



Cryomagnets Interconnections

- ❖ Status of the helium guard repair
 - ❖ Quick interconnection overview
 - ❖ Diagnostics and repair of interconnection cryostats [A Poncet/JPh Tock]
- Was also presented at ICC 01/02/2008



Helium guards status

| <u>Sector</u> | <u>To be replaced</u> | <u>Done</u> | <u>Remark</u> |
|---------------|-----------------------|-------------|------------------------|
| 1-2 | 24 | 12 | On-going ; end W7 |
| 2-3 | 9 | 8 | Completed |
| 3-4 | 3 | 3 | Completed |
| 4-5 | 8 ? | 0 | During shutdown of 4-5 |
| 5-6 | 13 ? | 0 | After warm-up |
| 6-7 | 25 | 25 | Completed / W6 |
| 7-8 | 7 | 7 | Completed |
| 8-1 | 1 | 1 | Completed |

* Components available for all sectors but part of 4-5 and 5-6 (ordered ; should be OK delivery W8))

* Endoscope inspections done in all sectors but 4-5 and 5-6

* Will be completed ahead of schedule thanks to improved procedure and learning :

N Bourcey, JM Hubert, [Staff]

O Mastel, G Favre, M Jamain [FSU]

N Marouan [IEG]

* Under control



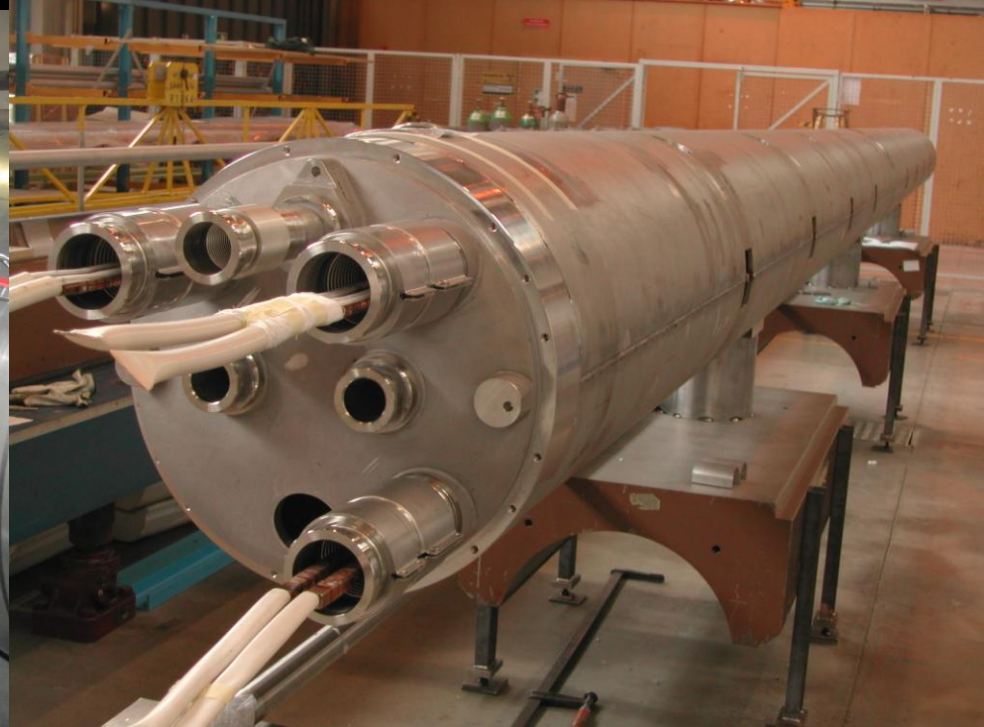
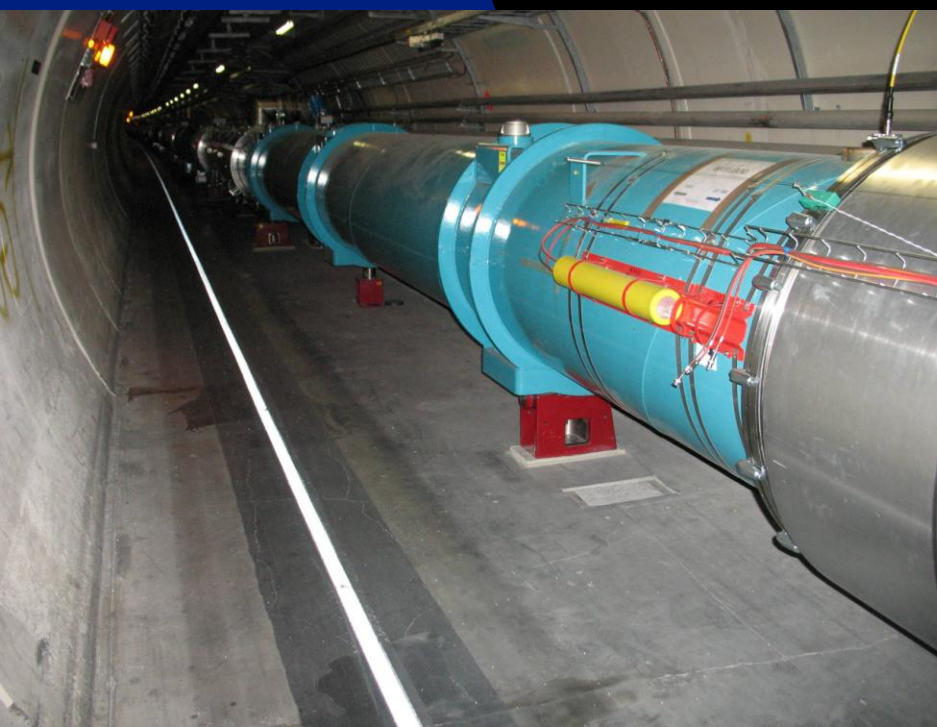
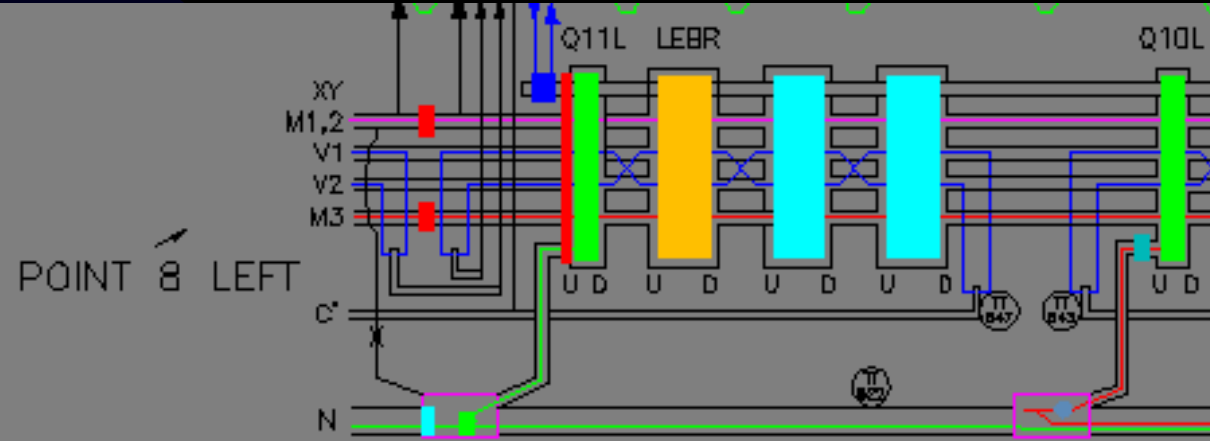
InterConnection Cryostats

