GeDSSD Neutron Damage Studies at UML

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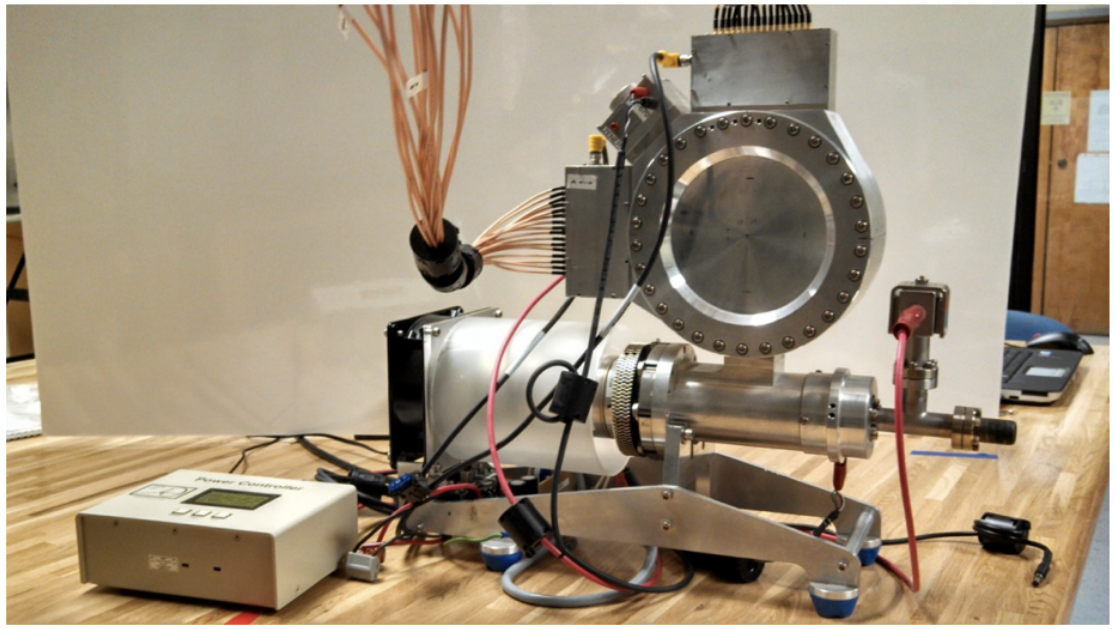
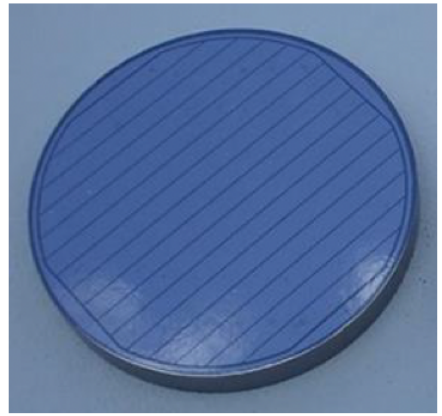
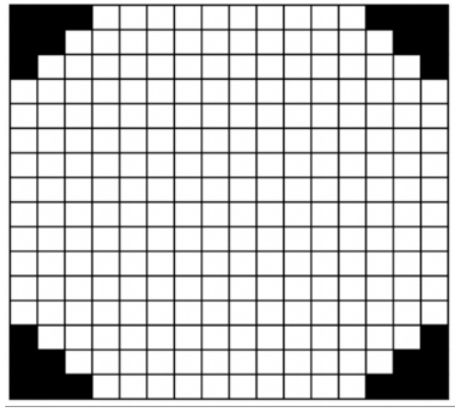
3rd AGATA-GRETINA Collaboration Meeting

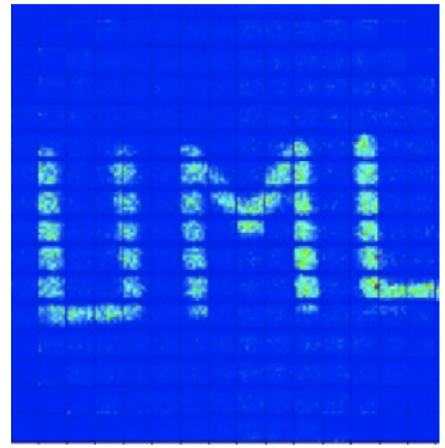
Ge-DSSD: PHDs Co.

- Small Business Innovation Research (SBIR) grant from USDOE (Lister)
- applications in imaging and high count rate capabilities
- test neutron damage and “repairability” for in-beam physics

