CLIC Handling Engineering

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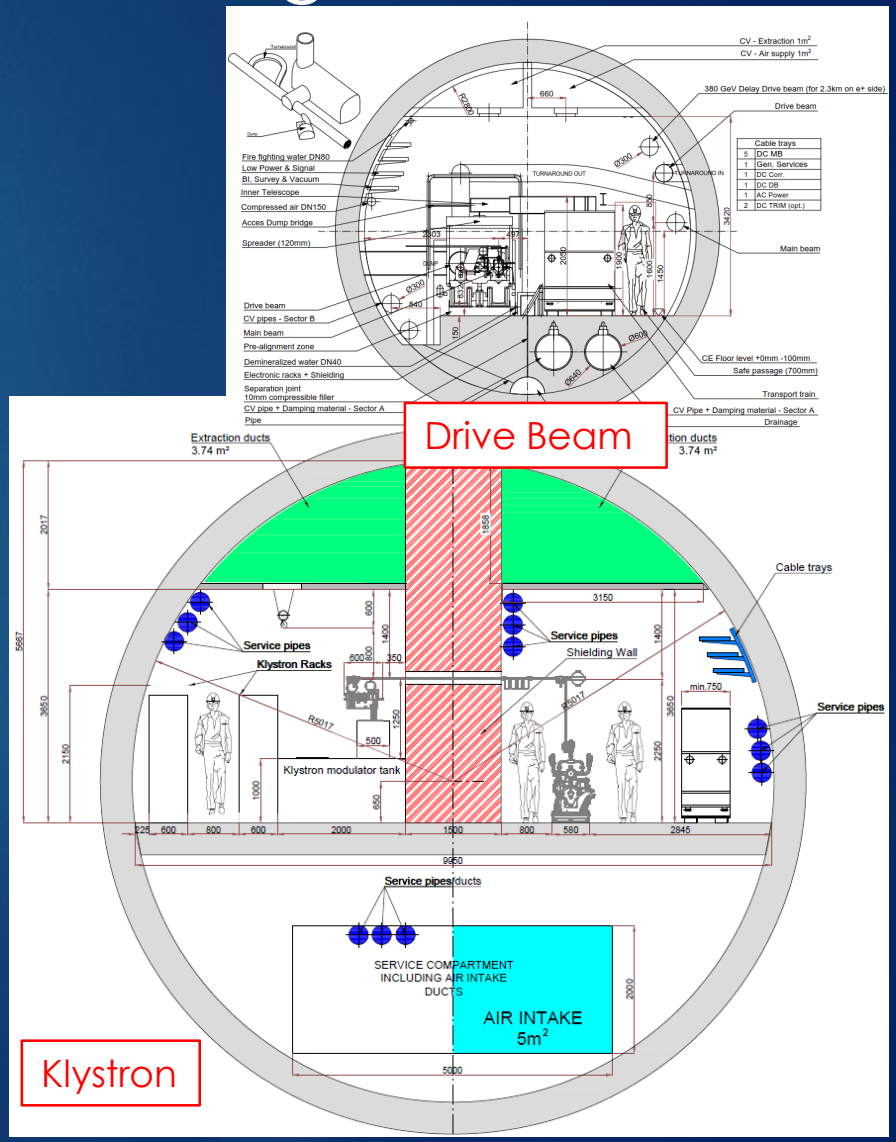
Outline

There are two leading studies on CLIC tunnel design:

- Drive Beam (DB) model,
- Klystron model.

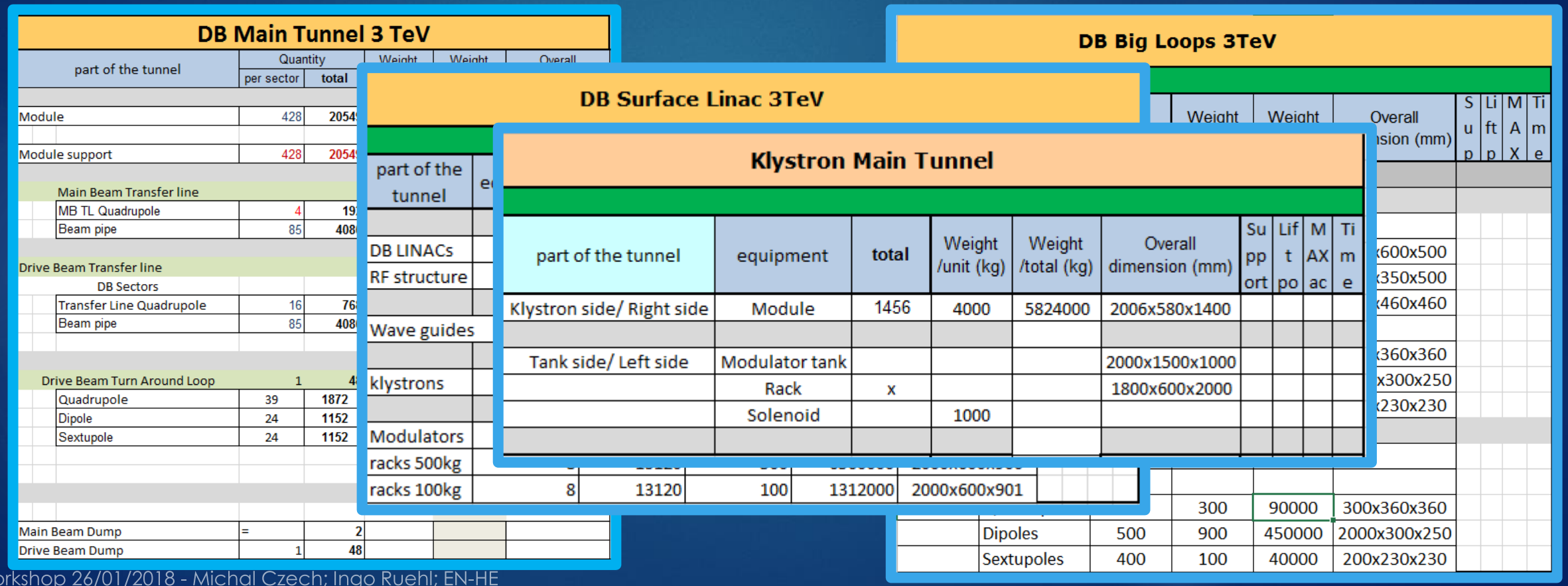
For each of them, following issues will be presented and discussed:

- Inventory data tables
- Surface transport & handling
- Shaft
- Underground handling
- What is next?
- Questions



Inventory input data tables – DB & Klystron

- Based on the general input on the characteristics and number of the equipment it is possible to define transport needs in underground and surface facilities.
- The tables were created and gradually updated in order to organize all the equipment, their location, their characteristics and quantity.



DB Main Tunnel 3 TeV

part of the tunnel	Quantity per sector	Quantity total
Module	428	2054
Module support	428	2054
Main Beam Transfer line		
MB TL Quadrupole	4	19
Beam pipe	85	408
Drive Beam Transfer line		
DB Sectors		
Transfer Line Quadrupole	16	76
Beam pipe	85	408
Drive Beam Turn Around Loop	1	4
Quadrupole	39	1872
Dipole	24	1152
Sextupole	24	1152
Main Beam Dump	=	2
Drive Beam Dump	1	48

DB Surface Linac 3TeV

part of the tunnel	e				
DB LINACs					
RF structure					
Wave guides					
klystrons					
Modulators					
racks 500kg					
racks 100kg	8	13120	100	1312000	2000x600x901

Klystron Main Tunnel

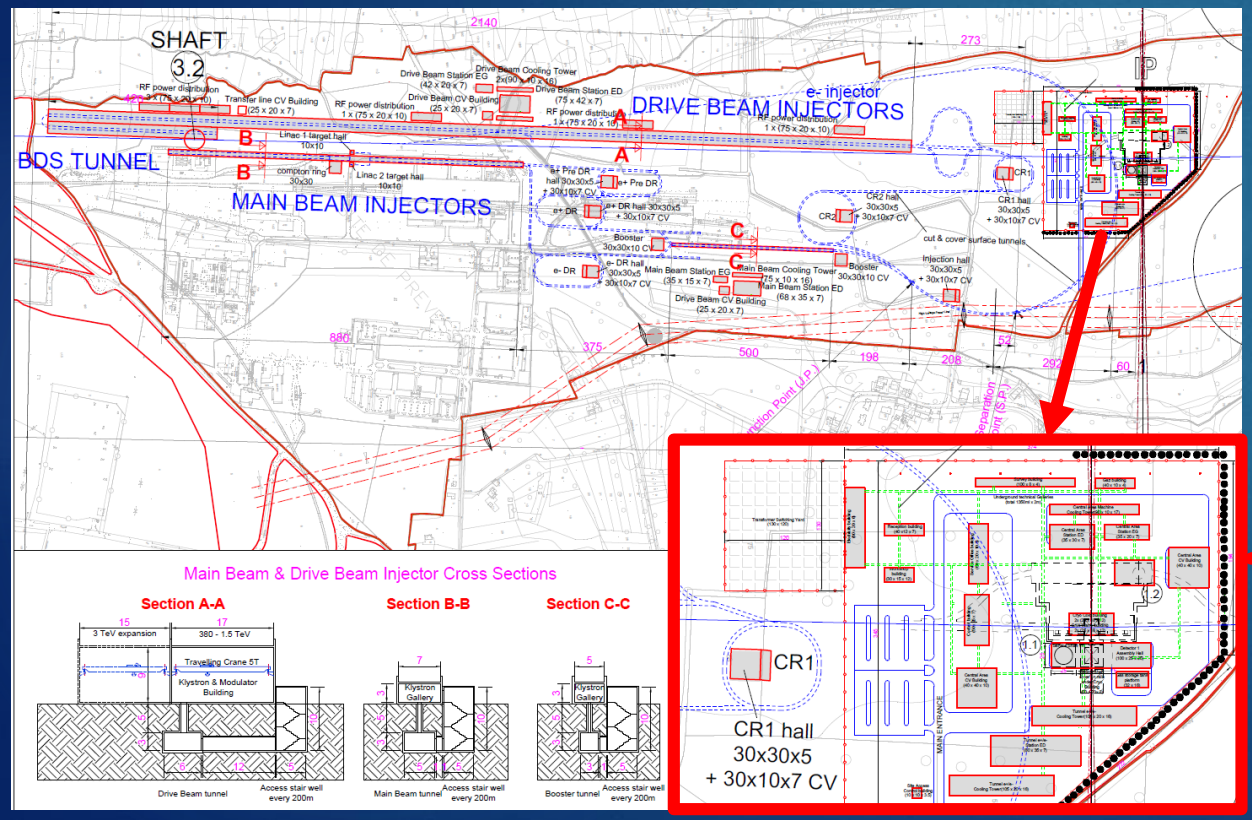
part of the tunnel	equipment	total	Weight /unit (kg)	Weight /total (kg)	Overall dimension (mm)	Support	Lift po	MAX ac	Time
Klystron side/ Right side	Module	1456	4000	5824000	2006x580x1400				
Tank side/ Left side	Modulator tank				2000x1500x1000				
	Rack	x			1800x600x2000				
	Solenoid		1000						

