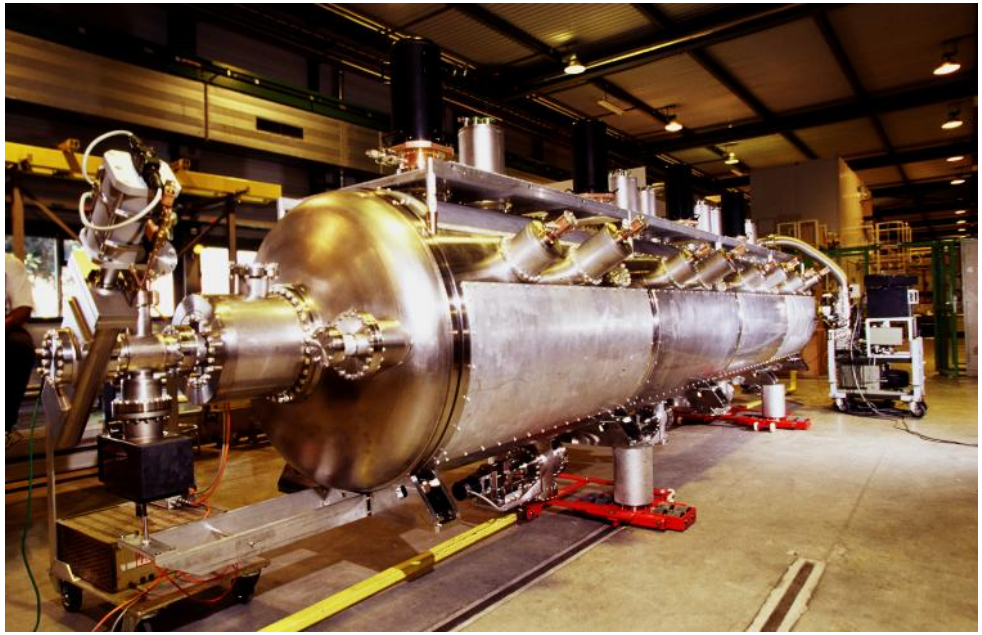
# Special Coatings for the LHC

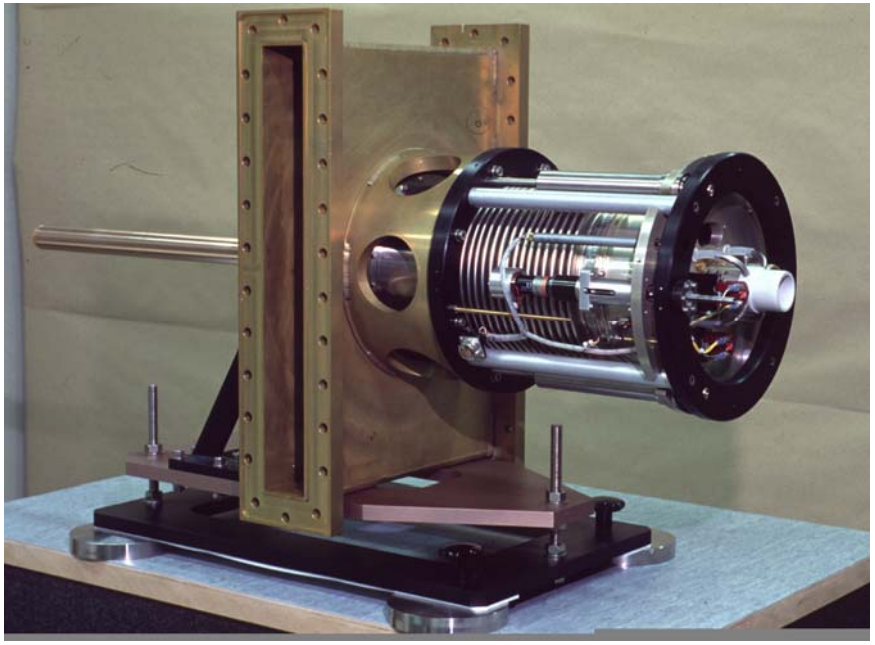
Sergio Calatroni, TS-MME-SC

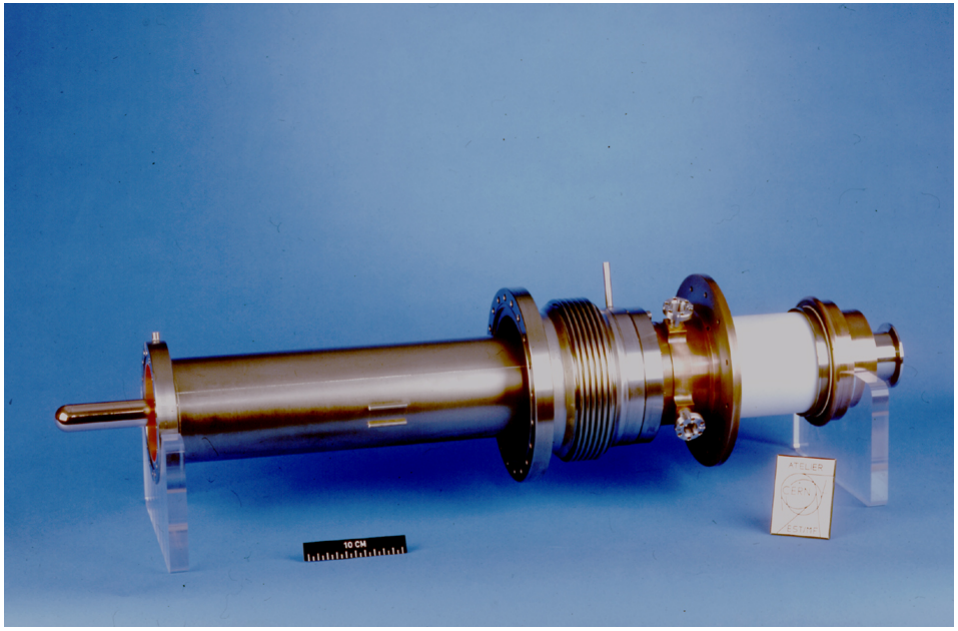
- Coatings for RF cavities & couplers
- NEG coatings for experimental vacuum chambers
- Coatings for reducing the beam impedance
- Conclusion



**400 MHz RF cavities**
**1.5 µm thick Nb film on Cu**

- Specs: $Q_0=2x10^9$ @ 6 MVm @ 4.5 K
- Prototypes at CERN + production of 20 units by industry + repairs at CERN
- Project completed but facilities kept operational



