

MADCOR

NSUF Annual Program Review – In-situ Irradiation and Molten Salt Corrosion at UW-Madison IBL

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UW-Madison Ion Beam Laboratory

UW-Madison IBL is an NSUF facility for ion irradiation of materials. This presentation will focus on the in-situ irradiation and molten salt corrosion capabilities.



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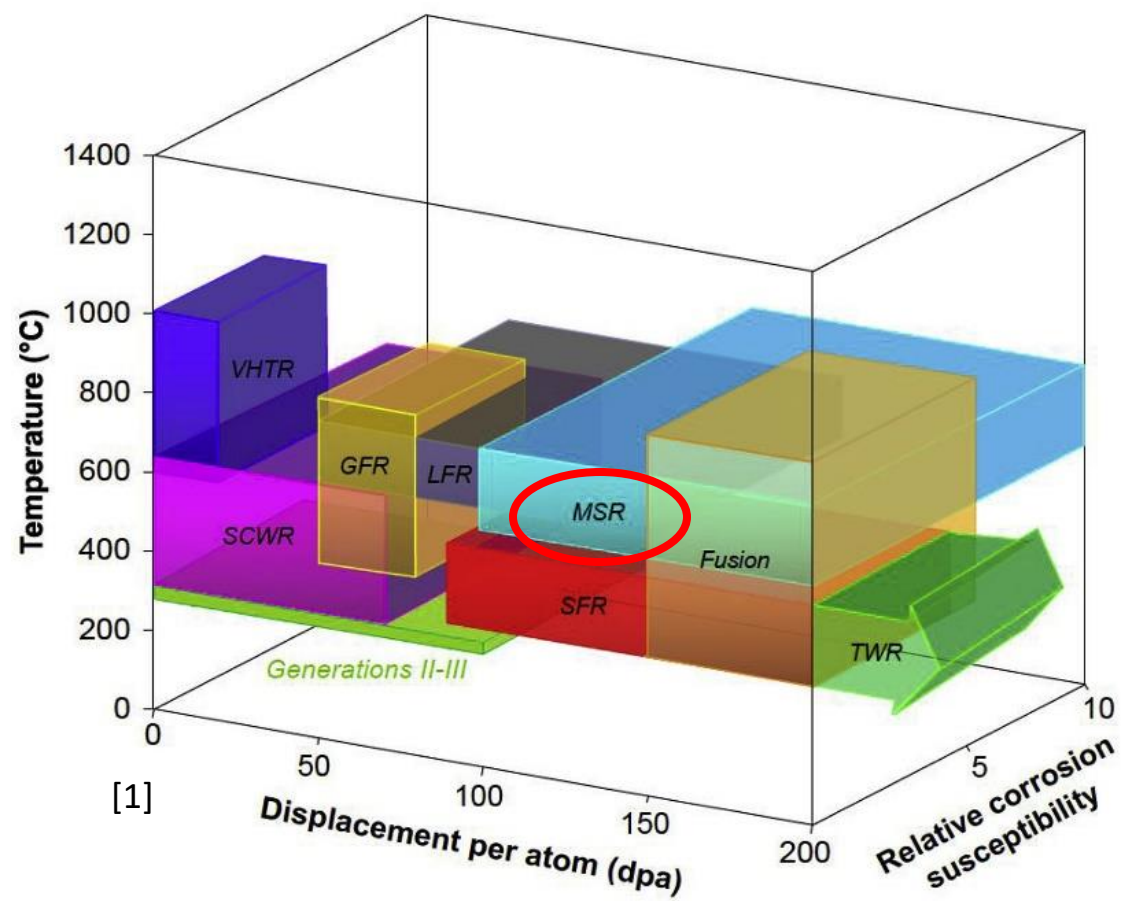
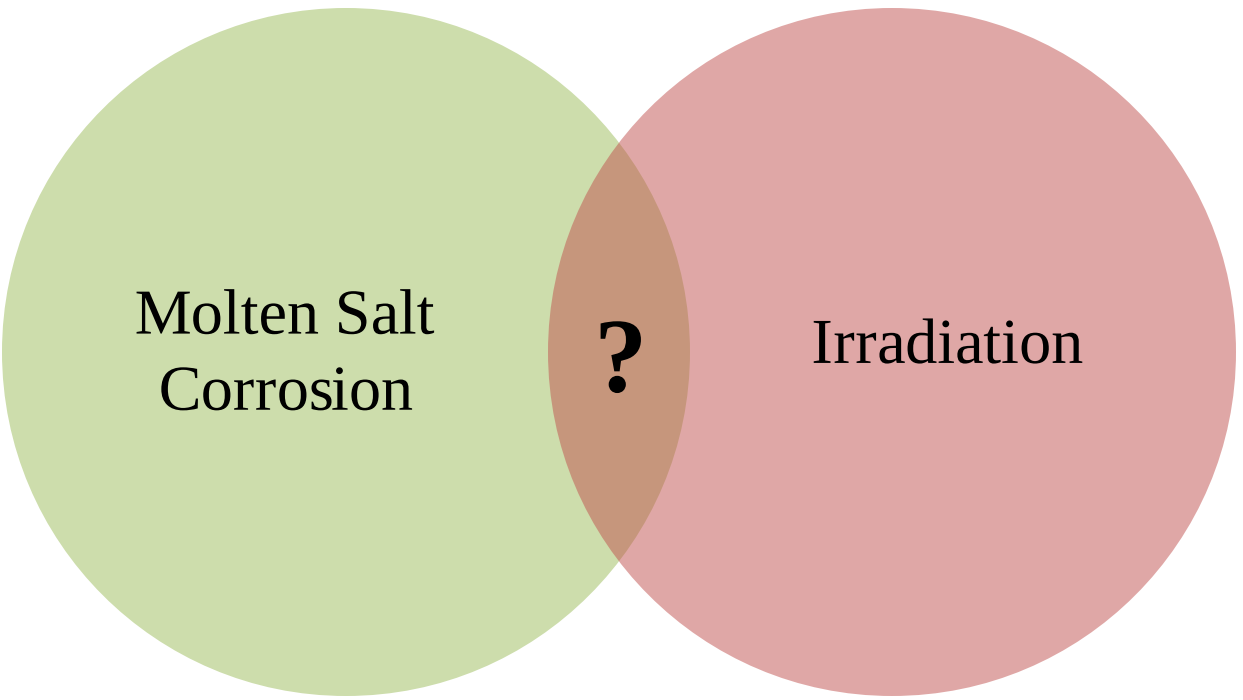
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Next Generation MSRs



