Thin Film and Glass Service (TFG)

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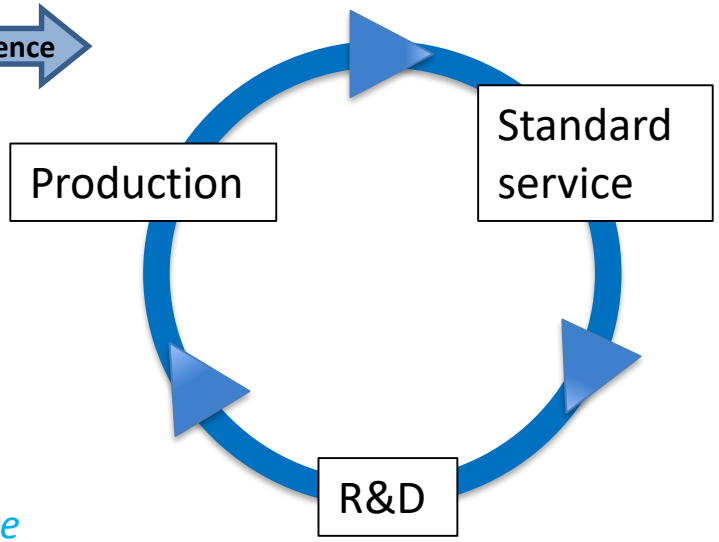
Students & Apprentices

- ***Thin film coating*** **More than 50 years growing experience**
- *Glass & ceramic machining*
- *Optics Quality Control lab*
- *Apprentice's training* (~3*3months)
- *General support to DT detector projects*

See link=> https://ep-dep-dt.web.cern.ch/thin-film-glass-service



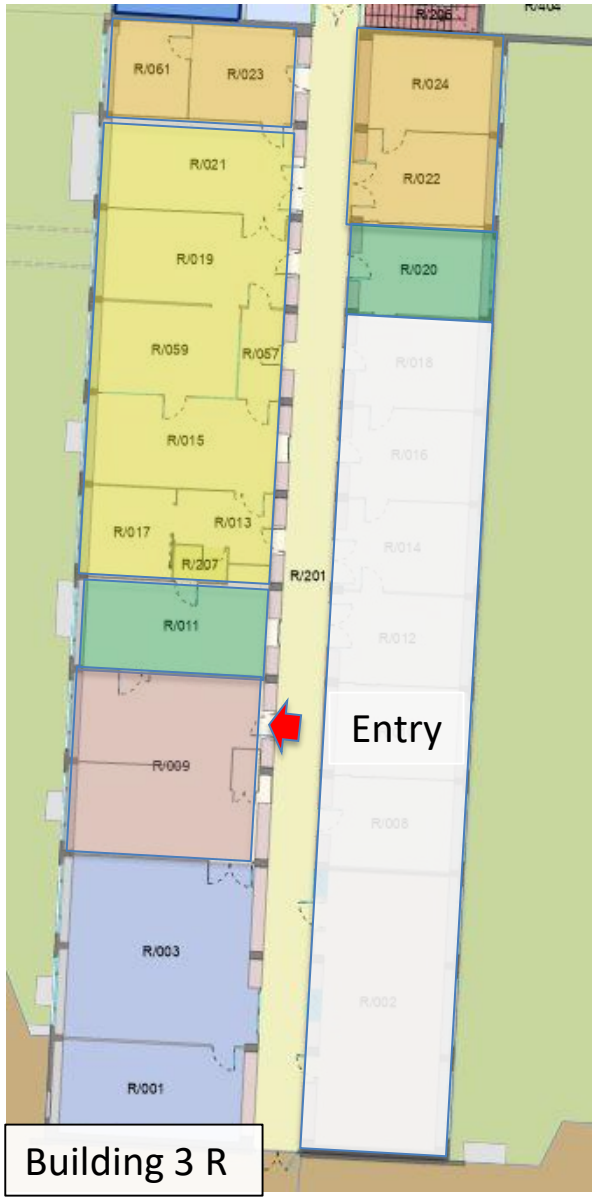
Location

Optical QC lab
(Microscopes)

Clean room with
7 coating devices

Entrance area
with ovens
and gluing
facility

Glass and
Ceramic
workshop



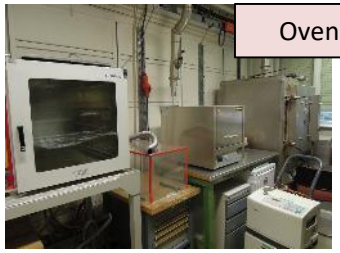
Building 3 R

Optical QC lab
(optical spectrometer)

Offices

Building 108

Gluing area (Fibre beam monitor)



Ovens

Entrance area

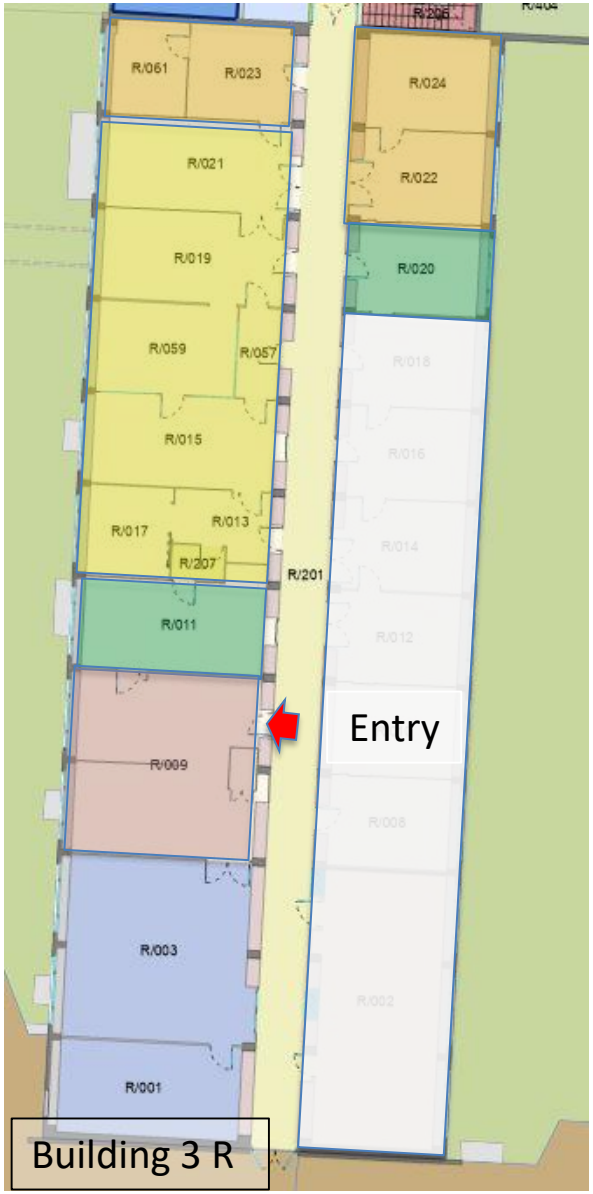
Chemistry and cleaning

Glass and Ceramic workshop

Turning and milling machine

Basic glass ceramics cutting facilities

CNC machine



Building 3 R

Production of activated Carbon Filters for NOVEC cooling:

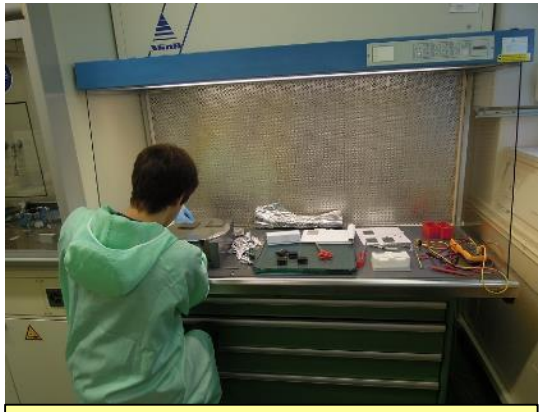
Vacuum bake-out (16h @180°C)

Quantify Humidity loss (5% down to few ppm)

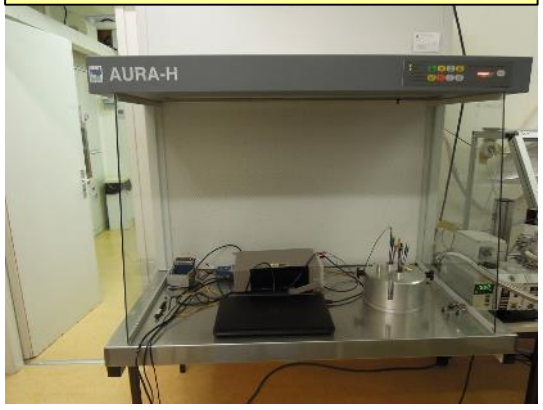
Sealed packing in dry Nitrogen bags

Procedure see link:
https://edms.cern.ch/document/1751219/1.0

Clean room (ISO class 7) preparation areas open for EP-DT and other detector groups

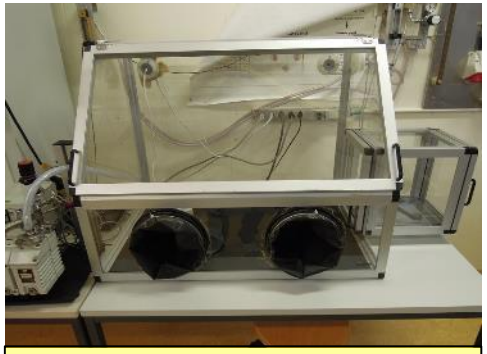


3 laminar flow cabinets for assembly activities (ISO class 5)



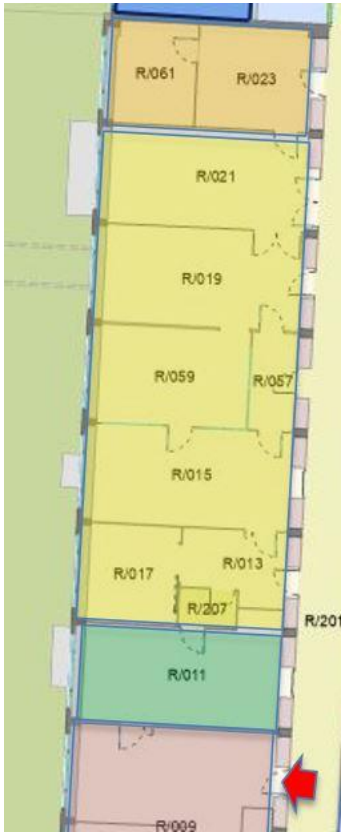
Several Ultra sonic baths

Cleanroom assembly area (NA62)



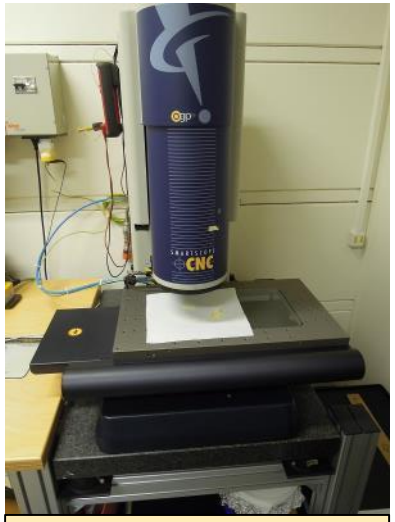
Dry nitrogen glove box

Visual inspection LHCb Muon



Optical Quality Control equipment

Different microscopes



OGP 3D metrology

UV spectrometer

Perkin Elmer spectrometer for spectral/diffuse reflection and transmission (200-900nm)

