Vacuum chambers for LHC LSS

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the Long Straight Sections of the LHC

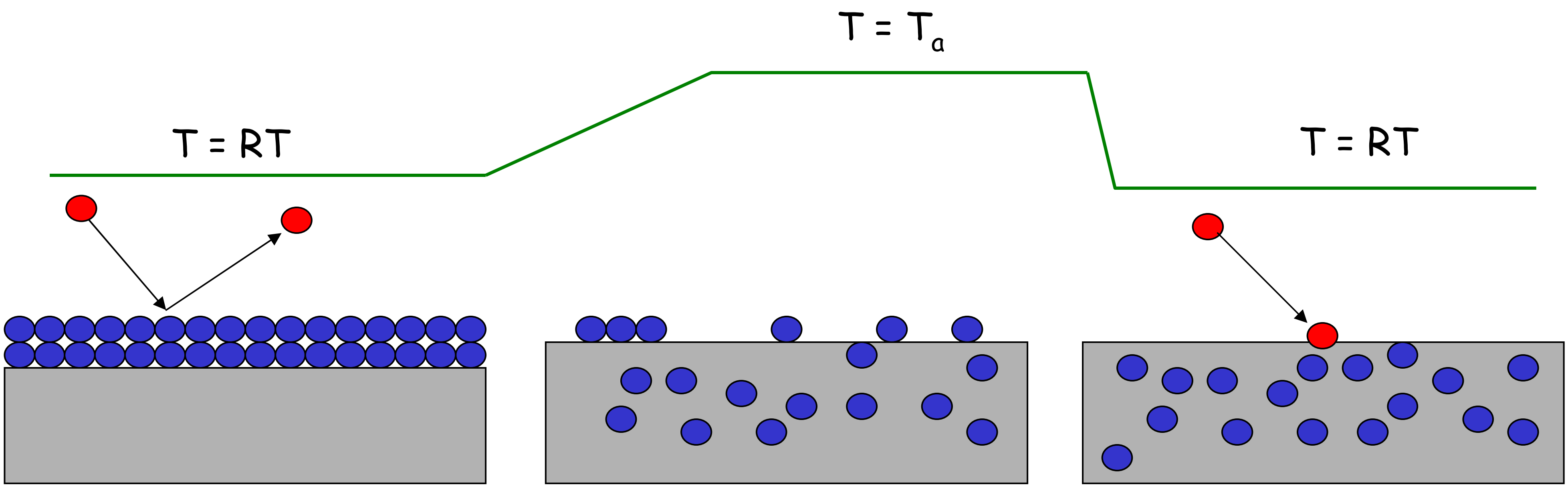
- The LHC Long Straight Sections (LSS), operating at room temperature, are interposed between the cryogenic modules of the LHC.

- The NEG materials, developed at CERN, will assure the main pumping of the LSS vacuum system.

- NEG films were chosen for their benefical characteristics: high distributed pumping speed, low static and dynamic degassing and low secondary electron yield.

Definition of NEG material

Getters are materials capable of chemically adsorbing gas molecules. To do so their surface must be clean. For Non-Evaporable Getters a clean surface is obtained by heating to a temperature high enough to dissolve the native oxide layer into the bulk.



Native oxide layer
-> no pumping

Heating in vacuum
Oxide dissolution -> activation

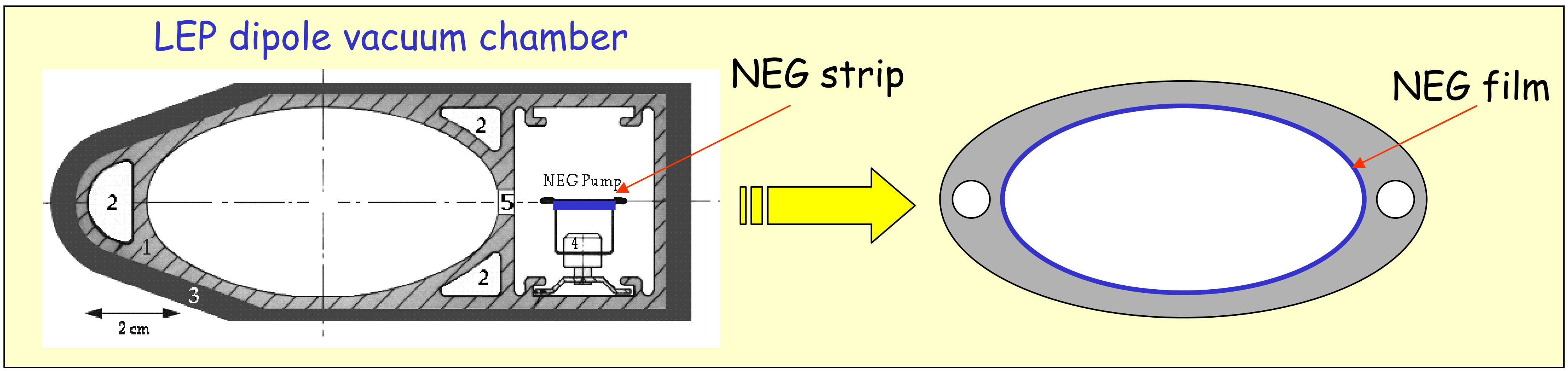
Pumping

NEGs pump most of the gas except rare gases and methane at room temperature

NEG materials in accelerators

NEG strips (st101 and st707) were already used to assure linear pumping speed in LEP. It requires electrical insulators and feedthroughs, limiting the pumping speed that can be installed in the chamber.

