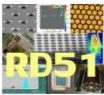


DLC machine at CERN

INFN

CERN EP/DT group

MPT workshop

CERN 

1

RD51 DLC Workshop Report

Mini Week 10-13 February 2020, CERN
<https://indico.cern.ch/event/872501>

Abstract

Current report highlights detector and technological aspects connected to Diamond Like Carbon (DLC) coatings that have been discussed during the RD51 DLC workshop. The workshop has been organized with the purpose of initiating a technical and open discussion on processes, problems and production centers with the aim of evaluating the impact and importance of enriching the existing production capabilities with a sputtering machine at CERN. The CERN MIT workshop has identified a machine that, in the existing scenario, would enlarge the current R&D and production capabilities, in particular in the context of coating reasonable large surfaces. Use of this machine would cover additional field of research and interest for CERN, one example among the others, the possibility of aluminum deposition for low material budget circuits.

Geneva, Switzerland
November 3, 2020

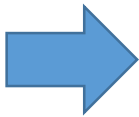
 


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Proposta di una DLC (e non solo) sputtering facility congiunta CERN - INFN

G. Bencivenni (LNF), M. Iodice (Roma3), G. Cibinetto (Ferrara), P. Giacomelli (Bologna), M. G. Alviggi (Napoli), M. Della Pietra (Napoli), P. Verwilligen (Bari), A. Ranieri (Bari), A. Colaleo (Bari), M. Maggi (Bari), A. Valentini (Bari), S. Dalla Torre (Trieste), F. Tessarotto (Trieste), D. Pinci (Roma1), M. Greco (Torino), M. Maggiore (Torino)

Commissione Nazionale I - 20 Novembre 2020 1



 European Organization for Nuclear Research
 Organisation européenne pour la recherche nucléaire

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AGREEMENT
 REFERENCE KMXXXX
 (THE "AGREEMENT")

BETWEEN

THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

AND

ISTITUTO NAZIONALE DI FISICA NUCLEARE (INFN)

CONCERNING

THE PURCHASE AND OPERATION OF A MAGNETRON SPUTTERING DEPOSITION FACILITY

In the framework
of RD51



MoU for the RD-51 Collaboration

Memorandum of Understanding
 For the
RD-51 Collaboration

between

The EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH,
 hereinafter referred to as CERN, Geneva, as the Host Laboratory

on the one hand

RD-51 COLLABORATION

Agreement II of prolongation
 to the
Memorandum of Understanding
 for the RD-51 Collaboration

Considering that:

A group of institutes and funding agencies from CERN Member and non-Member States and CERN agreed to collaborate to form the RD-51 Collaboration (the "Collaboration");

These institutes and funding agencies (the "Members of the RD-51 Collaboration") signed a Memorandum of Understanding (the "MoU") establishing the Collaboration and setting out their responsibilities¹; The MoU was signed for a period of five (5) years until the 31st of December 2013;

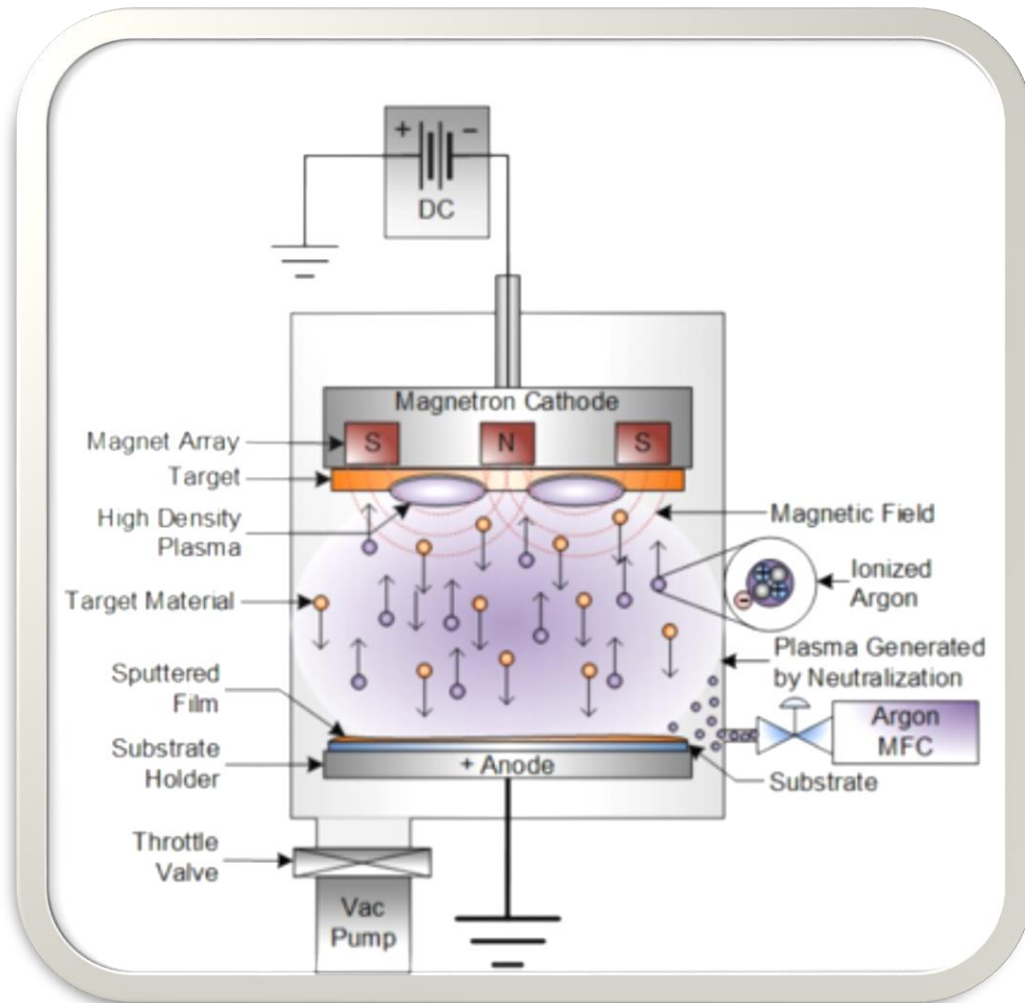
The first prolongation of the Collaboration has been approved at the meeting of the CERN Research Board on the 28th of August 2013 for a period of five (5) years until 31 December 2018;