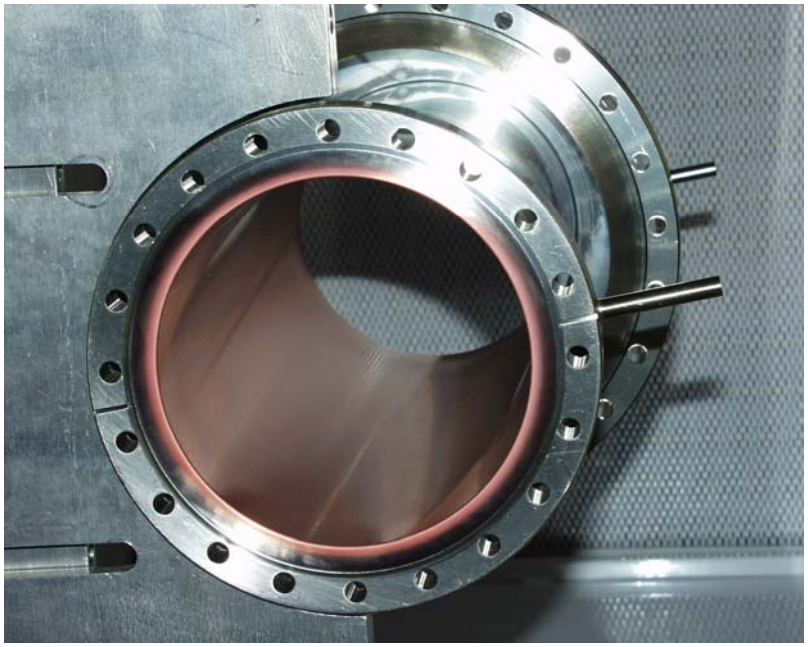


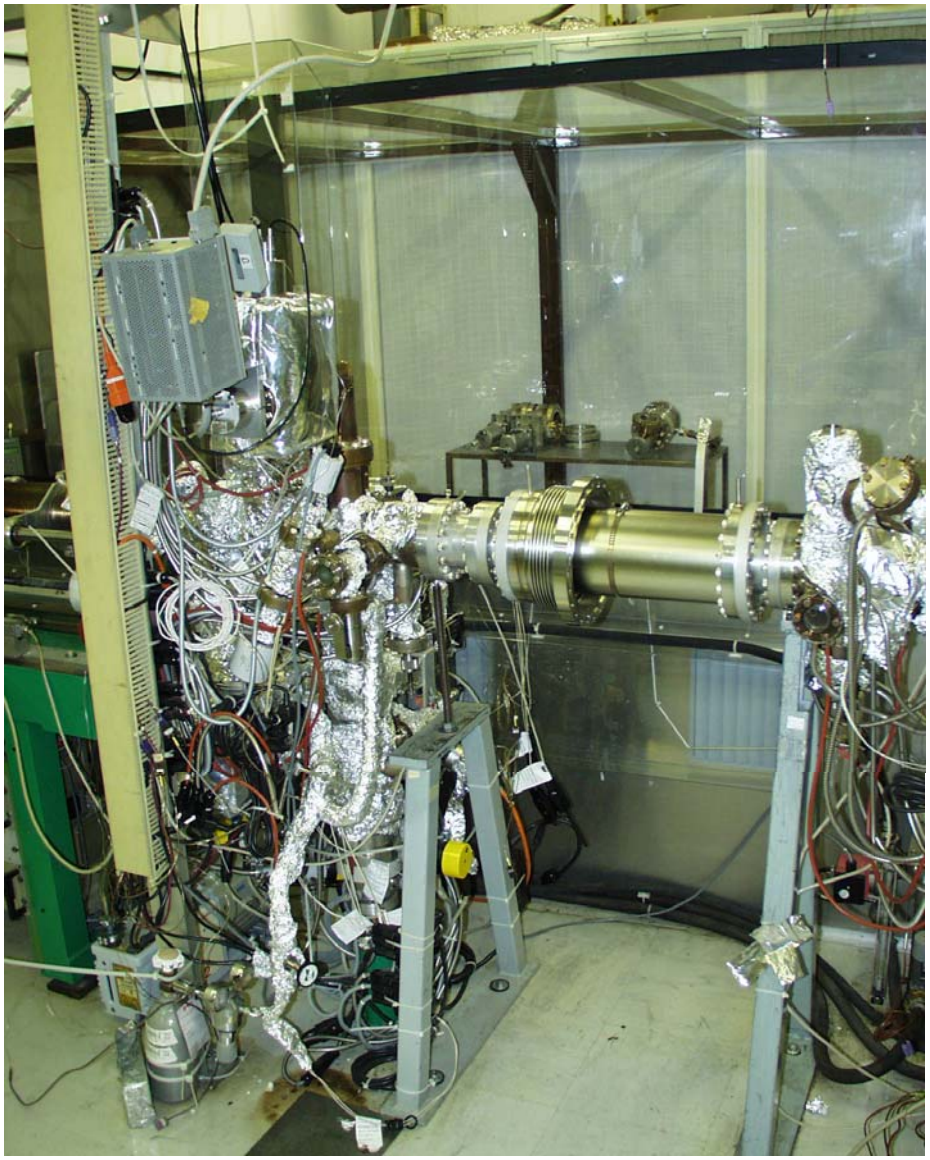
## RF power couplers, >150 kW CW

- 10 MΩ Ti layer on ceramic window (for reduction of SEY, evacuation of electrical charges)
- 10 µm thick, RRR>50 Cu layer on s.steel extension, with 0.5 µm thick Ti layer for adhesion (for 10x reduction of impedance)

**Coating system for highly resistive Ti films on ceramics**

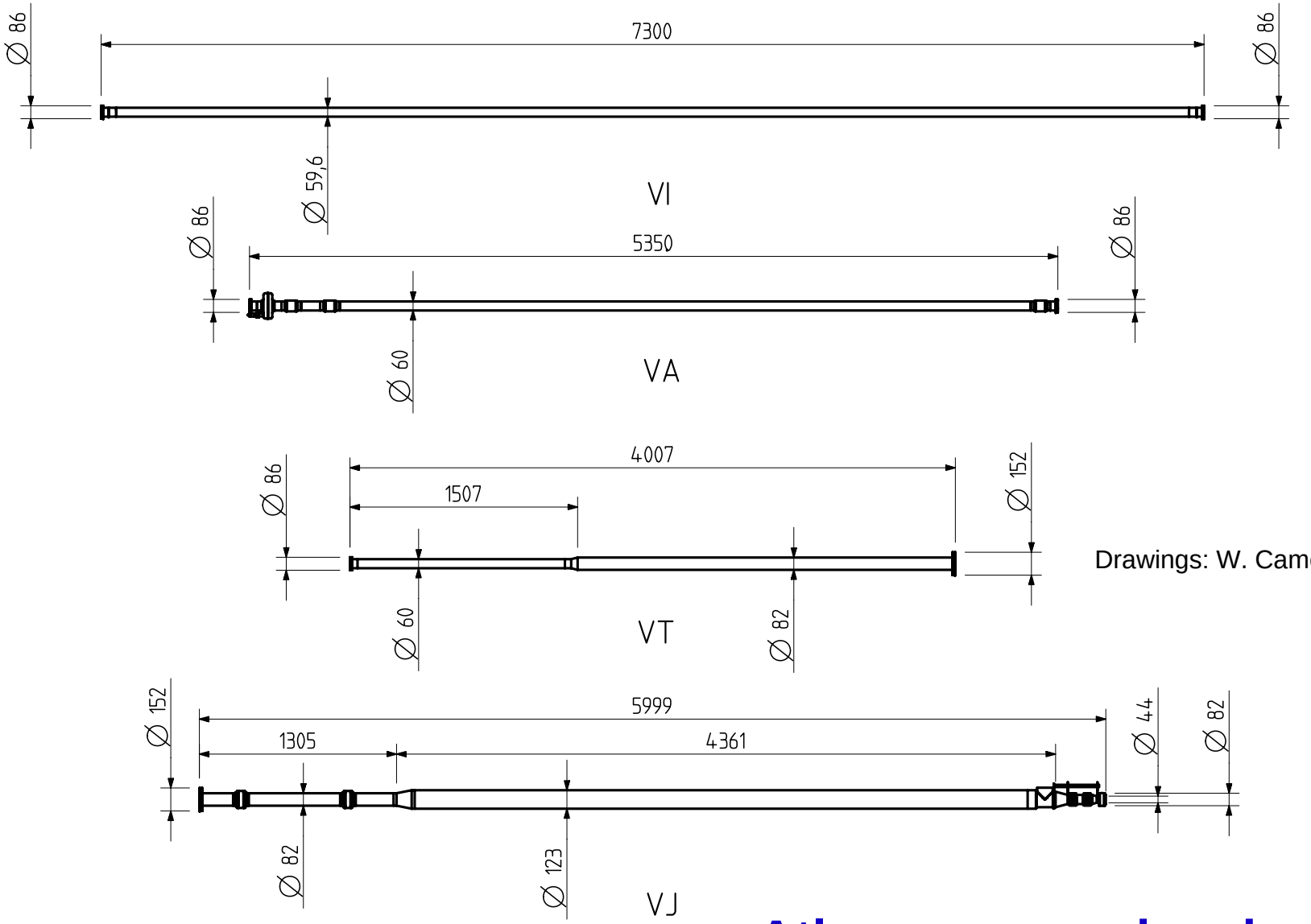
- HV coating system
- The resistance is monitored during coating
- Typical coating time is 5 min, resulting resistance 10 ± 1 MΩ
- Project still ongoing





