Europe / CERN studies for SB2009 ILC Re-Baseling

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2009 Linear Collider Workshop of the Americas
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Contents

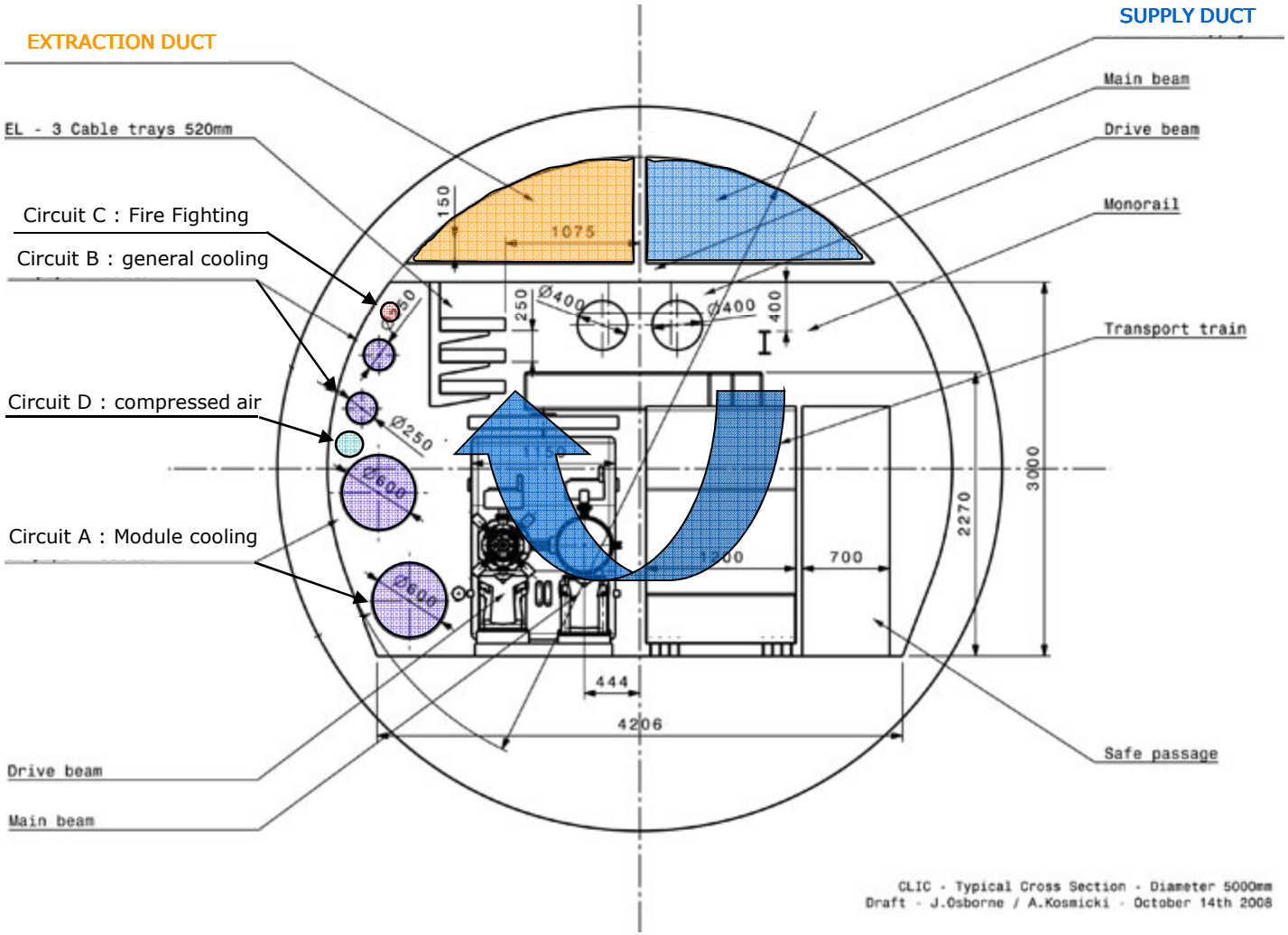
- ILC single tunnel solutions adapted to the CERN site
- Main Safety considerations
- Cost savings for Main Linac compared to RDR
- 3d studies at CERN for other SB2009 proposals

ILC Single tunnel solutions

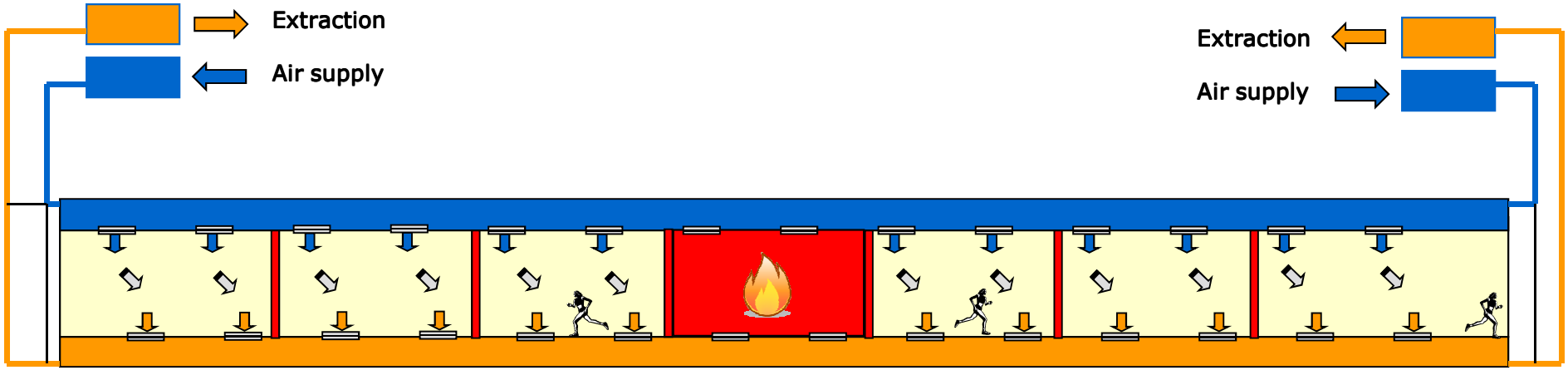
- CERN have looked at the civil engineering for tunnelling both the :
  - RF Klycluster
  - Distributed RF System
- What diameter tunnel ?
- One of the key determining factors is the ventilation concept
- For CLIC single tunnel solution, we have concluded that the 'Transversal Ventilation' system is preferred because :
  - Combined with Tunnel Compartmentalisation (firewalls) it provides a credible escape path in the event of a fire
  - better temperature stability, as opposed to 'Longitudinal Ventilation'
  - For ILC the return duct could potentially be used as a 'vent' for an unexpected Helium Release
- This implies that a larger tunnel is required, so for these ILC studies we have assumed a 5.2m diameter tunnel, although, this needs to be reviewed.

