

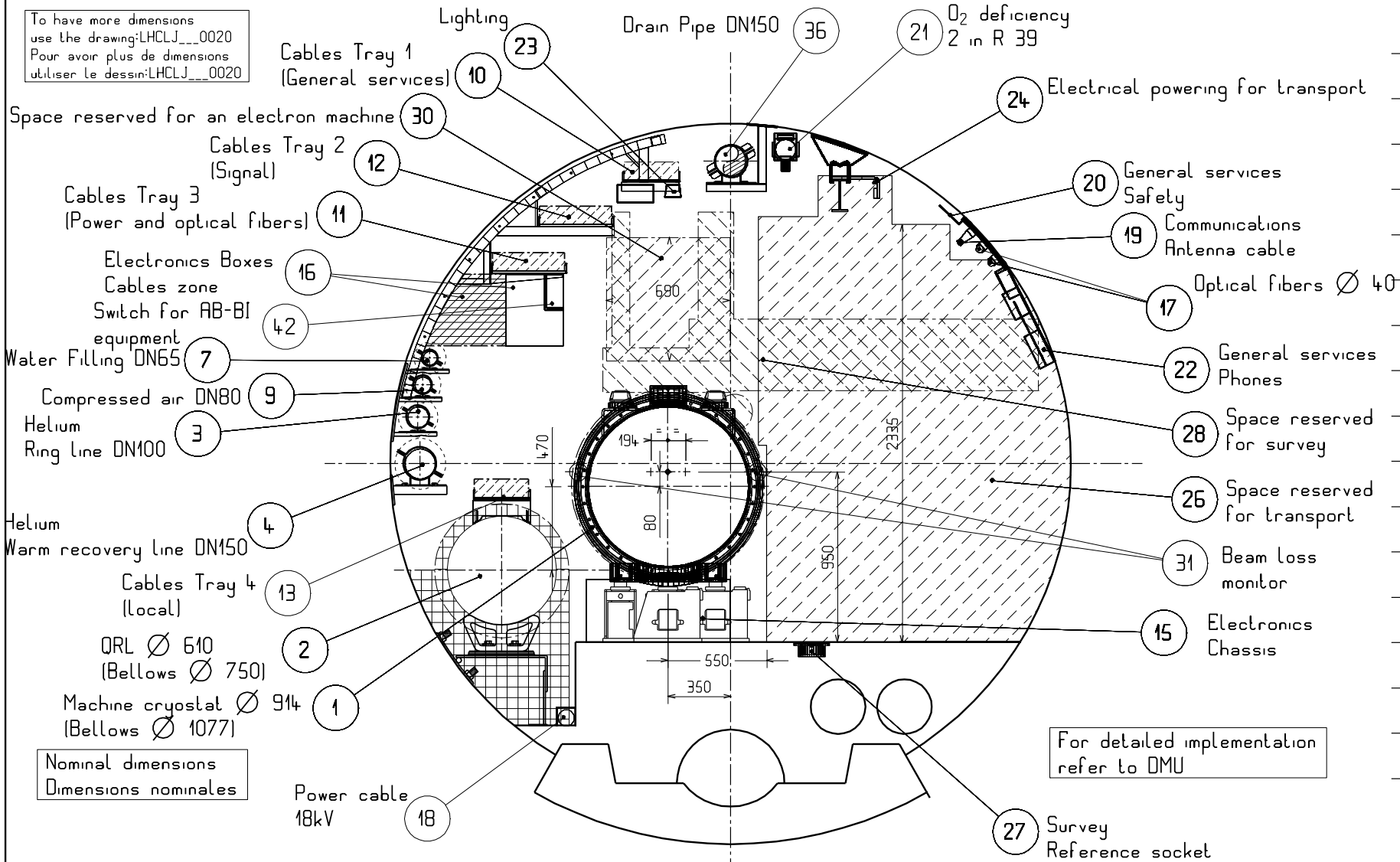
# Integration and machine protection issues

The work was mainly done by  
Y. Muttoni and J.-P. Corso

# Space requirements

- Tunnel is narrow and LHC is big
- Originally space was foreseen for a second machine, but ...

To have more dimensions  
use the drawing: LHCLJ\_\_\_0020  
Pour avoir plus de dimensions  
utiliser le dessin: LHCLJ\_\_\_0020



KHM, Chavannes Nov. 2010

LAYOUT INFRASTRUCTURE		ECHELLE SCALE	DES/DRA.	J. CORSO	2003-03-13
TUNNEL R Ø 3800		1:20	CONTROLLED	Y. MUTTONI	2004-03-31
TYPICAL SECTION - R39 / R41			RELEASED	R. VALBUENA	2004-03-31
TUNNEL R Ø 3800			APPROVED	-	-
COUPE TYPE - R39 / R41			LHCO,OLAY...LAYOUT...000,0001,00012366PL		
			REPLACE/REPLACES		

