



Istituto Nazionale di Fisica Nucleare Laboratori Nazionali di Legnaro

#### Current status of 6 GHz DCMS **thick** film deposition

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**thinfilms** and New Ideas for Pushing the Limits of RF Superconductivity

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## Outline

- Why thick films?
- Our approach
- Results:
  - Morphology
  - DC magnetometer
  - RF performances and trapped flux
- Reproducibility issues

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• What is next?

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## Why thick films?



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- ✓ High Q<sub>0</sub>
   ✓ Thermal stability
   ✓ Cost reduction
  - ALPI (LNL-INFN)
  - ISOLDE (CERN)
  - LHC (CERN)
  - LEP2 (CERN)

Why **thick** films?

High Q<sub>0</sub> Thermal stability Cost reduction





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- Nb bulk like properties
- Decrease thermal boundary resistance
- → Palmieri and Vaglio model

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University of Ferrara Palmieri and R. Vaglio, Supercond. Sci. Technol, Jan. 2016





#### Our approach



Total time of process ~ 5 hours

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#### Our approach

Thick film by long pulse deposition



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Larger grains



 $\label{eq:cav21:75} \ \mu m \\ \textbf{500nm} \ \text{single layer thickness} \\$ 



# I. A. Thornton and D. W. Hoffman, "Stress-related effects in thin films," Thin Solid Films, vol. 171, no. 1, pp. 5–31, 1989.



## Our approach



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# "Stress-related effects in thin films," 5–31, 1989. I. A. Thornton and D. W. Hoffman, <sup>•</sup> Thin Solid Films, vol. 171, no. 1, pp.



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Long pulse deposition

**One pulse deposition** 











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Long pulse deposition

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Directional

growth









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Courtesy of Reza Valizadeh (STFC)

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Regulus 1.5kV x1.00k PDBSE(CP)

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Cavity 21. Single layer thickness 500nm

#### Results: DC magnetometry



section view

#### Results: DC magnetometry



stripped Nb film on Kapton tape @ 4,2 K Courtesy of Reza Valizadeh (STFC, All measurements were done on

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Single layer thickness dependence



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Single layer thickness dependence



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Nb04



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## Results: RF performances (Trapped flux)

It is needed more statistic to confirm but this data indicates that **Nb bulk** cavities are more sensitive to magnetic field respect to **thin film** cavities, as expected

Effect higher in Bulk Nb. **Thick** films effect?...

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#### Vibrotumbling

Substrate defects

Defects that may prevailed after chemical treatments and are reproduced by sputtering

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400 um 100 um rraphy analysis ihari (STFC)







#### Vibrotumbling

Substrate defects

Defects that may prevailed after chemical treatments and are reproduced by sputtering

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400 um 100 um tomography analysis



#### **Plasma Electrolytic Polishing?**

Plasma electrolytic polishing technology as a modern, powerful, and green way to prepare surfaces for SRF Dr Eduard Chyhyrynets

yrynets (LNL)



computed

#### Defects

Crack observed

 HV
 curr
 WD
 tilt
 HFW
 mag tett
 20 µm
 100 µm

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#### FIB Cross-section







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of S.

Courtesy

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 HFW
 WD
 HV
 tilt
 mag ⊞
 curr

 19.9 μm
 10.1 mm
 5.00 kV
 54 °
 7 500 x
 9.47 nÅ

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Old

Hot leaks



I Copper gasket 2 Viton o-rings

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Re-design of source

<image>

New



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- Study on QuadruPole Resonator (QPR) samples of Nb thick film on Cu to be characterized by a different RF technique (Collaboration with HZB).
- Test were made already to optimize coating conditions



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- Scaling of 6 GHz system and coating
  - approaches into 1,3 GHz cavities
    - Post magnetron configuration
    - Cavity inside vacuum system



10 cm

6 GHz

- Scaling from 6 GHz to 1,3 GHz
  - Post magnetron configuration
  - Cavity inside vacuum chamber
  - High temperature (550°C)







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- Scaling from 6 GHz to 1,3 GHz
  - Post magnetron configuration
  - Cavity inside vacuum chamber
  - High temperature?

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Phase of design

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Material science and technology for nuclear physics service

Special thanks to my colleagues!



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# Thank you for your attention!