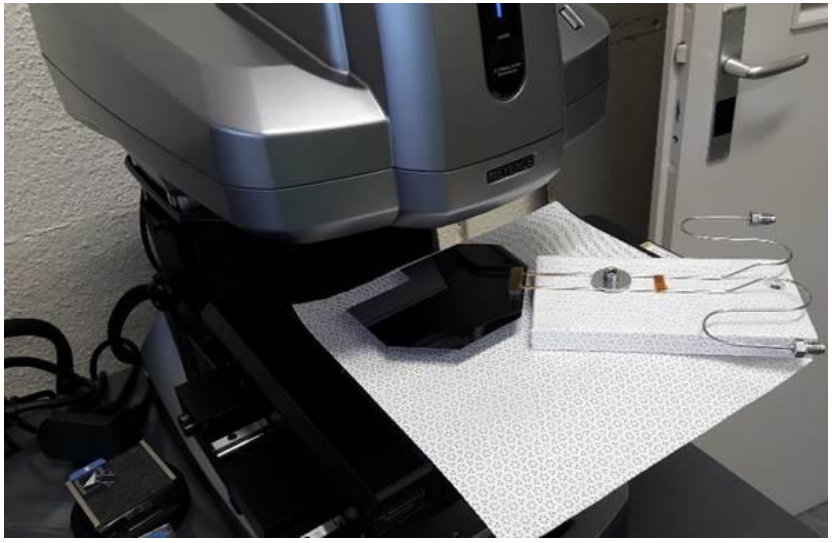
HPD/PM QE measurement

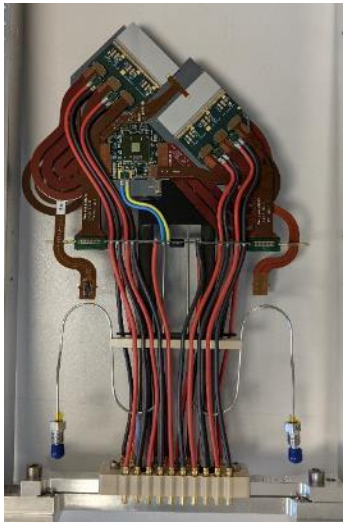
Keyence VR3000 3D measurement system

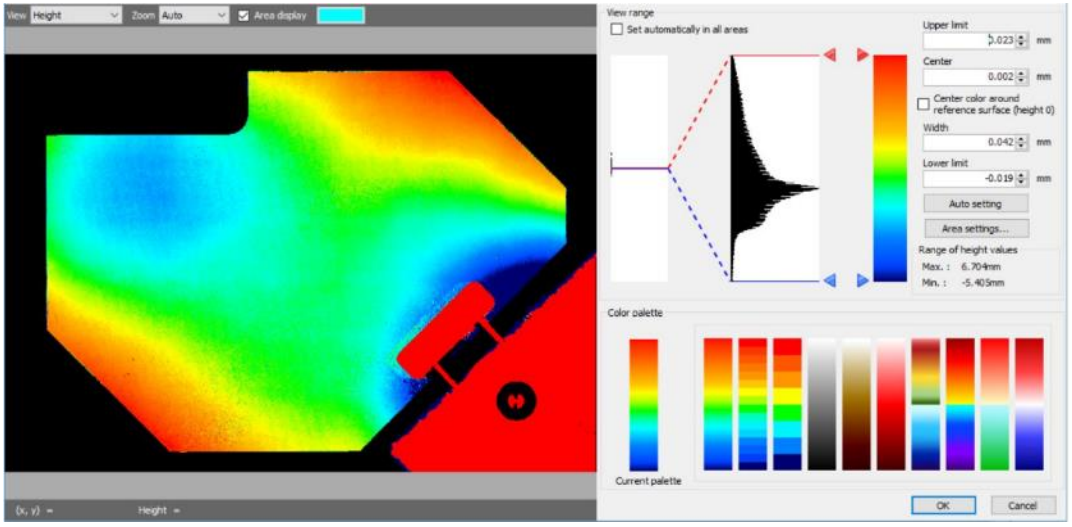
VELO Substrate metrology

(Keyence VR3200)

Microchannel planarity measurement after soldering and before place front end components.







List of detector groups or users profiting of our infrastructure (~last 5 years):

- NA62 Giga Tracker (assembly, cleaning and metrology in cleanroom)
- LHCb SciFi (close collaboration, QC tools)
- LHCb SciFi/RICH (Carbon filter regeneration)
- LHCb SPACAL R&D (fibre machining/prototype assembly)
- LHCb Velo (component cleaning/surface metrology)
- LHCb Muon (microscopic chamber inspection)
- CMS HGCal (large silicon sensor cleaning)
- TE-VSC (ceramic machining/spectroscopy)
- CAST –CAPP (repair of turning mechanism for cavity)
- Student workshop (Optics lab of TFG)
- Neutrino platform (PM QE measurements)
- BE-BI (Fibre detector production)
- ATLAS ITk (cleaning/surface metrology)
- DT µ-channel cooling (cleaning/surface metrology)
- DT µ-fabrication facilities (cleaning/surface metrology)
- Picosec project with RD51 (machining/handling of photocathodes)

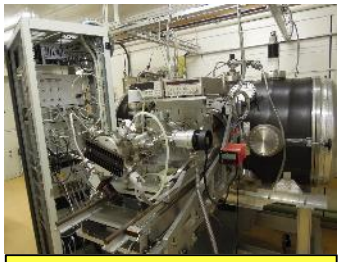
Open lab?!

The Perkin Elmer spectrometer (UV-VIS) is used by various CERN users

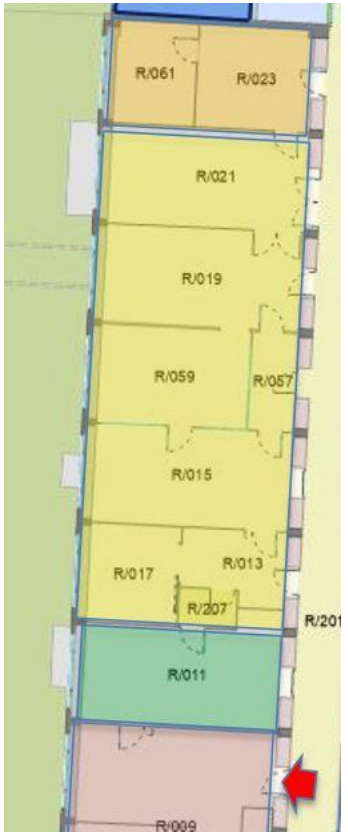
PVD thin film coating devices

Generic coating unit (Balzers 1957!)

New state of the art coating unit



Big CsI coating unit



HPD coating plant

WLS/Zinc coater

Small CSI coater

Big production coater (1m diameter)

Motivation for vacuum thin film coating:

- High purity thin layers <=*vacuum environment*
- Low cost of material <=*thin layers with same performance as bulk material*
- Good reproducibility <=*precise control of process parameters*

Different kind of technologies available:

Physical **V**apour **D**eposition (PVD):

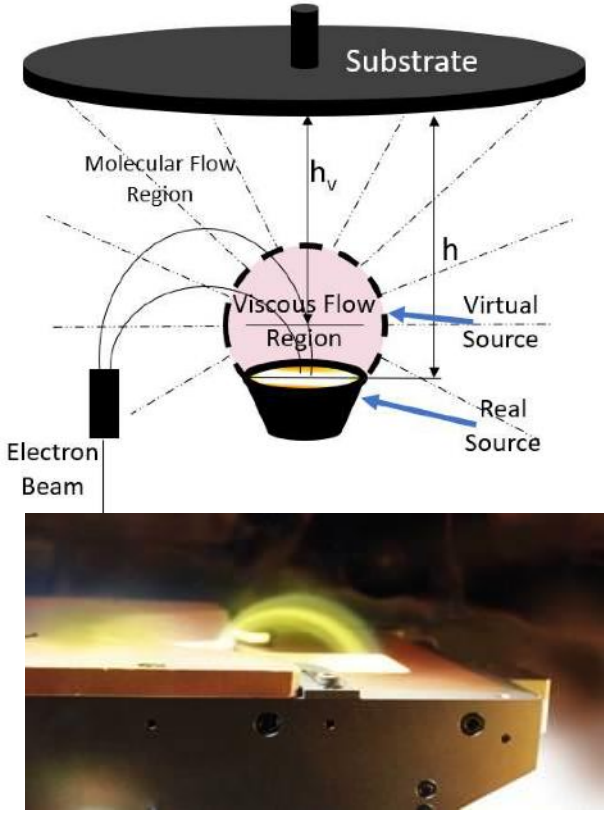
- Thermal Evaporation (30th) (EP-DT) — Resistive / E-beam
- Sputtering (70th) (TE-VSC) — Cathodic / Magnetron

