Review of the cryogenic by-pass for the LHC DS collimators

26 May 2011

Modifications to the DFBs, DSLC and cryogenic extensions

A. Perin, N. Veillet, TE-CRG

and contributions of many others…

Outline

Cryogenic extensions

Modifications of the DFBs and related equipment

Modification of the superconducting link (DSLC)

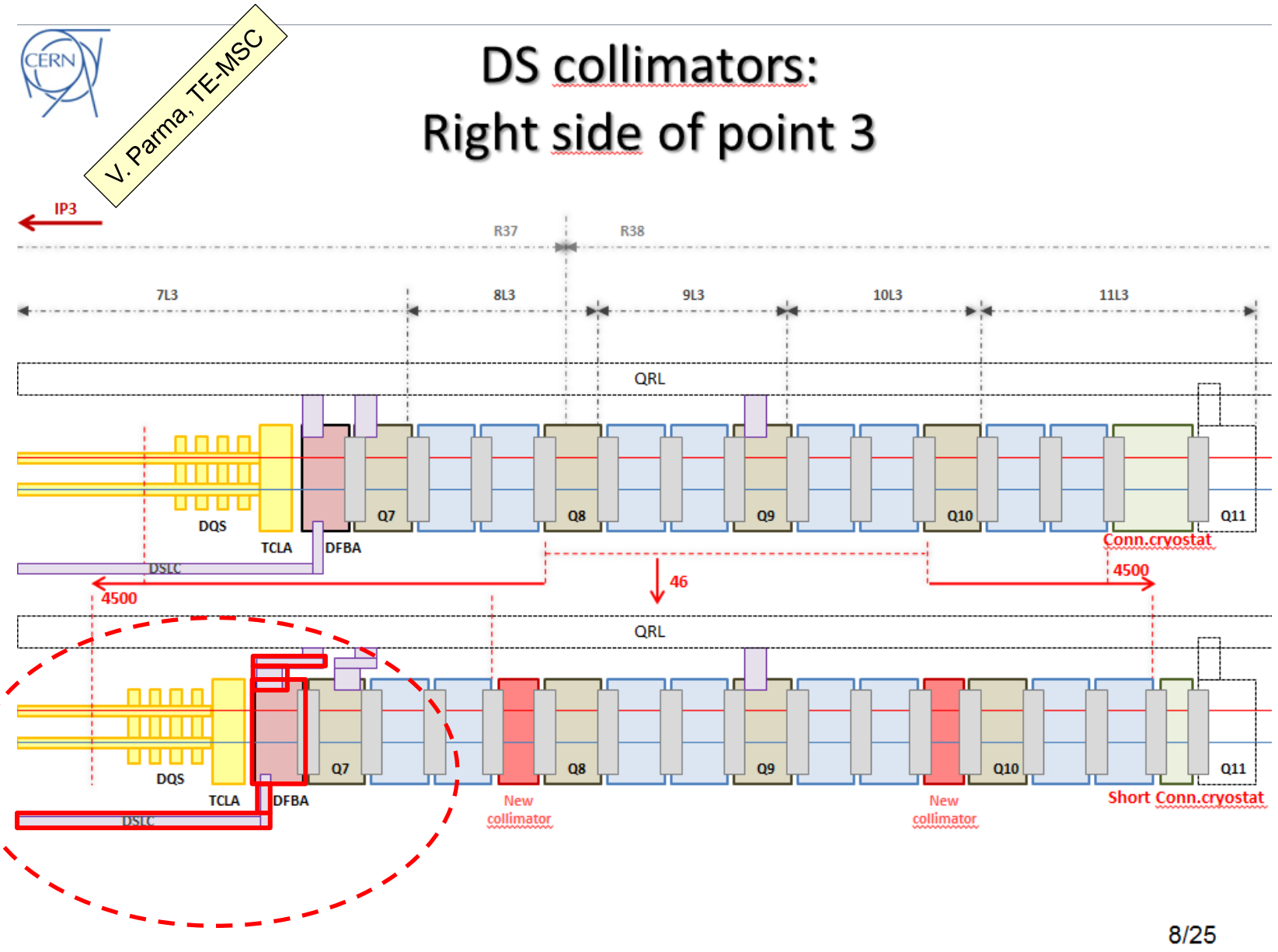
Scope: TE-CRG activities

(not included: cabling, transport, interconnections, electrical proximity equipment components and assembly)

Design and production of jumper extensions
Design and production of components for the modifications of the DFBAs
Design and production of the proximity equipment frames and warm helium piping
Design and production of the DSLC components & tooling for shortening

Installation of the jumper extensions (without interconnection to QRL) an their supports
Modification of the DFBAs to accommodate jumper extensions
Shortening of the DSLC (cryo piping)
All leak tightness and pressure tests for the DFBAs & DSLs prior to connection to the continuous cryostat