[1] "Materials for future nuclear energy systems," Was et al., 2019

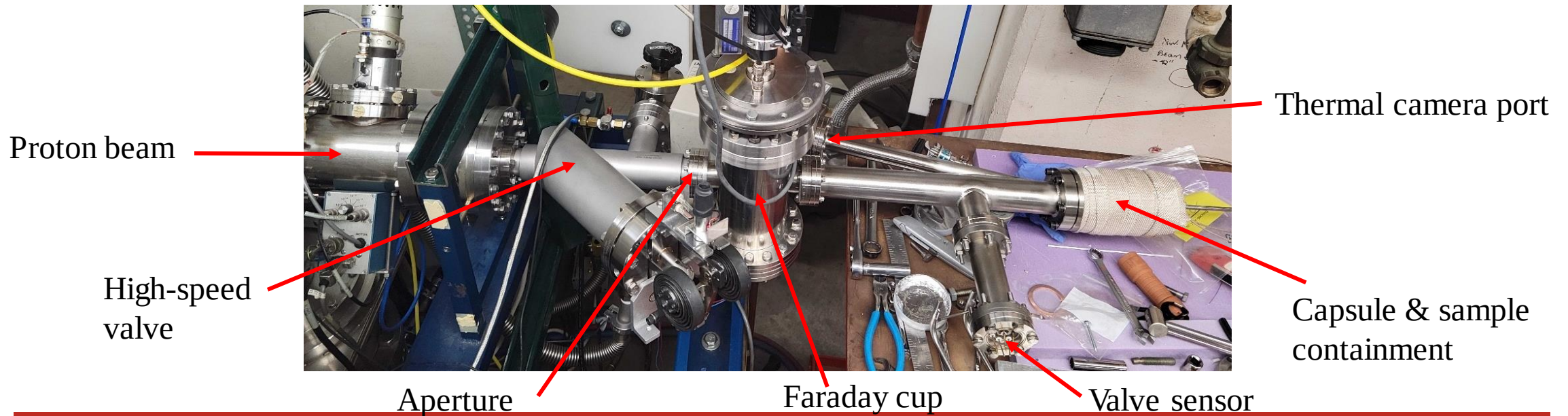
Irradiation + Molten Salt Corrosion Experimental Setup