A second prolongation of the Collaboration has been approved at the meeting of the CERN Research Board on 6th of June 2018 for a period of five years until 31 December 2023;

The Members of the RD-51 Collaboration now want to extend their adherence to the MoU.

Coating Machine Project

Theory



-PVD = PHYSICAL VAPOR DEPOSITION

-PECVD= Physical-Chemical Vapor Deposition or Reactive PVD

-Magnetron DC sputtering

-DC or Pulsed DC to work with dielectrics

Coating Machine Project

In our Workshop, we (Serge ferry) have already experience in :

- PVD AL thick coating up to 30um
Aluminium bus circuit (Alice) 12microns to 35microns thickness
- PVD coating for tribological properties
TiN, TiCN, TiAlN, CrN, BN in machining application, molded plastic application
- PVD coating for STD protection
TiO₂, Cr, Au, Ni
- PECVD DLC coating for automotive application
- Surface activation of polymers by Reactive ion (RF plasma)
- Thin etching or reactive thin etching of polymers and metals
- Plasma preparation
Grafting molecule Polyvinyl-pyrrolidone on medical implant

Coating Machine Project

typical deposition sequence by PECVD DC Magnetron

Step 1-Bake → degas the substrate in vacuum

Step 2-Clean

- reverse sputtering of the substrate (RF plasma for dielectrics)

Step 3-Sputtering / Co-sputtering/ reactive sputtering

- adjustable gradient of material or layer by layer coating

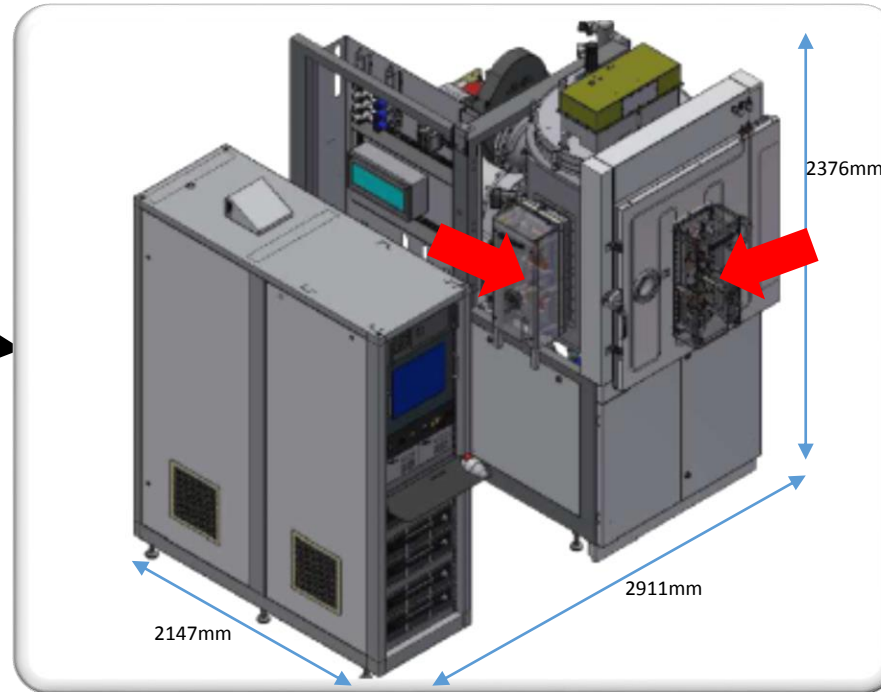
- adding H₂, N₂, CH₄, C₄H₁₀, Ne to Argon