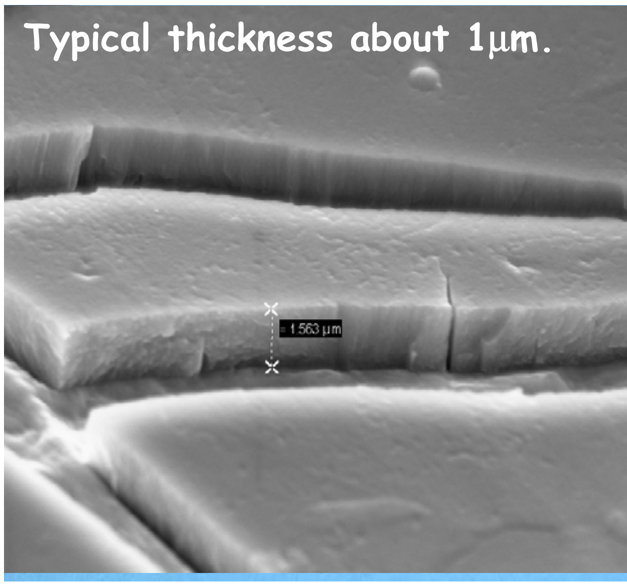
Coating the inner surface of the vacuum chamber with a NEG film transforms it from a source of gas into a pump.



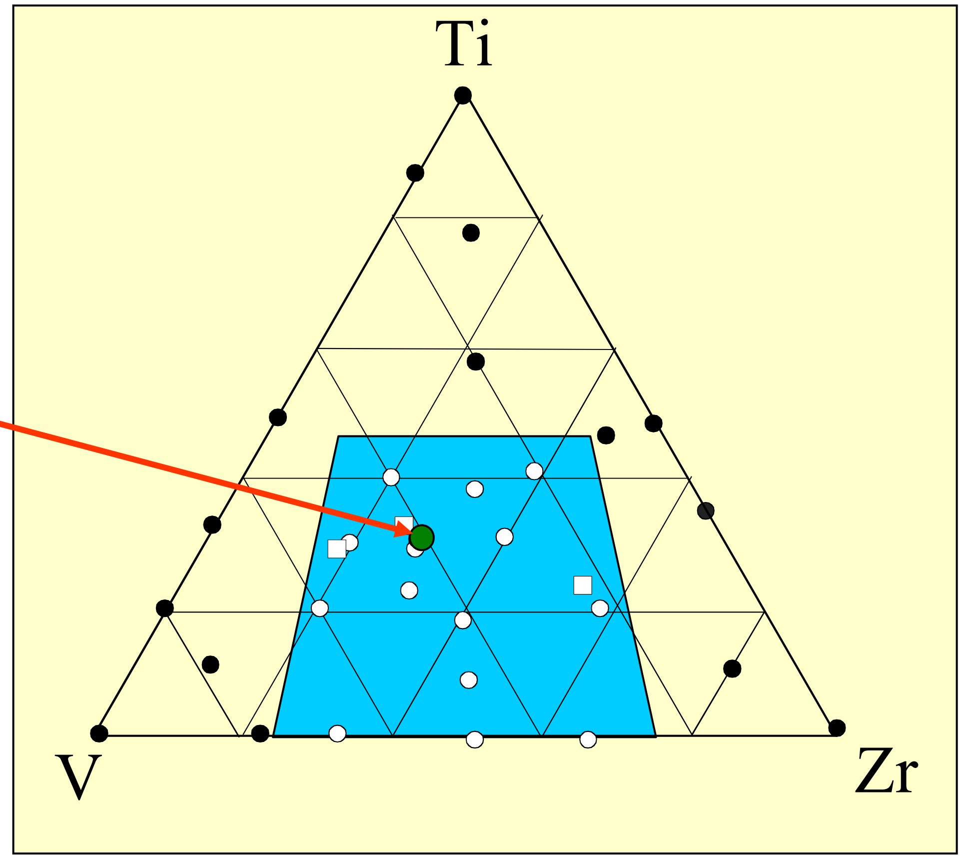
The best NEG for the LHC: TiZrV

To be compatible with the structural materials of the vacuum chambers, NEG film should allow a complete dissolution of the oxide layer at a reasonable low temperature.

