

Status of new smaller H011 cavity and RF measurement of irradiated samples

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 - Non-irradiated Ø10mm samples
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Introduction

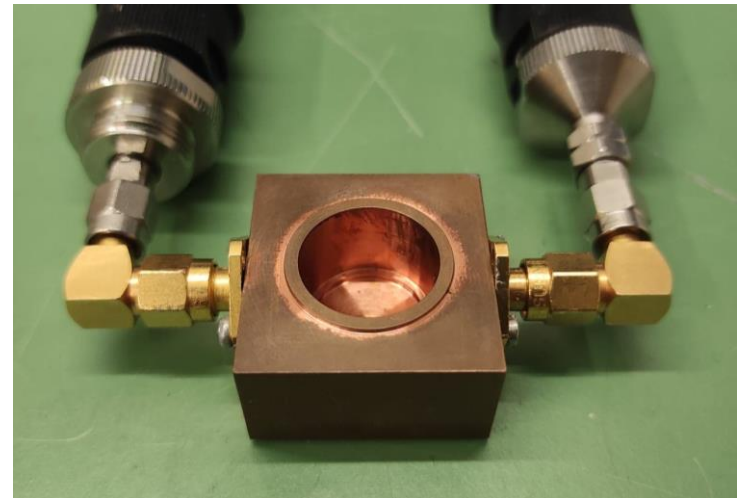
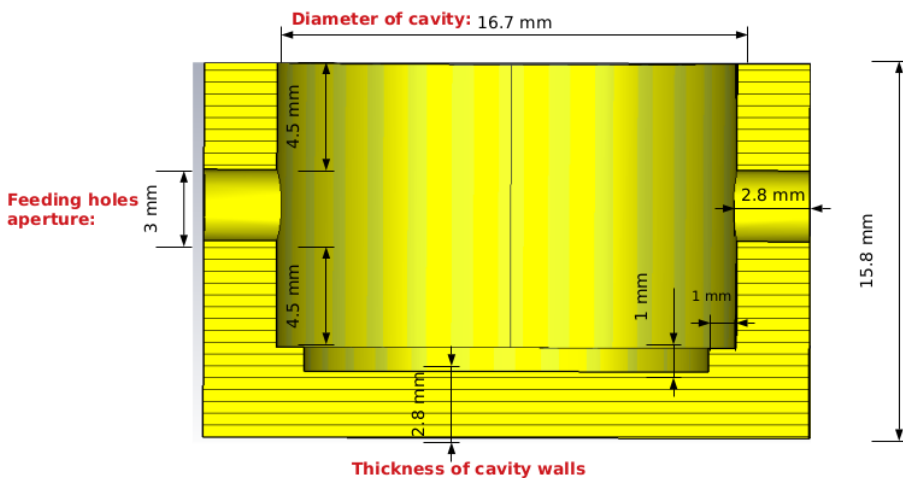
- Irradiated samples (GSI) have been already tested with **larger** H011 cavity.
- The aspect ratio was unfavourable and sample placement inaccurate **not usable**.
- New smaller H011 cavity has been designed for 20x20 mm BNL 2020 campaign samples.
- It is also suitable to re-measure the GSI-2019 samples ($\text{Ø}10\text{mm}$) with a little modification on the cavity
 - **A mask and adaptor applied** → ~3% sensitivity to detect x2 Mo



GSI sample on “large cavity”

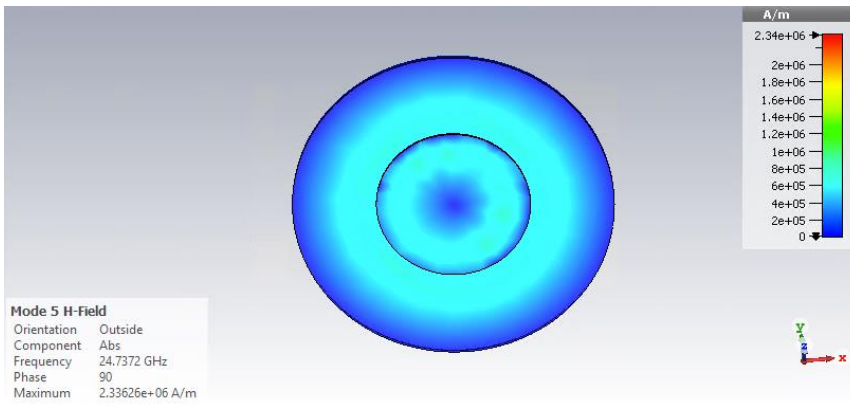
The new smaller H011 cavity design

- Dimensions and the geometry of the new cavity have been shown below.
- It is suitable for irradiated samples (GSI, BNL) and any 20x20mm samples (thanks IWG team).
- The cavity is fabricated (thanks EN-STI) and tested.



The new smaller H011 cavity design

- Irradiated samples (GSI-diameter of 10mm) have 1mm of circular bulk material mask on the coated face.
- In order to characterise the resistivity of coating material only, thin Cu foil (with an aperture of 8mm) needed for masking bulk material.

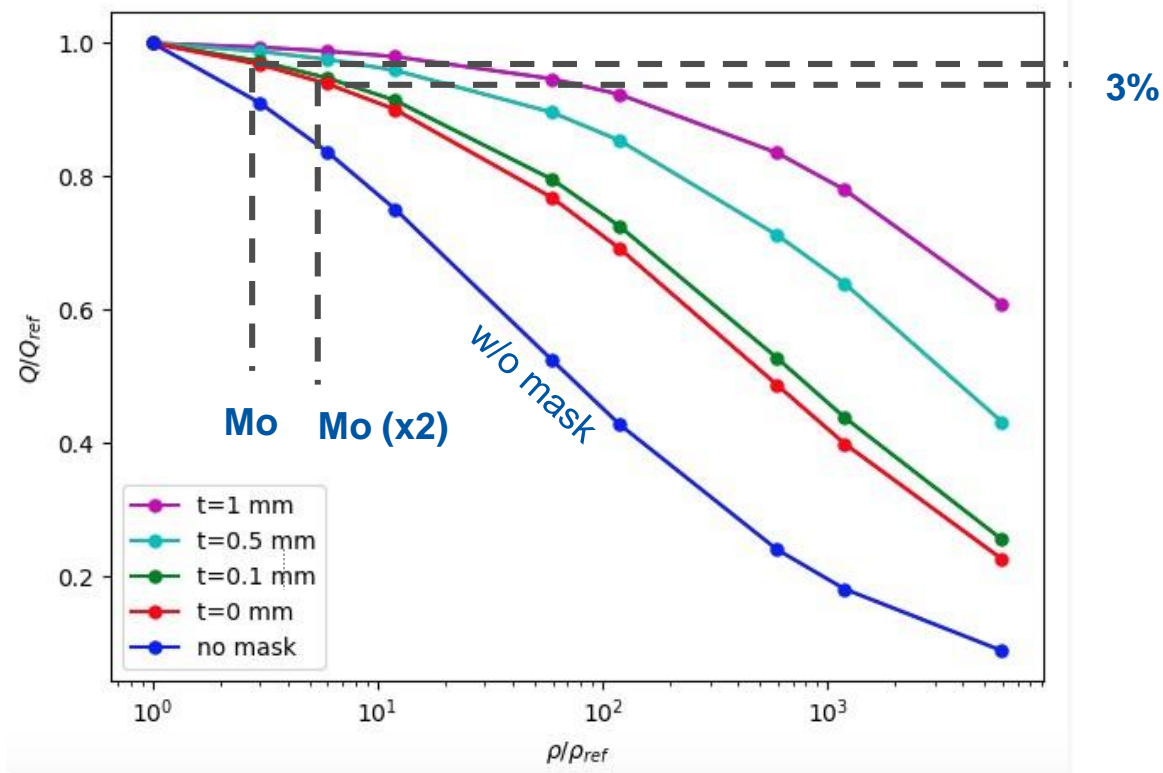


A mask is needed to reduce aperture size.

Detailed explanation of the resonant cavity method can be found: <https://doi.org/10.3390/coatings10040361>

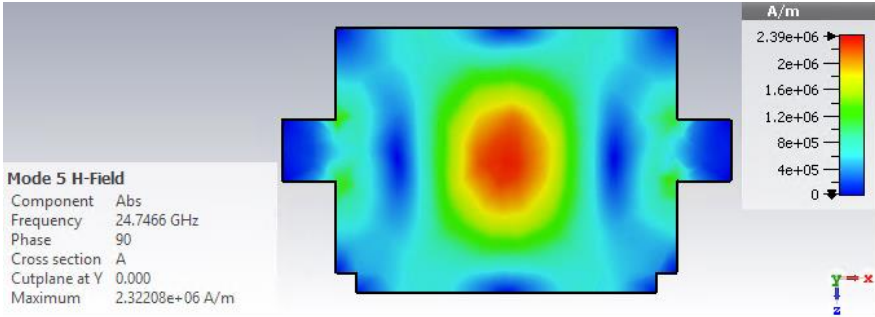
The new smaller H011 cavity design

- The effect of mask thickness is studied on sensitivity of the cavity.
- With 0.1mm mask thickness → ~ 3% sensitivity to detect x2 Mo.