Irradiation capabilities:

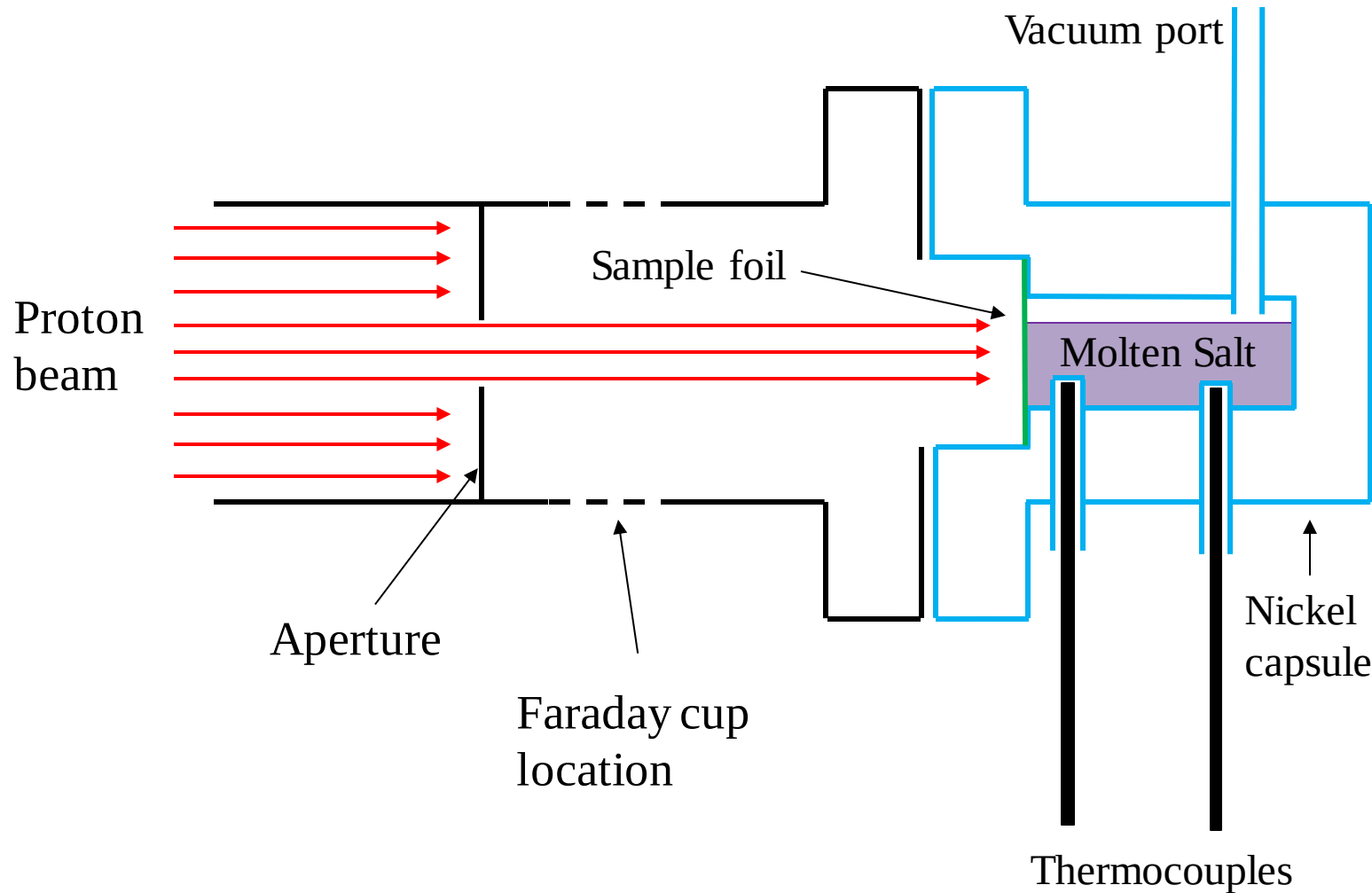
- Metallic target that can be manufactured to 25-40 μm thick
- 2.8-3.2 MeV protons
- 1.5-30 μA beam current on target
- $1.2\text{e-}6$ dpa/s – $2.4\text{e-}5$ dpa/s damage rate (in SS316)
- 500°C - 600°C temp range

