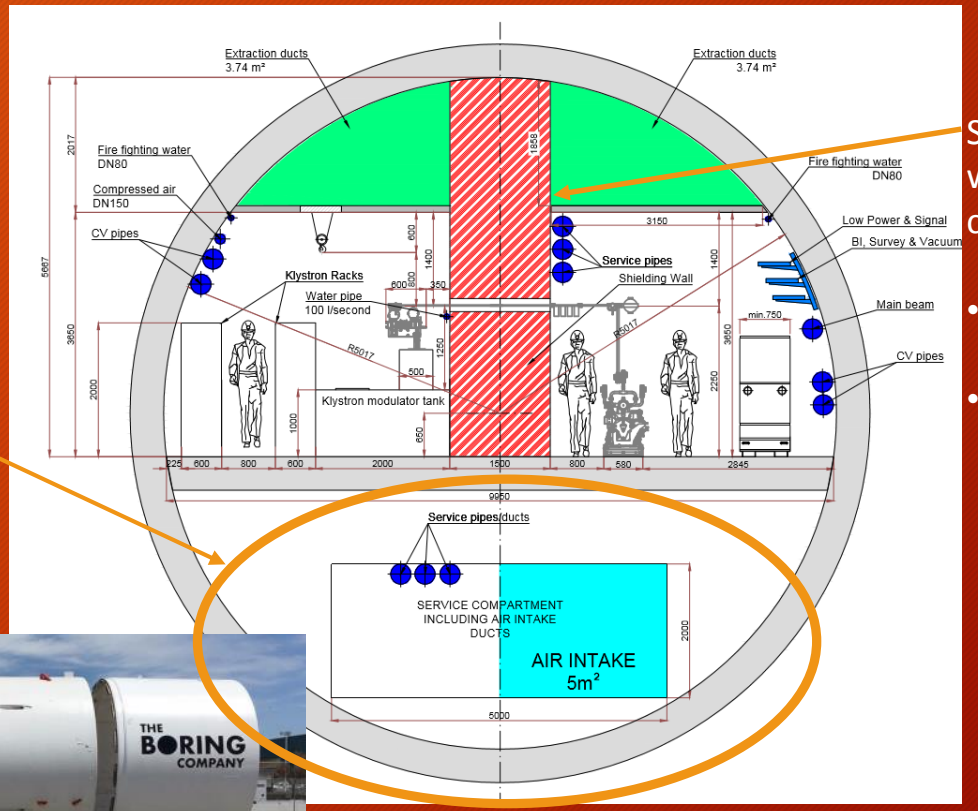
CLIC Civil Engineering Update

Matthew Stuart – John Osborne SMB-SE-FAS

Civil Engineering Klystron Design

<u>10m Internal Diameter TBM tunnelling method is proposed for the Klystron 380 GeV design:</u>

- The cost for an 11km tunnel for the TBM is an estimated 10% cheaper than a mined tunnel.
- The underfloor space can be utilised and therefore reduce the amount of wasted space.
- The excavation rate per m of tunnel is considerably quicker for a TBM and therefore construction time is reduced.
- The geology for the 380 GeV is expected to be majority molasse and suited for a TBM.



Shielding wall thickness will play a key role in the cost:

- Large effect on tunnel Diameter.
- Has a considerable associated cost.

PBS Update

Drive Beam

1. PBS Responsibilities to be confirmed for the main Nodes for both the Drive Beam and Klystron Design

2. PBS Structure requires confirmation – Meetings to be held with those who have confirmed they are technically responsible for a node.