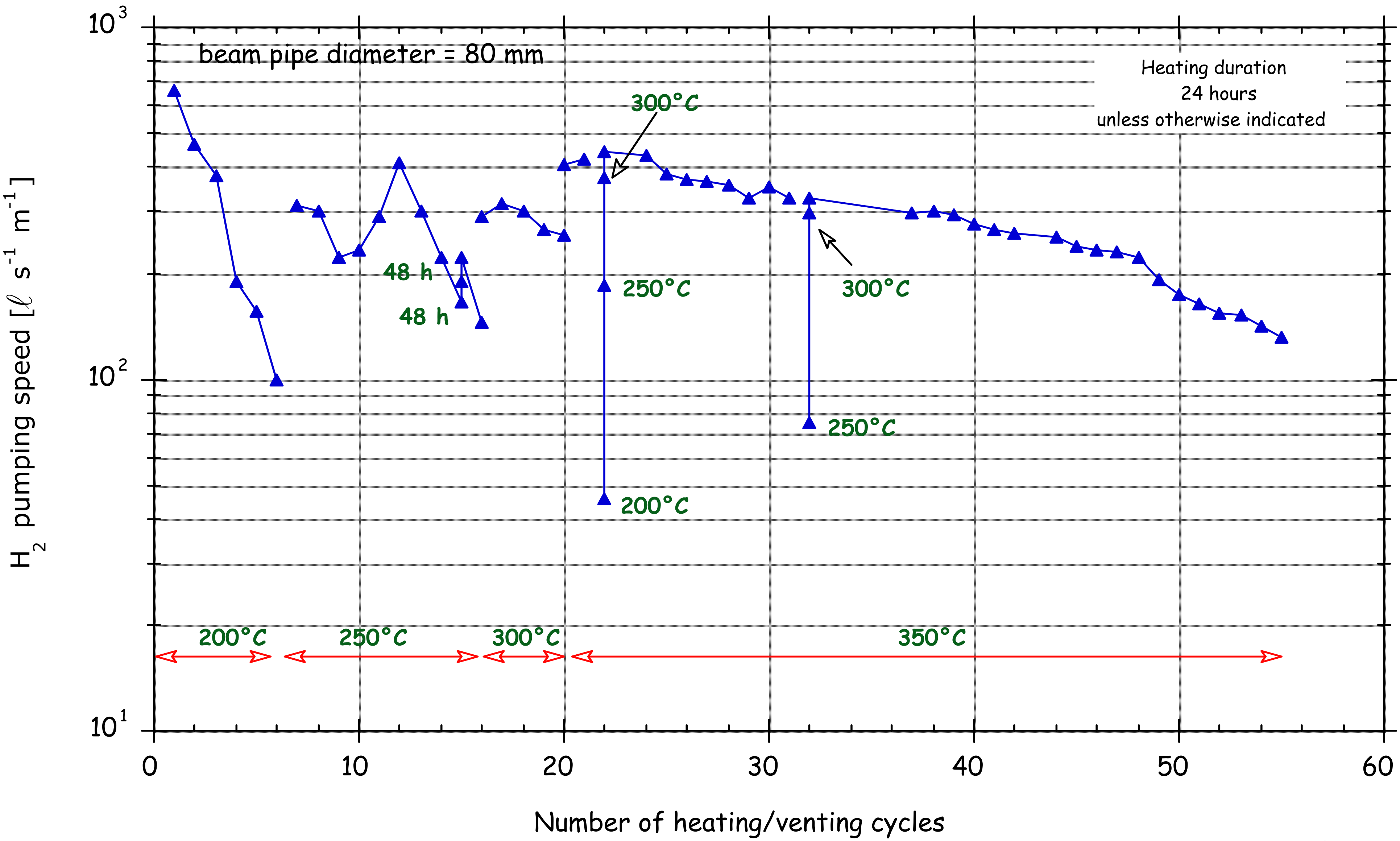
The lowest activation temperature was found in a wide range of composition in the Ti-Zr-V system: 180 °C (24 h heating).



Intertwisted Ti, Zr, and V elemental wires give rise to Ti30 -Zr30 -V40 film composition