**Double cathode coating system for Cu films**

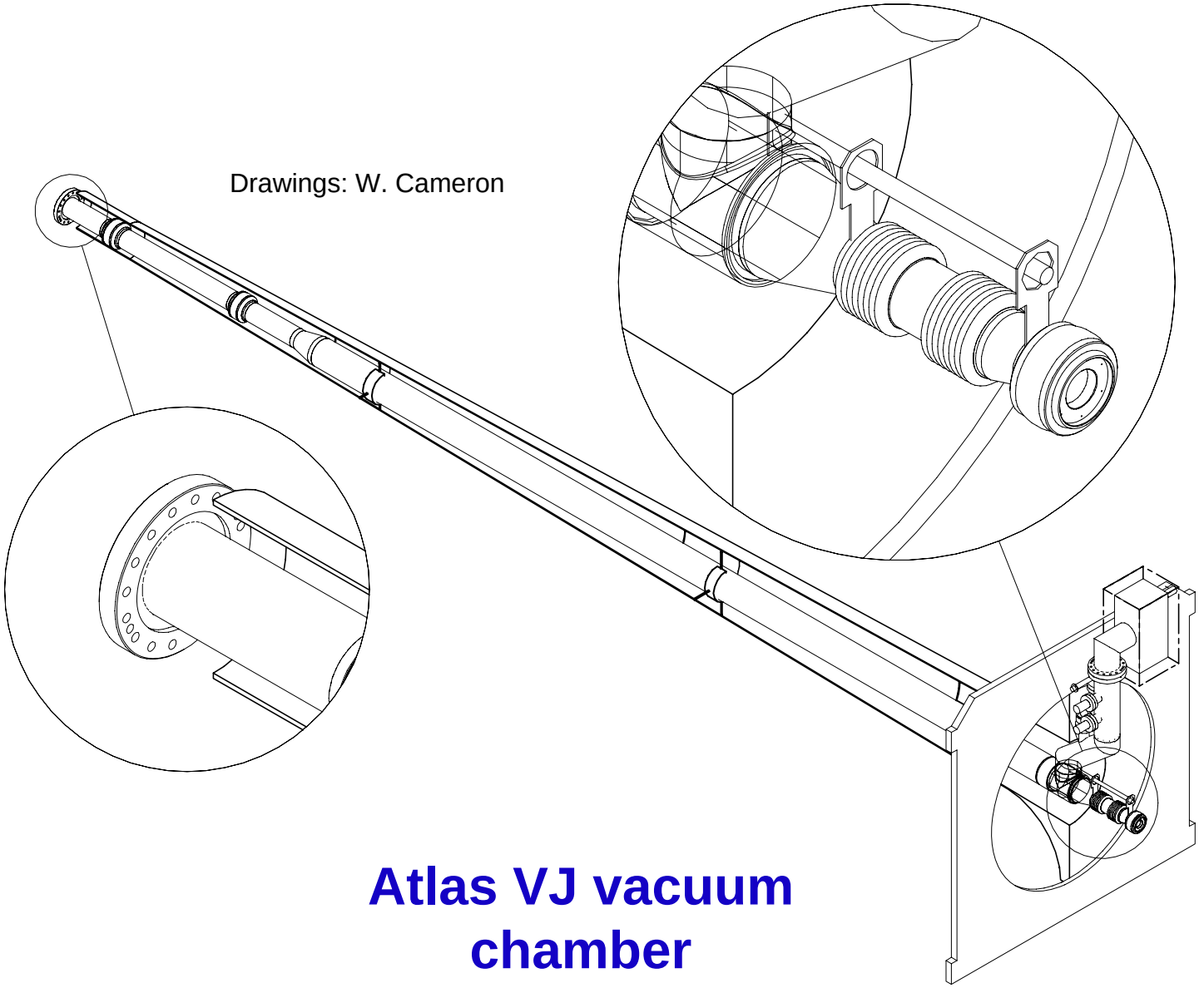
- UHV coating system
- Project completed
- Any combination of two films among Al, Cu, Nb, Ti can be performed at present



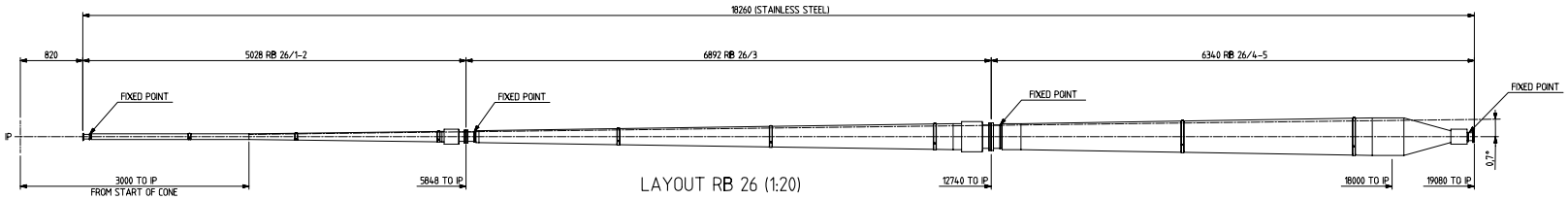

Drawings: W. Cameron

# Atlas vacuum chambers

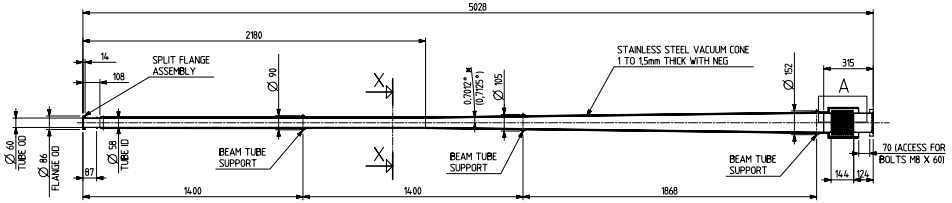
Drawings: W. Cameron



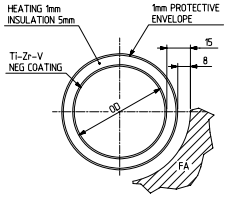
# Atlas VJ vacuum chamber




LAYOUT RB 26 (1:20)

