Structure of the task 12.2

Niobium on copper (µm)

- After ~ 20 years stagnation : new revolutionary deposition techniques (HPIMS)
- Great expectations in cost reduction
- No improved performances/ bulk Nb

Subtask 1

Higher Tc material (µm)

- Based on superheating model.
- Higher field and lower Q0 expected

Higher Tc material (nm), multilayer

- Based on trapped vortices model (Gurevich)
- Higher field and lower Q0 expected
- Recent experimental evidences

Subtask 2

Specific characterization tools needed

Better understanding of SRF physics needed

Subtask 3

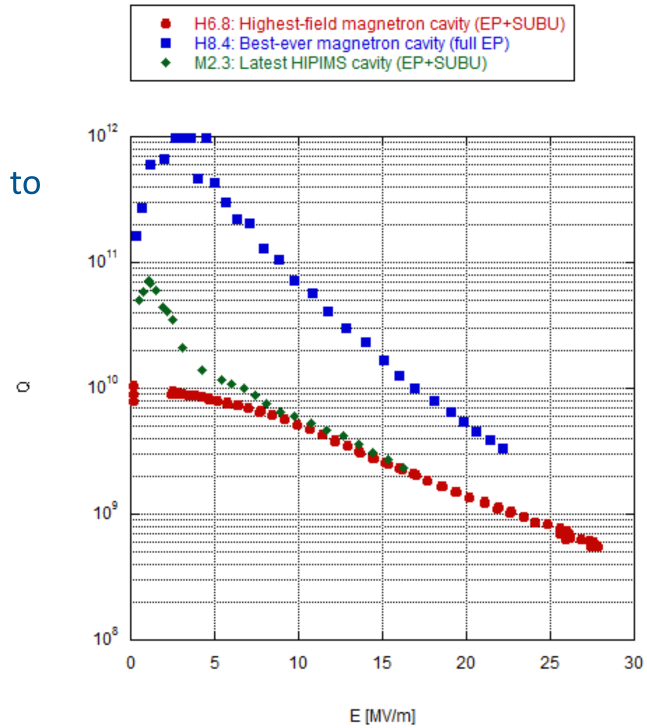
Samples preparation, optimisation of the deposition processes

THIN FILM DEPOSITION

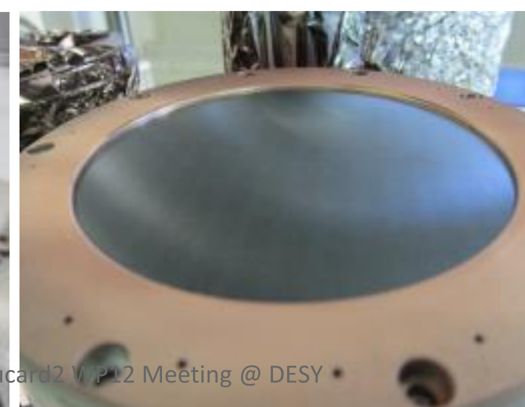
Claire Antoine Eucard2 WP12 Meeting @ DESY

HPIMS & Nb_3Sn @ CERN

- HiPIMS activity (subtask 1)
  - Two cavities have been coated with HIPIMS. Performance equivalent to the best cavities coated in the past by magnetron.
  - Toward Biased experiments
    - Modification of the coating setup planned
    - Magnetic configuration to be optimized

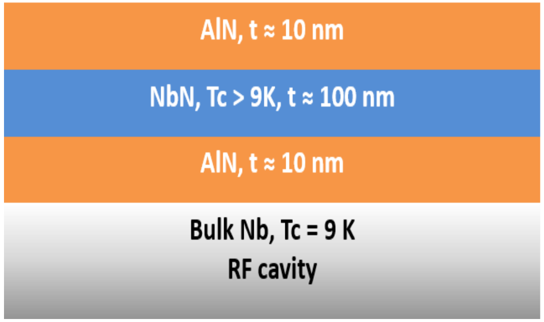


- Nb_3Sn activity launched Jan 2015 (subtask 2)
  - First samples coated
  - SEM/XRD characterizations on-going
  - Thermal treatment to be performed
  - QPR coating forecast : Dec 2015



ALD deposition of NbN/AlN at Grenoble (WP12-2.2)

- Received special R&D ALD set-up (March 2014)
  - Commissioning during Summer 2014
  - PhD student started fall 2014
  - Development of AlN films completed (precursors , plasma conditions, structure…)
  - NbN development starting now in parallel with CVD NbN deposition