TiZrV coating performances: ageing

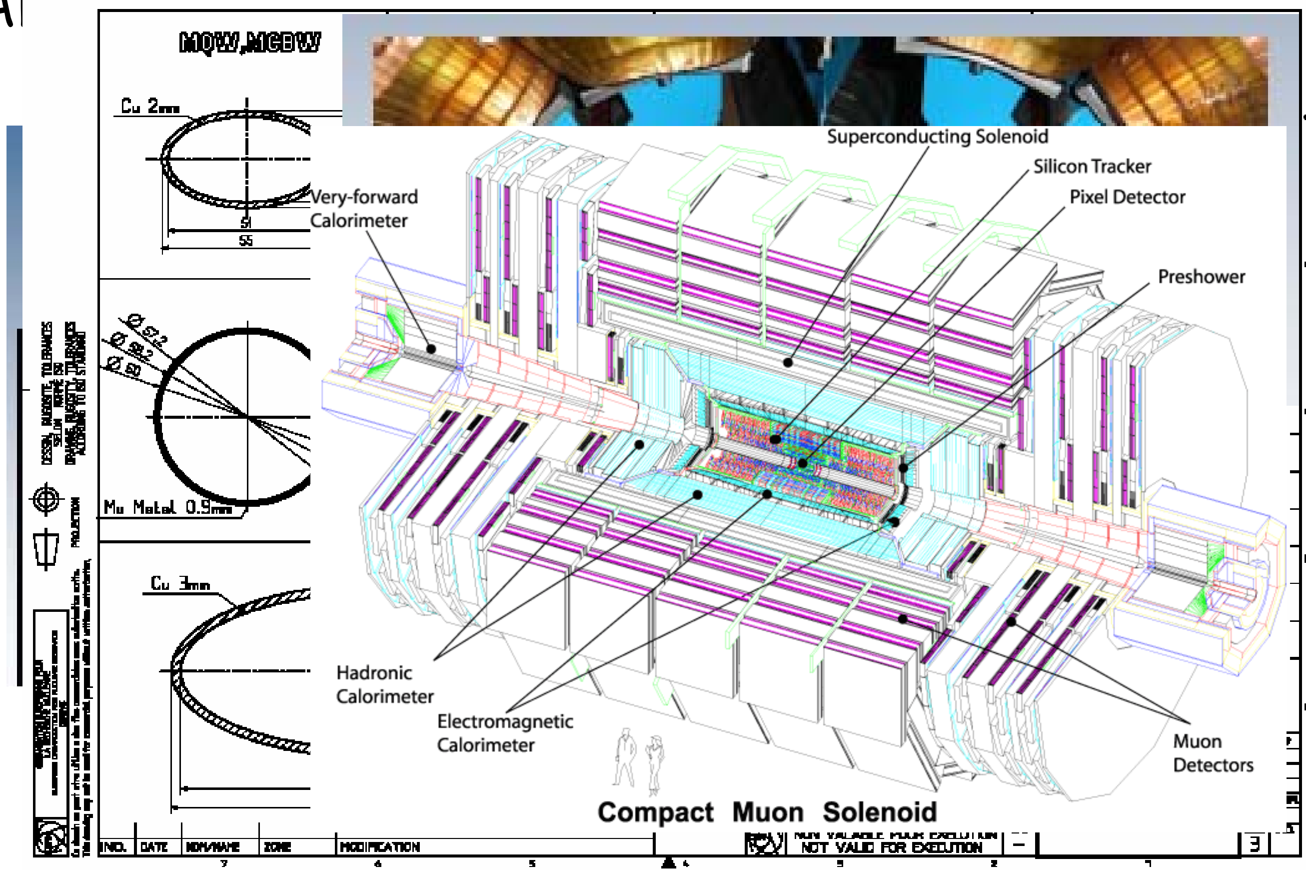


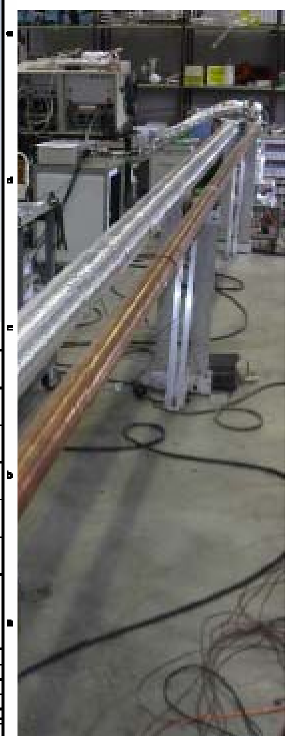
NEG film coatings in the LHC

- 675 LSS drift space chambers: Ø 80 mm, L=0.3m ~ 7m (work-package attributed to the EST division)

- About 285 non-standard LSS chambers for the warm magnets

- Al





- Overview of the fabrication of the LSS drift space chambers:

The two stainless steel flanges are each vacuum brazed to a OFE Cu stub

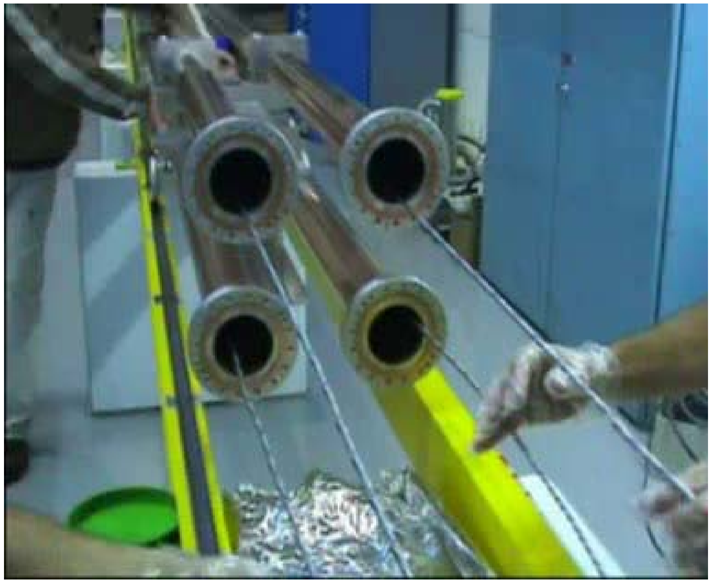
Welding of the flange/Cu stub assemblies to the OFS Cu tube

Leak test

Surface treatment: degreasing, etching 70μm and passivation of the surface

NEG coating by DC magnetron sputtering

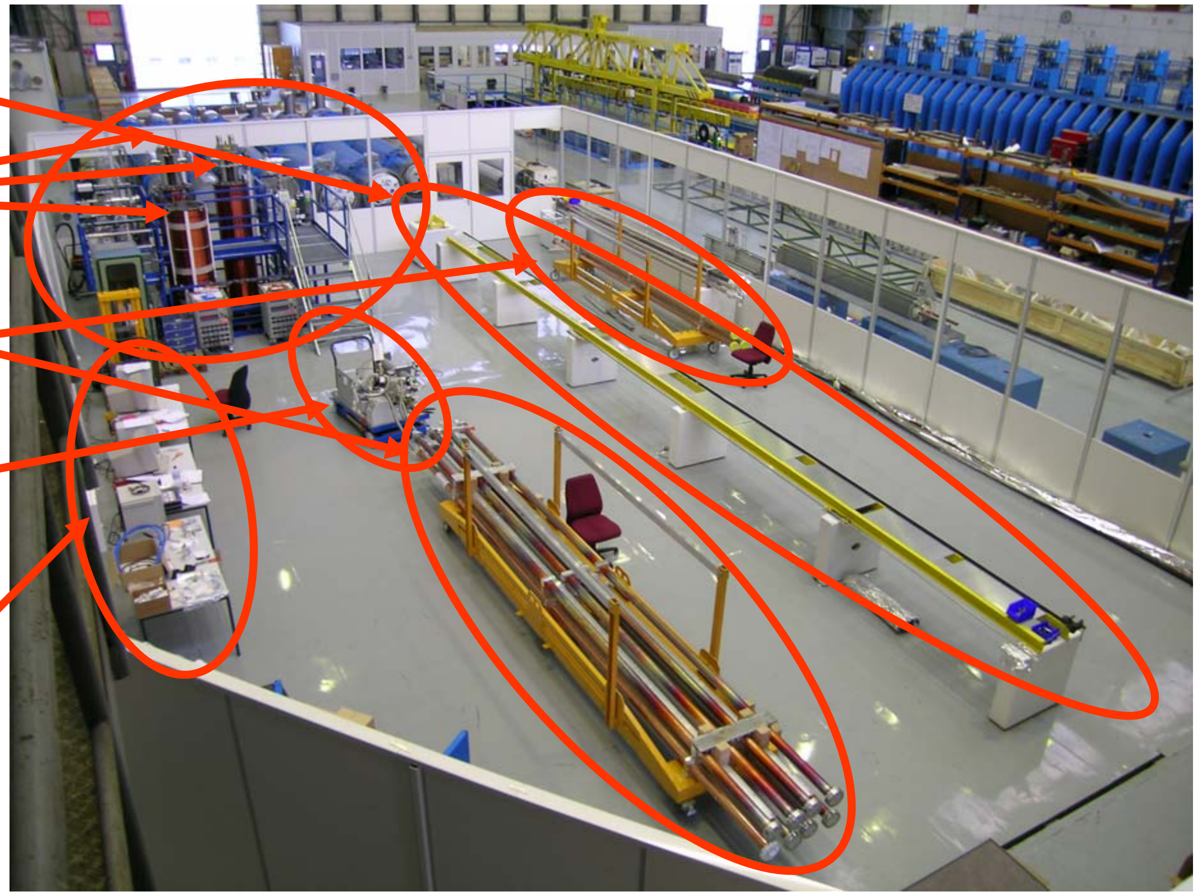
MME-SC (bldg 181)