DECORA 760+

Standard configuration



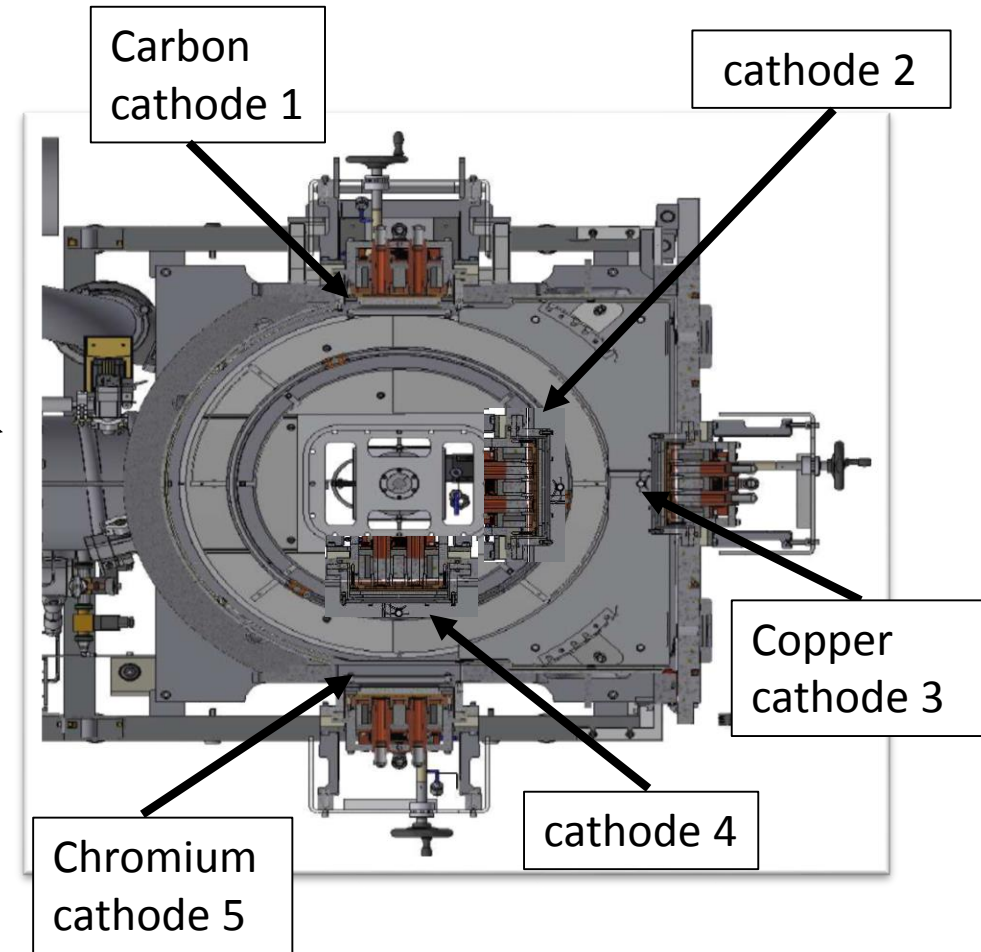
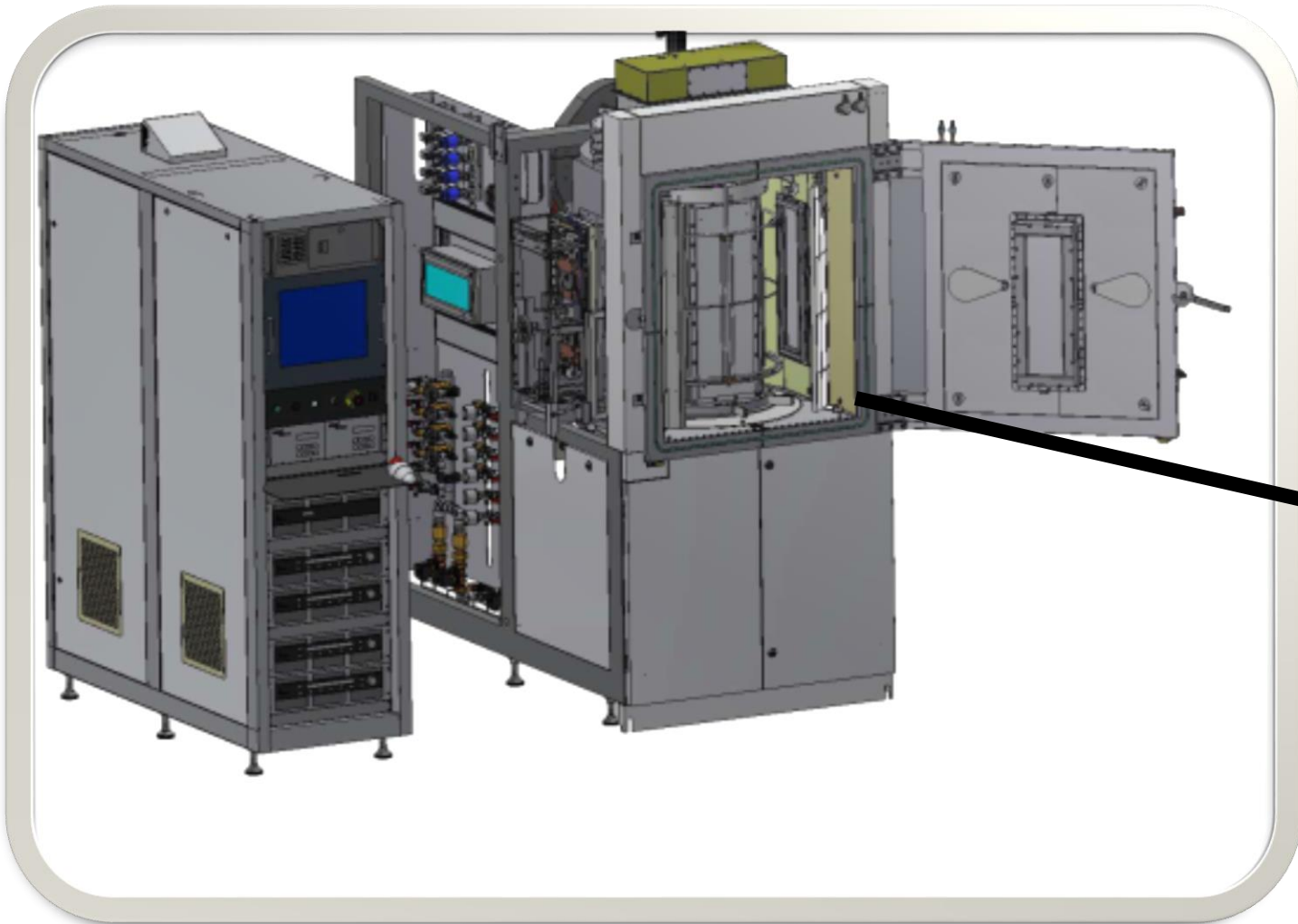
Upgrade configuration