- ❖ Introduction on ICCs
- ❖ Sequence of events
- ❖ Analysis of the origin of the defect
- ❖ Reinforcement of electrical insulation
 - * Quadrupole busbars
 - * Dipole busbars
 - * Lyras
- ❖ Intervention steps
- ❖ Summary - Conclusions



InterConnection Cryostats

Introduction on ICCs





InterConnection Cryostats Introduction on ICCs





Interconnection Cryostats

Sequence (1/3)

- Thursday 24/01/08 @ 6 o'clock : Alarm on TP4-C on line monitoring (insulation with respect to ground) of the circuit RQF.A78
- Friday 25/01/08 : Additional ELQA tests localised the defect in the middle of the CC. End of the afternoon, it was decided to warm-up the subsector to allow in-situ intervention
- Monday 28/01/08 : Active warm-up launched by CRG with a partial venting (10 mbar)
Retrieval of data on connection cryostat and analysis of possible failure
- Tuesday 29/01/08 : Warm-up continued with a venting to Pa started around 18h00
Meeting to define the possible intervention procedure ; defect likely in the Iyra
- Wednesday 30/01/08 : Room temperature and Pa reached in the concerned subsector in the morning

Geometrical references taken by Survey before opening of cryostat

Opening of cryostat – removal of thermal screens and MLI – drilling of first hole in shuffling module in 2 “extended” shifts



InterConnection Cryostats

Previous endoscope inspections (8R)



This lead to the decision to open directly the shuffling module and not the adjacent interconnections

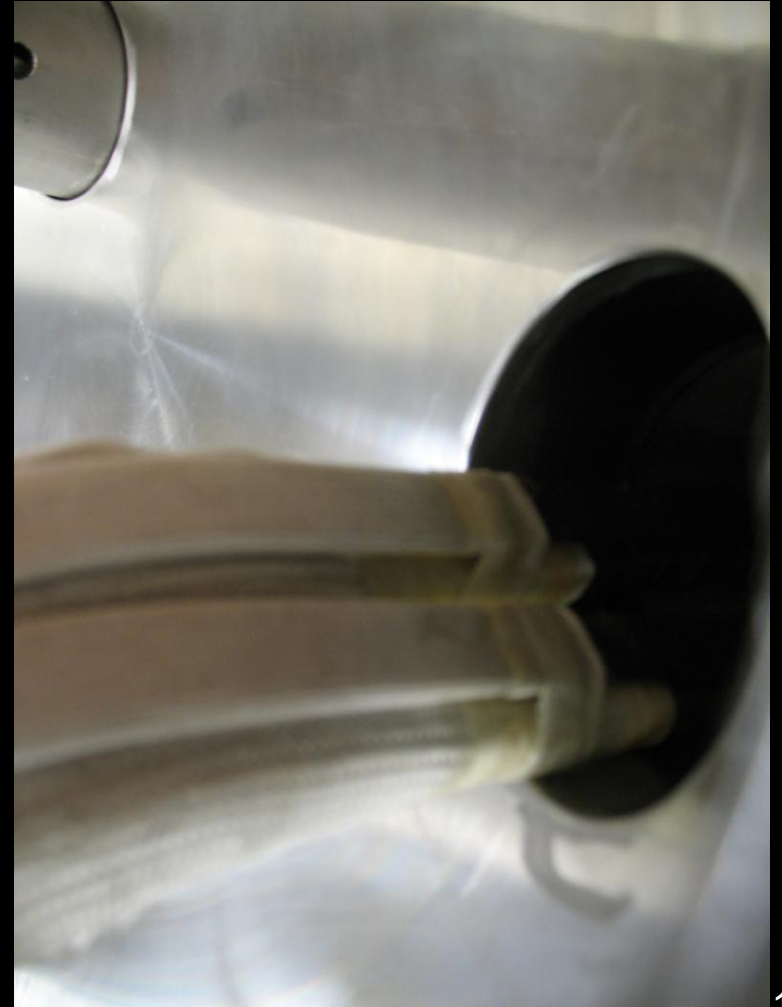
InterConnection Cryostats Opening in L8





InterConnection Cryostats

Opening in L8 : First images from inside





Interconnection Cryostats

Sequence (2/3)

- Thursday 31/01/08

Opening of 2 other holes in the shuffling module

Partial endoscope inspections

Analysis of manufacturing pictures (nothing indicates that it is not a systematic problem) [R Lopez]

Discussion with electrician for the insulation reinforcement

Definition with SC of the procedure to reclose the shuffling module

Introduction in 4-5 consolidation schedule of the interventions on the 2 CCs

Manufacturing of insulating pieces (2 evolutions / 2 types) / Not final

- Friday 01/02/08

Test in-situ of insulating pieces

Check of material availability

Manufacturing of test pieces to validate welding procedure with SC

Plan for repair of R7- Start of warm-up at 17h00 of DSR7

Meeting on-site (L8) with experts to validate/improve the procedure to reinforce the electrical insulation

