Progress on Nb_3Sn and V_3Si

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Nb_3Sn

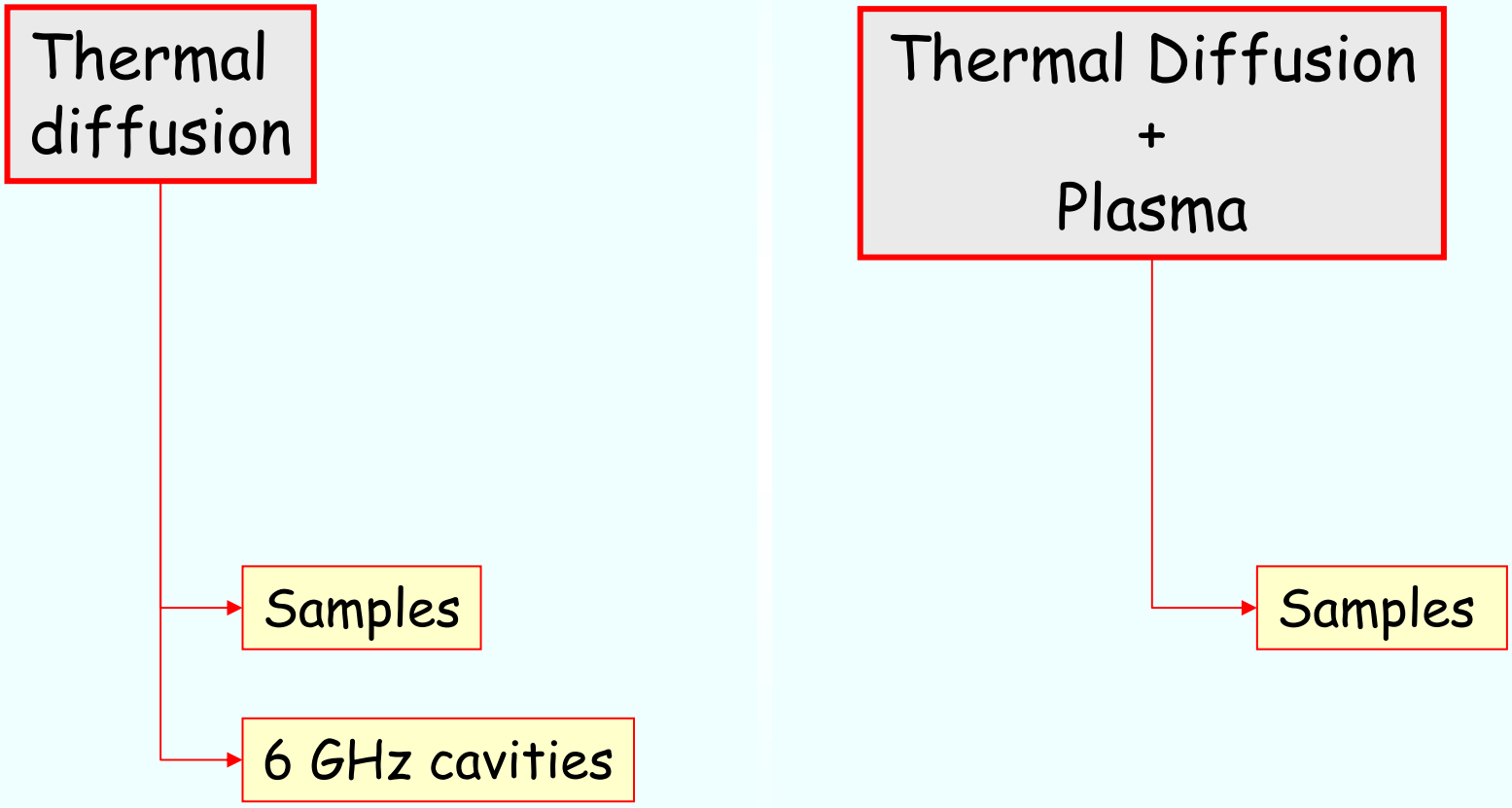
Tin Diffusion

- Liquid Sn diffusion
  - Hybrid Process
    - Samples
    - 6 GHz
  - Double Furnace System
- Mechanical Plating
  - 6 GHz

Multilayer

- Double Magnetron
  - Samples
- Post Magnetron
  - Samples
  - 6 GHz

V_3Si


Thermal diffusion
Samples
6 GHz cavities
Thermal Diffusion
+
Plasma
Samples

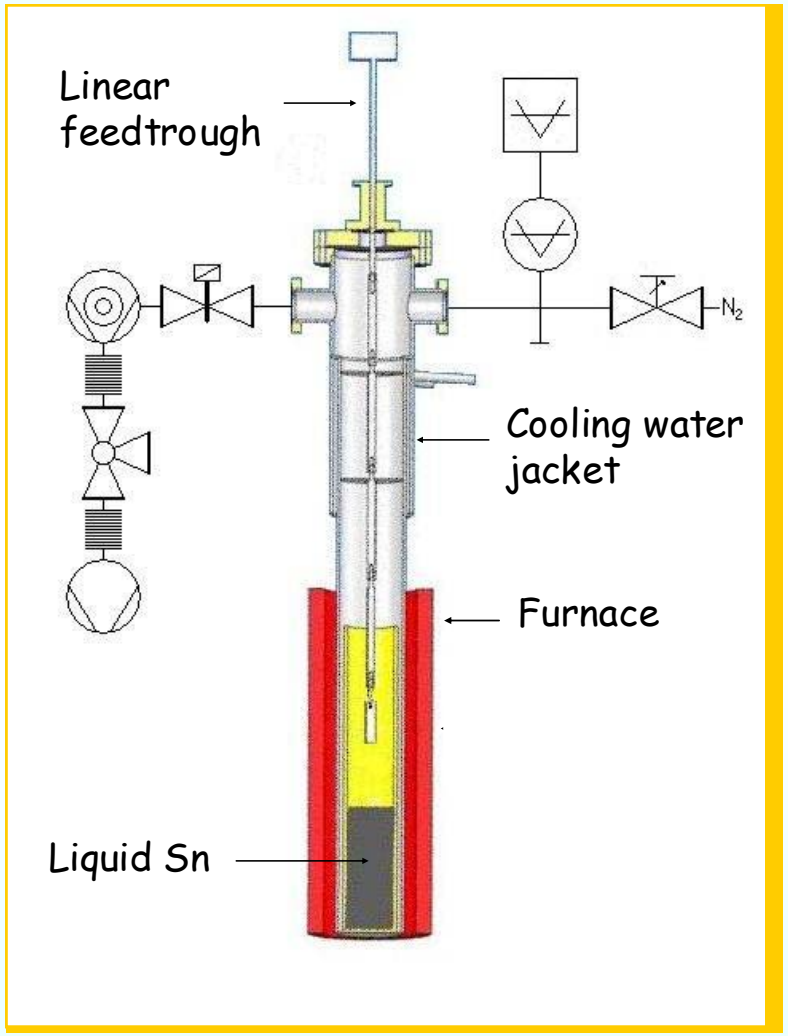
Liquid Sn Diffusion

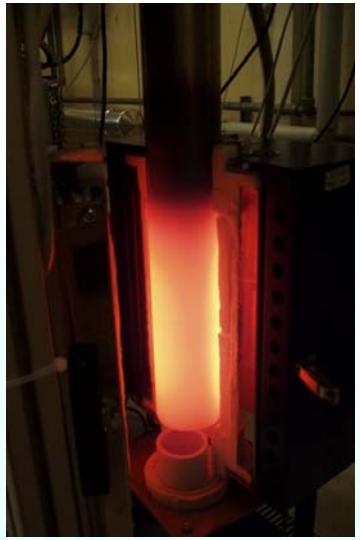
Nb_3Sn can be obtained using different techniques:

- Bronze Process,
- Vapor Sn diffusion (Wuppertal),
- Liquid Phase Diffusion ⇒ **Annealing**

