CERN Site Engineering

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CERN 28th October 2014

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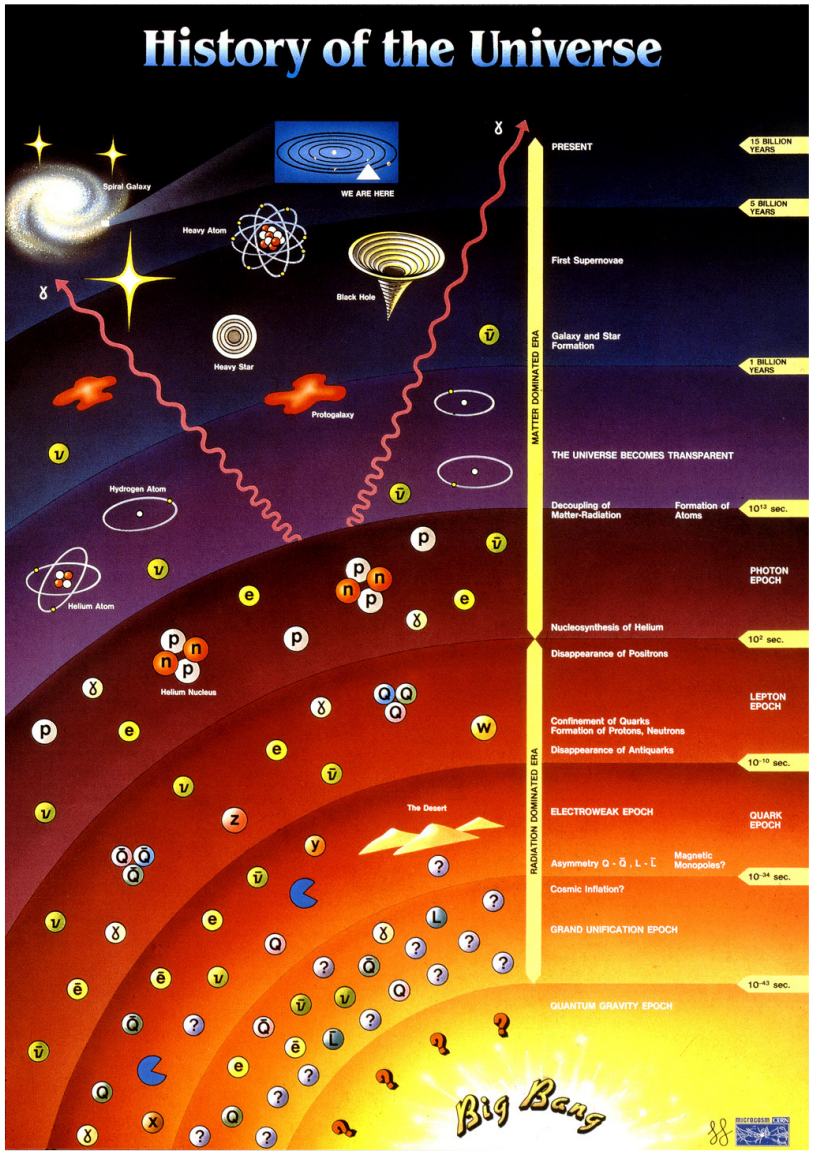
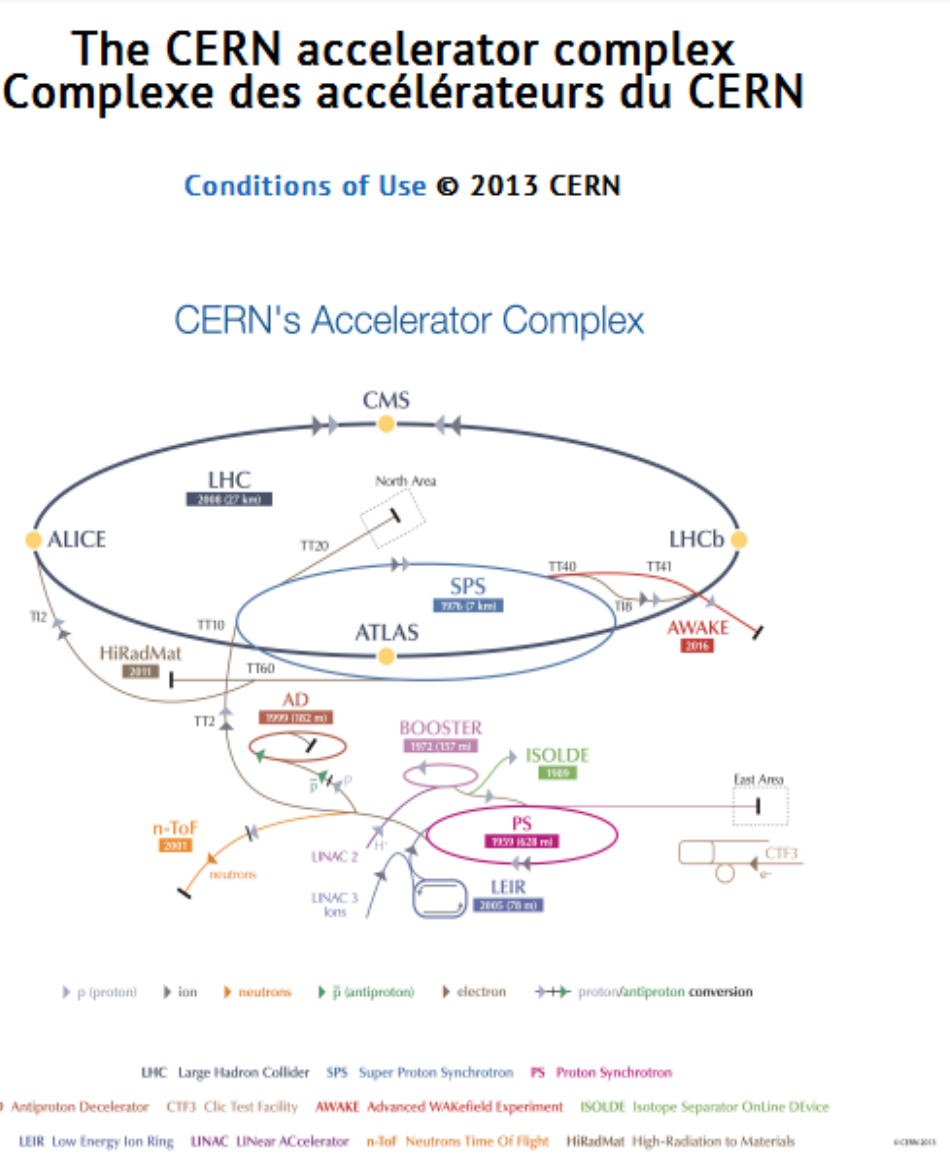
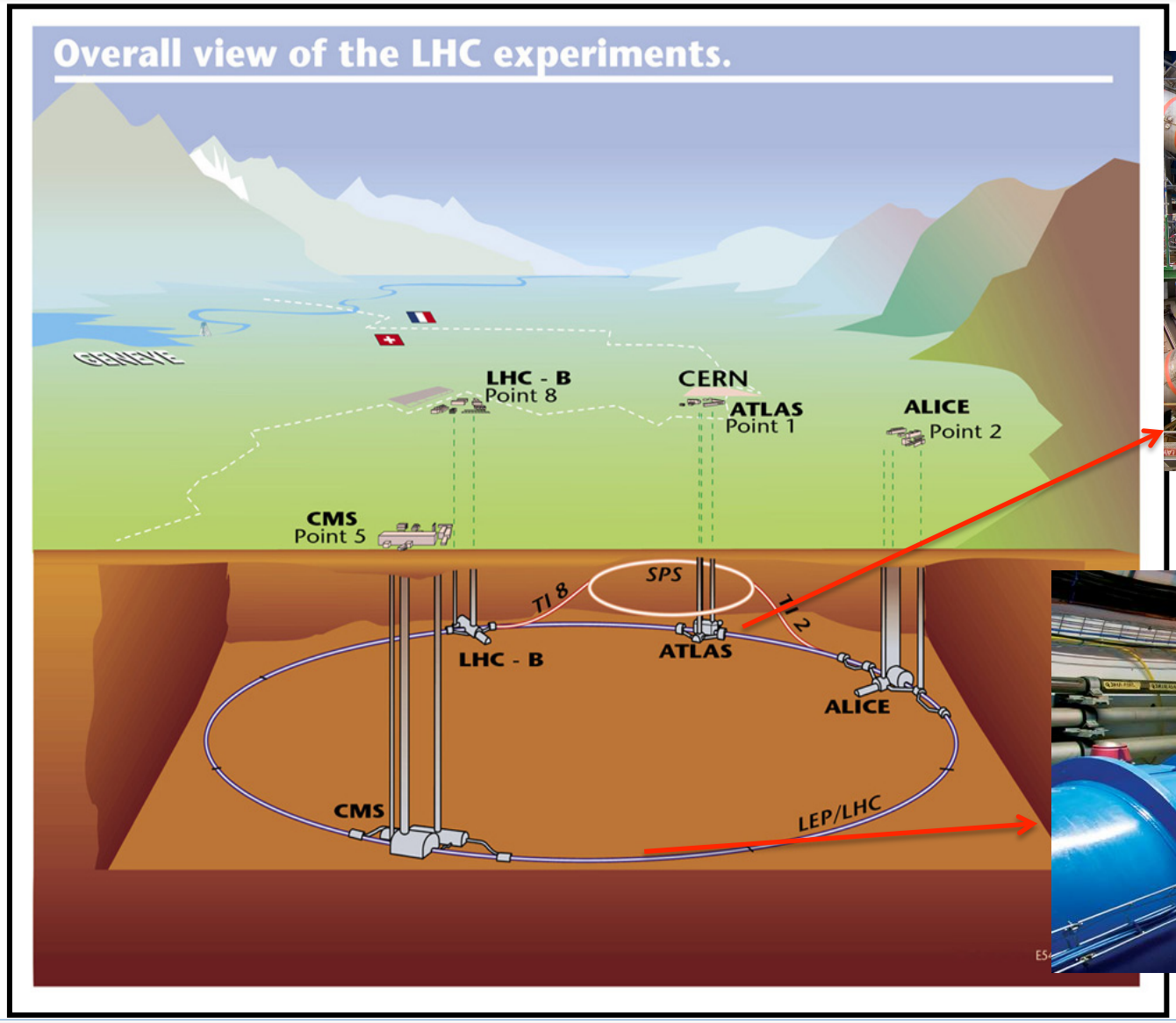
- CERN
- Existing CERN Infrastructure and brief history
- CERN Site Engineering Group
- Some examples of recent projects
- Opportunities at CERN for Bulgarian Consultancy firms & Contractors