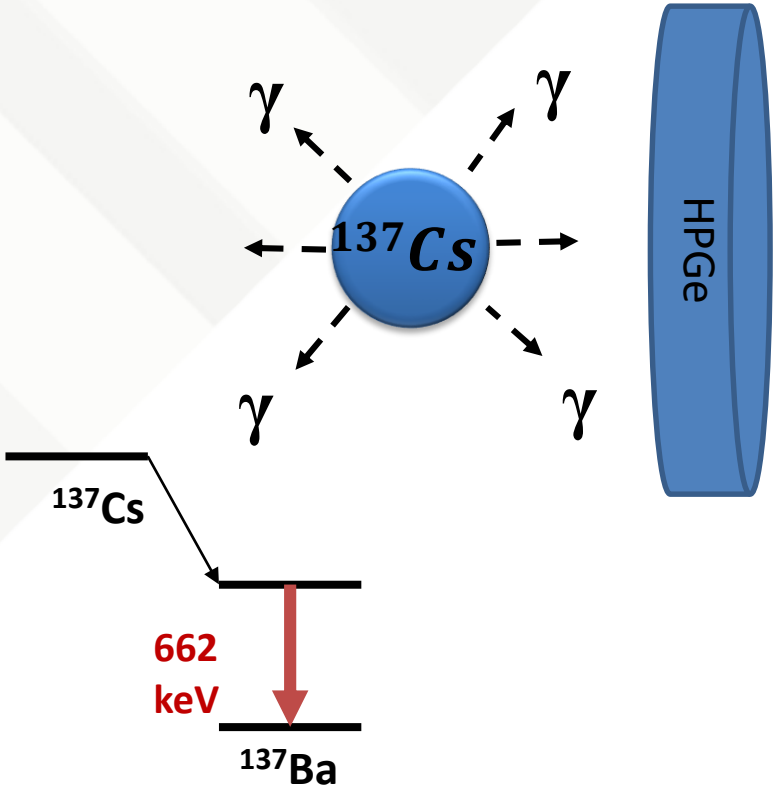




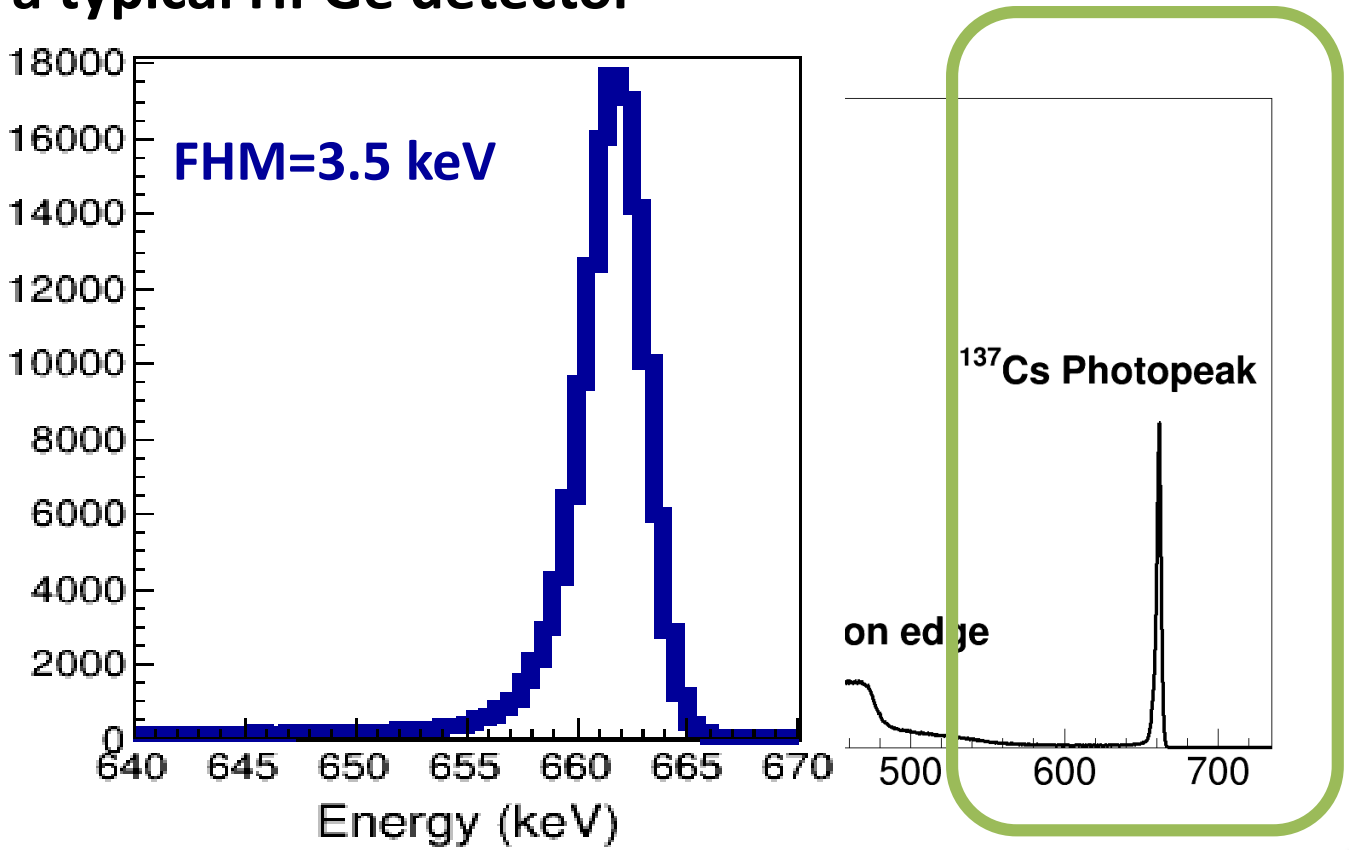




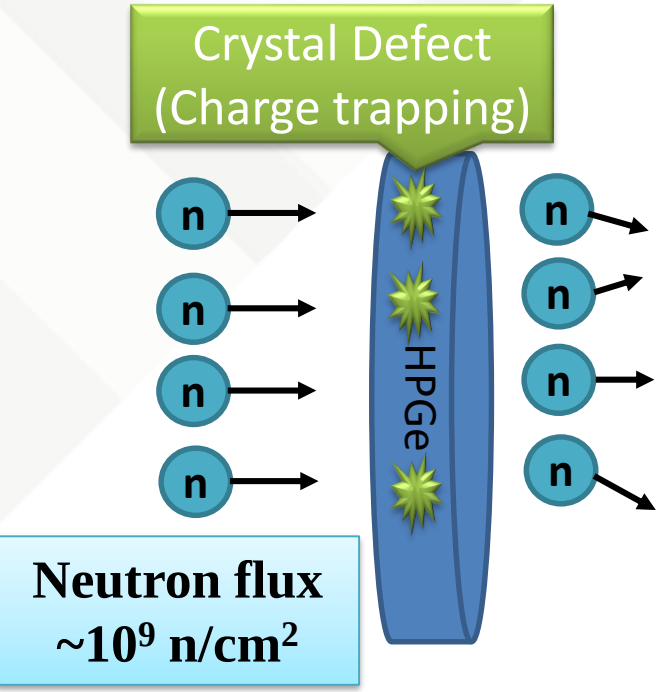
Typical HPGe Detector Peak Shape

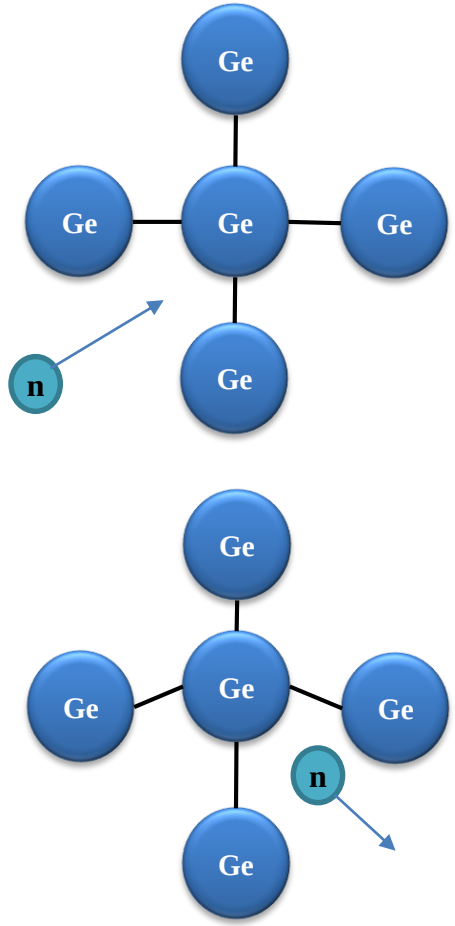


Full-energy deposition of 662-kev in a typical HPGe detector

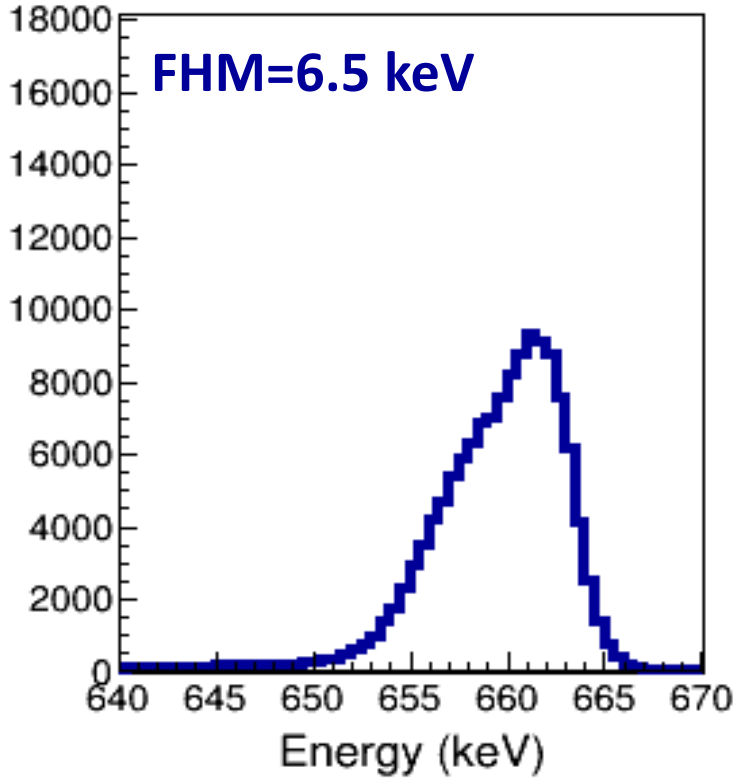


Effect of Neutrons on Peak Shapes