- No nucleation sites on Nb are required
- Fast growth of Nb_3Sn layer

Liquid Sn Diffusion





Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

Post Magnetron

V_3Si

Thermal diffusion

Thermal Diffusion + Plasma

Hybrid Process

Cornell Workshop → Peking Workshop → Peking Workshop

1 step

↓

Sn vapor Annealing

↓

- residual Sn
- spurious phases

2 steps

↓

Vacuum Annealing

↓

- low T_cs
- spurious phases

Now: ***Hybrid***

↓

Sn vapor Annealing

+

Vacuum Annealing

↓

Good T_cs,
No residual Sn,
No spurious phases

Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

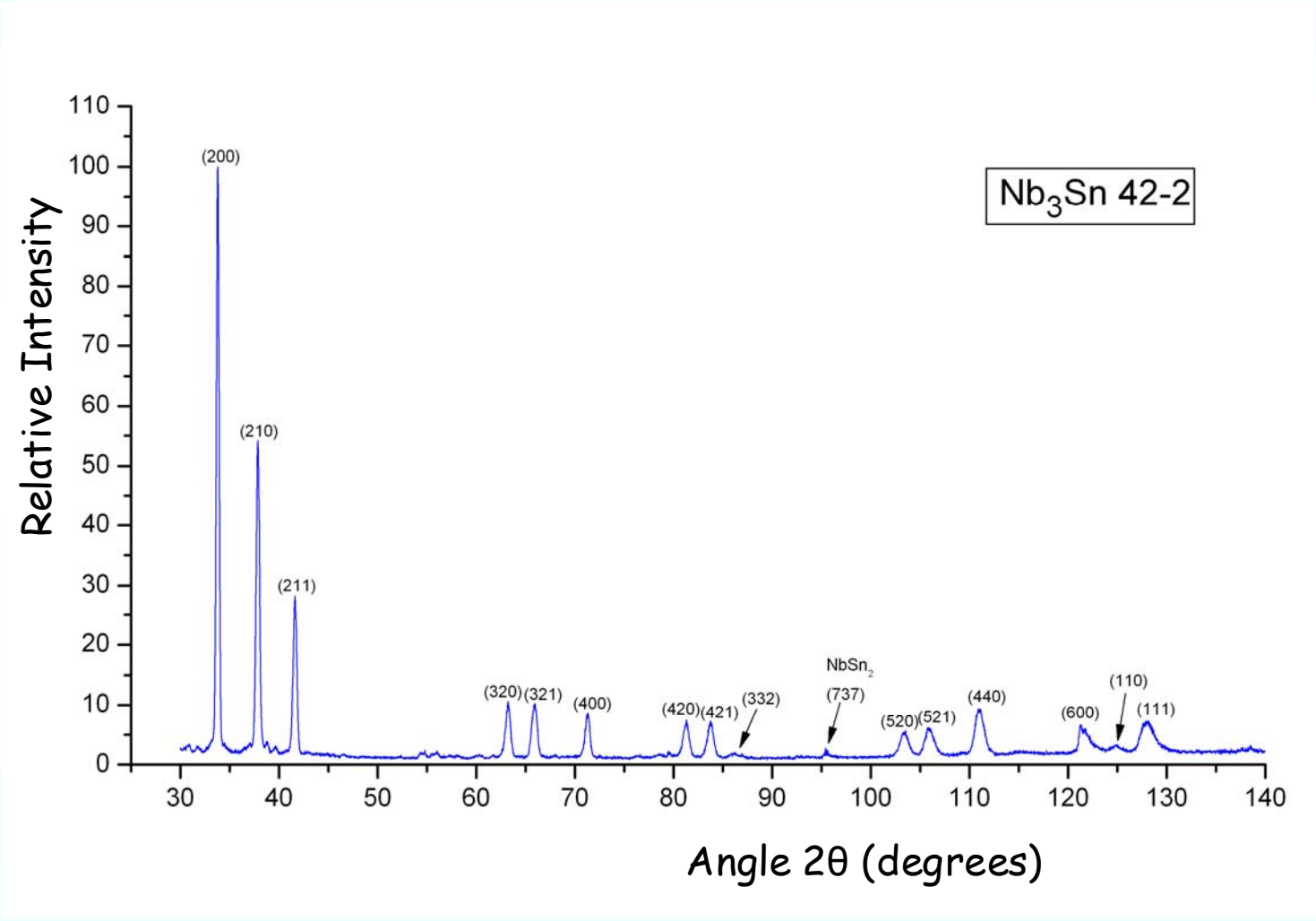
Post Magnetron

V_3Si

Thermal diffusion

Thermal Diffusion + Plasma

Hybrid Process: Samples



Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

Post Magnetron

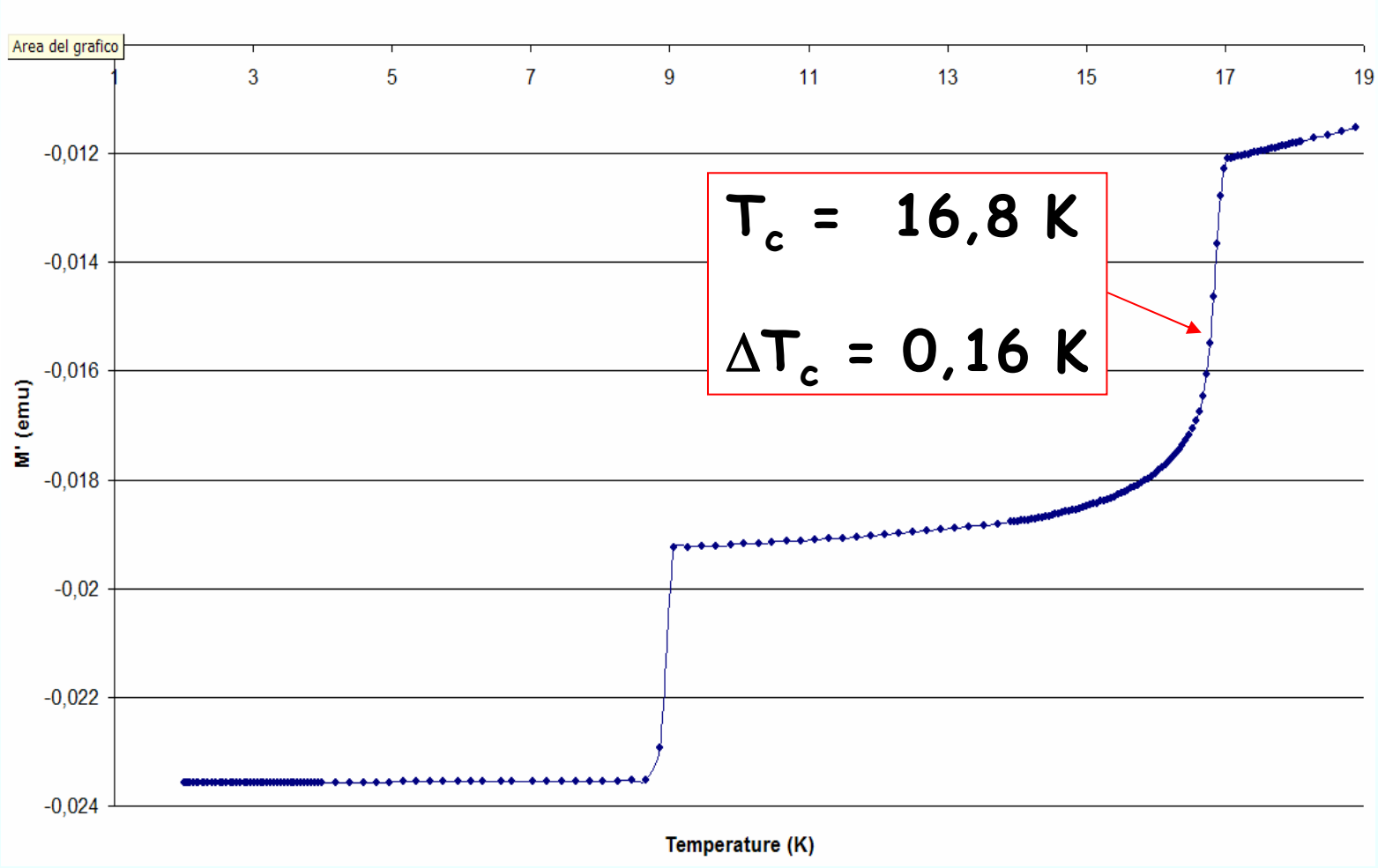
V_3Si

Thermal diffusion

Thermal Diffusion + Plasma