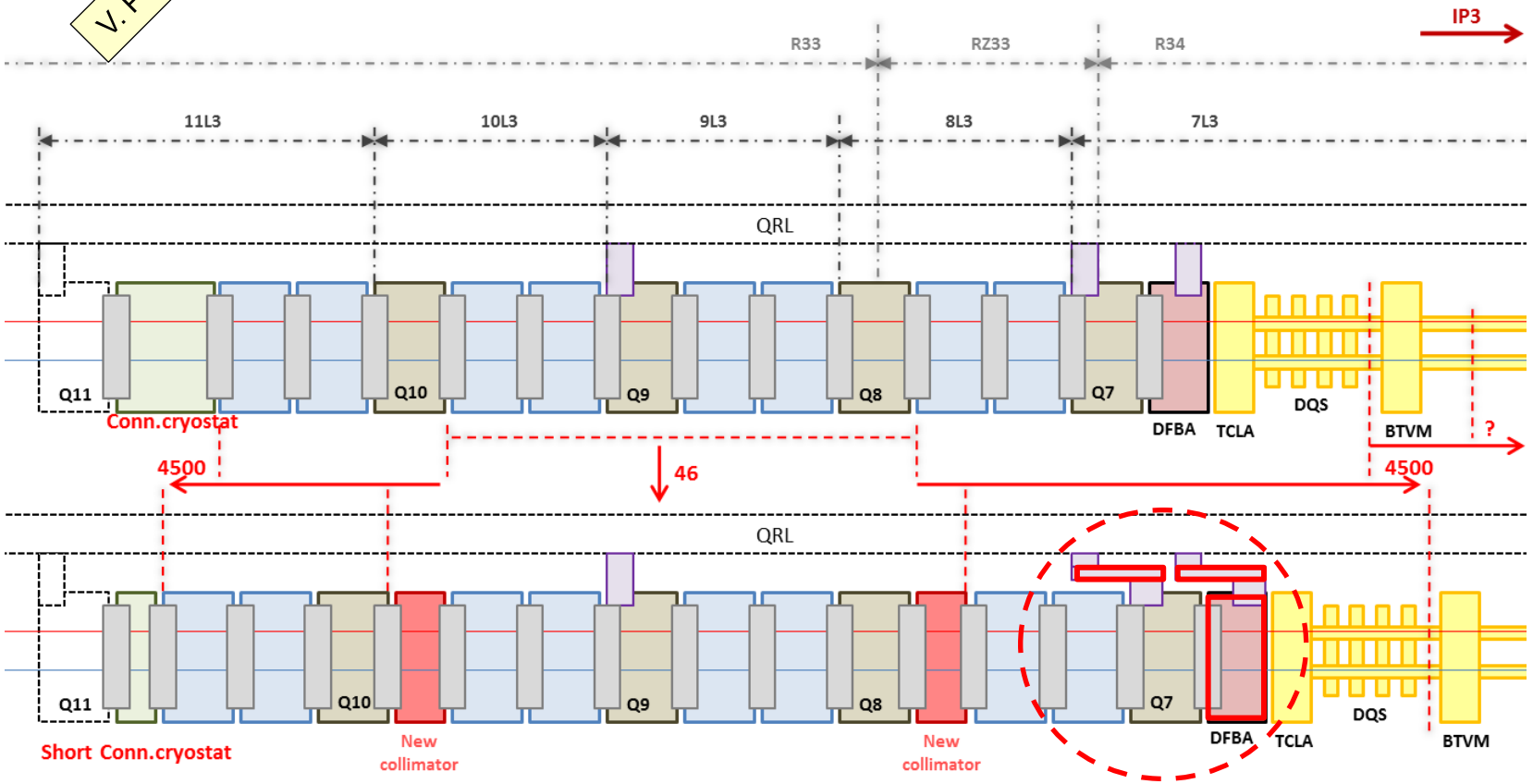
Impact on cryo-equipement and DFBs



Impact on cryo-equipement and DFBs

V. Parma, TE-MSC

DS collimators: Left side of point 3



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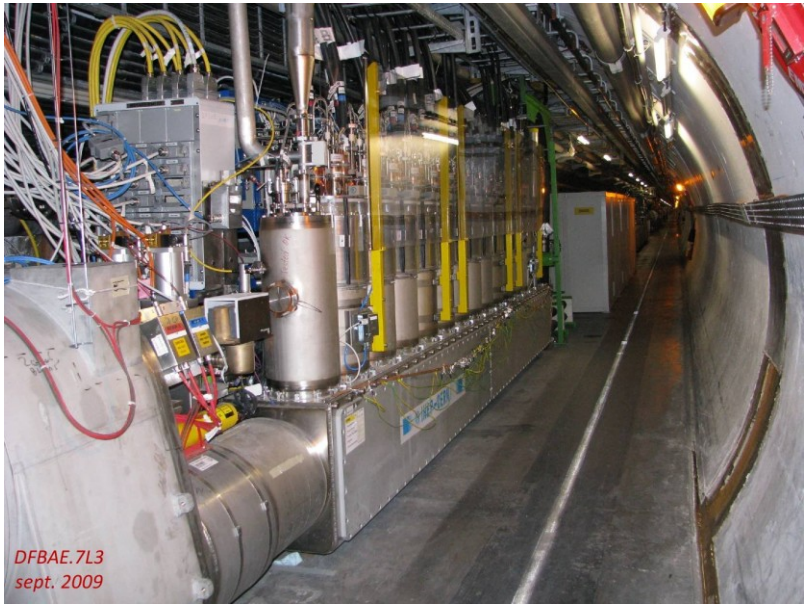
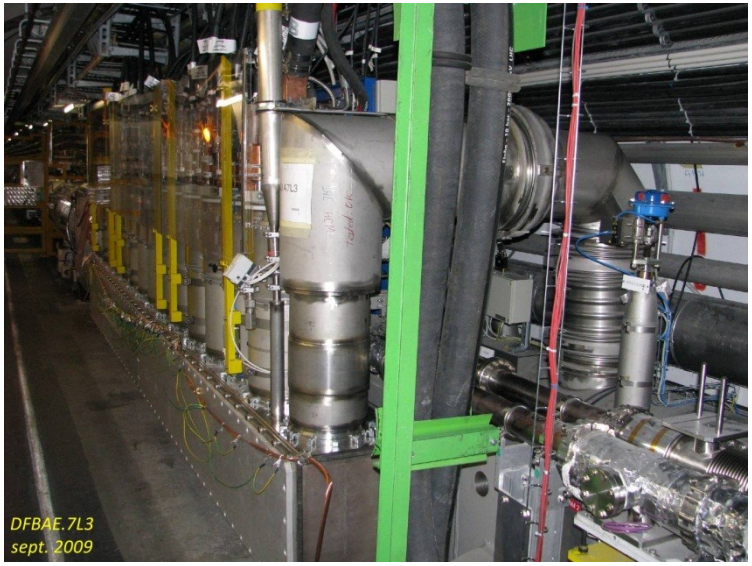
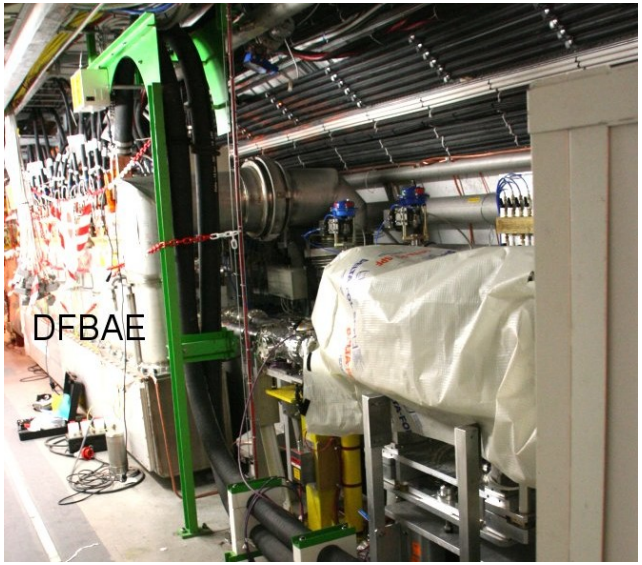
Summary of impact on cryo-equipement and DFBs

Equipment	Modification	Remarks
QRL	No change. Interface to QRL stays the same	
Jumpers to Q7 magnets	Extension to be added to compensate for shift	
(Q7 magnets)	New jumper	
Jumpers to DFBA	Extension to be added to compensate for shift	
DFBAs	Jumper connection to be modified because of jumper extension	
DFBAs proximity equipment • Helium recovery piping • Instrumentation + transformers, etc.	Extension to the warm recovery line Modification due to interference with jumper extension Modification due to interference with the jumper extensions	
DSLC	Must be shortened by 4.5 m	