Chamber treatment:
800mm x diam 760mm
5 cathodes

Pumping system :
-1 dry pump
-2 turbomolecular pump

Pressure limit 5.10-7mbar
Getters if necessary



❑ 5 Cathodes for SPUTTERING :

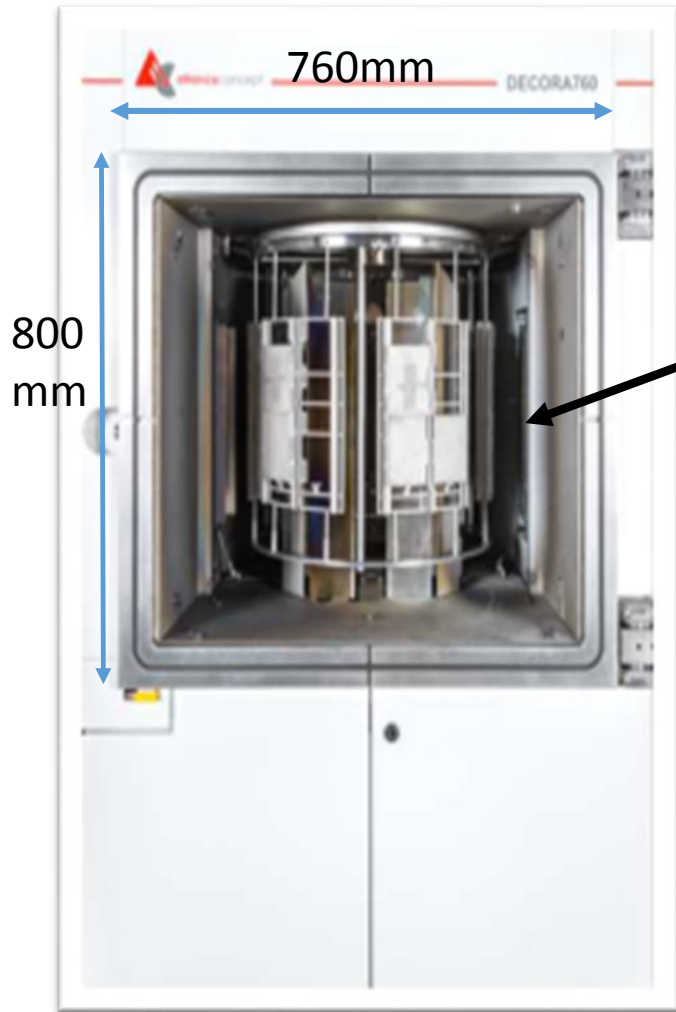
Possibility to deposit simultaneously different material : carbon, metals, alloys, B4C etc..

