Bibet-Chevallier, Cerema
Alain Blondel, UNIGE
Pierre Boillon, Cerema
Benjamin Bradu, CERN
Johann Peter Brasser, AMBERG
Christine Brawand, OCLPF Genève
Liam Bromiley, CERN
Olivier Brunner, CERN
Jean-Paul Burnet, CERN
Heloise Candolfi, OCAN Genève
Jérôme Chablais, Hydro-Geo Environnement
Didier Chanal, Cerema
Gilles Chapelier, Cerema
Suzanne Chibli, CERN
Nicolas Clerc, GESDEC Genève
Charles Cook, CERN
Angel Navascues Cornago, CERN
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Julien Joos, Cerema
Ivan Karpov, CERN
Laurent Kompf, DDT74
Patrycja Laidouni, CERN
Pauline Le Guen, CERN
Yann Lechevin, CERN
Yung Loo, ARUP
D. Magnard, DGITM
P. Magnière, DGITM
Clotilde Malan, Cerema
Olivier Martin, MAE
Antoine Mayoux, CERN
Volker Mertens, CERN
Thierry Messager, DI Genève
Pascal Michel, DT Genève
Nicolas Montanaro, DDT01
Andrea Moscariello, Université de Genève
Tao Ni Song, McKinsey
Katsunobu Oide, KEK et Université de Genève
John Osborne, CERN
Thomas Otto, CERN
Amael Paillex, Ecotec
Francois Pasquini, DT OCEau Genève
Franck Peauger, CERN
Marion Penelas, OCBA Genève
Guillermo Peon, CERN
Luc Petitpain, Cerema
Pierre Philippe, SERMA Genève
Michael Poehler, CERN
Aude Poiron, Ecotec
Corentin Pueyo, CERN
Tor Raubenheimer, SLAC
Lucy Rew, EGIS
Werner Riegler, CERN
Thys Risselada, CERN
Youri Robert, CERN
Pierre Roche, Setec
Ingo Rühl, CERN
Maude Sauvain, Latitude Durable
Joscha Schabram, McKinsey
Delphine Stagnara, Setec
Joanna Louise Stanyard, CERN
Craig Sturzaker, ARUP
Matthew Sykes, ARUP
Laurent Tavian, CERN
Cécile Tétrel, Cerema
Cyril Thomas, GADZ
Sandrine Tissandier, Cerema
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Fani Valchkova-Georgieva, CERN
Jean-Marc Valet, Cerema
Anne-Laure Verdier, CERN
Walter Vetterli, OCEV Genève
Jérémy Voiron, BG
Anne Vuichard, DT Genève
Timothy Watson, CERN
Gerhard Widmer, DI Genève
Markus Widorski, CERN
Matthieu Zahnd, Ecotec
Linhao Zhang, CERN
Frank Zimmermann, CERN

A balance of stakes

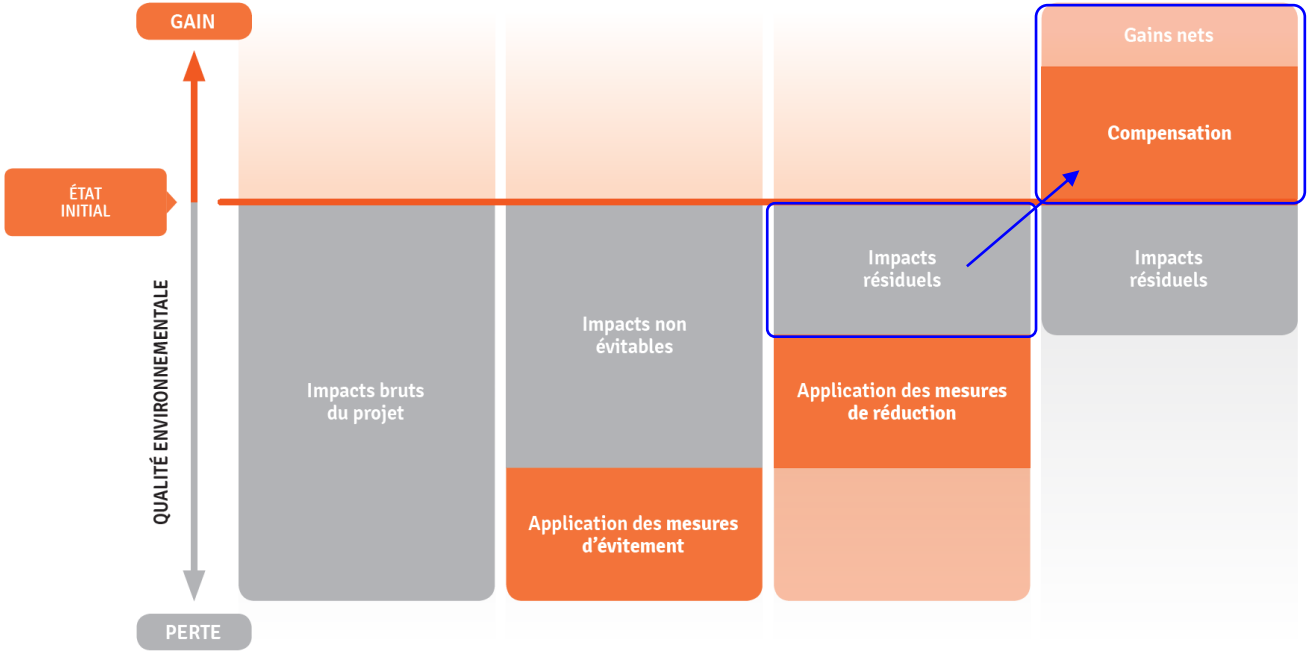
« Avoid-Reduce-Compensate » approach to develop iteratively a well-balanced reference scenario