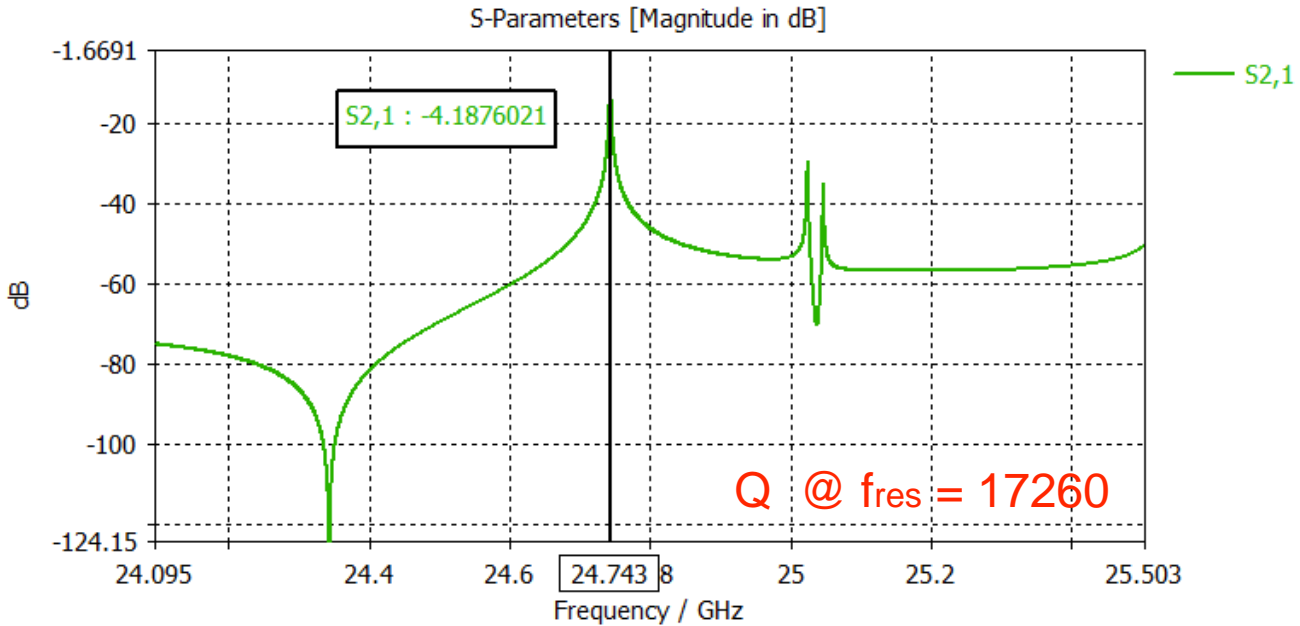


Simulation results

- H field distribution of the new cavity is shown on the right.
- Adjacent mode near resonant frequency is separated by 1mm of step geometry on the bottom of the cavity.

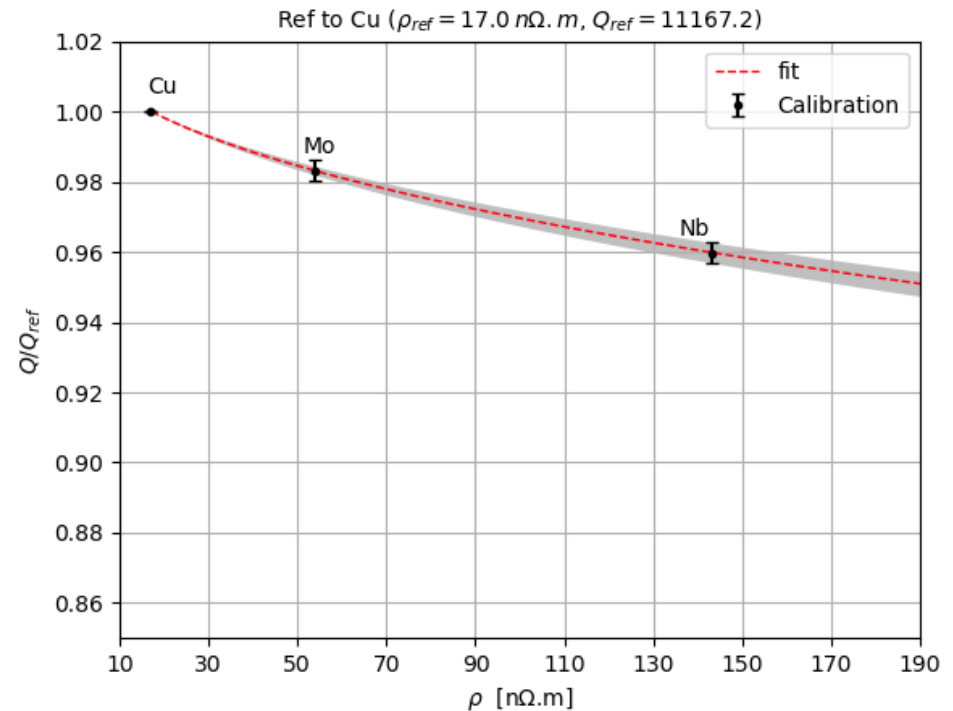
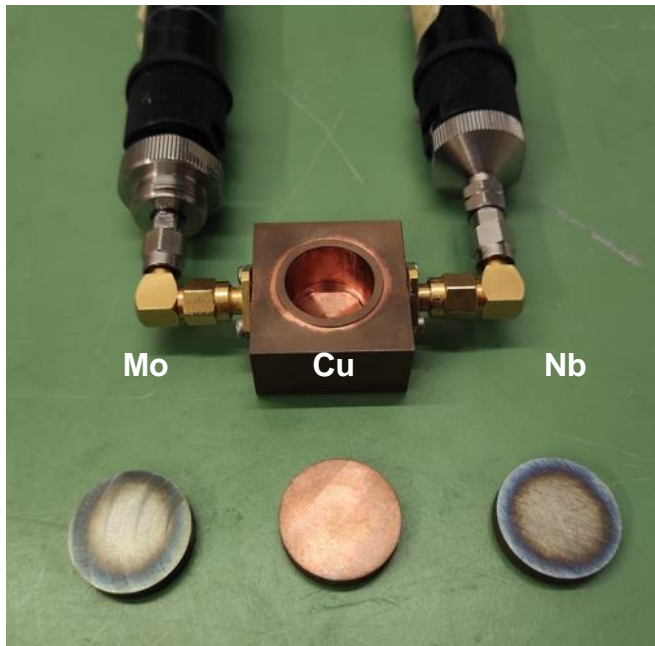


fres @ 24.76 GHz



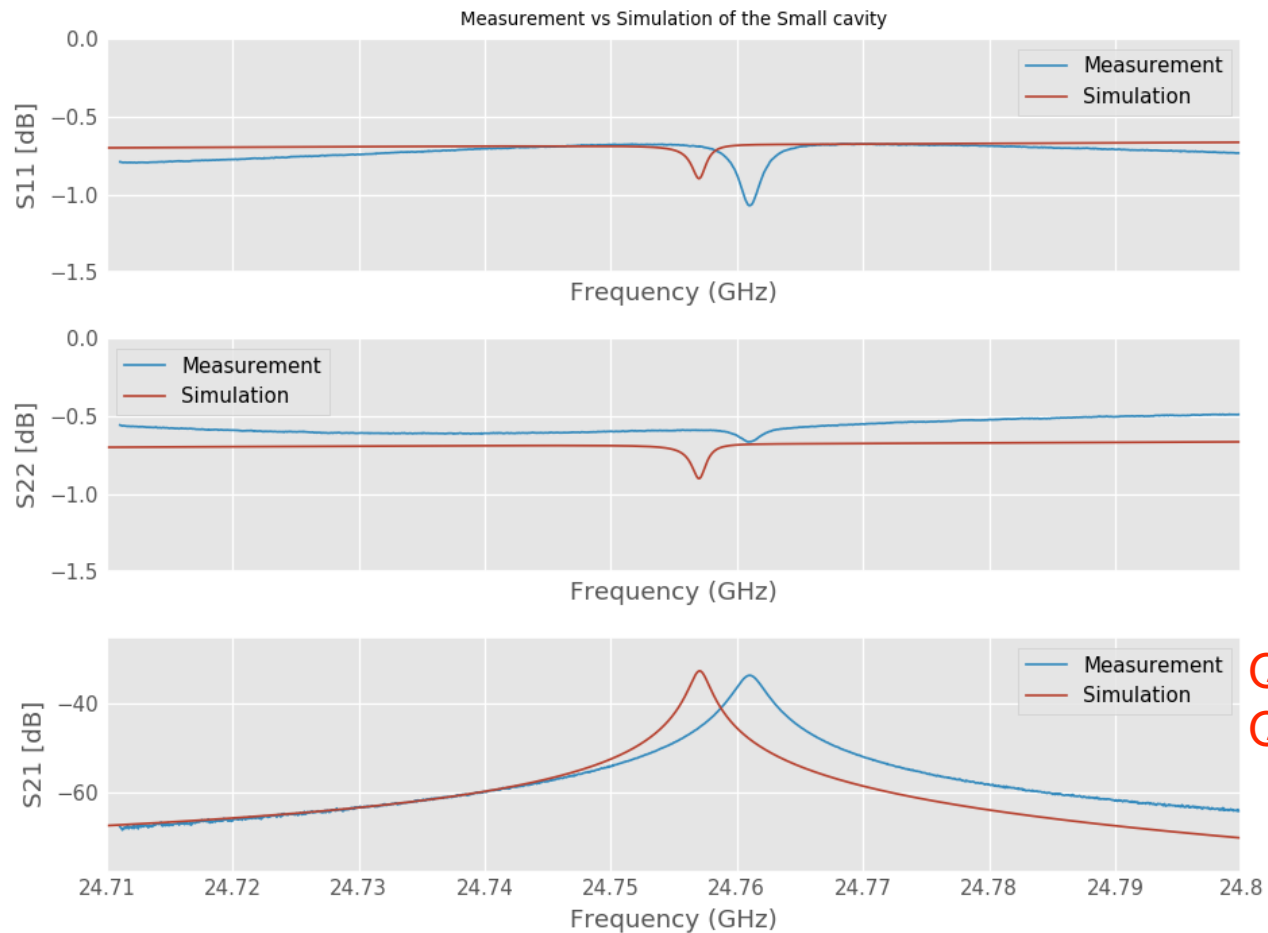
Measurements

- The cavity was tested with new calibration samples (not polished).
- Calibration samples: Cu, Mo, Nb.
- Two openings available: $\varnothing 16.7\text{mm}$ and $\varnothing 8\text{mm}$ (with adaptor)
- Measurements are compared with the simulation results.
- Measured Q is smaller than simulated one due to roughness of cavity walls.



Measurements

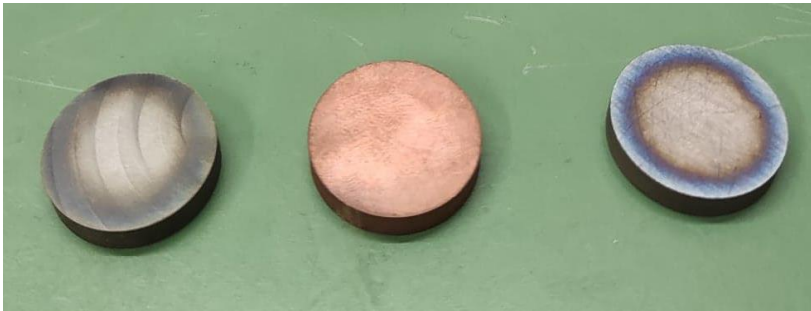
- Comparison of scattering parameters are given on the figure below for Cu.
- There is $\sim 8\text{MHz}$ of frequency shift on resonant mode.



