# Vacuum system in the cleaning insertions

*External Review of LHC Collimation Project,*

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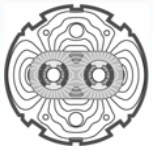
Christian Rathjen

christian.rathjen@cern.ch

*AT/VAC*

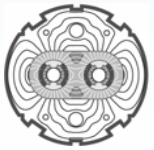
CERN, Geneva, Switzerland

# Contents





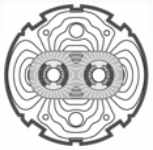
# Base line for warm vacuum system of LSS

- NEG (TiZrV) coated copper chambers
  - Standard: ID 80 mm, 2 mm thickness, 7 m long
- 300 ºC design temperature (250 ºC nom. for NEG)
- Separate vacuum systems for the two beam lines wherever possible
- Sectorisation at each cold-warm transition

LSS in numbers: 4 km long

6 km of beam line



# LSS standard components

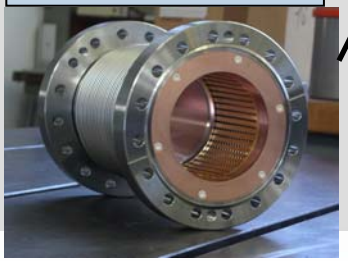
Chamber support

Standard drift space chamber

Sector valve assemblies

Bellows module
with pumping

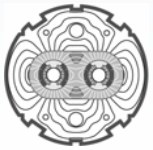
without pumping



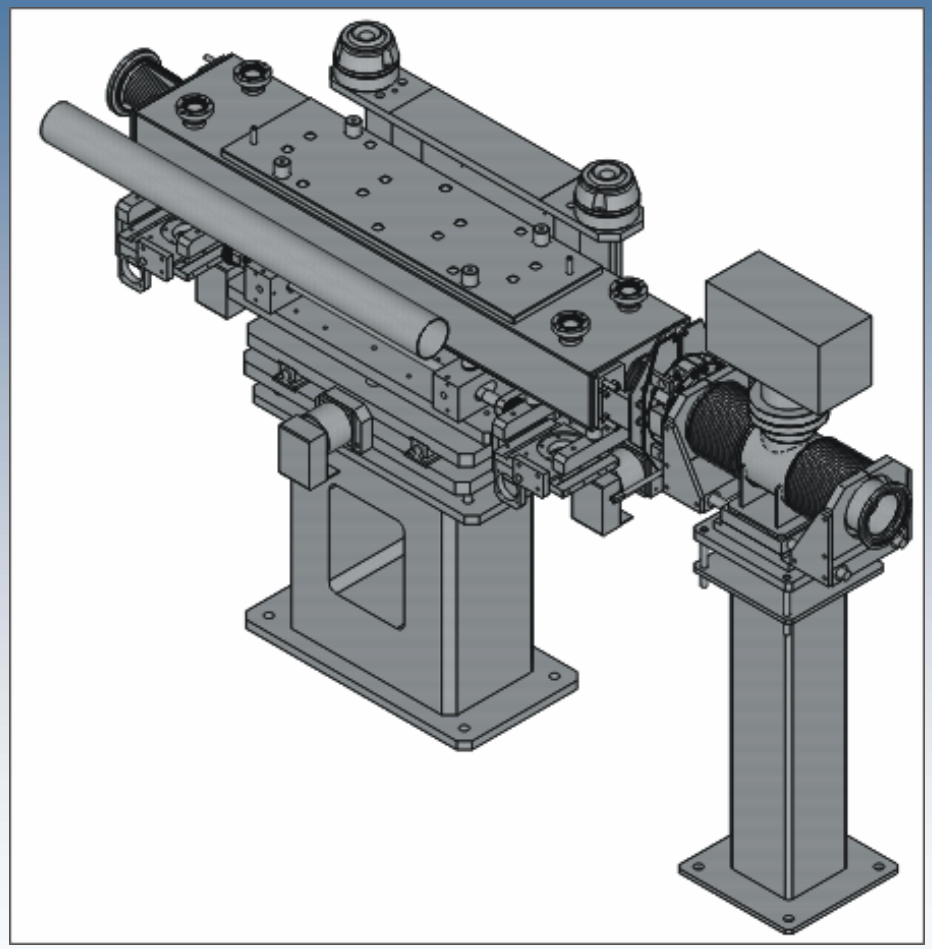
# Vacuum system in the cleaning insertions