Hybrid Process: Samples

$T = 975^\circ C$, $t_{Dipp} = 30'$, Ann_{Sn} t = 2h, Ann_V t =



Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

Post Magnetron

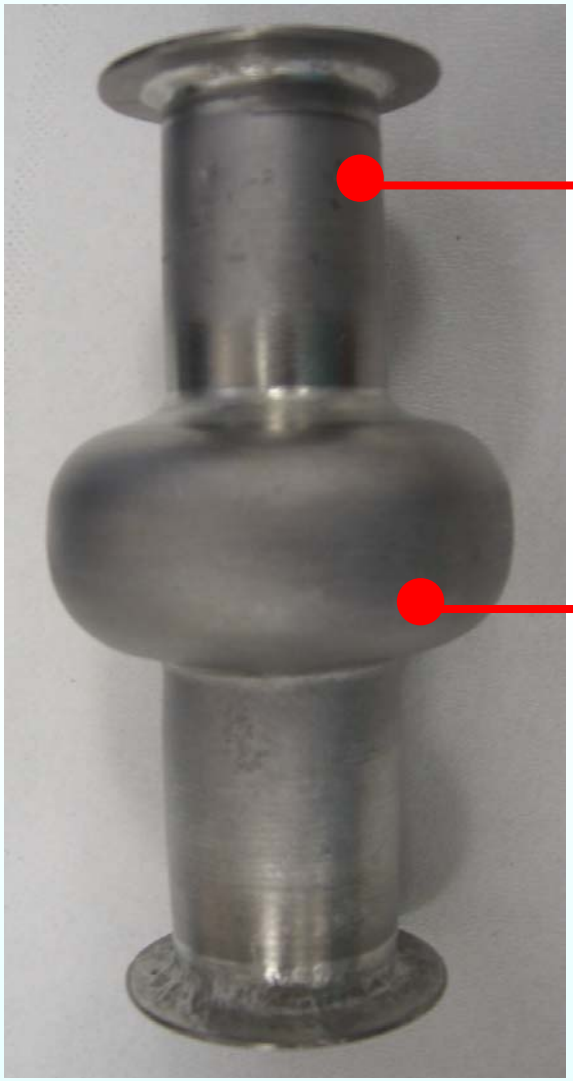
V_3Si

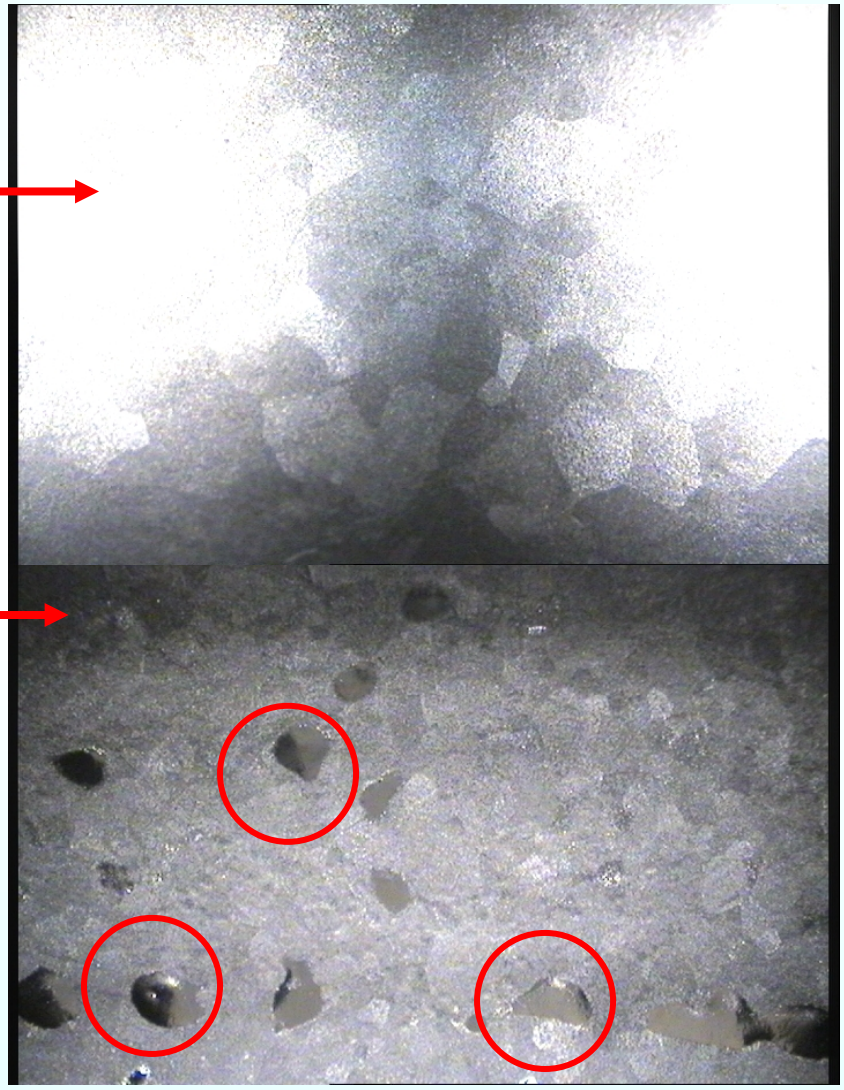
Thermal diffusion

Thermal Diffusion + Plasma

Hybrid Process: 6 GHz cavities

"Hybrid" Method for **Nb_3Sn 6 GHz Cavities**





Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

Post Magnetron

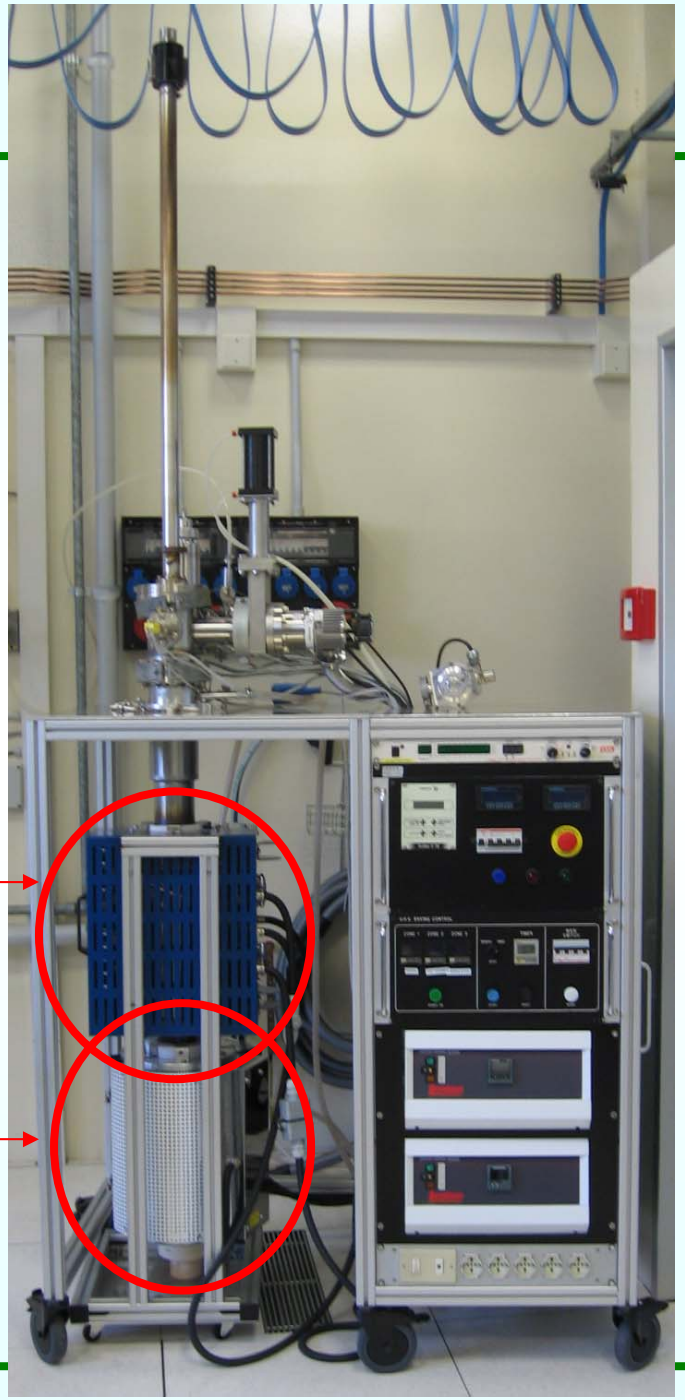
V_3Si

Thermal diffusion

Thermal Diffusion + Plasma

Double Furnace System

Built to avoid air contamination of the superconducting thin film while opening the vacuum system



Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

Post Magnetron

V_3Si

Thermal diffusion

Thermal Diffusion + Plasma

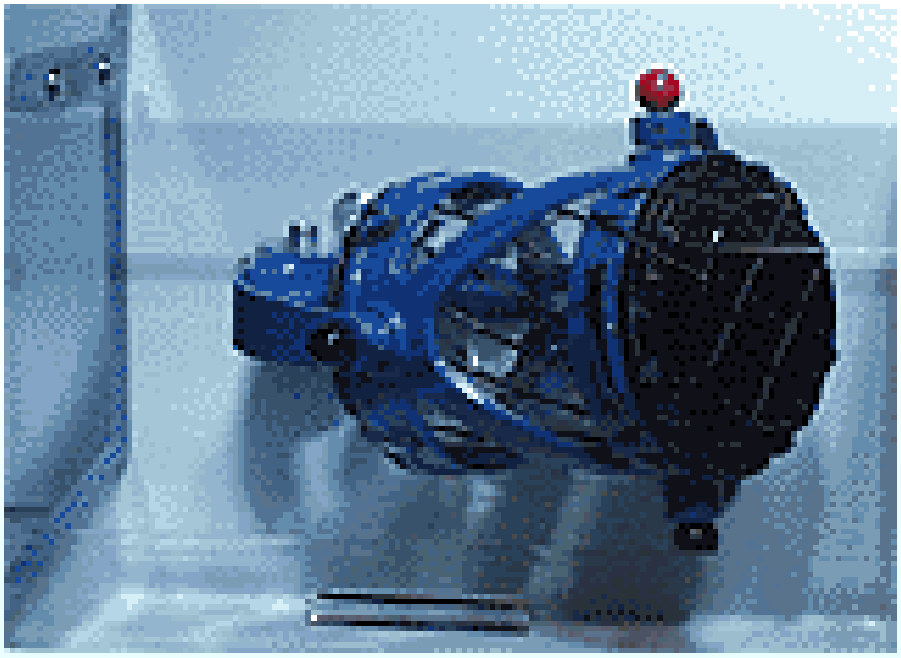
Mechanical Plating

Preliminary preparation:

Cavity
- Mechanical etching
- Chemical etching (1:1:1)

Sn pieces
- Ultra sonic cleaning

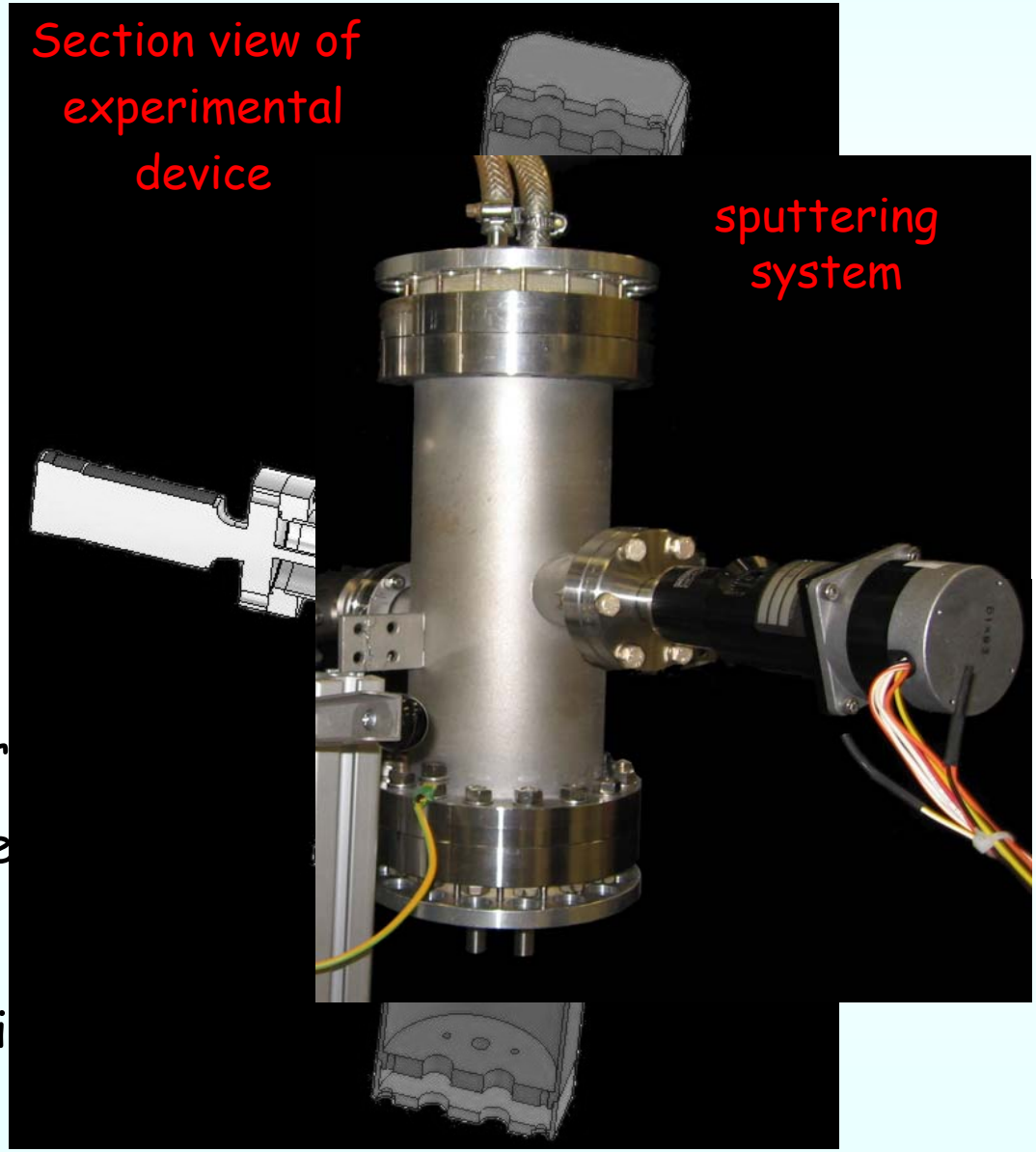
A 6 GHz cavity in the working tumbler



Sn pieces after the treatment

Nb_3Sn
Liquid Sn diffusion
Mechanical Plating
Double Magnetron
Post Magnetron
V_3Si
Thermal diffusion
Thermal Diffusion + Plasma

Multilayer: Double Magnetron



- ✓Balanced Magnetr
- ✓Target-Substrate distance = 60 mm
- ✓2 inches target di

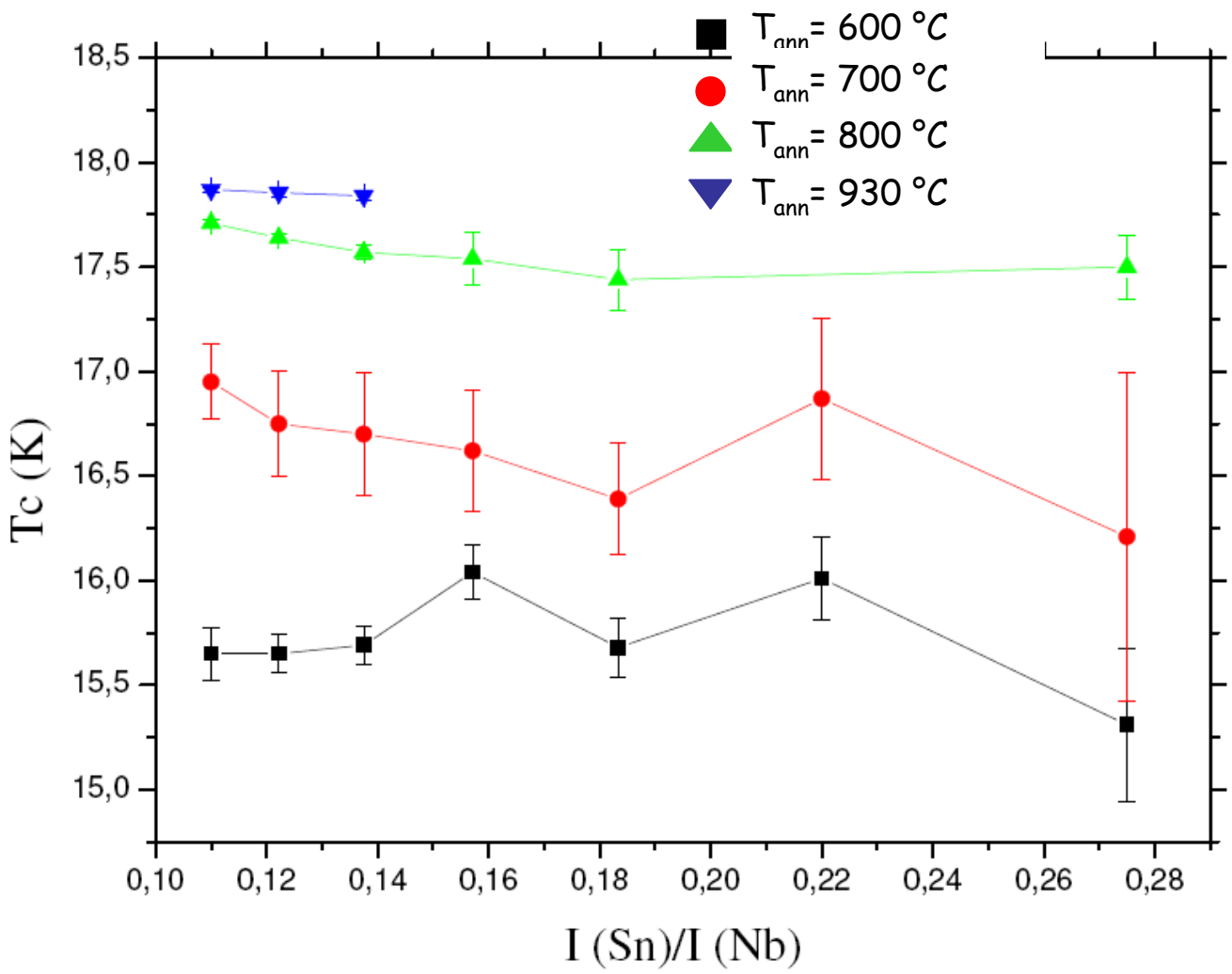
Nb_3Sn

- Liquid Sn diffusion
- Mechanical Plating
- **Double Magnetron**
- Post Magnetron