$Q_{\text{sim}} = 17260$
 $Q_{\text{meas}} = 11160$

Measurements

- The samples were prepared by subsequent steps of mechanical grinding including PT320, PT600, PT1200 (Thanks to Ana Perez).
- Later on, colloidal silica polishing applied.
- The cavity is tested with **polished** calibration samples.
- Calibration samples: Cu, Mo, Nb.



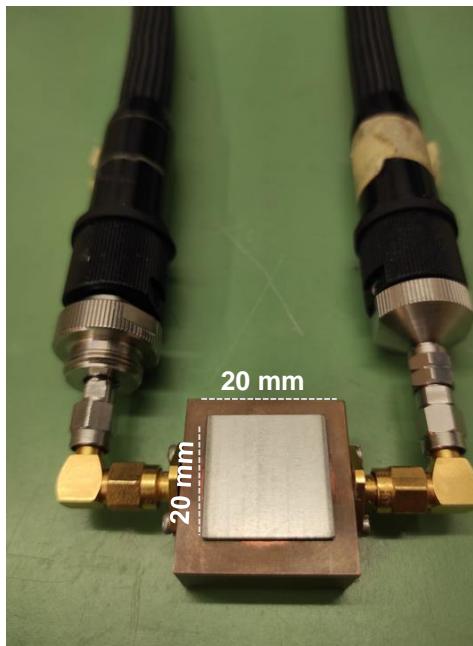
Before Polishing



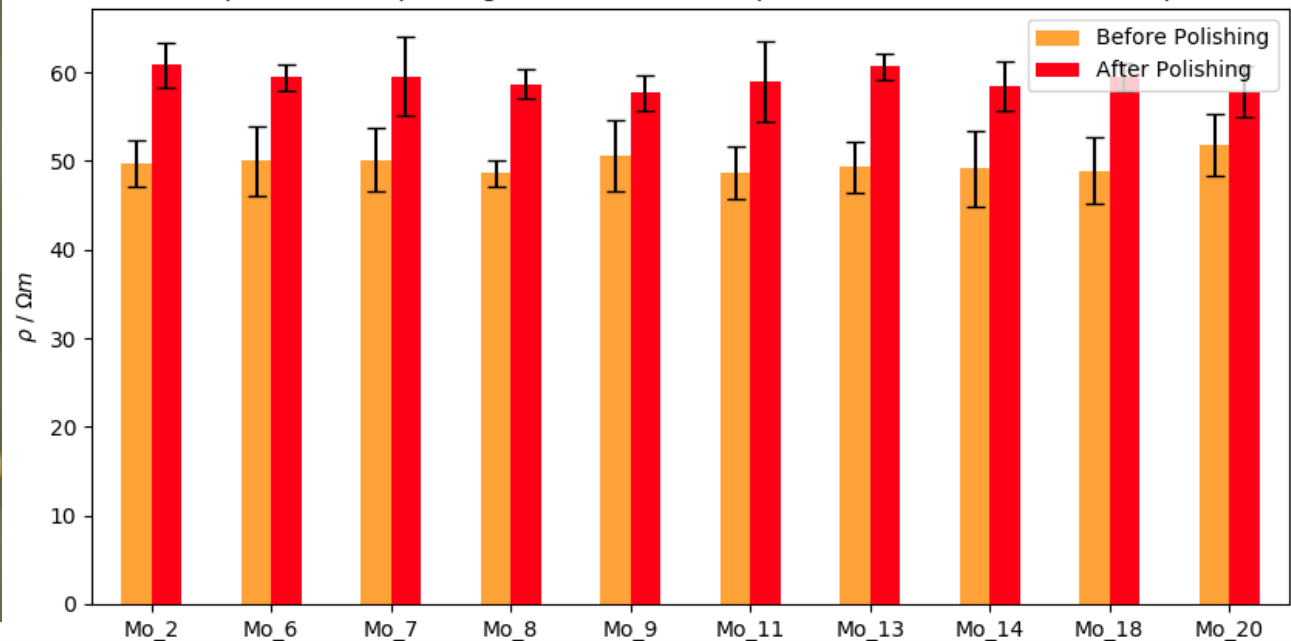
After Polishing

Measurements

- 20x20 samples measured (non-irradiated, Mo on MoGr, Mo on Gr)
- There is around ~15% increment on resistivity after polishing which can be described by the effect of **surface roughness**.



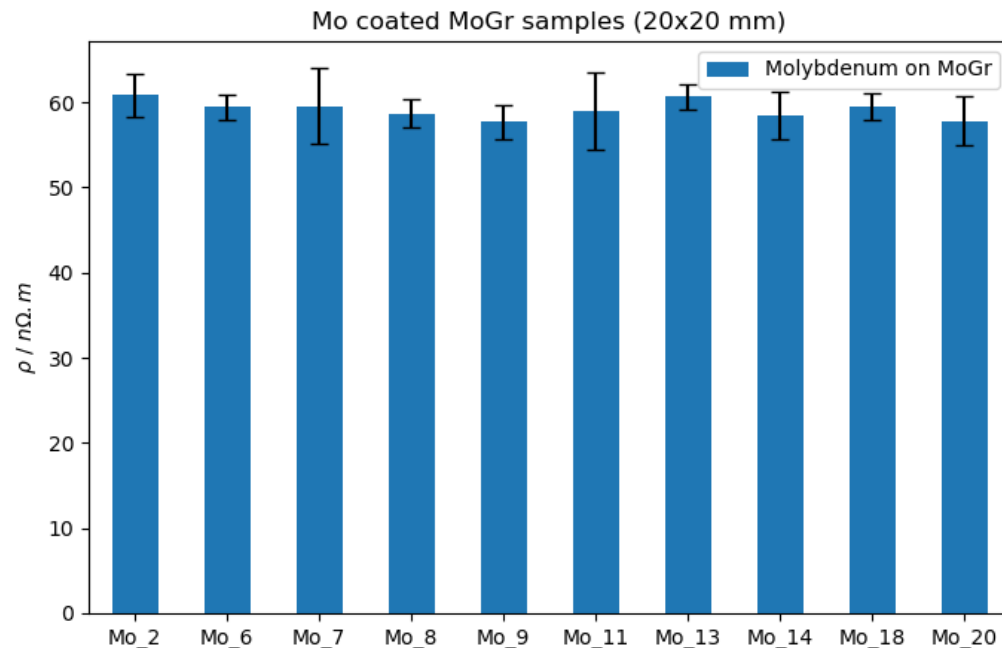
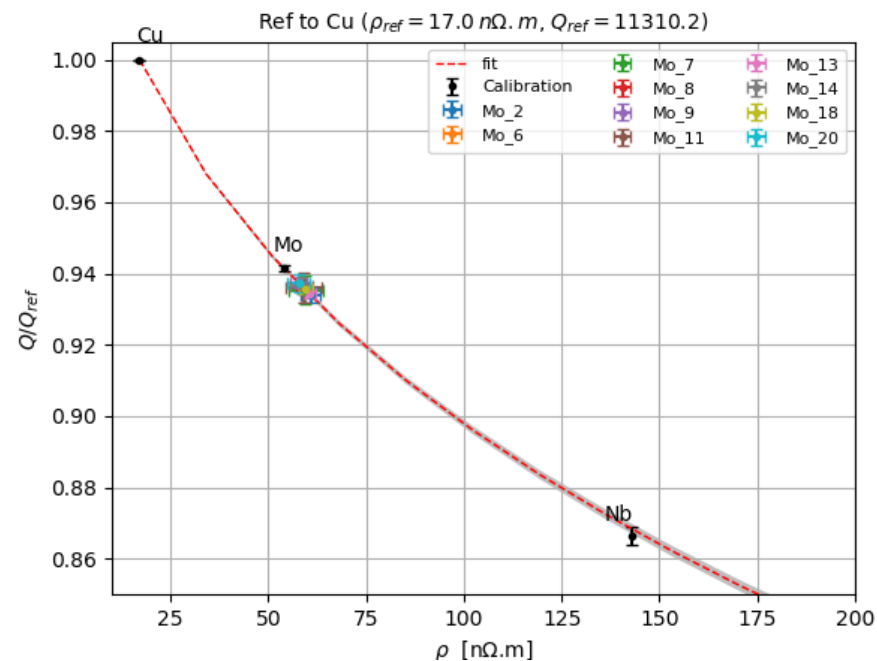
Comparison after polishing the calibration samples on 20x20 Mo on MoGr samples



20x20 mm BNL 2020 Campaign Samples

- 20x20 mm samples measured (non-irradiated, Mo on MoGr, Mo on Gr) with calibration of polished samples.
- The results are consistent with previous DTI's batches measured with big cavity.