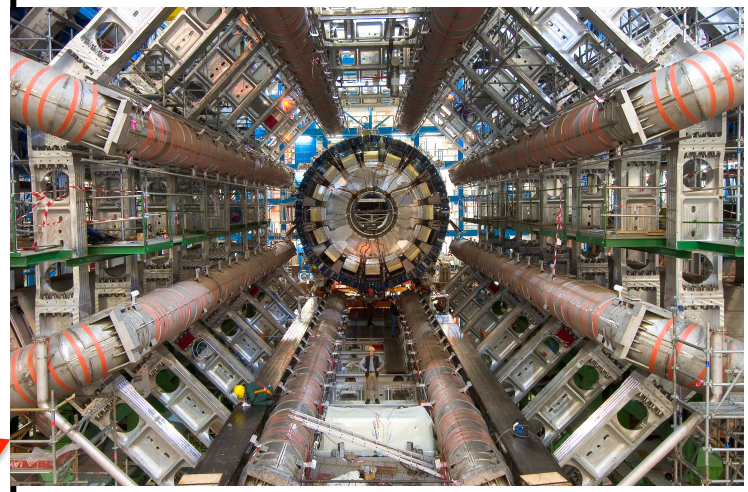
CERN (1/2)

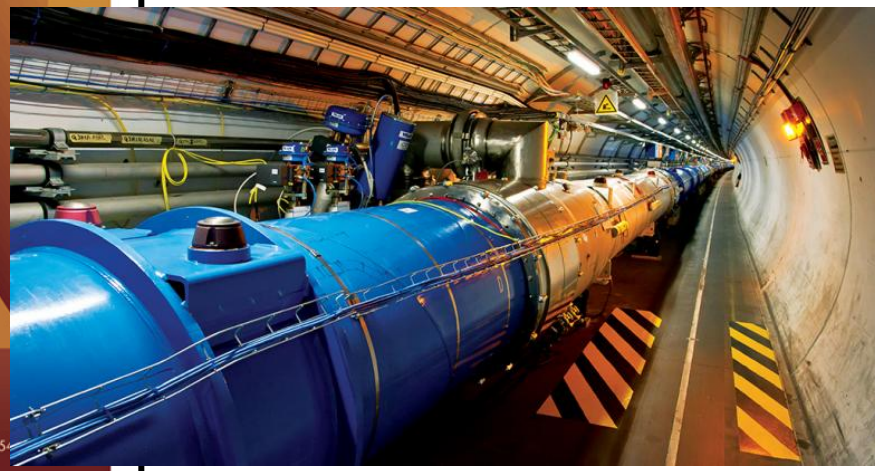

History of the Universe
WE ARE HERE
Spiral Galaxy
Heavy Atom
Black Hole
Heavy Star
Protogalaxy
Hydrogen Atom
Helium Atom
Helium Nucleus
The Desert
PRESENT
15 BILLION YEARS
5 BILLION YEARS
First Supernovae
Galaxy and Star Formation
1 BILLION YEARS
THE UNIVERSE BECOMES TRANSPARENT
Decoupling of Matter-Radiation
Formation of Atoms
10^13 sec.
PHOTON EPOCH
Nucleosynthesis of Helium
10^2 sec.
Disappearance of Positrons
LEPTON EPOCH
Confinement of Quarks
Formation of Protons, Neutrons
Disappearance of Antiquarks
10^-10 sec.
ELECTROWEAK EPOCH
QUARK EPOCH
Asymmetry Q - Q̄ , L - L̄
Magnetic Monopoles?
10^-34 sec.
Cosmic Inflation?
GRAND UNIFICATION EPOCH
10^-43 sec.
QUANTUM GRAVITY EPOCH
MATTER DOMINATED ERA
RADIATION DOMINATED ERA
Big Bang


The CERN accelerator complex
Complexe des accélérateurs du CERN
Conditions of Use © 2013 CERN
CERN's Accelerator Complex
CMS
LHC
North Area
ALICE
LHCb
TT20
TT40
TT41
SPS
TT12
TT10
ATLAS
AWAKE
HiRadMat
TT60
AD
TT2
BOOSTER
ISOLDE
East Area
n-ToF
PS
LINAC 2
neutrons
CTF3
LINAC 3
Ions
LEIR
p (proton)
ion
neutrons
p̄ (antiproton)
electron
proton/antiproton conversion
LHC Large Hadron Collider
SPS Super Proton Synchrotron
PS Proton Synchrotron
AD Antiproton Decelerator
CTF3 Clic Test Facility
AWAKE Advanced WAKefield Experiment
ISOLDE Isotope Separator OnLine DEvice
LEIR Low Energy Ion Ring
LINAC LINear ACcelerator
n-ToF Neutrons Time Of Flight
HiRadMat High-Radiation to Materials

CERN (2/2)


Overall view of the LHC experiments.
GENEVE
LHC - B
Point 8
CERN
ATLAS
Point 1
ALICE
Point 2
CMS
Point 5
SPS
TI 8
TI 2
LHC - B
ATLAS
ALICE
CMS
LEP/LHC