- Major components
  - Collimators
  - Warm magnets
    - MBW (D3, D4)
    - MQW (Q4, Q5)
    - MCBW (correctors)
  - Beam instrumentation
    - Beam position monitors
    - Beam loss monitors
  - Absorbers
  - Sector valves
  - Ion pumps
- Special requirements due to
  - Beam induced losses
    - Outgassing
    - Component heat up
    - Component lifetime
  - Radioactivity
    - Reliability/ Redundancy
    - Interventions/ Maintenance
    - Phased installation
  - Space restrictions
    - Component sequencing
    - Beam separation
    - Tunnel diameter
    - Services
    - Aperture



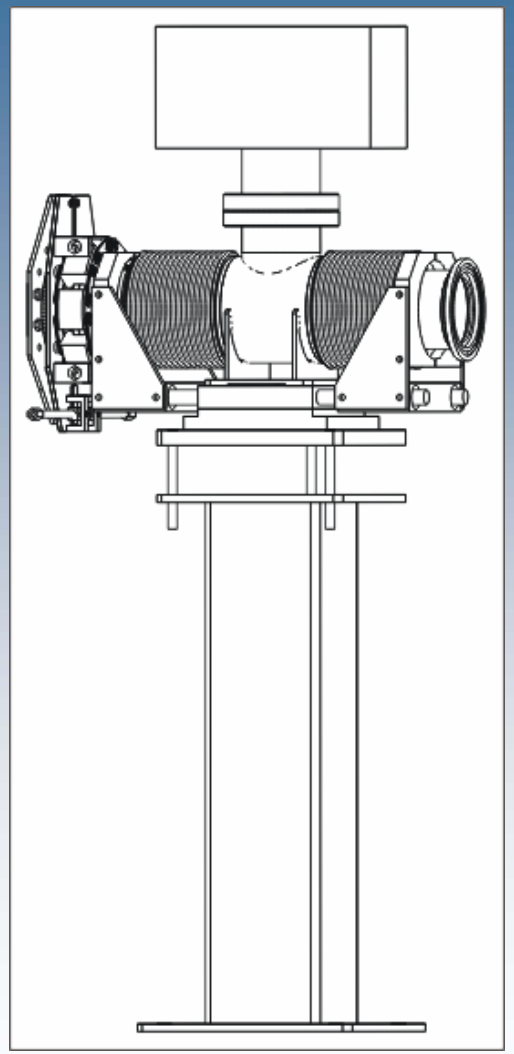



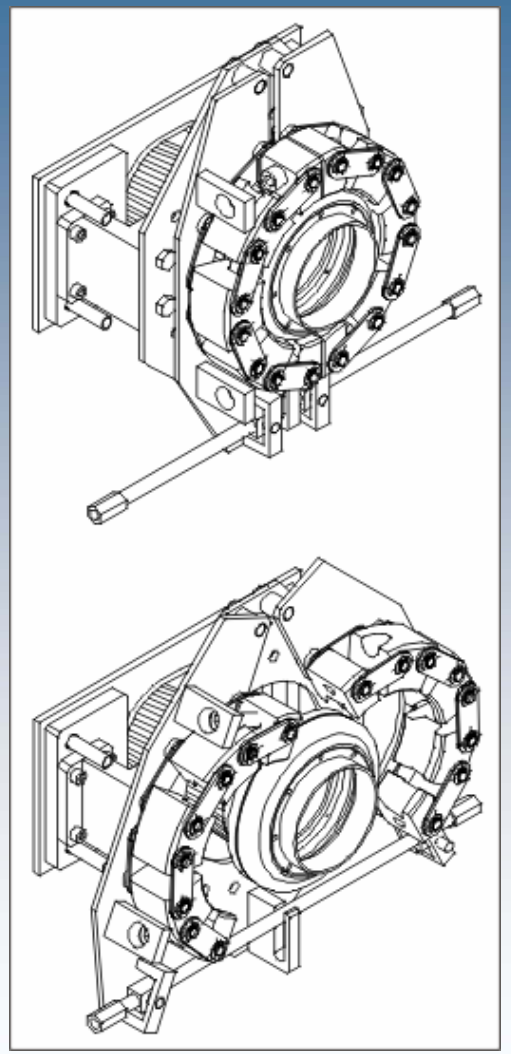
# Collimator vacuum

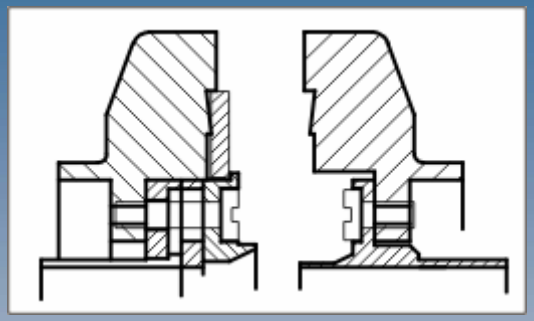


- Pressure in warm regions:
  - ~ 10E-10 mbar static and better
  - ~ 10E-8 mbar dynamic required for 100 h life time
- Collimator jaws
  - Conditioning:
    - 1000 ºC @ air for 2 h