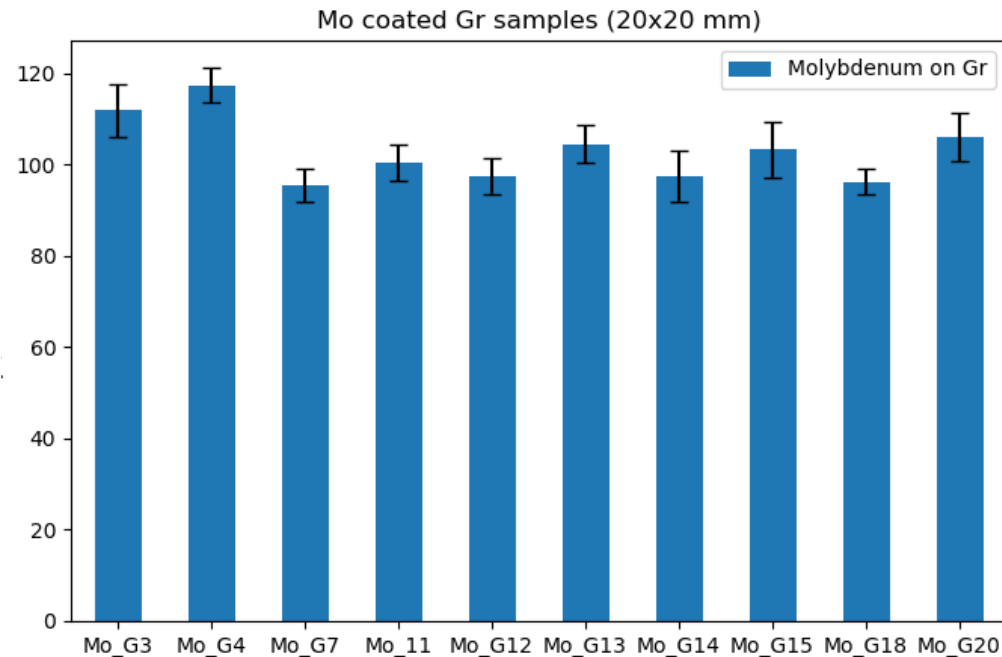
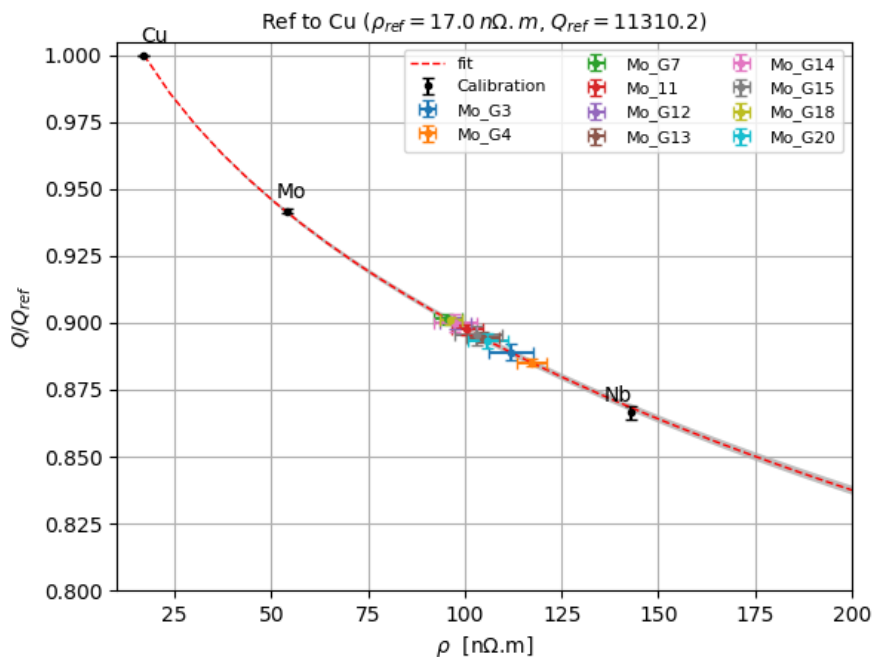
Mo on MoGr samples



20x20 mm BNL 2020 Campaign Samples

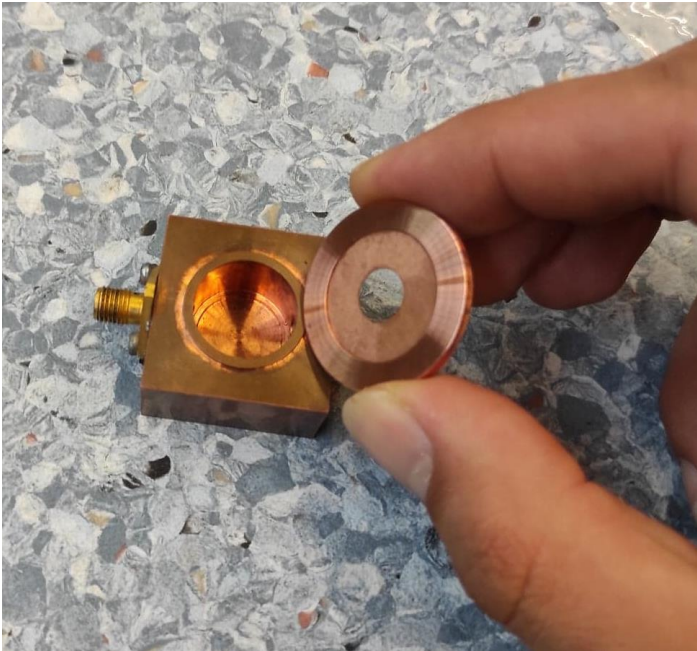
- 20x20 mm samples measured (non-irradiated, Mo on MoGr, Mo on Gr) with calibration of polished samples.
- The results are consistent with previous DTI's batches measured with big cavity.

Mo on Gr samples



Non-irradiated $\text{Ø}10\text{mm}$ samples

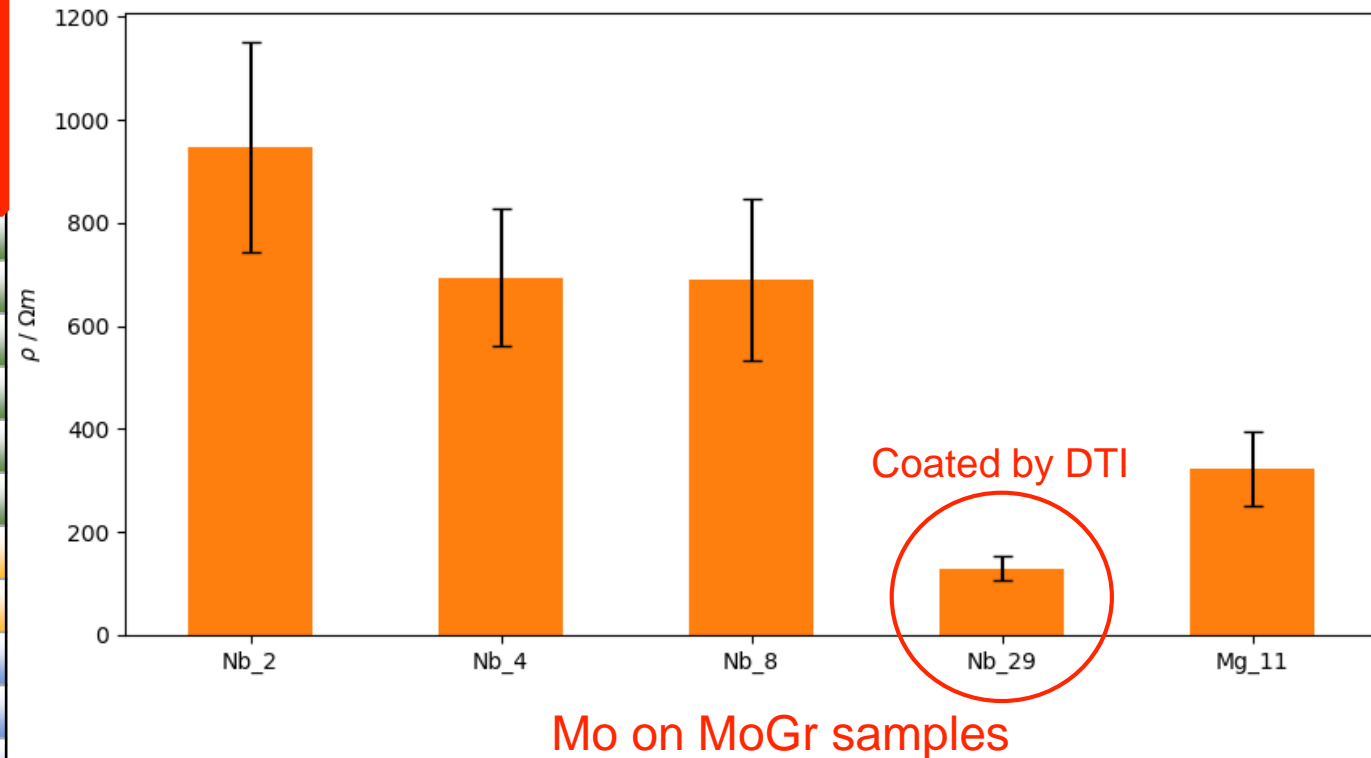
- A mask and adaptor applied in order to measure $\text{Ø}10\text{mm}$ samples.
- With 0.1mm mask thickness $\sim 3\%$ sensitivity to detect x2 Mo.



Non-irradiated Ø10mm samples

- List of non-irradiated samples are given with their names, bulks and coatings below.

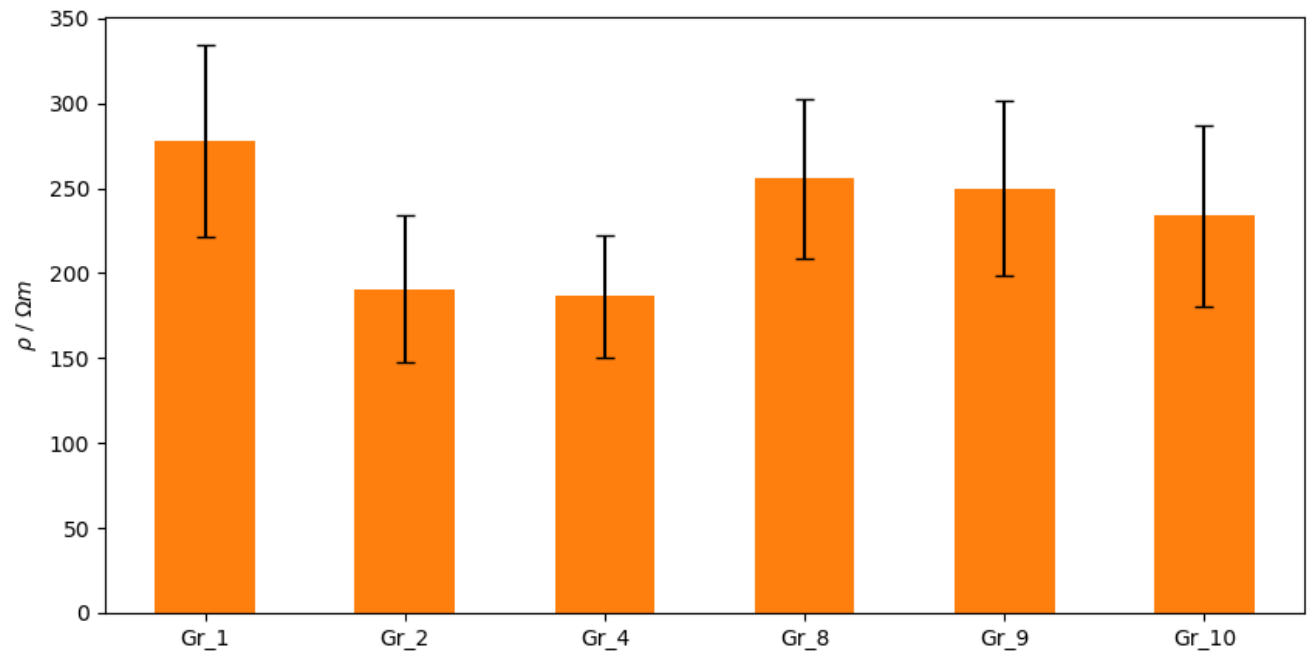
Name	Bulk	Coating
NB2	MoGr	Mo DCMS
NB4	MoGr	Mo DCMS
NB8	MoGr	Mo DCMS
NB26	MoGr	Nb HIPIMS
MG11	MoGr	Mo DCMS
GR1	Graphite	Mo DCMS
GR2	Graphite	Mo DCMS
GR4	Graphite	Mo DCMS
GR8	Graphite	Mo DCMS
GR9	Graphite	Mo DCMS
GR10	Graphite	Mo DCMS
GR29	Graphite	Cu HIPIMS
GR30	Graphite	Cu HIPIMS
CFC12	CFC	Mo DCMS
CFC13	CFC	Mo DCMS
CFC14	CFC	Mo DCMS