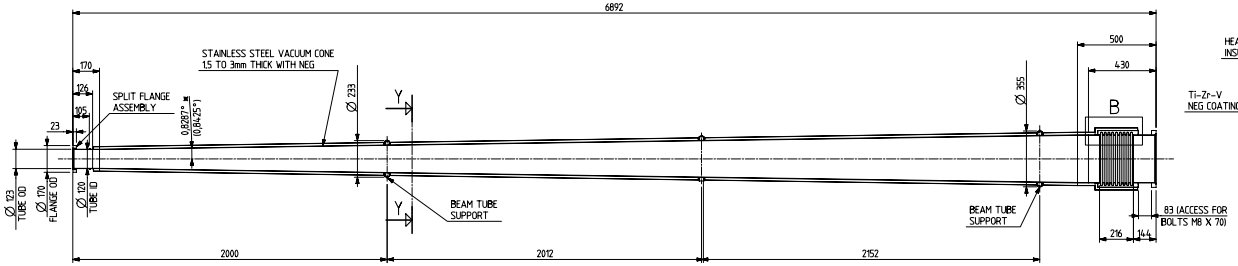



RB 26/1 RB 26/2

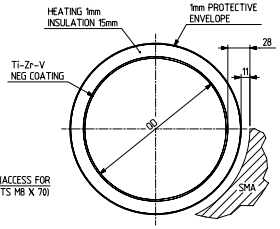



SECTION X-X (1:1)
VALID FOR RB 26/1-2

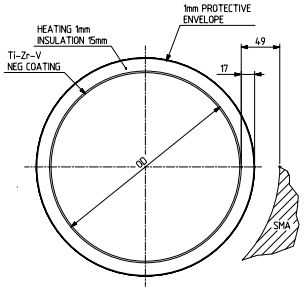
Drawings: W. Cameron



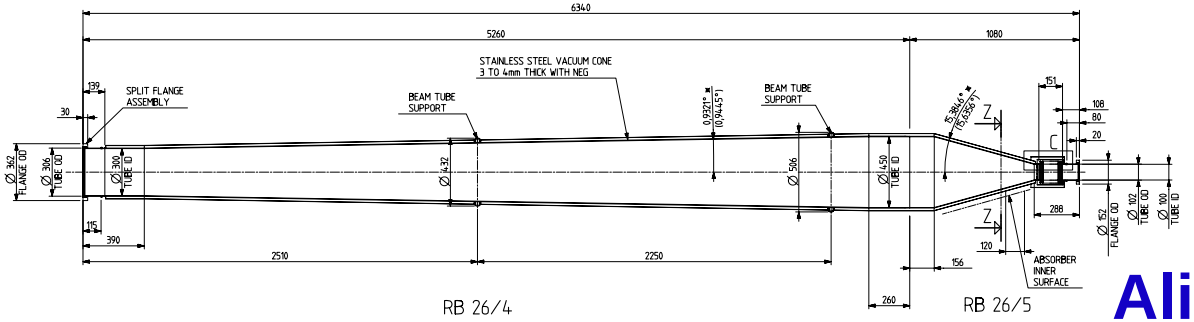

RB 26/3



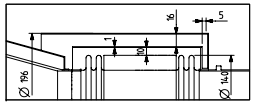

SECTION Y-Y (1:2)
VALID FOR RB 26/3-4



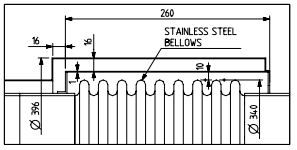

SECTION Z-Z (1:2)
VALID FOR RB 26/5
DIMENSIONS PERPENDICULAR TO CONICAL SURFACE




RB 26/4 RB 26/5

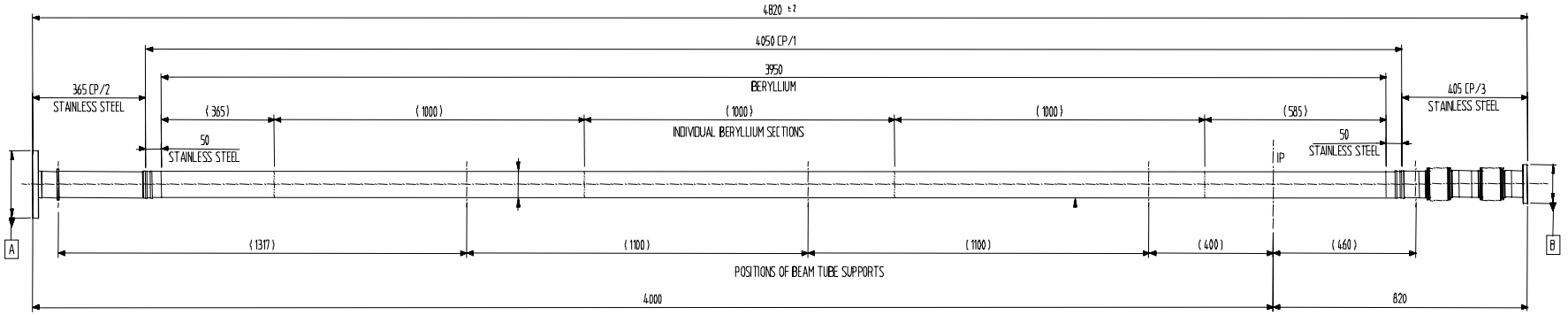


DETAIL C (1:2)

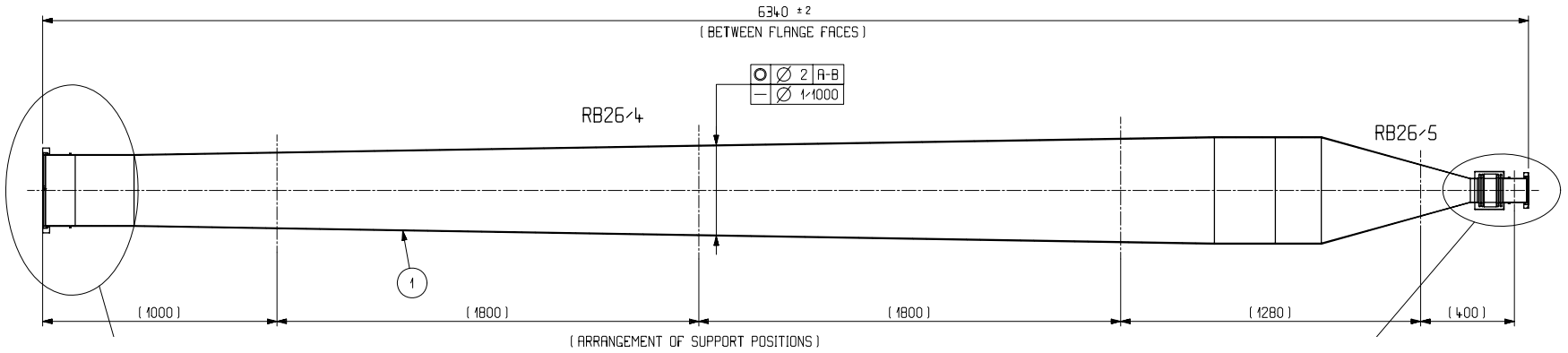



DETAIL B (1:2)