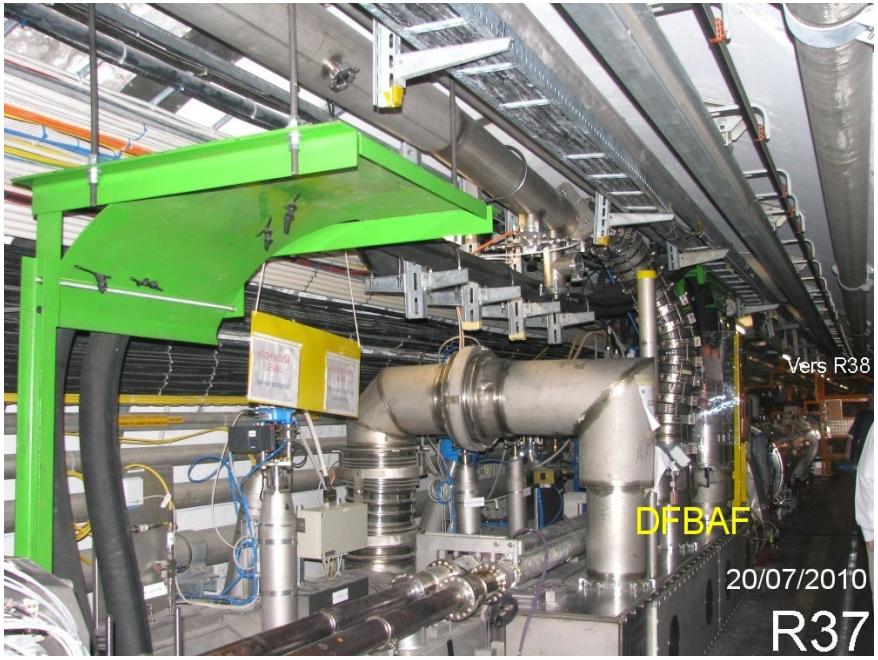
DFBA current situation left side

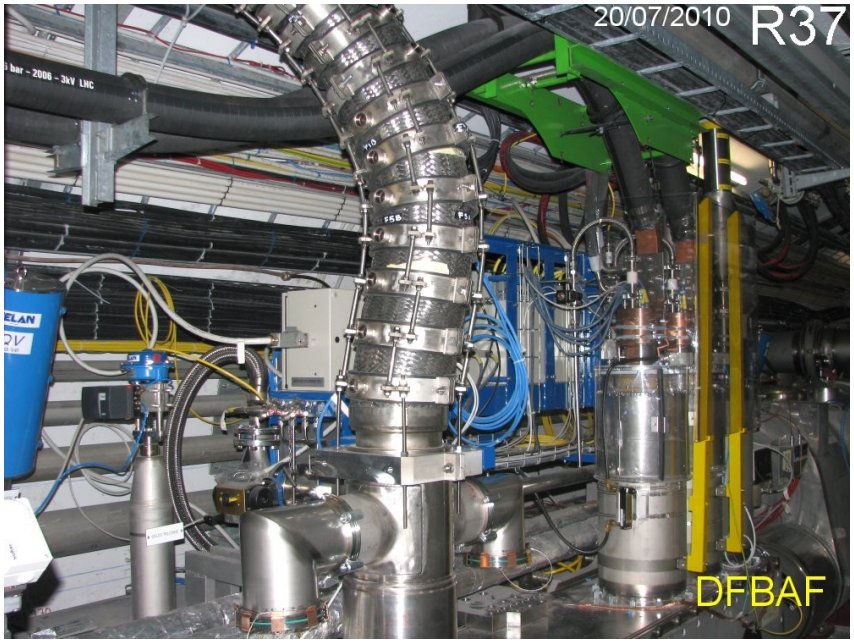


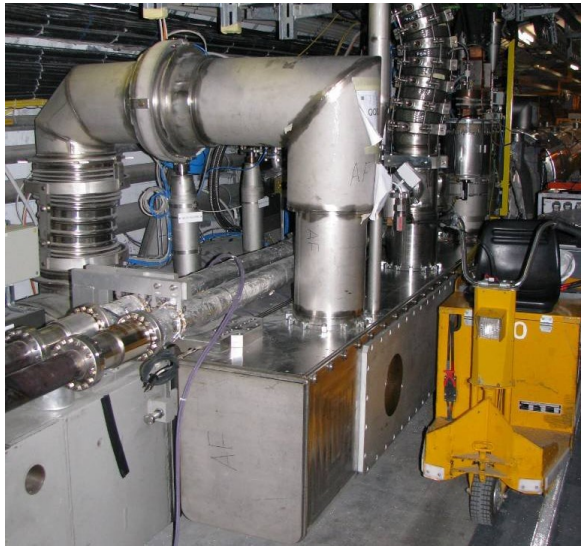




DFBA current situation right side







Jumper extensions

Functionalities

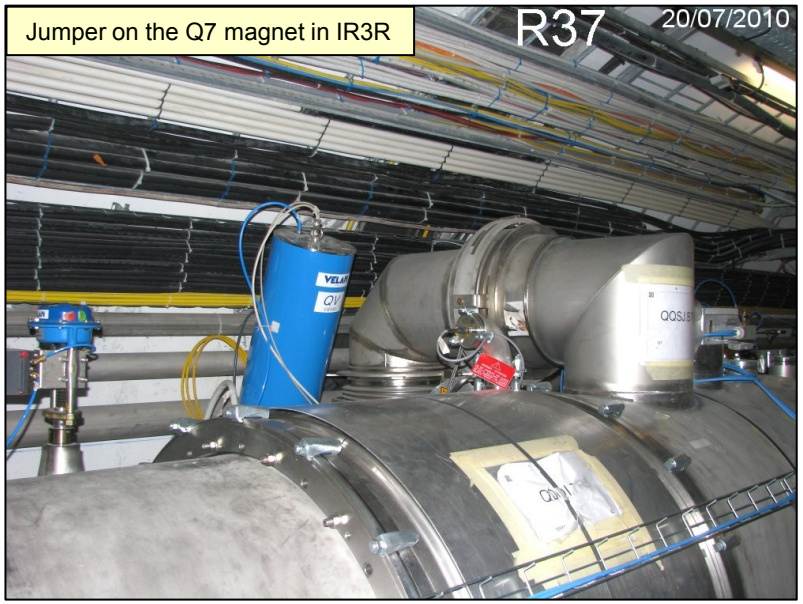
- Allow shifting of the magnets and DFBAs by 4.5 m
- Keep the same mobility as the original jumper
- No additional forces on the magnets and DFBA
- Limit the modifications to the magnets and DFBAs