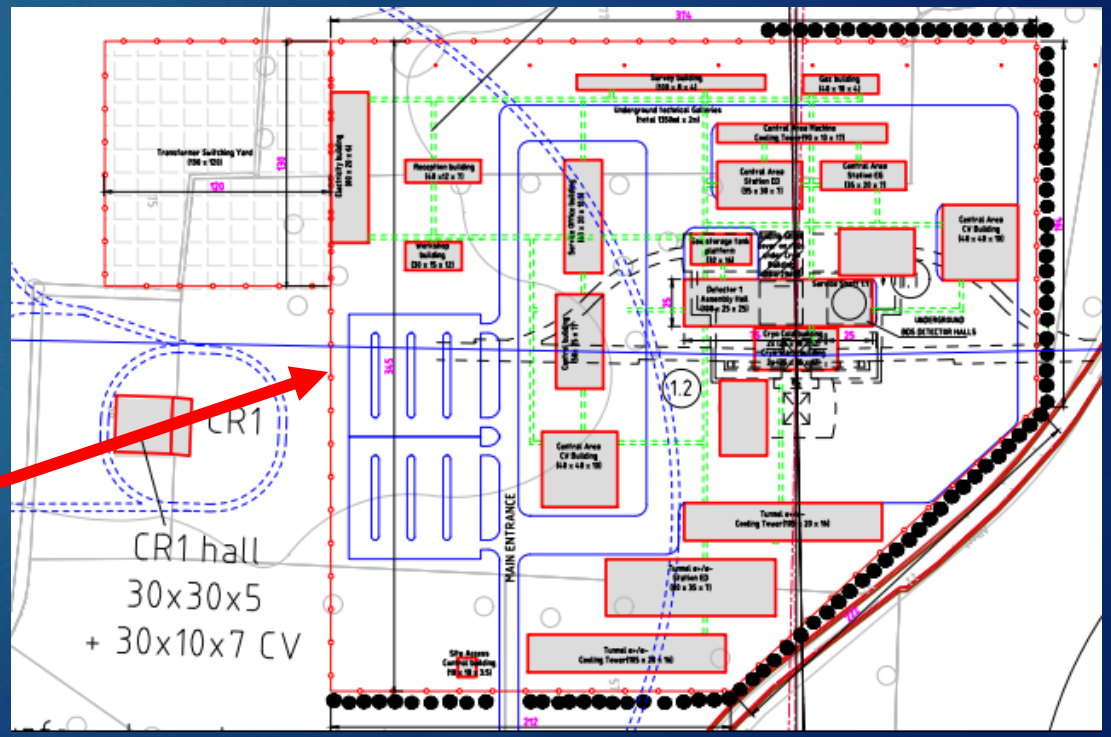
DB Big Loops 3TeV

					Weight	Weight	Overall sion (mm)	Sup	Lift p	MAX	Time
							x600x500				
							x350x500				
							x460x460				
							x360x360				
							x300x250				
							x230x230				
					300	90000	300x360x360				
	Dipoles	500	900	450000	2000x300x250						
	Sextupoles	400	100	40000	200x230x230						

Surface transport – Drive Beam

- Surface transport in between the buildings carried out using the fleet of road transport vehicles (feasibility studies to be done).
- Surface handling within buildings carried out by: mobile cranes, overhead cranes, forklifts, industrial lift trucks, trucks and trailers, pallet trucks, etc.