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NB2	MoGr	Mo DCMS
NB4	MoGr	Mo DCMS
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MG11	MoGr	Mo DCMS
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GR4	Graphite	Mo DCMS
GR8	Graphite	Mo DCMS
GR9	Graphite	Mo DCMS
GR10	Graphite	Mo DCMS
GR29	Graphite	Cu HIPIMS
GR30	Graphite	Cu HIPIMS
CFC12	CFC	Mo DCMS
CFC13	CFC	Mo DCMS
CFC14	CFC	Mo DCMS

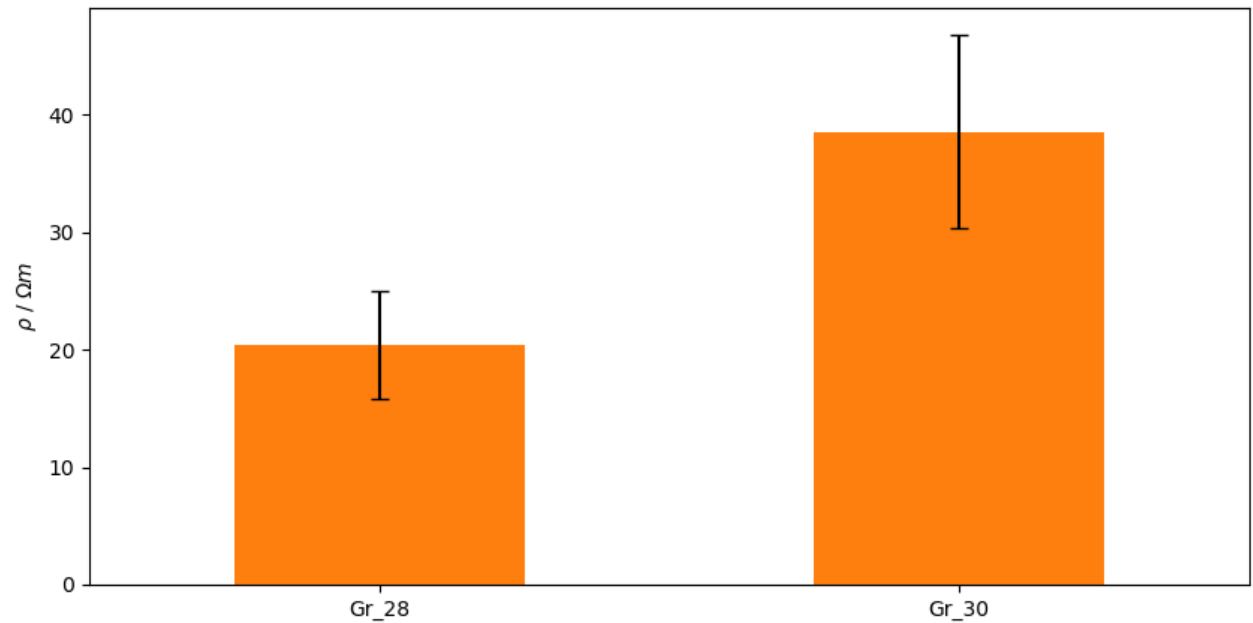


Mo on Gr samples

Non-irradiated Ø10mm samples

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Name	Bulk	Coating
NB2	MoGr	Mo DCMS
NB4	MoGr	Mo DCMS
NB8	MoGr	Mo DCMS
NB26	MoGr	Nb HIPIMS
MG11	MoGr	Mo DCMS
GR1	Graphite	Mo DCMS
GR2	Graphite	Mo DCMS
GR4	Graphite	Mo DCMS
GR8	Graphite	Mo DCMS
GR9	Graphite	Mo DCMS
GR10	Graphite	Mo DCMS
GR28	Graphite	Cu HIPIMS
GR30	Graphite	Cu HIPIMS
CFC12	CFC	Mo DCMS
CFC13	CFC	Mo DCMS
CFC14	CFC	Mo DCMS

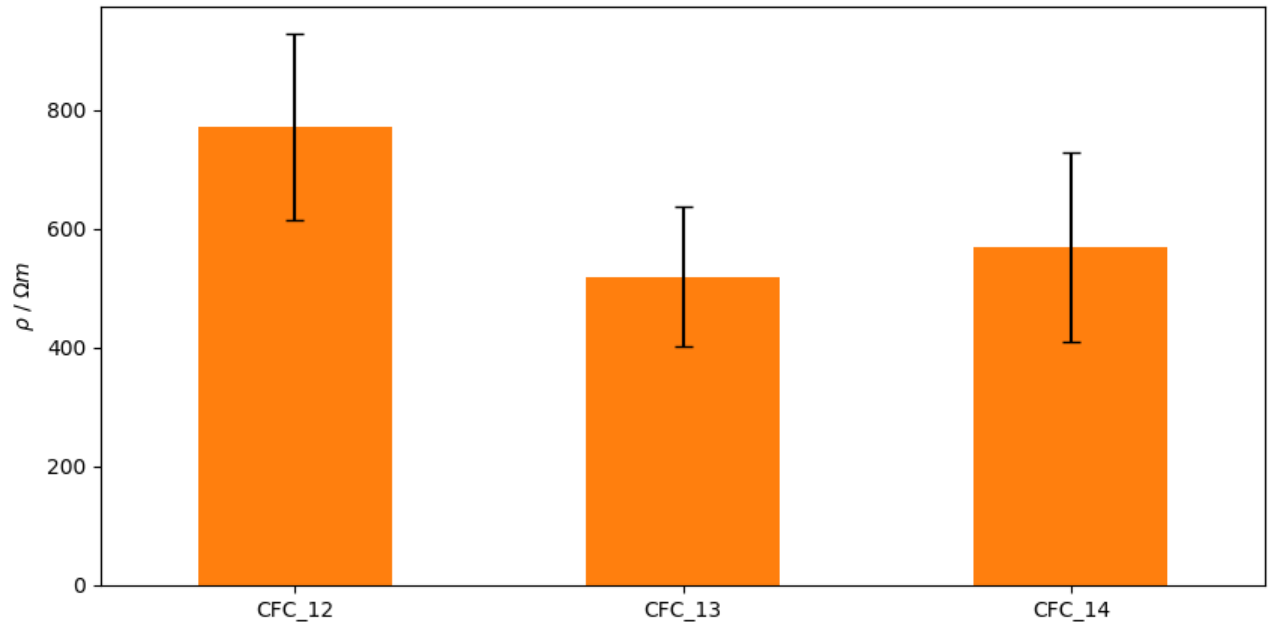


Cu on Gr samples

Non-irradiated Ø10mm samples

- List of non-irradiated samples are given with their names, bulks and coatings below.

Name	Bulk	Coating
NB2	MoGr	Mo DCMS
NB4	MoGr	Mo DCMS
NB8	MoGr	Mo DCMS
NB26	MoGr	Nb HIPIMS
MG11	MoGr	Mo DCMS
GR1	Graphite	Mo DCMS
GR2	Graphite	Mo DCMS
GR4	Graphite	Mo DCMS
GR8	Graphite	Mo DCMS
GR9	Graphite	Mo DCMS
GR10	Graphite	Mo DCMS
GR28	Graphite	Cu HIPIMS
GR30	Graphite	Cu HIPIMS
CFC12	CFC	Mo DCMS
CFC13	CFC	Mo DCMS
CFC14	CFC	Mo DCMS