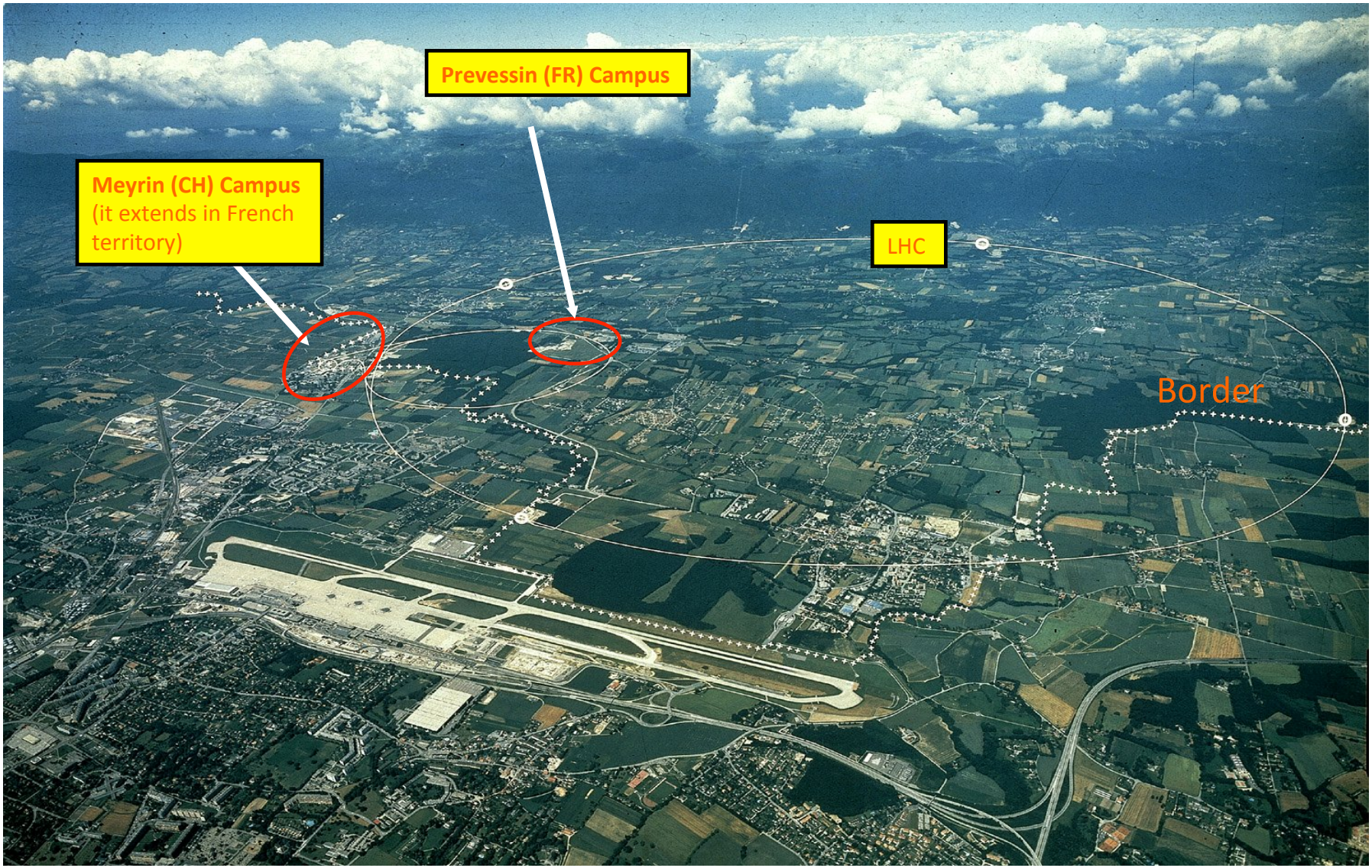
Who works at CERN

- ~2.400 Staff + 600 Fellows and associate
  - engineers, technicians, craftsmen, administrator, secretaries, workmen
  - design, build, operate, maintain CERN's intricate machinery
  - help to prepare , run, analyze and interpret the complex scientific experiments
- ~10.000 Scientists (1/2 world's particle physicists)
  - 500 universities, 113 nationalities
- ~5.000 Contract's staff (variable)

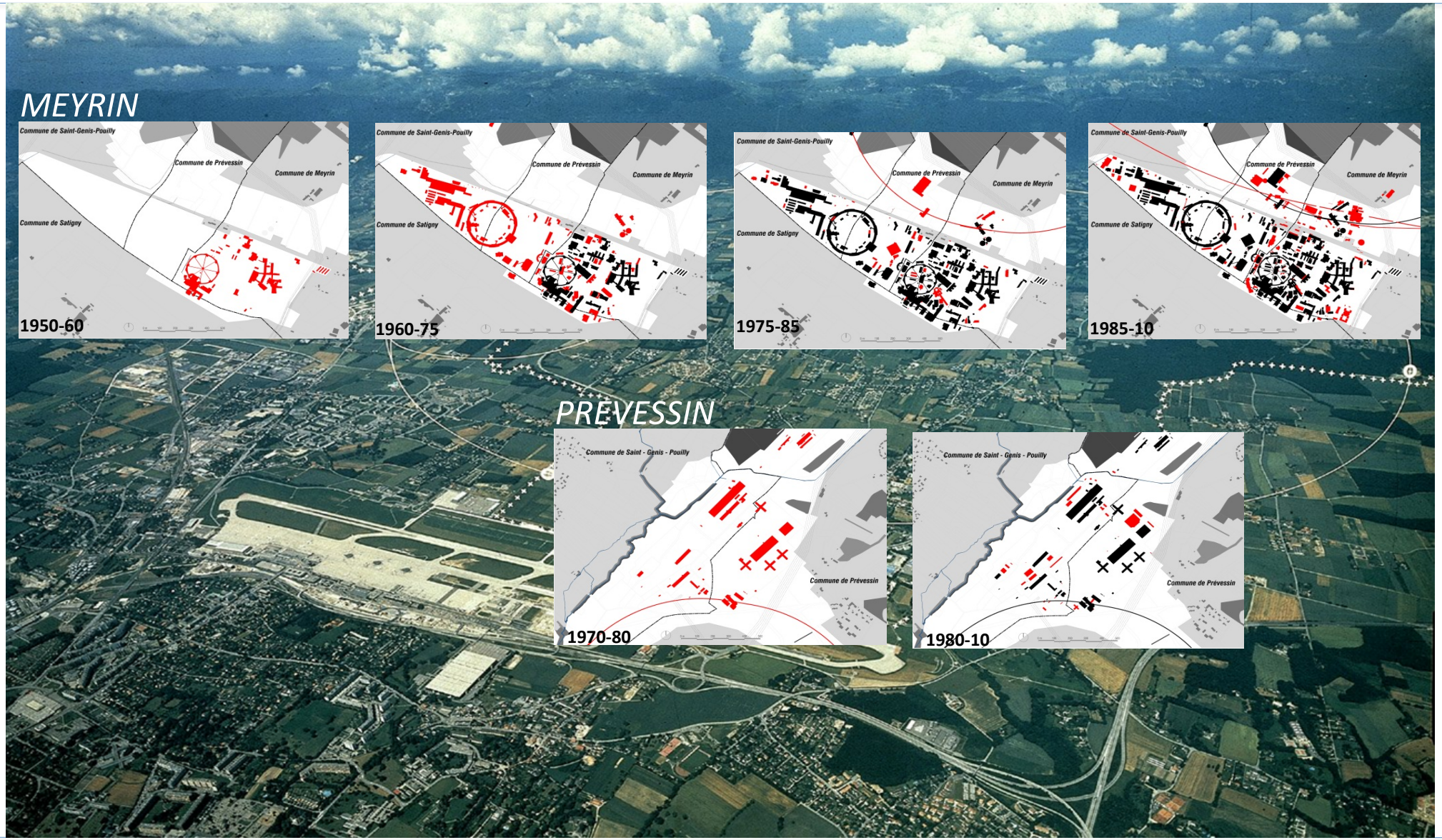
Existing CERN Infrastructure and brief history

1954 - Day 1

CERN Area


Prevessin (FR) Campus
Meyrin (CH) Campus
(it extends in French territory)
LHC
Border