Capsule specs:

- Made from pure Ni 201
- Ni 201 thermocouple wells
- Able to pull rough vacuum ($\sim 1\text{e-}3$ torr) in salt chamber
- $\sim 10\text{g}$ of salt fits within chamber



Capsule and Foil Setup in Beam Line



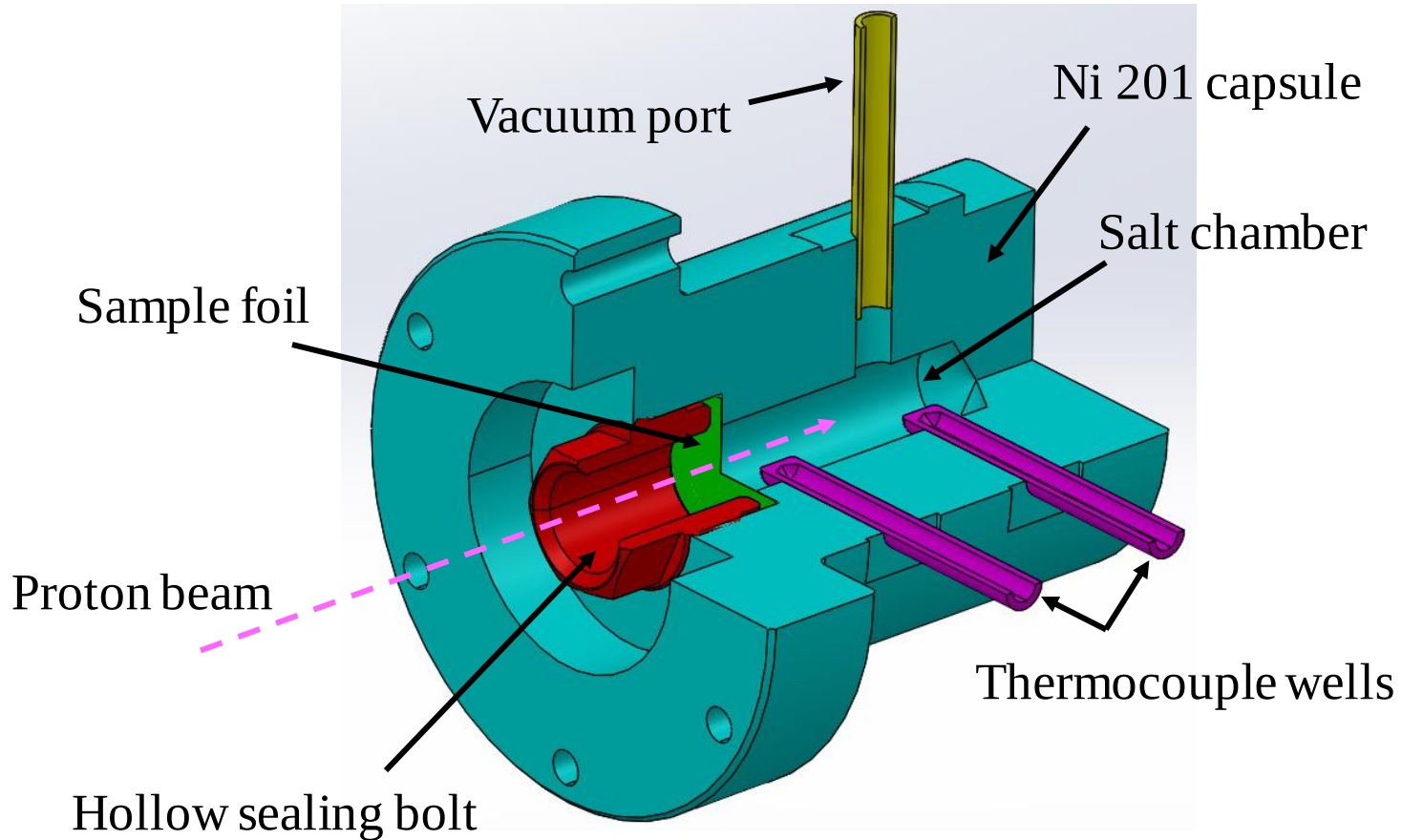
This is only a schematic of the beam line setup with the molten salt capsule.