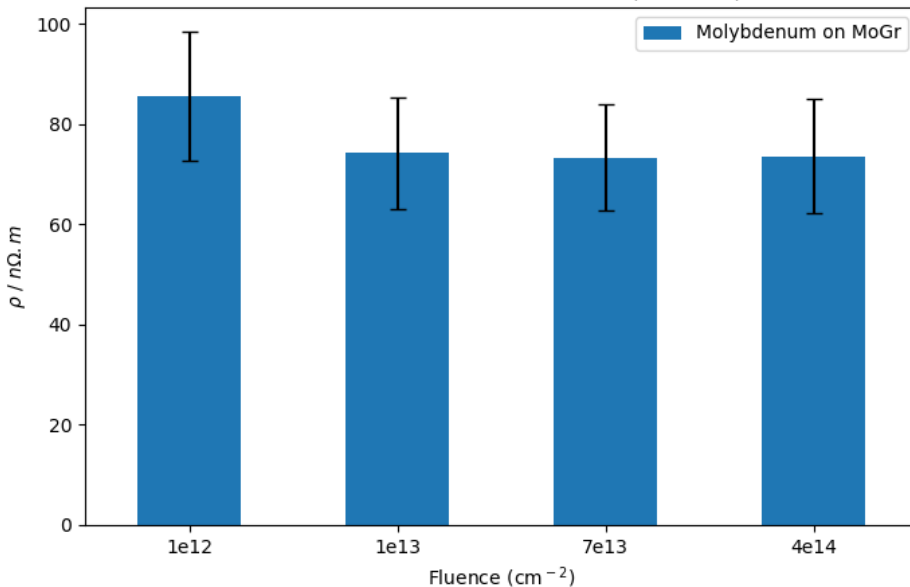
Mo on CFC samples

GSI-2019 irradiated Ø10mm samples

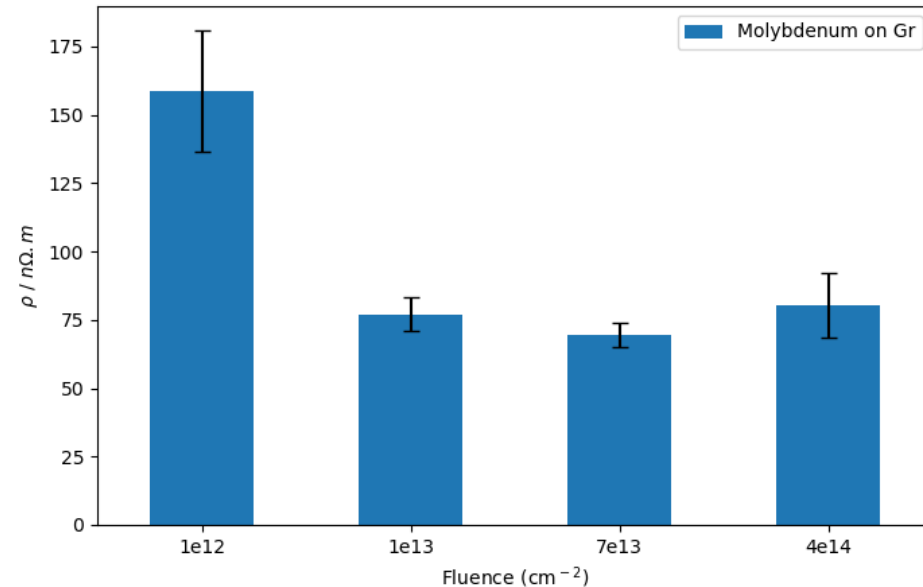
- Ion irradiation at GSI.
- All samples irradiated at 4 fluences: $1e12$, $1e13$, $7e13$, $4e14$.
- There are three different holders (holders 2-4-5) with different samples.
- Measurement results of Mo on MoGr (left) and Mo on Gr (right) are given below with four different fluencies levels in holder 2.

HOLDER 2

Irradiated Mo coated MoGr disks (Holder 2)

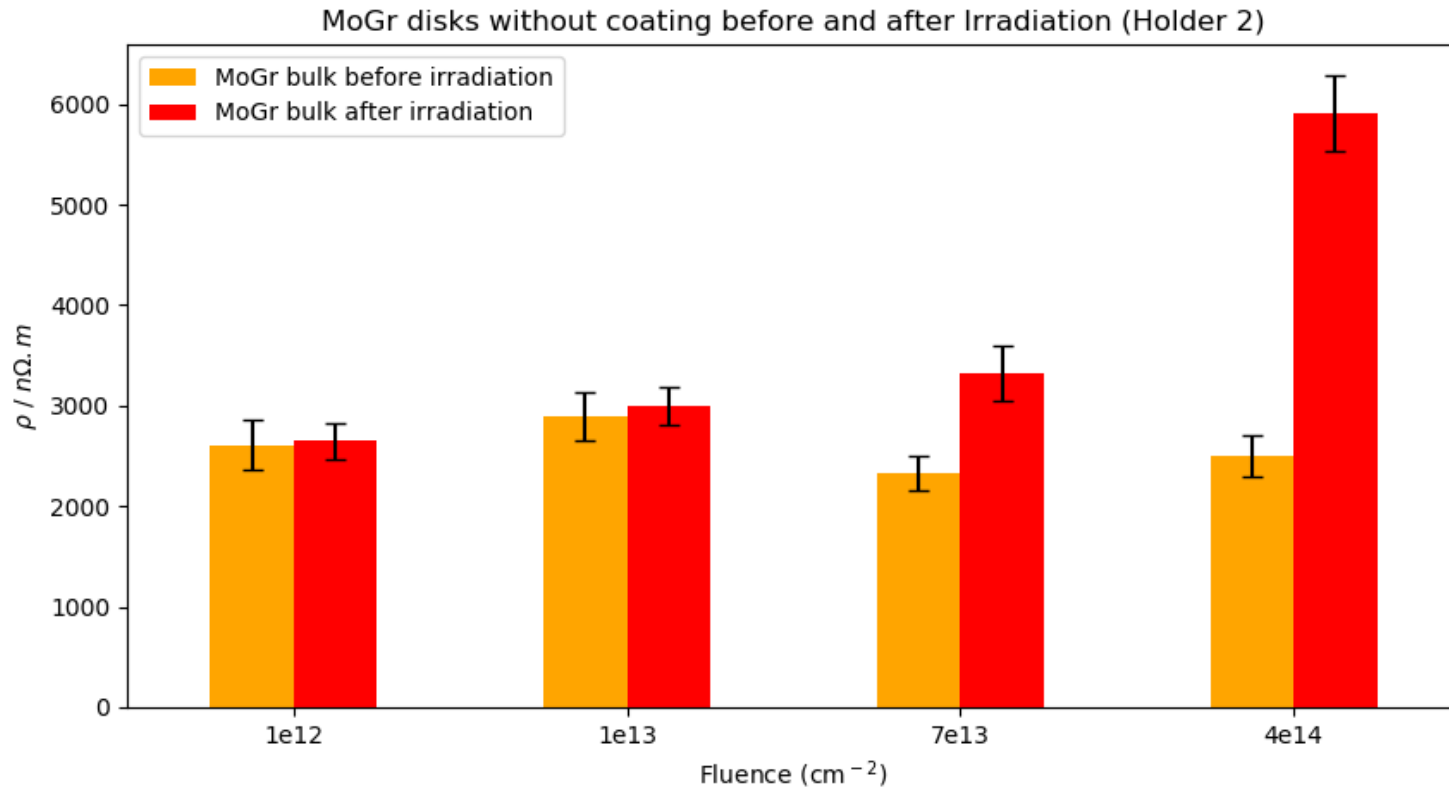


Irradiated Mo coated Gr disks (Holder 2)



GSI-2019 irradiated Ø10mm samples

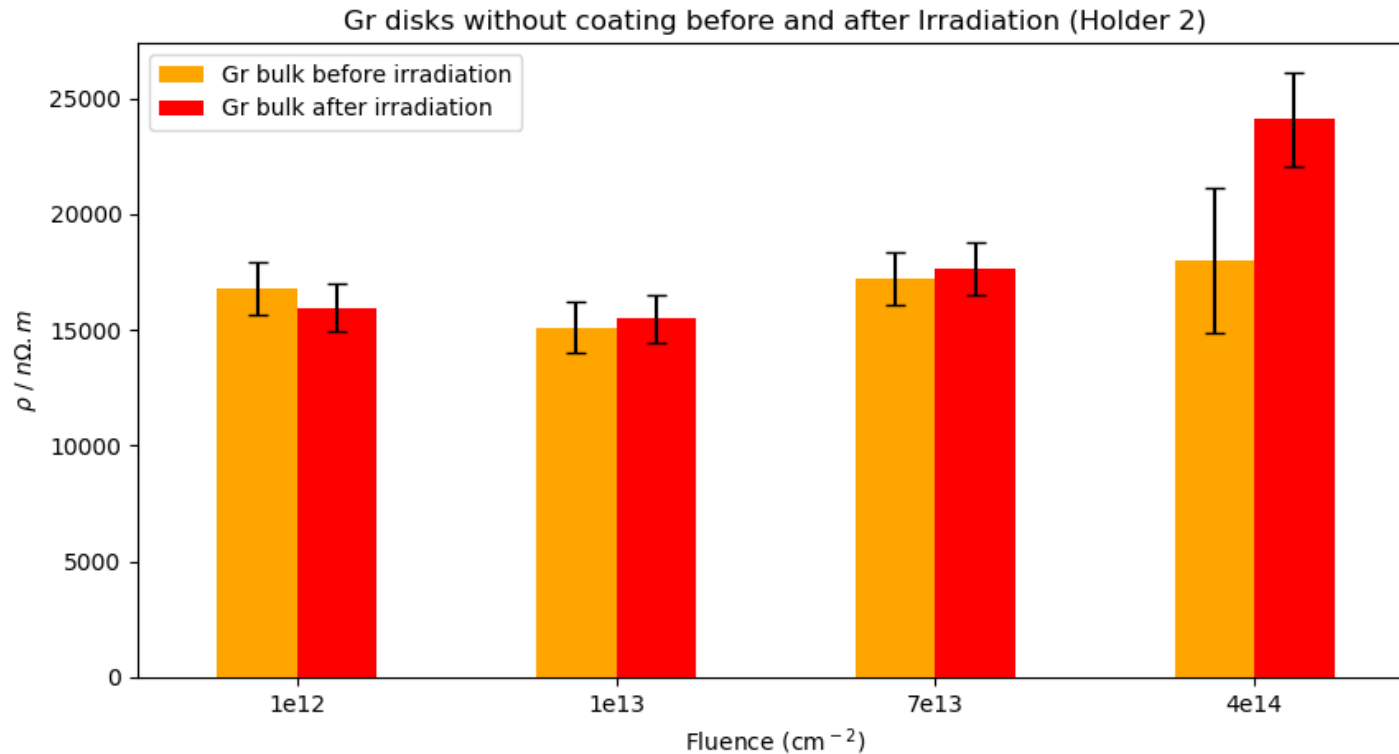
- Uncoated Ø10mm MoGr samples comparisons with irradiated and non-irradiated faces in holder 2.
- Increment of resistivity observed on irradiated face.



HOLDER 2

GSI-2019 irradiated Ø10mm samples

- Uncoated Ø10mm Gr samples comparisons with irradiated and non-irradiated faces in holder 2.
- **Increment** of resistivity observed on irradiated face (except at 1e13).