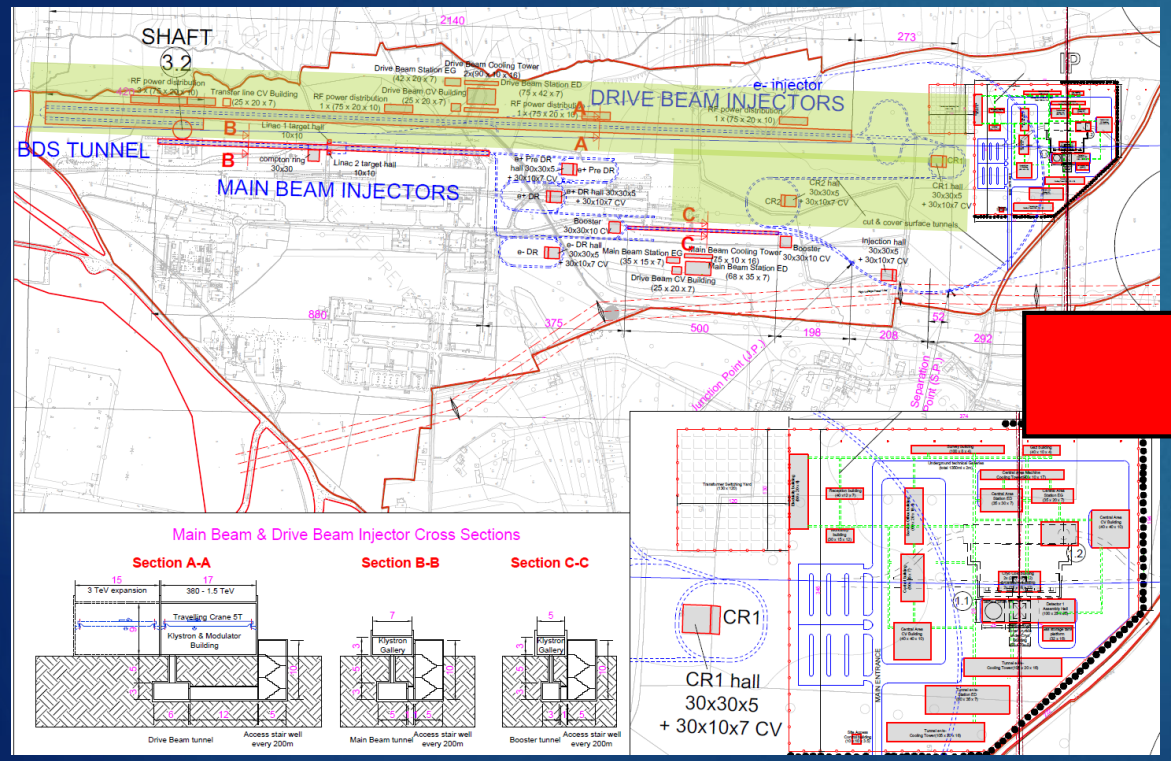


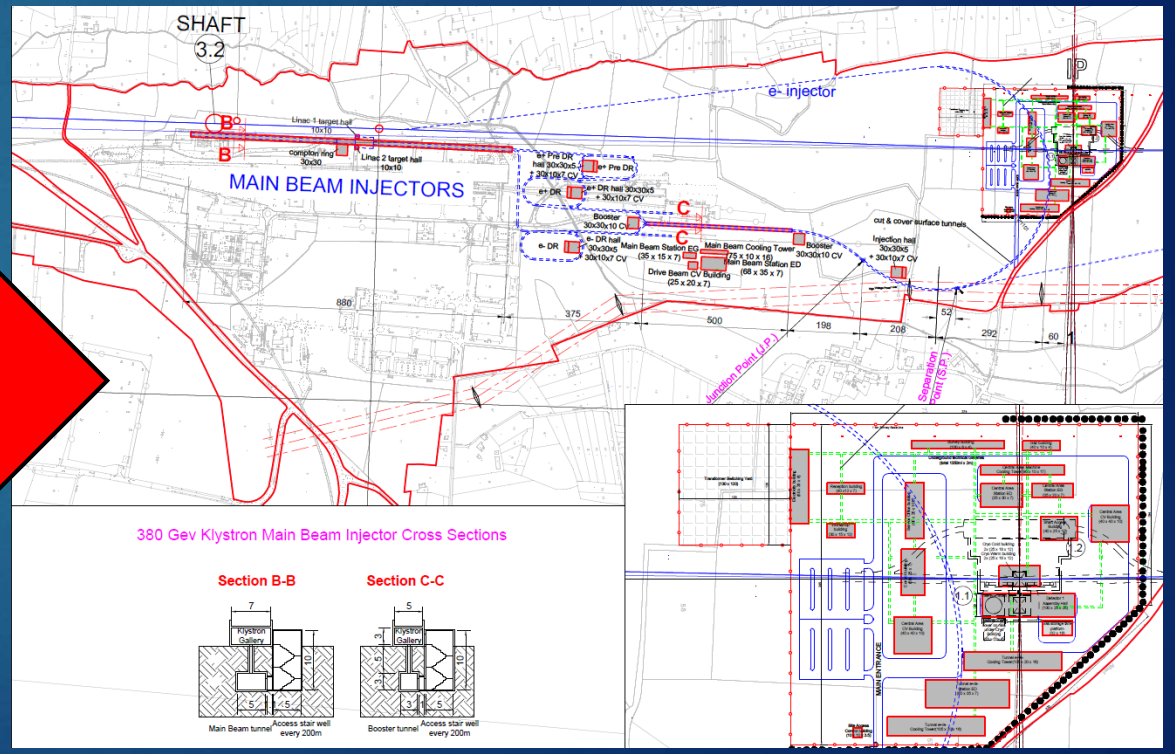


Surface transport – Klystron

Main difference for surface buildings:

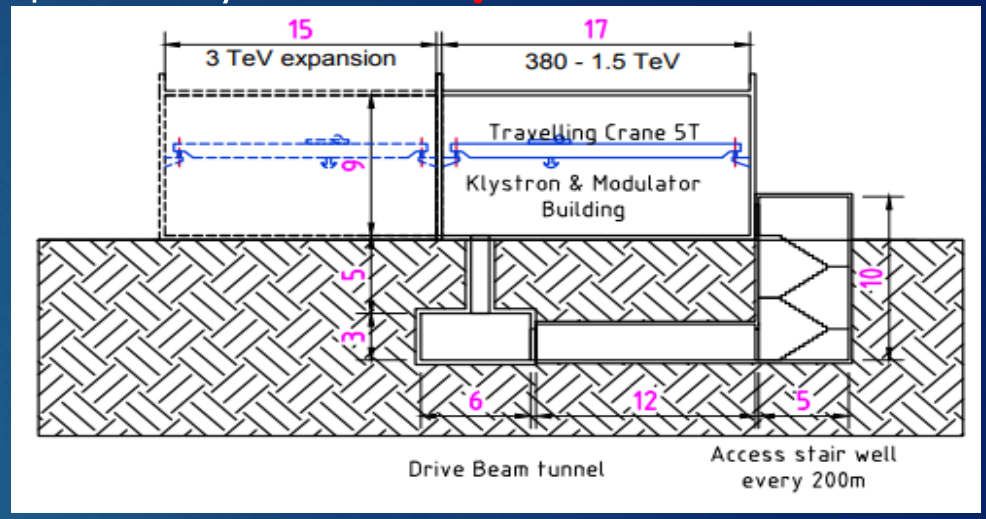
- No Drive Beam Complex (2,5 km surface building)