Klystron Design

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Beam and Services	PBS Code	Domain	Technical Responsible	Confirmed	Structure confirmed
Main Beam Production	1.1.	Injectors	S. Doebert	Yes	In Progress
	1.2.	Damping Rings	Y. Papaphilippou	Yes	Yes
	1.3.	Beam Transport	A. Latina	Yes	In Progress
Drive Beam Production	2.1.	Injectors	S. Doebert	Yes	In Progress
	2.1.3.	Satellite Removal System	A. Latina	Yes	In Progress
	2.1.4.	Linac	A. Latina	Yes	In Progress
	2.2.	Frequency Multiplication	A. Latina	Yes	In Progress
	2.3.	Beam Transport	A. Latina	Yes	In Progress
Two-beam Accelerator	3.1.	Two-Beam Modules	C. Rossi	Yes	Yes
	3.2.	Main Linac Hardware			
	3.2.2.	Magnet Powering System	S. Pittet	No	
	3.2.3.	Magnet System	J. Bauche	Yes	Waiting for confimation
	3.2.4.	Beam Instrumentation System	T. Lefevre	Yes	In Progress
	3.3.	Post Decelerators	A. Latina	Yes	In Progress
Interaction Region	4.1.	Beam Delivery Systems	L. Gatignon	Yes	Waiting for confimation
	4.2.	Experimental Area	L. Gatignon	Yes	Waiting for confimation
	4.3.	Post-collision Line	L. Gatignon	Yes	Waiting for confimation
Infrastructure and Services	5.1.	Civil Engineering	J. Osborne	Yes	Yes
	5.2.	Electricity	D. Bozzini	Yes	Waiting for confimation
	5.3.	Survey and Alignment	H. Mainaud-Durand	Yes	In Progress
	5.4.	Fluids	M. Nonis	Yes	In Progress
	5.4.4.	Gas	D. Delikaris	No	
	5.5.	Transport / installation	I. Ruehl	Yes	Waiting for confirmation
	5.6.	Safety	S. Marsh	Yes	In progress
Machine Control and Protection	6.1.	Machine Control Infrastructure	M. Draper	Yes	Waiting for confirmation
	6.2.	Machine Protection	M. Jonker	Yes	Waiting for confirmation
	6.3.	Access Safety & Control System	P. Sollander	Yes	Waiting for confirmation
	6.4.	Technical Alarm System	M. Jonker	Yes	Waiting for confirmation

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	2.1.3.	Satellite Removal System	A. Latina	Yes	In Progress
	2.1.4.	Linac	A. Latina	Yes	In Progress
	2.2.	Frequency Multiplication	A. Latina	Yes	In Progress
	2.3.	Beam Transport	A. Latina	Yes	In Progress
Two-beam Accelerator	3.1.	Two-Beam Modules	C. Rossi	Yes	Yes
	3.2.	Main Linac Hardware			
	3.2.2.	Magnet Powering System	S. Pittet	No	
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Two-beam Accelerator	3.1.	Two-Beam Modules	C. Rossi	Yes	Yes
	3.2.	Main Linac Hardware			
	3.2.1.	RF Powering System	O. Brunner	Yes	Waiting for confirmation
	3.2.2.	Magnet Powering System	S. Pittet	No	
	3.2.3.	Magnet System	J. Bauche	Yes	Waiting for confirmation
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PBS Update

Changes So Far:

1. Safety
   - Environmental Monitoring
   - Radiation Protection
   - Fire Safety and Detection

2. Satellite Removal System:
   - Steffen Doebert will be taking over this task from Andrea Latina.

3. PBS 380 GeV Klystron
   - Drive beam production Node and associated domains have been removed.

Going forward:

1. PBS Technical Responsibilities
   - Those down as a responsible person must provide confirmation.

2. PBS Structure:
   - All those responsible have received an email asking for confirmation that the structure of their node/s is adequate
   - Meetings can and are being held to discuss amendments.
   - Need responses from everyone.

3. Finally:
   - It is foreseen that the structure of the PBS will be complete with input and confirmation finalised by the **15th of December 2017.**
   - Can begin to include numbers at the start of next year.

TOT Timeline

The proposed programme task completion dates are as follows, assuming a project commencement at the end of April 2017:

Task 1	**Establish Project Setup and Technical Basis**
Task 2	**Data and Functionality Prioritisation**
Task 3	**Specifications and TOT-CLIC architecting/wireframing (Concept Stage)**
Task 4	**Data Integration and TOT-CLIC (beta) development** **Initial TOT-CLIC beta version**
Task 5	**Finalised TOT-CLIC Development**
Task 6	**Troubleshooting and Technical Support**

Data Integration

Completed:

- Data and Functionality Prioritisation
- Specifications
- Data Integration and Development.
- Lattice Files for all energy stages!

Ongoing

- Finalised Development
  - Only a few small changes still to be completed
- Troubleshooting and technical Support.
  - Integrating on to CERN servers is more difficult than originally thought.

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Thanks to Mark Jones and Andrea Latina for their work on the lattice files.