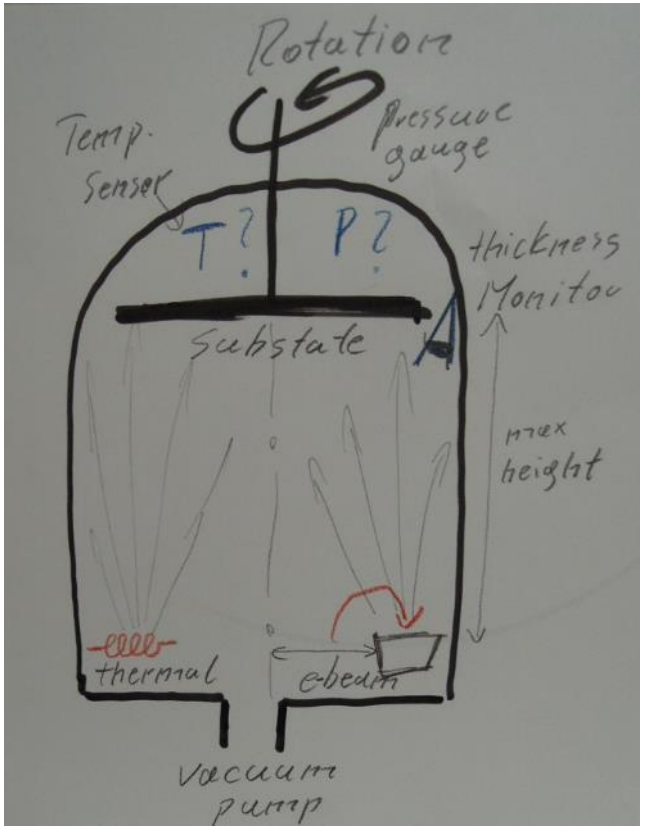
Chemical **V**apour **D**eposition (CVD)

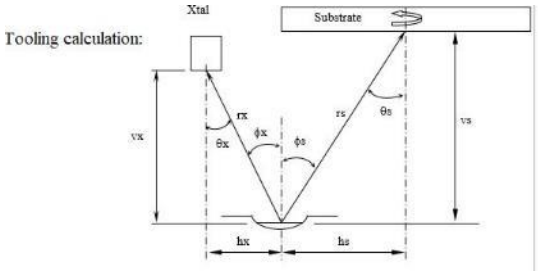
Thermal vs sputtering

"Thermal evaporation is the more mature technology...it allows coating almost all materials needed for "standard" coating applications"
+high flexibility in substrate material and geometry
+Also exotic material can be coated (low temp)
=>Best candidate for R&D device in TFG lab

-need high vacuum level (~10^{-7}mbar)
-lower energy coating (packing density/adherence)







Point source:

$$Tooling = \frac{rx^2 \cos \theta s}{rs^2 \cos \theta x}$$

Small area source:

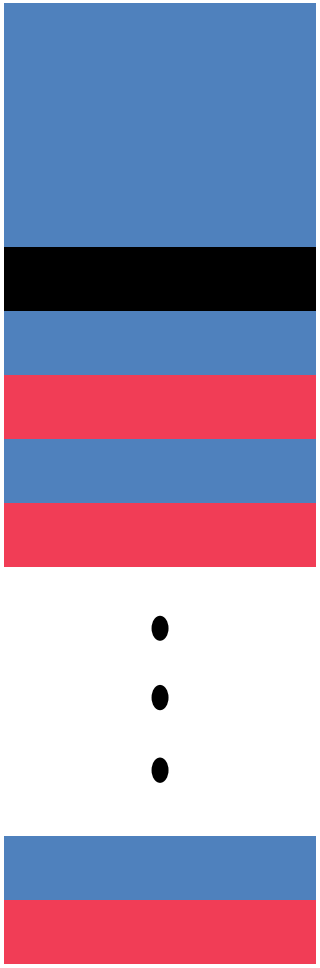
$$Tooling = \frac{rx^2 \cos \phi s \cos \theta s}{rs^2 \cos \phi x \cos \theta x}$$

Uniformity of layer thickness is key issue

concept for uniform large area coating:

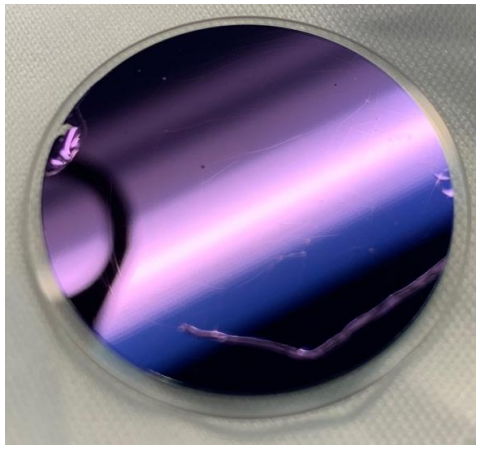
- Increase distance source –substrate
- Rotate substrate
- Position source most excentric

R&D LHCb RICH Photonic crystal

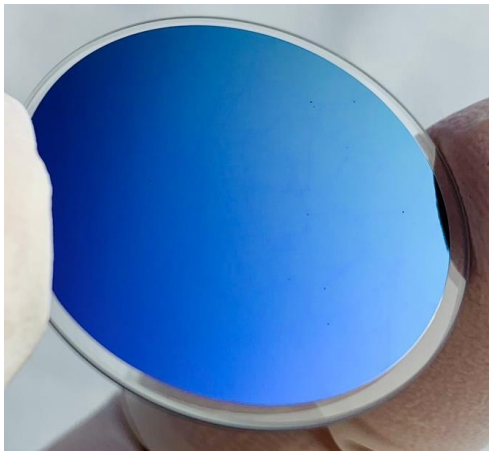


Two multi-layer samples successfully manufactured.