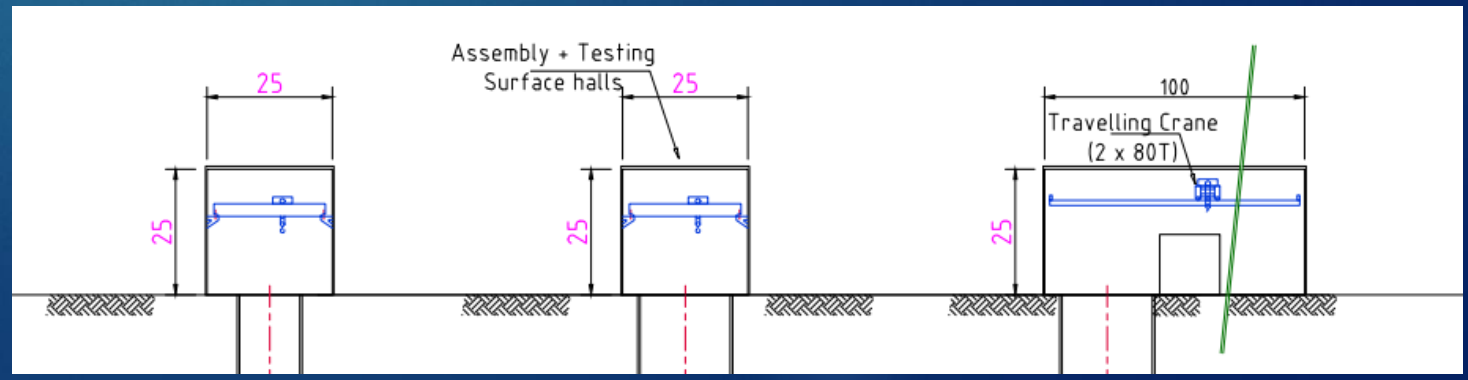




Surface handling – EOT cranes

Building Type:	Crane load capacity (tonnes)
Detector Assembly	2x80 (CMS approach) + strand jacks
Cooling Tower and Pump Station	3.2
Cooling and Ventilation	20
Cryogenic Warm compressor	20
Cryogenic Surface Cold Box	20
Workshop	10
Central Area Machine Cooling Towers	5
Shaft Access	20
Drive Beam Injectors	*5x5 for 380 GeV(the same or more for 3TeV)*



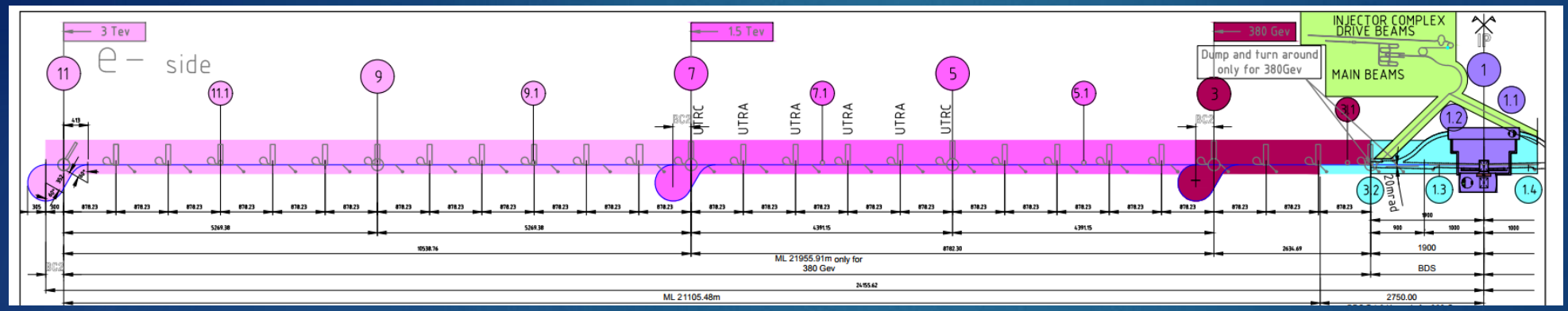


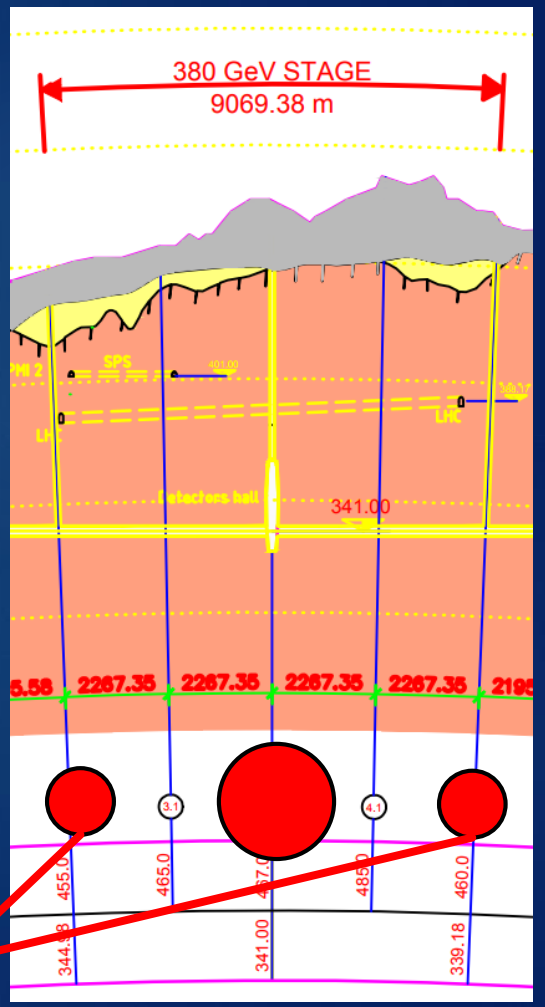
Transfer: Surface → Underground Shaft

- Access point: shafts every 5km – 10 total, 2 during 380 GeV stage

(+ shaft for the detector cavern)

* Inclined tunnels only when shafts are not feasible (geographical or environmental reasons)





