Progress with QPR at CERN

The 16th ARIES WP15 meeting

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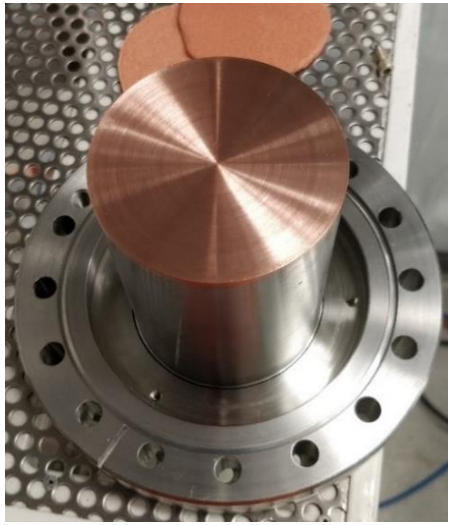
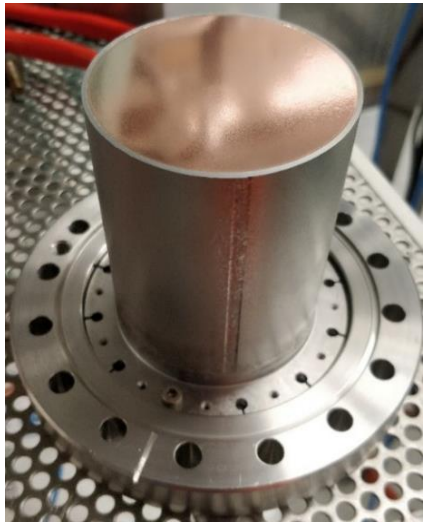
3rd December 2020

HZB2.2 sample: HiPIMS Nb on Cu

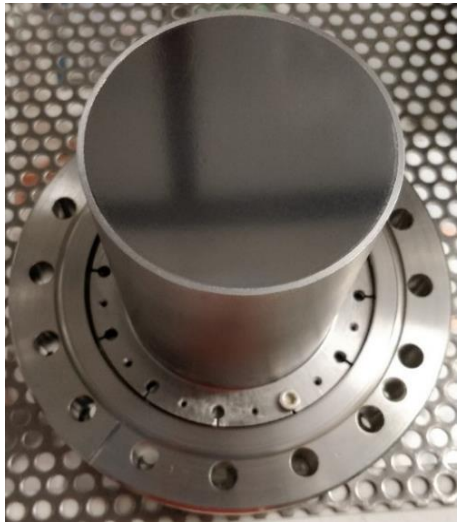
Coating



QPR sample holder



QPR sample mounted



After coating

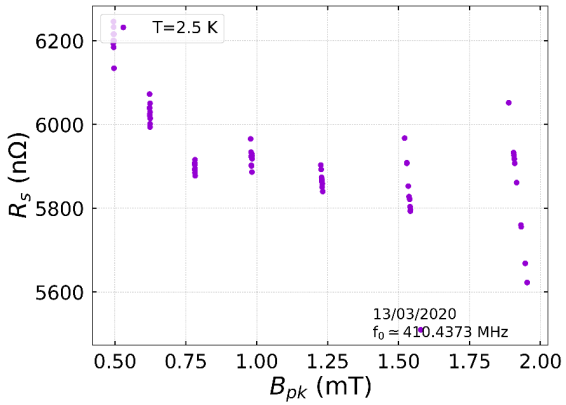
A happy ESR ☺

- Sample striped
- SUBU (20min)
- HPWR
- Coating HiPIMS / -50V bias.
- Final thickness ~ 8µm

HZB2.2 sample: HiPIMS Nb on Cu

The sample was going to be used for benchmarking:

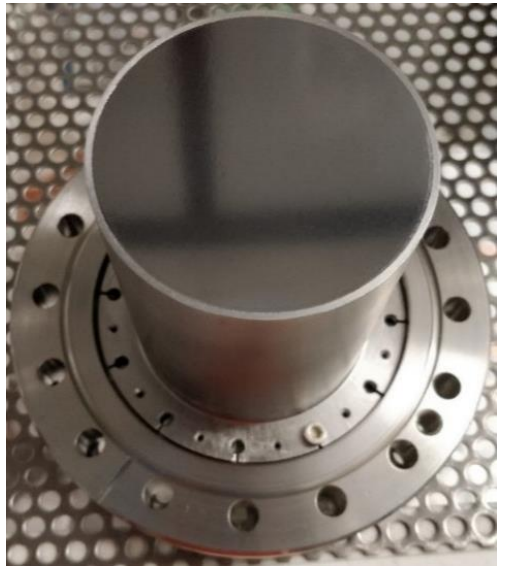
Rs vs Bpk @400MHz



Old QPR

Cancelled

New QPR



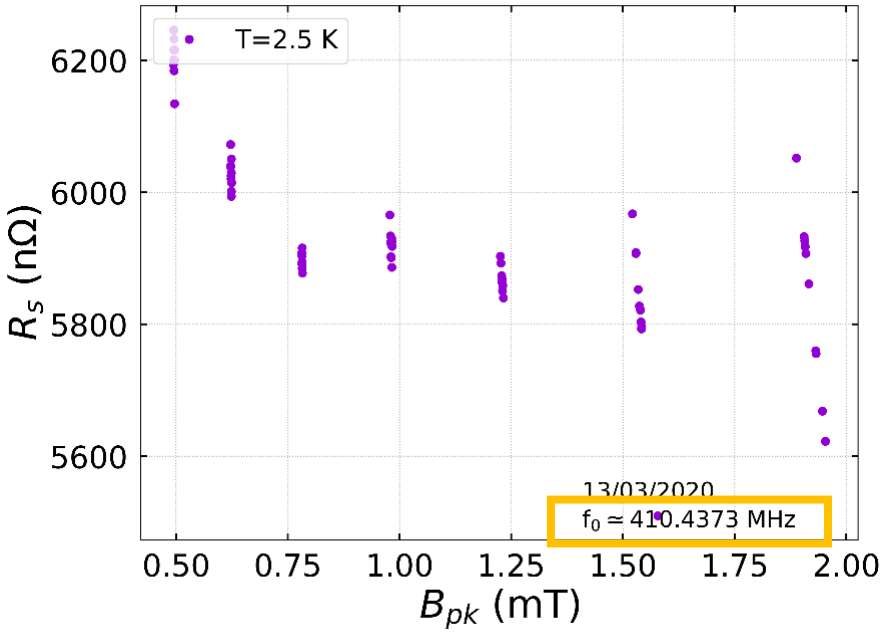
Output:

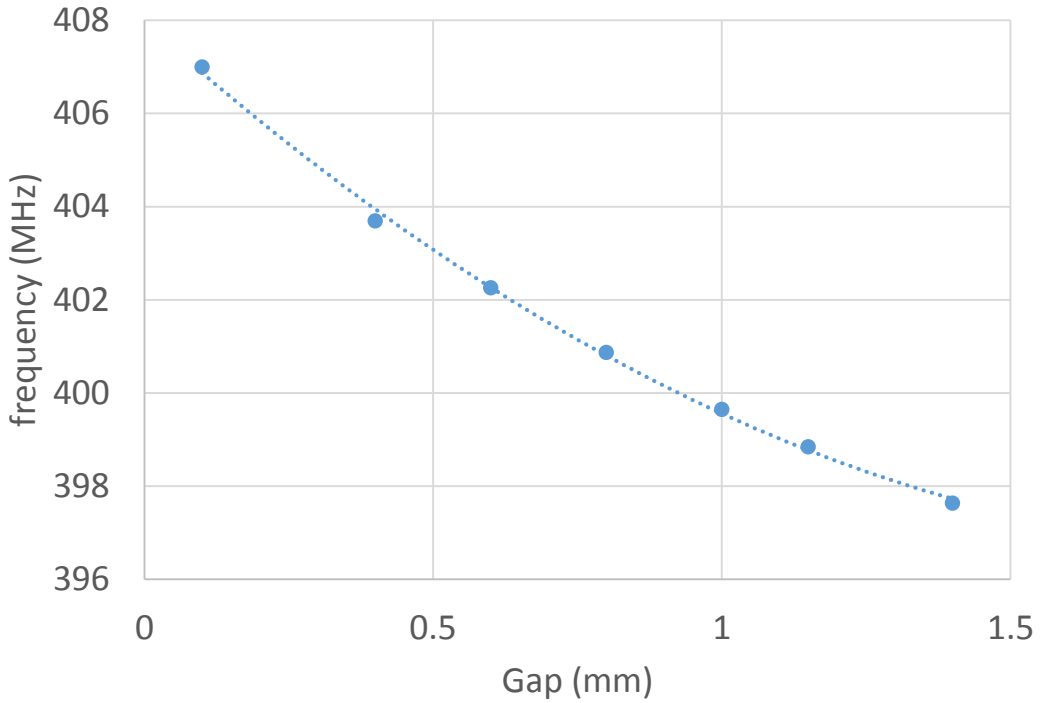
- It was first mounted in January 2020, but test was aborted due to vacuum leaks through indium seal of dismountable sample.
- It was again mounted in March 2020: Only one day of measurements was possible due to Covid-19 restrictions to work onsite. Results were very bad.