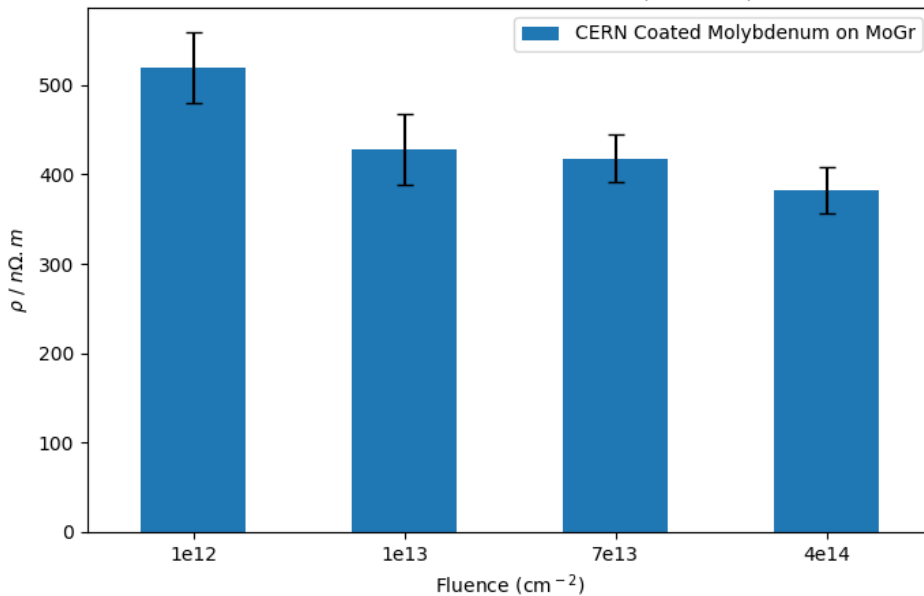
HOLDER 2

GSI-2019 irradiated Ø10mm samples

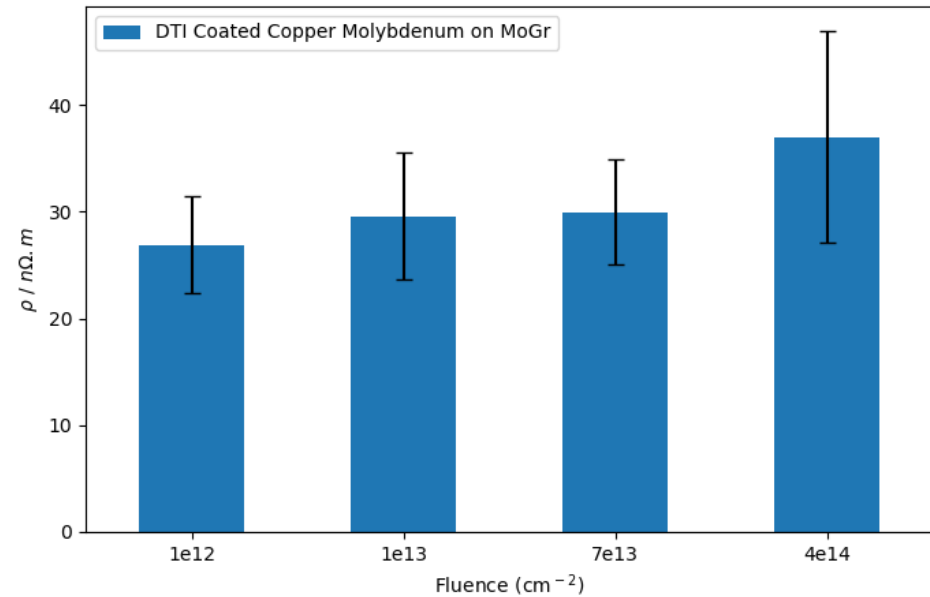
- Ion irradiation at GSI.
- All samples irradiated at 4 fluences: $1e12$, $1e13$, $7e13$, $4e14$.
- Measurement results of Mo on MoGr (left) and Cu on MoGr (right) are given below with four different fluencies levels in holder 4.

HOLDER 4

Irradiated Mo coated MoGr disks (Holder 4)

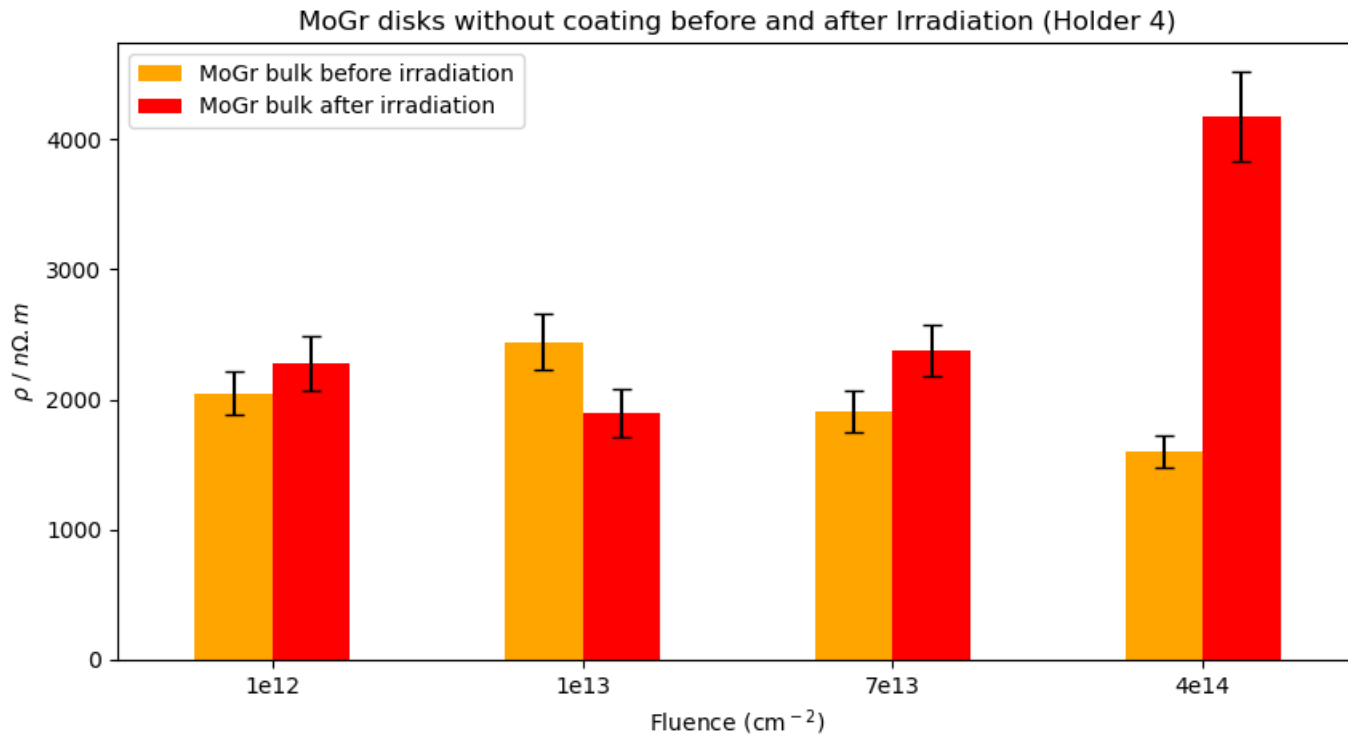


Irradiated Cu coated MoGr disks (Holder 4)



GSI-2019 irradiated Ø10mm samples

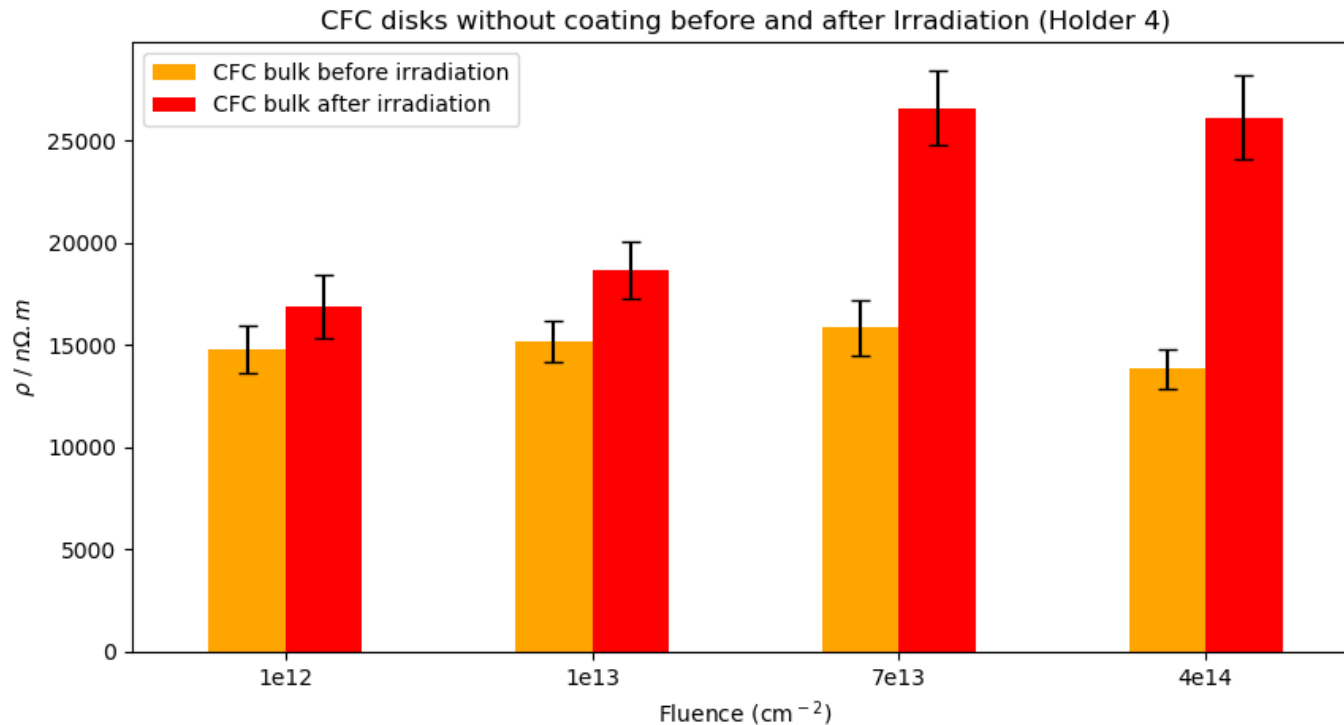
- Uncoated Ø10mm MoGr samples comparisons with irradiated and non-irradiated faces in holder 4.
- Increment of resistivity observed on irradiated face (except 1e13).



HOLDER 4

GSI-2019 irradiated Ø10mm samples

- Uncoated Ø10mm CFC samples comparisons with irradiated and non-irradiated faces in holder 4.
- Increment of resistivity observed on irradiated face.