Possibility to have segmented cathodes.

❑ Different configurations : layers made one after the other , co-sputtering and this without breaking the vaccum

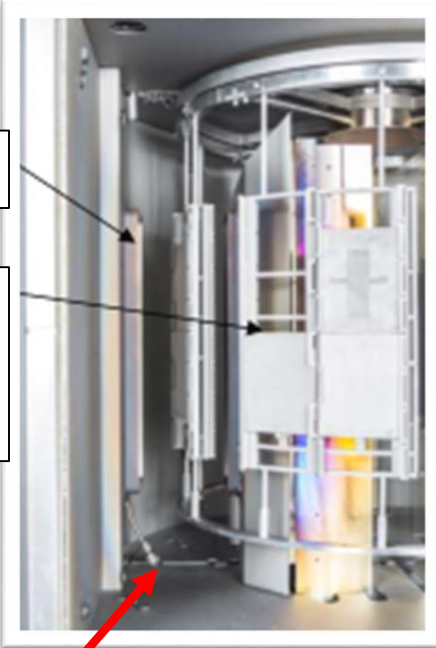
❑ Heater : 300 deg maximum to fully degas material in vaccum.

INTERNAL VIEW

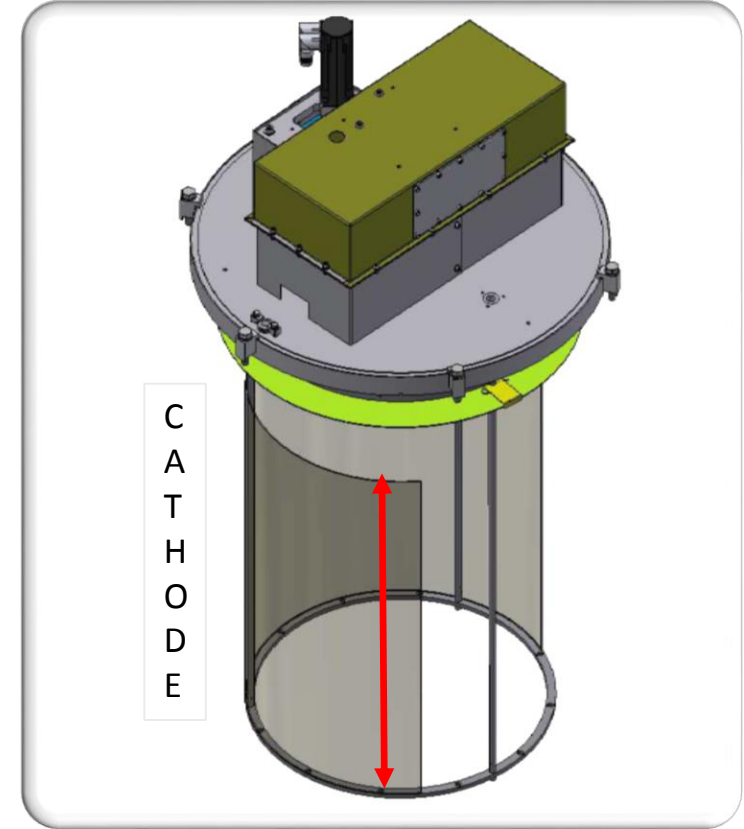


cathode

Substrate holder polarised



Gas injector close up of each cathode, mono pur gases or mixed gases (H₂, N₂, CH₄....)