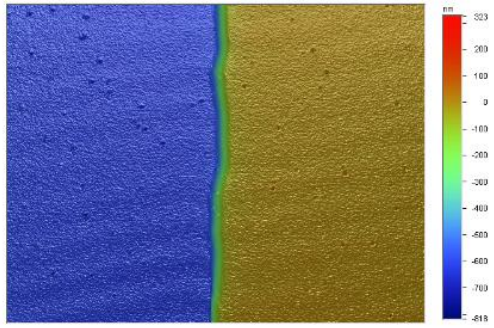
61 layers

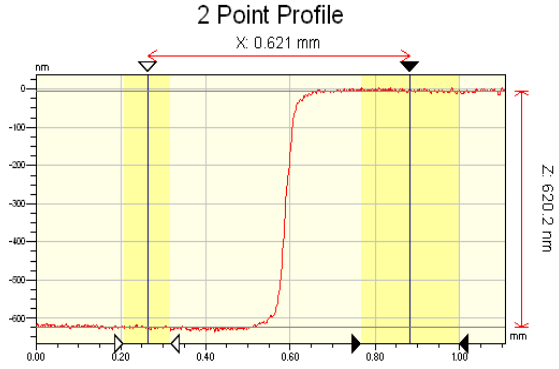


57 layers



Coater calibrated with single layer couples of SiO2 and TiO2.



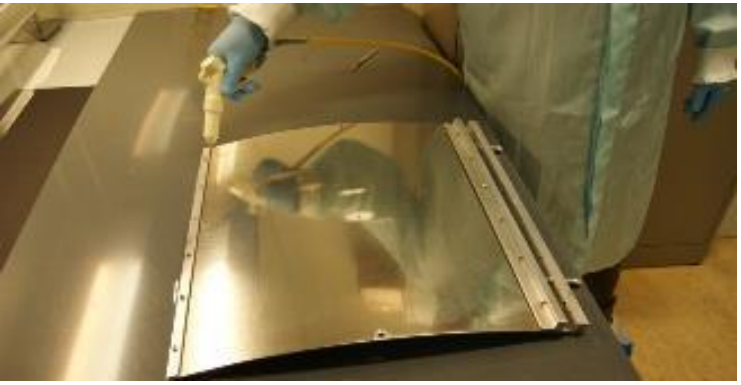


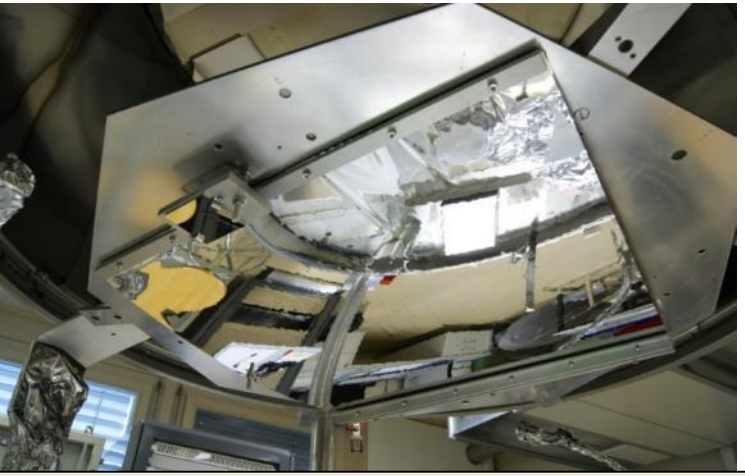
Dissertation Michele Blago 2021

PVD optical coatings

Optical coatings

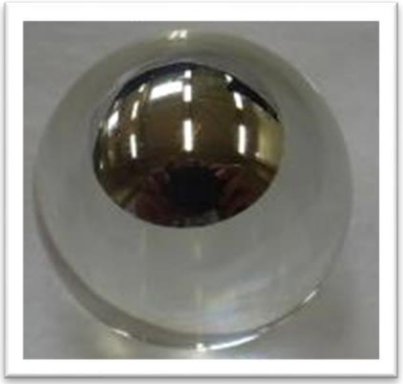
- Enhanced reflective coatings
- Anti reflective coatings

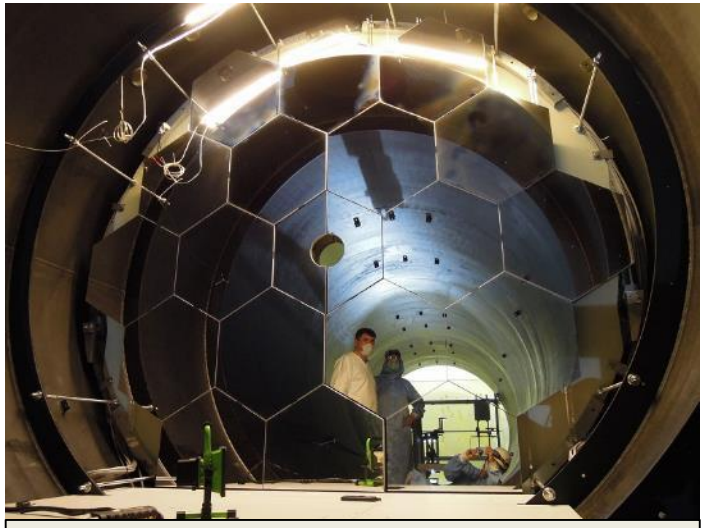




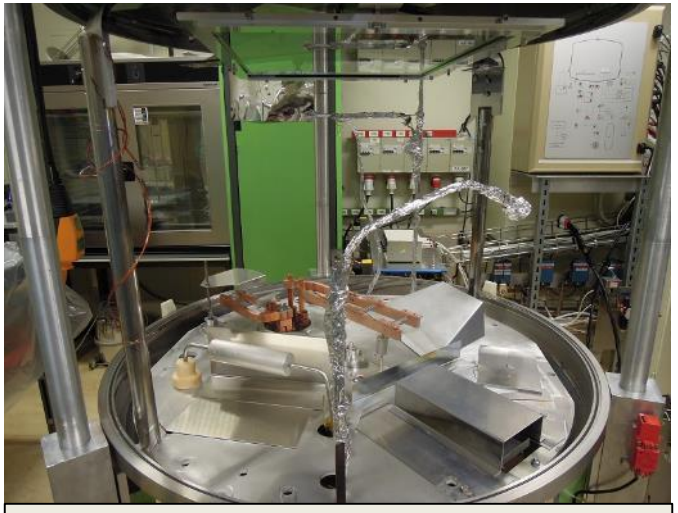
Mylar foil coating for NA62 RICH optical feed trough