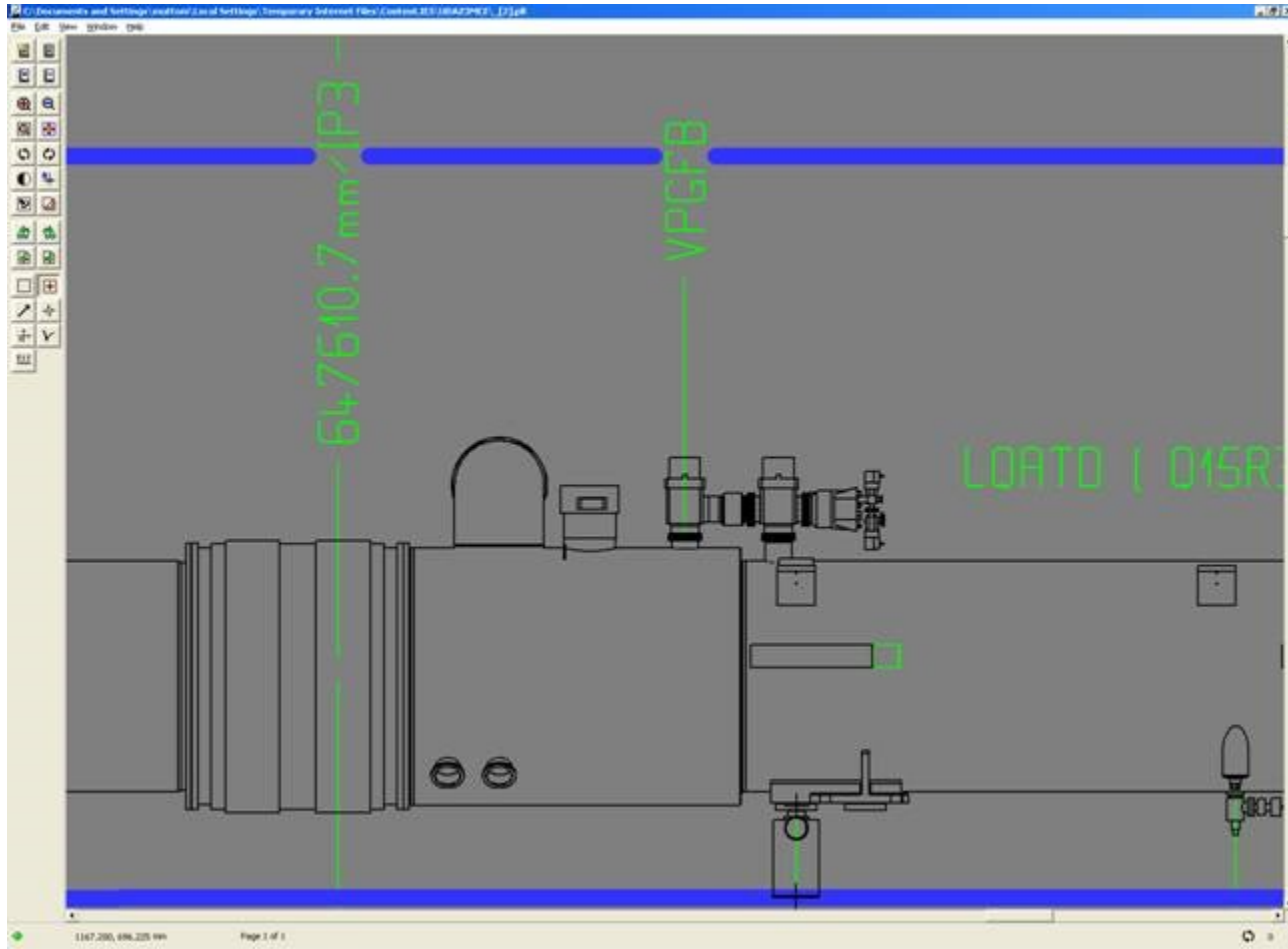
DRESSING, RUGOSITY, TOLERANCES ACCORDING TO ISO STANDARD  
 PROJECTION  
 dessin ne peut être utilisé a des fins commerciales sans autorisation écrite.  
 this drawing may not be used for commercial purposes without written authorisation.

A	2004-03-30	C. MAGNIER		Mise a jour support drain DN150
IND	DATE	NOM/NAME	ZONE	MODIFICATION

