

# PROTECTION SHELLS





**WHERE ?  
WHY ?  
HOW ?  
WHEN ?**

**In LHC Interconnections**

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- **To limit damage on cold vacuum line interconnections:**
  - **Bellows buckling**
  - **Electrical arcs on thin walled shells**
  - **Gas and external particulate inrush**

**By protecting the bellows to electrical arcs with dielectrical shells**

**For operation and installed during the Long Shutdown 1**



- **The material chosen is polyetherimide (PEI) or commonly ULTEM (not charged)**
- **Already used in LHC (DFBA, ...)**
- **Radiation resistant: (no significant damage up to 10 MGy)**  
 [Tavlet, Compilation of radiation damage test data, Part 2, CERN 98-01]
- **Cryogenic resistant**
- **Dielectric properties**
- **Good vacuum properties: Low outgassing polymer**
- **Amorphous polymer: Geometrical stability during molding process, especially for long pieces**

# Three models of parts for twelve types of interconnections



Dipole-Dipole

In LHC: #764



Dipole-Quadrupole

#468



Quadrupole-Dipole

#468

Total quantity:  $(764+468+468) \times 4 = 6800$  pcs



View from underneath

4 positions



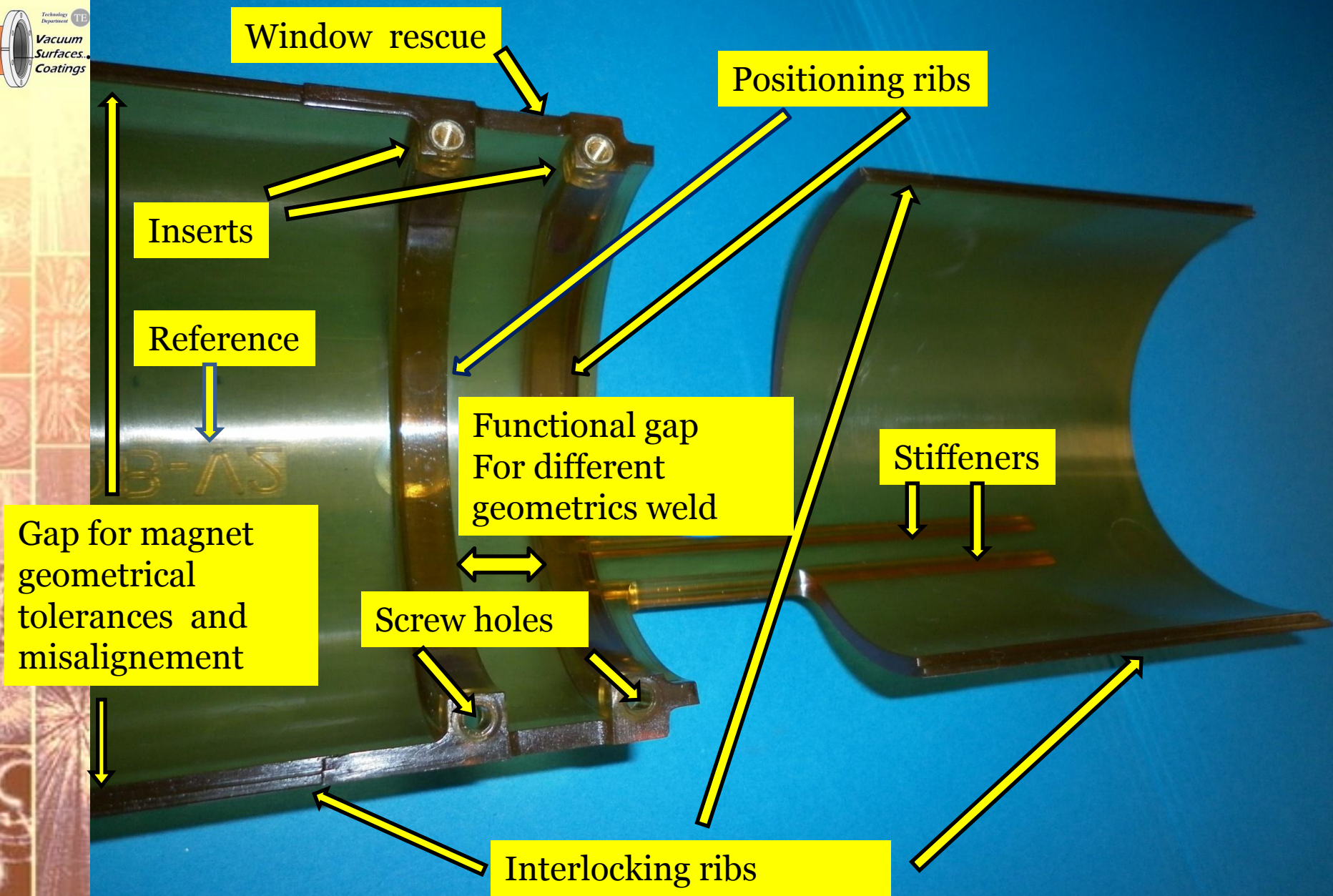
Forming and machining

Molding prototypes (polycarbonate)

Rapid prototypes (CERN polymer labo)

Pre-production series







- Good mechanical strength of threaded insert at room and cryogenic temperature (77 K and 4.2 K).
- Test of thermal shocks have been carried out at 77 K and threaded assemblies have been subjected to thermal cycles between 4.2 K and room temperature at cryolab.
- No damage has been observed.

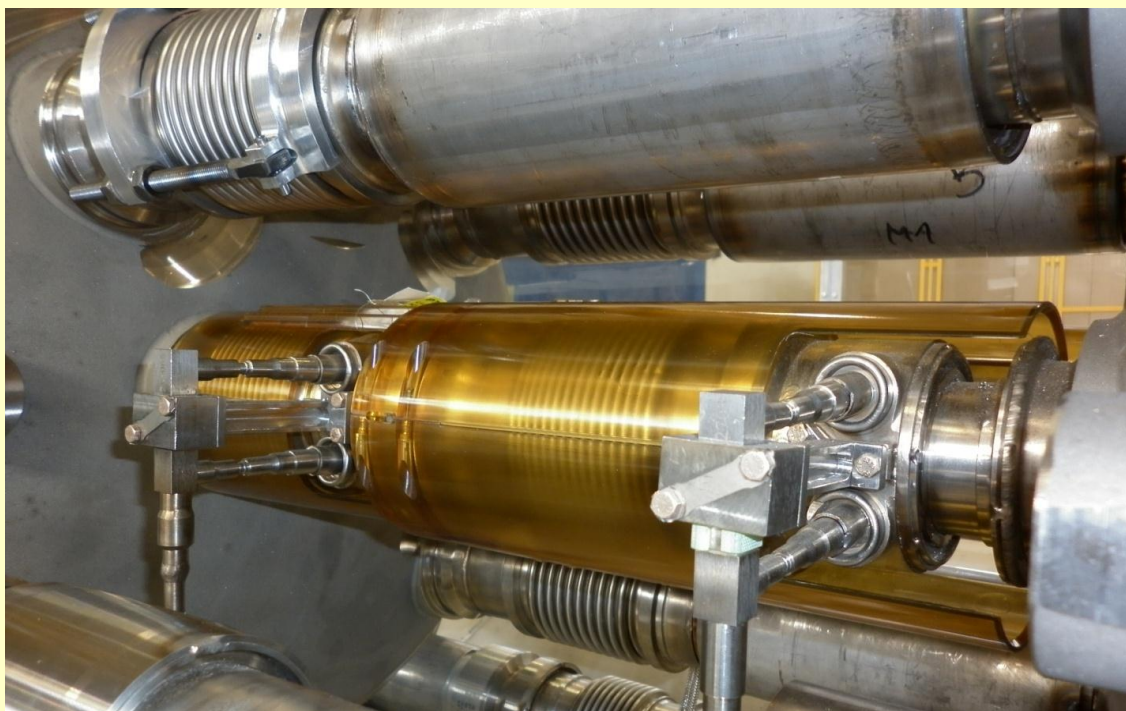


- Resistance to metallic projections at 1200°C!





- **Assembly test in an interconnect mock up**
- **Geometrical measurements**
- **Thermal shock cycles (77 K)**
- **Mechanical shock (hammer)**





- 1. Modification ongoing other pre-production inspection tests.**
- 2. Second pre-production reception and qualification.**
- 3. Series production (2 batches).**