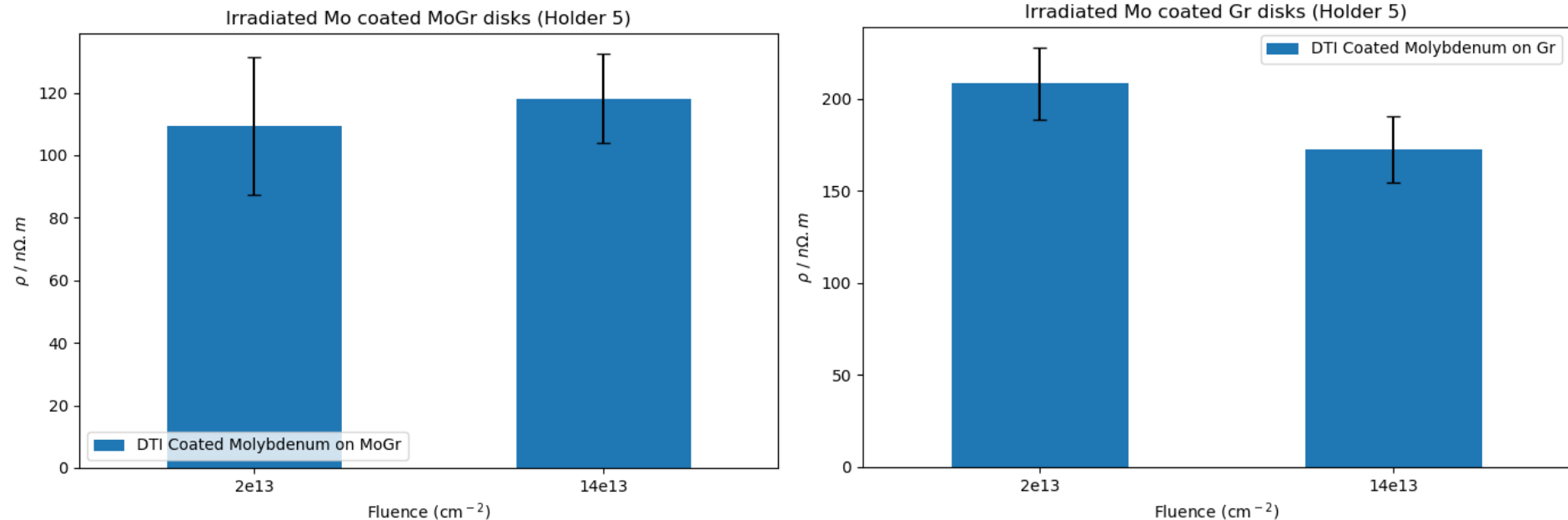


HOLDER 4

GSI-2019 irradiated Ø10mm samples

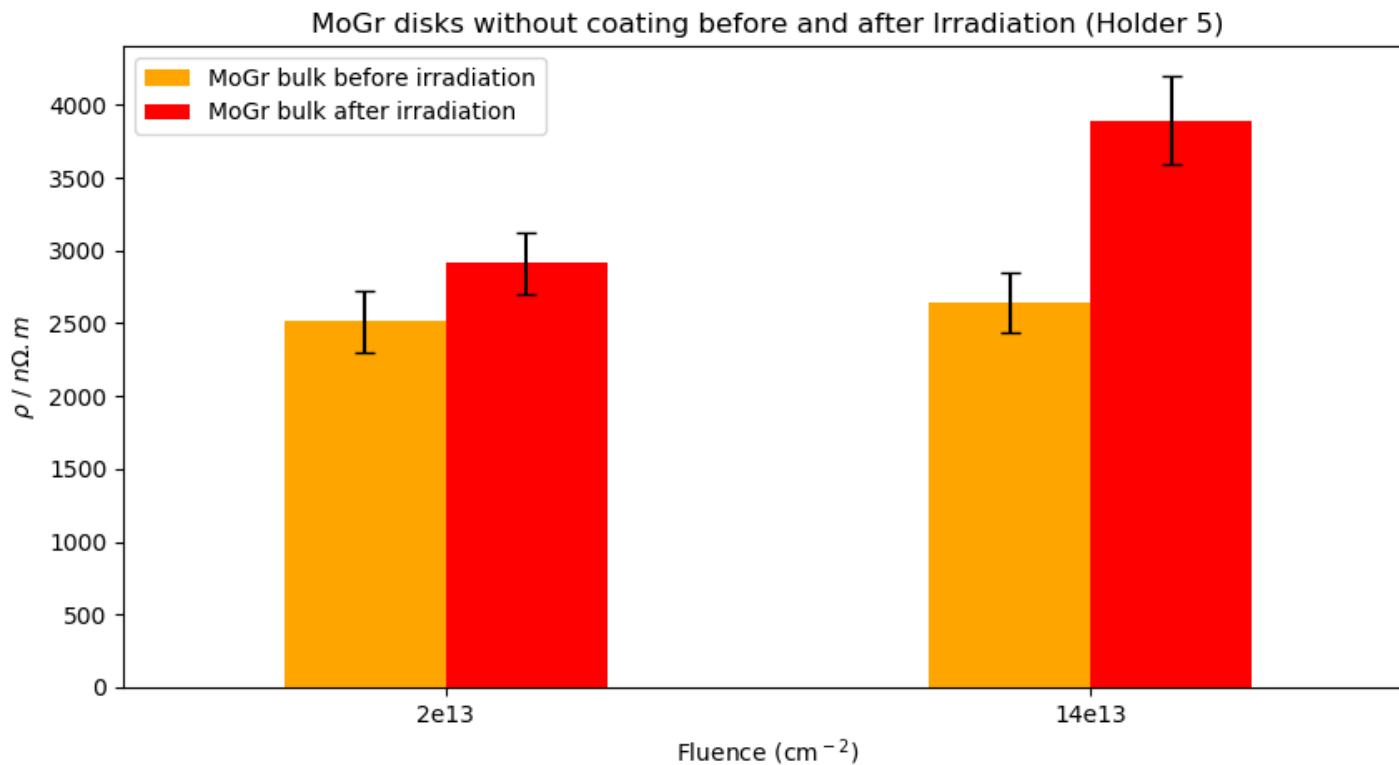
- Ion irradiation at GSI.
- All samples irradiated at 2 fluences: $2e13$, and $14e13$.
- Measurement results of Mo on MoGr (left) and Mo on Gr (right) are given below with four different fluencies levels in holder 5.

HOLDER 5



GSI-2019 irradiated Ø10mm samples

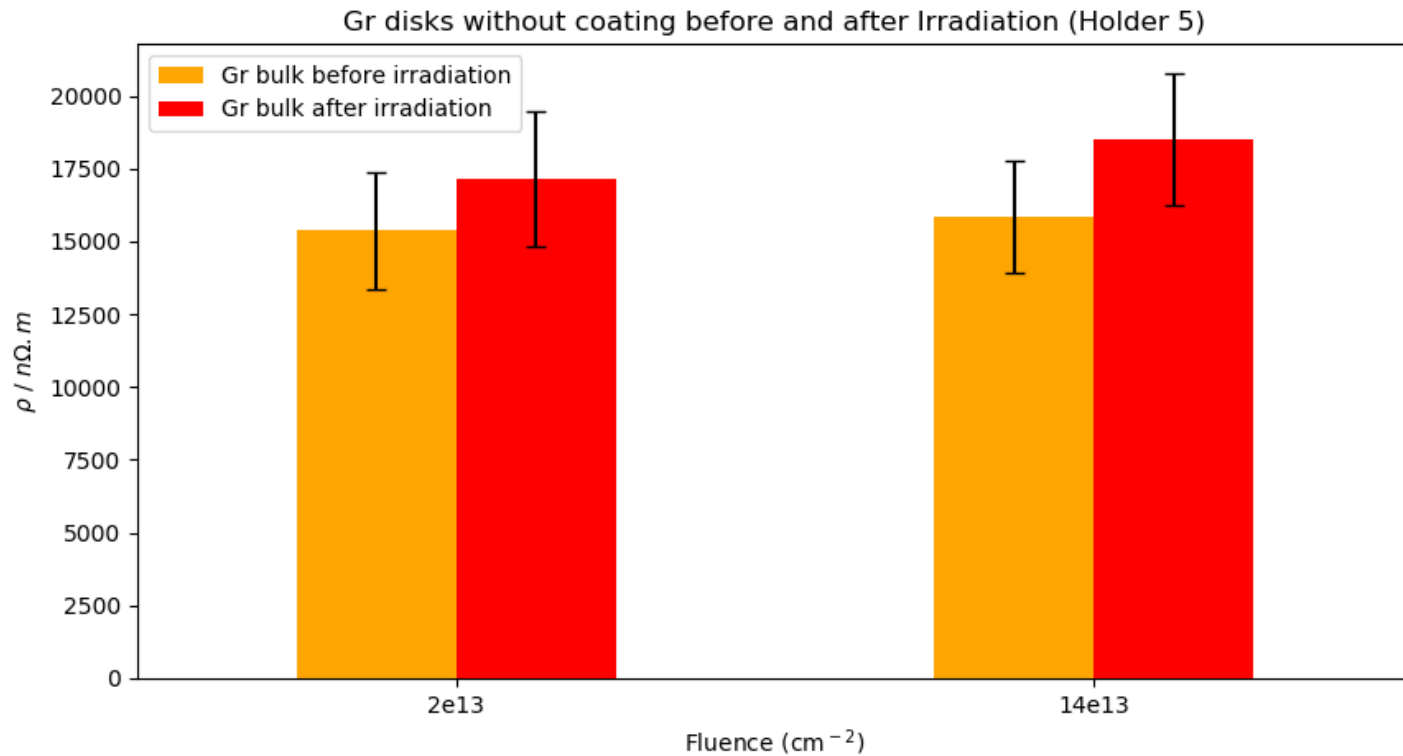
- Uncoated Ø10mm MoGr samples comparisons with irradiated and non-irradiated faces in holder 5.
- Increment of resistivity observed on irradiated face.



HOLDER 5

GSI-2019 irradiated Ø10mm samples

- Uncoated Ø10mm Gr samples comparisons with irradiated and non-irradiated faces in holder 5.
- **Increment** of resistivity observed on irradiated face.



HOLDER 5

Conclusions and next steps

- New smaller H011 cavity has been designed and fabricated for 20x20 mm and Ø10mm samples.
- The cavity is tested with calibration samples (Cu, Mo and Nb).
- Polishing is performed to reduce the effect of roughness (10% overestimate in conductivity).
- Resistivity measurements were performed on:
 - 20x20 mm BNL samples: **results consistent with previous DTI coatings measurements.**
 - non-irradiated Ø10mm samples: **results consistent with previous measurements.**
 - GSI-2019 irradiated Ø10mm samples: **increment of bulk resistivity observed on irradiated faces, no relevant effect on coated samples.**

Conclusions and next steps

- 20x20 mm BNL samples will be shipped for 2021 irradiation tests.

Thanks for your attention!