Note:

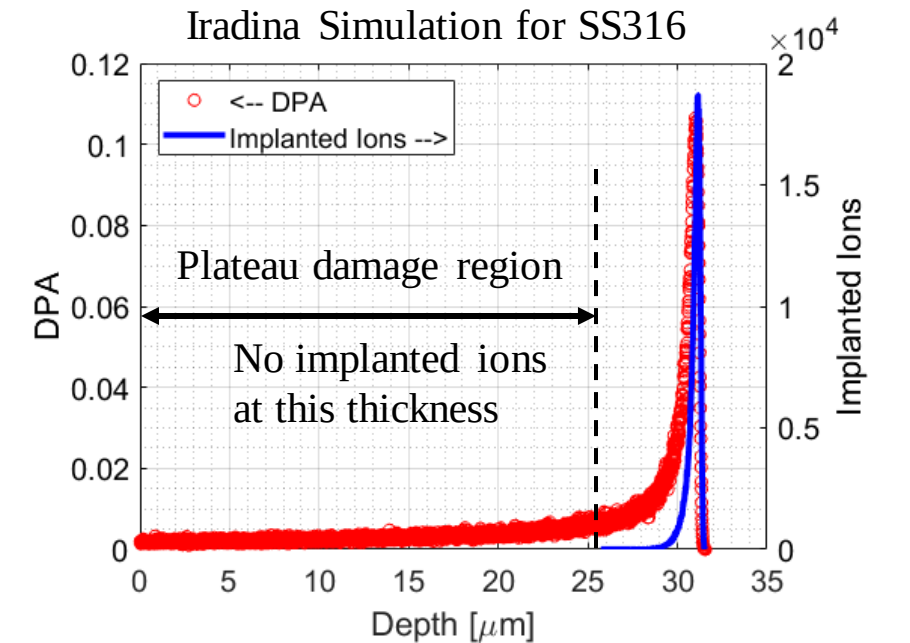
- Two thermocouple wells to monitor any localized effects of beam heating near the sample
- Vacuum Port to pull vacuum on back side of foil
- Pure Ni 201 capsule to minimize salt interaction with chamber (except for dissimilar metal corrosion with irradiated sample)