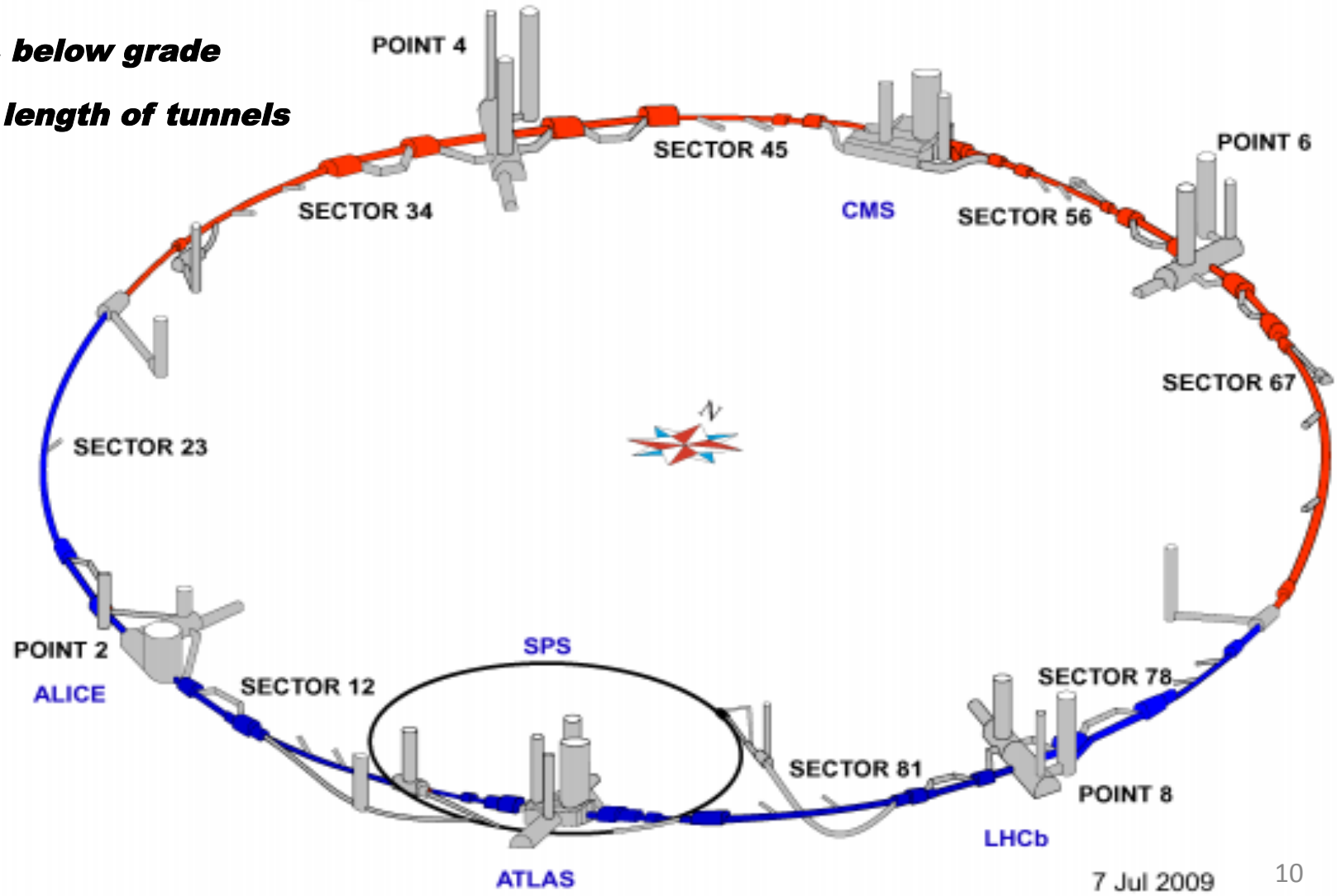
Two sites with a history



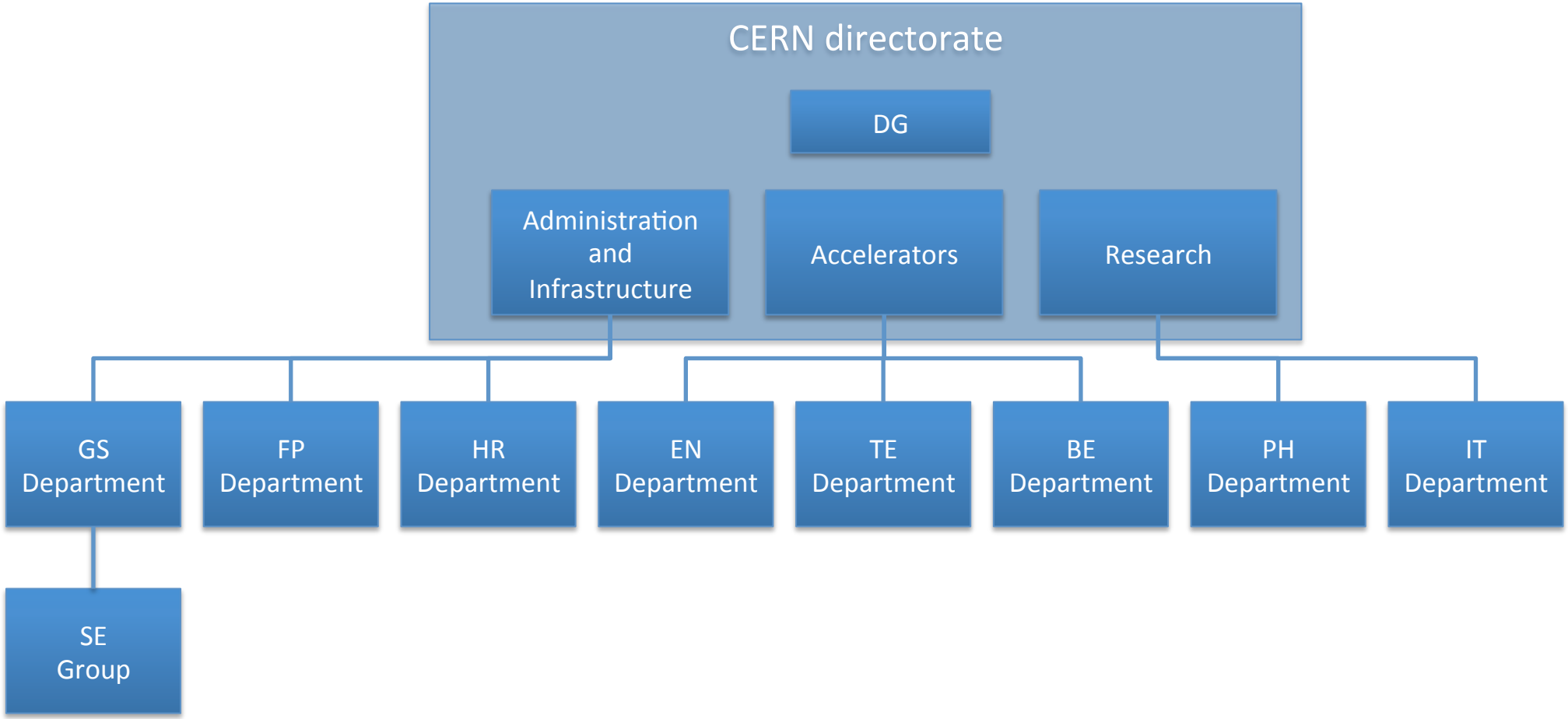
Current underground infrastructure

Tunnels:

- ***27km long***
- ***100m approx. below grade***
- ***≈ 80km total length of tunnels***

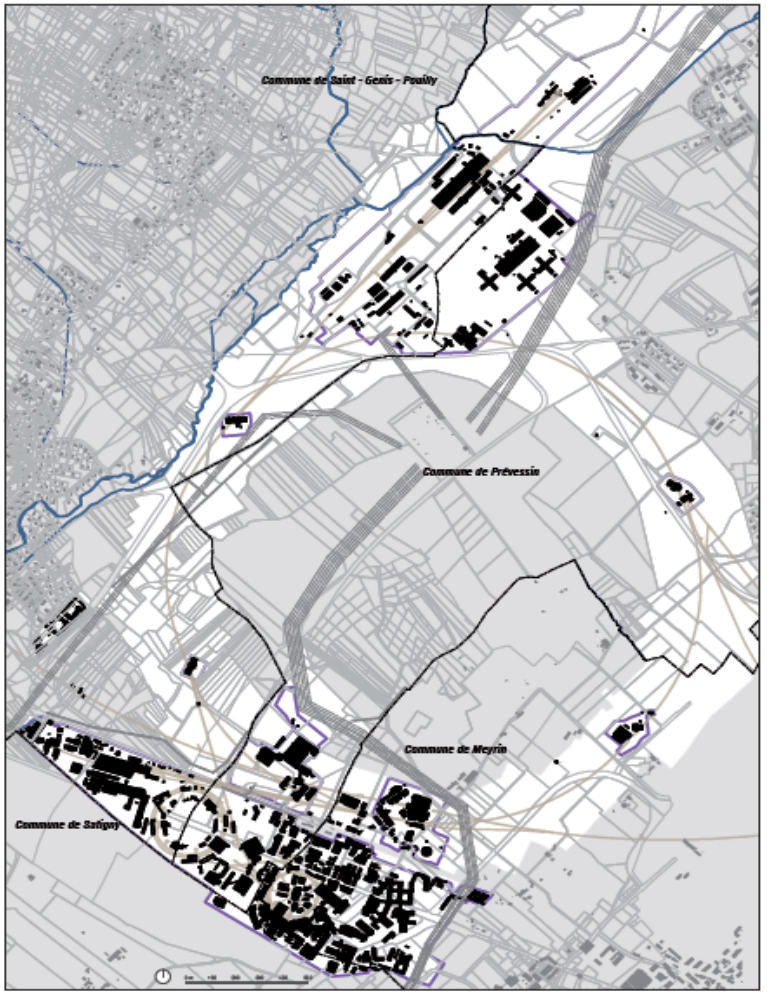


Site Engineering group



Overall key figures

- 590 hectares of available land
- 2 main sites
  - Meyrin (CH)
  - Prévessin (FR)
- 15 satellite sites
- 650 buildings - 10m^2 up to 20.000m^2 , 500,000 m^2 of surface
- 60% of the buildings are 30+ years old
- 80 km of tunnels
- 250 km of roads
- 1000 km of buried services



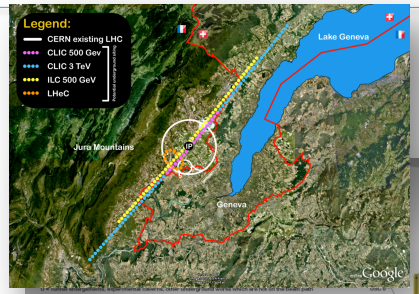
Site Engineering Group

- The Site Engineering Group is responsible for :
  - Design of all **new buildings & civil engineering structures on CERN Site**. Feasibility studies more often done in-house with outsourced consultancy services for more detailed design.
  - Project Management for execution (with Consultants for larger projects)
  - Maintenance of all buildings and underground structures
  - Renovation Works
  - **HVAC & Electrical installation and maintenance for 'tertiary' buildings**
  - Patrimony data collection

- Group consists of approximately :
  - 10 engineers/architects
  - 15 draughtsman/designers
  - 20 site Supervisors

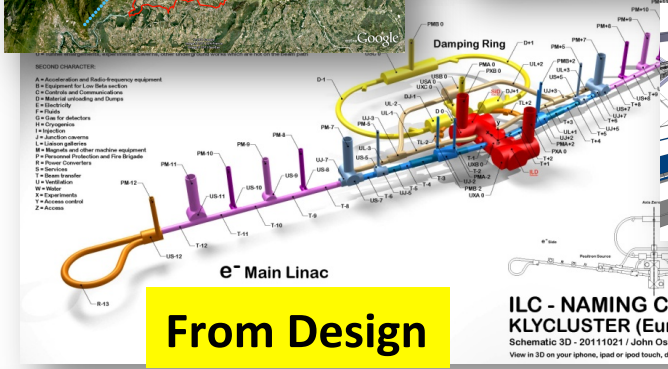
- Annual Group Budget approximately
  - 50+MCHF for Projects & Operation / Renovation Works