	RELEASED BY	FOR INFORMATION	GAC	HC	0031	SIZE	IND.
	PROJECT ENGINEER		R		3	A	

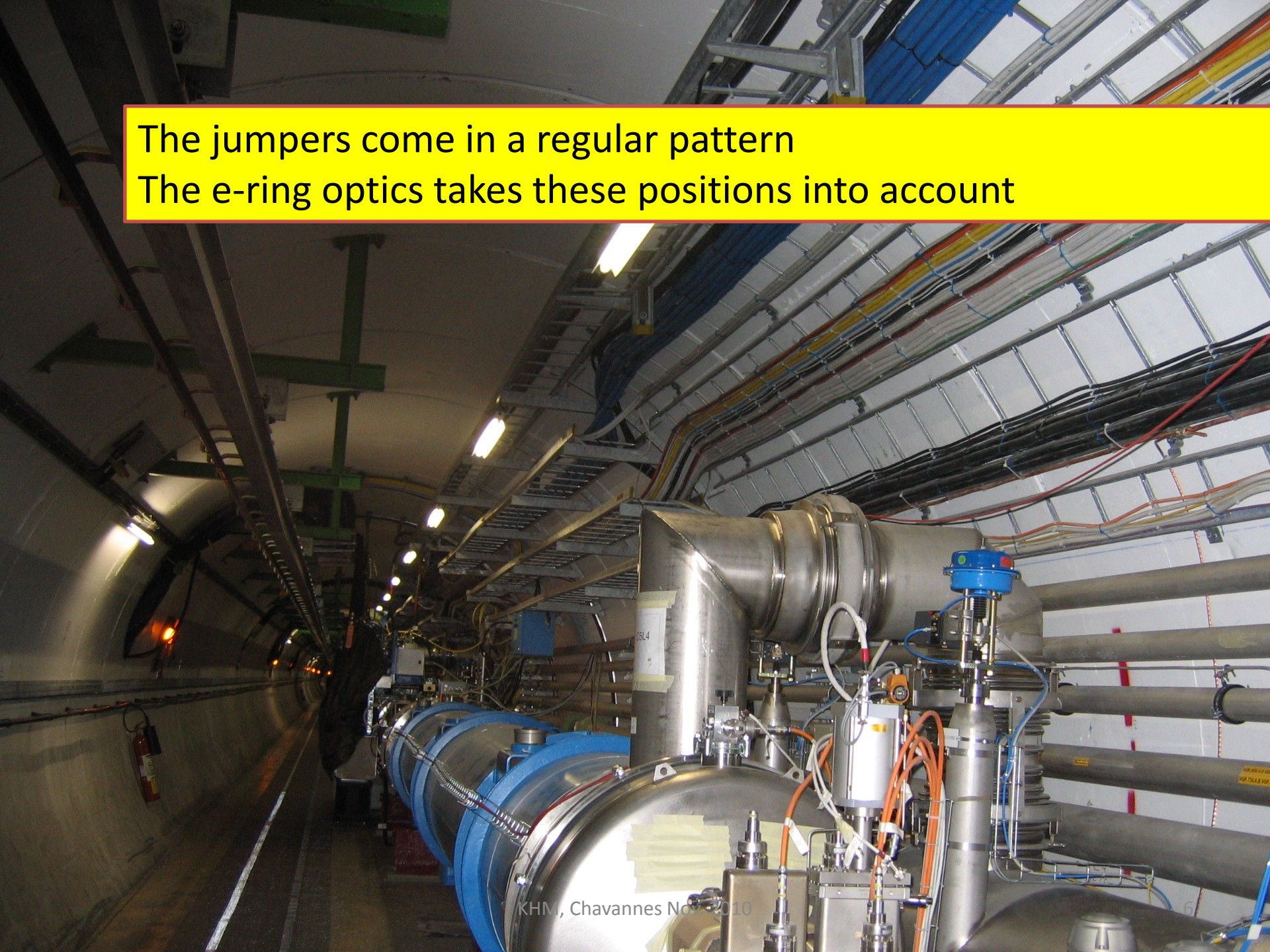


In the arcs we have at each odd SSS between C7 and C33 a „Jumper Connection“



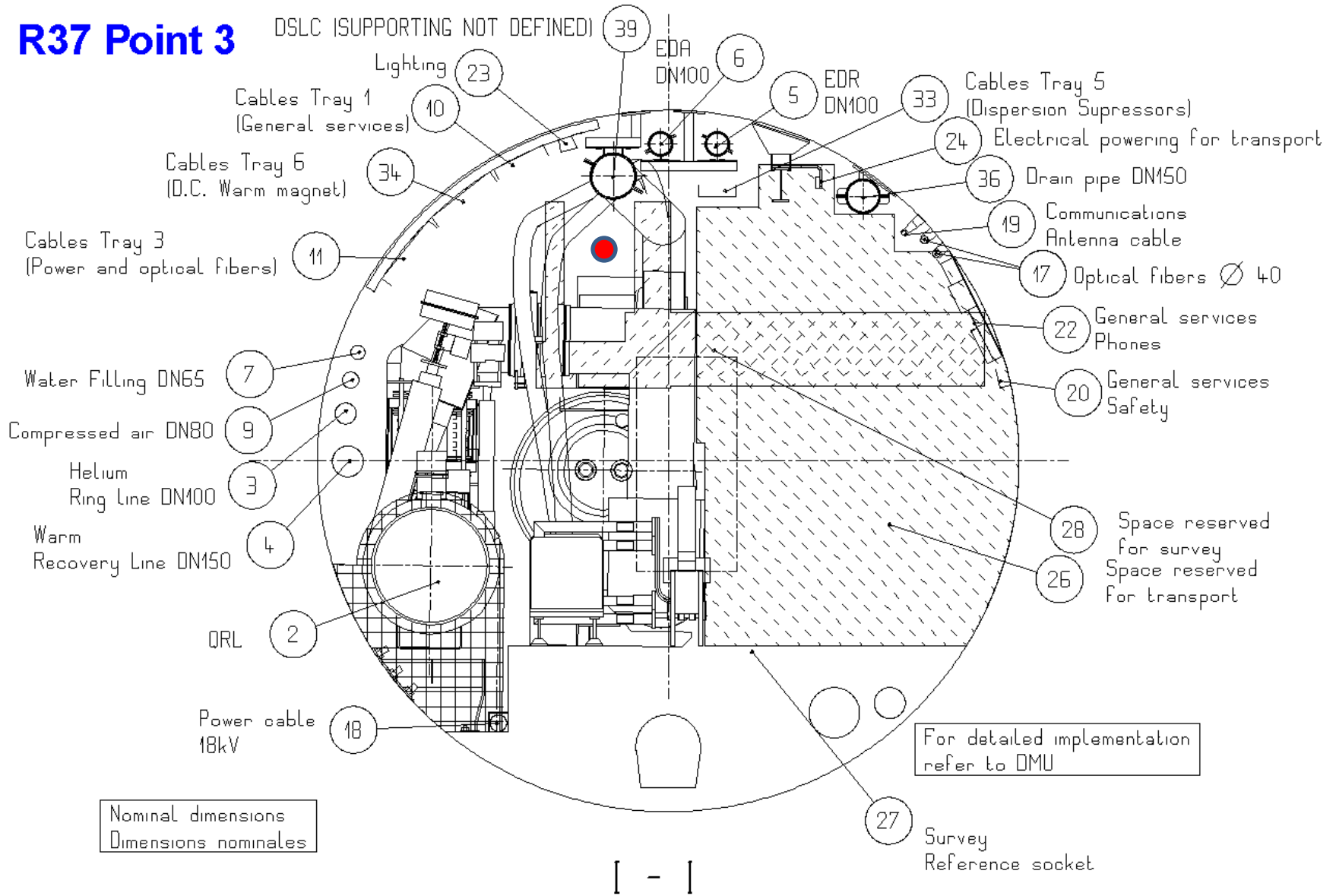
No feet allowed in this area.