CLIC Ventilation Concept

CLIC Tunnel section



Safety considerations



- Control of the pressure from both ends of a sector.
- Control of the pressure (overpressure or underpressure in each area).
- Fire detection per sector compatible to fire fighting via water mist.

Security and Workplace Safety Concepts for the Construction, Installation and Operation of the XFEL Research Facility

(Issue date: 4/8/2005)

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3.5 Tunnel

3.5.1 Standard and minimum dimensions of escape routes in the tunnel

Although from its geometric dimensions the structural character of the tunnel is similar to that of tunnels that convey road and rail traffic, it differs with regard to function and use. There are no safety regulations for such research tunnels, so that in this case it is necessary to draw upon the corresponding regulations for traffic-conveying tunnels.

The regulations that apply to escape and rescue routes in the case of traffic-conveying tunnels are summarized in Table 5 below.

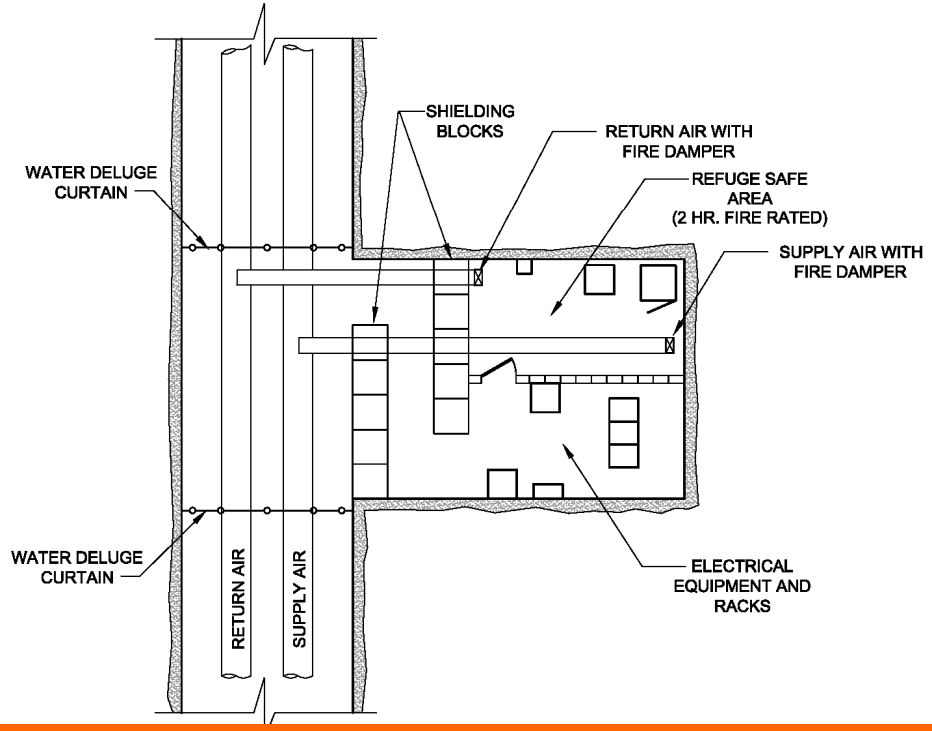
3.5.2 General fire prevention and safety requirements in tunnel structures

The tunnel is subject to the following safety requirements:

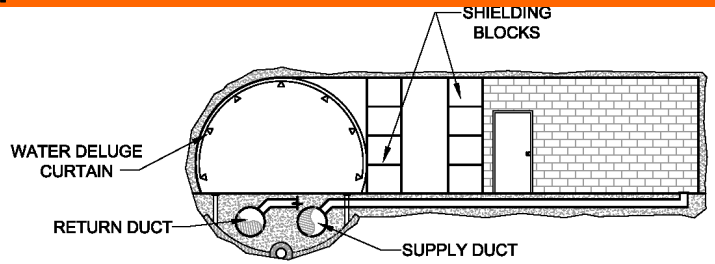
- Structure to have a fire resistance classification of at least F 90 (corresponds to the IndBauRL requirement for basements)
- Solid fire compartment separation from the shafts and experiment hall
- Creation of fire and smoke compartments through provision of a solid partition covering the cross-section or a solid partition in combination with a triple water curtain in the passageway every 600 m (or spaced in multiples of 150 m, i.e. of a cryo compartment in the XTL, in special cases of a low fire load in the XTDs, max. 700 m)
- Water mist extinguishing system for oil transformers
- Inert gas extinguishing system in all instrumentation and control cabinets
- Early fire detection, fire location identification
- Smoke extraction in all tunnels
- Design of smoke extraction systems in the tunnels based on smoke generation during the self-rescue phase. Based on the longest escape time of 7 min (compare Section 4.4.2.1), this approach offers an adequate safety reserve.
- General accompaniment of self-rescuers (that last at least 30 minutes) for all fellow employees in all tunnels
- Escape route identification/emergency information system (audible/visible), incident-dependent
- Backup power supply for safety and fire alarm equipment (ventilation systems, emergency lighting, escape route identification), functionality retention E90
- Luminescent escape route marking
- Safety and emergency lighting
- Escape and rescue routes
- Separation from the shaft structures and experiment hall by means of T30 doors
- Access control system/single-entry
- Communication points/emergency telephone at least every 50 m
- Installation of antennas and antenna systems for communication purposes (radios, cellular telephones, emergency radio communication)
- Handrail approx. 1.10 m above floor along escape route
- Fire-extinguishing line, filled (utility water line) with outlets at least every 50 m
- Accelerator suspension system to be designed with the possibility of a fire taken into account
- Gurneys that can be carried past obstacles for rescuing injured individuals
- Absolute smoking prohibition during construction, commissioning, maintenance and operation