Irradiation + Molten Salt Corrosion Experimental Setup

SolidWorks Model of Salt Capsule



Sample Foil Thickness Justification

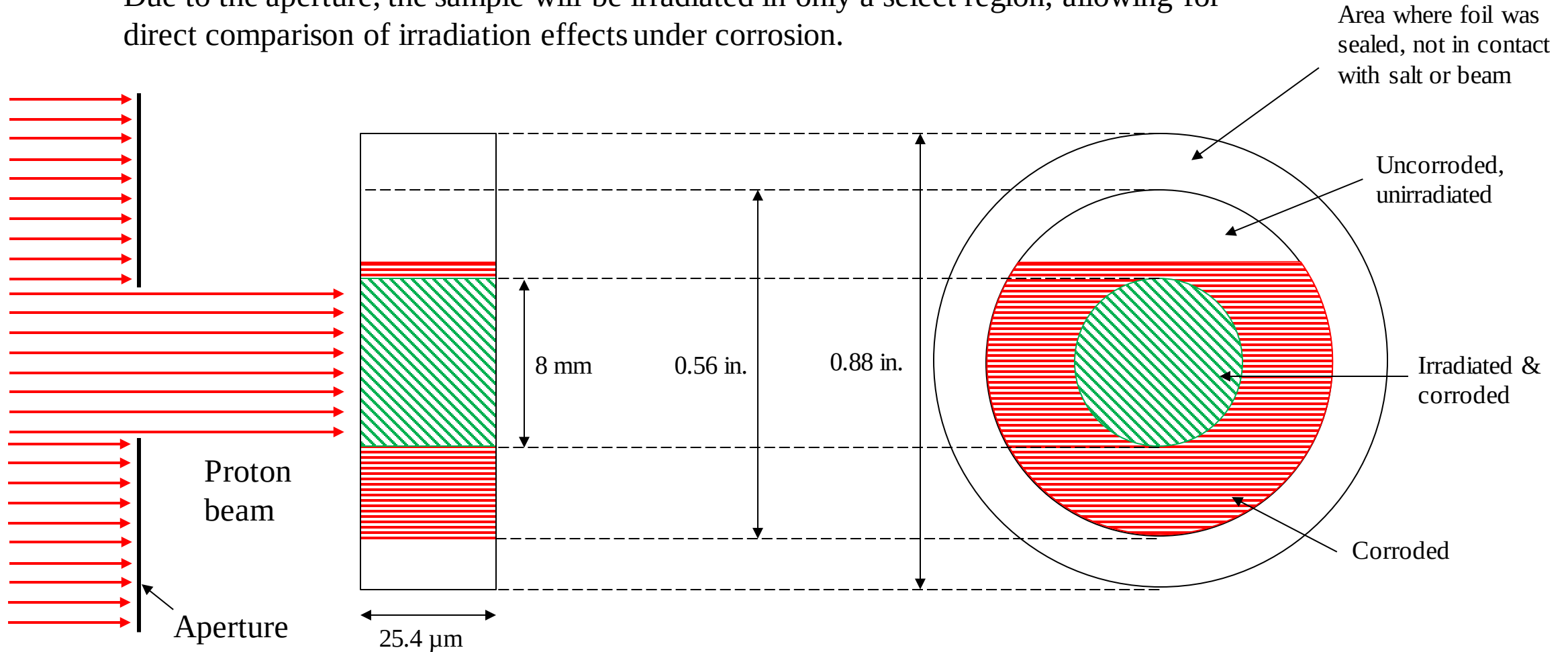


$$E_0 = 2.8 \text{ MeV}, \quad E_d = 40 \text{ eV}, \quad \text{flux} = 1.86 \times 10^{13} \frac{\text{ions}}{\text{cm}^2 \cdot \text{s}}$$