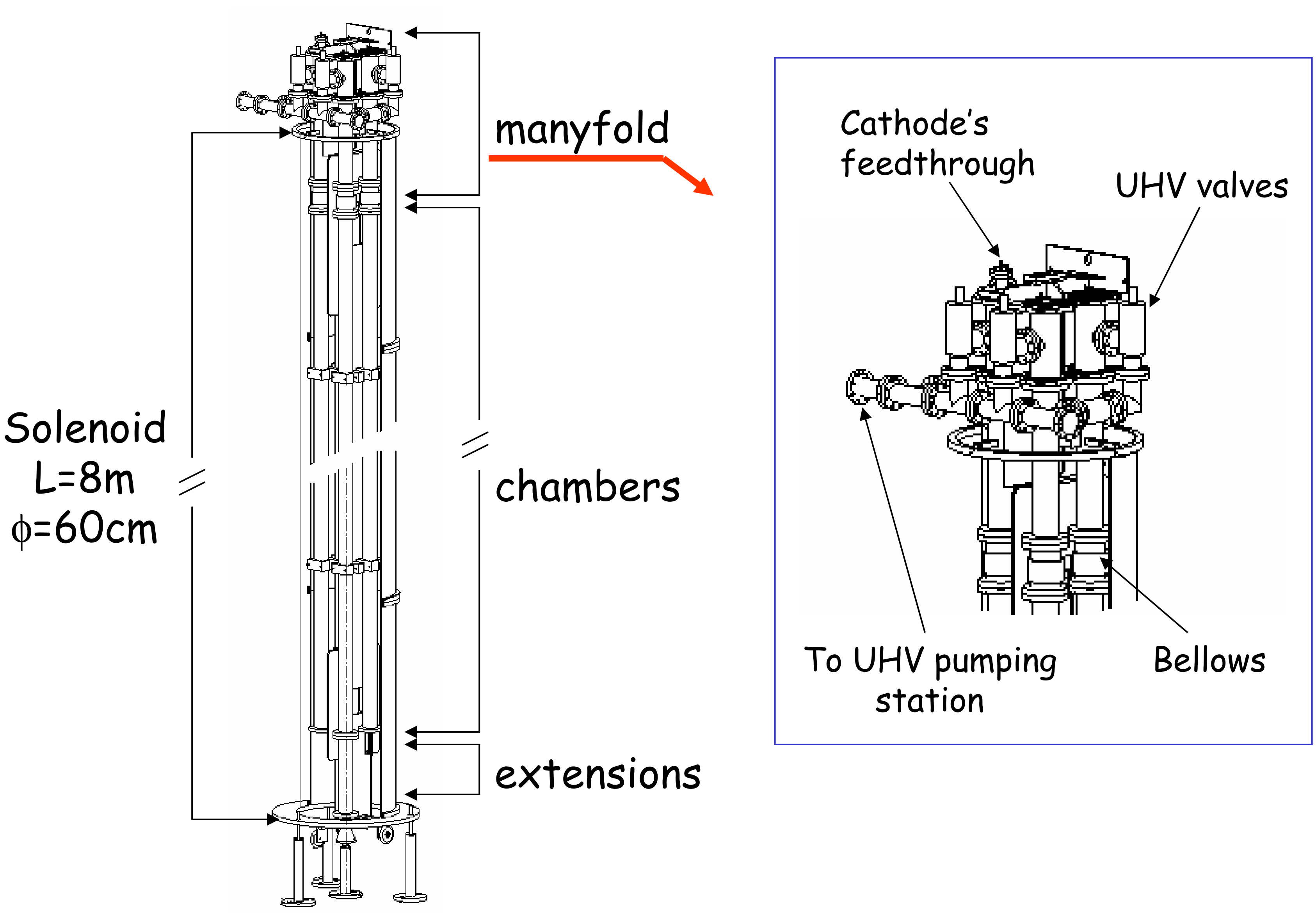
The NEG coating facilities

- assembling bench
- 3 coating units
- karts with chambers
- Storage system (to pump coated chambers and fill with N_2)
- monitoring area