# Alice vacuum chambers

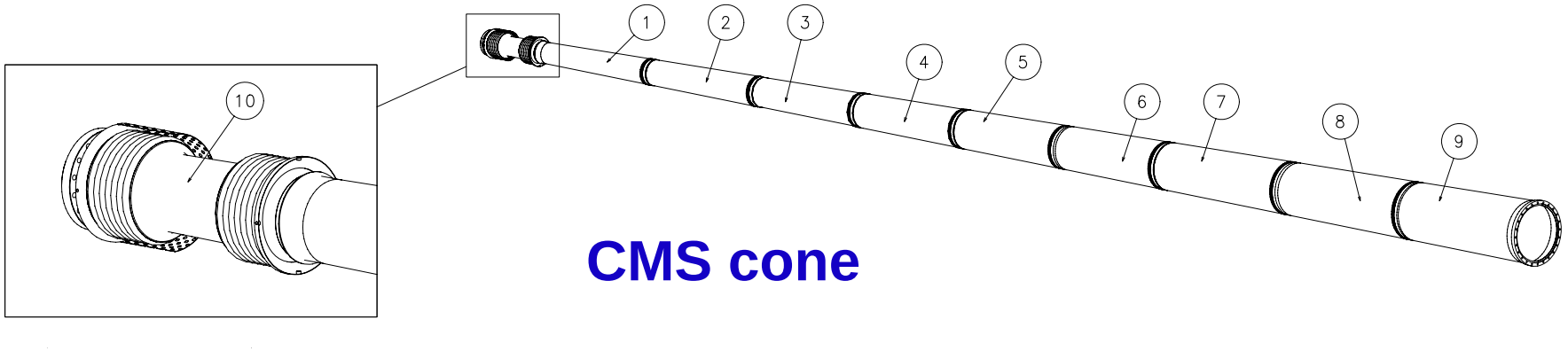



Drawings: W. Cameron




# Alice Be chamber and double cone

Drawings: G. Foffano

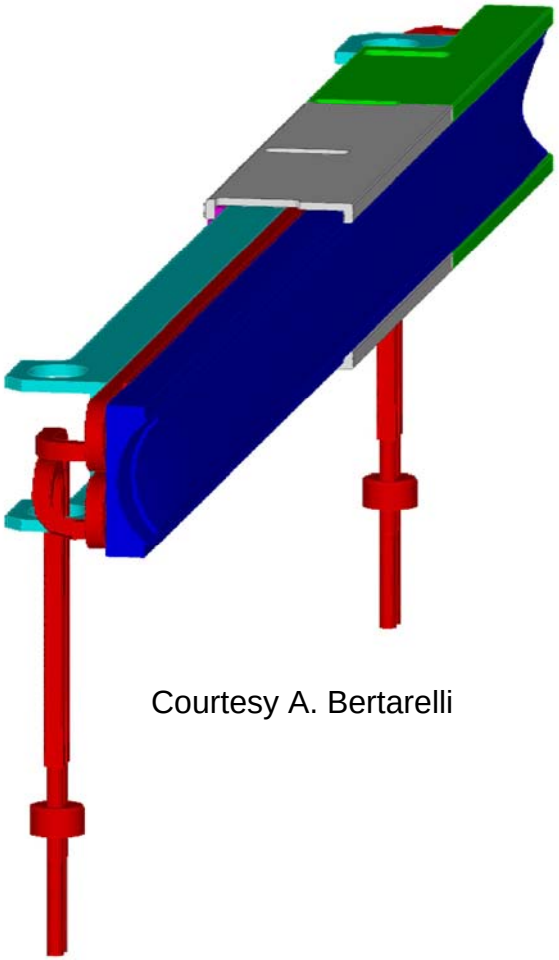



## CMS cone

All these chambers will be coated in the LSS facility (« third system ») with a NEG film for increasing pumping speed and reducing SEY

However the coating parameters must be adapted for each single chamber, in order to obtain a uniform coating thickness and quality

Special tooling is required for handling
First coatings will start in summer 2004