Territorial impact limitation leads to Societal acceptance

Performance of particle collider leads to **scientific excellence**

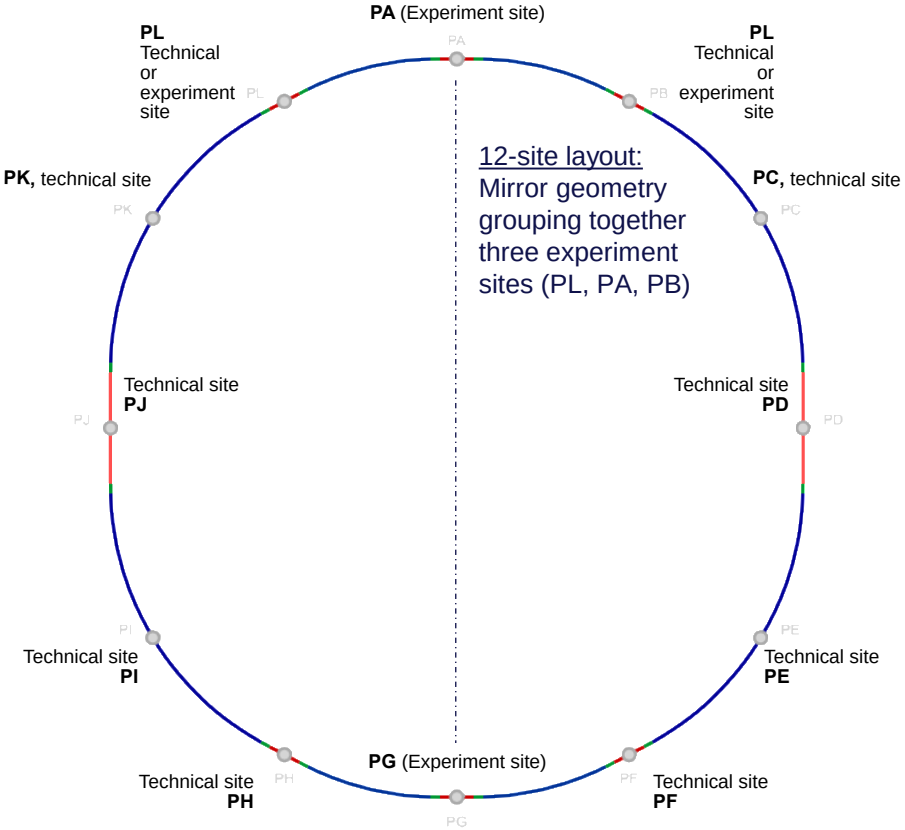
Technical feasibility and cost control lead to **Acceptable project risks**

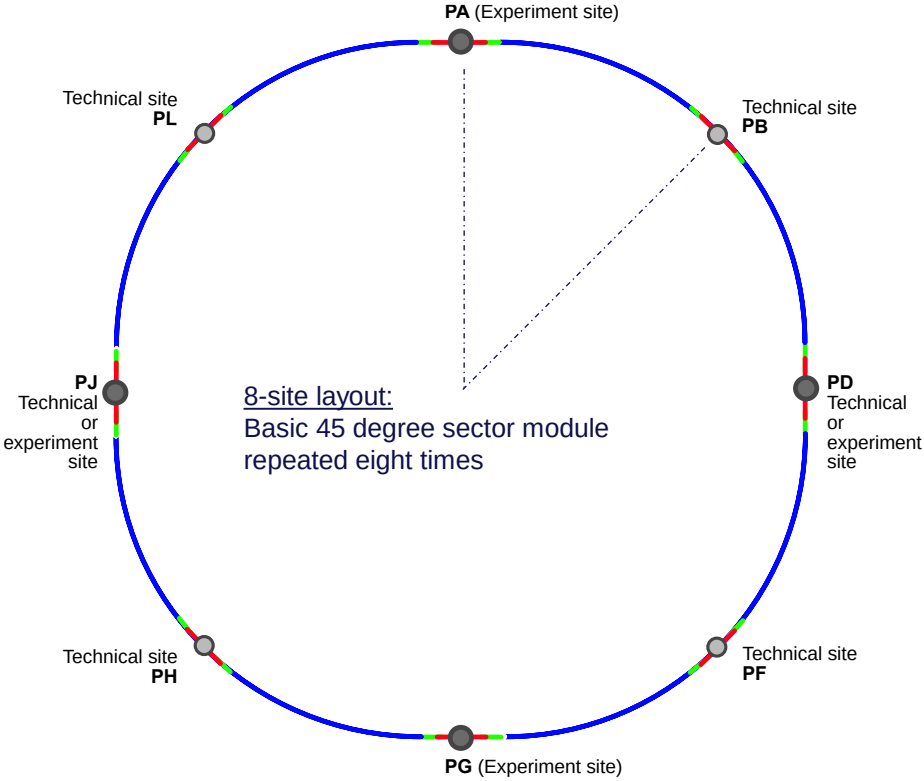
Approach “Eviter-Reduire-Compenser”



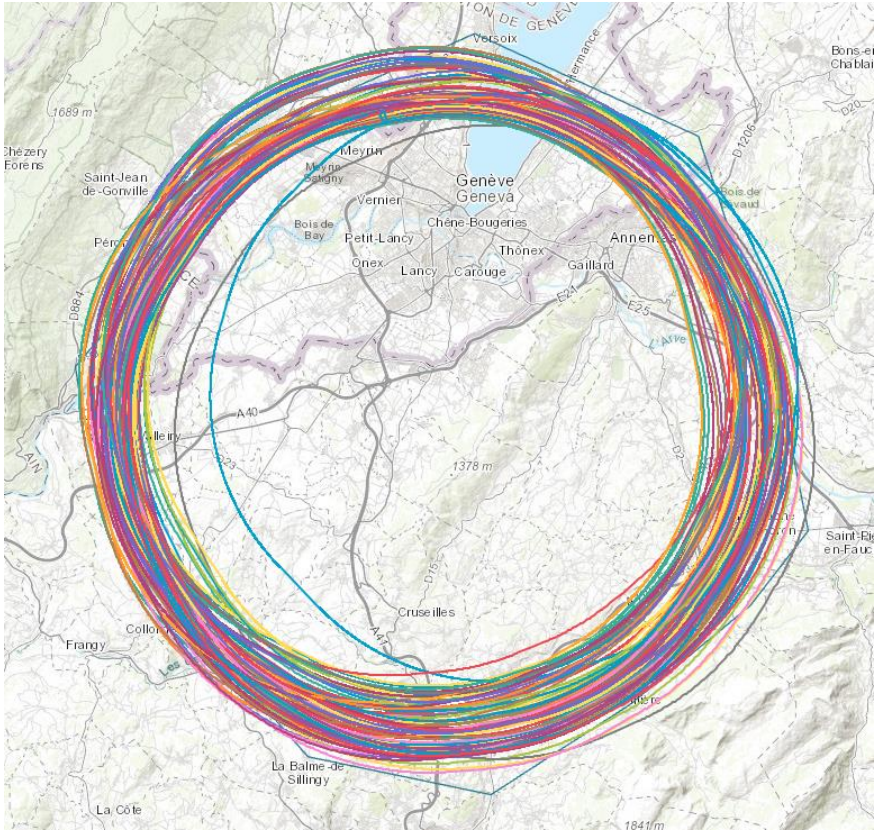
Note: approach required by French environmental law.
Similar concept anchored in swisss project authorisation process.

Reminder of layouts studied



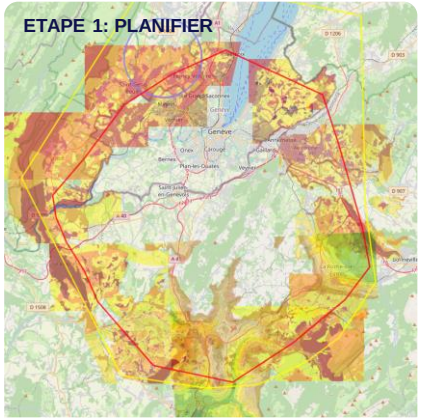


More than 100 scenarios developed & analysed

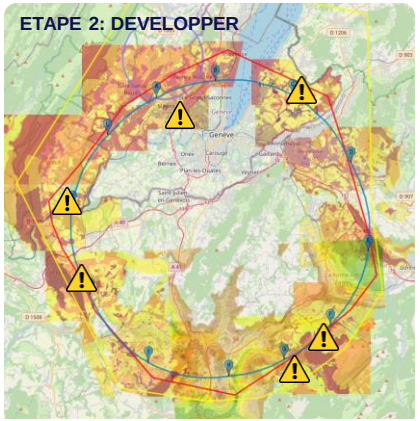


Multi-criteria approach covering 37 aspects

Legal and administrative aspects – 5 criteria
Connectivity – 2 criteria
Availability of services – 2 criteria
Accessibility of infrastructures – 6 criteria
Land plot related aspects – 9 criteria
Environnement – 8 criteria
Accelerator configuration – 3 criteria
Cost of construction
Risks linked to the construction



Identifier les **exigences et les contraintes** pour la mise en œuvre technique et territoriale nécessaire dans le cadre des études de placement.