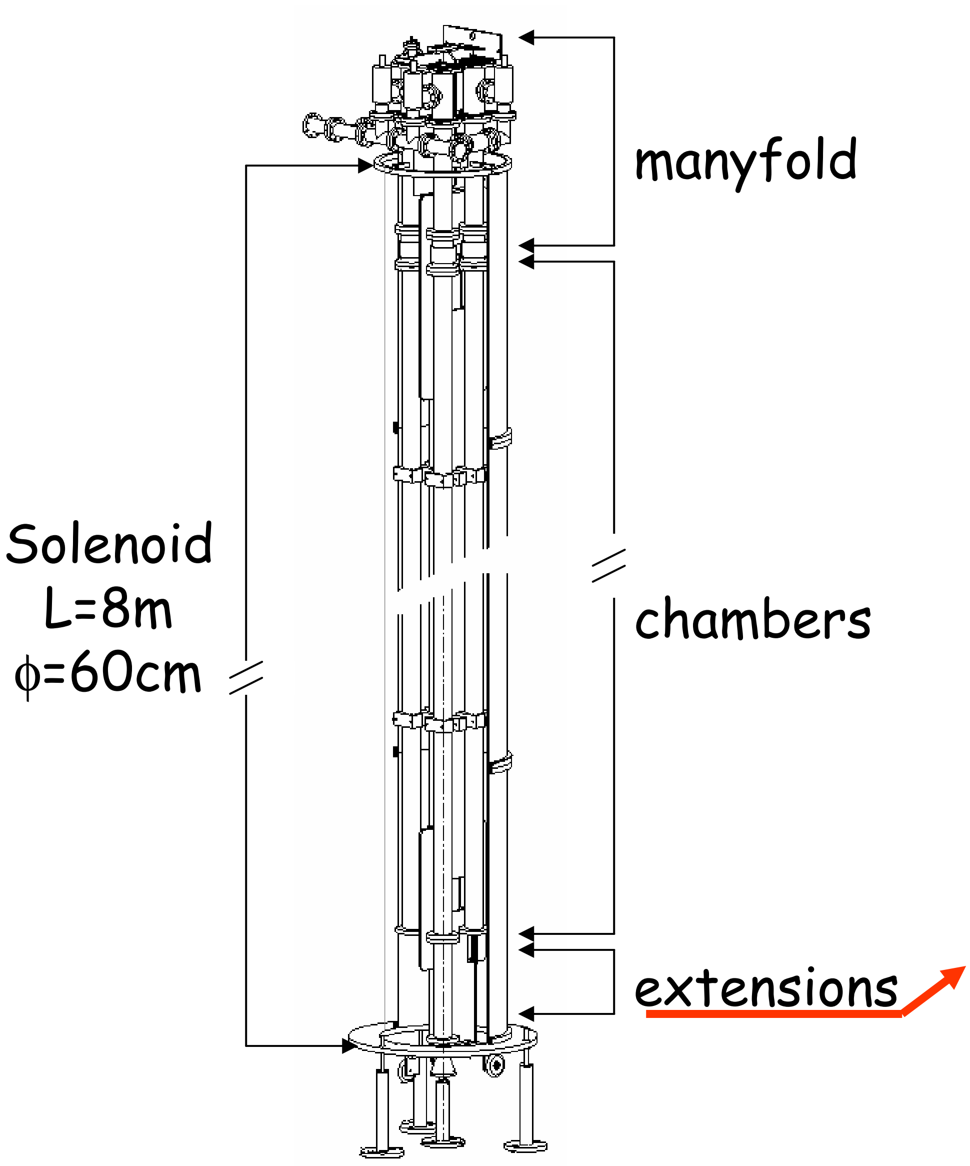
Building 181

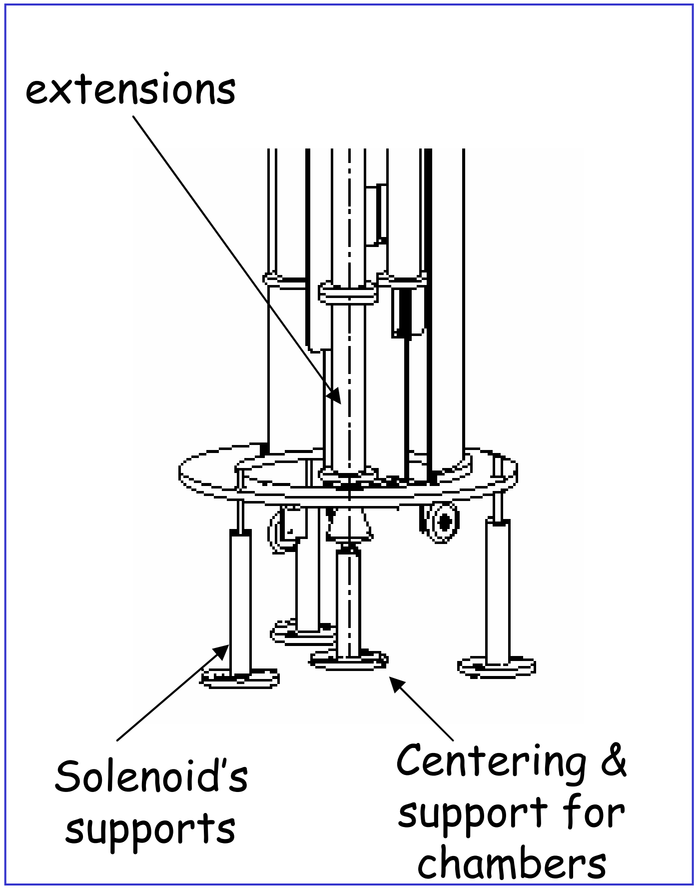


LSS NEG coating unit



LSS NEG coating unit





LSS NEG coating production: the coating parameters

- Discharge gas Pressure -> 4x10-3 Torr — Supply atoms for the ionization process.
- Potential U -> -500 V — Defines the energy of the ions.
- Current I -> 1.5 A — Defines the rate of the ions hitting the cathode.
- Magnetic field -> 150 G — Increase the ionization efficiency improving stability and allowing lower discharge pressure
- Discharge gas -> Kr — Noble gas. Kr chosen in order to minimize the discharge gas trapping in the coating.
- Deposition rate -> 0.2 μm/h => **10h for a 2μm coating**

LSS NEG coating production timing

System 1	time	System 2
Leak test Start coating	8:30	Leak test Demount the 4 chambers coated the day before
Stop coating	18:30	Mount cradle with four uncoated chambers Start pumping

PRODUCTION RATE: 20 CHAMBERS/WEEK

The quality assessment

- **Before coating:** Visual inspection of the internal surface of each chamber;

- **During coating:** Leak detection: mass spectra before and after coating and monitoring mass 20 (Ar^{++}) to detect an eventual leak during the coating process.