Geometer target



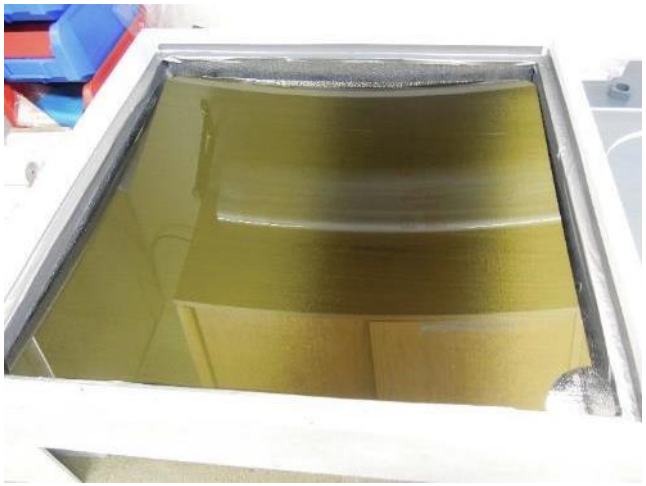


NA62 RICH UV mirror system

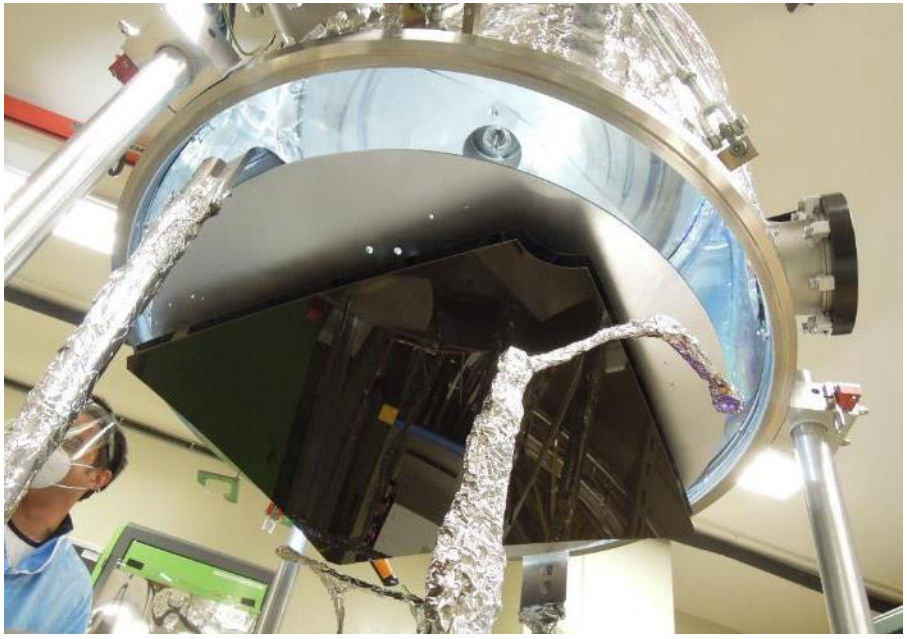


AR quartz window for LHCb RICH1

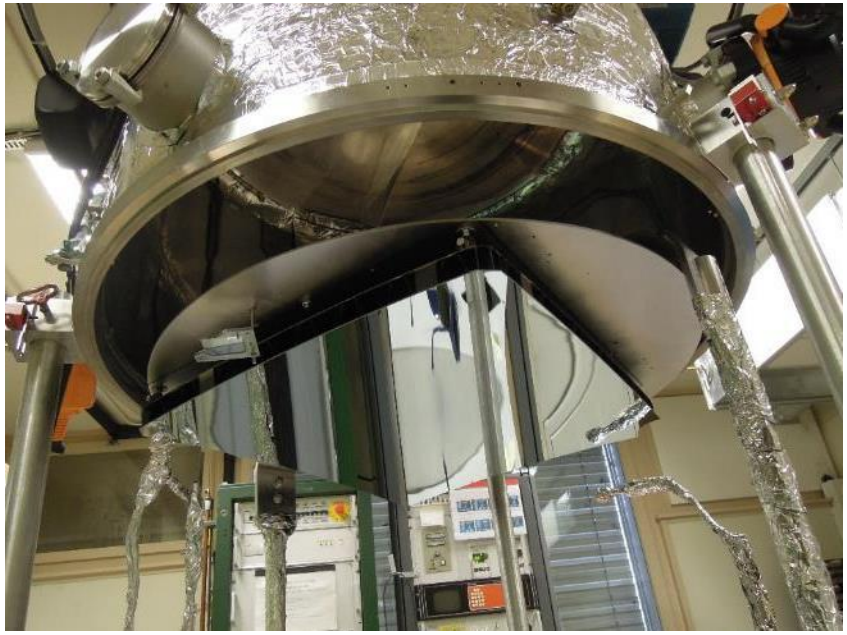
LHCb RICH1 enhanced mirror coating



The LHCb RICH1 upgrade is certainly the Flagship project of our coating service. Enhanced Reflective coating (Cr/Al/SiO2/HfO2) has been applied to spherical composite substrates (1m diameter)