Constraints

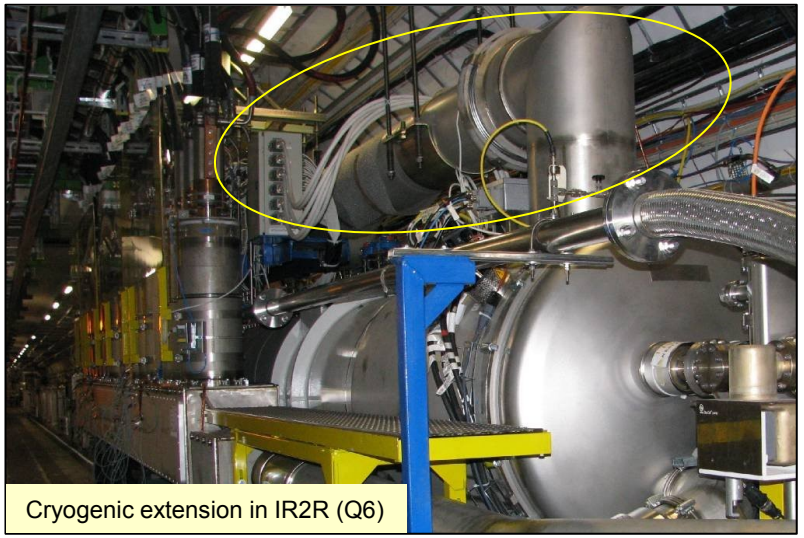
- Very limited space in the tunnel
- Difficult integration with numerous equipment
- No screen cooling circuit available to the Q7 jumpers
- No modification of the cryogenic flowschemes

Design

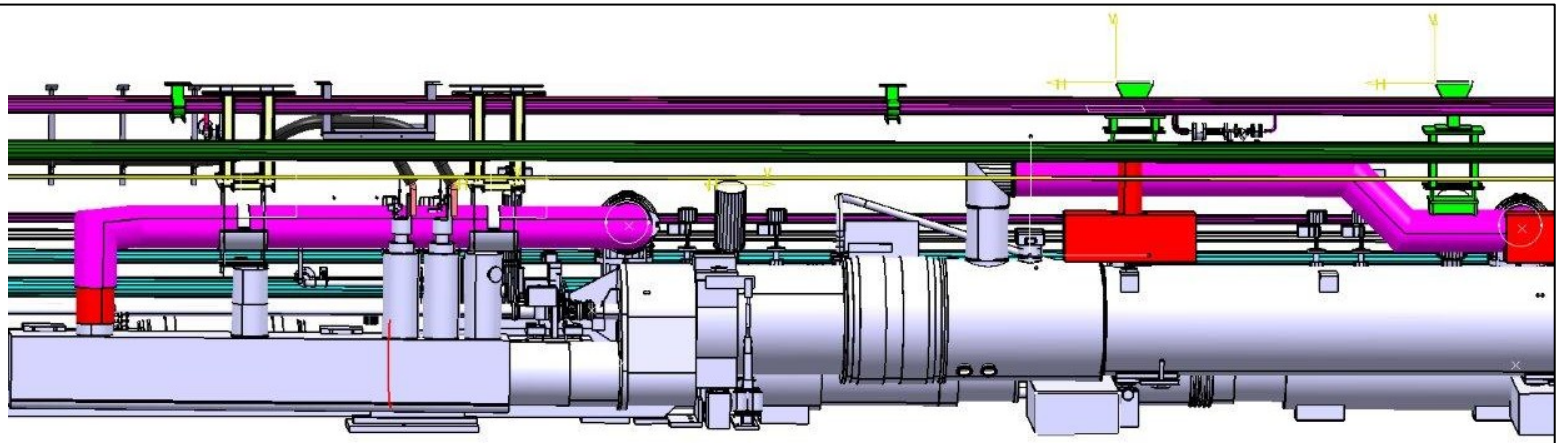
- Copy/paste from existing QRL extensions in IR2
- Invar cold lines.
- Thermal screen cooled by conduction only
- Flexibility provided at the QRL jumper. Rigid connection to the magnet & DFBA
- Spring mounted supports in order to provide the freedom of movement and limit the forces to the magnets and DFBAs.



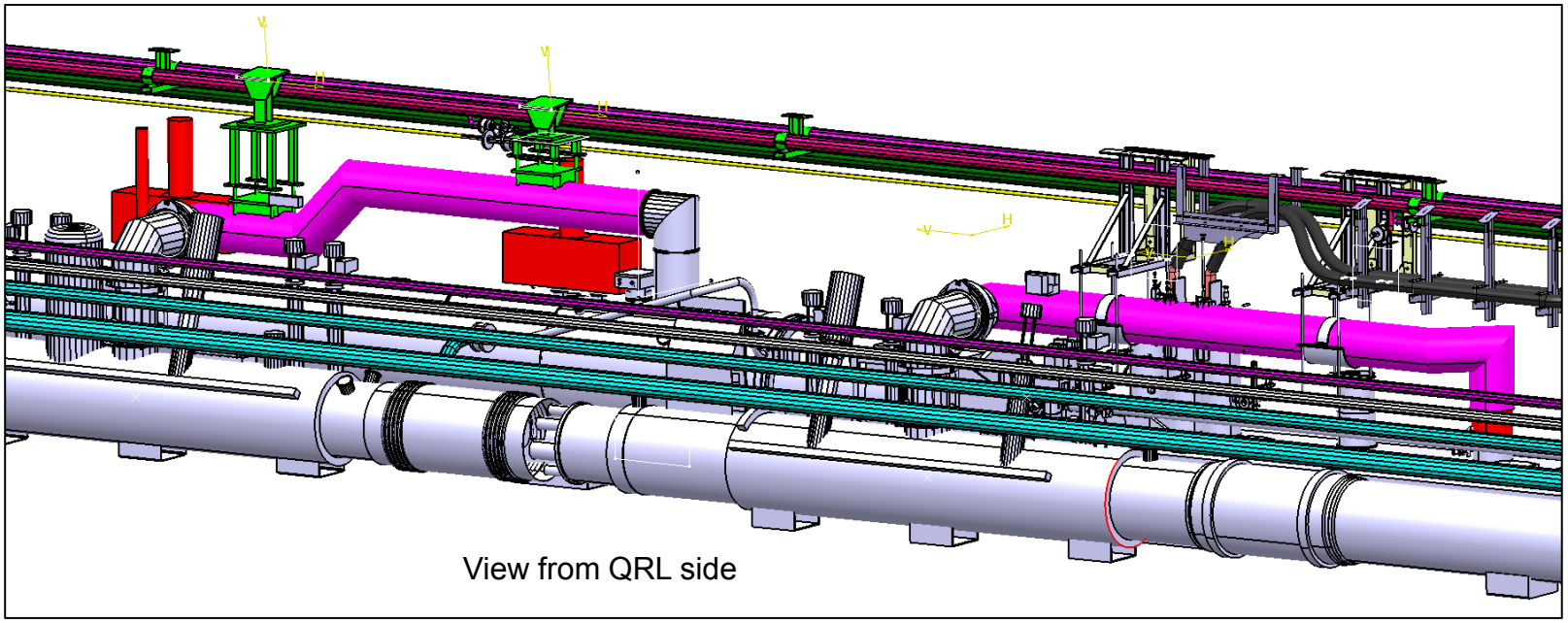
Jumper on the Q7 magnet in IR3R


Cryogenic extension in IR2R (Q6)