    - 1000 ºC @ vacuum for 2 h
    - 250 ºC bakeout for 24 h
  - Graphite Outgassing
    - 10 times worse than copper
    - Doubled at 70 ºC
  - CERN experience
    - TPS6 at SPS
    - 100x100x200 $mm^3$
    - Static and dynamic test for LHC

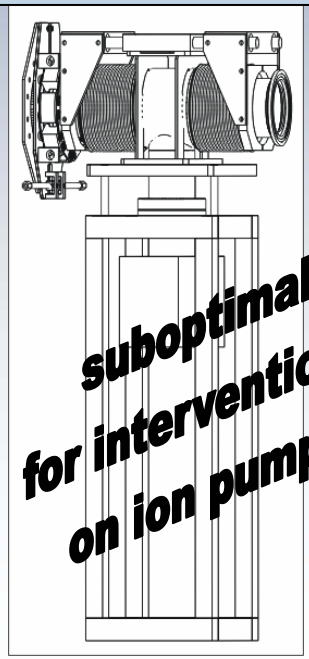
# Collimator interconnect



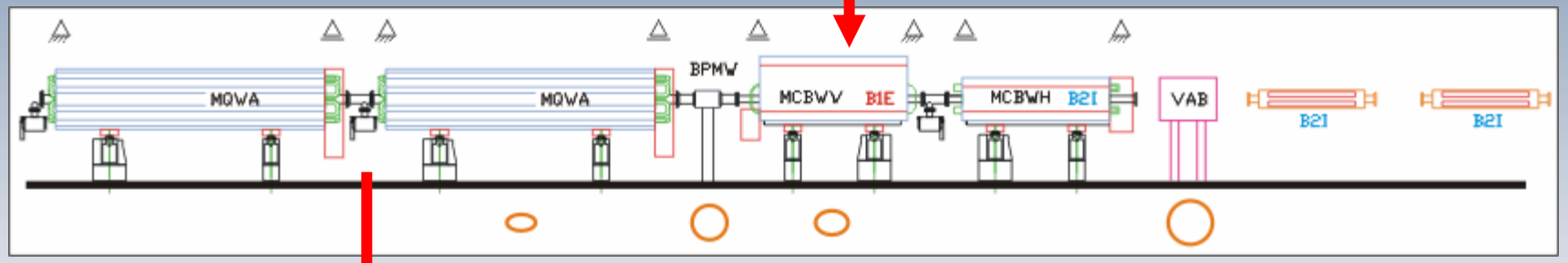


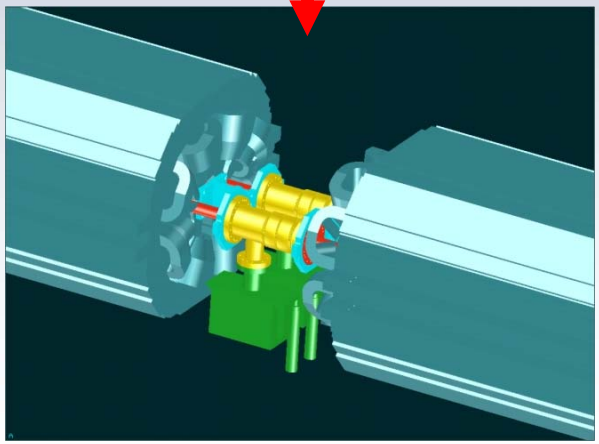


Alternative ion pump integration



# Integration example: IR7 left

- Optimized for
  - Short interconnects
  - Magnet exposure (MQW, MCBW)
  - Interventions
  - Correctors variants
  - Transitions variants & apertures

# Magnet vacuum system

## Main difficulties due to

### Magnet design

- no opening for installation
  - ⇨ in-situ weld
- no space for bakeout system
  - ⇨ new technology
- no alignment reference
  - ⇨ supports difficult

### Aperture

- non circular chamber
  - ⇨ fabrication difficult
  - ⇨ orientation !