XFEL have also adopted ‘Fire Compartments / Escape Routes’

Area of Refuge



This concept is not the recommended solution for CERN site



LIFE SERIES

REFUGE CHAMBER

LIFE SERIES is a Refuge Chamber specifically designed and manufactured in order to provide a safe haven in the event of underground emergency to personnel working in Mines, NATM and TBM excavated tunnels.

The unit is classified as a temporary Installation and must be intended as a unit capable to provide a safest environment with reference to prescribed usage time and type of emergency (clearly pointed out by specific risk assessments).

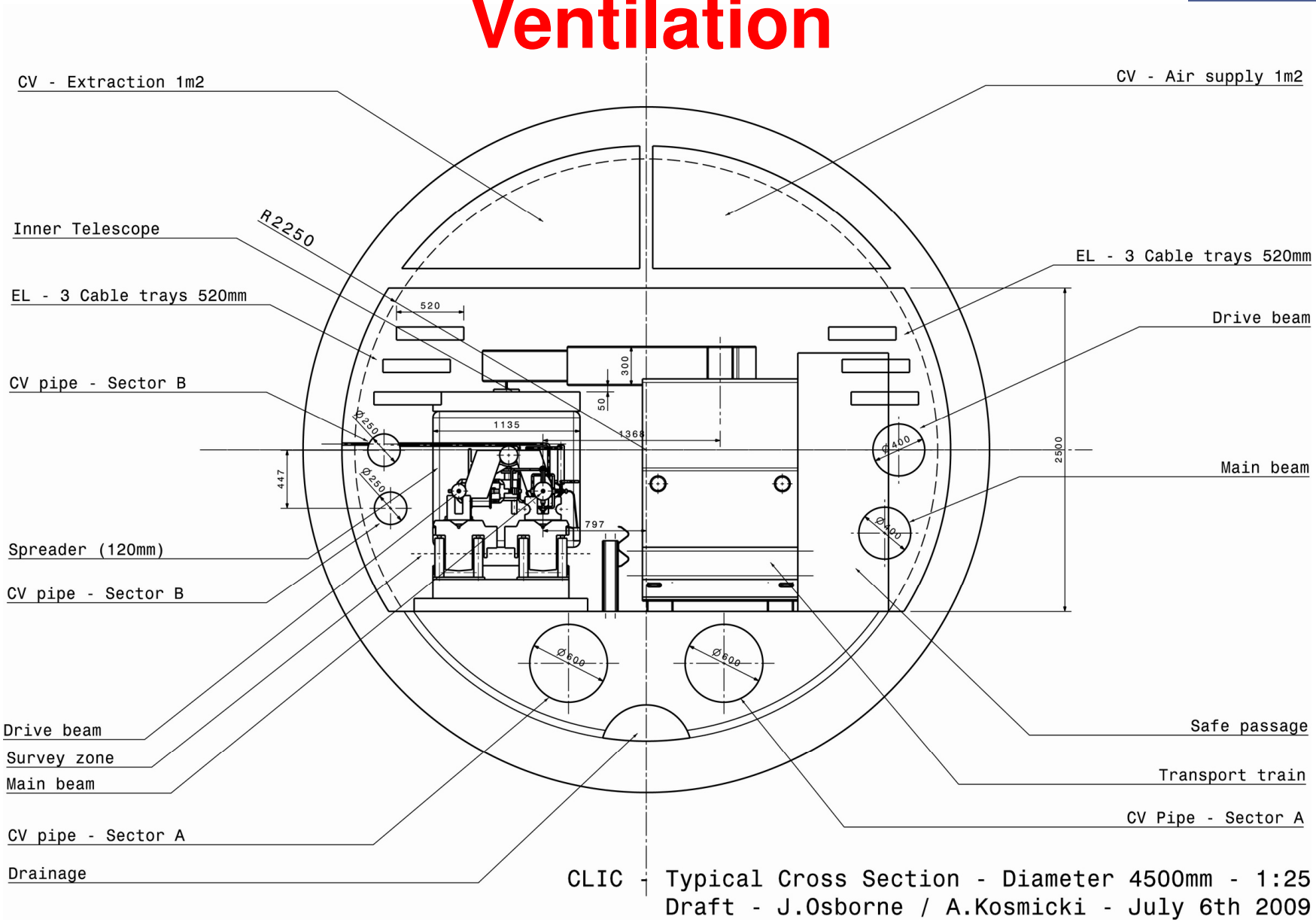
TECHNICAL DATA

Capacity	Up to 20 people
Dimensions W x D x H	mm 6500 x 1600 x 2000 for 20 people
Weight	~3'500 kg
Enclosure mechanical resistance	2000 N/m2 - Blast resistant to 0,2bar shock wave
Disposable Living space	≥ 0,4 m2 / person
Fire resistance	2 hours (at a minimum distance of 50mt from fire loads)
Acoustic level attenuation	≤ 30 dB(A)
Pressurisation system	Compressed Air, externally supplied by separate compressor
Positive Pressure	100 Pa
Compressed air flow for inner atmosphere regeneration	Qm ≥ 200 Nm3/h - 10Nm3 /h *person
Emergency breathing system	nbr.20 high pressure cylinders 50 litres capacity each @ 300Bar
Survival time without pressurisation	12 hours (with compressed air line breathing system)
Standard Power Supply Source	230V-1ph-50Hz externally supplied
Lighting system	4 lighting fixture with 2hrs. battery back-up for 12hrs lighting autonomy
Air quality control	Portable multifunction Gas monitoring device for O2-CO-CO2-CH4