Jumper extensions: IR3 Right

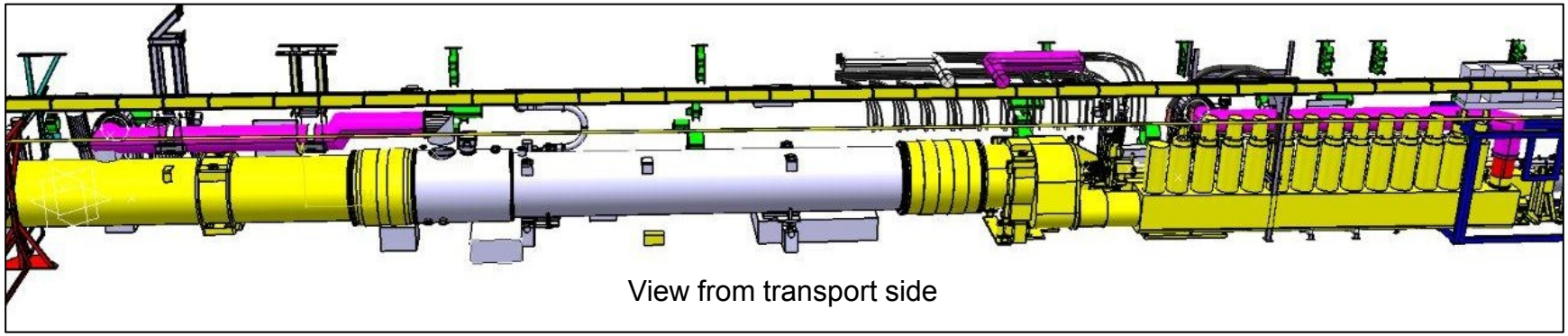


View from transport side

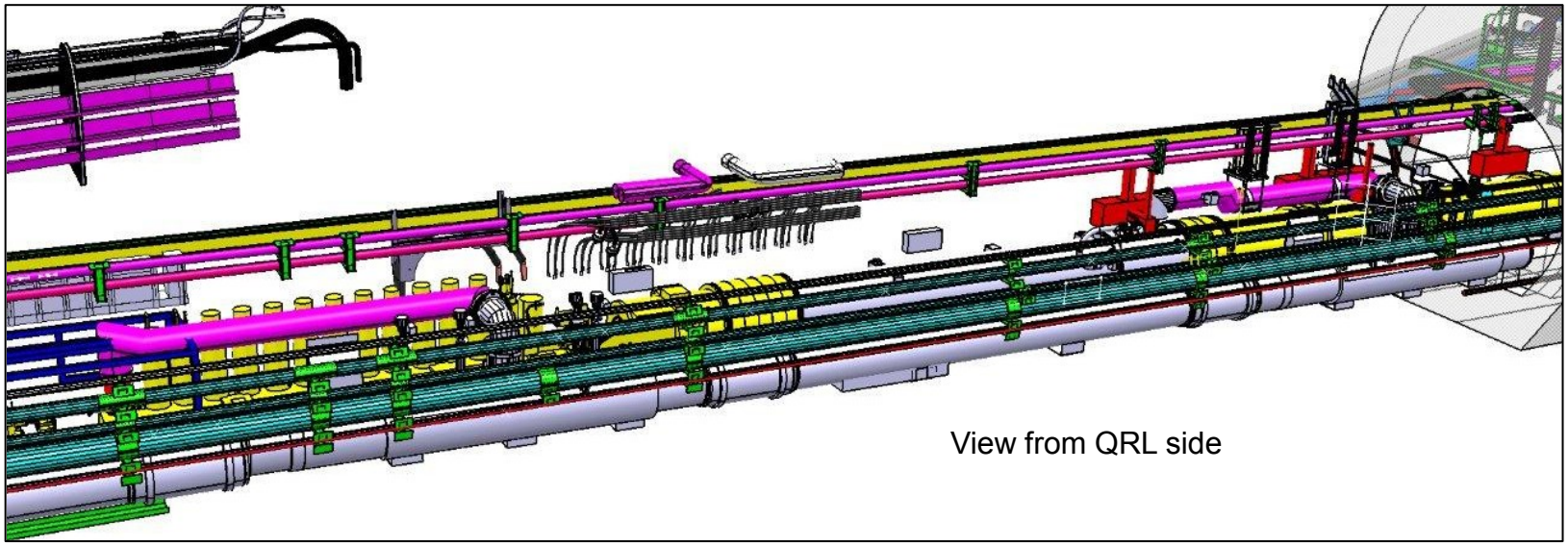


View from QRL side

Jumper extensions: IR3 left

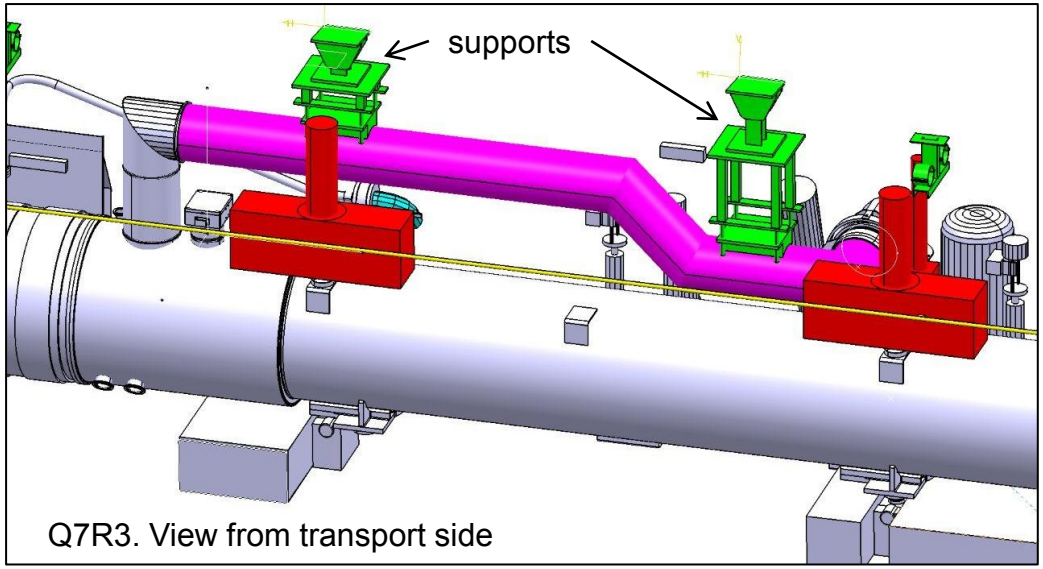


View from transport side

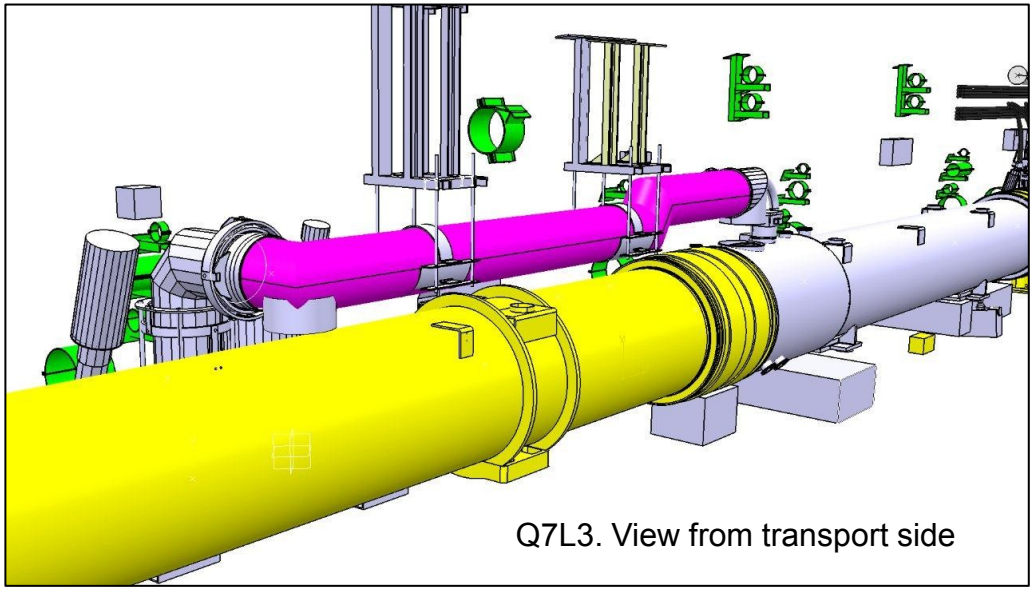


View from QRL side

Jumper extensions for the Q7 magnets

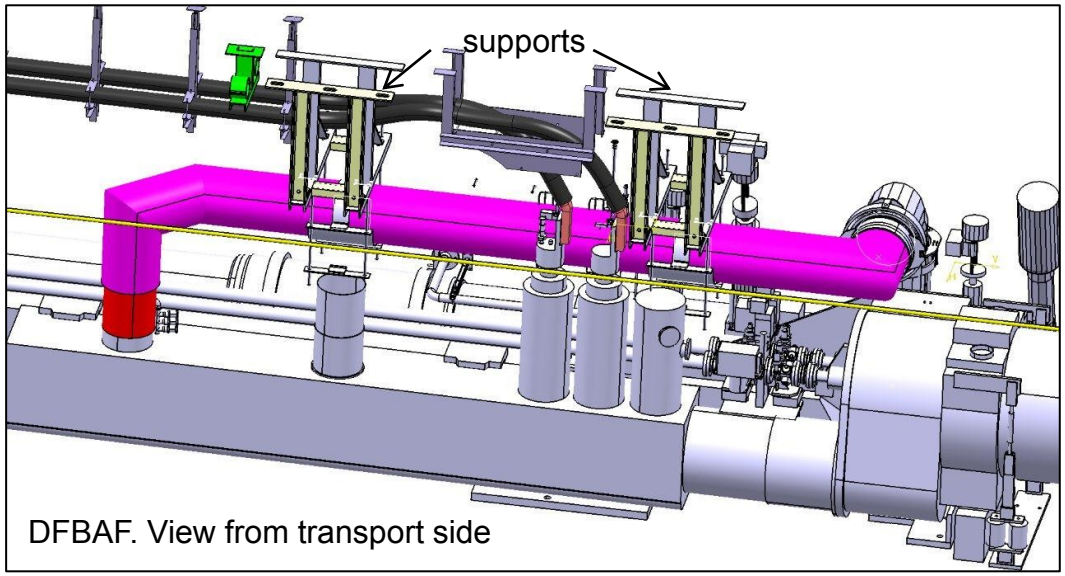