  Monitoring of the discharge parameters (I,V,P);

- **After coating:** Visual inspection of the coating

  Whitness samples:

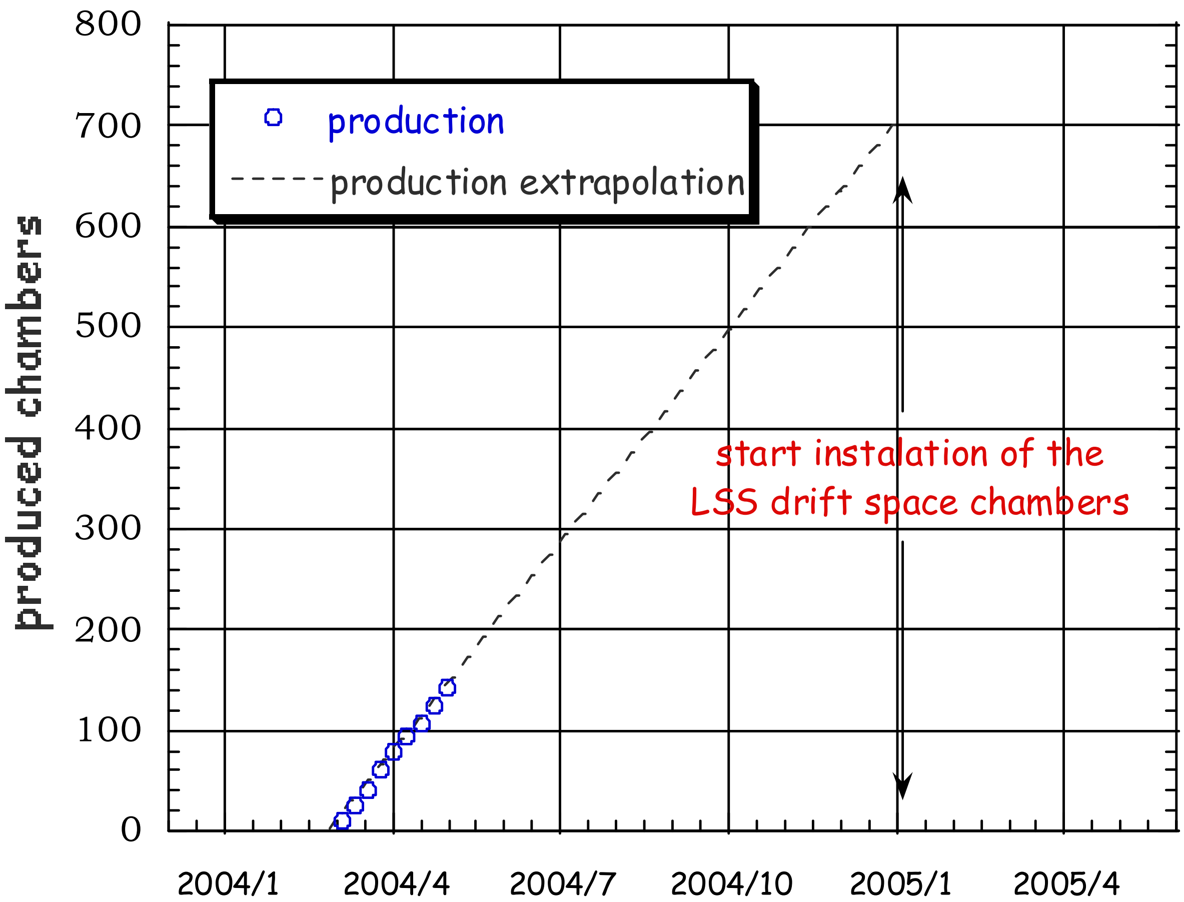
  ✓ 10x15mm^2 to measure coating thickness by SEM, composition by EDX and activation by XPS.

  ✓ 25 cm long chambers for pumping speed measurements (2 per week)

  ✓ Every month one chamber is fully characterized (pumping speed, surface capacity, CH_4 and Kr outgassing)

The state of the production

In 9 weeks, 142 chambers were coated, representing 21.5% of the total production.



At the actual rate, the production will be completed by beginning 2005.

One day at building 181…