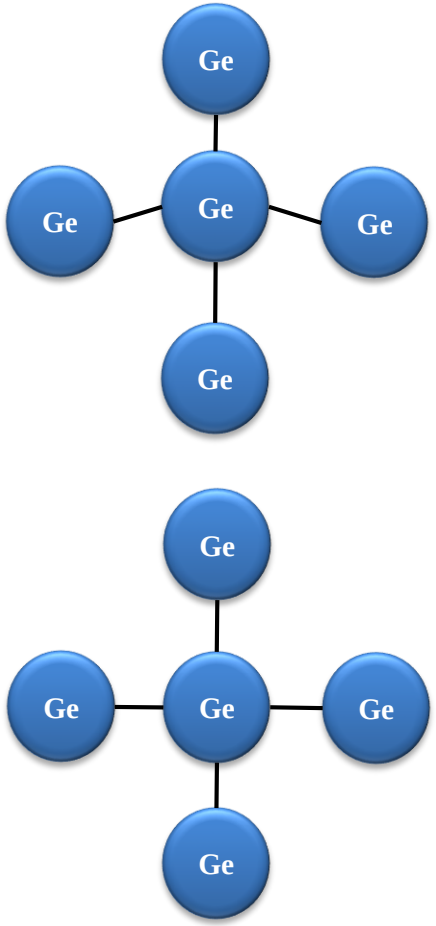


Full-energy deposition of 662-kev in a neutron damaged HPGe detector

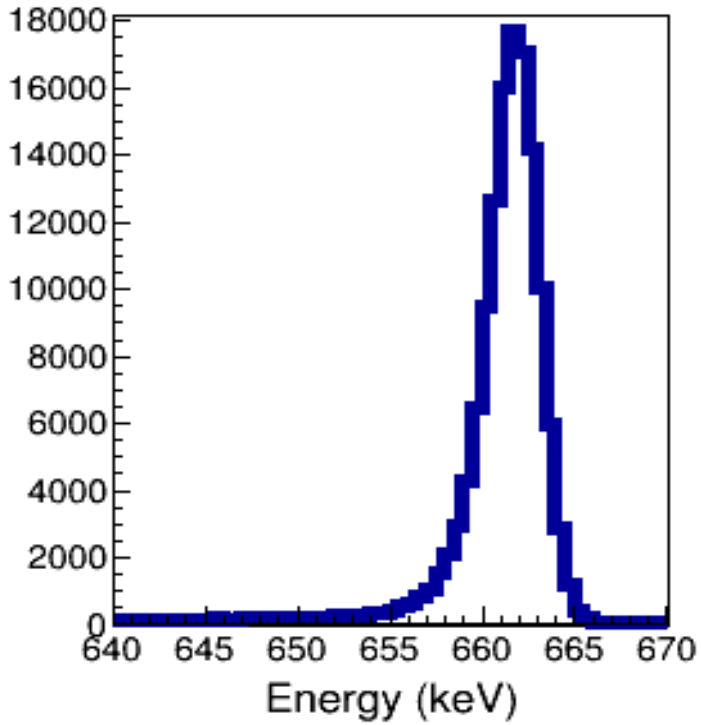


Effect of Annealing on Peak Shapes

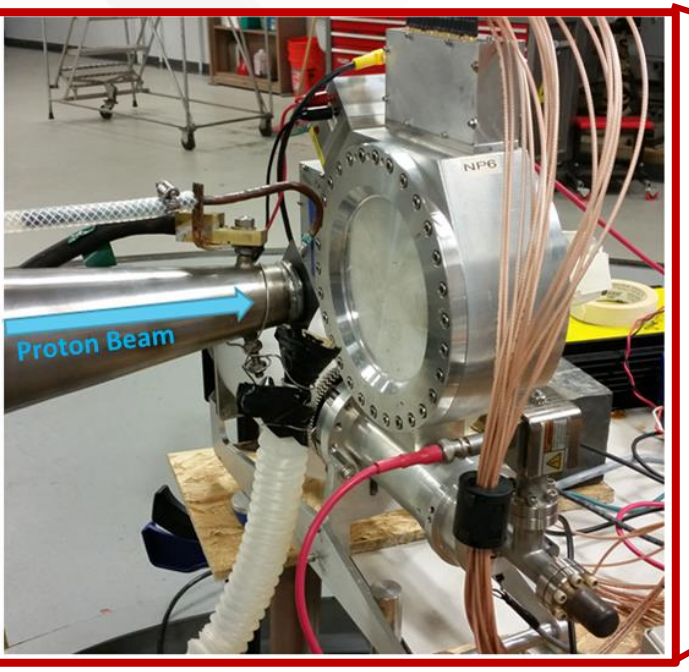
Anneal at ~370 K for ~3 days

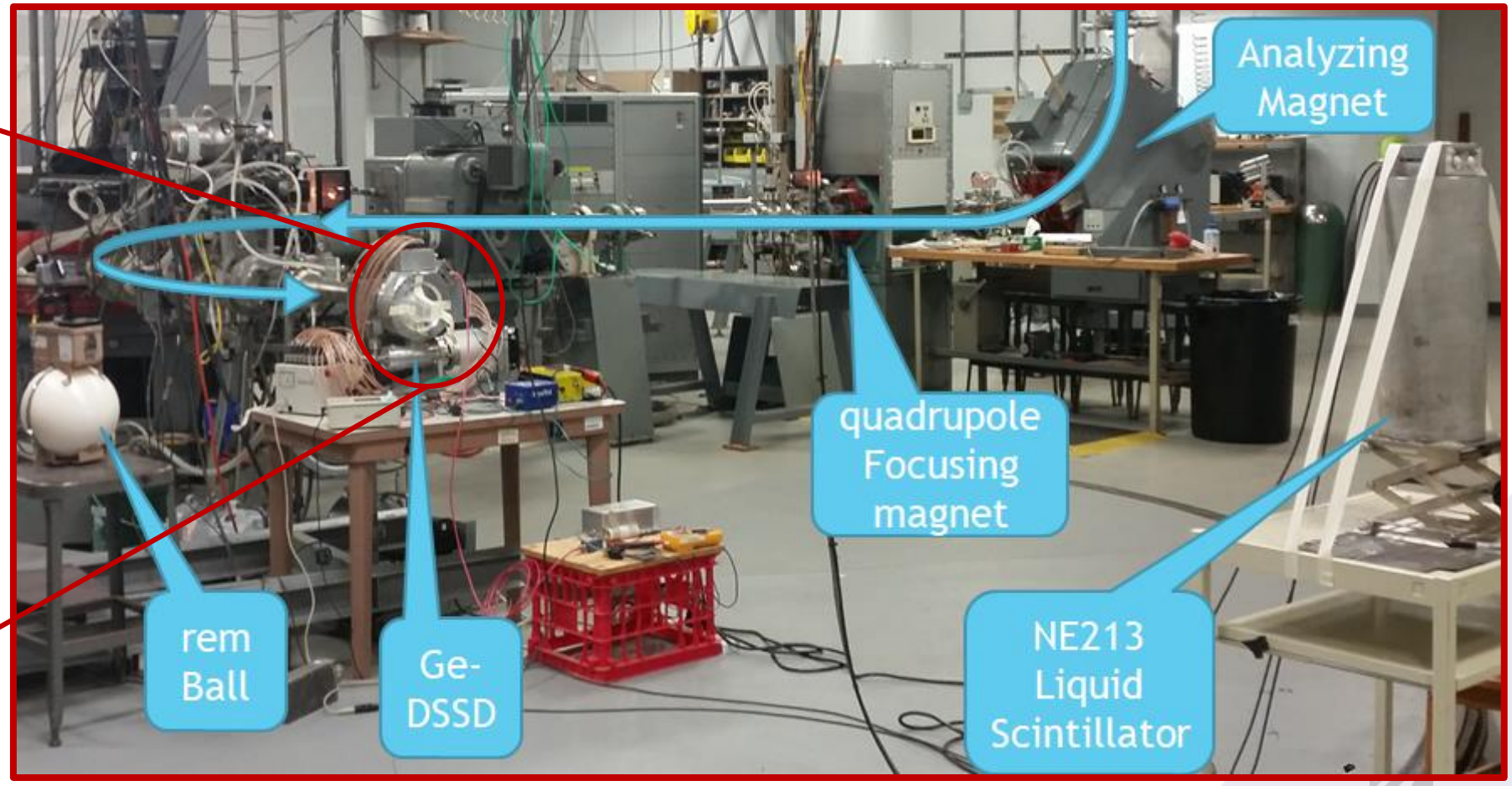


Full-energy deposition of 662-kev in an annealed HPGe detector