V_3Si

- Thermal diffusion
- Thermal Diffusion + Plasma

Double Magnetron: Samples



Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

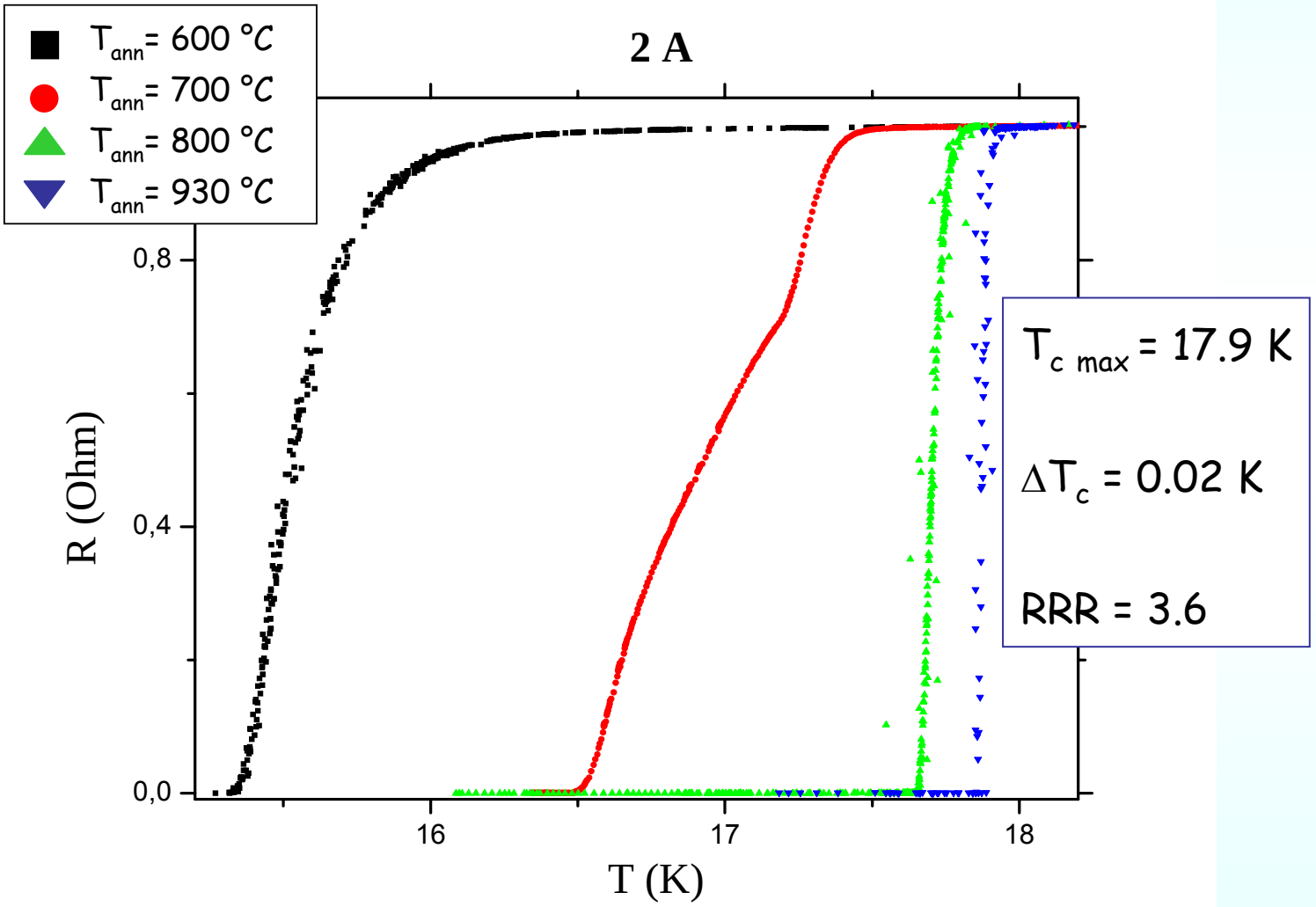
Post Magnetron

V_3Si

Thermal diffusion

Thermal Diffusion + Plasma

Double Magnetron: Samples



Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

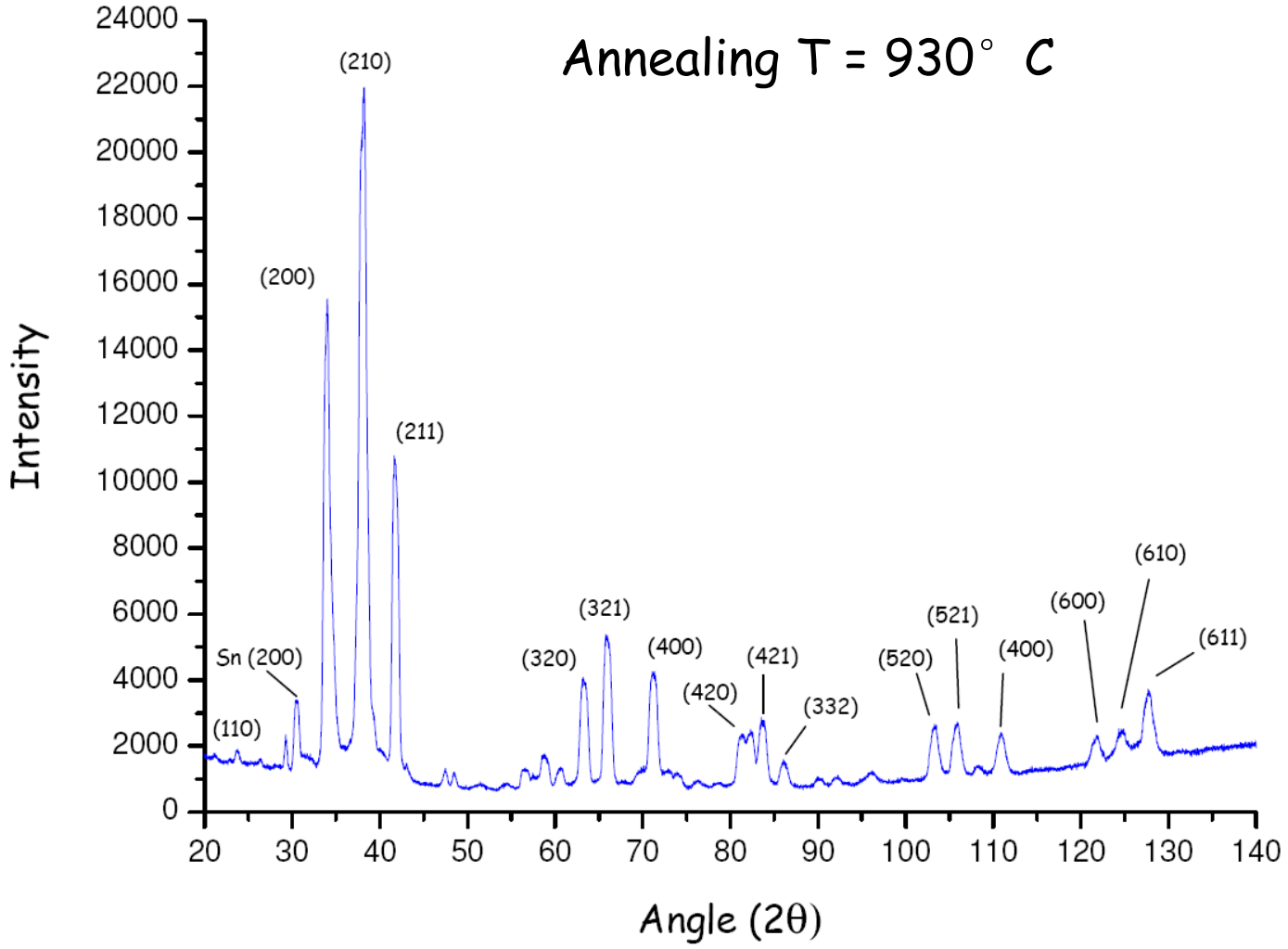
Post Magnetron

V_3Si

Thermal diffusion

Thermal Diffusion + Plasma

Double Magnetron: Samples



Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

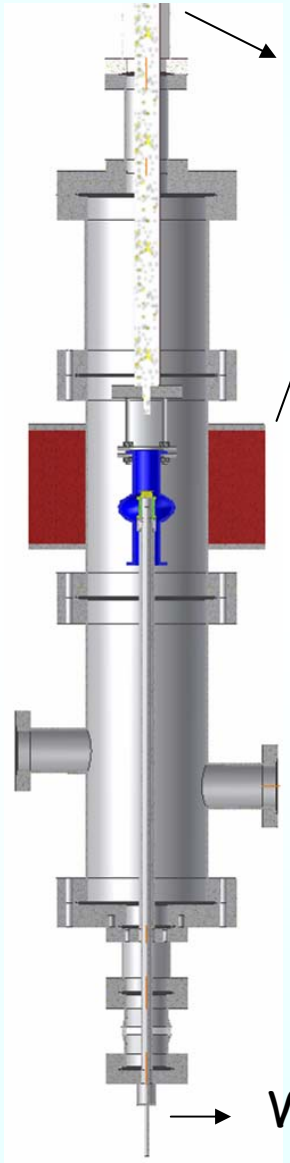
Post Magnetron

V_3Si

Thermal diffusion

Thermal Diffusion + Plasma

Post Magnetron: 6 GHz Cavities



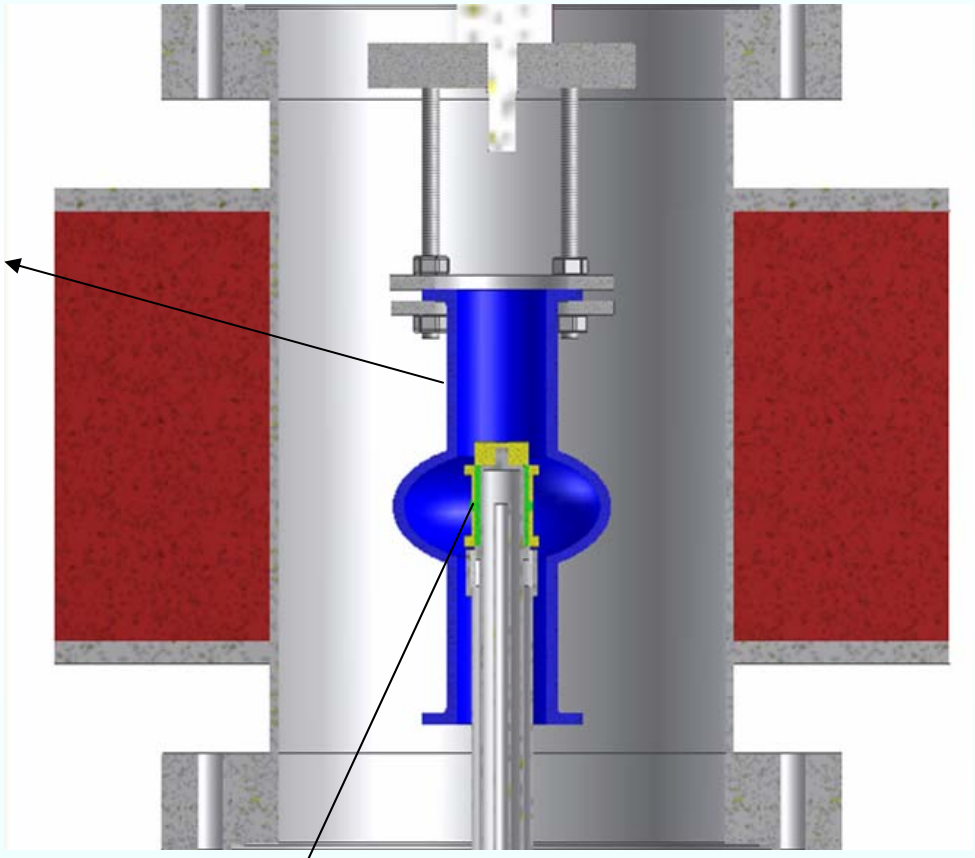
Linear Feedthrough

Coil

Cavity

Window

Water Cooling



Cathode Nb(Yellow)/Sn(Green)

Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

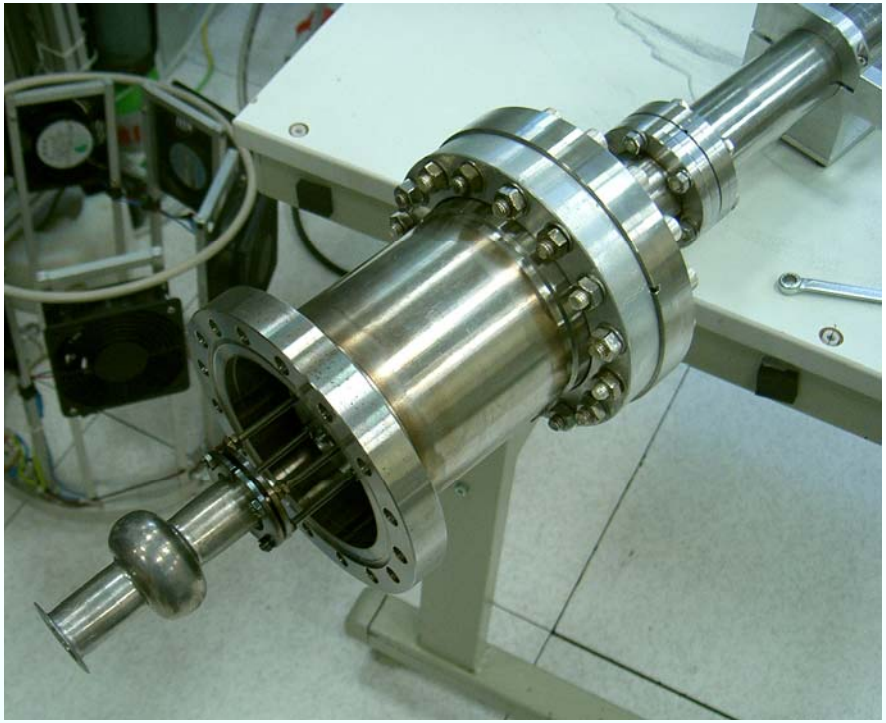