Cause:

- After dismounting we discover that the sample was wrongly assembled and it was touching the rods.

Lessons learned from HZB2.2 measurements in old QPR





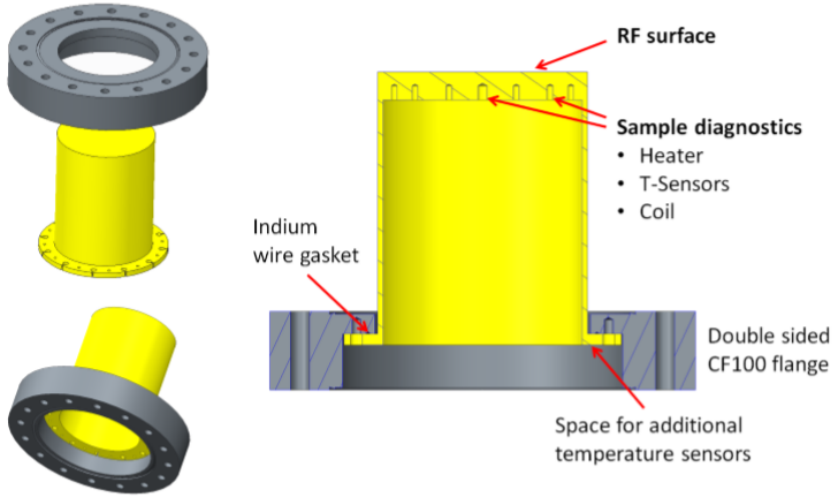
- Extremely high values for a bulk Nb sample.
- The resonance frequency was 410 MHz!

Lessons learned from HZB2.2 measurements in old QPR

NEW SAMPLE HOLDER

Up to now
Niobium sample brazed into stainless steel flange
⇒ No heat treatments of sample assembly possible (few hundred °C max.)

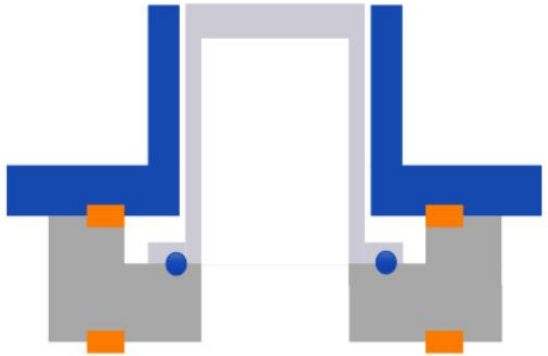
Workaround: Electron-beam weld on niobium part after treatment
⇒ Possible impact on relevant material properties of the sample

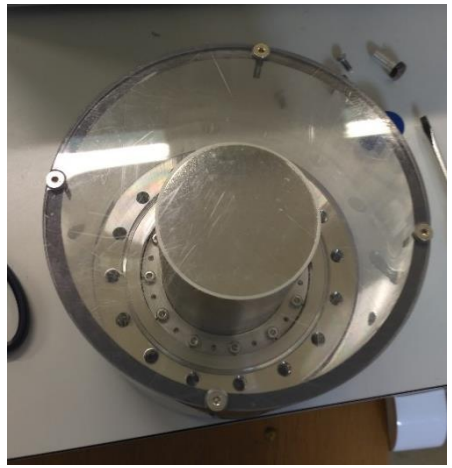


New sample holder design
Connection with titanium screws and indium wire gasket
⇒ Pure Nb sample allows high T treatments (Nb_3Sn coating, N doping/infusion, …)
⇒ UHV compatible at RT and in LHe
⇒ Opportunity for additional temperature sensors
⇒ Exchangeability between QPRs at CERN and HZB

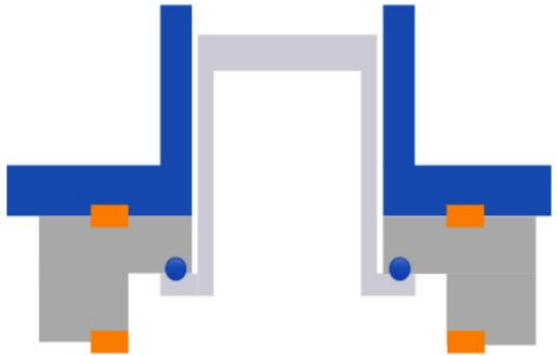
https://accelconf.web.cern.ch/srf2017/posters/thpb053_poster.pdf