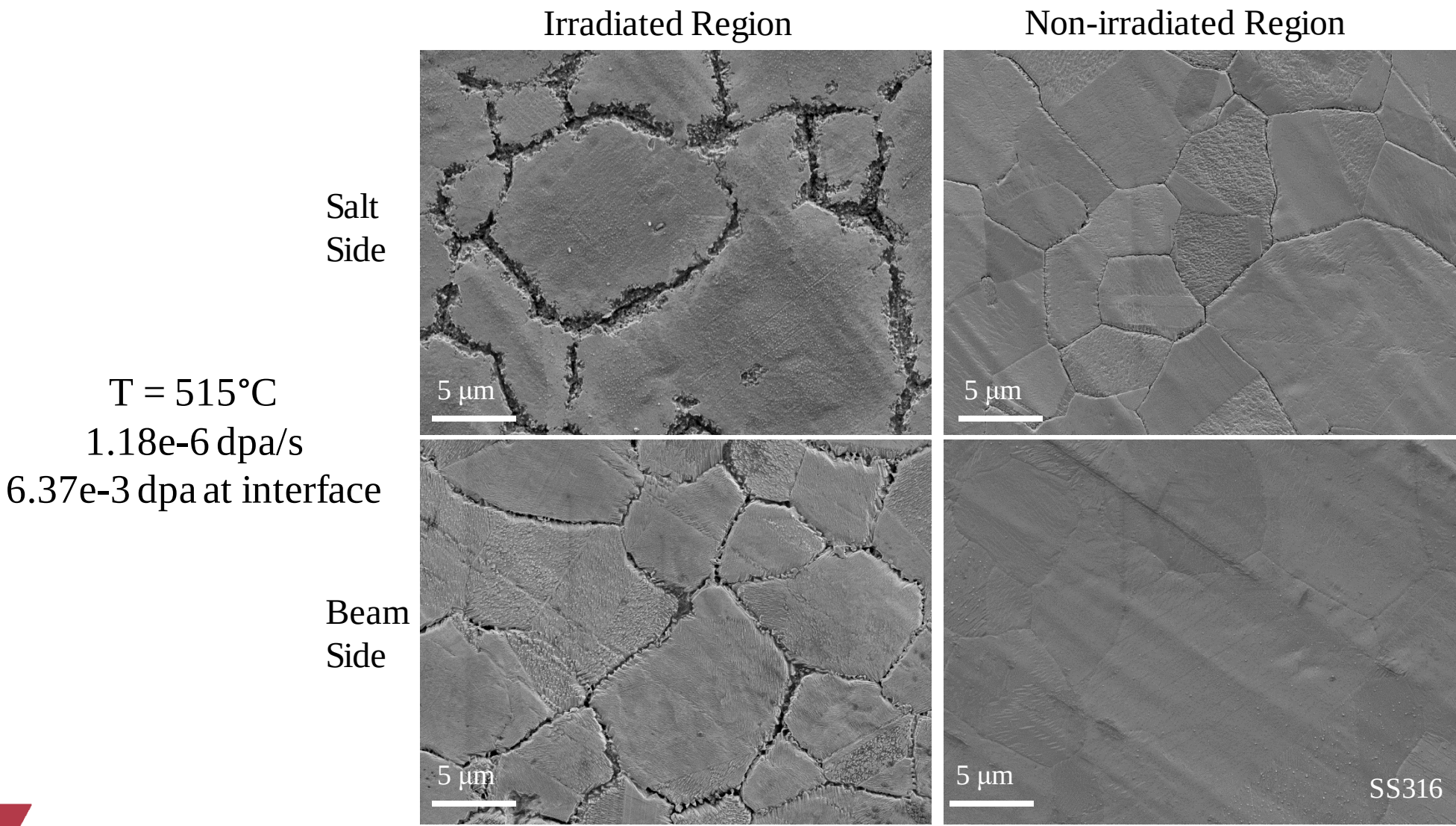
$$\text{beam current} = 1.5 \mu\text{A}$$

Sample Irradiated Area

- The sample will be subjected to corrosion across almost all of its surface
- Due to the aperture, the sample will be irradiated in only a select region, allowing for direct comparison of irradiation effects under corrosion.