GENERAL INTERNAL ARRANGEMENT

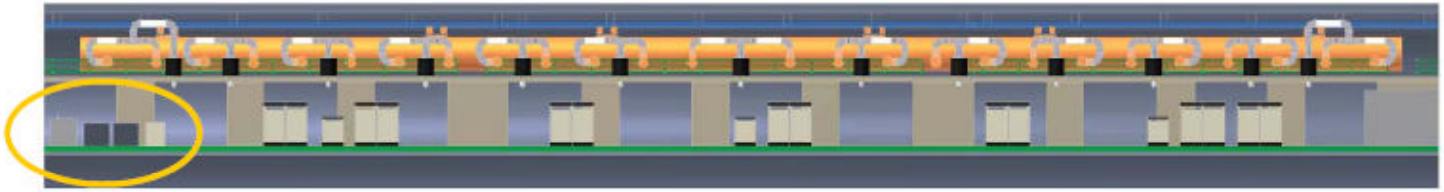
AIR FILTERING SYSTEM

CLIC 4.5m tunnel : Transversal Ventilation

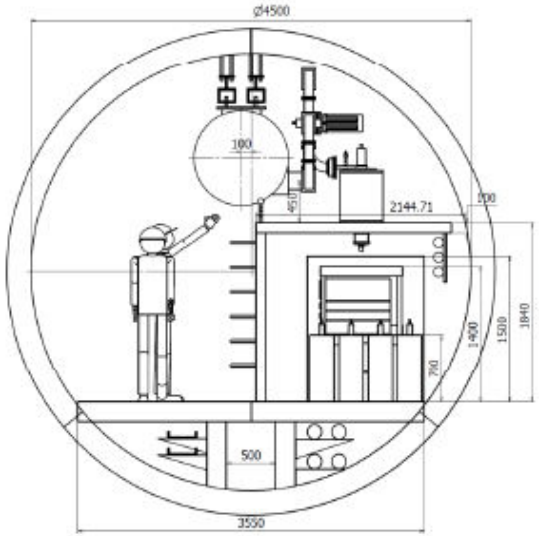


Distributed RF System for CERN Site (1)