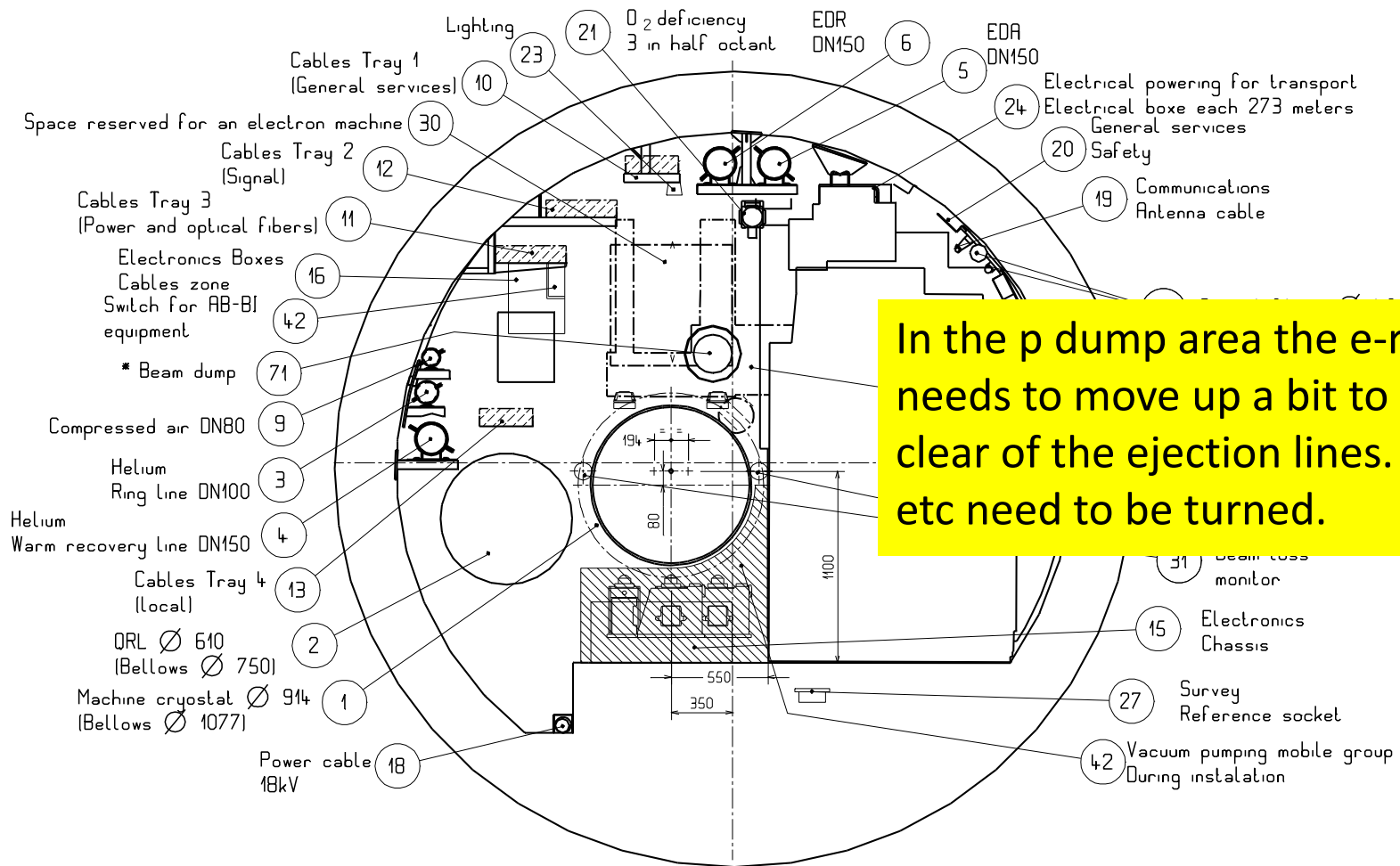
The jumpers come in a regular pattern  
The e-ring optics takes these positions into account



# R37 Point 3

DSL (SUPPORTING NOT DEFINED)





In the p dump area the e-ring needs to move up a bit to stay clear of the ejection lines. Pumps etc need to be turned.