$^{7}Li(p,n)^{7}Be$ Reaction at UML



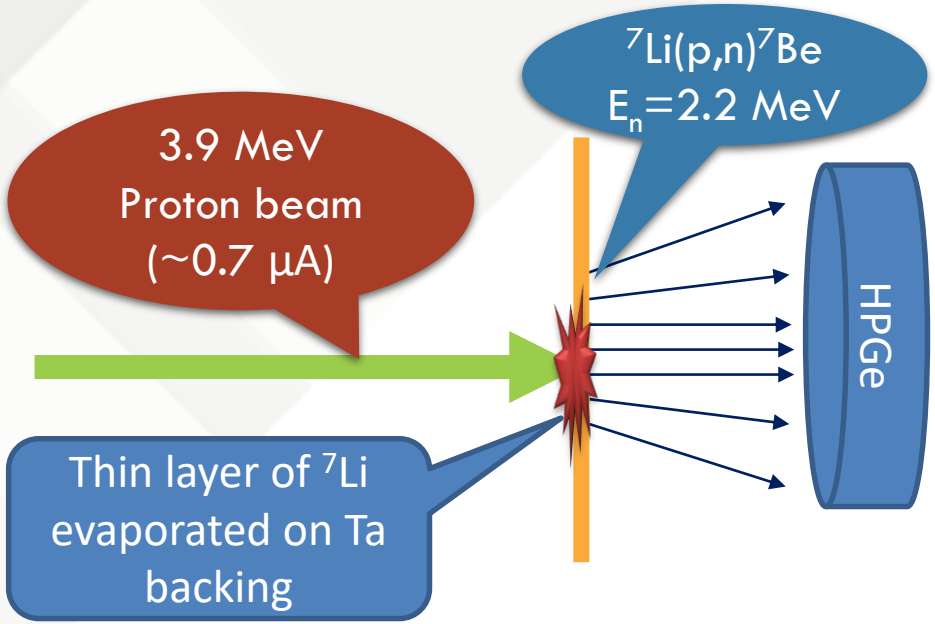


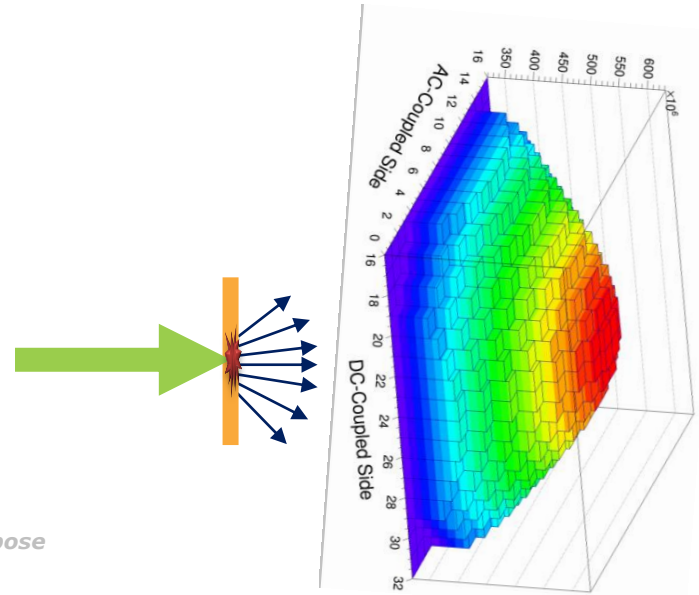
Experimental Plan

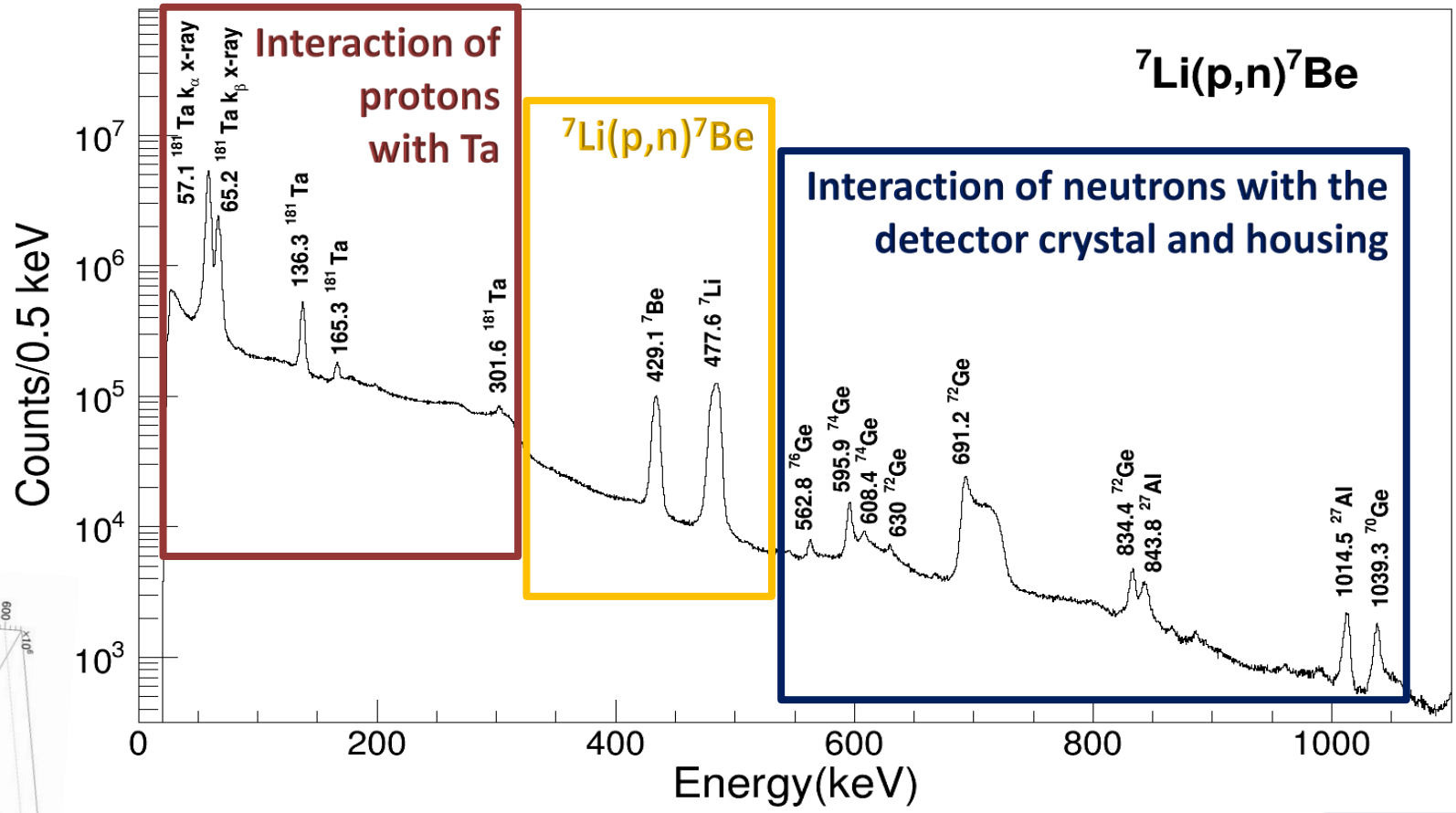
- Three irradiation were made, so the accumulation of damage could be followed.
- The detector was Thermally Cycled to room temperature.
- The detector was Annealed to 350K for three days.
- ^{137}Cs source was used to determine the peak shapes after each stage.

Stage	No	Neutron (n/cm^2)	Accumulated Neutron (n/cm^2)
Neutron damage	1	$1.08(5)\times10^9$	$1.08(5)\times10^9$
	2	$0.40(2)\times10^9$	$1.48(5)\times10^9$
	3	$0.45(2)\times10^9$	$1.93(9)\times10^9$
Thermal Cycled			
350K Anneal			