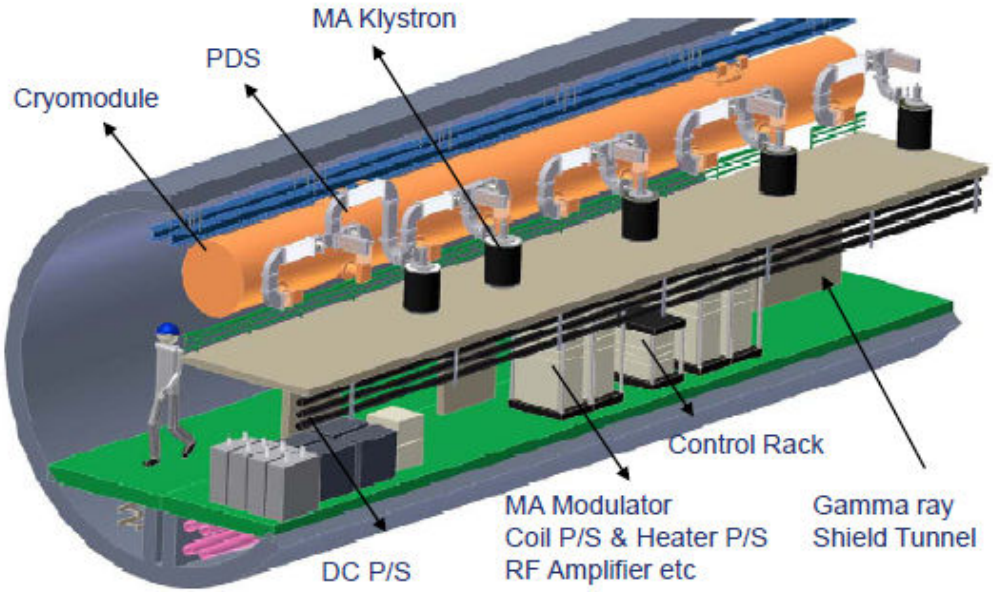
Sketch of 3-Cryo-odule unit



6.6kV In & Rectifier Transformer
Capacitor Bank, Bouncer

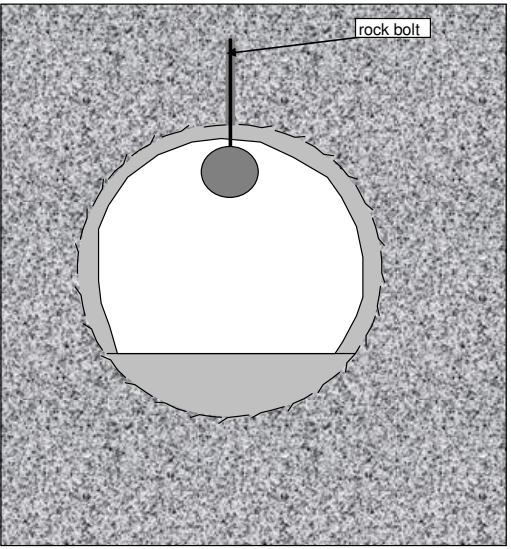


Cross Section



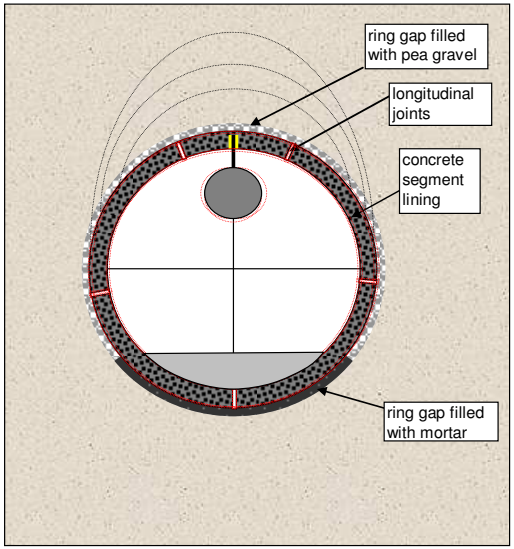
Distributed RF Scheme for CERN Geology (2)

situation in hard rock



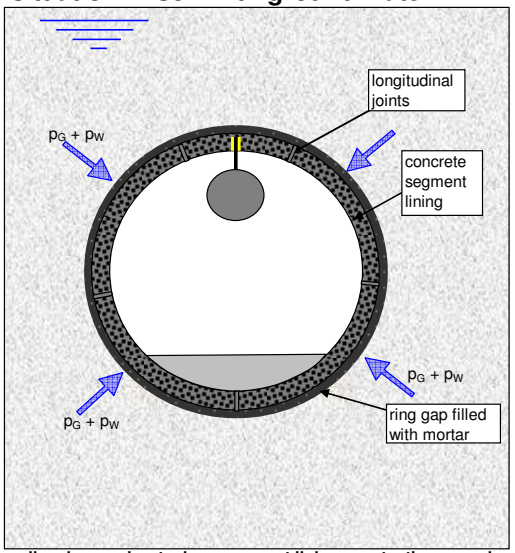
no deformation of the rock
= beam line stable

situation in soft rock



soft rock has long term deformations
pea gravel filling of ring gap is not 100% compact
= only floor area on mortar ring gap filling is stable

situation in soil with ground water



soil and ground water keep segment lining constantly pressurised
longitudinal joints are completely closed
= lining ring is stable around the whole perimeter

Asia/Americas

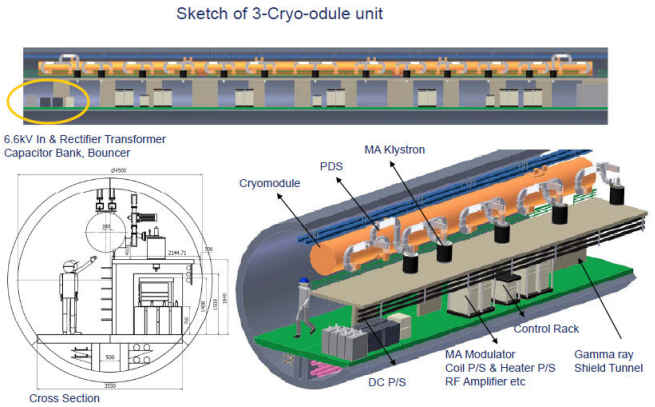
CERN

DESY

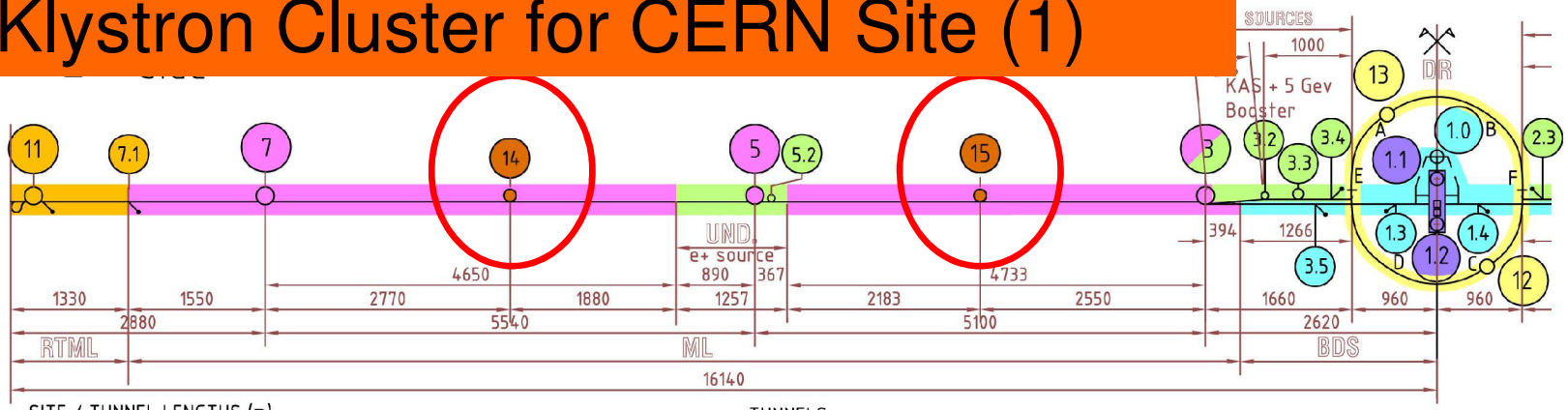
• Distributed RF Scheme for CERN Geology (3)

- Very preliminary studies with Amberg Engineering have concluded that although certainly not excluded, it is not recommended to suspend cryo modules from tunnel crown in Molasse soft rock