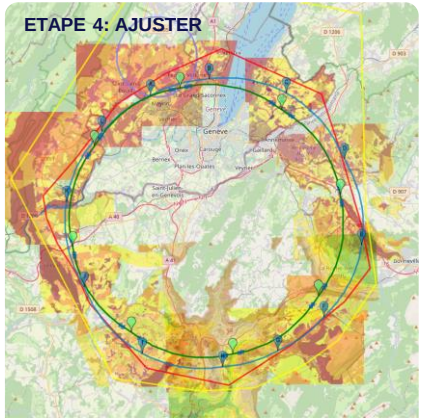


Adapter les ouvrages souterrains et les sites de surface aux exigences et contraintes identifiés. Enregistrer les incompatibilités techniques rencontrées.

ETAPE 3: CONTROLER

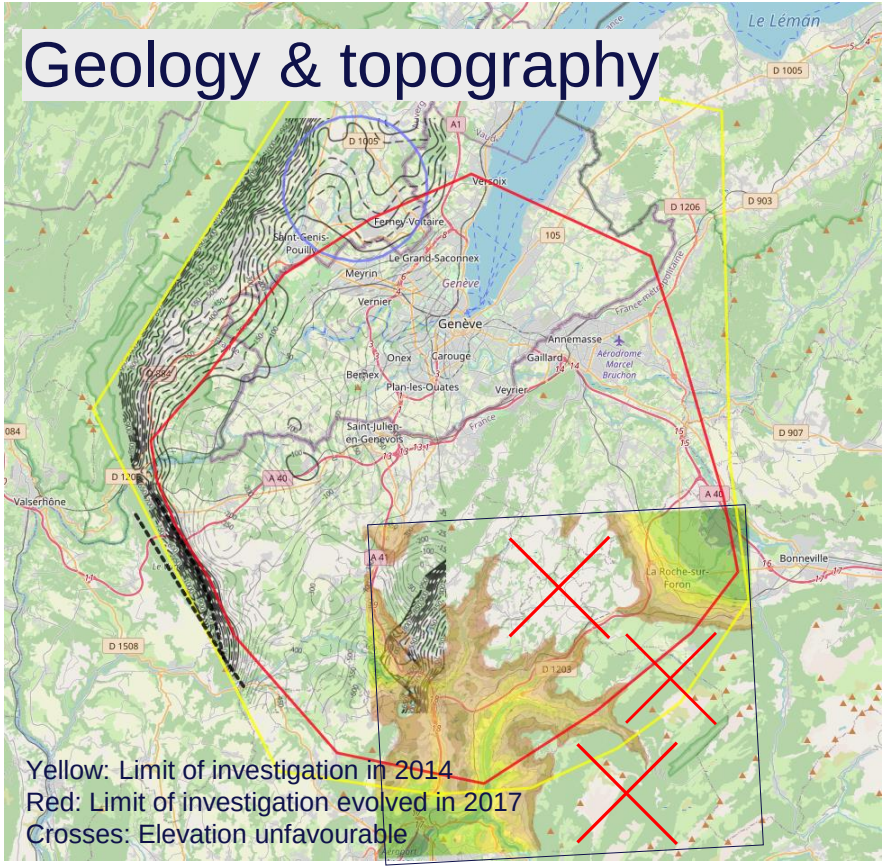
	Territory	Layout	Cost & risk	Overall
CDR				
PB17				
Score	57	66	68	
PB19				
Score	74	33	25	
PA21				
Score	88	59	25	

Analyser la pertinence de l'hypothèse de travail. Si le scénario semble inacceptable, l'ajuster (étape 4). Sinon, conserver pour les études plus détaillées.

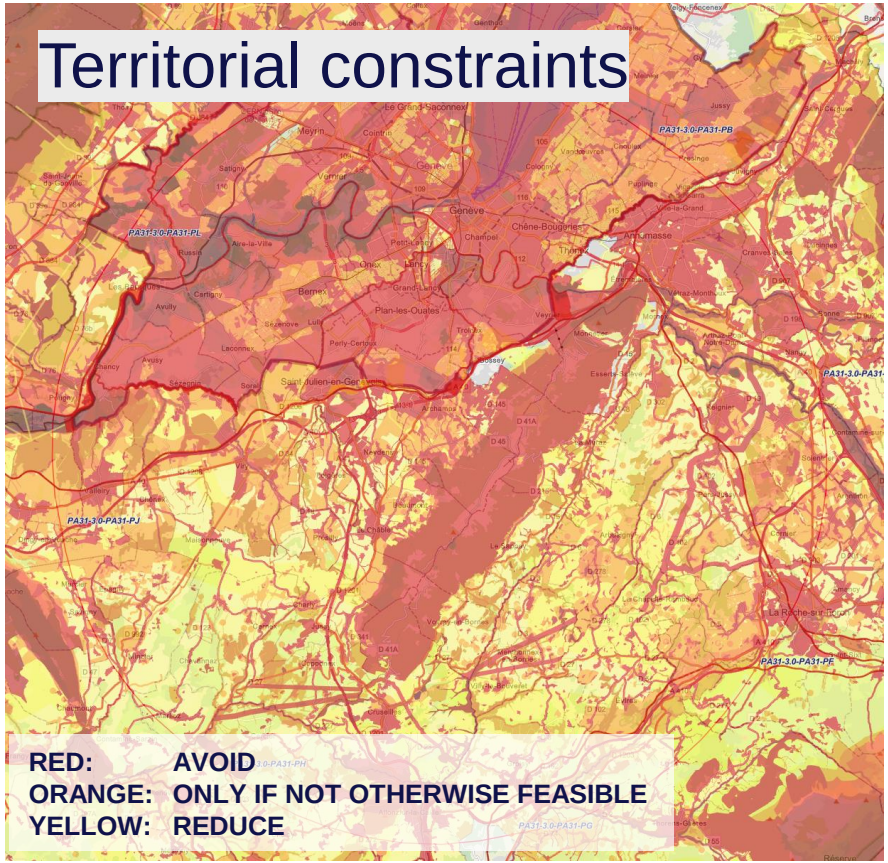


Développer des mesures « **Éviter-Réduire-Compenser** » pour répondre aux points inacceptables identifiés dans le scénario (étape 3)