-Surface treatment of foil :
external face = 1,7m x 0,6m
Internal face = 3 segments of 0.5m x 0,6m

Estimated homogeneity from the supplier

-Homogeneity with a cathode 500mm x 127mm

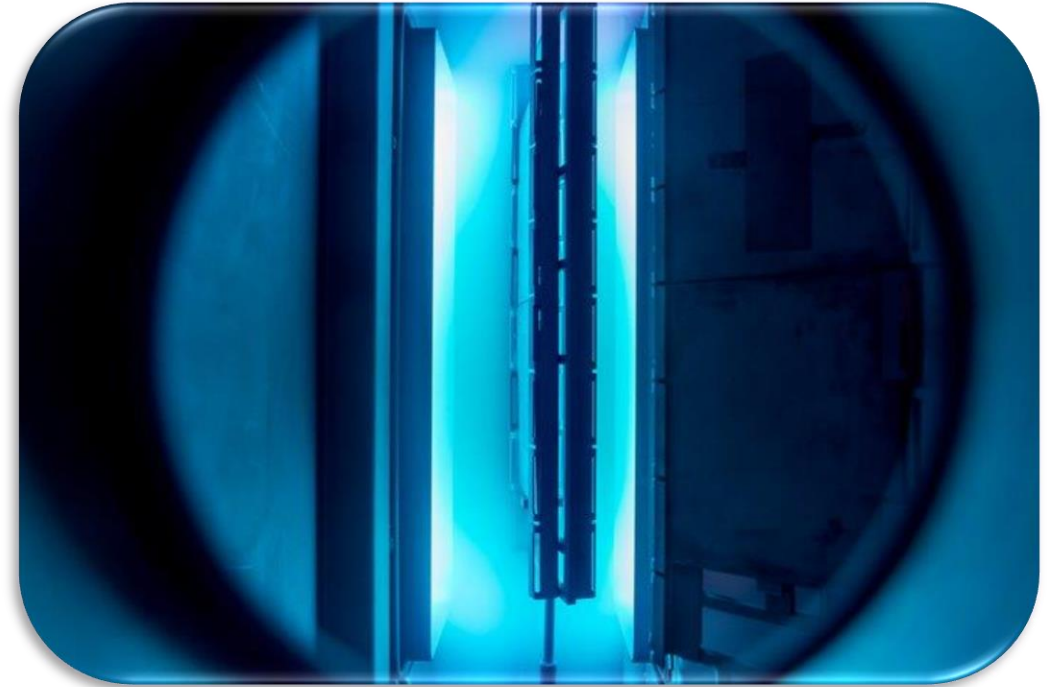
+/-4% → 360mm width

+/-30% → 450mm width

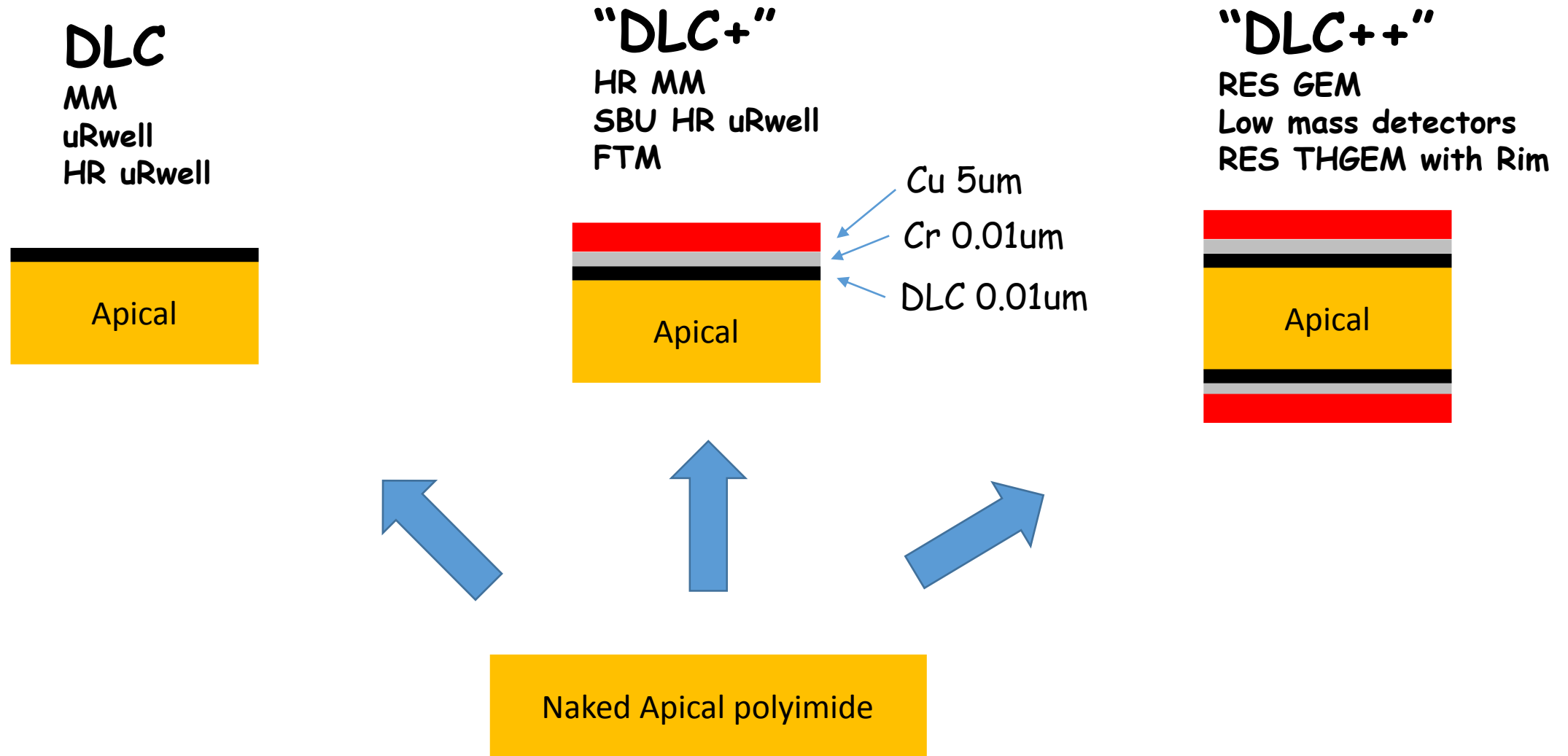
+/-50% → 470mm width

-We have already some ideas to adjust this parameter

-Theoretical capacity of coating : 1 foil 1.7mx 0.6m per batch