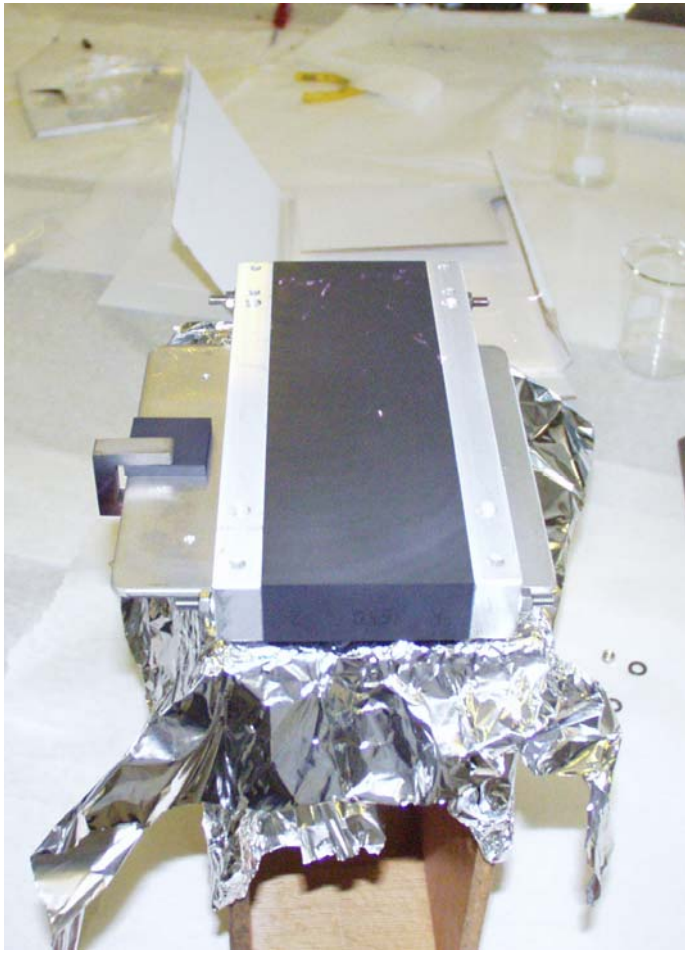


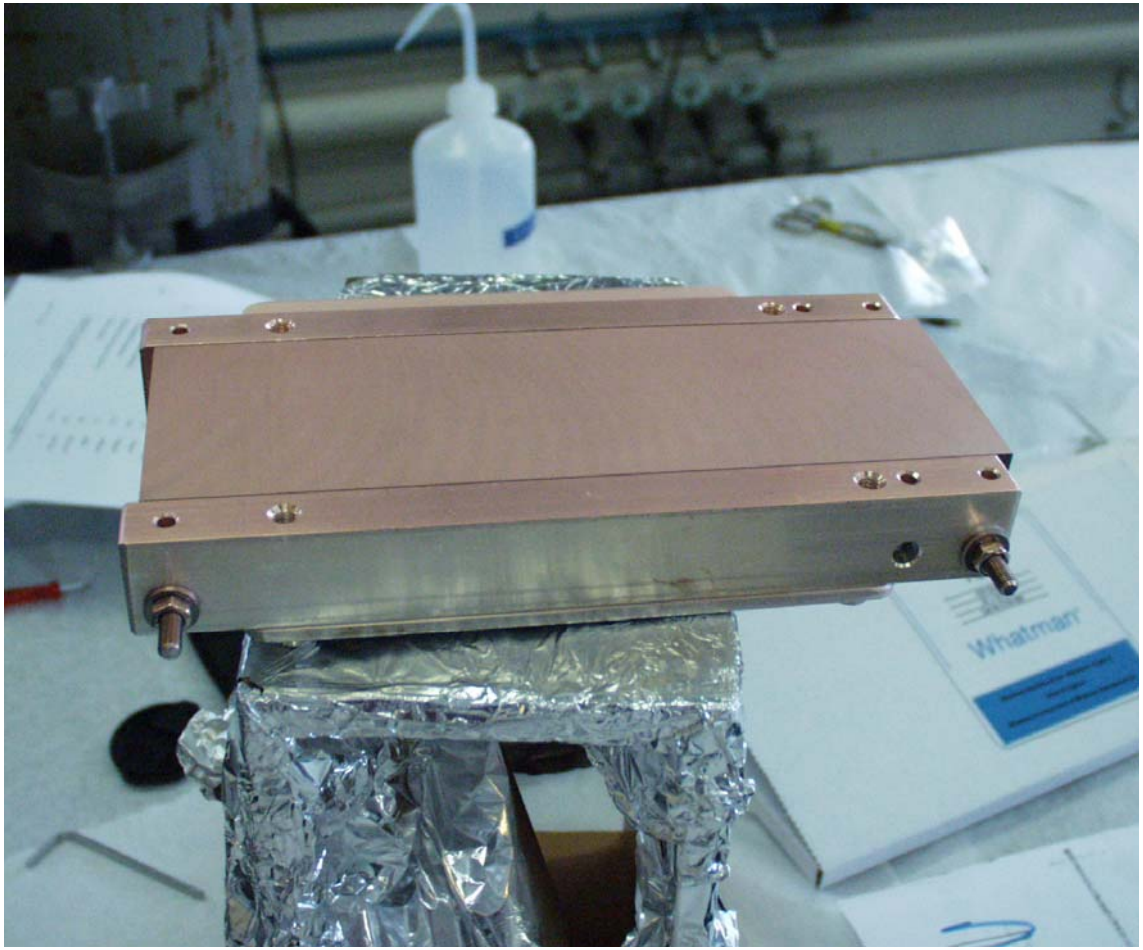
Courtesy A. Bertarelli

**Collimator carbon-carbon** (or graphite) **blocks** must be coated for impedance reduction (ρ of graphite is ~1000 times higher than for copper).

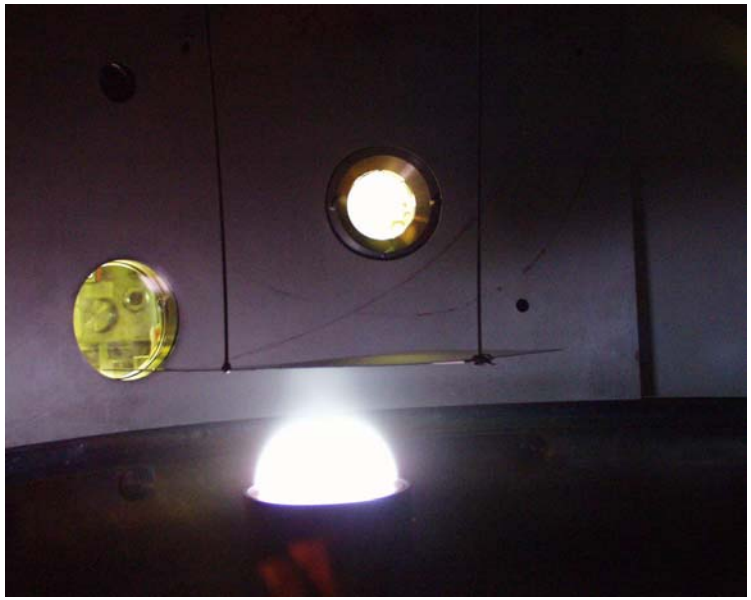
Material choice is a compromise between impedance and heating by particle bombardment

⇒ 5 μm of Cu will be deposited by sputtering, with a fraction of μm of Ti for adhesion purpose