Civil Update - TOT

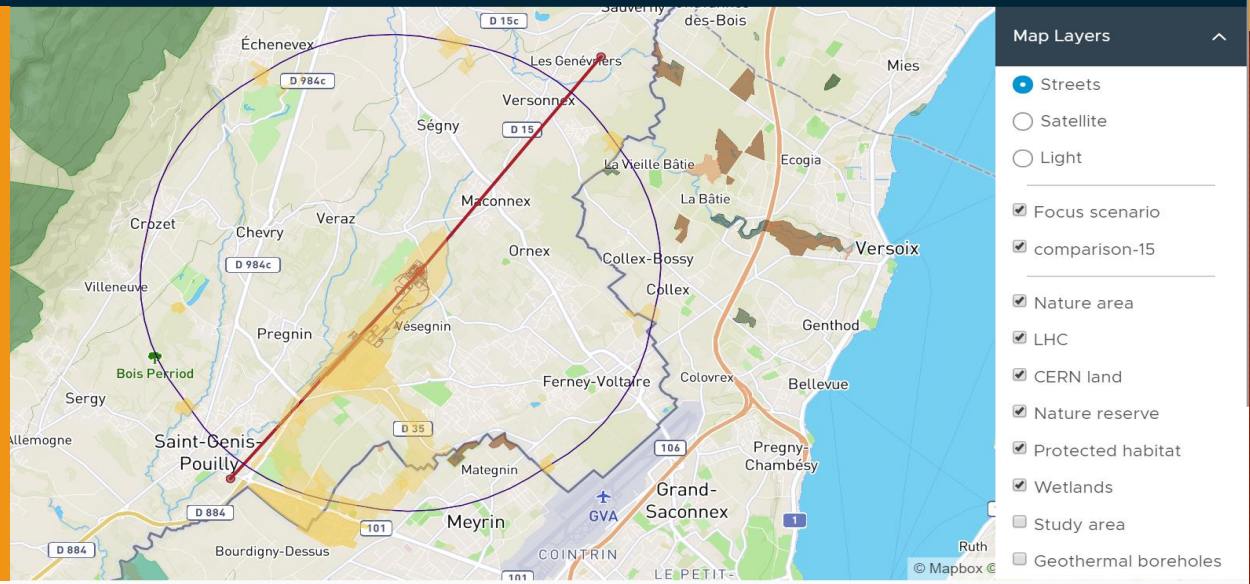
ARUP

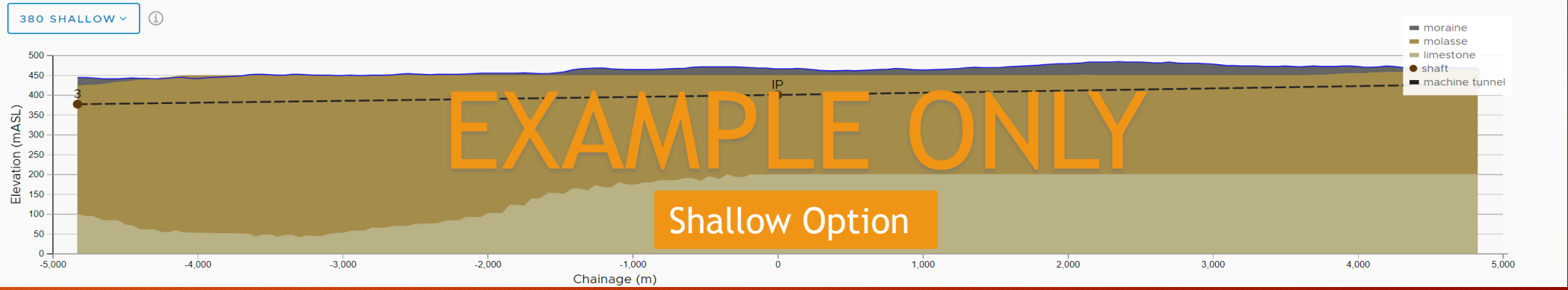
Scenarios My Profile Log out

3
IP
2

CLIC Advantages

- Allows quick movement of the entire machine.
- Easier to find optimised locations.
- User can run through many positions quickly and efficiently.
- Simpler to find and compare new positions.