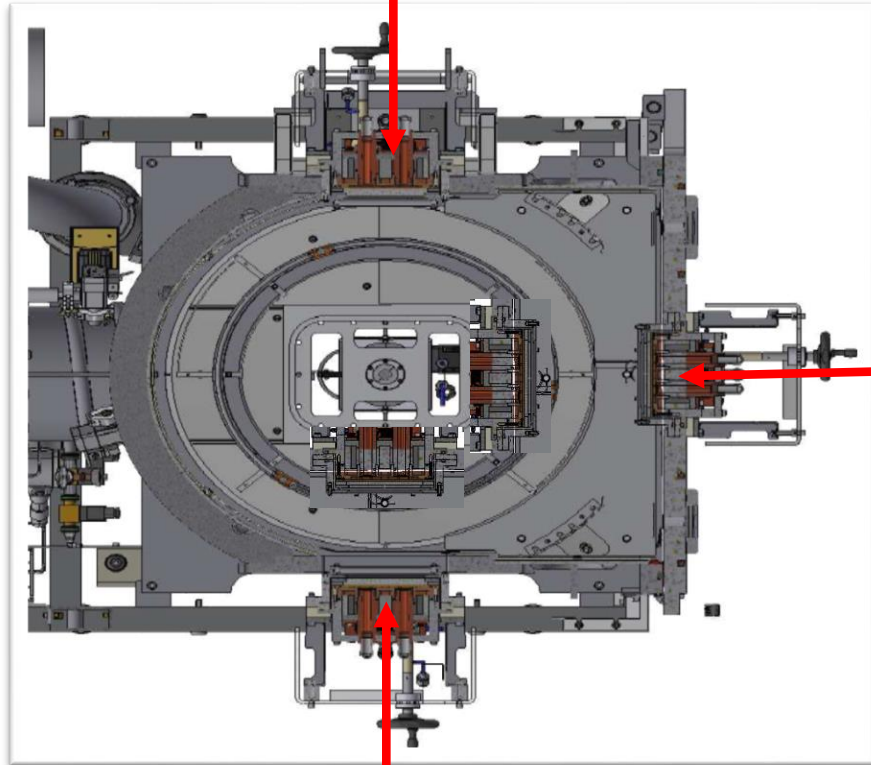


Main application of the machine



cathode 4
NC

cathode 2
NC



Graphite
cathode 1

Copper
cathode 3

Chromium
cathode 5

Other possible applications : Florian Slide from Picosec photocathodes CsI replacement study

Photocathode robustness

Protection and alternatives

Making CsI more robust

Thin coating layers on CsI:

- ✗ • MgF₂
- ✗ • LiF
- ...