$^{7}Li(p,n)^{7}Be$ Reaction at UML

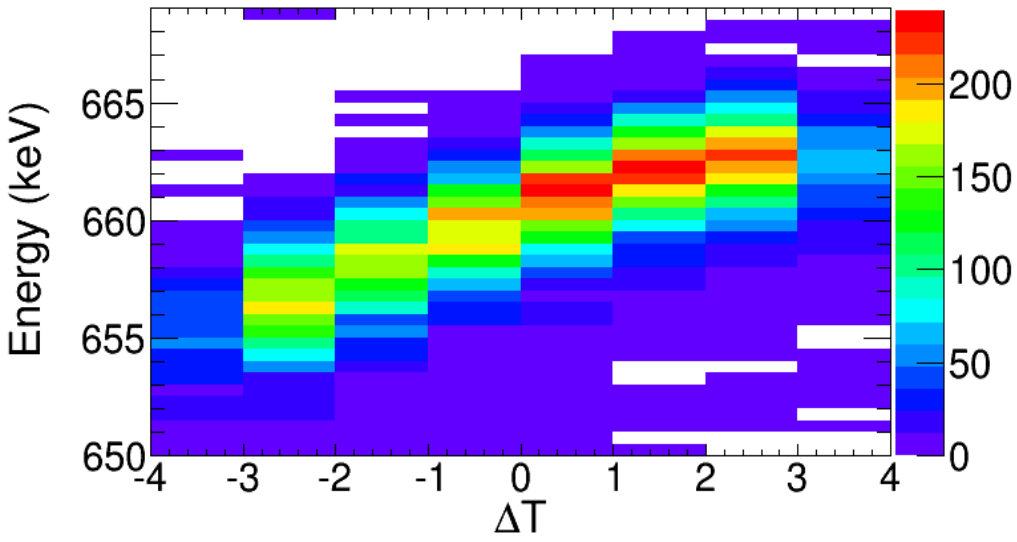


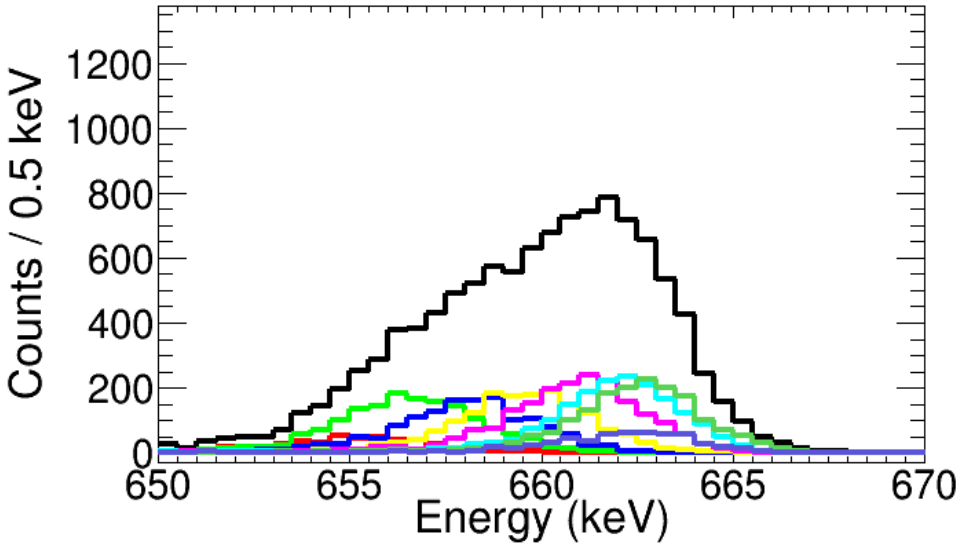


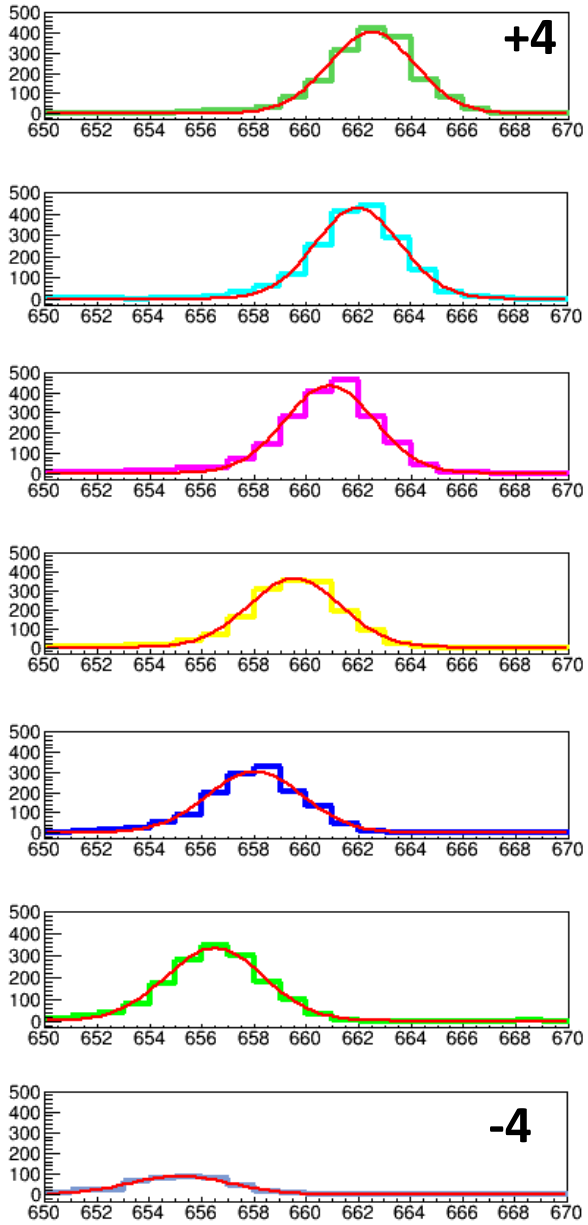


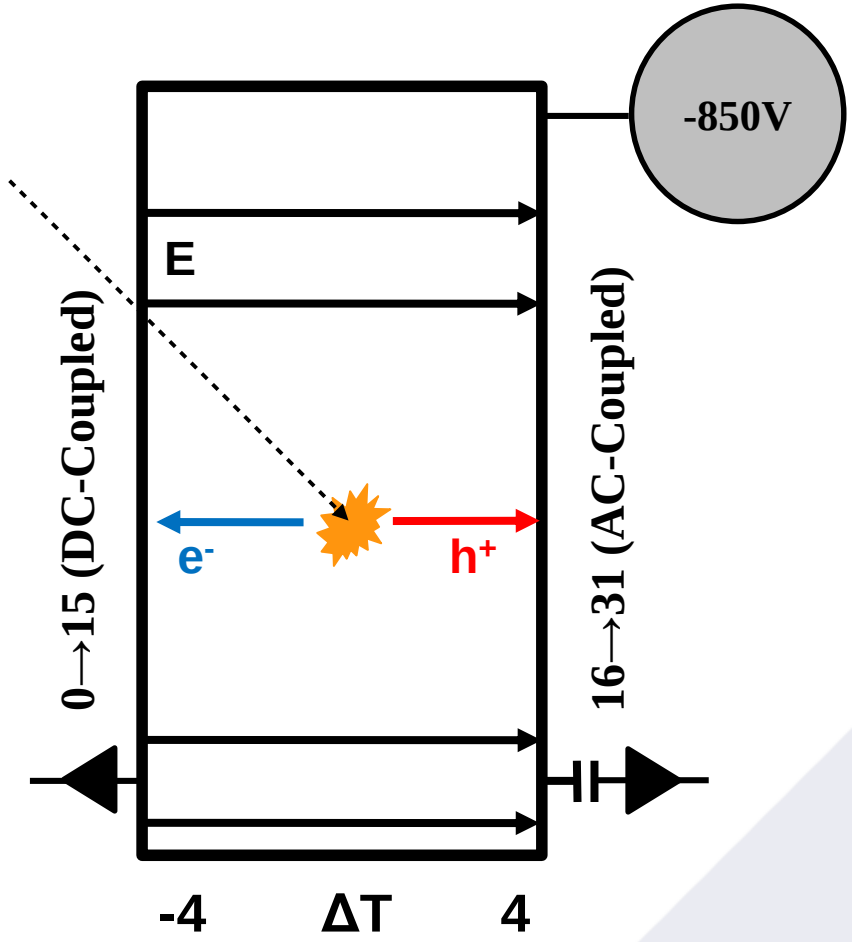
- Number of neutrons was determined by assaying the target.