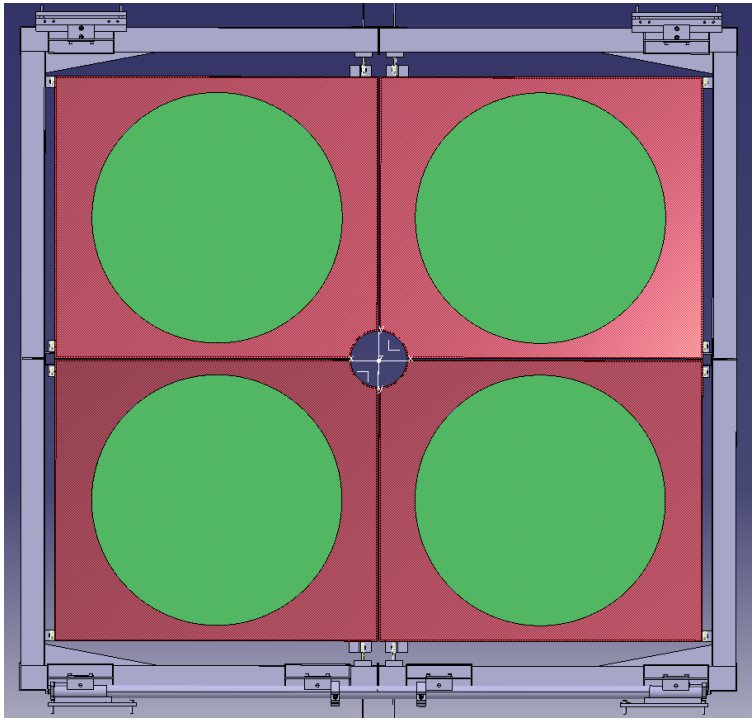


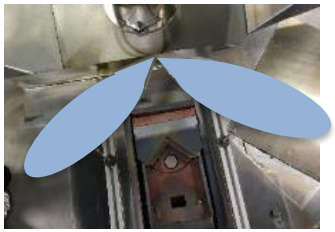
COATING



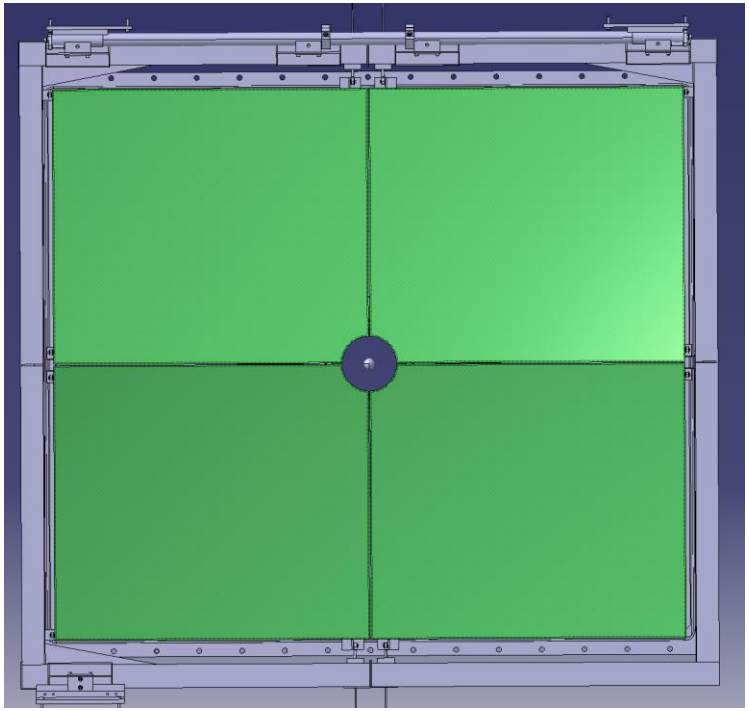
LHCb RICH1 enhanced mirror coating

2018
Thickness variation < 30%





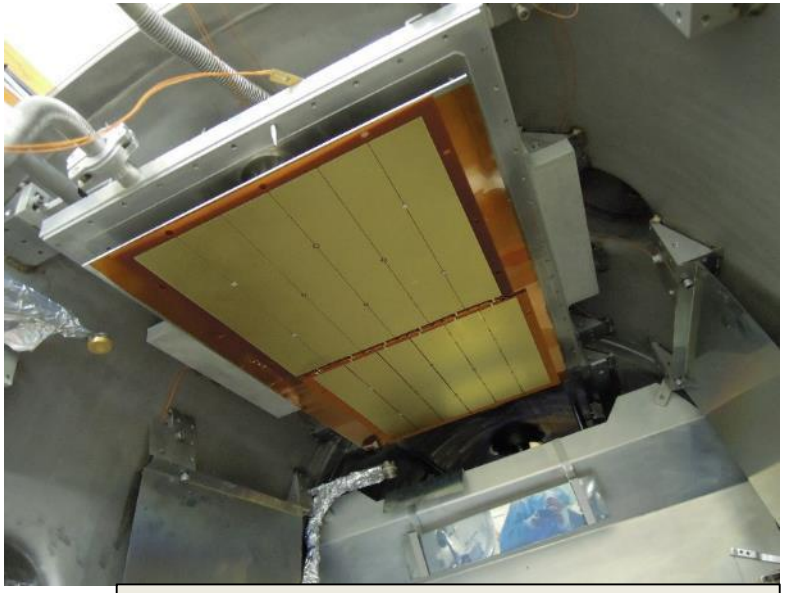
2020
Thickness variation < 10%



With aligned mask system uniformity of reflectance on the big composite mirrors has been improved! > 90% reflectivity 275nm and 500nm.
This improvement will be extremely useful for further projects.

Other light related coatings

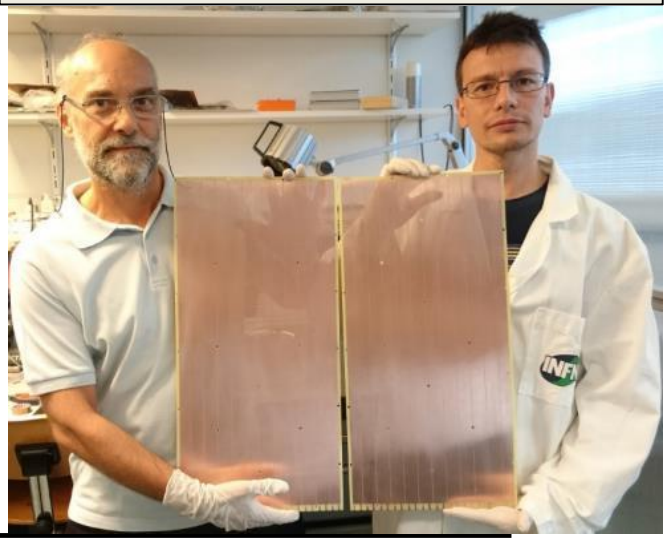
- Wavelength shifter coatings (WLS)
- Photocathode layers (PC)



Compass Thick-gem PC coating (CsI)

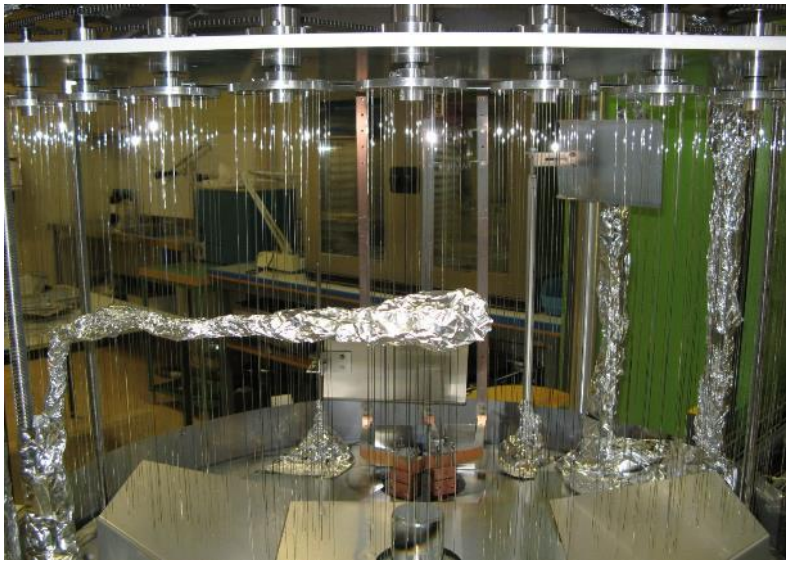
PM wavelength shifter coating (TPB)