Localisation of the defect (ELQA) on the edge close to the head extremity

MARIC
06/02/2008

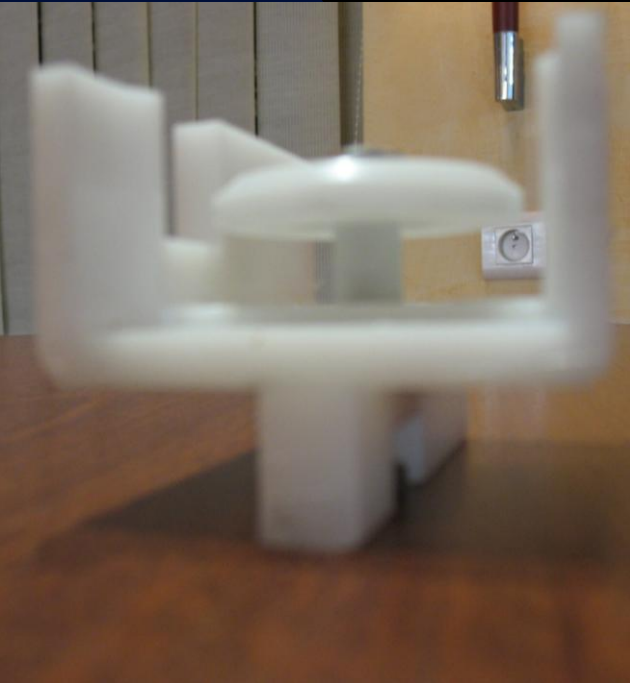
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J.Ph. TOCK



Interconnection Cryo



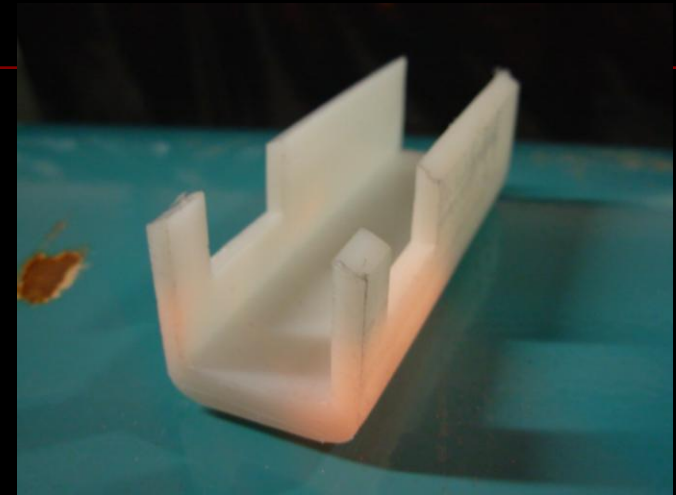
First ideas to reinforce insulation



Improved by :

- Rounding edges
- Add insulating cap
- Change shape of some pieces
- Add insulation between spool and main BBs

Intended for all busbars but not “mountable” on dipole BB



Reduced profiles for dipole BB – not possible to mount



Plozip – not possible to mount in-situ



Interconnection Cryostats

Sequence (3/3)

- Monday 04/02/08

Production of test samples for validation of welding procedure

Improvement of insulation pieces for quadrupole and installation

Trials of solution on dipole busbars

DSR7 : Installation of the worksite ; start opening of cryostat

- Tuesday 05/02/08

Test of another solution (3rd one) for the dipole busbars

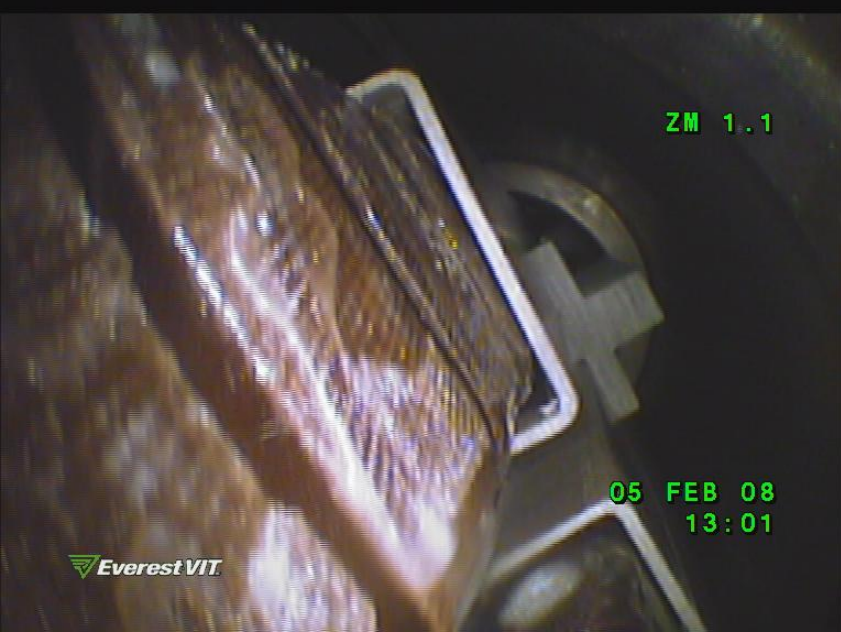
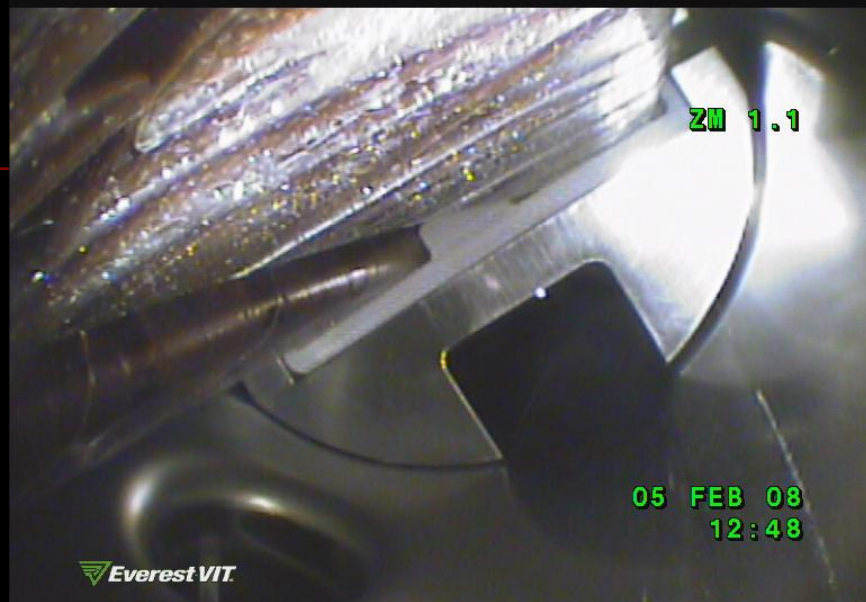
Brainstorming about Iyras insulation reinforcement