Example of Results from SS316 Irradiation Under FLiNaK Corrosion

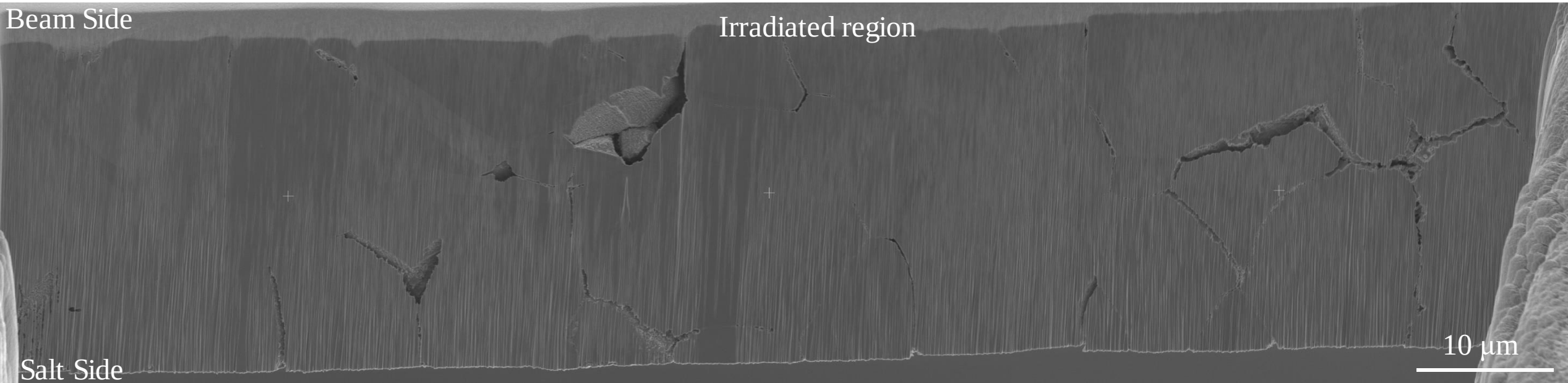
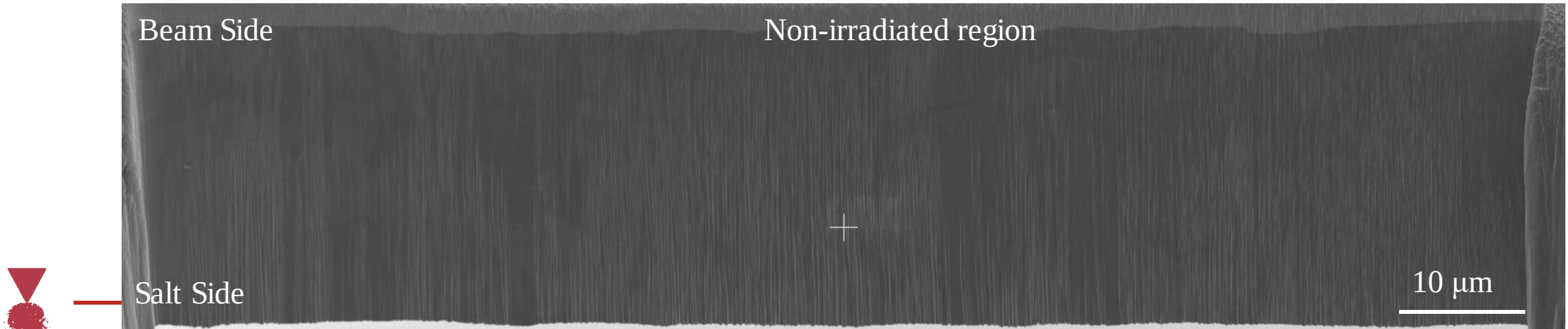


Proton irradiation resulted in accelerated grain boundary attack under molten salt corrosion

T = 515°C

T = 515°C
 1.18e-6 dpa/s
 6.37e-3 dpa at interface

Cross-Sectional Results of SS316 Irradiation



Acknowledgments + Contact Info

I would like to acknowledge the IBL staff members Nate Eklof and Zack Rielley for all of their help in running the accelerator and completing experiments!

Big thank you to Adrien Couet and Kumar Sridharan, the PIs in charge of making sure we get to use the IBL!

Feel free to email me at cevered@wisc.edu if you have any more questions about the molten salt + irradiation capabilities.

If you would like to chat about submitting a request for an RTE or other experiment, you can email Adrien Couet at couet@wisc.edu

Please visit our lab websites to see the great work we are doing with molten salt and irradiated materials:

MaDCoR: <https://madcor.neep.wisc.edu/>

IBL: <https://ibl.neep.wisc.edu/>

Questions?