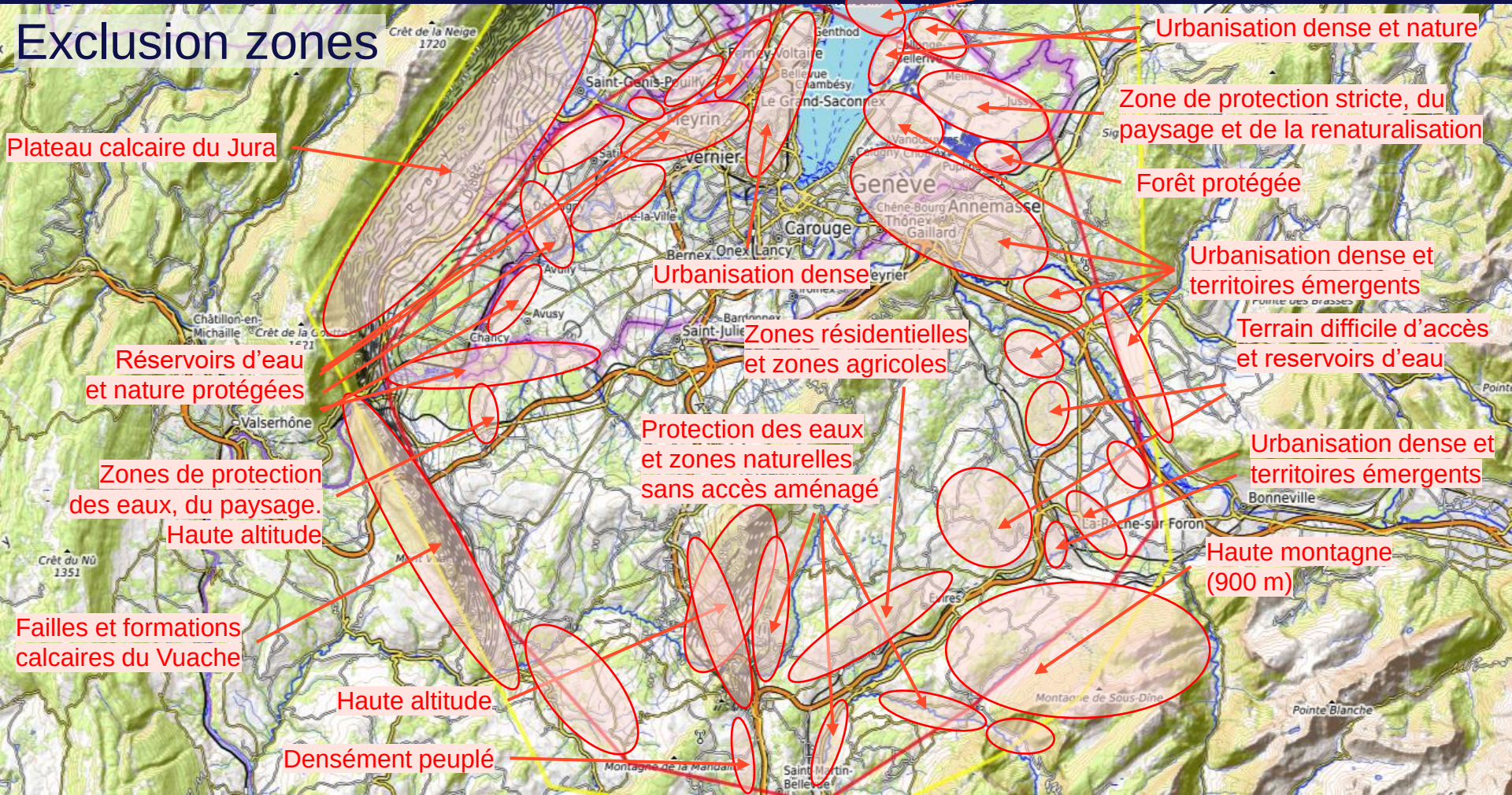
Geology & topography



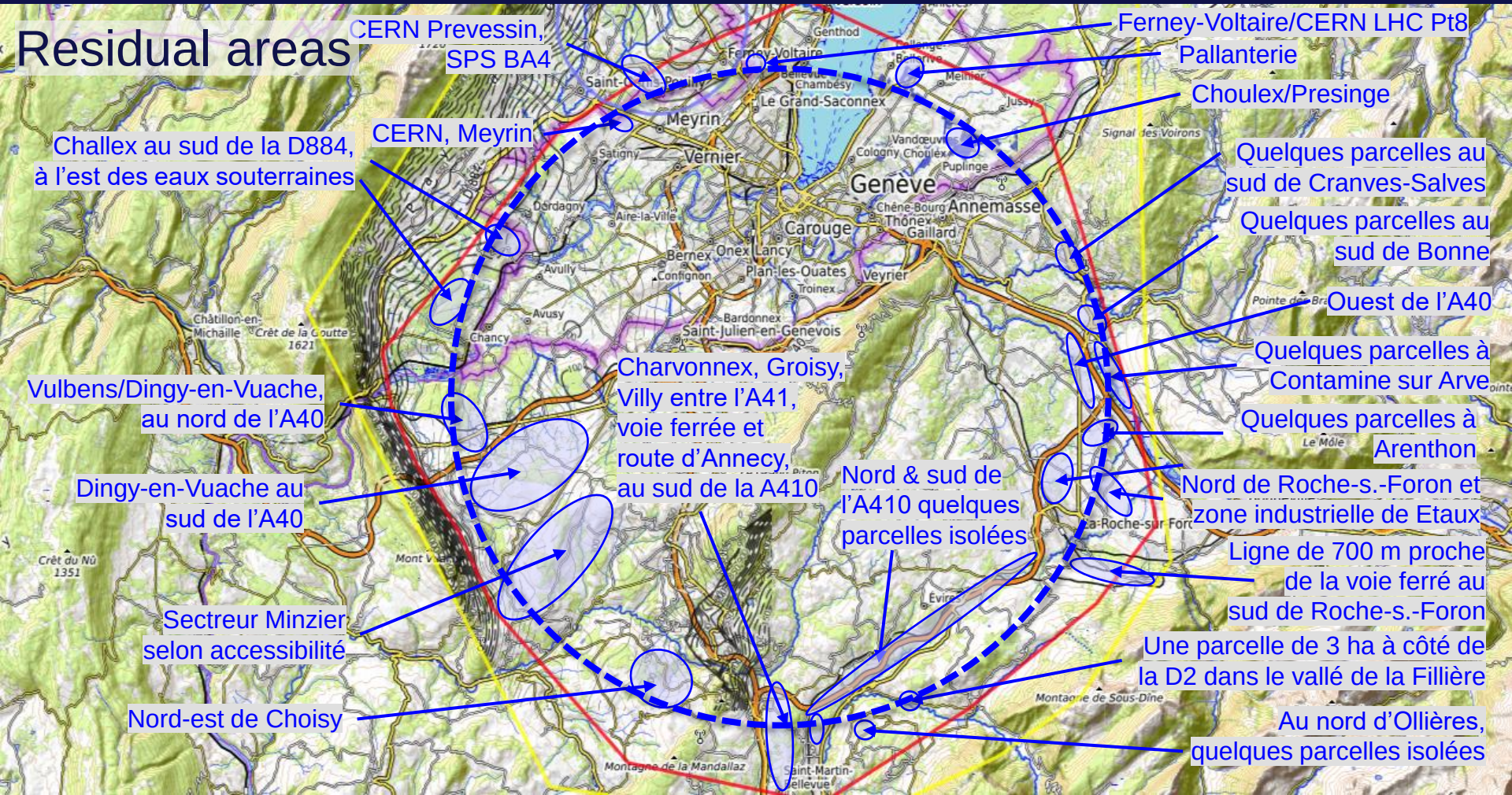
Territorial constraints



Exclusion zones

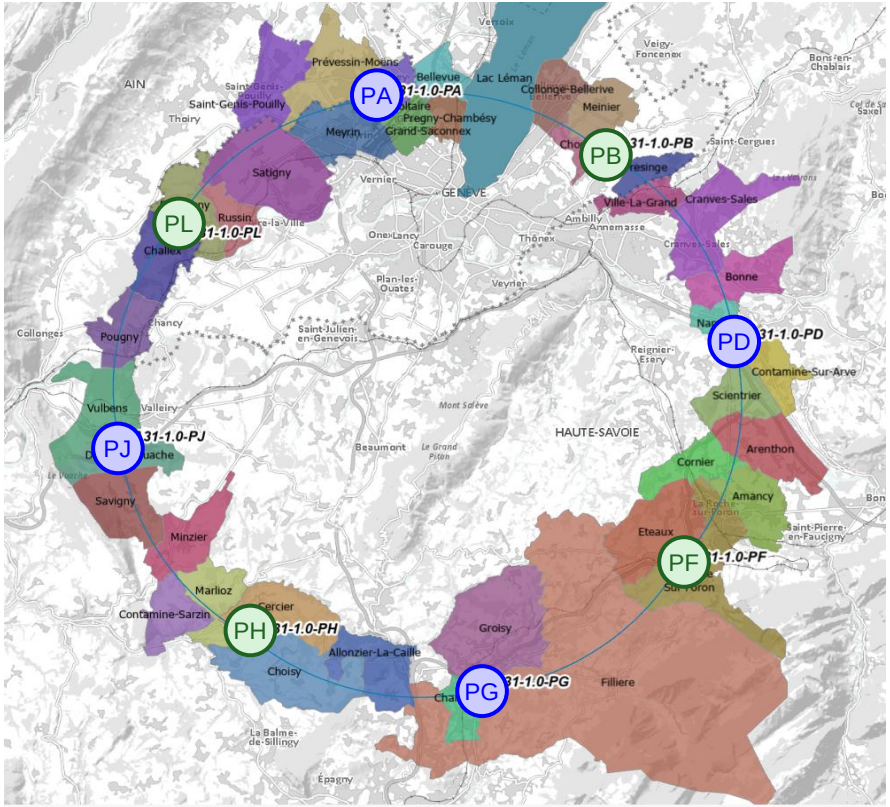


Residual areas



Reference scenario PA31 surface site locations

1. **PA – Ferney Voltaire** (FR, 01) – experiment
2. **PB – Choulex** (CH) – technical
3. **PD – Nangy** (FR, 74) – experiment
4. **PF – Etaux/La Roche-sur-Foron** (FR, 74) - technical
5. **PG – Charvonnex/Groisy** (FR, 74) - experiment
6. **PH – Cercier/Marlioz** (FR, 74) – technical, main RF
7. **PJ – Vulbens/Dingy en Vuache** (FR, 74) – experiment
8. **PL – Challex** (FR, 01) – technical, booster RF



Scenario PA31 parameters

Straight section @IP: 1 400 m

Straight technical section: 2032 m

Sum of arcs: 76 929.609 m

Total length: 90 658.828 m

FCC-hh RF length required is: 90 657.4 m

Therefore some further minor adjustment of the trace is currently taking place to produce an ee/hh integrated trace that meets both requirements and limits the necessary the tunnel widening on both sides of the IPs.

Inclination: 0.5% (about a line from PD to PJ with PA moving upwards and PG downwards)