Grenoble INP

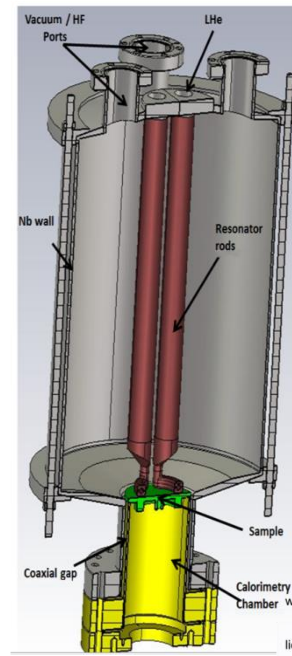
Measurement of RF surface resistance and highest achievable field

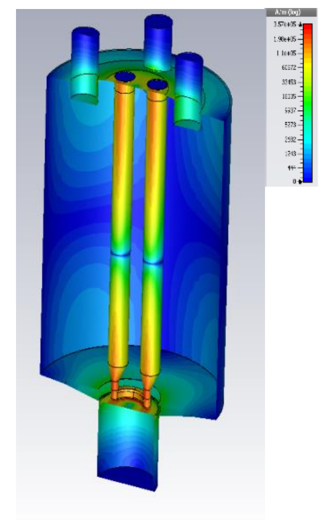
THIN FILM CHARATERIZATION

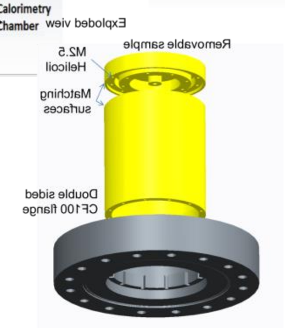
Claire Antoine Eucard2 WP12 Meeting @ DESY

Quadrupole Resonator

- **Pillbox-like cavity with four pairwise-connected niobium rods**
- **Quadrupole modes have high magnetic rf-fields on sample surface, decay in coaxial gap**
- **Sample and Resonator thermally decoupled**
- **Calorimetric measurement of RF-losses possible:**
  - **at frequencies = 433, 866, 1300 MHz**
  - **within wide magnetic field range**
- **Samples can be characterized at arbitrary temperatures, also near and above T_c.**
- **Original setup at CERN[1], changes to RF design presented at SRF 2013[2]**
- **Commissioned @ HZB march 2015**
- **Alternative sample geometries under study**