### SECTION A-A (TUNNEL REEL)

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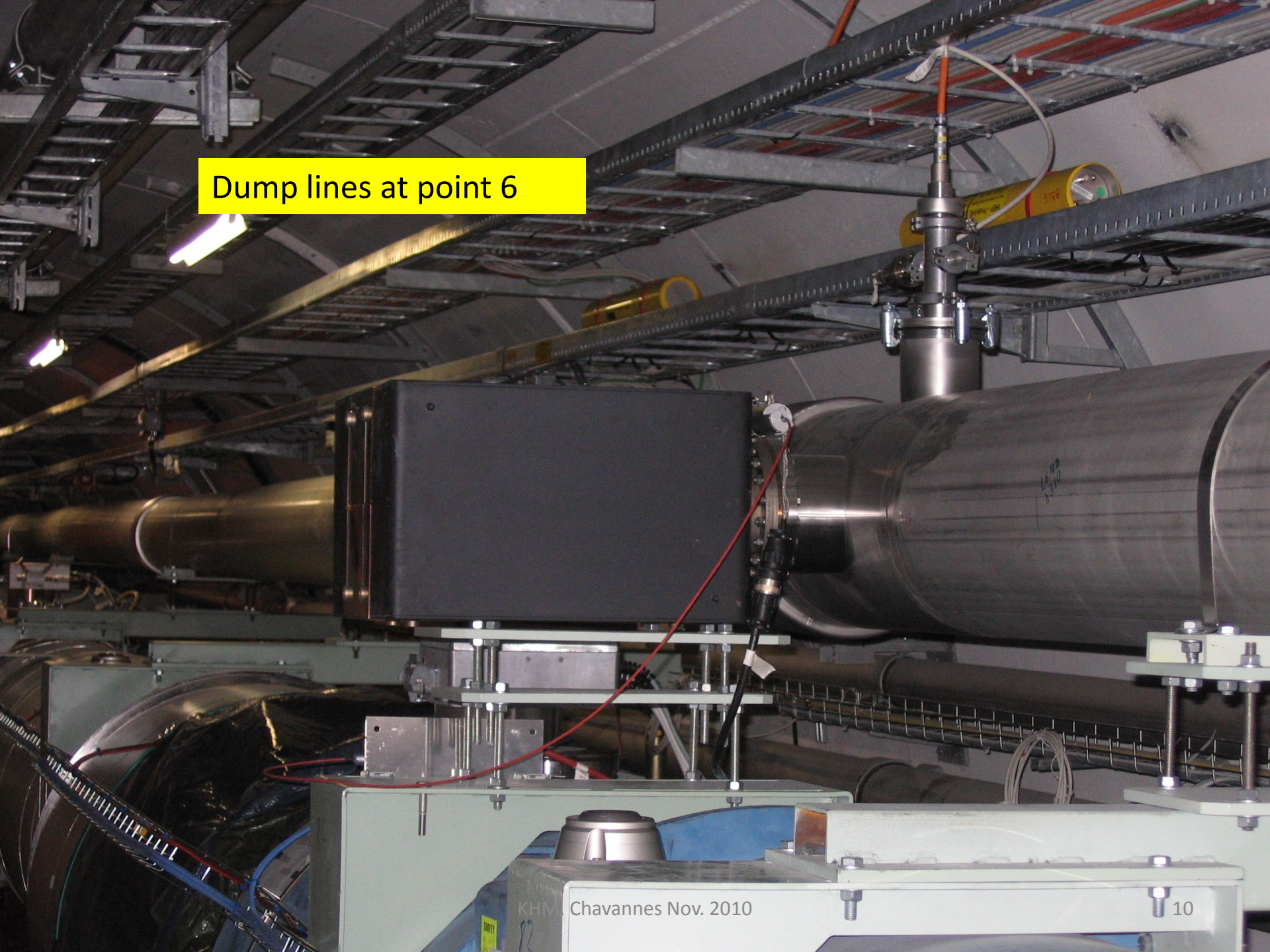