- CERN transport / installation group are wary of this concept of fixing magnets on the tunnel crown and installing equipment under a false floor. Further study needed……



Klystron Cluster for CERN Site (1)

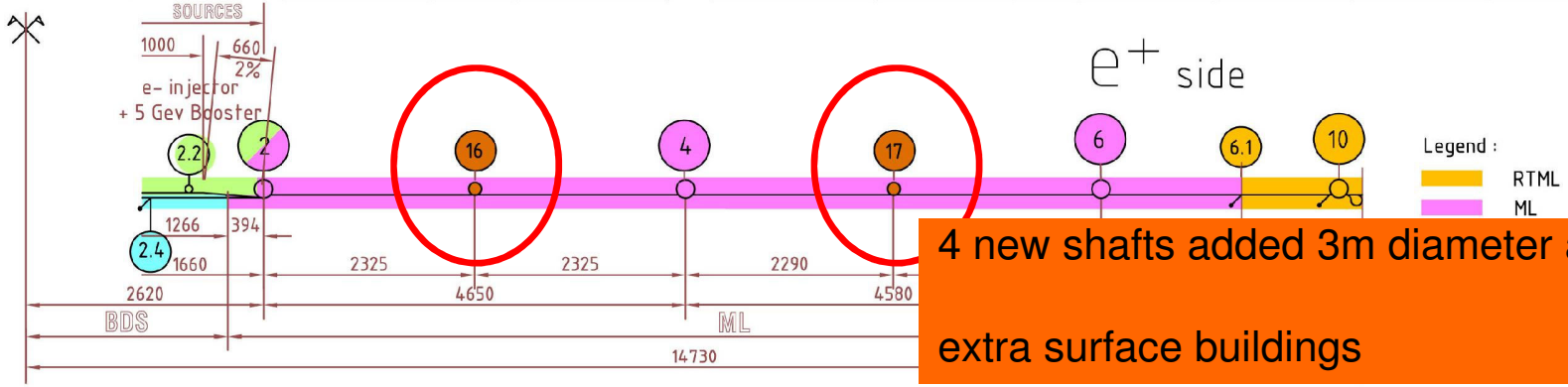


SITE / TUNNEL LENGTHS (m)

e– side + Undulator ML + RTML	e+ side ML + RTML	BDS + sources	DR	TOTAL
13 914 / 27 948	12 504 / 25 128	4452 / 12 236	0 / 6704	30 870 / 72 016

TUNNELS

Area	e- inject.,KAS beam + serv	DR	RTML beam + serv	ML beam + serv	BDS beam + serv	BDS Survey
Øm	4.5	5.0	4.5 + 4.5	4.5 + 4.5	4.5 + 4.5	1.5 x 2.2



4 new shafts added 3m diameter and

extra surface buildings

SHAFTS

Point	1.0	1.1	1.2	2	3	3.3	5.2	4	5	6	7	10	11	12/C	13/A	14	15	16	17
Øm	9	16	16	14	14	4	4	14	14	9	9	14	14	9	9	3	3	3	3

BORINGS

Point	2.2, 3.2	1.3, 1.4, 2.4, 3.5
Øm	1.50	

SHAFT BASE CAVERNS

Point	2, 3,	4, 5, 6, 7,	10, 11
(LxWxH) m	49 x 16 x 18 + 3 storeys		

MUON WALL WIDENINGS

Point	1.3, 1.4
(LxWxH) m	25 x7x6 +15x7x6

SOURCES CAVERNS

Point	Undulator 5.2	KAS 3.3	2.2, 3.2
(LxWxH) m	21 161m3	6 574m3	7 X 15 X 7.5

DR ALCOVES

Point	12/C, 13/A	B, D, E, F
(LxWxH) m	75 x 10 x 10 + 1 storey	16 x 8 x 8

DETECTORS HALL

Point	1.1, 1.2	1.0
(LxWxH) m	120 x 25 x 39	40 x 15 x 15

BEAM DUMPS CAVERNS (↖)

Point	SOURCES 2.3, 3.4	RTML 6.1, 7.1, 10, 11	BDS 1.3, 1.4, 2.4, 3.5
(LxWxH) m	5 x 4 x 4		20 x 9 x 15 + 1 storey

BEAM DUMP SERVICE HALLS (↖)