Q7R3. View from transport side

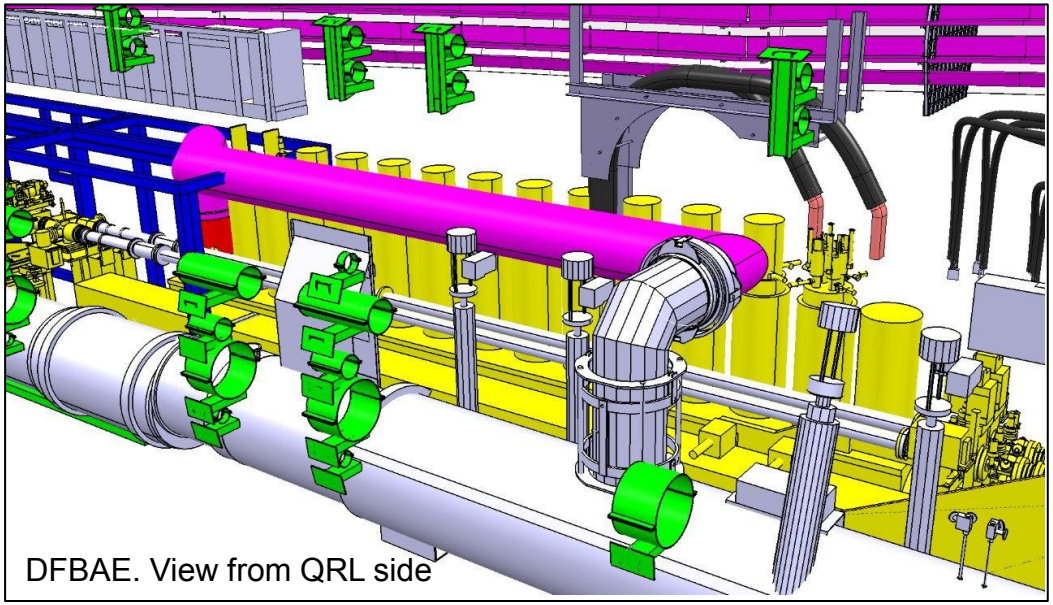

Q7L3. View from transport side

- Special supports for displacement
- Requires rotation of 90° of magnet jumper with respect to original.
- Magnet jumper also higher by about 300 mm
- In IR3L, the jumper extension will be installed after the interconnection work in order to guarantee the best access for the intervention.