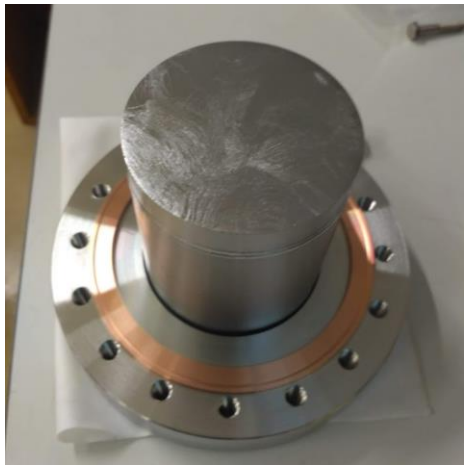
How it was



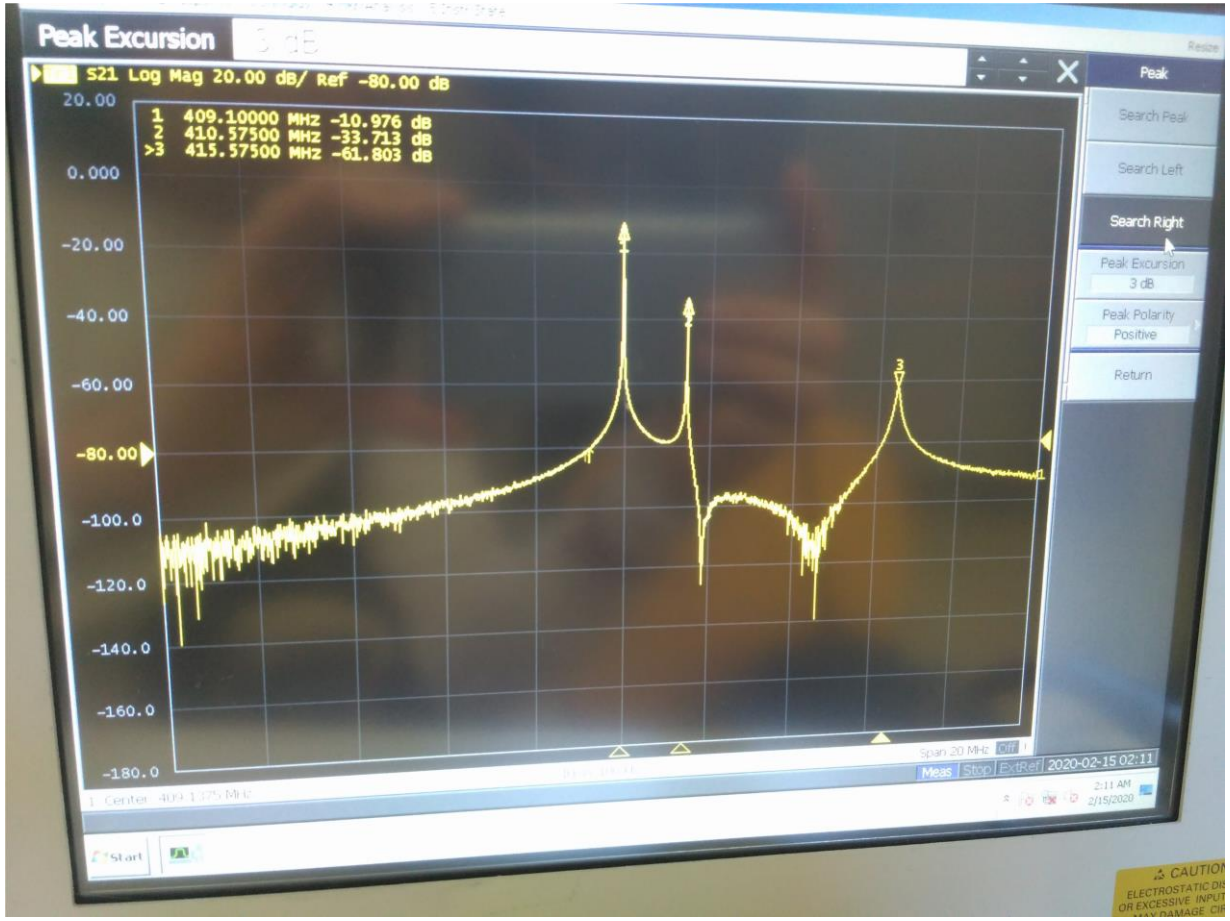


How it should be





Lessons learned from last HZB2.2 measurements in old QPR



During the measurements, three frequency peaks were found very close:

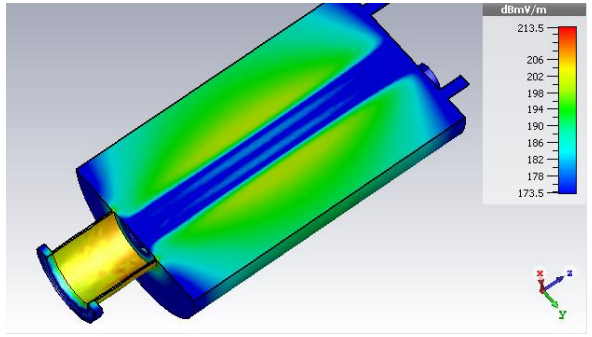
- 409.1 MHz
- 410.57 MHz
- 415.575 MHz

These three peaks have been predicted in simulations when touching the rods, confirming the hypothesis that this sample touched the rods.