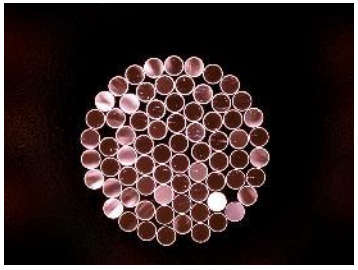
Pico-sec (GDD)



optical *Fiber activities*

- Construction and installation of ATLAS ALFA detector (initially started with lateral fibre coating)
- Demonstrator construction for AX-PET
- Strongly involved in LHCb SciFi development
- Development and construction of 15 Fibre beam monitors for Neutino Platform (collaboration with BE-BI)
- Contribution to prototype of E-cal LHCb
- Individual fibre polishing for various detector groups (fibre–fin)

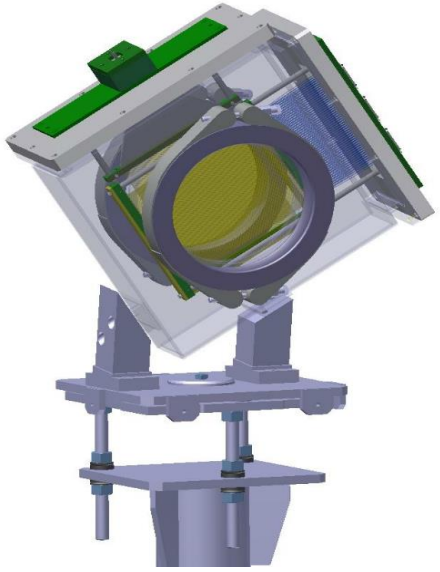


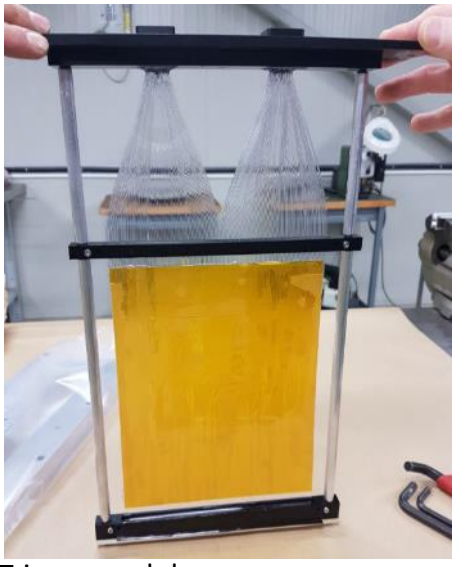


Competencies:

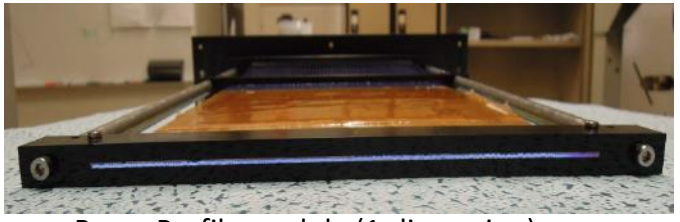
- Individual fibre polishing
- Fibre gluing
- Fibre detector construction
- Reflective (Al) lateral fibre coating
- Fibre end coating

optical *Fiber activities*





Trigger module



Beam Profile module (1-dimension)

- Worked out concept for this detector
- Hired TTE to work on this project
- Started prototyping
- Launched coating campaign for lateral AL coating
- Trained TTE on different production steps
- Supervised production of 15 modules

2018: Delivery for installation in Neutrino platform
2021: Coating campaign for east hall equipment
2023: Planned to equip north hall

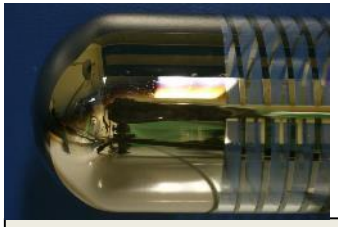
Installation in ENH1

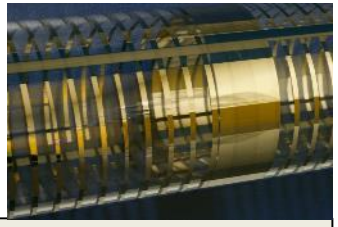
PVD coating application

Functional layers

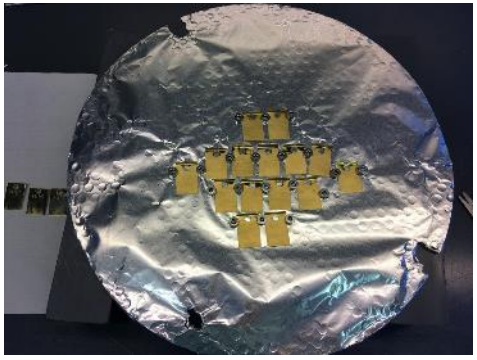
- Pre-coating of conductive layers
- Transparent conductive layers
- De-moulding layers
- Zinc layer for isotropic radicals

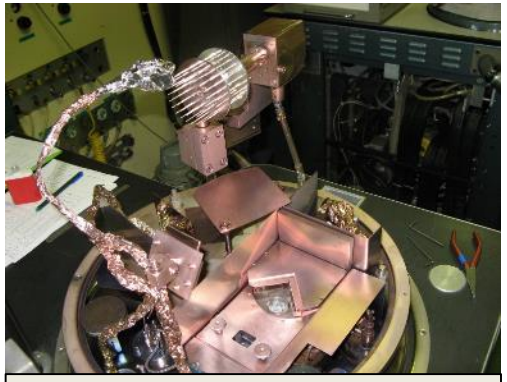
Micro buses de-molding layer (Au)



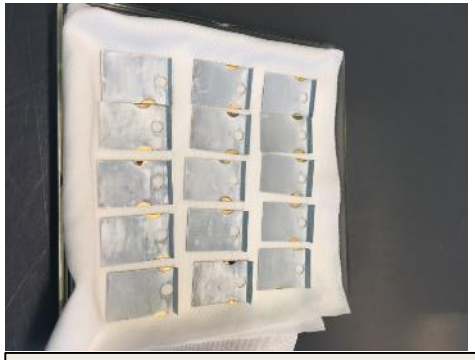


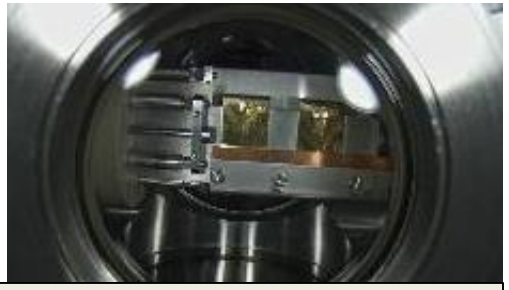
Titanium (conductive) spirals on CLOUD UV sabre





Conductive layer (Cu) on ceramics





Zinc layer on gold plates for MEDICIS (Medical Isotopes Collection ISOLDE)

End ?questions? End