Point	BDS 1.3, 1.4, 2.4, 3.5
(LxWxH) m	30x20x 10

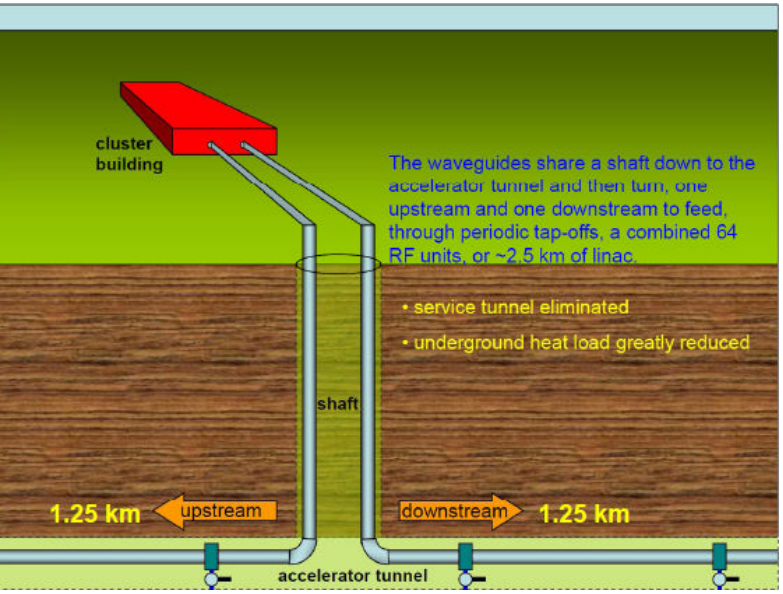
ILC - RE-BASELINING PROPOSALS
KLYCLUSTER DESIGN

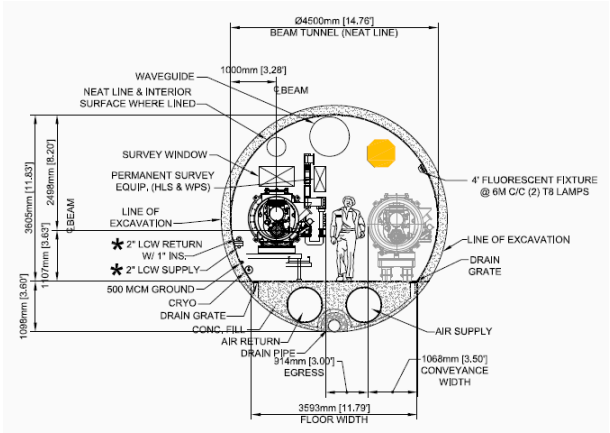
EUROPEAN REGION

GROUP : TS-CE
CIVIL ENGINEERING
SUPERVISOR : J.OSBORNE
DESIGNER : A.KOSMICKI

SCALE : 1/50000(A3_FORMAT) DATE: JUNE_4TH_2009
ILC-.CE-1.1649.0023 SIZE 3 INDICE

Klystron Cluster for CERN Site (2)





New surface buildings for RF 1500m2

Required on 4 sites :

Environmental challenges for CERN site……..

Amberg have costed various tunnel diameters using different safety concepts and compared them to RDR (using same WBS template)

ILC International Linear Collider

TWIN TUNNELS 4.5m + 4.5m Push-Pull

CONVENTIONAL FACILITIES

WORK BREAK DOWN STRUCTURE

EUROPE REGION / 29.03.2007
CERN SAMPLE SITE FOR 1.7.1
Final Prices

				Area systems								TOTAL	single tunnel on ML 4.5m with alcoves and safety chambers	percentage COMPARED with TWIN 4.5m + 4.5m	single tunnel on ML 4.9m with ventilation in crown and firewall	percentage COMPARED with TWIN 4.5m + 4.5m	single tunnel on ML 5.2m with ventilation in crown and firewall	percentage COMPARED with TWIN 4.5m + 4.5m
CURRENCY : KEUROS				A1	A2	A3	A4	A5	A6	E	G		A5		A5		A5	
				e- source	e+ source	DR	RTML	Main Linac	BDS	Exp'mt	Gen'l &		Main Linac		Main Linac		Main Linac	
1.7			Conventional Facilities															
1.7.1			Civil Engineering	77,863	46,181	137,749	123,418	585,382	173,815	131,195	34,197	1,309,800	469,478	-19.8%	466,936	-20.2%	482,703	-17.5%
	1.7.1.1		Engineering, study work and documentation	4,758	2,881	8,402	7,238	35,741	10,889	8,211	2,340	80,460	29,356	-17.9%	29,199	-18.3%	30,171	-15.6%
		1.7.1.1.1	In-house Engineering (man-year)															
		1.7.1.1.2	Outsourced Consultancy Services - underground	3,897	1,688	6,327	5,003	29,957	9,666	6,302		62,841	18,601	-37.9%	18,445	-38.4%	19,417	-35.2%
			Outsourced Consultancy Services - surface	861	1,193	2,075	2,235	5,784	1,223	1,909	2,340	17,619	10,754	85.9%	10,754	85.9%	10,754	85.9%
	1.7.1.2		Underground Facilities	59,314	25,691	96,288	80,506	455,926	147,113	95,916		960,753	283,102	-37.9%	280,717	-38.4%	295,512	-35.2%
		1.7.1.2.1	Shafts	8,523	4,045	11,278	13,159	32,047	8,575	21,899		99,525	35,253	10.0%	35,253	10.0%	35,253	10.0%
		1.7.1.2.2	Tunnels	12,453	14,188	60,064	43,927	364,725	77,748			573,106	178,459	-51.1%	185,159	-49.2%	199,954	-45.2%
		1.7.1.2.3	Halls						4,467	74,016		78,484						

ILC_Europ_RDR_costs			SINGLE TUNNEL on ML, D=4.5m with alcoves and safety chambers			SINGLE TUNNEL on ML, D=4.9m with ventilation and firewall			SINGLE TUNNEL on ML, D=5.2m with ventilation and firewall		
TWIN TUNNELS 4.5m + 4.5m Push-Pull											
SHAFTS			SHAFTS			SHAFTS			SHAFTS		
survey borings 3.1	raisedrill	509,453	shaft 15	raisedrill	1,256,779	shaft 15	raisedrill	1,256,779	shaft 15	raisedrill	1,256,779
survey borings 3.1 cavern	conv.	143,451	shaft 15 cavern	conv.	143,451	shaft 15 cavern	conv.	143,451	shaft 15 cavern	conv.	143,451
survey borings 5.1	raisedrill	316,687	shaft 14	raisedrill	907,673	shaft 14	raisedrill	907,673	shaft 14	raisedrill	907,673
survey borings 5.1 cavern	conv.	143,451	shaft 14 cavern	conv.	143,451	shaft 14 cavern	conv.	143,451	shaft 14 cavern	conv.	143,451
survey borings 2.1	raisedrill	583,805	shaft 16	raisedrill	1,466,242	shaft 16	raisedrill	1,466,242	shaft 16	raisedrill	1,466,242
survey borings 2.1 cavern	conv.	143,451	shaft 16 cavern	conv.	143,451	shaft 16 cavern	conv.	143,451	shaft 16 cavern	conv.	143,451
survey borings 4.1	raisedrill	531,483	shaft 17	raisedrill	1,396,421	shaft 17	raisedrill	1,396,421	shaft 17	raisedrill	1,396,421
survey borings 4.1 cavern	conv.	143,451	shaft 17 cavern	conv.	143,451	shaft 17 cavern	conv.	143,451	shaft 17 cavern	conv.	143,451
TUNNELS			TUNNELS			TUNNELS			TUNNELS		
beam tunnel e-	TBM	48,458,666	beam tunnel e-	TBM	48,458,666	beam tunnel e-	TBM	50,310,738	beam tunnel e-	TBM	54,332,500
service tunnel e-	TBM	48,458,666									
beam tunnel e-	Hydroshield	12,519,693	beam tunnel e-	Hydroshield	12,519,693	beam tunnel e-	Hydroshield	12,933,702	beam tunnel e-	Hydroshield	13,929,321
service tunnel e-	Hydroshield	12,519,693									