Lessons learned from last HZB2.2 measurements in old QPR

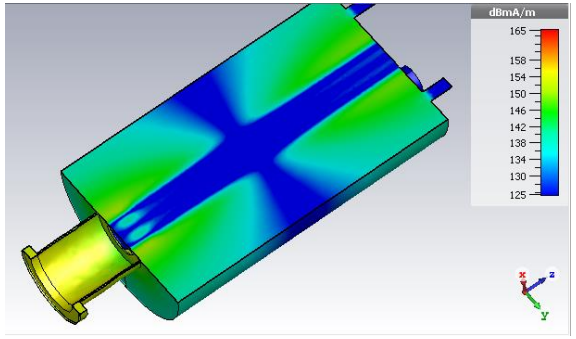
Nb coating of gasket at sample holder:
The greyish layer is Nb with a thickness of 756+/-72 nm. It also appears that the gasket had significantly heated up as its external surface was goldish like if it was oxidized.

Simulations show a TEM mode resonating in the gap at the cut off tube



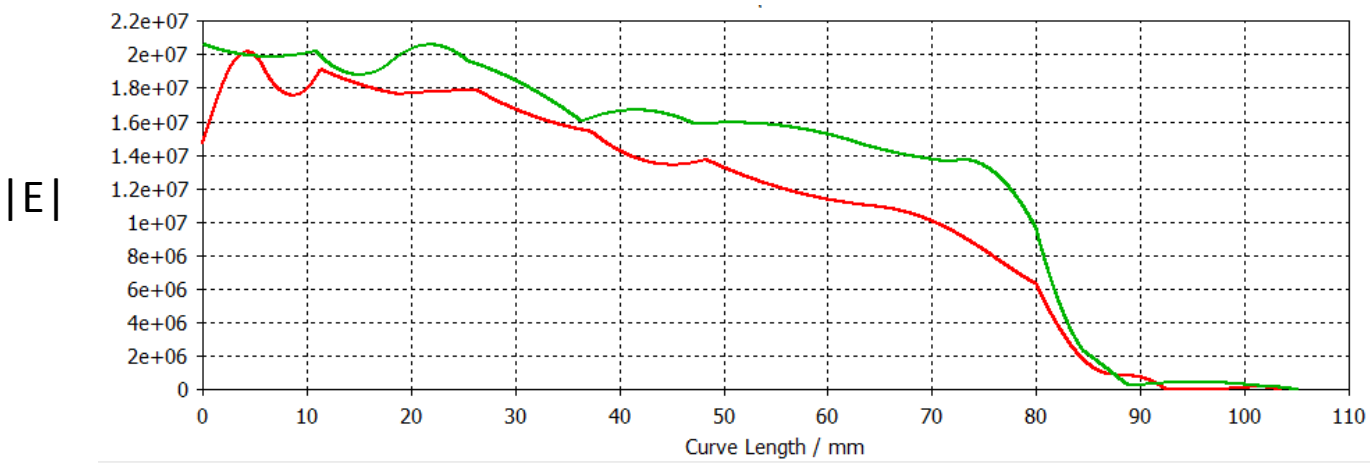
|E|-field

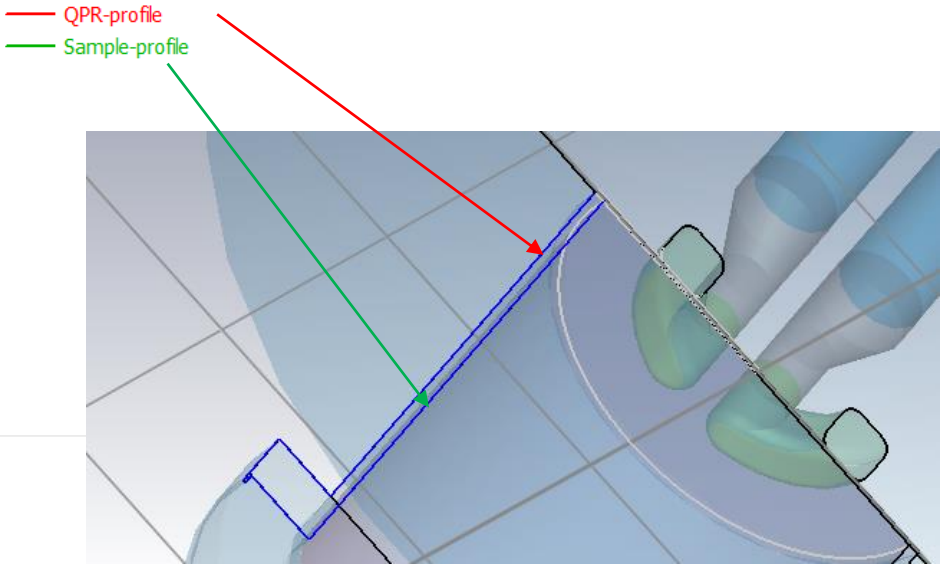