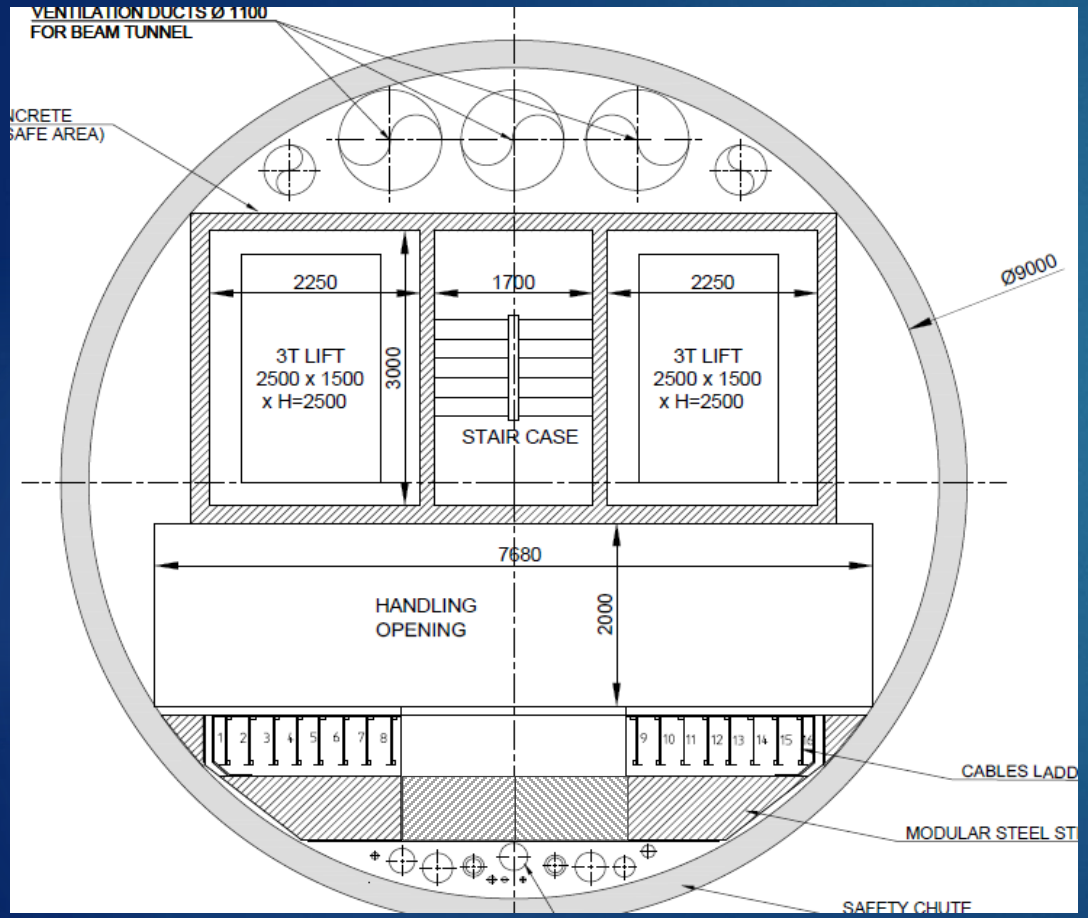
Shaft requirements:

- Evacuation → Lifts (exceptionally stairs)
- Shaft maintenance (cables, pipes, etc.) → Stairs/ tremie (crane maintenance platform)
- Quick access for people and equipment → Lifts/ tremie

Transport means:

Access shafts

Transfer Surface – Underground Shaft



Size of the shaft is defined by the biggest objects that will need to be transferred underground

Key features:

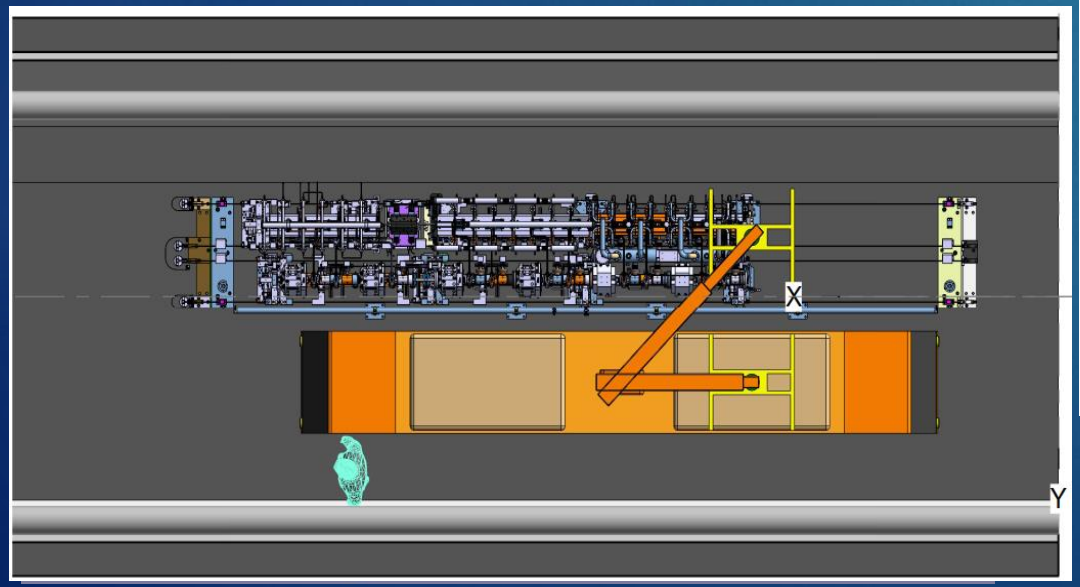
- Two lifts for redundancy:
  - Dimensions – Capacity: 3t,
    L=2500 mm x W=1500 mm x H=2500 mm,
  - Objects to transport:
    - Modules in DB Main tunnel,