### Impedance requirements

- ⇨ copper

### Vacuum requirements

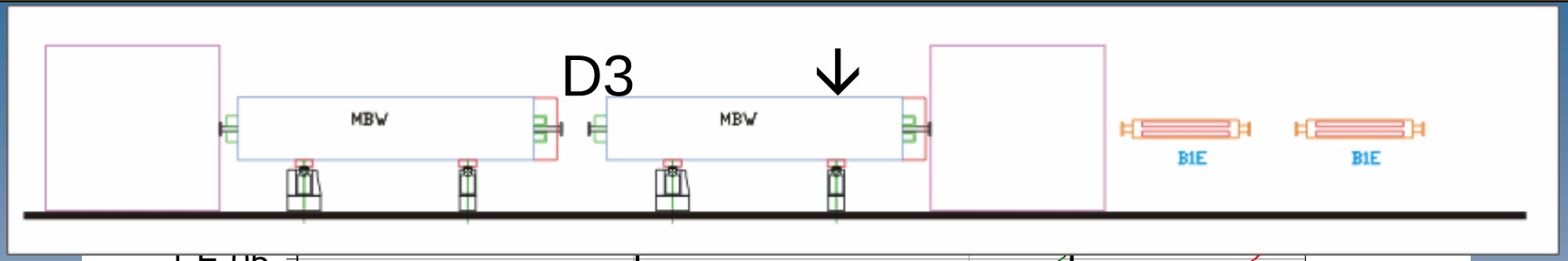
- ⇨ NEG

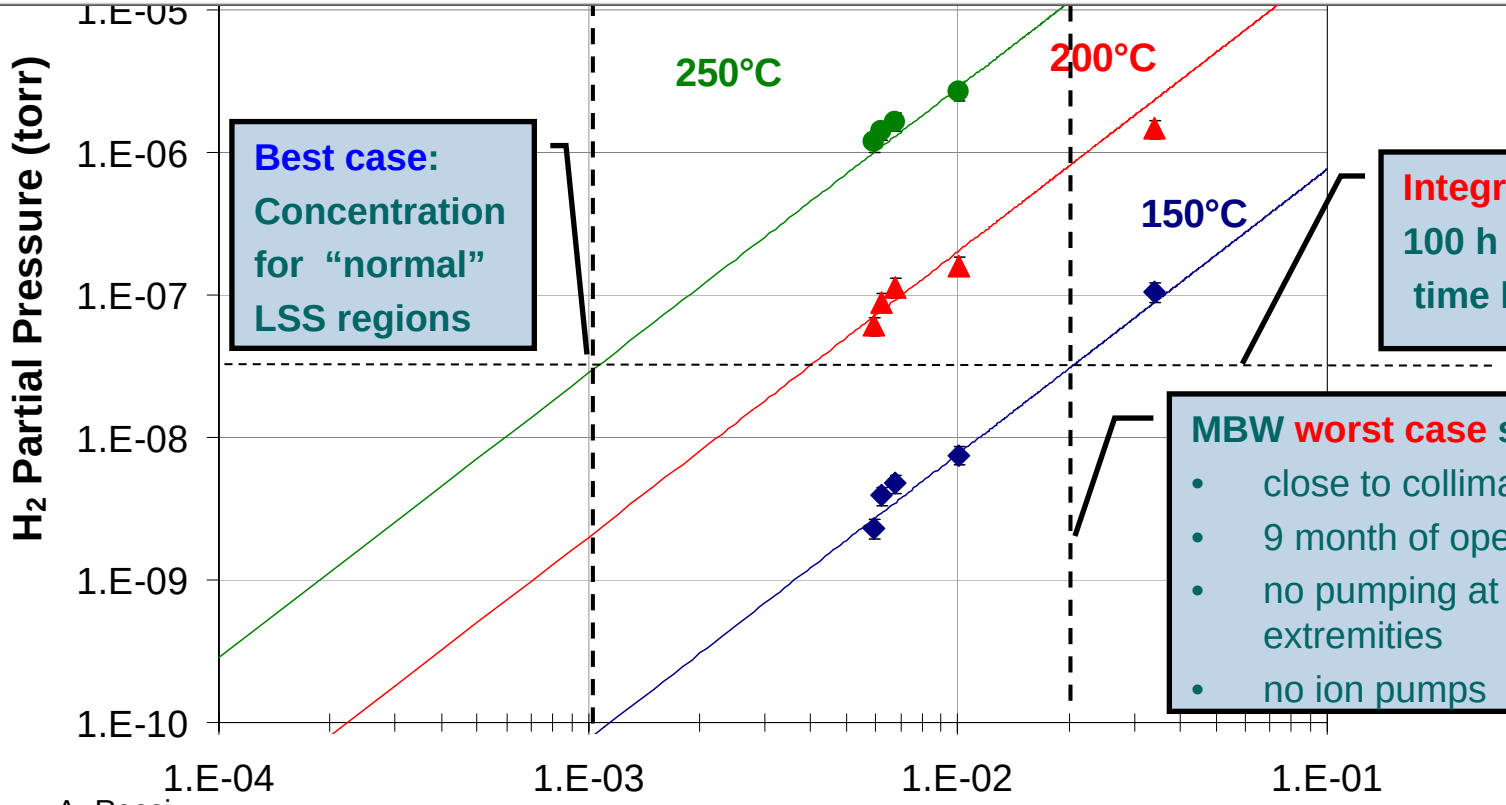
MQW magnet system

Braised copper insert

TIG weld

# Particle showers: Pressure increase




**Best