Civil Update - TOT

380 GeV "CDR" Design

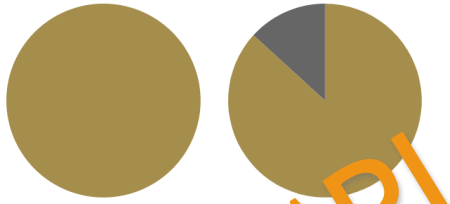
- Total Shaft Length: 325m
- Main Tunnel entirely in Molasse

380 GeV Shallow Option

- Total Shaft Length: 175m
- Main Tunnel still remains in the molasse

Focus: 380 Baseline

Tunnel	IP
Energy stage: 380 GeV	x: 2494510.09
Gradient: 0.3°	y: 1125552.01
Created by: matthew.stuart	Elevation: 350mASL
Last edit date: 20/10/2017	



Shaft geology & length (m)

3: 117.44	
IP: 116.00	
2: 91.90	

380 shallow

Tunnel	IP
Energy stage: 380 GeV	x: 2494510.09
Gradient: 0.3°	y: 1125552.01
Created by: matthew.stuart	Elevation: 400mASL
Last edit date: 20/10/2017	

Shaft geology & length (m)

3: 67.44	
IP: 66.00	
2: 41.90	

EXAMPLE ONLY

Focus: 380 Baseline

Natural feature overview (machine)

Under water body (%)	0.00
Nature area (%)	0.00
Protected habitat (%)	0.00
Wetlands (%)	0.00

Distance between shafts (m)

3-IP	4,826.84
IP-2	4,826.59

380 shallow

Natural feature overview (machine)

Under water body (%)	0.00
Nature area (%)	0.00
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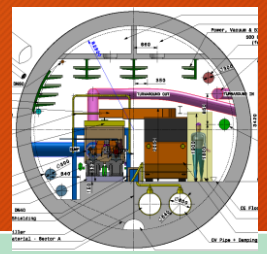
Wetlands (%)	0.00

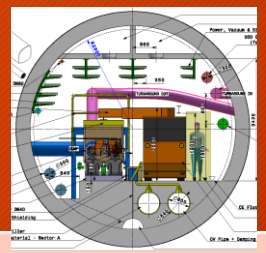
Distance between shafts (m)

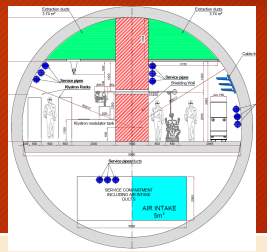
3-IP	4,826.84
IP-2	4,826.59

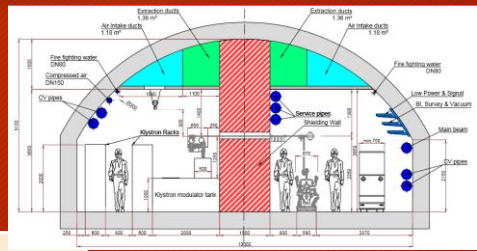
Civil Cost Update

- Compare the cost of multiple scenarios depending on geology.
- Analyse the cost of changing structural dimensions like tunnel width shaft depth etc…
- Allow us to compare the three tunnel options shown in the table.