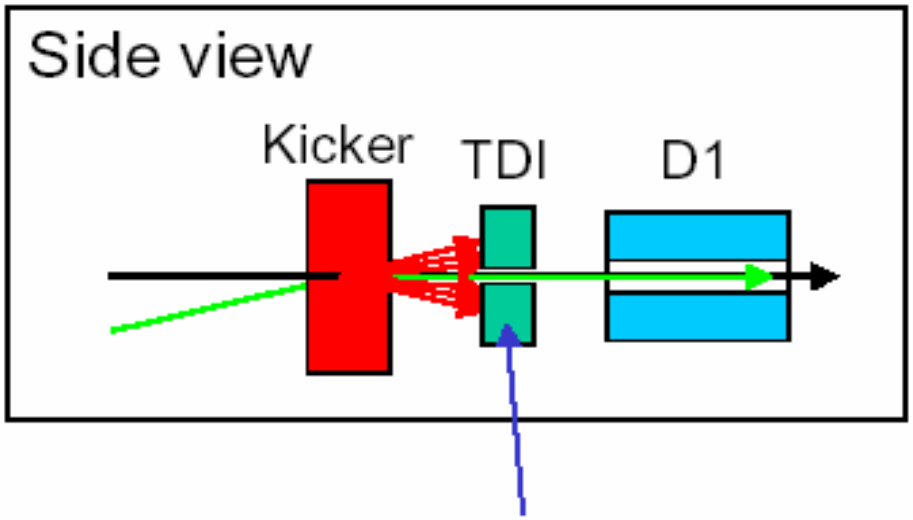


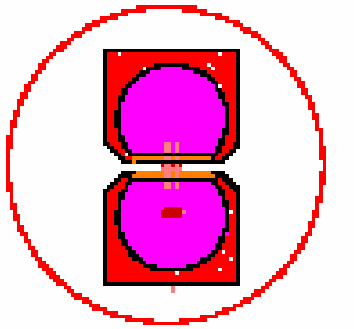

Prototype sample of **graphite, coated with copper**



**Large coating facility**, recently refurbished with TMP pumps and magnetron sputter sources.

Ideally suited for the large graphite blocks of collimators



Courtesy M. Lamont

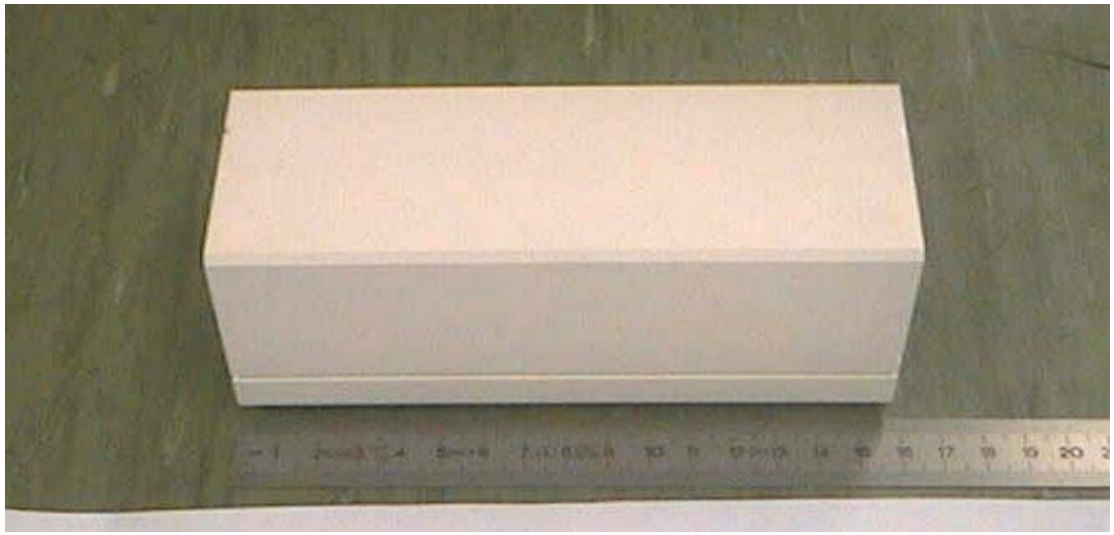
(200 kg each, precision: 0.1 mm ≈ 0.2 σ).

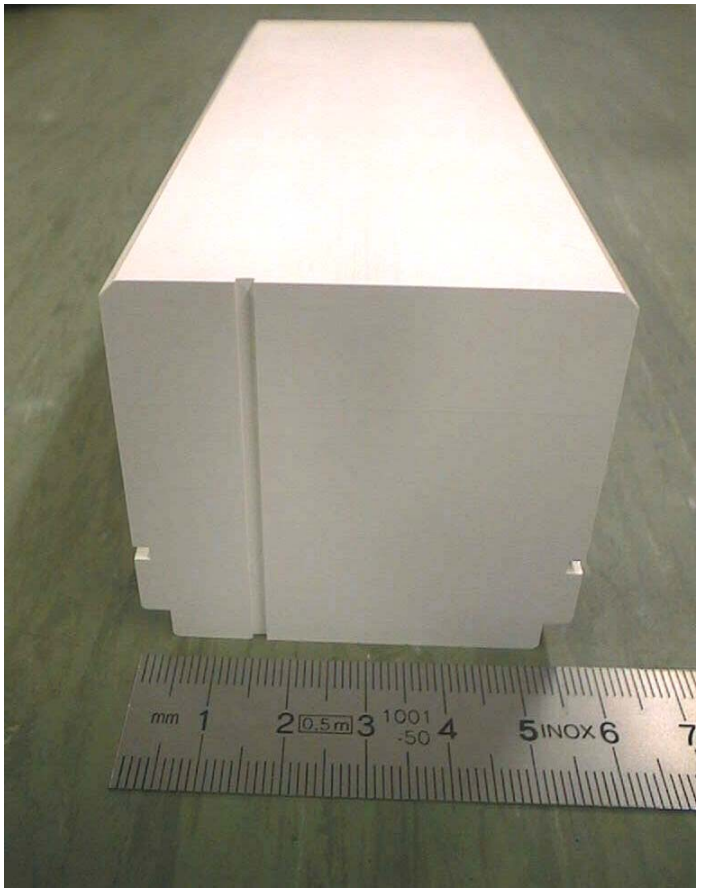
**TDI** injector beam scraper: 108 blocks of **h-BN** to be coated in order to reduce the high-frequency component of the beam impedance.

The objective is obtained with 4 μm of Ti resulting in $R_{\square} < 0.3\ \Omega$

