





# New Magnetron configurations for sputtered Nb onto Cu

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#### **CERN** geometry



C. Benvenuti, S. Calatroni, I.E. Campisi, P. Darriulat, M.A. Peck, R. Russo, A.-M. Valente, "*Study of the surface resistance of superconducting niobium films at 1.5 GHz*", Physica C 316 (1999) 153-188.

#### **Cylindrical Magnetron**



#### Understanding:

• Film morphology strictly correlated to the deposition angle

Electrical and superconducting film properties degrade vs deposition angle



 Comprehension of sputtering principles is compulsory for conceiving new magnetron configurations

#### Deposition technique: magnetron sputtering



#### Ideas to improve the film quality:

**1. Increasing the sputtering rate R** 

$$f_i = \frac{N_i \alpha_i}{N_i \alpha_i + R}$$

 $f_i$  = Fraction of impurities trapped into the film α<sub>i</sub> = Impurities sticking coefficient

N<sub>i</sub> = Number of atoms impurities arriving on the film surface



2 inches planar target



2 inches squared target



#### 2 inches rounded target









#### Niobium ring positioned in the cell center



#### Ideas to improve the film quality:

- 1. Increasing the sputtering rate **R**
- 2. Reducing the deposition angle
- 3. Promoting atoms rearrangement and impurities re-sputtering during film growing

$$f_i = \frac{(N_i \alpha_i - \beta)}{(N_i \alpha_i - \beta) + R}$$

- f<sub>i</sub> = fraction of impurities trapped into the film
- $\alpha_i$  = impurities sticking coefficient
- $N_i$  = atoms impurities arriving on the film
- B = function of the bias current due to impurities ions
- **R** = sputtering rate

#### **Biased Diode Sputtering**





#### Bias LNL Up to now

The bias technique is highly reliable: over 40 QWRs are installed and working at LNL



#### **Biased grid**





















#### Ideas to improve the film quality:

- 1. Increasing the sputtering rate **R**
- 2. Reducing the deposition angle
- 3. Promoting atoms rearrangement and impurities re-sputtering during film growing

# 4. Increase the cathode/substrate area ratio

#### **Biased Diode Sputtering**



#### Cavity shaped cathode





High ratio cathode/substrate area



## Cavity shaped cathode



in progress...



# Three new magnetron sputtering configurations are ready!

#### ...soon 20 cavities to measure.



#### **Cylindrical Post-Magnetron**



Magnetic field lines follow the cavity shape



Niobium cathode

# Optimizing new magnetron sputtering configurations is compulsory for achieving!