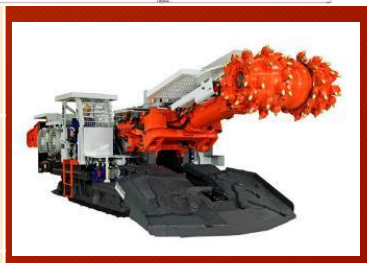




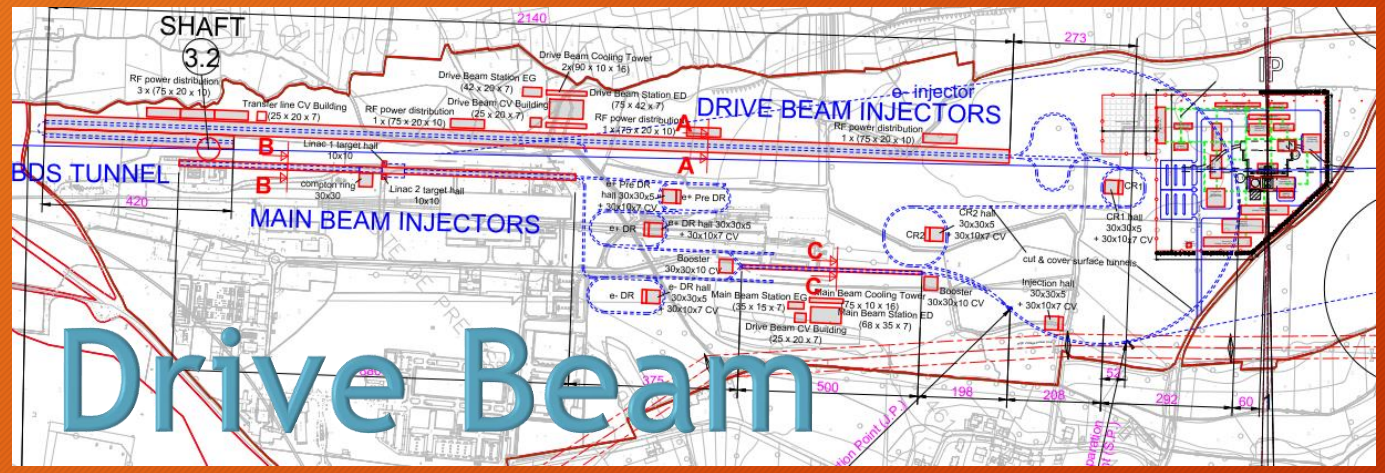




	CDR 500 GeV	New 380 GeV Drive Beam	Klystron 380 GeV 10m TBM
Main Underground Site Length	13,736	10,280	10,061
Drive Beam Complex	Full drive beam complex required	Partial drive beam complex required	No drive beam complex required
Underground structures + drive beam cost	All cut and cover tunnels required	All cut and cover tunnels required	Removal of drive beam complex associated cut and cover tunnels



Civil Cost Update

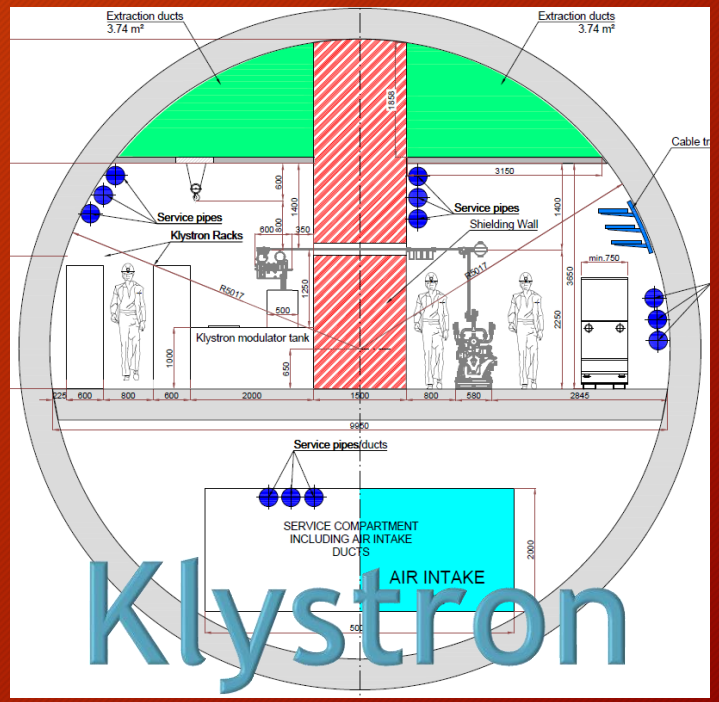


Large Drive beam building an area to save money for the initial 380 GeV energy stage:

- As previously discussed can be reduced in width to almost half the original size.
- Length of the Drive beam for the 380 GeV can potentially be reduced for further cost savings.

Shielding wall thickness will play a key role in the cost:

- Large effect on tunnel Diameter.
- Has a considerable associated cost.



Civil Update - Conclusions

Civil Engineering Cost Spreadsheet:

- Quick and consistent updates of the Civil Cost, to be used in conjunction with TOT.
- Still requires some work to ensure all Civil structures are accurately assessed.

TOT:

- CLIC TOT is being finalised and integrated onto CERN servers.
- Will be used to optimise the position of the tunnel allowing the most sustainable position of the tunnel to be found.

General Comments:

- Studies ongoing for the shielding wall and the Cooling and ventilation systems.
- Environmental factors are to be included in a separate study being led by HSE, however TOT does take into account environmental constraints.
- CV looking into thermal power dissipation to air, Civil Engineering to provide assistance on the effects the surrounding wall and rock have on this model.