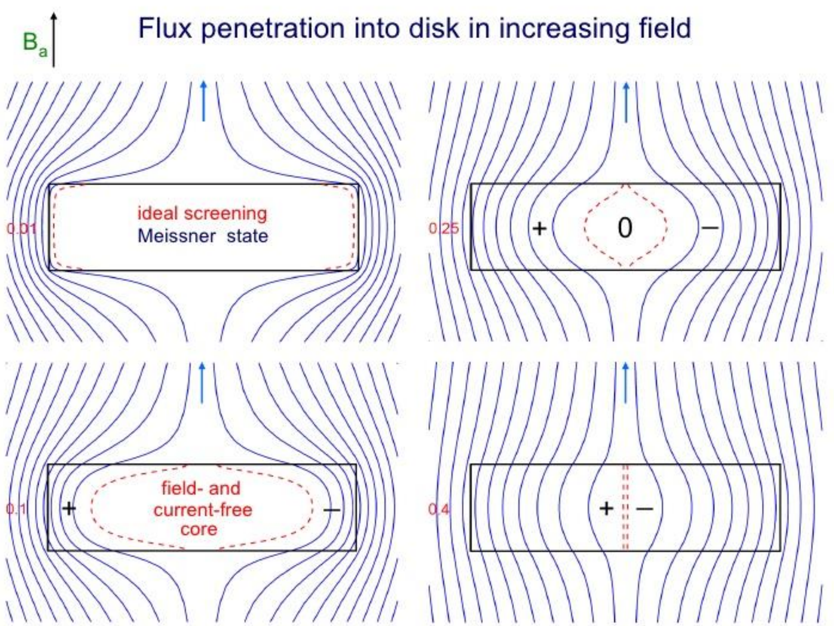


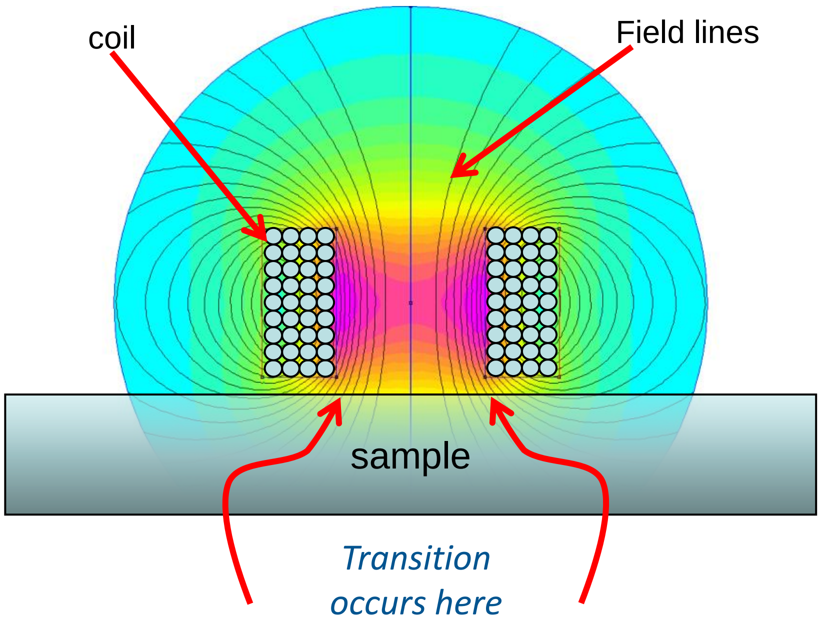
1: E.Haebel et al. „ The Quadrupole Resonator, Design Considerations and Layout of a New Instrument for the RF Characterization of Superconducting Samples “, EPAC 98

2: R.Kleindienst, „Developement of an Optimized Quadrupole Resonator“, SRF 2013

Magnetometry @ Saclay (subtask 3)

- SRF cavities : measuring the ultimate acc. field limits (i.e. when magn. field stats to enter the SC)
- Classical magnetometry not adapted to thin films
  - Field penetration can occur on the back or edges
  - Need to have a local measurement





- Although efficiency demonstrated, under refurbishment => unexpected delays

CONCLUSION

Program under progress

- In most of the labs, the tools are getting close to ready
- Echanges/Tests of samples should start within the next 6-8 months and bring the collaboration into its full potential

Nevertheless some delays are to e expected compare to the initial schedule :

- delay in student hiring,
- experimental drawbacks,
- competition with other projects (resources, manpower, overlapping schedules)

Thank you

Task 12.2 Thin Films

Why thin films ? 2 reasons

Making cheaper cavities :

Bulk like Nb on copper (1-5 µm)

Nb : λ~50 nm => only a few 100s nm of SC necessary

(the remaining thickness= mechanical support only) **=> Make thin films !**

Advantages

- Thermal stability (substrate cavity = copper)
- Cost
- Optimization of R_{BCS} possible (e^- mean free path)

Disadvantages

- Fabrication and surface preparation (at least) as difficult as for bulk
- Superconductivity very sensitive to crystalline quality (lower in thin films for now)

Overcoming Nb monopoly:

Nb_3Sn, MgB_2, Multilayers…

Advantages

- Can also be deposited onto copper
- Higher Tc => higher Q0
- Higher H_{SH} or H_{C1} => higher accelerating field

Disadvantages

- Fabrication and surface preparation (at least) as difficult as for bulk
- Superconductivity very sensitive to crystalline quality (lower in thin films for now)
- Deposition of innovative materials is very difficult (exact composition + structure)
- Theoretical limit (HSH vs HC1) still controverted => choice of ideal material !?

Thin films Challenges:

depends on the strategy

Optimizing structure/composition of the films on samples

Advantages

- Structure /composition can be optimized with conventional techniques
- Ideal structure and composition can be achieved on model sample (guide for deposition of cavities)
- Cost

Disadvantages

- RF performances cannot be directly measured
- **Specific measurement tools need to be developed** (sample cavity, magnetometer…)
- Ultimately a cavity deposition set-up will be needed, but with a known aimed structure

Optimizing deposition inside cavities

Advantages

- RF testing easy and gives direct performance
- Work is done only once, direct cavity production

Disadvantages

- Very heavy and lengthy, many parameters
- Need to develop a specific cavity deposition set-up
- **Difficult to optimize set-up and film together**
- Optimization of the structure/composition of the film is difficult