Jumper extensions for the DFBAs

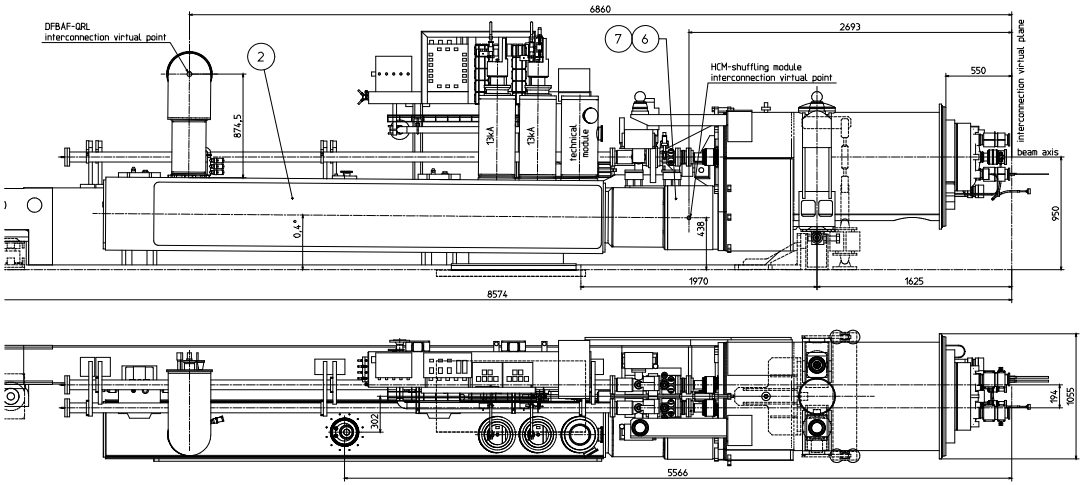


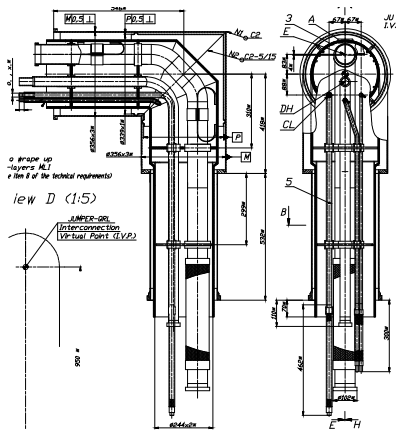
DFBAF. View from transport side


DFBAE. View from QRL side

- Special supports for displacement
- Requires rotation of 45° of DFBA jumper with respect to original.
- Interference with “proximity equipment”: transformers, connection boxes, etc.

Moving the DFBAs





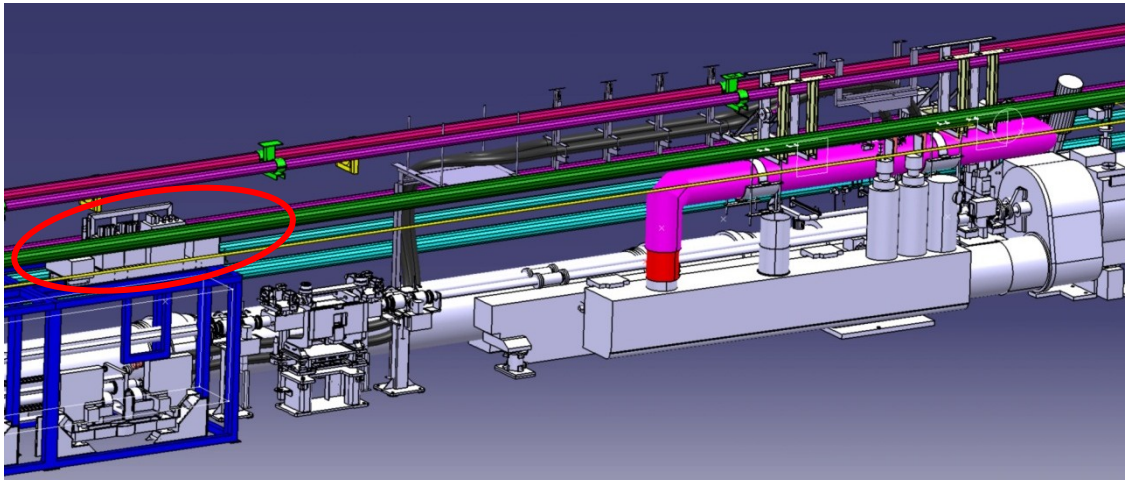
Impact on the DFBAs

- Connection to the jumper extension requires a rotation of 45° of the DFBA jumpers an internal piping with respect to original: essentially completely rebuild the jumper.
- Interference with “proximity equipment”: transformers, connection boxes, etc: displacement of the proximity equipment
- No spare DFBA!

Tentative sequence of interventions

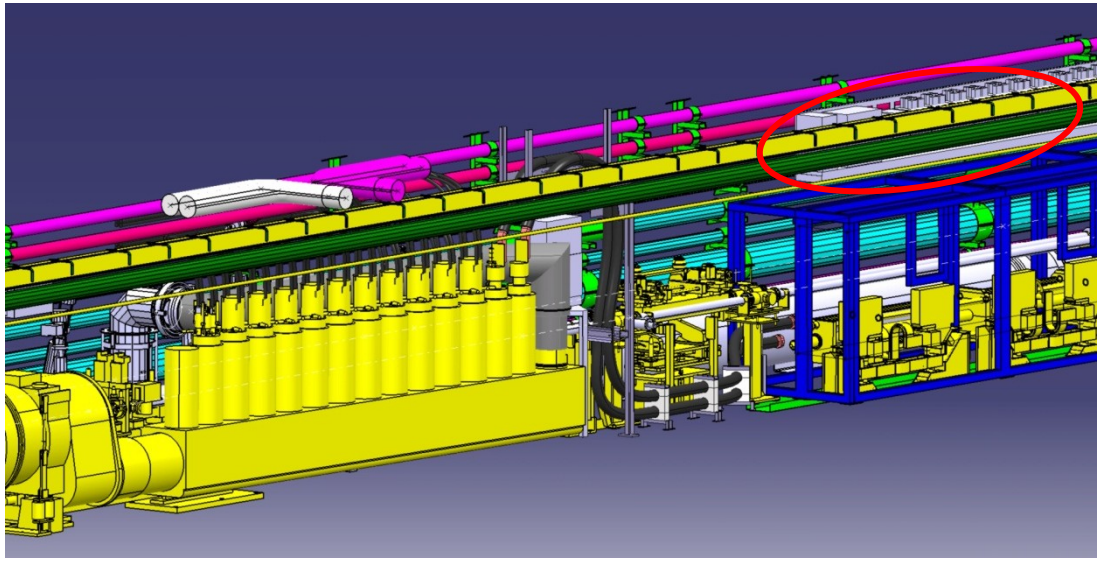
- Open interconnection to Q7, disconnect the DFBA from the QRL, from WL and cabling
- Move DFBA in a safe place (possibly IP4). Re-use the installation tooling.
- Perform all modifications on the DFBA jumper
- Full leak and pressure test of the modified piping on the DFBA (+ electrical qualification)
- Transport the DFBA in the new location and reconnect