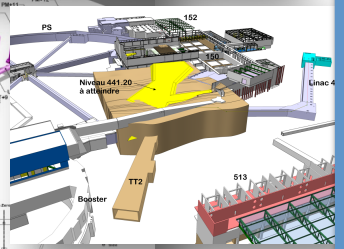
Groups scope



to large projects

COMPLEXITY

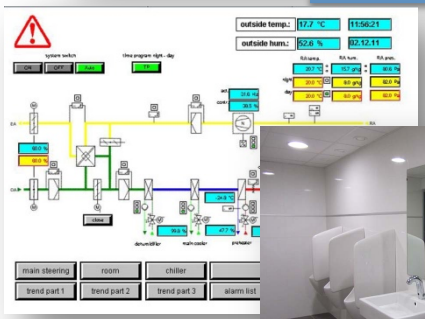




From Design

to construction

and Operation & Maintenance

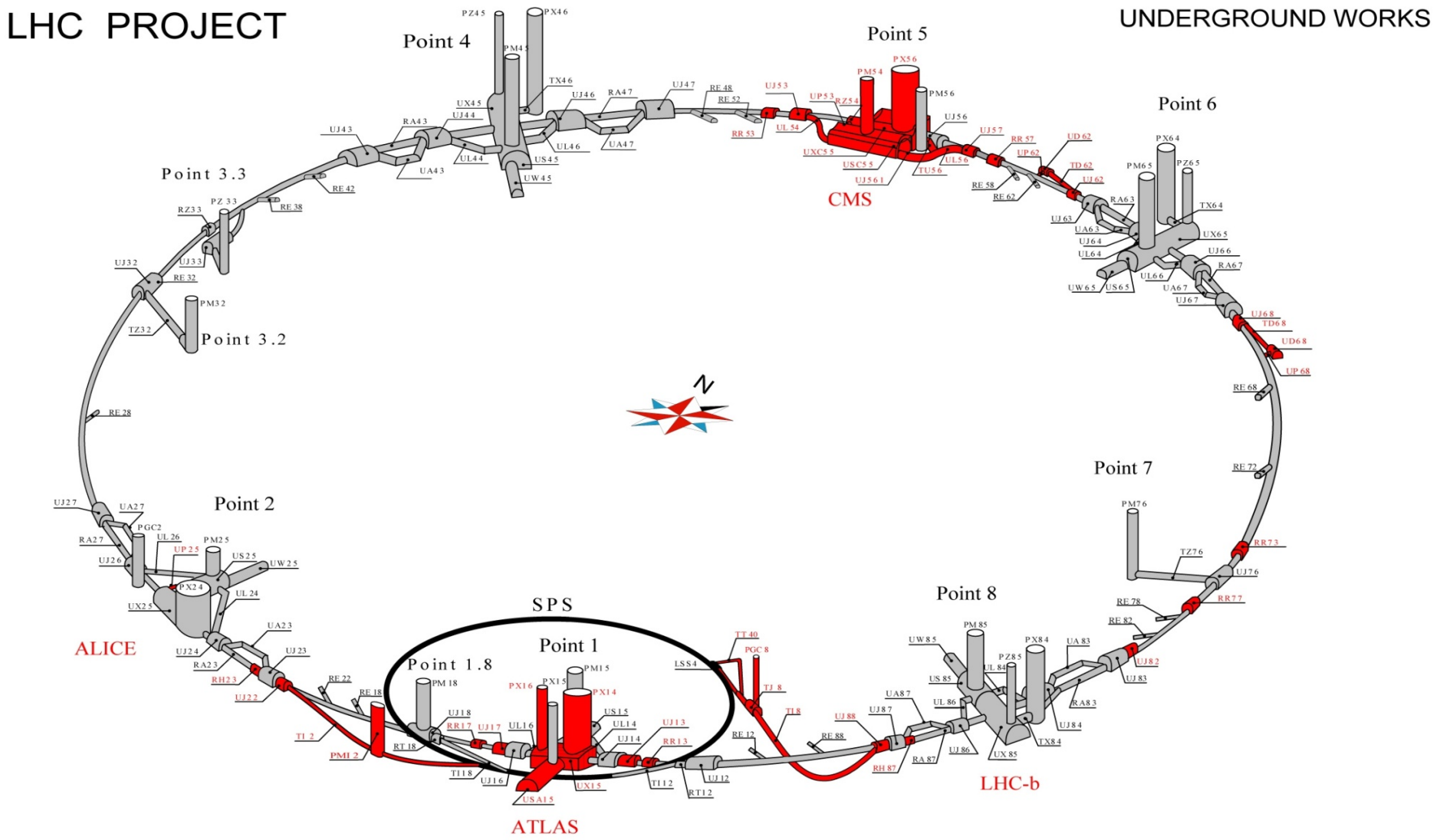


TIME

From minor works

Some examples of recent projects

LHC Project


LHC PROJECT
UNDERGROUND WORKS
Point 4
Point 5
Point 6
Point 3.3
Point 3.2
Point 2
Point 7
Point 8
Point 1
Point 1.8
SPS
CMS
ALICE
ATLAS
LHC-b
N
Existing Structures
LHC Project Structures

LHC Work Packages

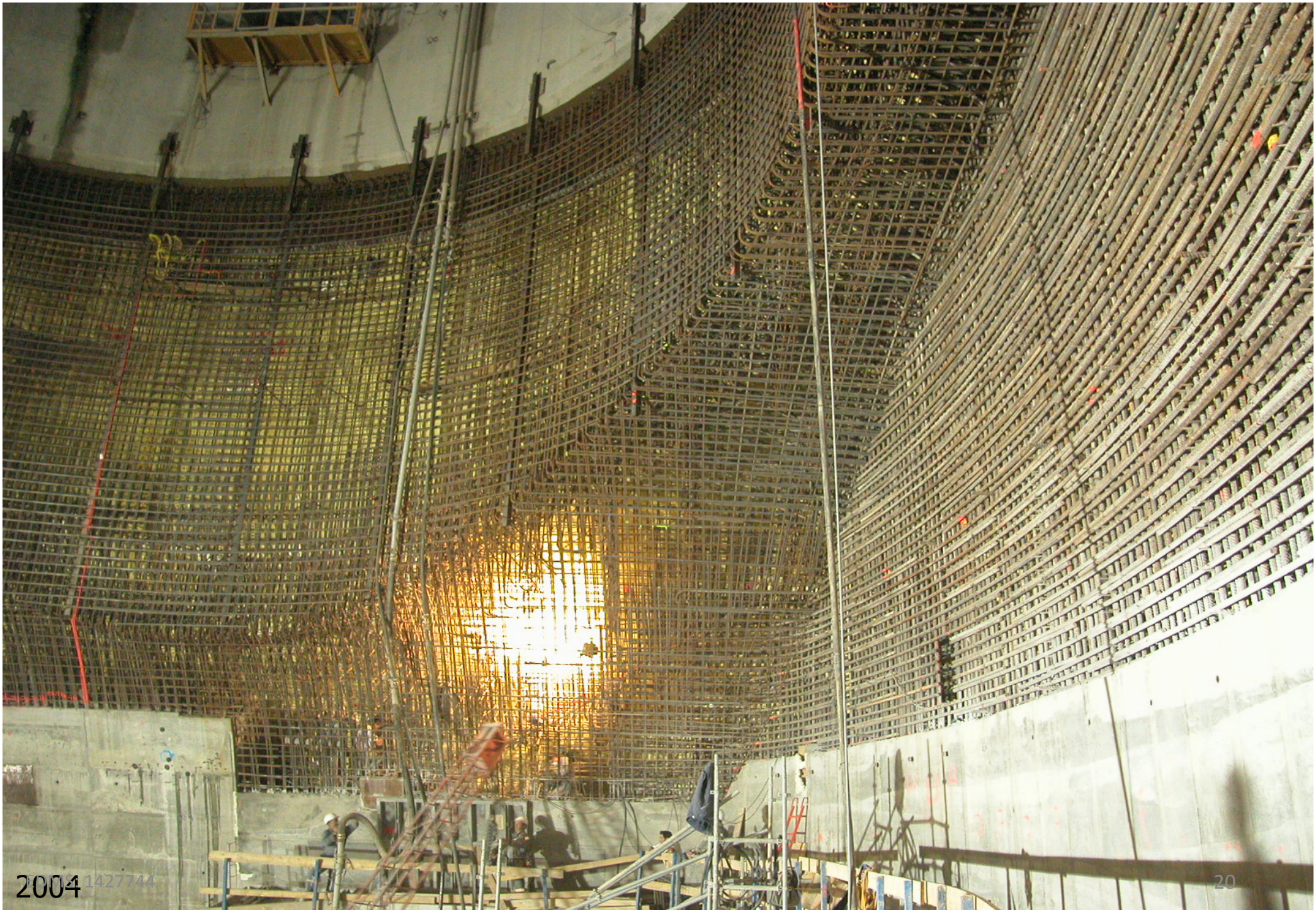
Package	Place		Consultants	Contractors
1	POINT 1	ATLAS	- EDF (F) - KNIGHT & PIESOLD (GB)	- TEERAG-ASDAG (A) - BARESEL (D) - LOCHER (CH)
2	POINT 5	CMS	- GIBB (GB) - GEOCONSULT (A) - SIG (CH)	- DRAGADOS (E) - SELI (I)
3A	Other Points	All other points except TI8 (including ALICE and LHC-b)	- BROWN & ROOT (GB) - INTECSA (E) - HYDROTECHNICA (P)	- TAYLOR-WOODROW (GB) - AMEC (GB) - SPIE-BATIGNOLLES (F)
3B	TI 8	TI 8 tunnel	DITO	- LOSINGER (CH)