Complete and detailed endoscopy, revealing no other defect from IC to IC

DSR7 : End of cryostat opening, removal of thermal shield, start drilling in the shuffling module

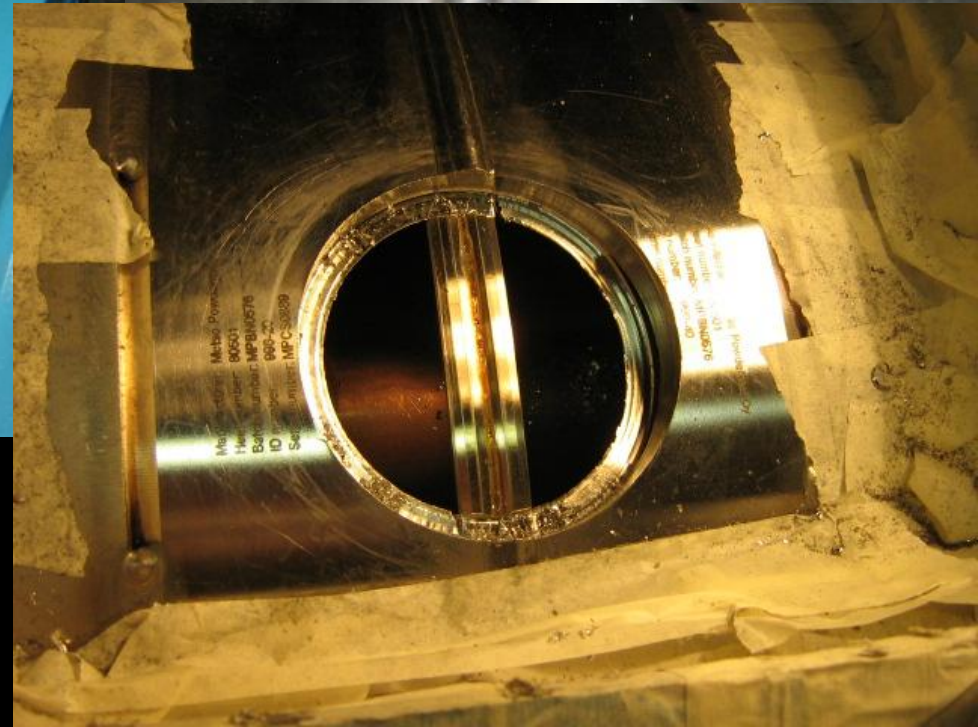
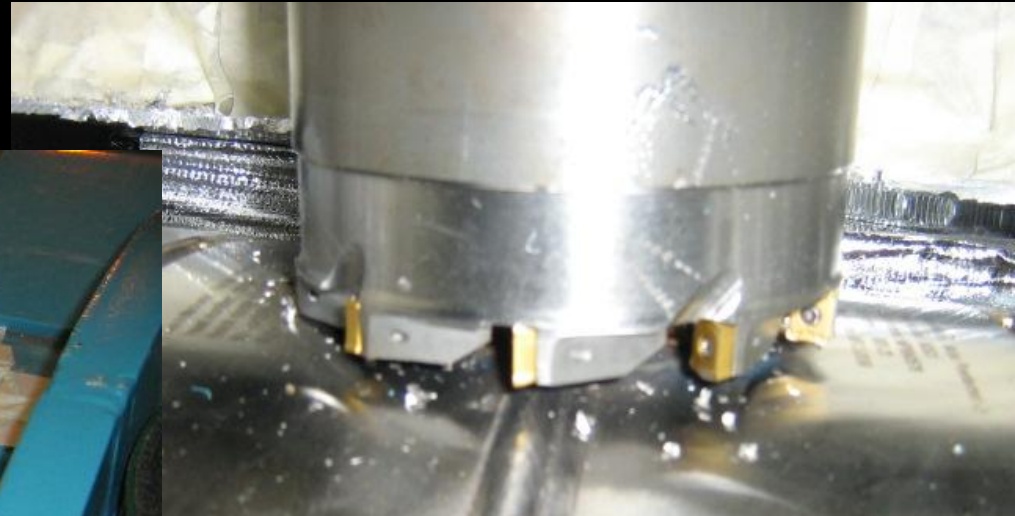
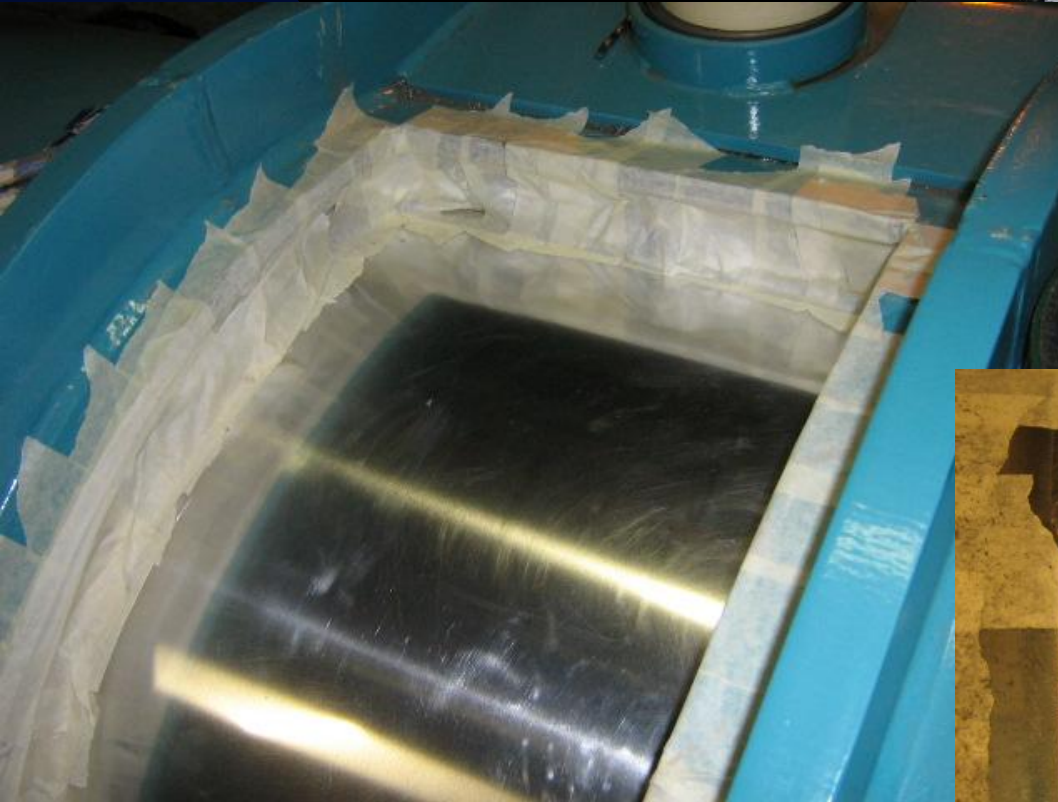