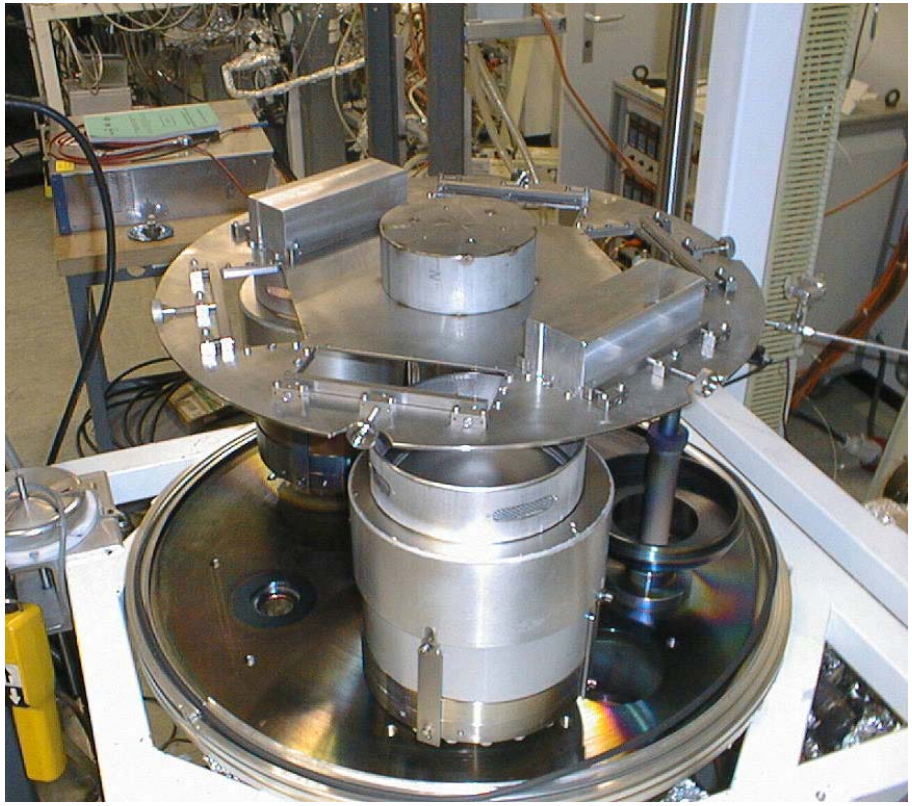


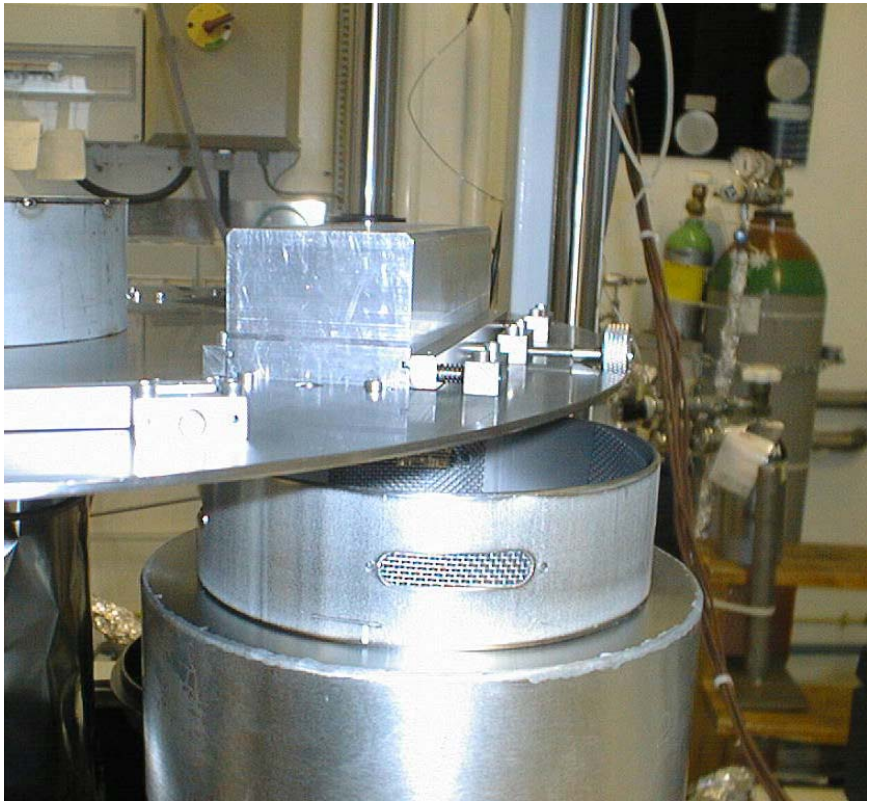
Adhesion of films on h-BN and graphite is limited by the cohesion of the material itself. **$CO_2$ snow blasting** proved effective in improving it by removing the topmost surface layer. SEM analyses and roughness measurements show no degradation of the surface, only some smoothening






**h-BN blocks**. The coating must be performed on the bottom face, but it should not be present on the other faces





**Dual magnetron** system adapted for production coatings.
Estimated production time is 4 months, starting probably in autumn 2004

Several coating facilities are available for prototyping
New facilities are designed for series production, or existing ones are adapted

Choice of material and technology is the role of thin film specialists

Production for LHC has been and will be the major activity for a few years to come

CLIC is on the horizon, and films could be a part of the game

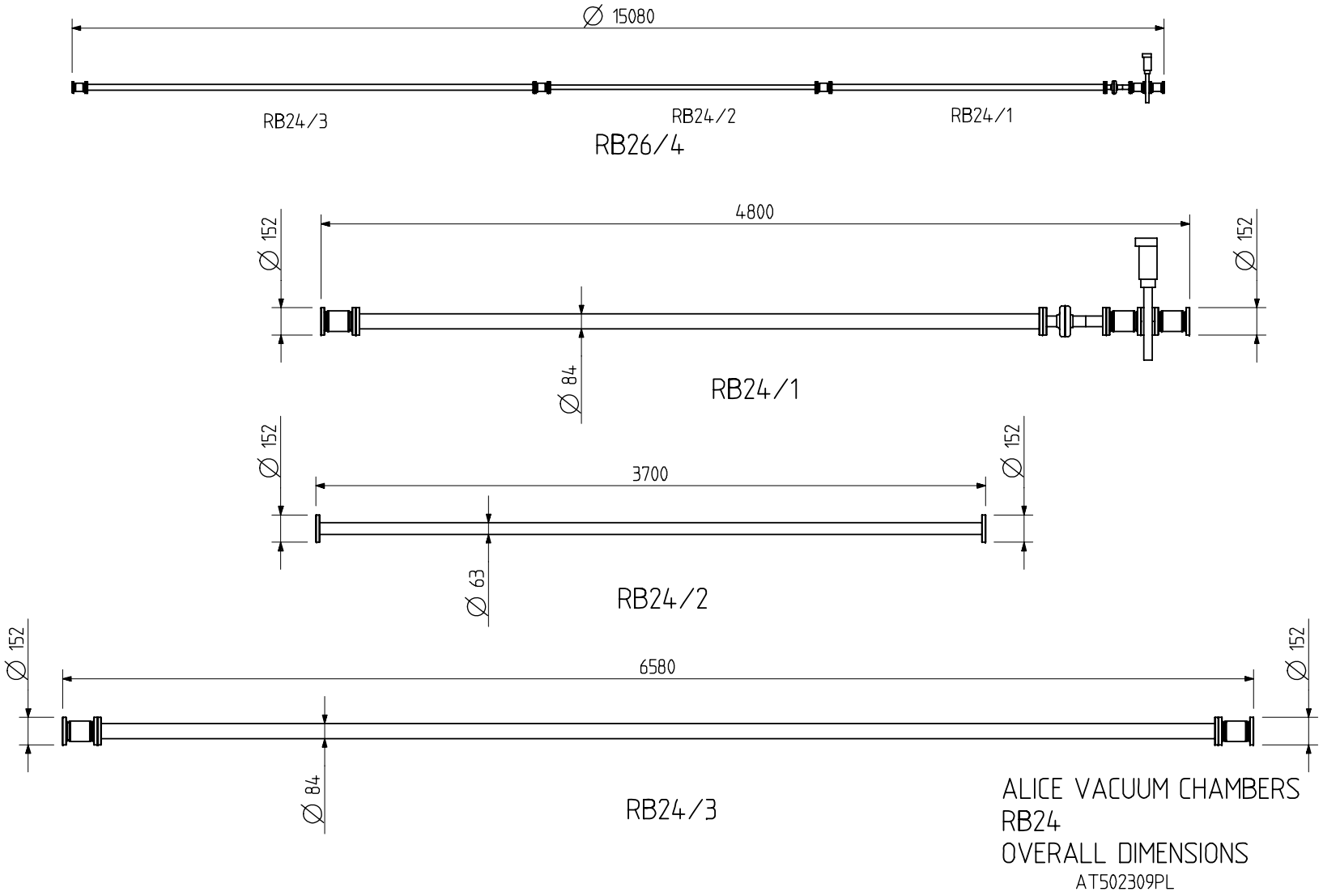
**Acknowledgments:**

Jean Cavé

Holger Neupert

Wil Vollenberg

# atlas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RB24/3
RB24/2
RB24/1
RB26/4
4800
∅ 152
∅ 152
∅ 84
RB24/1
∅ 152
∅ 152
3700
∅ 63
RB24/2
∅ 152
6580
∅ 152
∅ 84
RB24/3
ALICE VACUUM CHAMBERS
RB24
OVERALL DIMENSIONS
AT502309PL