Post Magnetron

V_3Si

Thermal diffusion

Thermal Diffusion + Plasma

Post Magnetron: 6 GHz Cavities



Post Magnetron: 6 GHz Cavities

Time of sputtering: 70 min

Annealing Time: 1 h at 850°C

Four hypotheses:

1) **Sn evaporation** due to plasma interaction with the growing film

2) Too **thin Film**

3) **Spurious phases** presence (slow annealing ramp time)

4) We suspect the **substrate treatment** requires even more attention

Thermal Diffusion

Research for the **best Chemical Treatment of V**

- **SiH_4 Decomposition**
- **Si Diffusion**
- **V_3Si Nucleation**

- **Film Growing**
- **Recrystallization**
- **H_2 Removal**

Variables: T, t, p(SiH_4)

Nb_3Sn
Liquid Sn diffusion
Mechanical Plating
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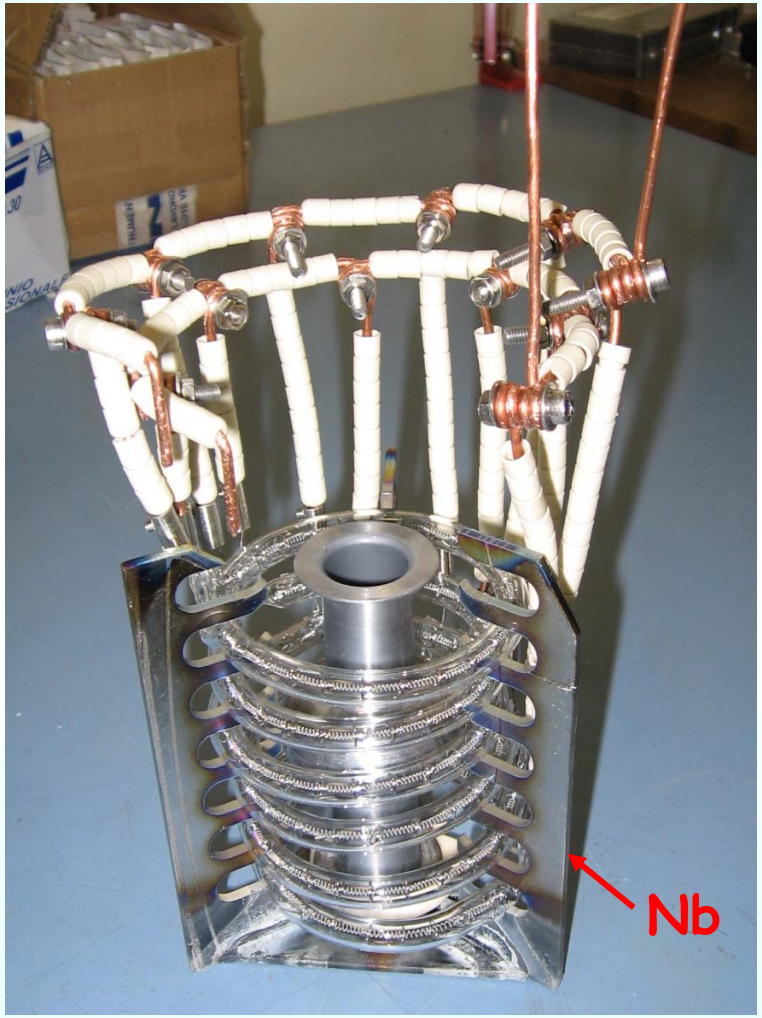
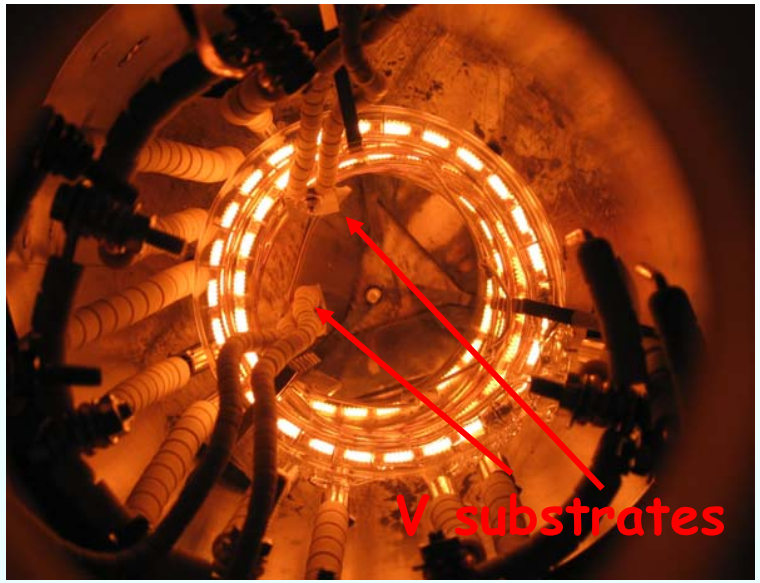
Post Magnetron
V_3Si
Thermal diffusion
Thermal Diffusion + Plasma