|H|-field



Lessons learned from HZB2.2 measurements in old QPR

- There is EM filed going thorugh the gap which can lead to plasma.

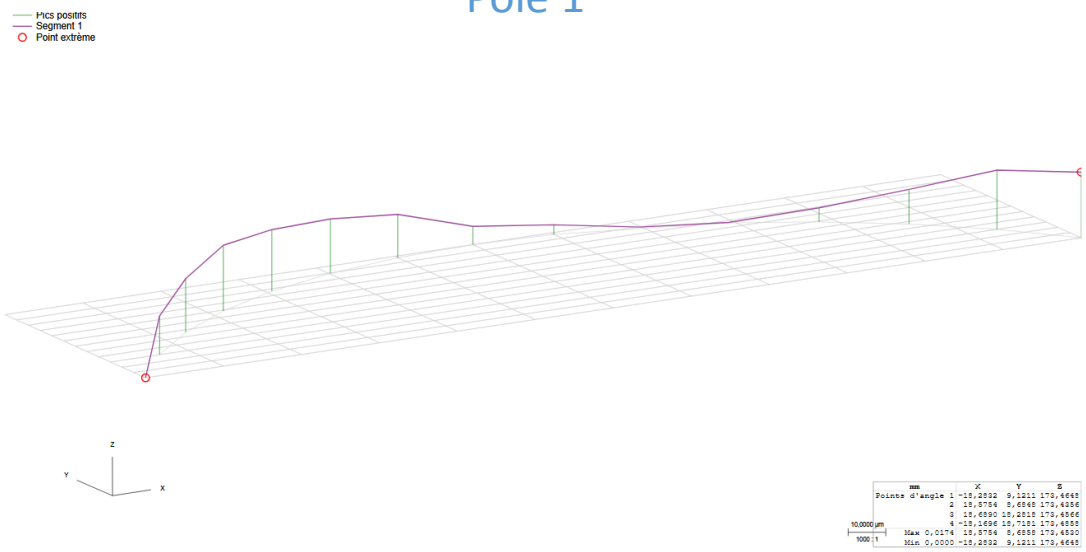




Metrology check of planarity of the rods in old QPR

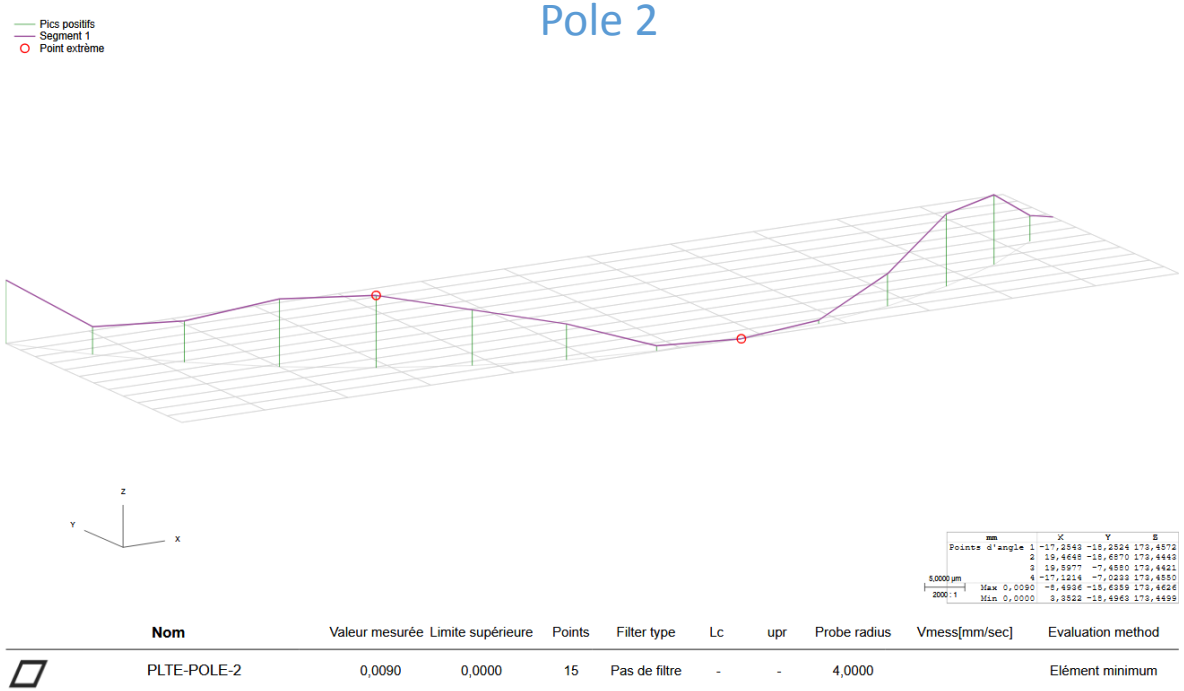
- The old QPR has been inoperative in the last months.
- It has been dismounted and sent to metrology to verify the planarity of the rods: It is confirmed that it remains within the tolerances.