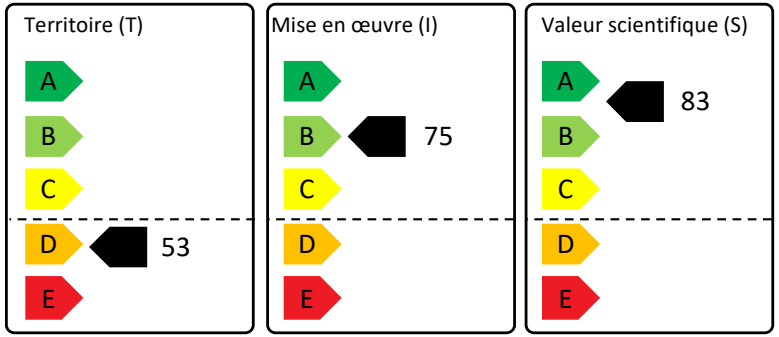
Shaft depths:

PA: 201 m (2 shafts)
PB: 201 m (1 shaft displaced ca. 150 m along LSS)
PD: 181 m (2 shafts)
PF: 400 m (1 shaft 300 m to 600 m inside the ring)
PG: 226 m (2 shafts)
PH: 235 m (1 shaft)
PJ: 253 m (2 shafts)
PL: 250 m (1 shaft displaced 1 000 m along LSS)

Optimisation of scenario since CDR publication

Element	CDR	Feasibility study	Change	Effect
Number of surface sites sites	12	8	▼	BETTER
Synergies with CERN infrastructures	1	1 (+ Prevessin)	-	NEUTRAL
Land surface needs	108 ha	~ 41 ha	▼	BETTER
Total circumference	97.75 km	90.66 km (-7.25 %)	▼	BETTER
Sum of arcs	83.75 km	76.93 km (- 8.1%)	▼	WORSE
IP straight lengths	1400 m	1400 m	-	NEUTRAL
Amount of excavated materials	9 m^3	8 m^3	▼	BETTER
Possible interaction points for hh/ee	4/2	4/4	▲	BETTER
Lengths of access roads	3.5 km	3.5 - 2.5 km	▼	BETTER
Number of shafts	20	12	▼	BETTER
Ecological surfaces affected	23 ha	8 ha	▼	BETTER
Access synergies	4/12 (33 %)	7/8 (87%)	▲	BETTER
Synergy potentials public infrastructures	2/12 (16%)	5/8 (62 %)	▲	BETTER
Synergy potentials private structures	5/12 (41%)	8/8 (100%)	▲	BETTER