Thermal Diffusion: Experimental SetUp





Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

Post Magnetron

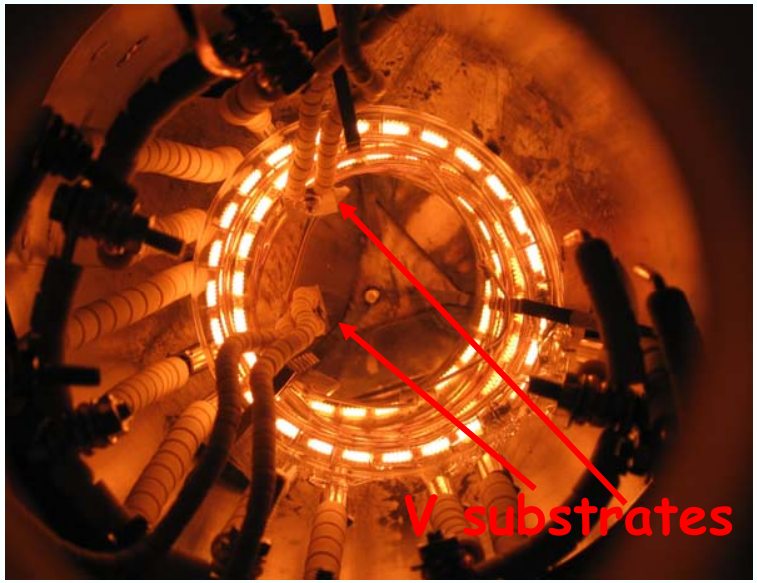
V_3Si

Thermal diffusion

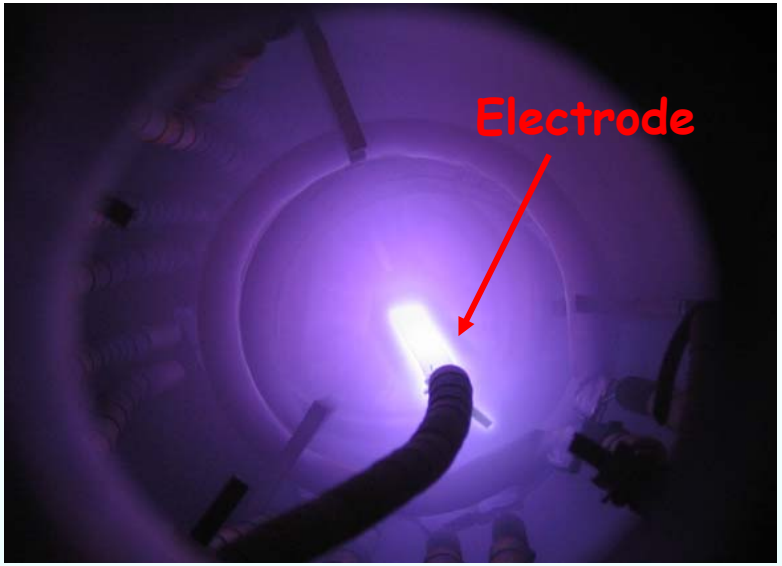
Thermal Diffusion + Plasma

Thermal Diffusion + Plasma: Experimental SetUp

Lamps on



Plasma on



Nb_3Sn

Liquid Sn diffusion

Mechanical Plating

Double Magnetron

Post Magnetron

V_3Si

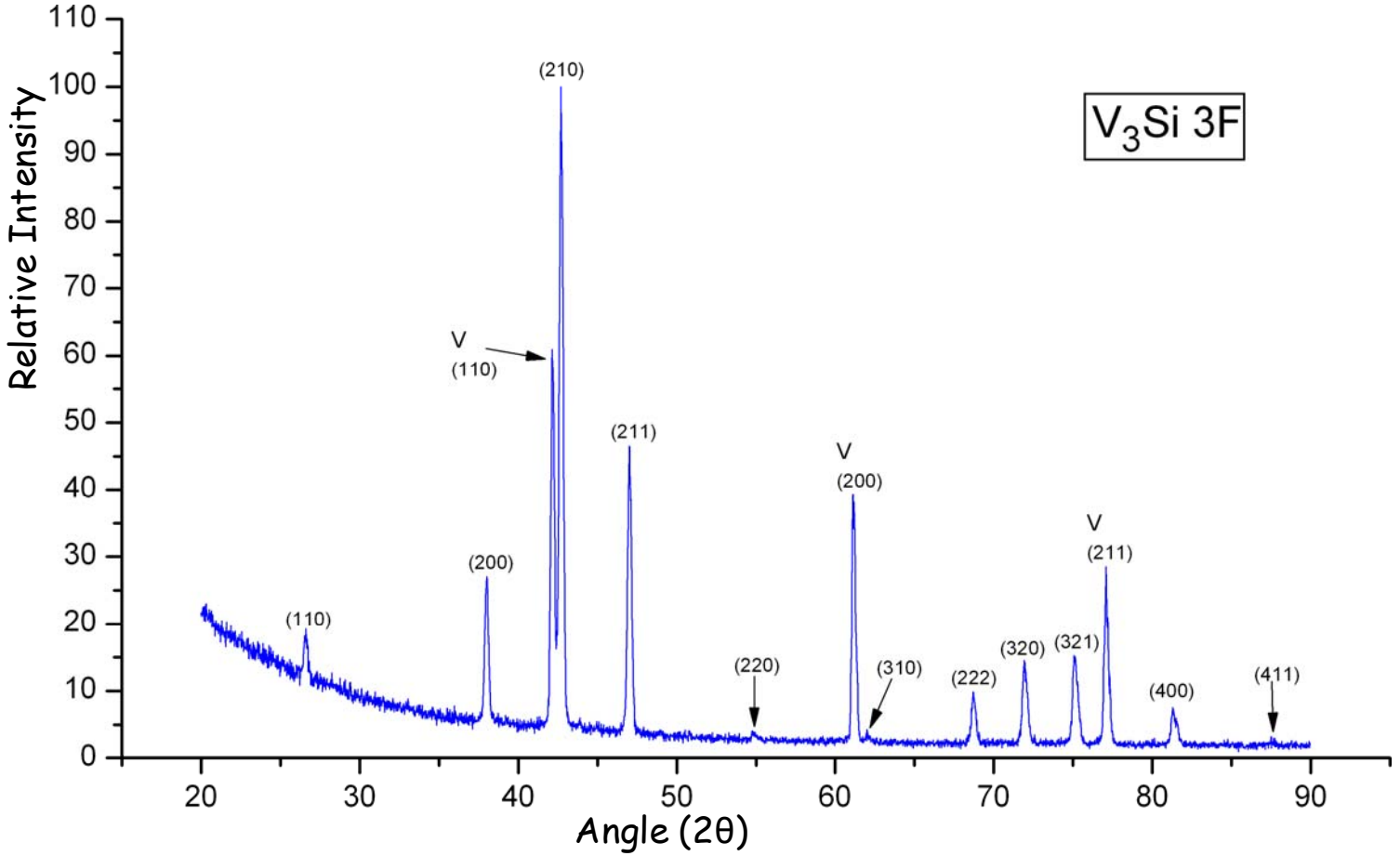
Thermal diffusion

Thermal Diffusion + Plasma

Thermal Diffusion: Samples

Process T = 825° C, p (SiH_4) = 5,0x 10^{-4} mbar

Silanization t = 10h, Annealing t = 20h



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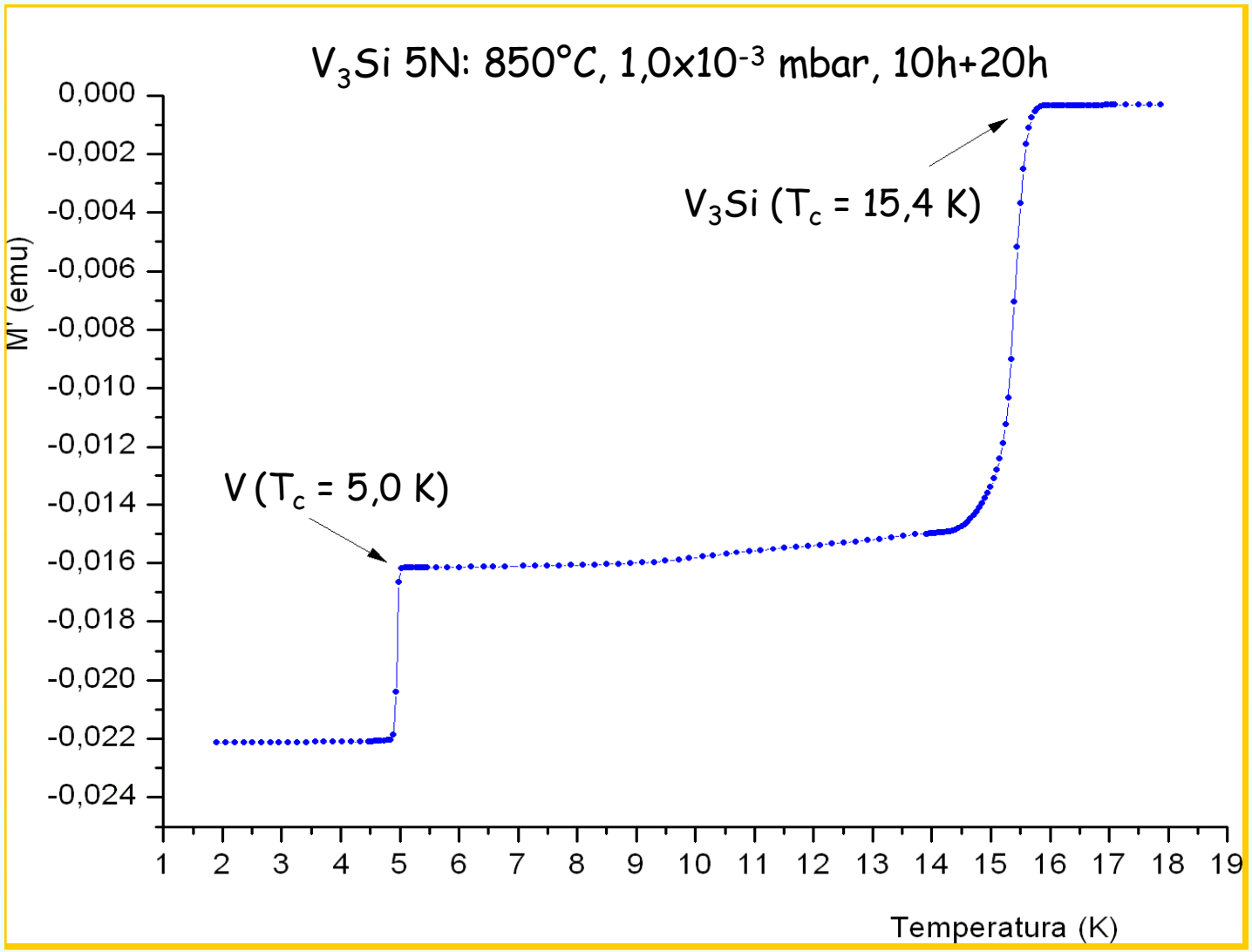
Thermal Diffusion: Samples



Nb_3Sn