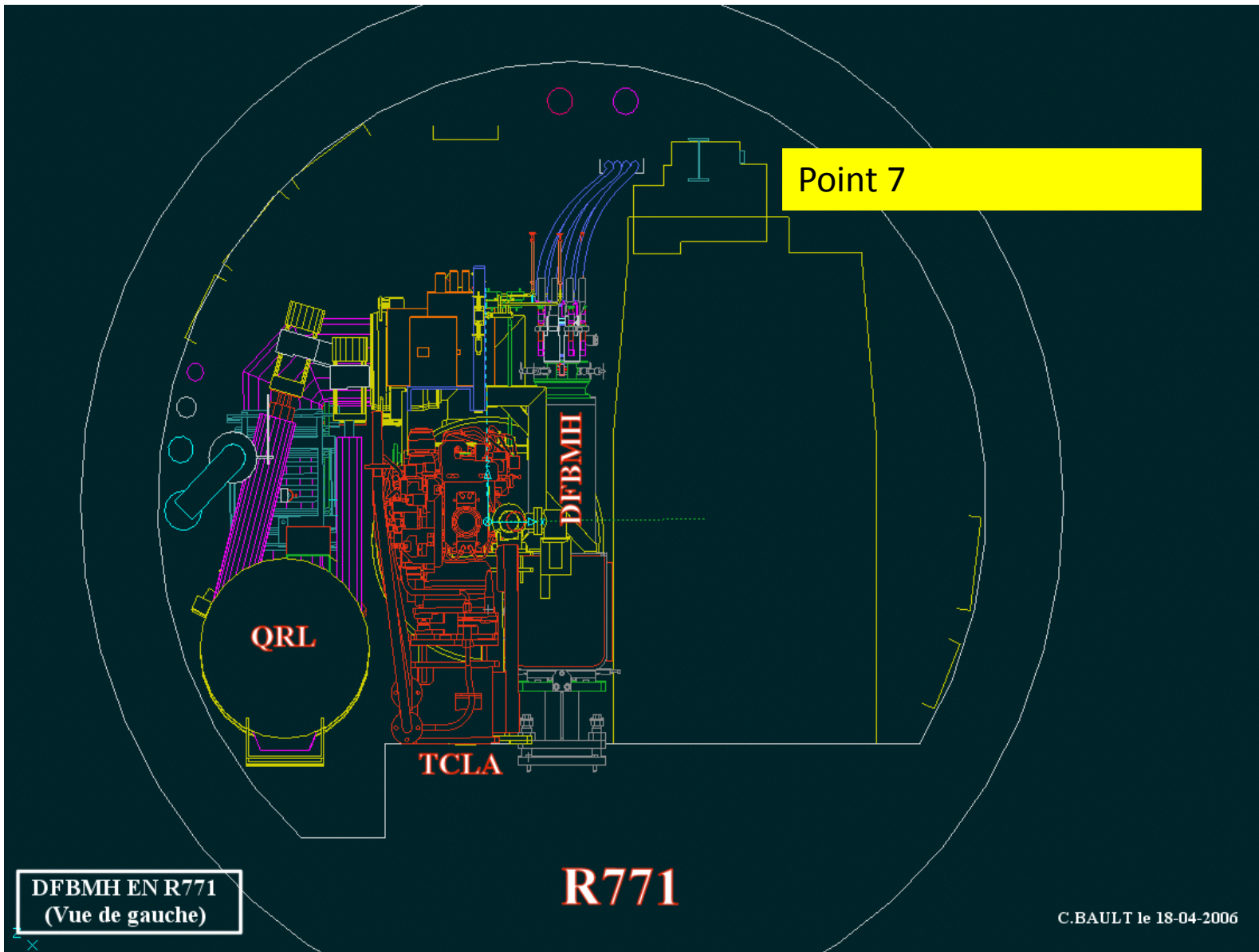


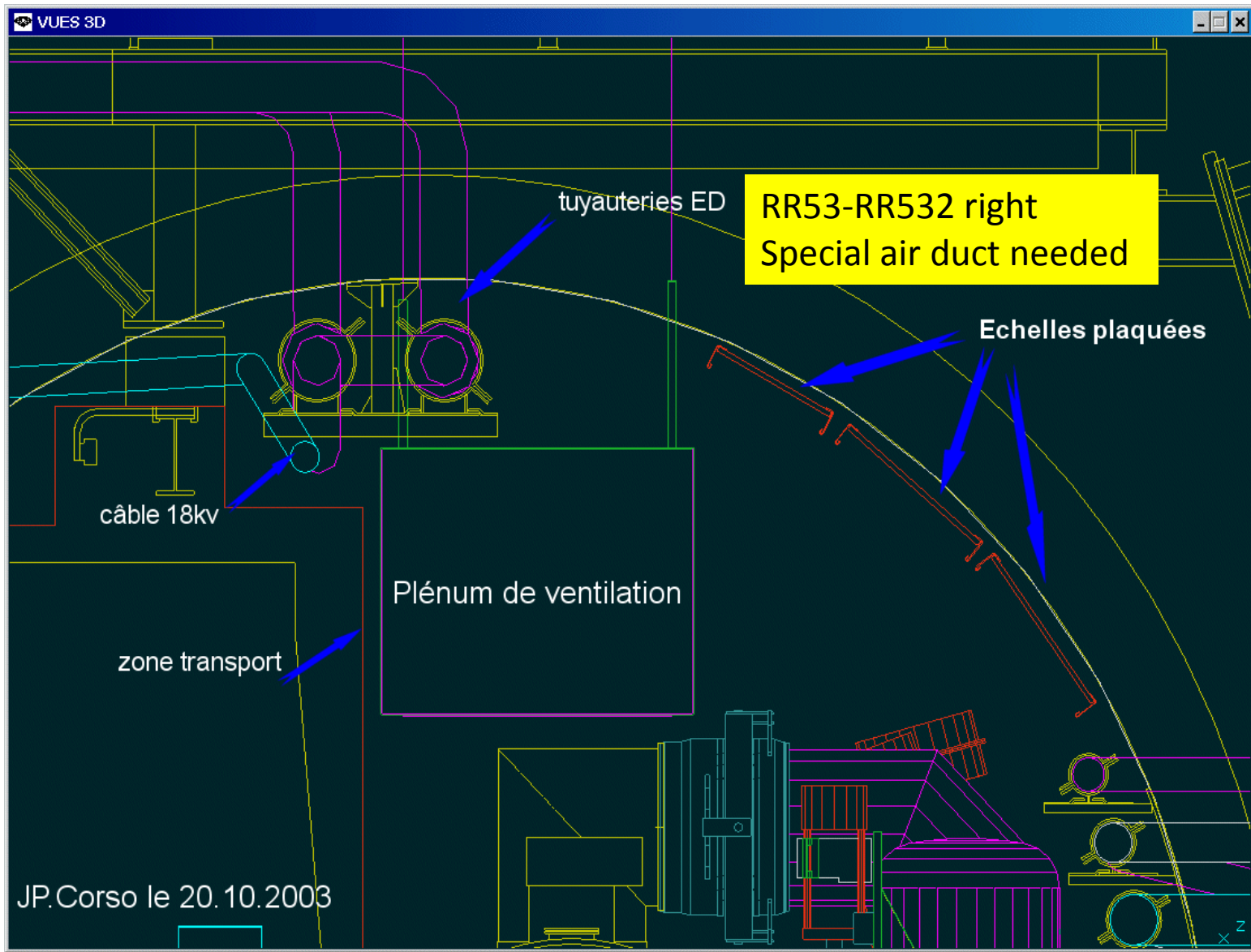
Kicker at point 6

Magnet support from above (steel rom arch) will be needed to bridge the kicker

Dump lines at point 6

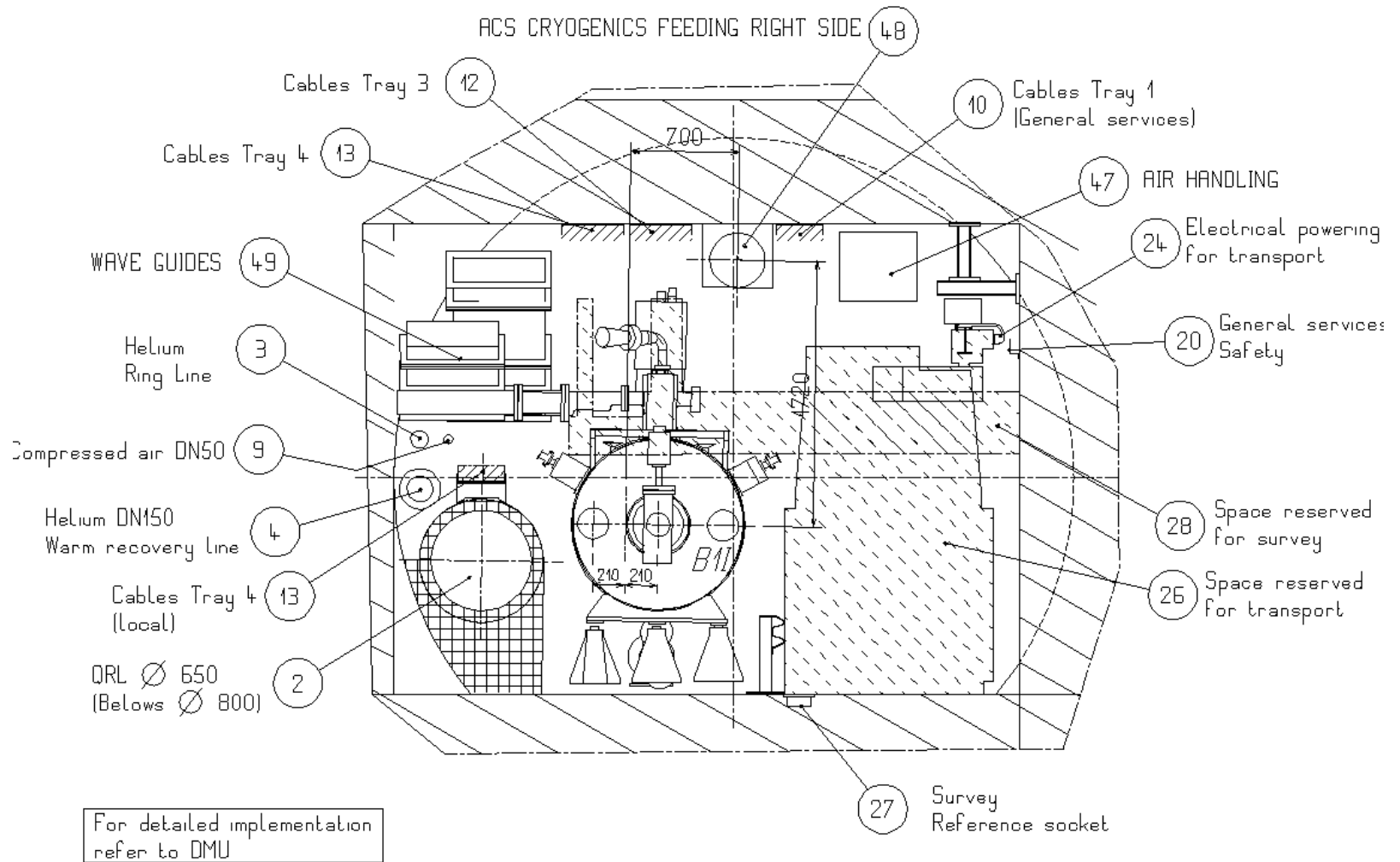




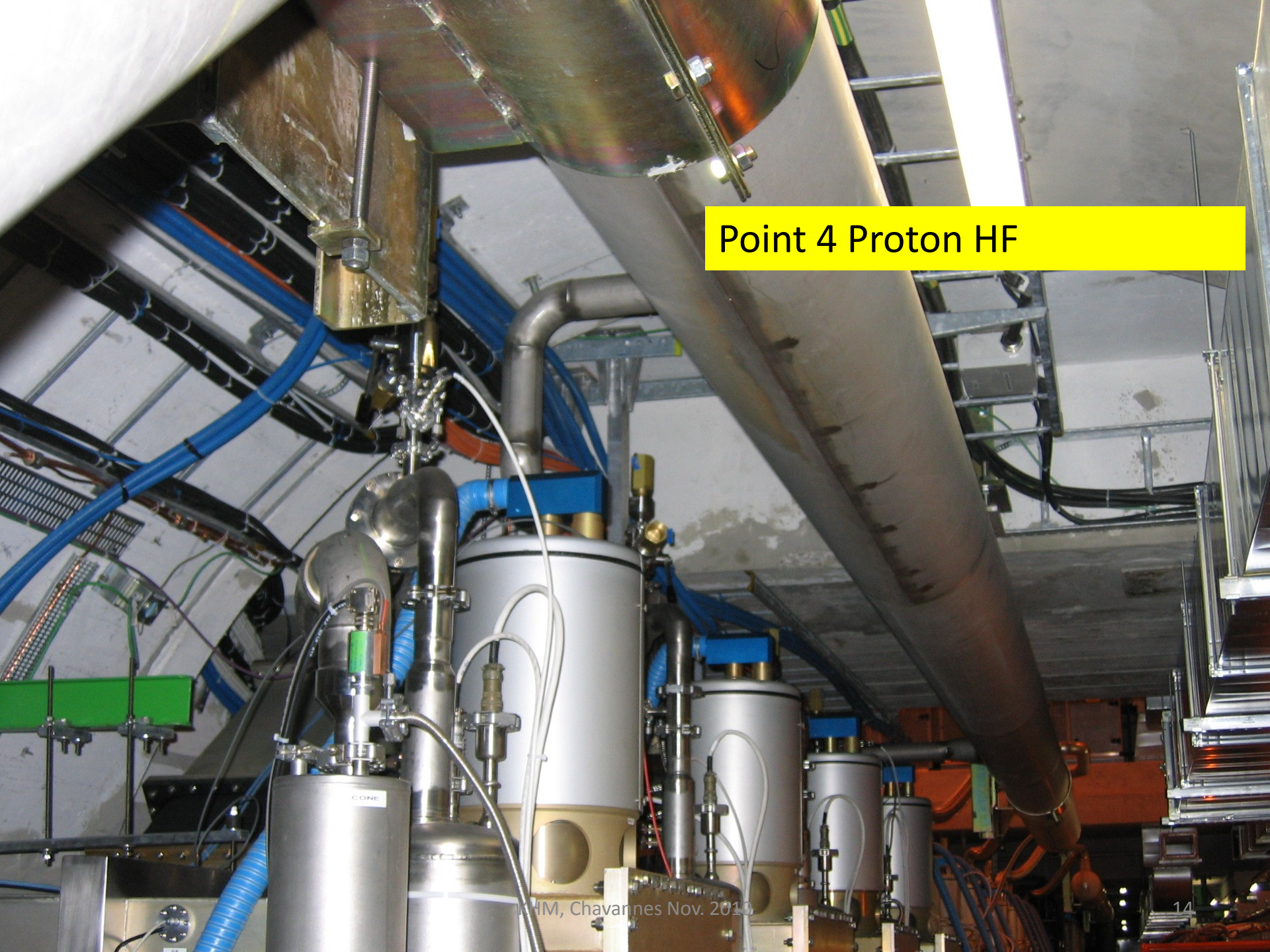


# RUX45 Point 4

E - E



Point 4 Proton HF



- General rule: e-machine shall be fast **removable**
- (**time of removal**  $\ll$  **warm-up time**)
- Transport space is (almost) forbidden. E-magnets are at the space limit to adjust the overall circumference (or can we live with all bunches colliding with all bunches? Feedback? To be studied)
- Regular pattern of jumpers – can be avoided , if the lattice is chosen properly
- e-magnets to be supported from below on pillars, which need to “lean” on the tunnel walls, to control vibrations

- Point 3 : very tight, needs attention, collimators!
- Point 6 : The dump lines and the kickers need special attention
- Point 2 & 8 : The design of the interaction region has to respect the cryogenic installations, in the worst case the cryogenics has to be modified.