Further Study

Transport:

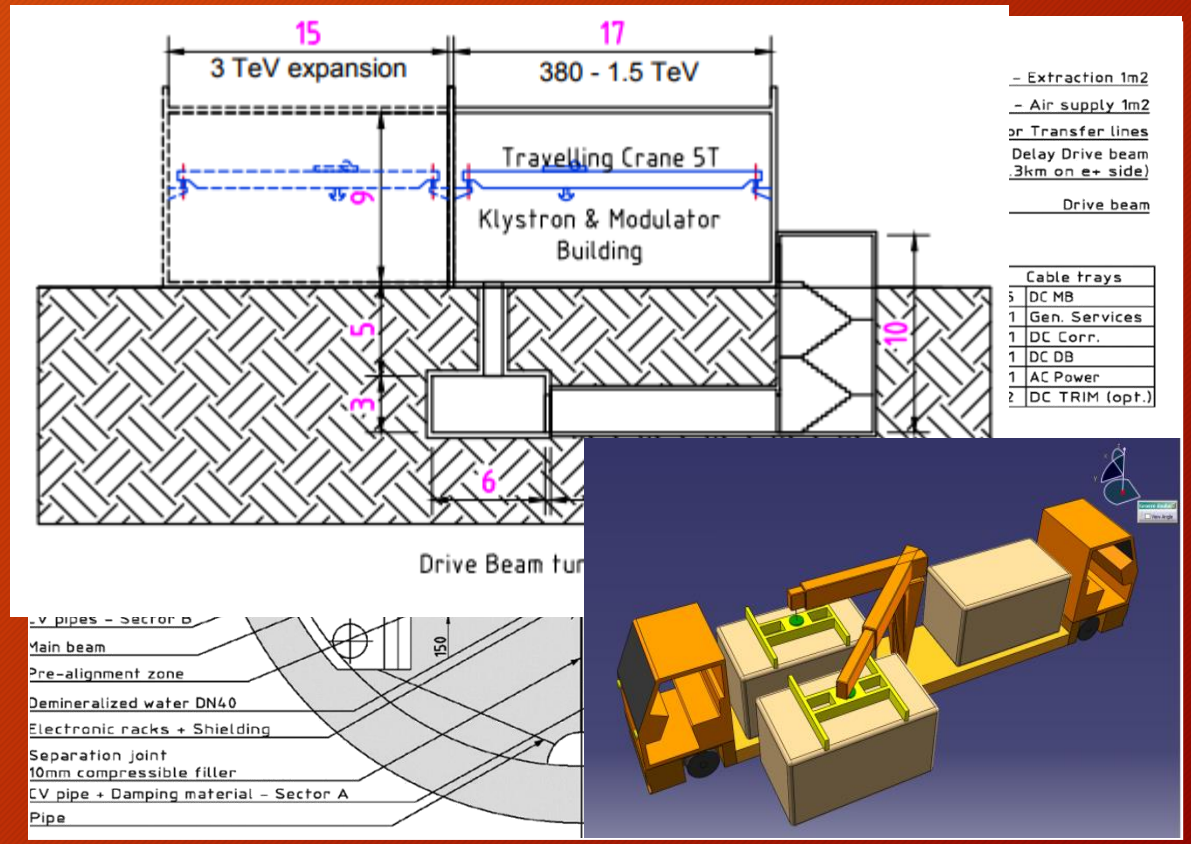
- An updated items list for transport is required for the Klystron and the Drive beam design.
- Transportation logistics need to be studied to allow a construction and installation schedule to be produced.

Cooling and Ventilation:

- Update of heat loads from ALL users is required to allow a solution to be implemented properly.
- Smoke extraction and radiation protection systems need to be integrated into the requirements (to be done with safety).
- Finalise the solutions for both Cooling and Ventilation.

Safety:

- Identification of hazards and mitigations that fall under standard procedure.
- Hazard register to be produced and populated by all disciplines.