LHC - Point 5


Shafts 12.1m and 20.5m diameters, both approx. 100m deep
Dragados
SELI
Dragados
SELI

LHC - Point 5

Point 5 - UXC55 cavern excavation - LEP demolition - January 23, 2002 - CERN ST-CE



2004

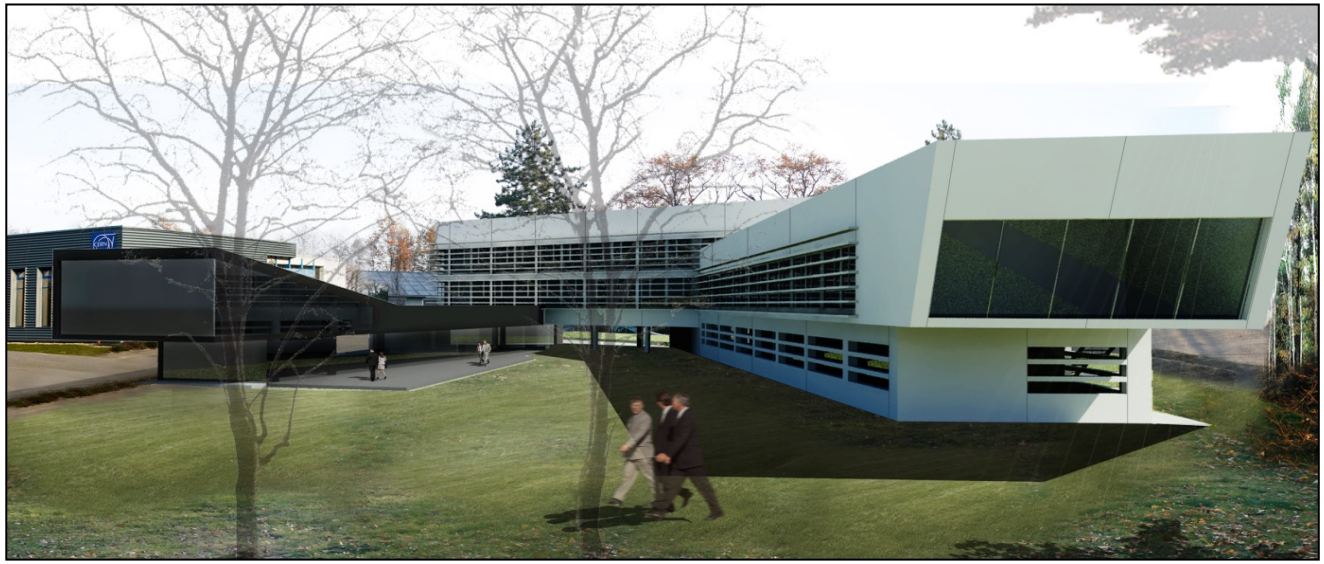

2005
CMS cavern 53m long, 27m wide by 25m high

Building 42

Recent Projects – Bld 107

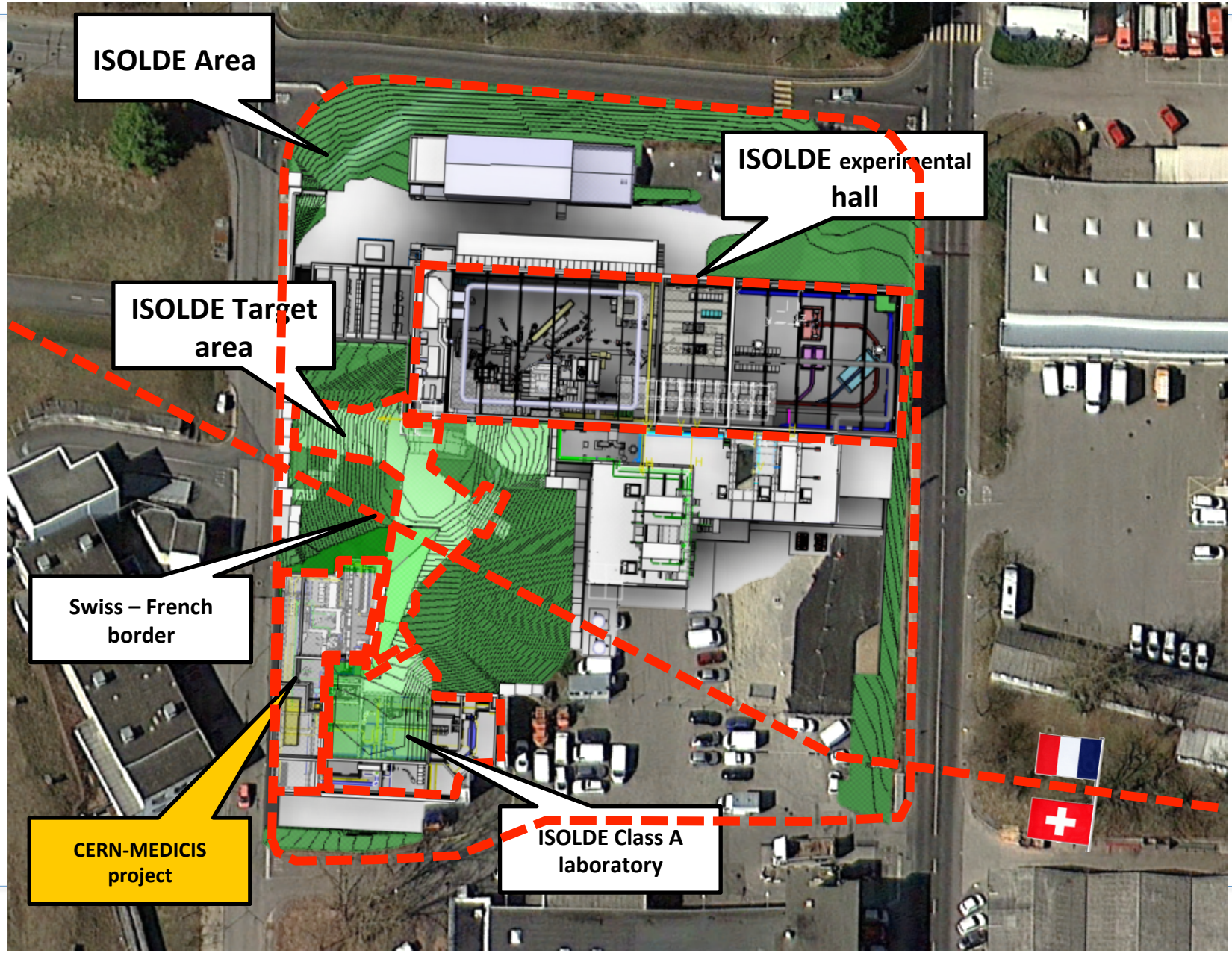
- **Bld 107 : New Chemical Surface Treatment Facility**
  Construction started

Building 774



Computer Centre Upgrade

MEDICIS (1/2)

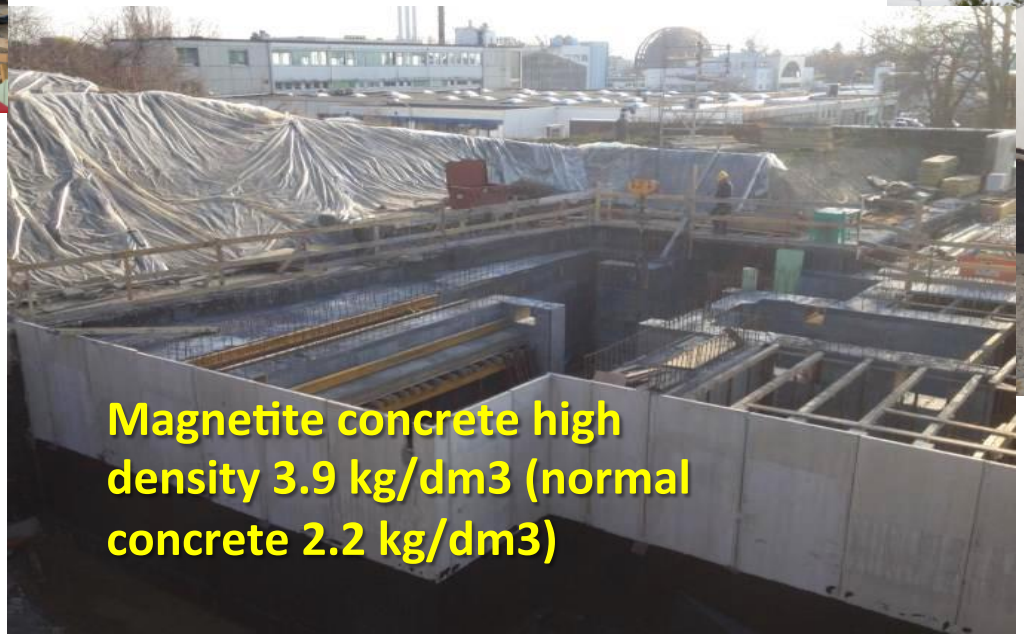

ISOLDE Area
ISOLDE experimental hall
ISOLDE Target area
Swiss – French border
CERN-MEDICIS project
ISOLDE Class A laboratory