Interaction Depth





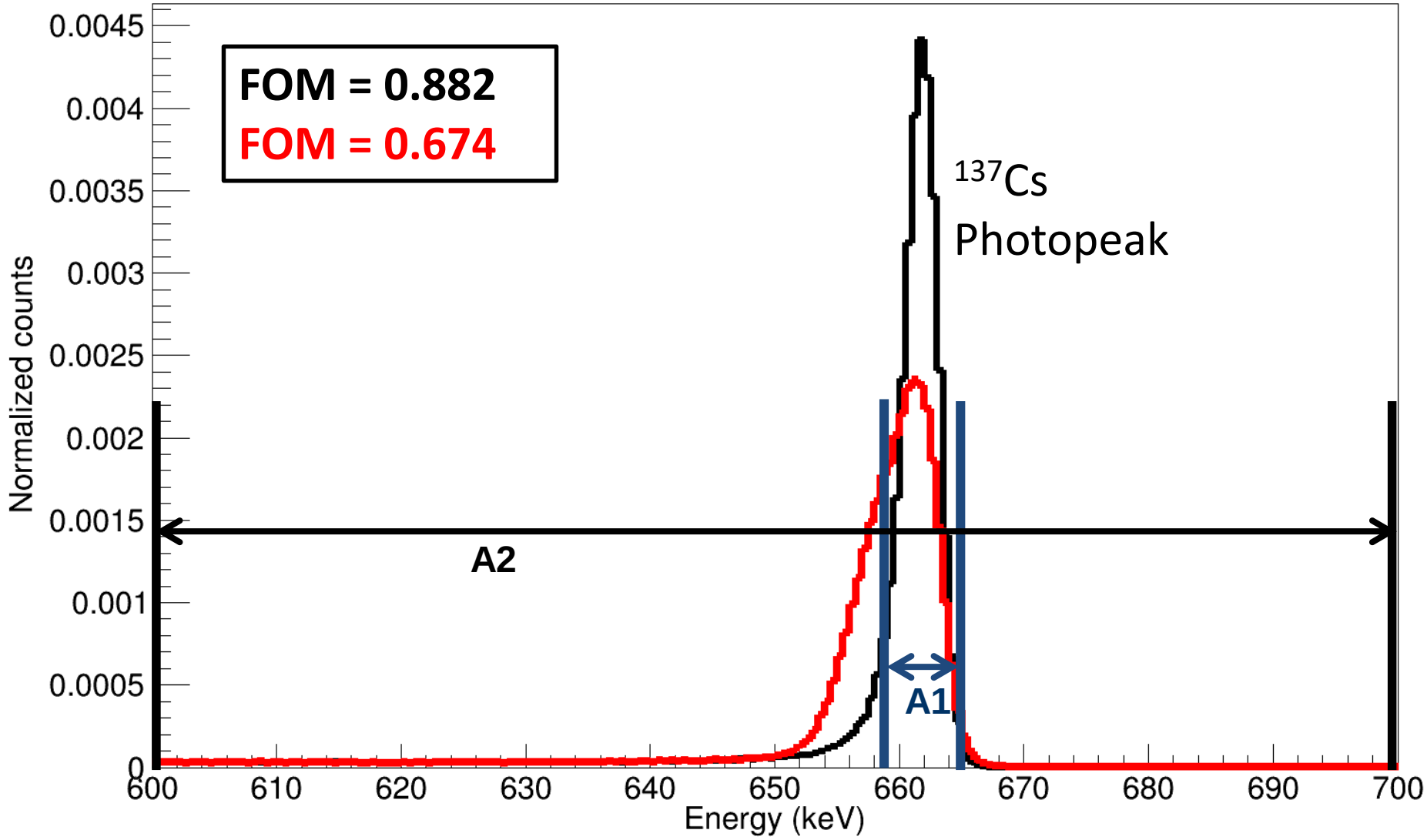




$$\Delta T = T_{DC} - T_{AC}$$

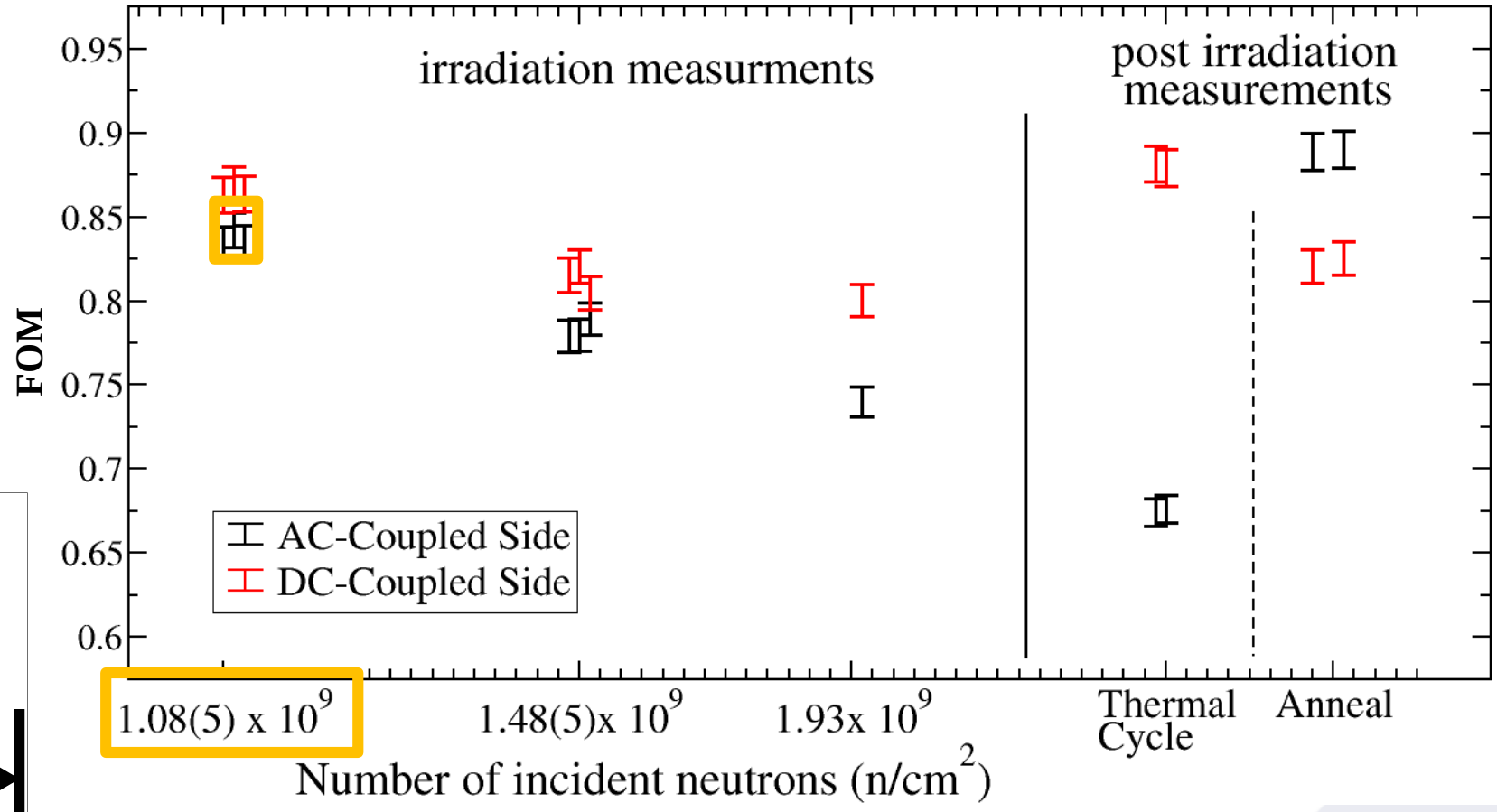
Quantifying Neutron Damage in a Peak

- $\mathbf{FOM} = \frac{\mathbf{A1}}{\mathbf{A2}}$
  - FOM ~ 1 Typical