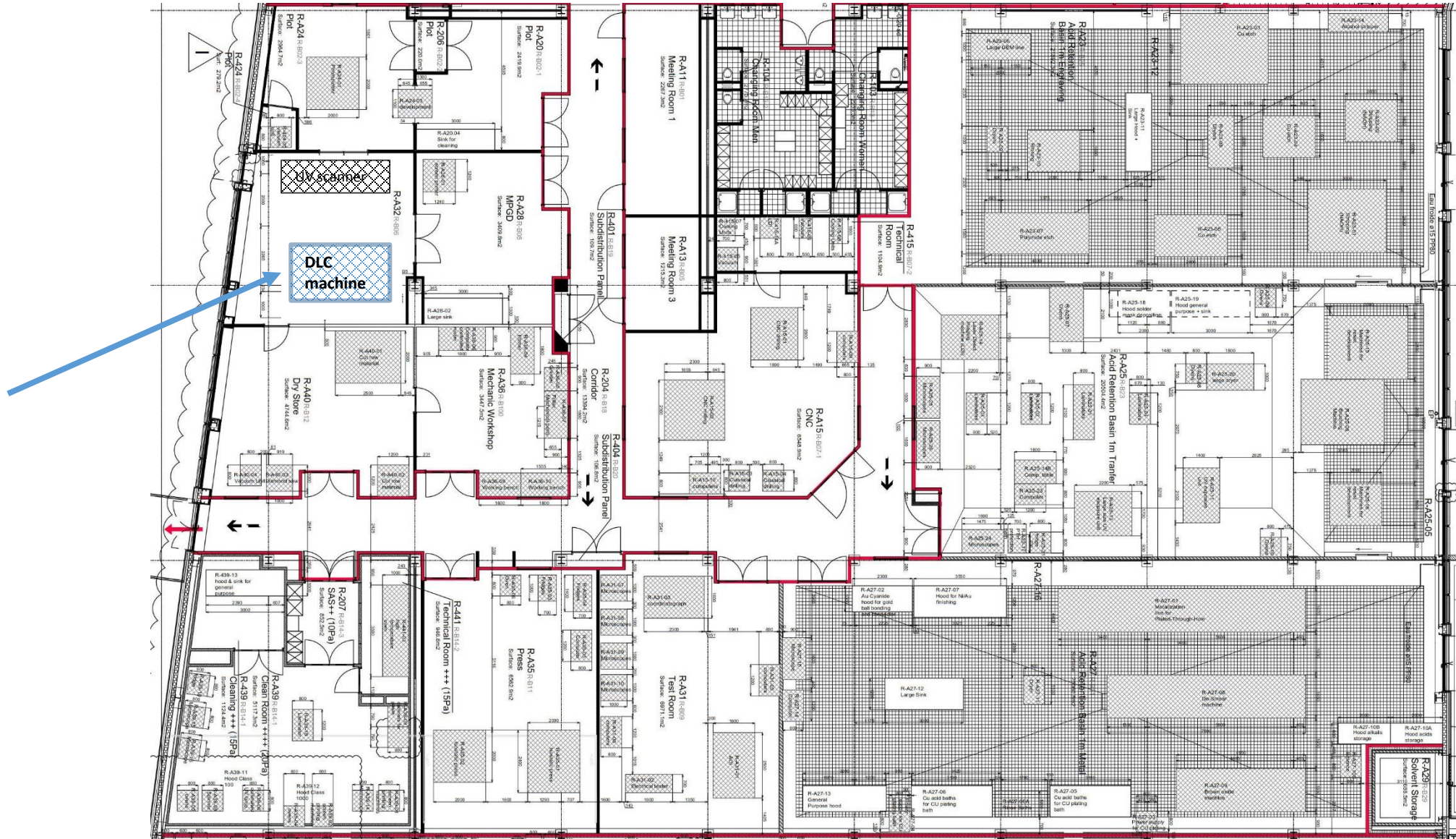
- Could minimise effect of ion back flow on CsI and mitigate degradation
- May inhibit electron extraction and result in low QE

Alternative photocathodes

- ➡ • Metallic
- ➡ • DLC
- ➡ • B₄C
- ✗ • Nano diamond (ND) powder
- ✗ • CVD diamond
- ➡ • GaN
- ...

- Could be inherently more robust to environmental influence and ion bombardment
- May only offer low QE

Implementation in 107 Building



Funding/purchasing/operation

-Targeted budget around 550 Keuros

- 150 K Euros from INFN (MOU pending , first step OK)
- 120 K Euros from EP/DT group (EP / Finance dep agreement on going)
- 280 K Euros from MPT workshop (EP / Finance dep agreement on going)

-Machine-access directly proportional to contribution.

-The purchasing process is started (1st step Divisionnal Request DR).

-No funding commitment is needed to start the process.

-Tentative planning

- | | | |
|--------------------|-------|--|
| -M/S | 03/21 | |
| -I/T | 05/21 | |
| -Order | 08/21 | → need funding commitment of all parties |
| -Machine delivery | 02/22 | |
| -Machine operation | 04/22 | |

Thank you