MEDICIS (2/2)

- **Addition of experimental area**
- **Special shielding**
- **Cross-border difficulties**

Magnetite ore

Preparation



Magnetite concrete high density 3.9 kg/dm3 (normal concrete 2.2 kg/dm3)

Asbestos Removal

Building 185

GT 815

Renovation works: Offices

Renovation Works: Hotels

Renovation Works: Main hall

Renovation Works: Main auditorium

B30 concrete repairs

Opportunities at CERN for Consultancy firms & Contractors :

1.‘Framework’ Contracts
2.‘Call for tender’ Contracts for specific Projects

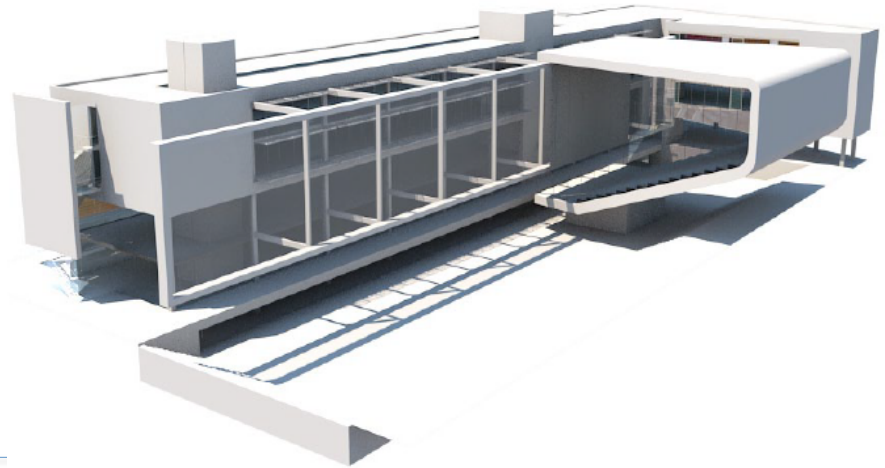
Future and ongoing 'Call for tender' (1/2)

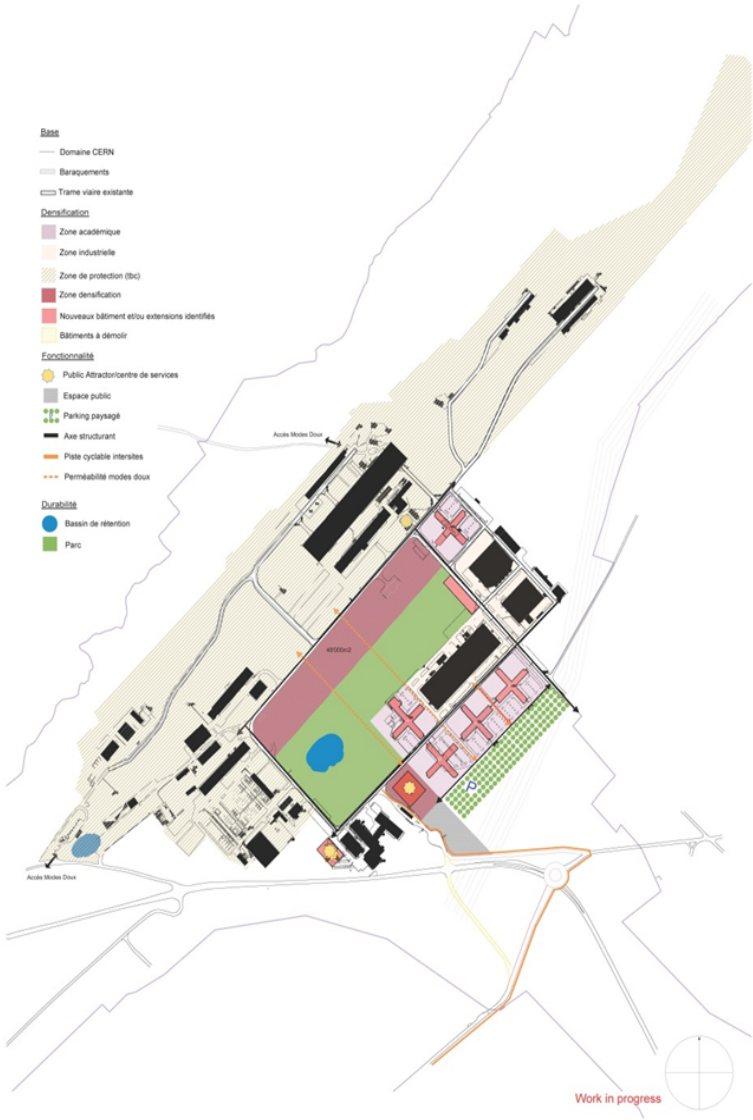
- Accelerator's consolidation (2015-2018)
  - ~2 Contracts 3500kCHF ÷ 10000kCHF
  - ~10 Contracts 200kCHF ÷ 750kCHF
- R2E phase 2 works (2015-2018):
  - Contract ~ 10000kCHF
- HL-LHC (2015-2018):
  - ~2 Contracts 3500kCHF ÷ 10000kCHF
  - ~5 Contracts 200kCHF ÷ 750kCHF

Future and ongoing 'Call for tender' (2/2)

- Implementation of the Consolidation of the infrastructure program and new buildings (2015-2018):
  - ~3 contracts 3500kCHF ÷ 10000kCHF
  - ~ 15 contracts 750kCHF ÷ 2500kCHF
  - ~ 45 contracts 200kCHF ÷ 750kCHF
- Hotels interior renovation (2014-2016):
  - Contract ~ 2000kCHF
- Renewal of frame contracts (2015-2018):
  - ~5 contracts 1000kCHF/y ÷ 8000kCHF/y

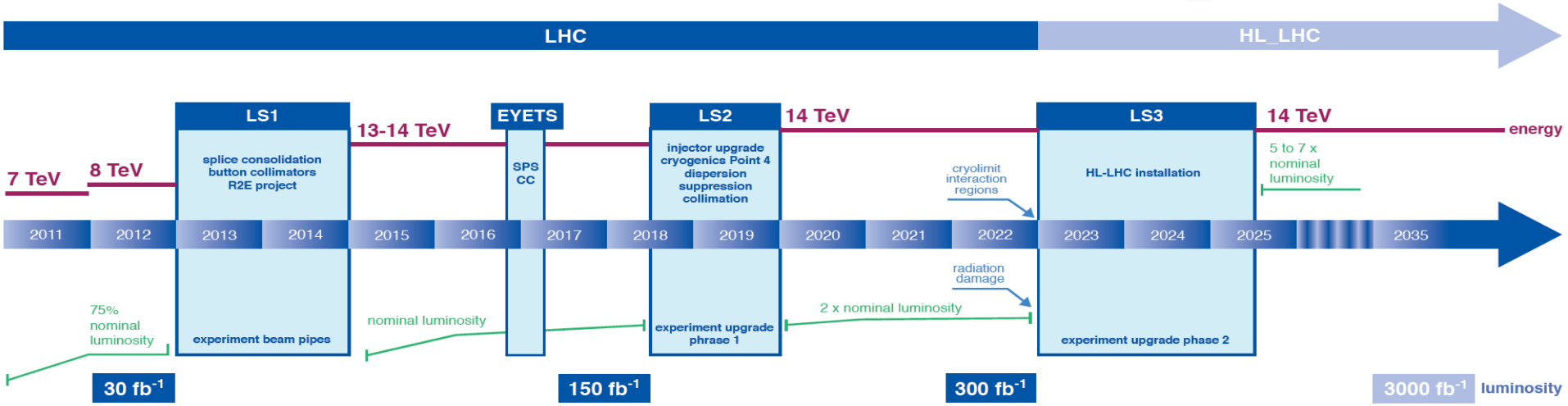
CERN 2030 MasterPlan

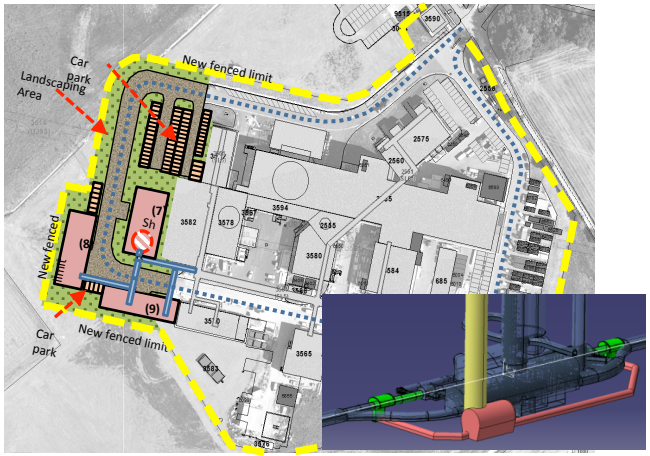




High Luminosity LHC (HL-LHC)