Pole 1



Nom	Valeur mesurée	Limite supérieure	Points	Filter type	Lc	upr	Probe radius	Vmess[mm/sec]	Evaluation method
PLTE-POLE-1	0,0174	0,0000	15	Pas de filtre	-	-	4,0000		Elément minimum

Pole 2

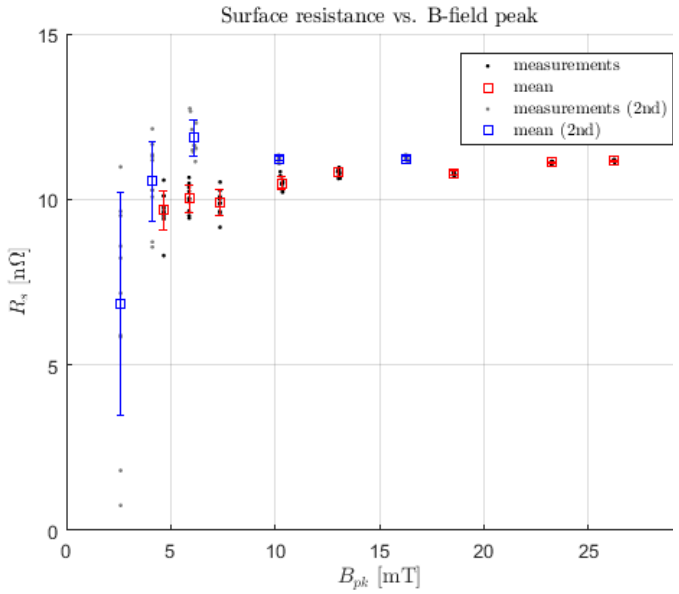


Nom	Valeur mesurée	Limite supérieure	Points	Filter type	Lc	upr	Probe radius	Vmess[mm/sec]	Evaluation method
PLTE-POLE-2	0,0090	0,0000	15	Pas de filtre	-	-	4,0000		Elément minimum

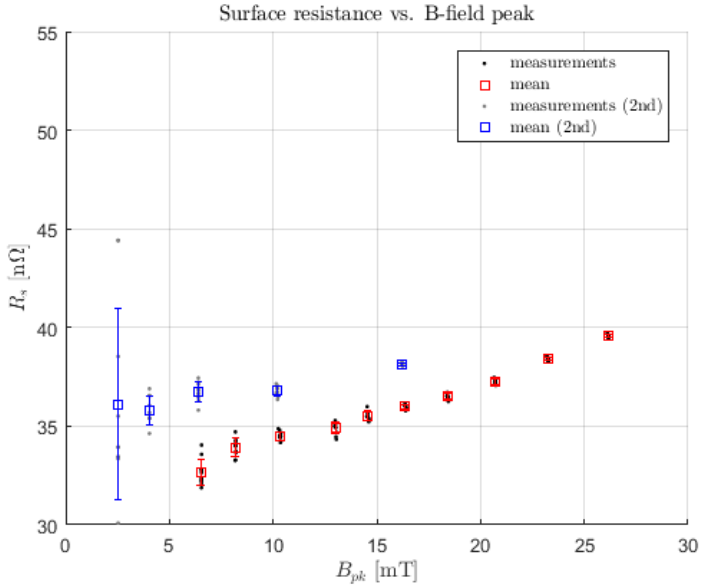
I.5. Bulk Nb sample

A bulk Nb sample machined at CERN has been measured to verify that the old QPR is reliable after metrology checks:

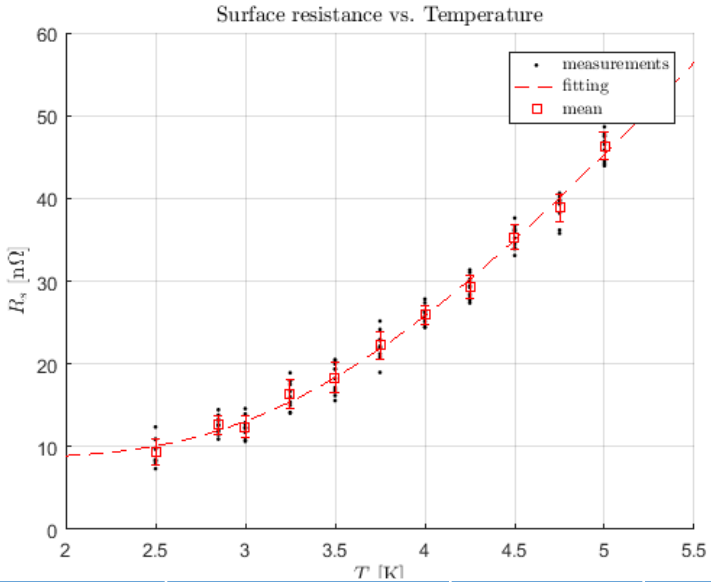
Rs vs Bpk @2.5K



Rs vs Bpk @4.5K



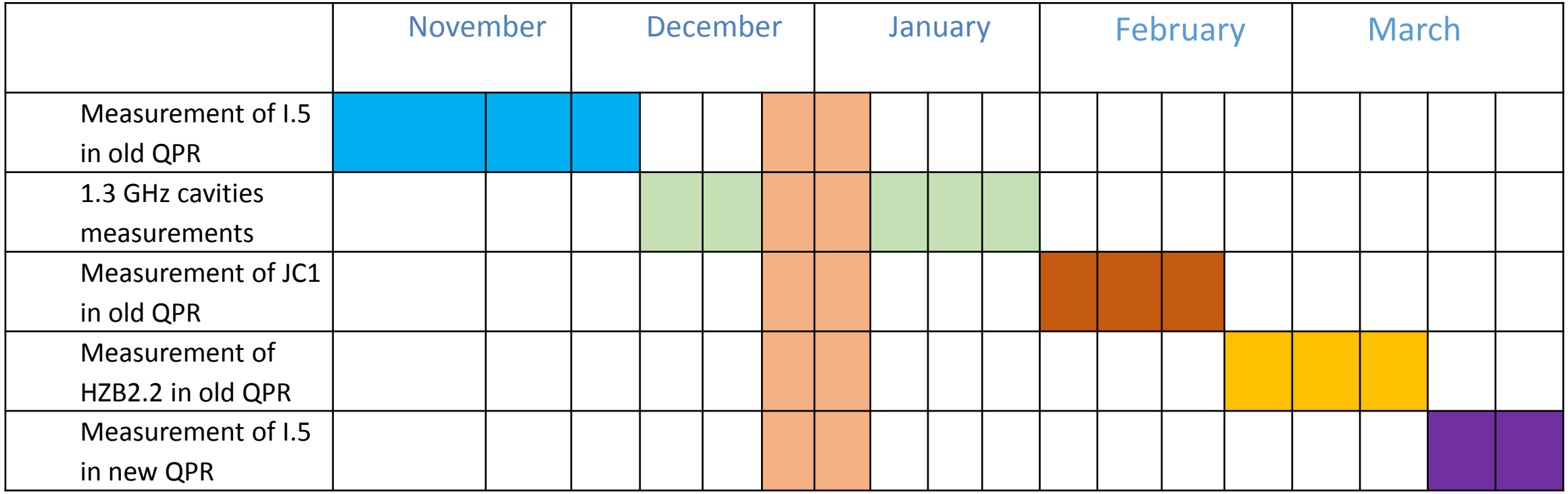
Rs vs T @400MHz



	A_{BCS} [nΩ K]	Δ/k_B [K]	R_{Res} [nΩ]
400 MHz	9443	22.472	8.656

- *Output:* Good preliminary results in old QPR.
- *To do next*: Measure this sample in the new QPR.

Next steps


November
December
January
February
March
Measurement of I.5 in old QPR
1.3 GHz cavities measurements
Measurement of JC1 in old QPR
Measurement of HZB2.2 in old QPR
Measurement of I.5 in new QPR

Points for discussion

- In the 2nd Annual QPR Workshop, it was discussed to have a common sample to use as a reference for calibrating all the existing QPRs at different laboratories.
- We can use the HZB2.2 sample.
- Proposal: Measure HZB2.2 at CERN in old QPR.
  - ❑If results are good: Send it back to HZB to be measured.
  - ❑If results are bad: Should we strip the coating and re-coat it?

Thanks for your attention