Interconnection Cryostats Endoscope inspection of CC L8



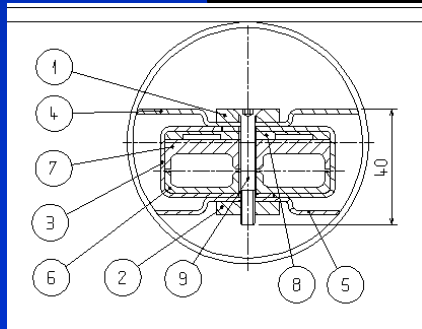
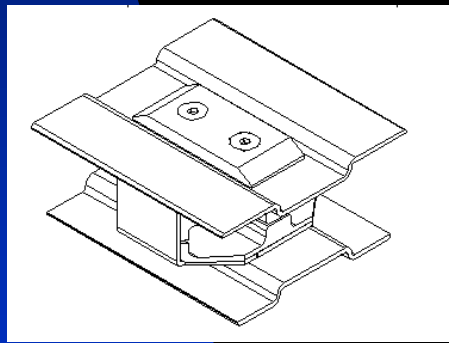
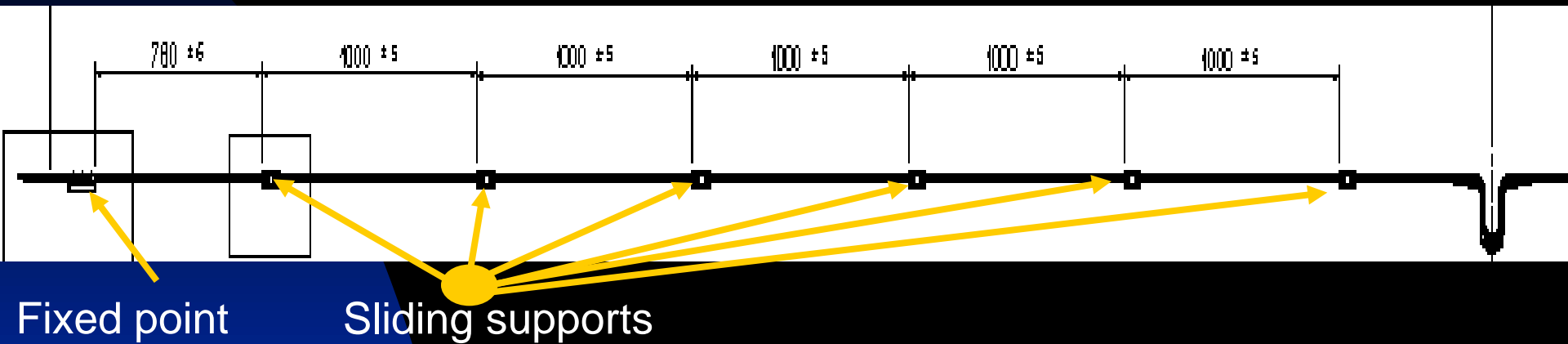


Interconnection Cryostats Opening of CC R7



Interconnection Cryostats

Origin of the problem :