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Thermal Diffusion + Plasma

Summary

Nb_3Sn

1) Sn diffusion:

T_c = 16,8 K, ΔT_c = 0,16 K,

Nb_3Sn 6 GHz cavities has been produced

2) **Multilayer:**

Double Magnetron: **T_c = 17.9 K, ΔT_c = 0.02 K**

Post Magnetron: the first **Nb_3Sn 6 GHz cavity** has been measured

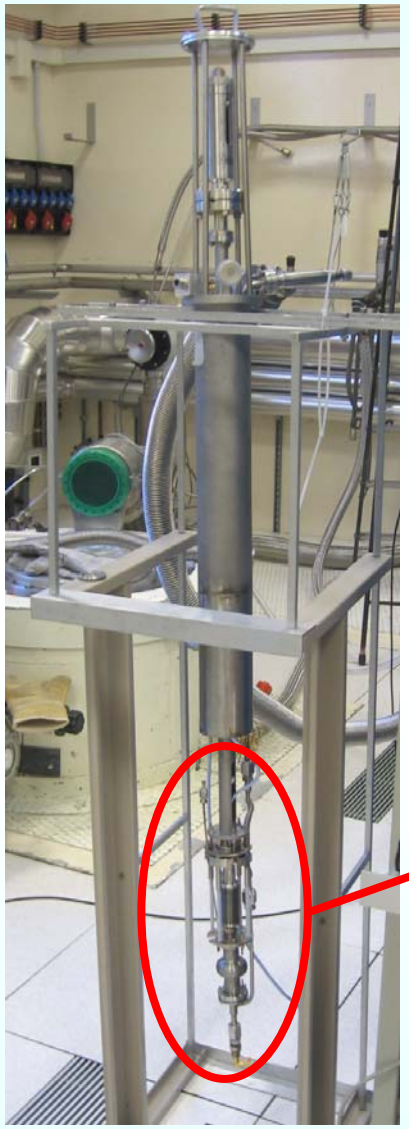
V_3Si

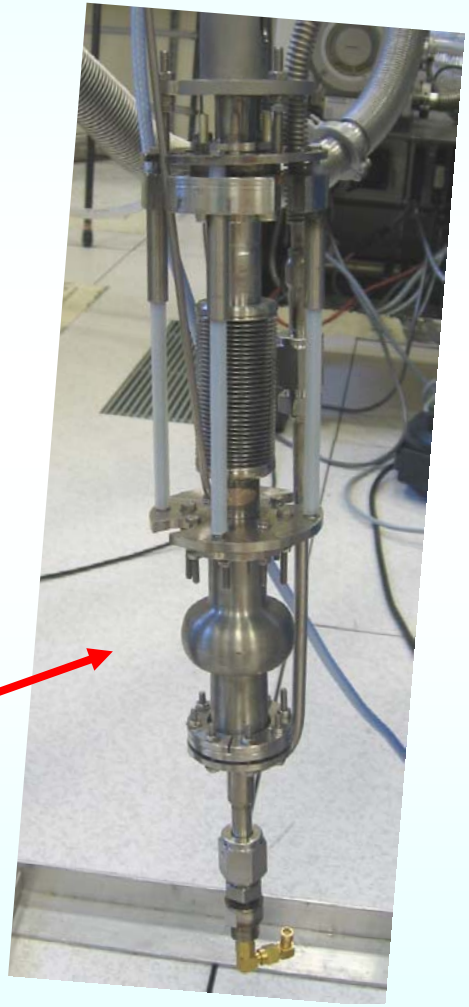
1) Plasma Silanization:

T_c = 15.7 K, ΔT_c = 0.2 K

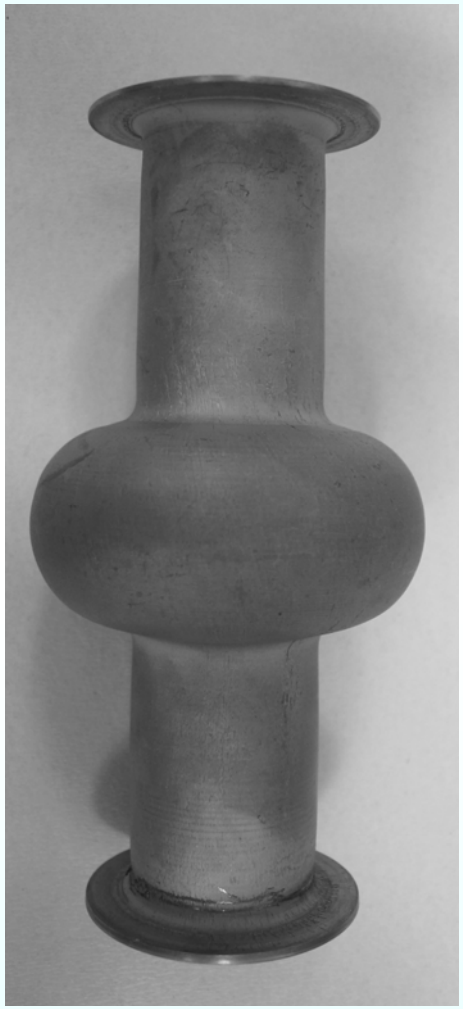
2) **V_3Si 6 GHz cavity obtained:** Work in progress

Good News Allen: 6 GHz Cavities





6 GHz Cavities



- 80 cavities are under fabrication using **Scrap Nb**
- Flanges are **seamless**: no brazing, no EB welding
- **It is possible to perform more than one RF test a day**

The End

NO SAMPLE IS COMPARABLE TO A CAVITY!