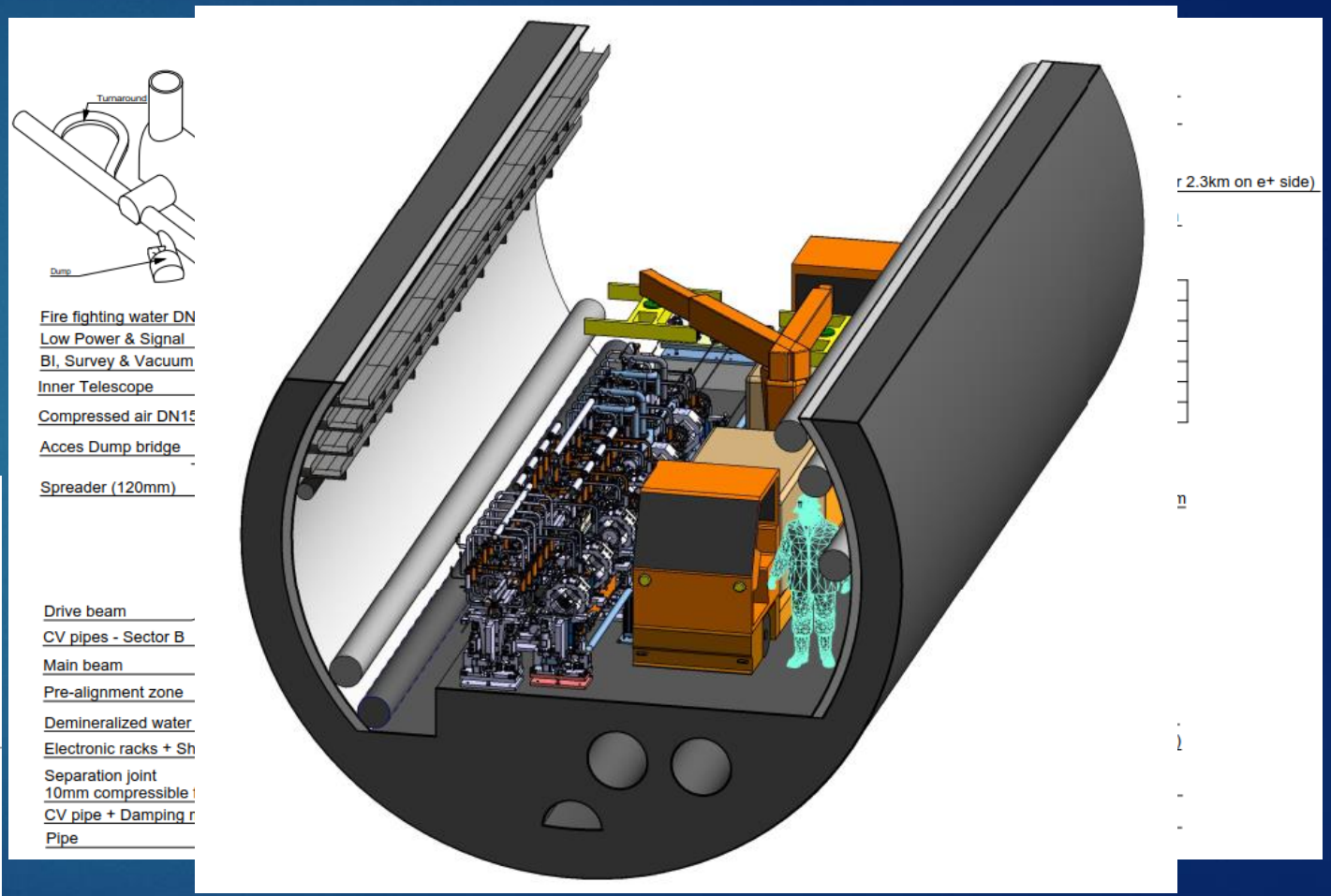
- TREMIE
  - Dimensions – L=7680 mm x W=2000 mm,
  - Biggest objects to transport:
    - Dipole (W:5t), Beam pipe (L~10m)

TUNNEL CROSS-SECTION – Drive Beam

CDR Tunnel Cross section basic information:

- Internal diameter: 5.6 m
- Transport Volume (mm): 2150 x 1200
- Width of the safe passage: 700 mm