PA0-0.1 – the 12 site CDR scenario 2018



<u>Conditions de faisabilité</u>

85 à 100: Réalisable avec des ajustements ou des efforts mineurs

70 à 84: Réalisable avec des ajustements ou des efforts modérés

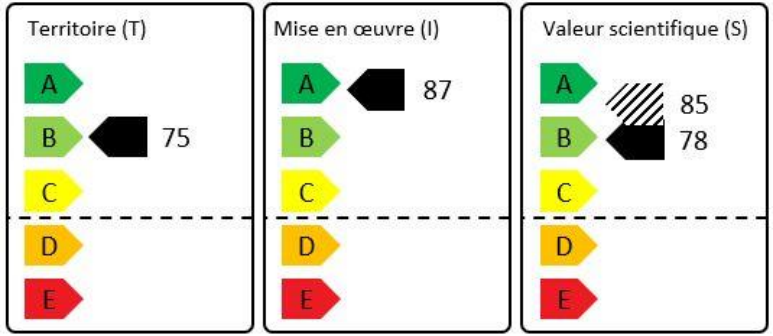
55 à 69: Réalisable avec des ajustements ou des efforts majeurs

40 à 54: Faisabilité faible — Seuil d'acceptation

0 - 39: Faisabilité improbable

PA0-0.1	PA	PB	PC	PD	PE	PF	PG	PH	PI	PJ	PK	PL	Trace	Total
FCC-ee	EXP			RF			EXP			RF			97.75 km	
FCC-hh	EXP	EXP	Cryo		Cryo	Col		RF	Cryo	Col	Cryo	EXP		
Site														
Score	89	52	51	61	75	40	41	36	49	45	33	36	84	53

PA31-3.0 – the **8 site reference scenario**



Conditions de faisabilité

85 à 100: Réalisable avec des ajustements ou des efforts mineurs

70 à 84: Réalisable avec des ajustements ou des efforts modérés

55 à 69: Réalisable avec des ajustements ou des efforts majeurs

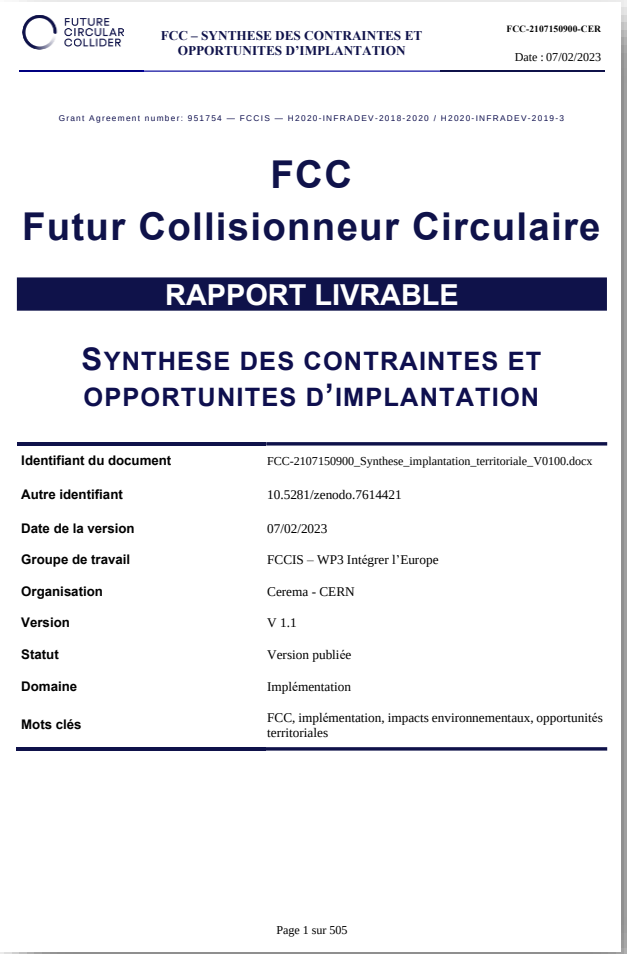
40 à 54: Faisabilité faible — Seuil d'acceptation

0 - 39: Faisabilité improbable

PA31-3.0	PA	PB	-	PD	-	PF	PG	PH	-	PJ	-	PL	Trace	Total
FCC-ee	EXP	Tec		Tec		Tec	EXP	RF		Tec		RF	90.6 km	B
FCC-hh	EXP	Cryo		EXP		Cryo	EXP	Cryo		EXP		Cryo		
Site														
Score	84	70	-	89	-	77	74	68	-	70	-	70	82	76

Implementation scenario documentation

- With the definition of a **“reference implementation scenario”, FCC entered a new phase**
- **Engagement of national actors has started in late 2022**
  - Communes
  - Notified bodies
  - Host state government representatives
  - Associations
- This **requires a <u>managed</u> and <u>single source of</u> information to provide national stakeholders with reliable, trustworthy and managed information relevant to them <u>in their language.</u>**
- The single reference documentation is FCCIS deliverable 3, currently titled **“*Synthèse des contraintes et opportunités d’implantation*”.**
- Made **available via the Zenodo Open Access platform.**
- Document and data sets are **properly versioned and undergo a quality management process.**
- **Geolocalised information is kept in an FCC Environmental Information System**, which has been put in place between 2022 and 2023 (to be gradually opened).



FUTURE CIRCULAR COLLIDER

FCC – SYNTHESE DES CONTRAINTES ET OPPORTUNITES D'IMPLANTATION

FCC-2107150900-CER

Date : 07/02/2023

Grant Agreement number: 951754 — FCCIS — H2020-INFRADEV-2018-2020 / H2020-INFRADEV-2019-3

FCC
Futur Collisionneur Circulaire

RAPPORT LIVRABLE

SYNTHESE DES CONTRAINTES ET OPPORTUNITES D'IMPLANTATION

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Autre identifiant	10.5281/zenodo.7614421
Date de la version	07/02/2023
Groupe de travail	FCCIS – WP3 Intégrer l'Europe
Organisation	Cerema - CERN
Version	V 1.1
Statut	Version publiée
Domaine	Implémentation
Mots clés	FCC, implémentation, impacts environnementaux, opportunités territoriales

Page 1 sur 505

https://doi.org/10.5281/zenodo.7614421

- **Deliverable** on the development and feasibility of implementation scenarios developed in the frame of the **EU co-funded H2020 project FCCIS** by CERN, Cerema and Latitude Durable
- One scenario (PA31-1.0) is standing out from all the others
- First version of the documentation released for work with host states and as project-internal reference
- Micro-optimisations with stakeholders
  - **1.0 – published** as reference in February 2023
  - 2.x – various trials to improve the siting for CE
  - 3.0 – adjustment of circumference after RF review
  - **4.0** – result of the **optimisation with communes** and CE **to be openly published in autumn**

Reference information kept in the document

- **Scenario development methodology**
- **Summary of project requirements, constraints (invariants)**
- **Territorial description & kown constraints**
  - Topography, geology, water, urbanism, nature, demography, economy, structured networks
- **Project risks**
- **Scenario evolution**
- **Detailed placement scenario documentation**
- **Environmental aspects**
- **Infrastructure environmental effects**
  - e.g. noise, em fields, radiation, traffic, waste
- **Regulatory and legal aspects to be considered**
- **Real estate aspects**
  - Needs, available plots, constraints
- **Water aspects**
  - Needs, available and protected resources, supply concepts, infrastructures to be built
- **Electricity aspects**
  - Needs, available infrastructures,supply concepts, infrastructures to be built
- **Transport aspects**
  - Needs, available infrastructures, infrastructures to be built
- **Civil structure overviews**
  - Needs on surface and equipment
  - Underground structure concepts
- **Matex challenges and strategy**
- **Synergy and development opportunities**