case:**
**Concentration for "normal" LSS regions**

**Integral**
**100 h beam life time limit**

**MBW worst case scenario**

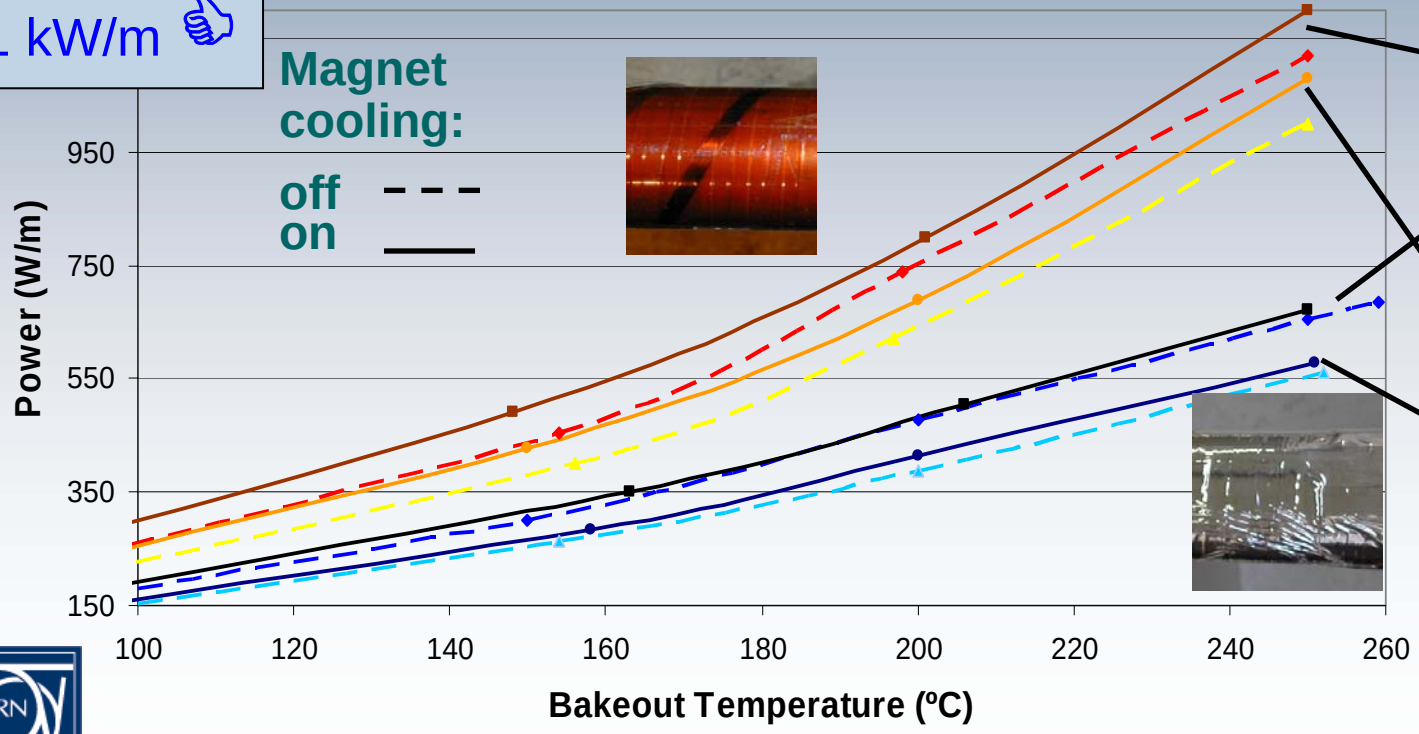
- close to collimator
- 9 month of operation
- no pumping at extremities
- no ion pumps