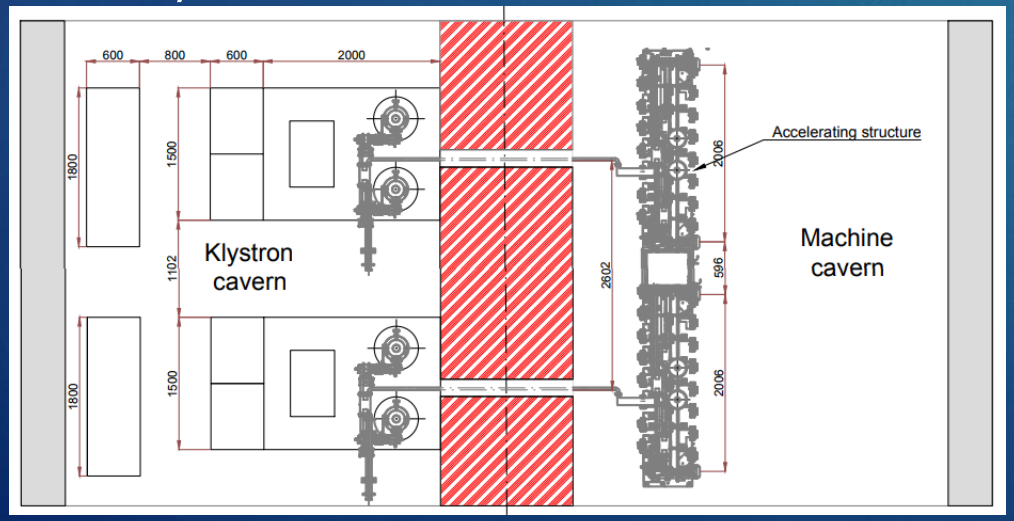


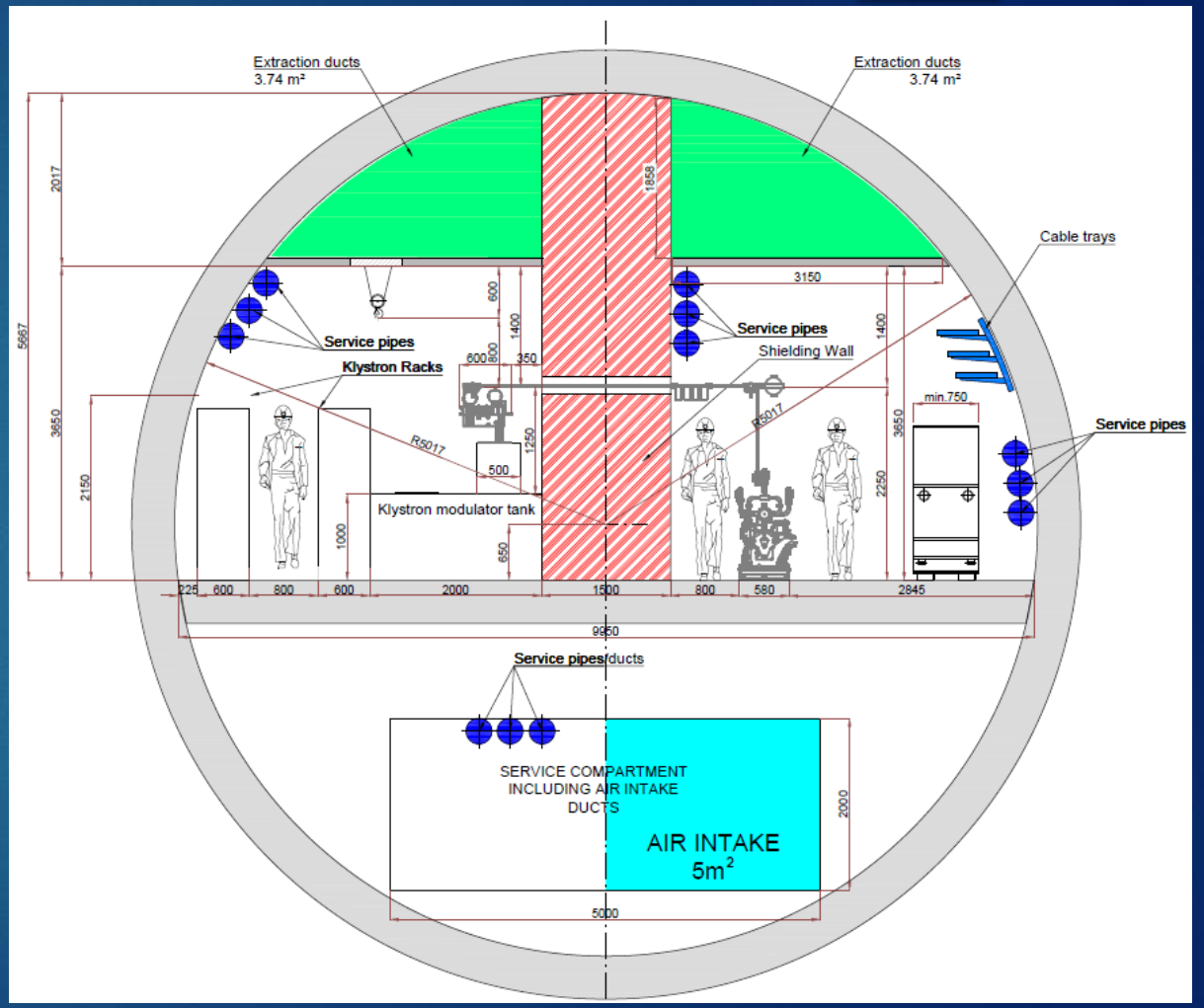
In order to transport all modules fluently, dedicated vehicle was proposed (design by K. Kershaw)

TUNNEL CROSS-SECTION – Klystron

CDR Tunnel Cross section basic information:

- Inner diameter: 10 m;
- Two section of the tunnel separated with a shielding wall (study ongoing);
- Two different transport needs (rails and hoists through the whole tunnel **or** classic transport volume with truck/trailer/forklift solution);





Estimate – Drive Beam total cost

Main differences/ similarities (3 TeV and 380 GeV):

- Less maintenance, operation manpower, cranes, lifts, etc.,
- Same injection + experiment surface buildings,
- Same installation rate.

Klystron approach cost comparison:

- Saving on the lack of the Drive Beam Injectors surface buildings complex,
- Losing on the enlarged underground tunnel.

The cost of the Klystron solution will be similar to the DB solution. Studies ongoing.

All available estimations are at 2007 levels; Since then costs may have changed!

Conclusion

- No major obstacles from the transport point of view,
- Shaft layout and infrastructure equipment (such as cranes and lifts) may evolve with CLIC machine equipment dimensions/ characteristics,
- Strongly recommend to move klystron racks out of the transport passage in the “Klystron tunnel”,
- Cost estimate will be reviewed once final tunnel and equipment layout available.

What's next?

- Equipment data tables to be updated,
- The Klystron tunnel is still to be studied (eg. monorail or forklift solution for installing solenoids),
- Cost estimation to be updated (PBS tool).

Questions?
Thank you ☺