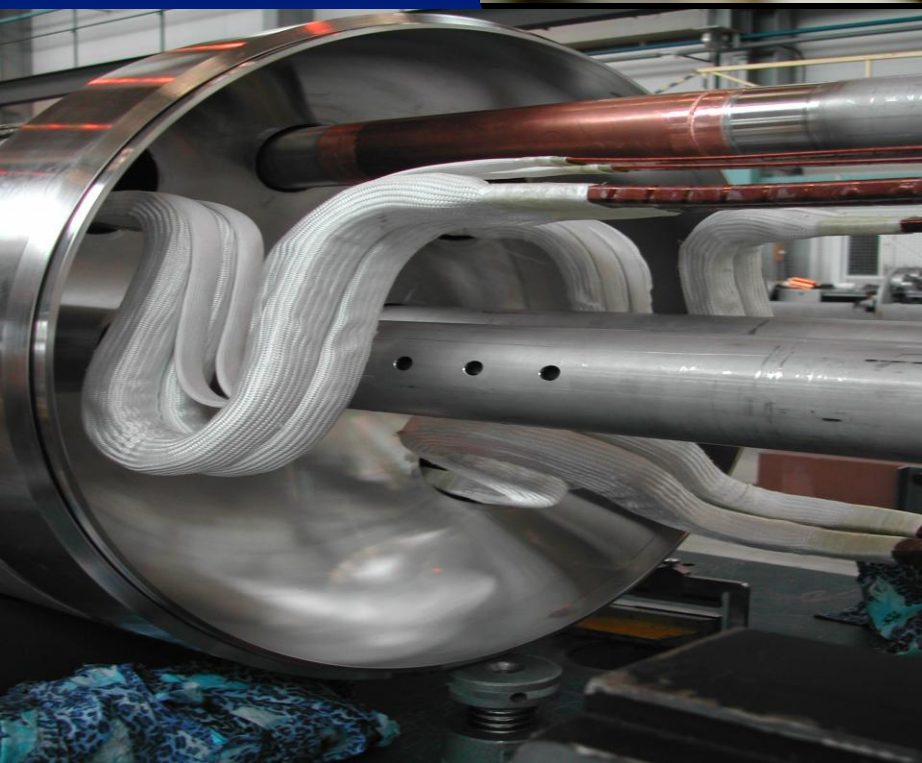


Busbars were bent and touched the edge of the tube ; that created a short circuit ; This would have been avoided with sliding supports closer to the central end covers