Reference data kept in the EIS

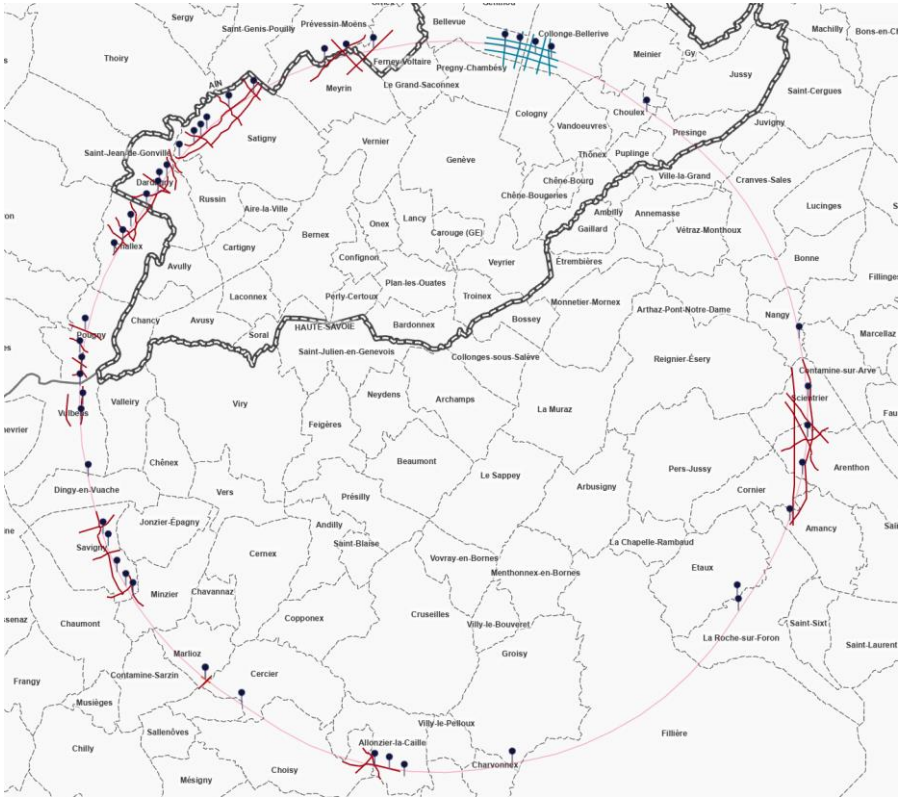
- **Physical environment**
- **Natural environment**
- **Strategic infrastructures**
- **Human environment**
- **Territorial sensibility**
- **Environmental aspect analysis results**
- **Urbanistic conditions and planning**
- **Geophysical & geotechnical investigation results (to be done, 2024/2025)**
- **Existing pollution**
- **Climate information**
- **Collider traces and their characteristics**
- **Site location options**
- **Technical infrastructure locations & characteristics**
- **Needs of technical annexes (grid connection, water intakes, roads)**
- **Surface site concepts**
  - Based on simple “blocks”
- **Road and train accesses**
- **Construction data (TBM, matex, …)**
- **Opportunity locations & capacities**
  - Water, agriculture, forests, waste heats, schools, public institutions, etc.

Subsurface investigations

Geophysical and geotechnical investigations **in selected zones** to understand the stability of the soil and to build a more detailed geological 3D model.

Interactions with host state notified bodies for the authorisations and to optimise the locations to limit the impacts of the campaign.

Interactions with affected land plot owners to obtain the permits and to optimise the locations to limit the impacts of the campaign.



Environmental aspects analysis

The analysis of environmental aspects in zones of surface site candidates is ongoing.
The required environmental analysis for the authorisations of the subsurface investigations has started.
Both activities take place over a time frame of 12 to 18 months. They include continuous and close interactions with local authorities and residents of the territory.

La biodiversité des milieux afin que les accès au tunnel de l'installation soient les moins intrusifs et pénalisants pour les espaces de faune et flore présents. Il s'agit également d'étudier la création de zones protégées ou renaturalisées autour des sites de surface.

Les caractéristiques des localités aux alentours lesquelles des accès au tunnel pourraient être envisagés, afin de préserver la vie communautaire, l'identité architecturale et l'activité économique.

La nature des strates géologiques car le percement de haute précision du tunnel circulaire demande une connaissance fine de leurs épaisseurs, de leur stabilité et de la présence éventuelle de failles. La composition des couches sera également étudiée afin d'anticiper une réutilisation durable des matériaux excavés.

Scheduled activities

Classic nature inventory establishment, endangered species localisation, recordings of environmental conditions, agricultural study, water, air, traffic, noise and light pollution analysis.

Exploration drillings in areas where geological conditions need to be clarified to be able to make reliable cost and CE project schedule estimates.

Acoustic techniques to gather reliable data on the sub-surface conditions without a need for drillings in areas where insufficient information about the geological conditions exist today.

Identification of opportunities and synergies that emerge from an FCC in the region together with territorial stakeholders. Optimise the surface site locaitons and layouts. Analyse the socio-economic impact potentials in greater detail.

Territorial dialogue

Communication plan established

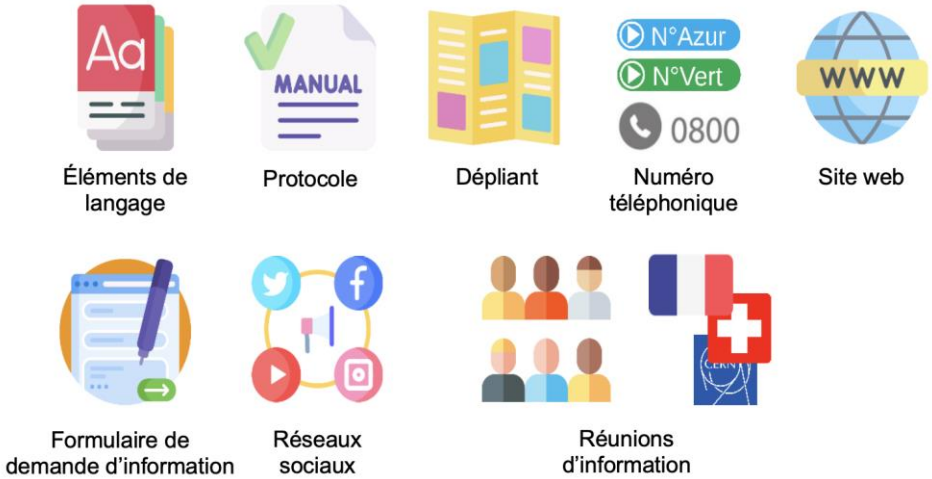
Tripartite working meetings to assure advancement in phase

Regular visits of territorial stakeholders at CERN

Information "kit" produced and used

Additional info materials (videos, sheets and leaflets) developed as the need arises, e.g.