- Point 7 : very tight, optics may have to be adjusted, to stay clear, collimators!
- RR53: Air conditioning to keep radioactive air in the tunnel (decay time) has to be modified/redesigned
- Point 4: RF cavities relatively short, can be bridged by a straight section
- Point 1 & 5 need bypasses, containing RF, dump, collimators



# The p-collimators need special attention:

- No space to place feet -> roman arch steel construction to suspend the e-magnets
- Collimators need the full height in case of repair/exchange
- E-machine must be removed first in the corresponding areas
- Beam pipe needs to be subdivided such that e-magnets with vacuum sections can be removed quasi remotely

# Impact of the synchrotron Radiation on tunnel electronics

- General rule: SR shall be intercepted at the source or close to it (shielding)
- EM showers predominant. Few n, few single event upsets.
- Radiation is way above the p-machine and its electronics (but for the p-ring energy extraction switches, additional shielding or see below.)
- For the electronics below the p-magnets local lead (concrete or iron?) shields are OK (tbc)
- By the time of the LHeC the p-power supplies should be outside of the tunnel and the connection cables replaced by sc-links.

# Compatibility with the proton beam loss system

- The existing system works fine for the protons alone
- p loss system is based on ionisation chambers
- Sensitive to particles from all directions and also to SR
- Has to be replaced by a system, which is
  - Either direction sensitive
  - Based on coincidences (suppress gammas) & shielded (suppress soft e)
  - HERA had/has such a system

# Protection of the p-machine against heavy electron losses

- Case is not worse than heavy p-losses (on the contrary)
- Remedy for the p-machine:
  - Beam loss system
  - Detection of fast current excursions
  - Fast ejection (dump)
  - Collimation
- The same to be repeated for the e-machine
- Architecture has to be the same
- Extension of the existing modular system is possible

# Summary

- Installation of an e ring is challenging
- Modifications of the existing installations will be necessary
- No show stopper