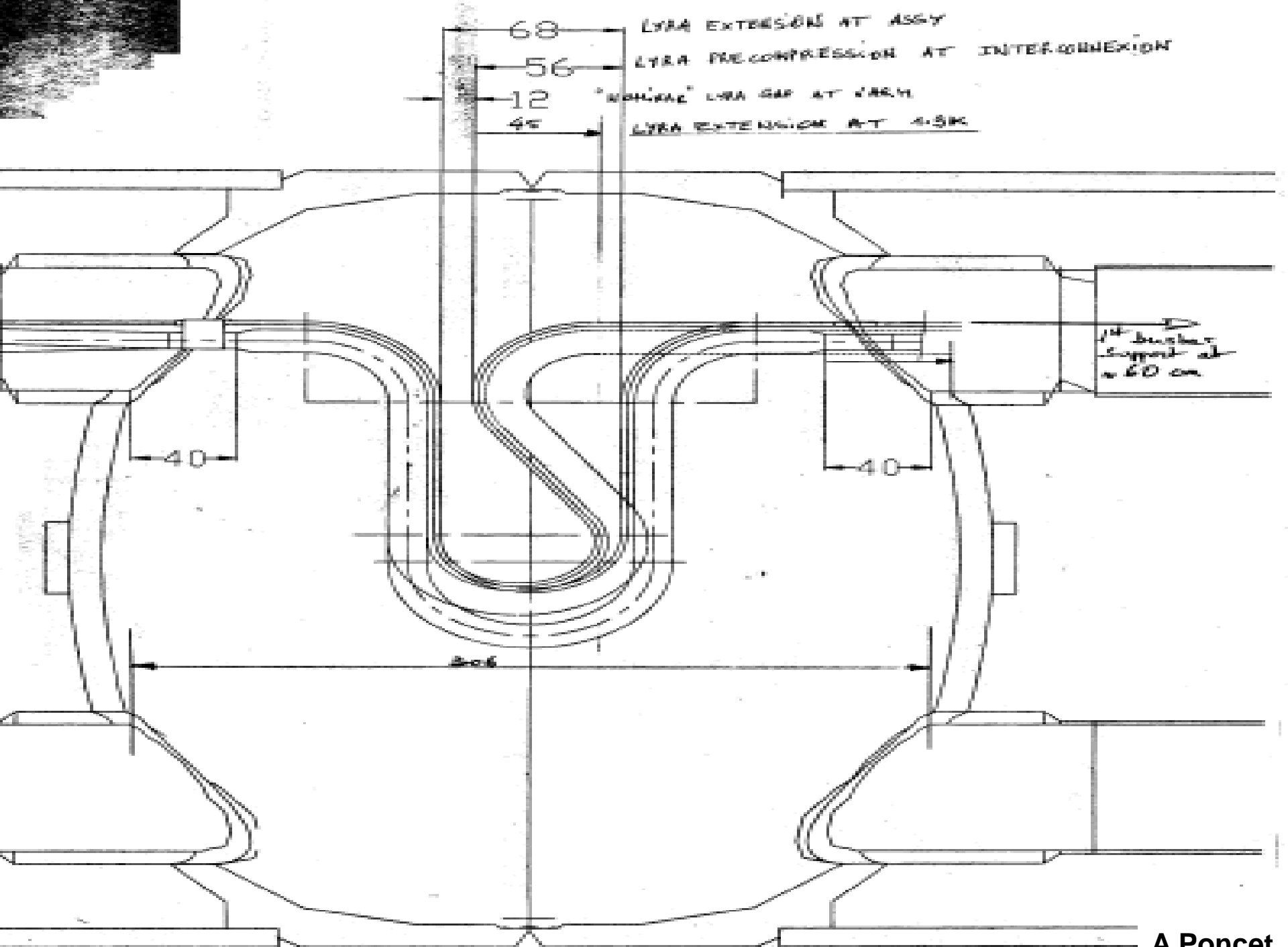


**Lyras pre-compressed,
As seen in CC11L8**

Lyras at assembly

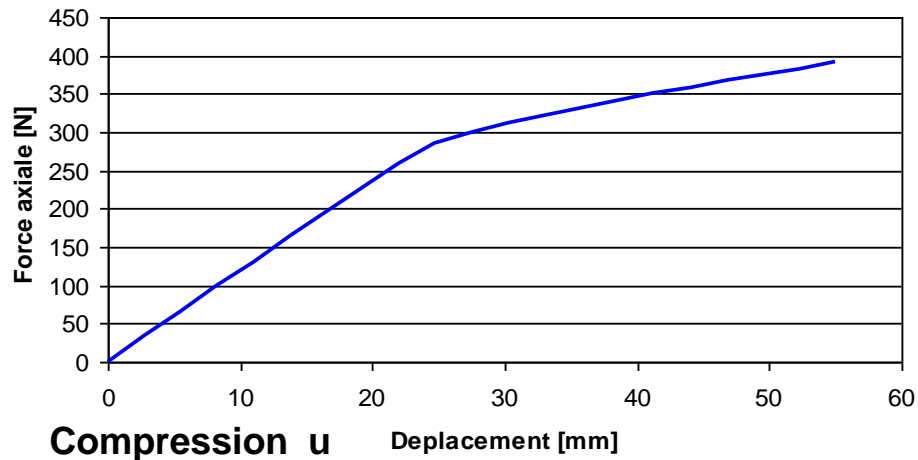


A Poncet

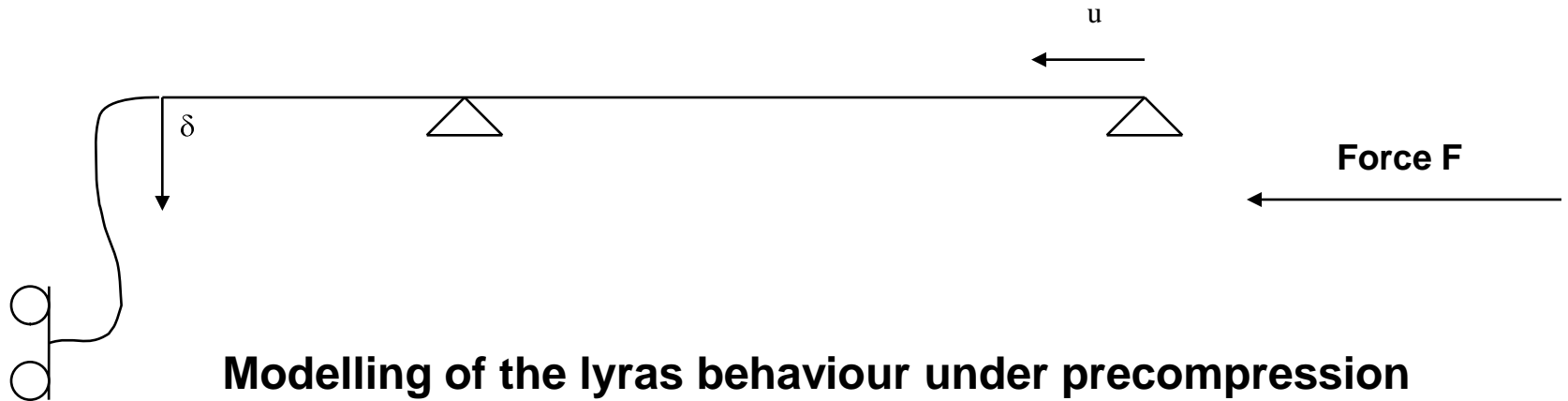
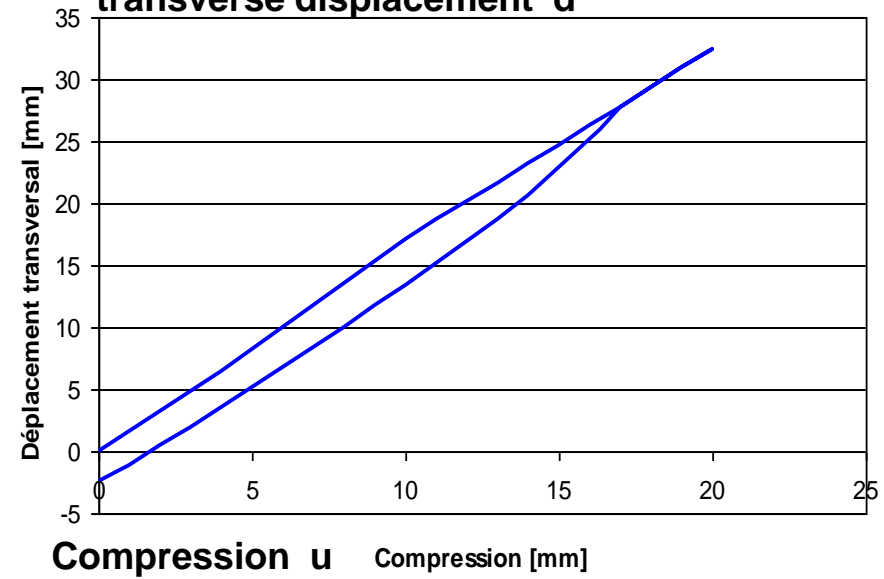