- info about seismic investigation and geotechnical investigations
- Socio-economic impact data
- Calendar of upcoming visits with descriptions of activities on sites and photos



Privilégier le dialogue

Les élus des communes de Pougny, Farges et Saint-Jean-de-Gonville se sont réunis pour une première rencontre avec l'équipe de l'étude de faisabilité du FCC.

Photo : Lise Benoit-Capel / DL

Le CERN souhaite que la conduite de cette étude repose sur un dialogue permanent avec les collectivités territoriales, les associations, les habitants et l'ensemble des acteurs locaux des territoires traversés.

C'est dans ce c
conseil munici
commune de P
en grande parti
FCC par une dé
présence de la
Marcelot, mais
Graziotti, maire
Monsieur Miche
Saint-Jean-de-
la Régie des Ea

N'hésitez p
présentatio

QUI? QUOI? OÙ? POURQUOI? COMMENT? QUAND?

Pourquoi?

Quelle est l'utilité de la recherche au CERN ? ↓

Pourquoi le besoin d'un nouveau collisionneur de particules ? ↓

Web site:
fcc-faisabilite.eu

Regular meetings with regional stakeholders

Government services

France:

- Region Auvergne-Rhône-Alpes
- Prefectures, sous-prefectures
- DDT, DREAL
- CGDD, CCPG and others coming

Switzerland:

- Department of Foreign Affairs
- Department of Economic Affairs, Education and Research
- State of Geneva

Elected representatives of the people

France:

- Conseil dêpartemental Haute-Savoie & Ain
- All communes affected by the trace
- Communautés d'agglomération

Switzerland:

- All communes affected by the trace
- A range of interest groups

Regular meetings with regional stakeholders

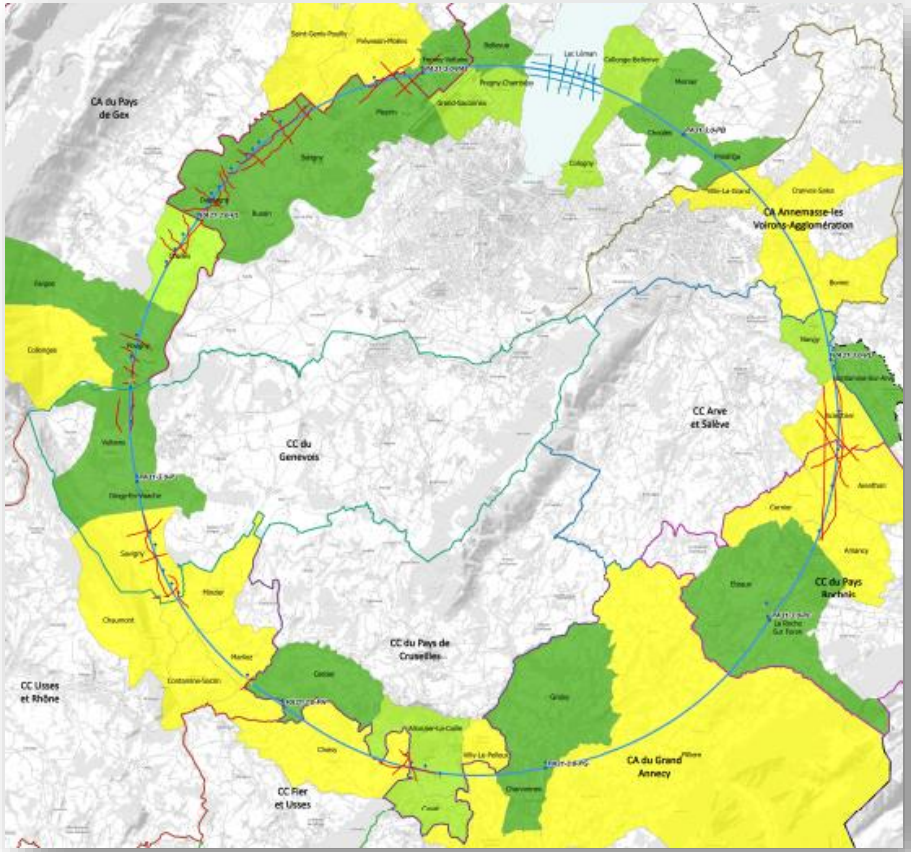
Reference scenario feedback

Feedback from all communes hosting surface sites in France and in Switzerland **so far positive**.

For surface sites **so far no showstoppers**.

Some communes enthusiastic about the potentials for co-development.

All **communes** in France and in Switzerland **expressed** the **need for top-level government support** for a project of national and international interest towards the government representatives in the working meetings.



Individual meetings

Meeting planned

Collective meetings

Typical concerns of people that we meet

<u>Concerns/interests</u> typically expressed:

- **Land** consumption (ZAN, SdA)
- Management of the **excavated materials** including their transport
- **Water** consumption
- **Electricity** landlines
- Need for **creation of local jobs**
- **Housing** needs for construction workers and engineers due to already stressed housing situation in the region
- **Integration** with landscape, typical rural architecture
- **Traffic** increase in congested zones

Synergy potentials typically evoked:

- Integration of surface sites in **local education programmes** from children to adult levels
- **Local employment** and service supply opportunities
  - as for instance also successfully implemented by SKA in South Africa
- **Visitor** centers and **tourism** development
- Integration into **public transport concepts**
- Integration with **public services** (healthcare, security, emergency)
- **Supply** of residual cooling **water for agriculture and re-naturalisation**
- **Supply of waste heat** for heating, food processing and industrial processes

Complementary studies

Carried out:

Mining the Future – technologies for innovative excavated materials re-use > Followup needed

Access to french highway system

Renewable energy source supply feasibility

Job creation

Regional impact on high-tech suppliers

Training value for students and post-docs

Tourism effects

Open ICT development impacts

Common good value

Ongoing or planned:

Access to the french national electricity grid

Local electricity connection

Excavated materials local re-use

Excavated materials deposit

Access to railroad system

Waste heat supply feasibility & socio-economy

Water intake

Supply of residual water

Conclusions

The placement **methodology and** the **evolution** of scenarios has been **documented**.

An **Environmental Information System (EIS) is being put in place** to document all relevant aspects of the choice and further evolution in detail as required by the legal frameworks.

A **reference scenario** has been identified and a **rationale for its selection has been documented**.

The **territory is continuously evolving**, therefore neither completeness nor correctness of the supplied information can be assured for a long period of time. No obvious alternative scenario potentials have been identified.

Land plot reservation for study purposes started.

Analysis of environmental aspects at the surface site locations has started.

Scenario **PA31** has been **verified with communes affected by surface site and so far no showstoppers have been identified**

Development on synergy potentials with communes has started.

The **permitting and authorisation process for the geophysical and geotechnical investigations** scheduled for 2024 is **ongoing.**

Dedicated support and contributions from government services in both countries required to advance on the validation of the scenario and the territorial optimisation for local excavated materials re-use.