Cost comparison summary for Main Linac Civil Engineering compared to Europe RDR :

1. Single tunnel for main linac 4.5m diameter with safety alcoves / chambers :

-19.8%

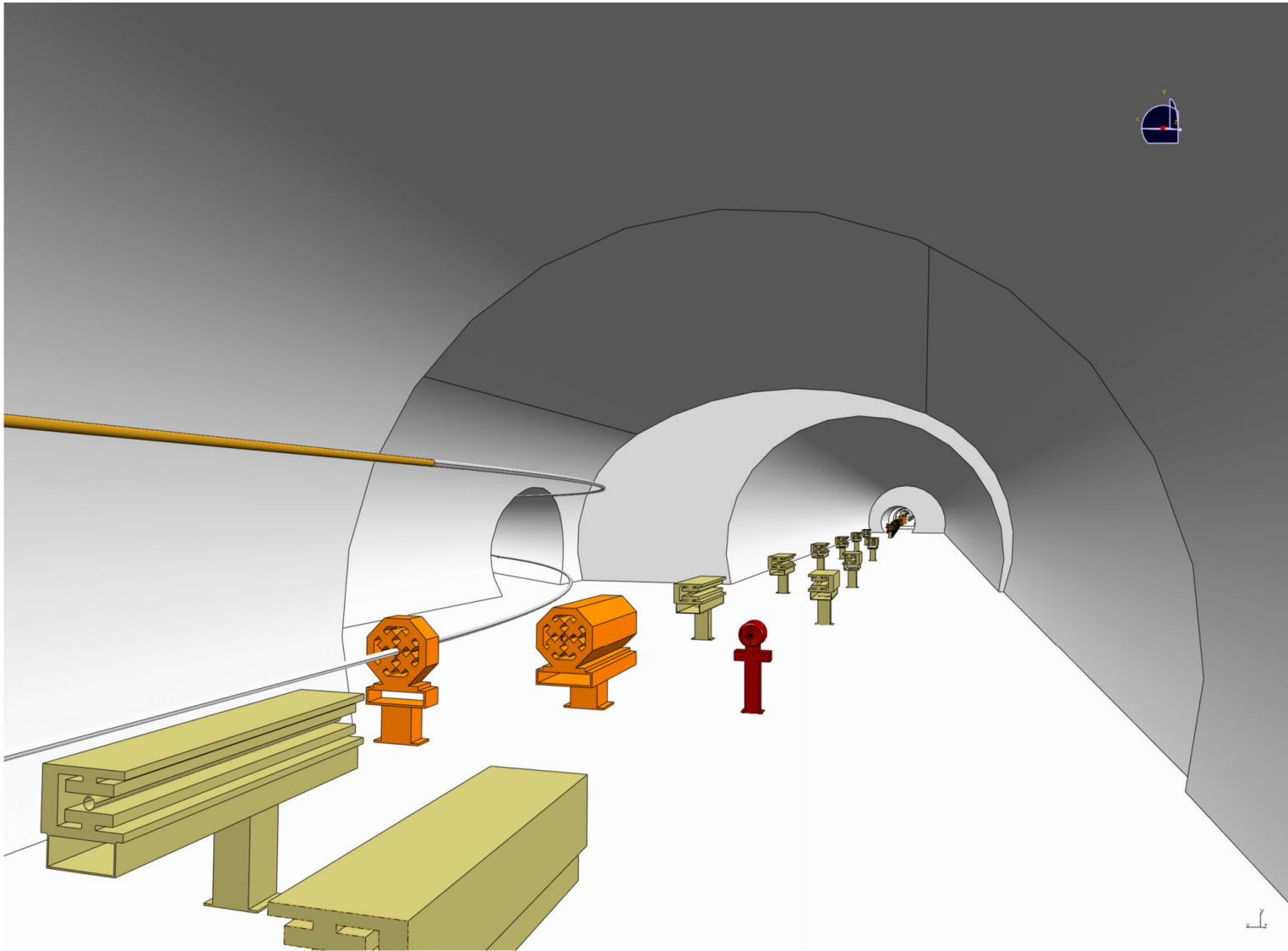
2. Single tunnel for main linac 4.9m diameter with transversal ventilation / firewalls :

-20.2%

3. Single tunnel for main linac 5.2m diameter with transversal ventilation / firewalls :

-17.5%

3d studies at CERN for other SB2009 Proposals



Summary

•If transversal ventilation with compartments is to be adopted for ‘Europe Site’, new tunnel cross section for both Single Tunnel concepts needs to be studied to ensure 5.2m is suitable.

•DRFS suspended from tunnel ceiling is not recommended for CERN geology (but not excluded). Better to increase tunnel size and support from tunnel floor.

•Cost reduction from RDR for 5.2m single tunnel (with transversal ventilation type concept/firewalls) for Main Linac approx. -17.5%