Réponse Lyre

Force F

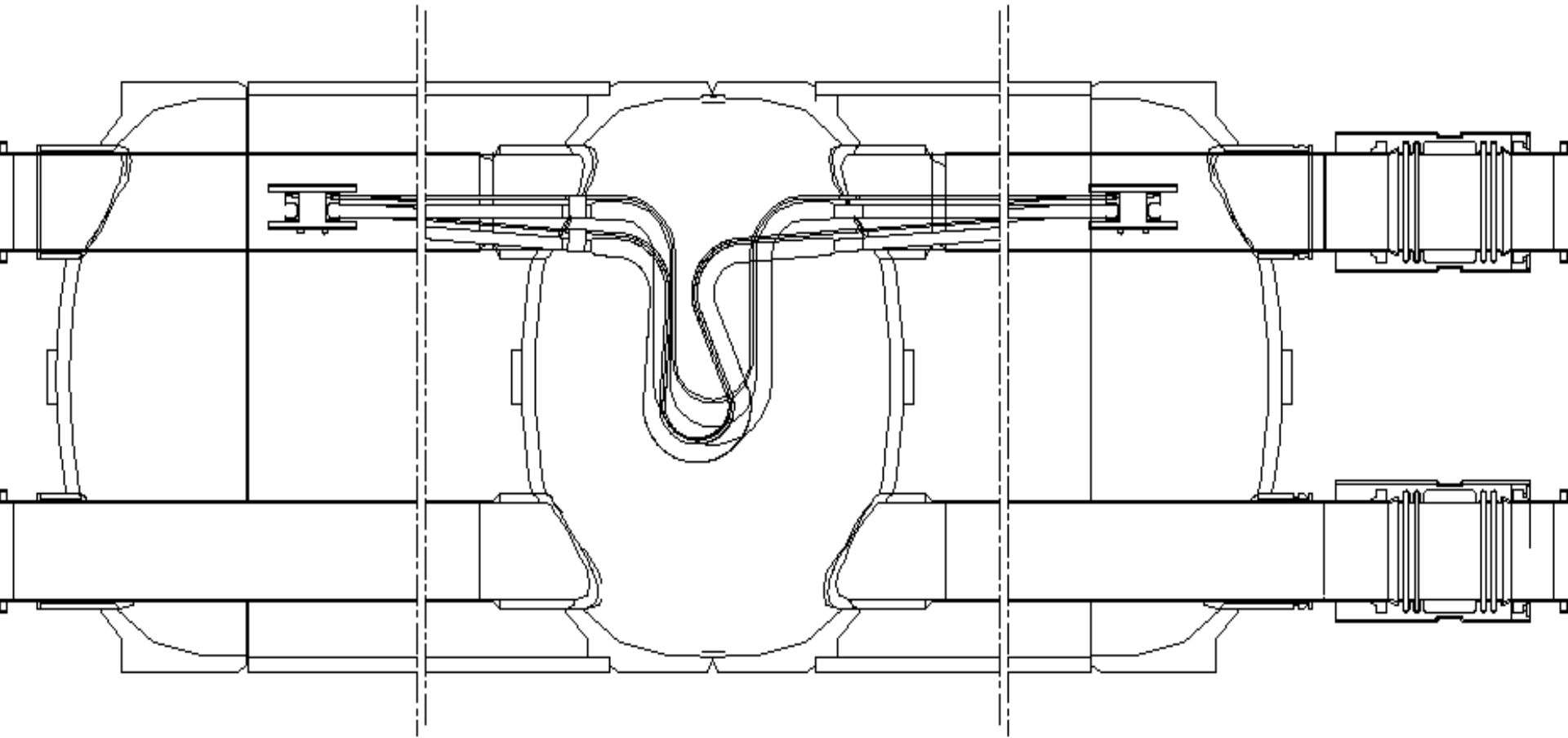


transverse displacement d



**Modelling of the lyras behaviour under precompression
(C.Garion)**

InterConnection Cryostats

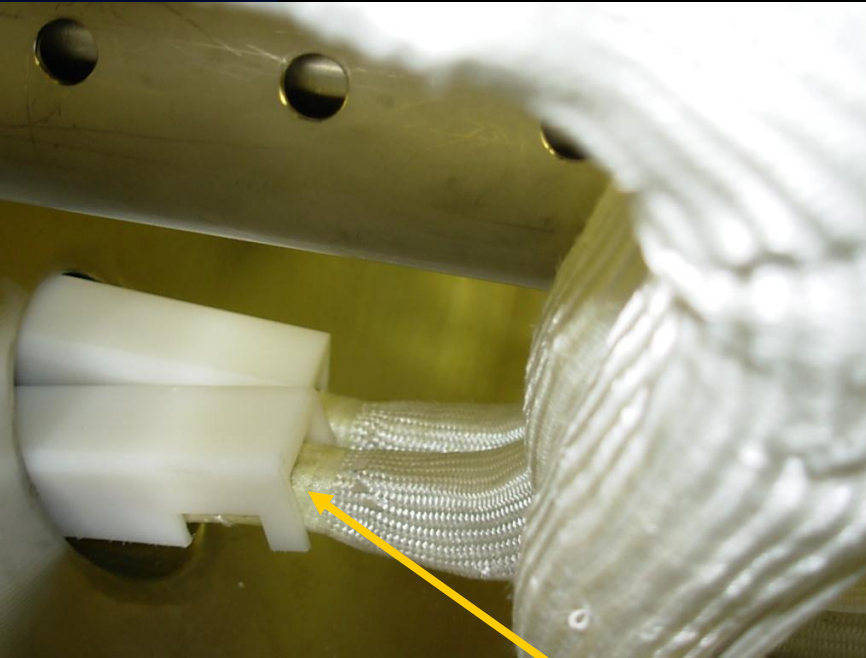






InterConnection Cryostats

Reinforcement of electrical insulation :
Dipole busbars [To be validated in-situ]



Not satisfactory for the U shapes PEHD profiles



Proposal : insulating PEHD tube around each BB + tubing of the inside of the tube with a blocking system with a binding at the accessible extremity from the 1st spacer to the lyra



InterConnection Cryostats

Reinforcement of electrical insulation :

Lyras [To be finalised]



Plozip can not be installed

Solutions to insulate lyra OR the V' tube are under finalisation ; the best will need to be selected (dish around lyra or ... or ...)



InterConnection Cryostats

Intervention steps :
Duration estimates are aggressive

1. Warm-up of the concerned subsectors and cooldown put in stand-by (for cold sectors) : 2-3 days
2. Vent the concerned subsectors (for pumped vacsec) : 1/2 day in parallel
3. Take geometrical reference measurement (to validate the first ones only ?) : 1/2 day
4. Open cryostat – Remove thermal shielding – open shuffling module : 4 shifts - 2 days [Reduced to 1.5 days after learning]
5. Reinforce insulation – Perform electrical test : 2 extended days [Reduced to 1.5 days after learning]
6. Reclose shuffling module, leak test, radiographic inspection : 4 shifts – 2 days
7. Remount MLI and thermal shield - close cryostat : 3 shifts – 1.5 days
8. Repump and leak test : 5 days
9. Reconditioning for cryo : 3 days in parallel



InterConnection Cryostats

Summary conclusions :

1. Additional tooling is under procurement
2. Raw material is ordered for the beginning of the production
3. Start of one intervention every 3 days
4. Shifts and extended days required
5. Overall schedule worked out with TS/ICC (K Foraz) for intervention on all sectors but 5-6 (and 4-5)
6. Solutions is validated for quadrupole BB, to be validated for dipole BB and to be finalised for liras
7. Opening in R7 will confirm/infirm the systematic aspect of the defect ; IF NOT, the strategy will need to be adapted
8. Plan is to complete 7-8 for end of next week.
9. This fast reaction was possible thanks to the availability and competence of experienced technical staff :
 - A Bastard, M Duret, D Etiembre, JM Hubert, M Pozzobon, S Triquet, CERN staff
 - G Favre, M Jamain, O Mastel, G Maury, FSU
 - Ph de Souza, IEG
 - P Borowiec, L Hajduk, ICIT