A. Roosi
J.-P. Sigaud

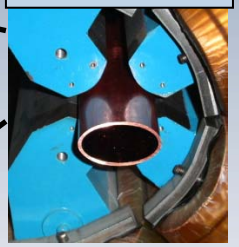
# Particle showers: Design issues (1)

- Pressure bumps are no issue
- Critical mode: **1h** lifetime operation longer than 10 min
- Vacuum system has to stay below 300 ºC.

1 kW/m



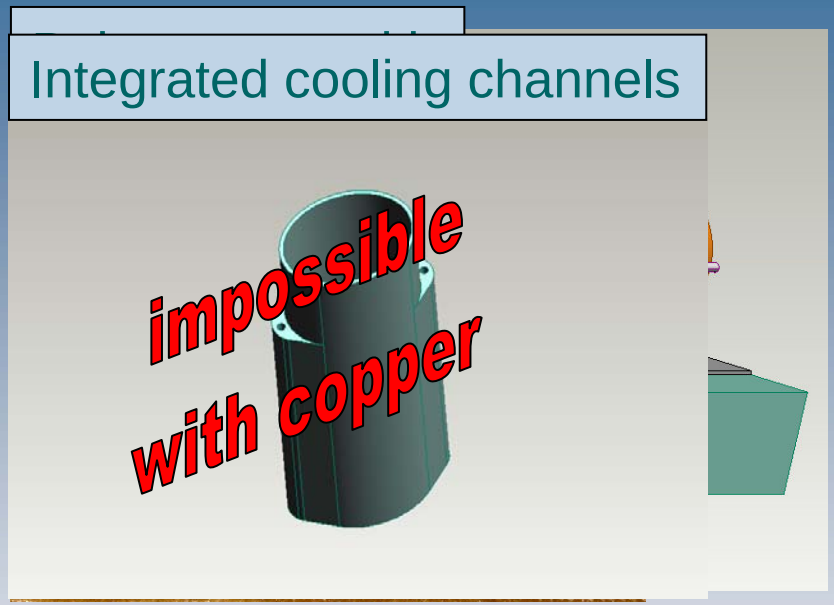

MQW



# Particle showers: Design issues (2)

## Strategy:

- cooling only where necessary
- passive cooling if possible
- if not: coax heaters and cooling tubes
- disable cooling circuits if not required
  (using phase 1 experience)

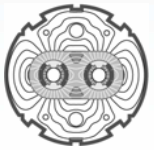




Preliminary classification: better data required

# Remaining points

- Test of chamber supports
  - Heat losses
  - Central supports
- Joints for magnet flanges
- Chamber allignement
  - Strategy
  - Tooling
  - Verification
- Interconnect
  - Evaluation of quick connect flange type
  - Single quick-connect
  - Absorbers
- Chamber cooling
  - Active or passive
  - Fabrication method
- Remote permanent bakeout
- Integration
  - Full 3d-study required
  - Phased installation

# Summary

- Integration at IR3 and IR7
  - Advanced on most critical regions and components
  - We have a clear picture but many points still to be addressed
- Operation
  - Temperature monitoring recommended (like LEP)
  - Active cooling only where indispensable
- Intervention and Maintenance
  - Remote permanent bakeout required
  - Planning requires:
    - Detailed dose maps
    - Full 3d integration studies

**We don't see a showstopper** (provided no shielding).

However, limited resources risk installation of not fully studied and tested components in 2006.