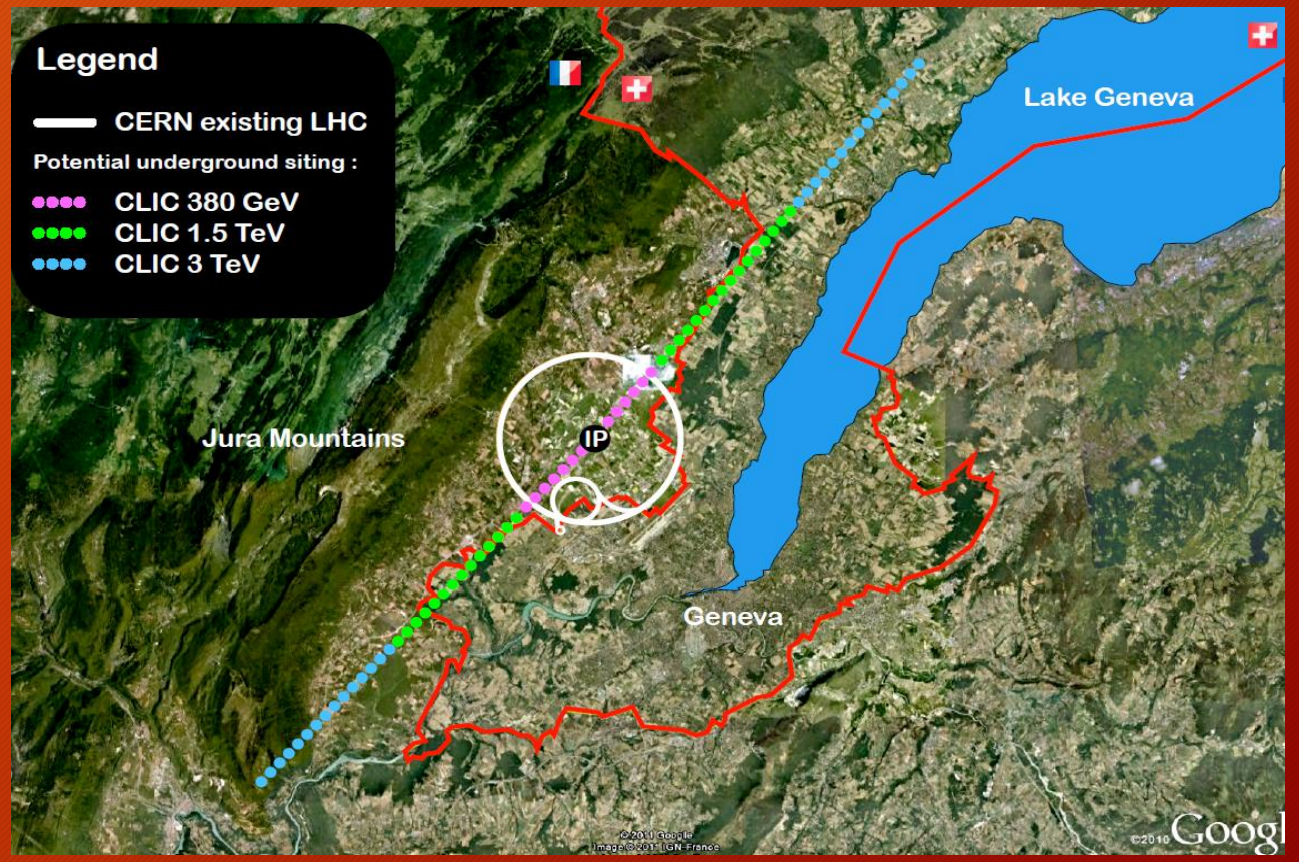
Further Study

Civil Engineering

- Use CLIC TOT to optimise the position of the tunnel for the different energy stages.
- Continue to update and integrate all disciplines into the surface and tunnel layouts and designs.
- Update surface building construction schedule

Electrical:

- Electrical power distribution layouts and electrical infrastructure requirements for both the Drive beam and the Klystron design are to be studied and integrated into the accelerators layouts.
- The availability of the required electrical power for all different CLIC machine configurations and energy levels will have to be studied and optimized.



Finally!

This is the Last CEIS meeting before the new year.

Some Final Notes:

- The CLIC Workshop from the 22nd – 26th of January.
  SIGN UP AT THIS LINK >>>> CLIC Workshop
- CEIS Working Group Meeting on the 12th of January (placeholder to go through presentations).
- PBS – Start to fill out with numbers
- To be well under way with all studies and communicate with those who rely on your information!
- Please check the task spreadsheet (link below) to ensure all tasks are being worked on and are up to date.

Civil Task Spreadsheet