Impact on the proximity equipment



IR3R

- No space in current position because of jumper extension
- The transformers and connector boxes could be fitted on a structure above the switches
- The CL valves and piping could stay at the same position



IR3L

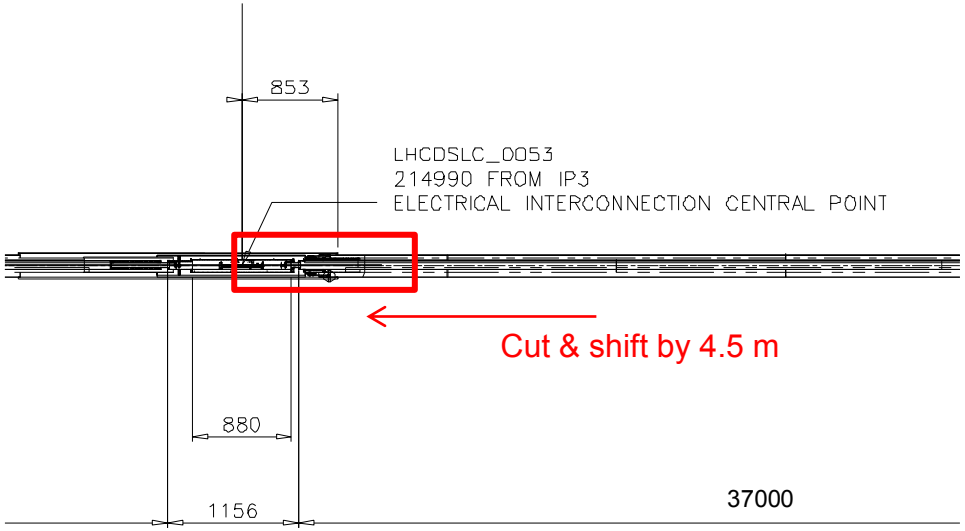
- No space in current position because of jumper extension
- The transformers and connector boxes could be fitted on astructure above the switches
- The CL valves and piping mst also be relocated

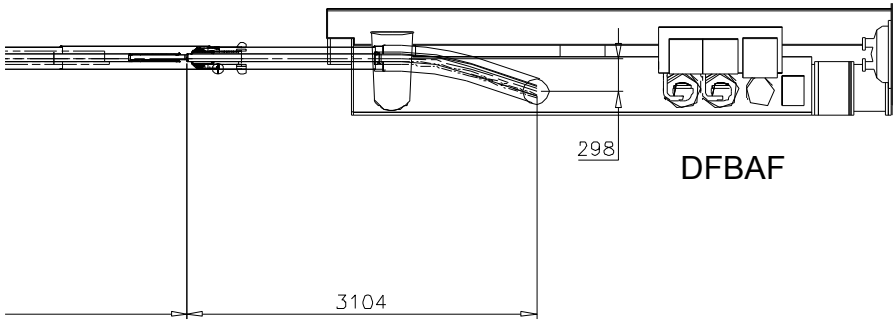
Modifications to the DSLC (superconducting link)

- The DSLC needs to be shortened by 4.5 m
- Cable is 44 x 600A busbars
- Delicate operation but experience exists. Unique system.

Tentative sequence (details being studied):

- Open and disconnect at the DLSC-DFBAF connection
- Open and disconnect at ceiling connection 40 meters from DFBAF
- Shorten the helium piping while preserving the SC cable on the DFBAF segment
- Reconstruct the interface flanges on the piping
- Install temporary sliding supports on the DSLC vacuum envelope
- Shift the DFBAF segment by 4.5 m to the new position
- Reconnect the DSLC
- Perform leak tighness & Hi Voltage tests on the DSLC before reconnection to the DFBAF
- Reconnect to the DFBAF + leak tests + electrical test





Planning and strategy

Production & installation strategy

- In-house detailed design
- Possible outsourcing for the production of the jumper extensions
- All tunnel operations under direct supervision of CERN.

Planned milestones

- End of 2011: completion of detailed design
- 2012: production of the components and assemblies.
- End of 2012: all jumper extensions, components for interconnection and other parts available
- 2013, coordinated with the other LS activities, installation in the tunnel

Estimated duration of tunnel operations & constraints (CRG operations only)

- Installation of jumper extensions: 2 weeks / extension. Installation performed after magnet interconnections.
- Disconnection of DFBA from WRL: 2 days / DFBA
- Modification of the jumpers of DFBA: 3 weeks/DFBA
- Shortening of the DSLC: 2 weeks to disconnect and shorten + 2 weeks to reconnect

Current status

- Integration and main parameters defined for the jumper extensions
- Integration study ongoing for frames
- Detailed design started for the modification of the DFBA jumpers
- Work on modification of DSLC not started yet

Estimated resources and costs (CRG tasks)

CRG tasks

Design and production of jumper extensions
Design and production of components to modifications of the DFBAs
Design and production of the proximity equipment frames and warm helium piping
Design and production of the DSLC components & tooling for shortening

Installation of the jumper extensions (without interconnection to QRL) an dheir supports
Modification of the DFBAs to accommodate jumper extensions
Shortening of the DSLC
All leak tightness and pressure tests

TE-CRG Resources	2011	2012	2013	2014	Total (FTE)
Engineers	0.2	0.8	0.8		1.8
Draftsmen		0.2	0.4		0.6
FSU			0.5		0.5

Estimated costs for TE-CRG activities (for installation in 2013)

Activity	2011	2012	2013	2014	Total (kCHF)
Cryo Ext		220	100		320
DFBA moving (incl. frames)		160	160		320
DSLC shortening		20	30		50
Grand total		**130**	**560**		**690**

Conclusions

The studies performed show that the modifications to the jumpers and to DFBAs and DSLs in order to introduce the collimators/cryo-bass in IR3 are feasible during the long shudtown of 2013-2014

No showstopper has been identified

The jumper extensions can be based on validated existing design

Moving the DFBAs requires to heavily modify the jumpers and some internal piping

The proximity equipment (valves, piping, cables, transformers, connection boxes) must be relocated

The preliminary study to shorten the DSLC shows that the best place to perform the operation is the first interconnection from 40 m from the DFBAF. Further studies are needed to precisely define the operation.