LHC / HL-LHC Plan





- Underground and surface infrastructure works
- Analyzing options

https://hilumilhc.web.cern.ch/

Future circular accelerators (1/2)

	Risk										
	Water Ingress	Heaving Ground	Weak Marls	Hydro-carbons	Support & Lining	Ground Response & Converg-ence	Hydro-static Pressures & Drainage	Pollution/ Exhausti-on of Aquifers	Effect of shafts on Nature	Effect of shafts on Urban / Recreati-on Areas	Total
Jura 80	5	3	0	0	5	4	5	5	4	2	33
Lake 80	2	0	3	3	3	3	2	2	3	2	23
Lake 47	1	0	2	2	2	2	1	1	2	5	18

Figure 16: Risk assessment matrix across the 3 ring options

Future circular accelerators (2/2)

Alignment | **Shaft Tools**

Choose alignment option

93km quasi-circular

Tunnel depth at centre: 271mASL

Gradient Parameters

Azimuth (°):	-15
Slope Angle x-x(%):	.8
Slope Angle y-y(%):	0

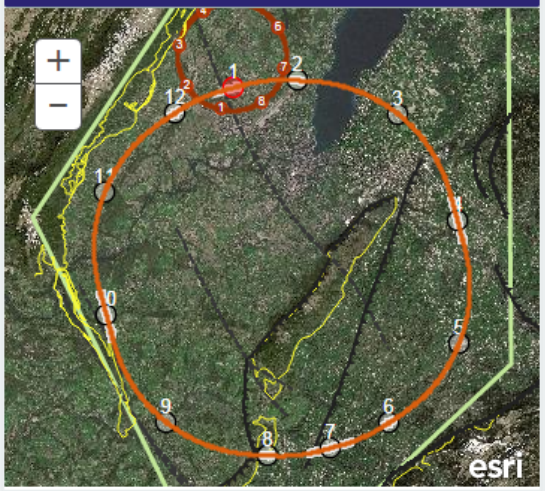
CALCULATE

Alignment centre

X: 2498083 Y: 1108977

LHC Intersection	IP 1	IP 2
Angle	-65°	65°
Depth	251m	200m

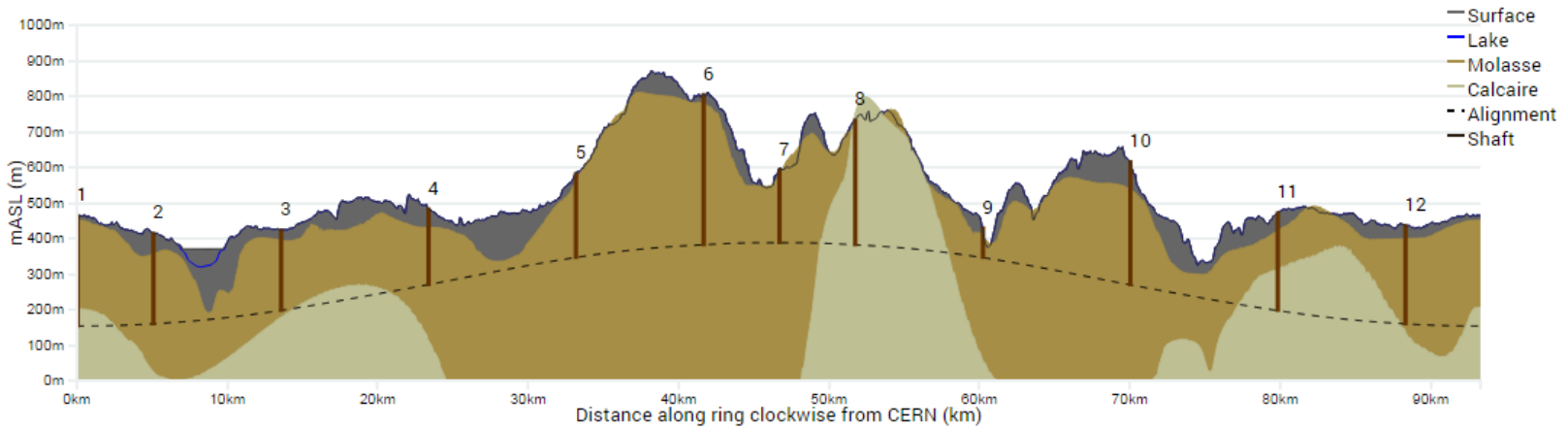
Alignment Location



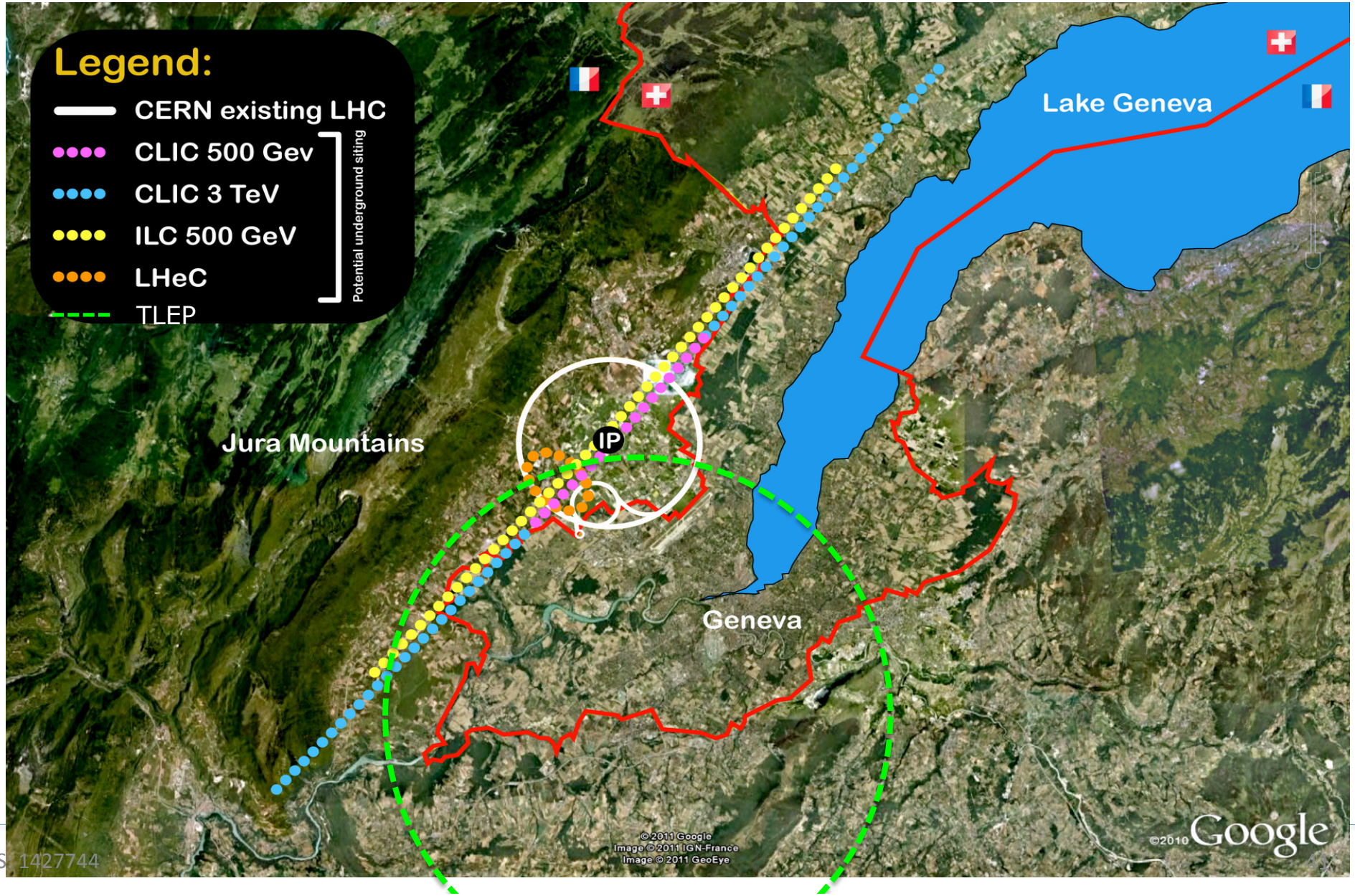
Geology Intersected by Shafts | **Shaft Depths**

	Shaft Depth (m)				Geology (m)		
Shaft	Actual	Min	Mean	Max	Moraine	Molasse	Calcaire
1	310	307	310	311	13	246	52
2	255	253	258	266	58	197	0
3	227	227	228	230	29	197	0
4	213	208	217	226	52	161	0
5	236	210	230	242	29	207	0
6	423	414	421	428	23	400	0
7	205	188	199	212	24	182	0
8	351	334	350	365	0	0	360
9	84	34	79	121	22	61	0
10	346	311	338	357	76	271	0
11	275	265	273	281	54	106	115
12	277	273	278	284	38	240	0
Total	3202	3024	3181	3323	417	2267	526

Alignment Profile



Future linear accelerators



Thank You for your attention