  - FOM << 1 Damaged

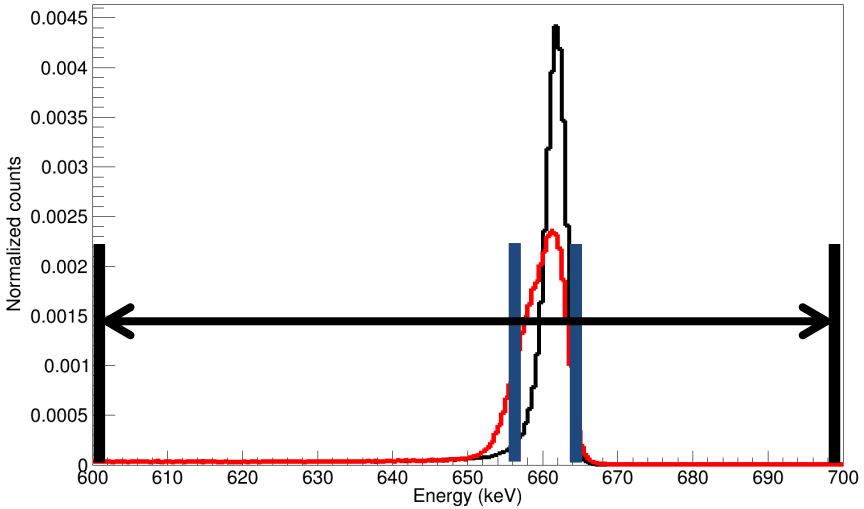


FOM for Stages

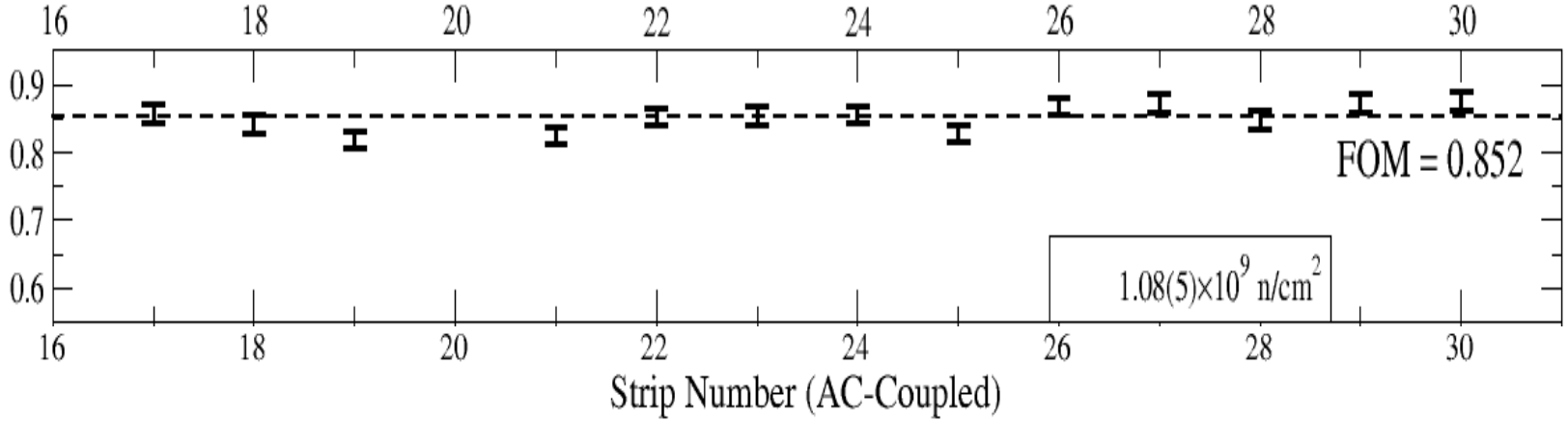
- Apply FOM for the sum spectrum for each side of the detector.

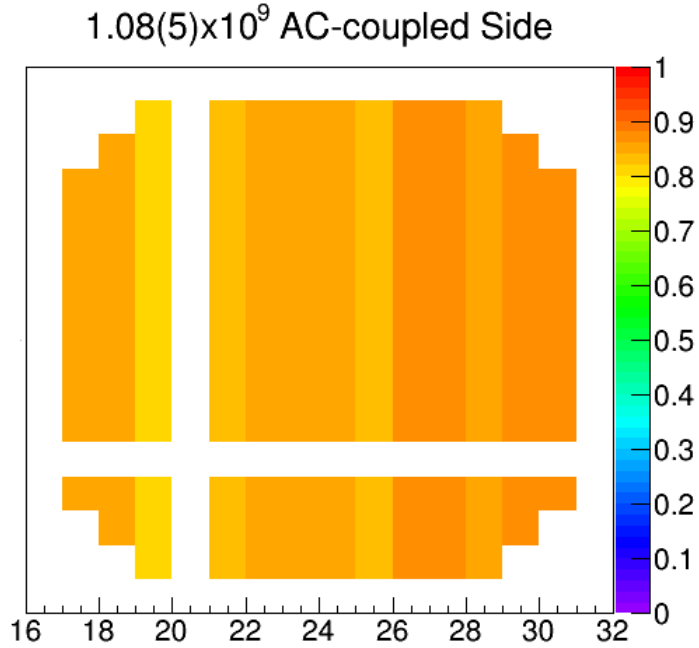


Colors does not match

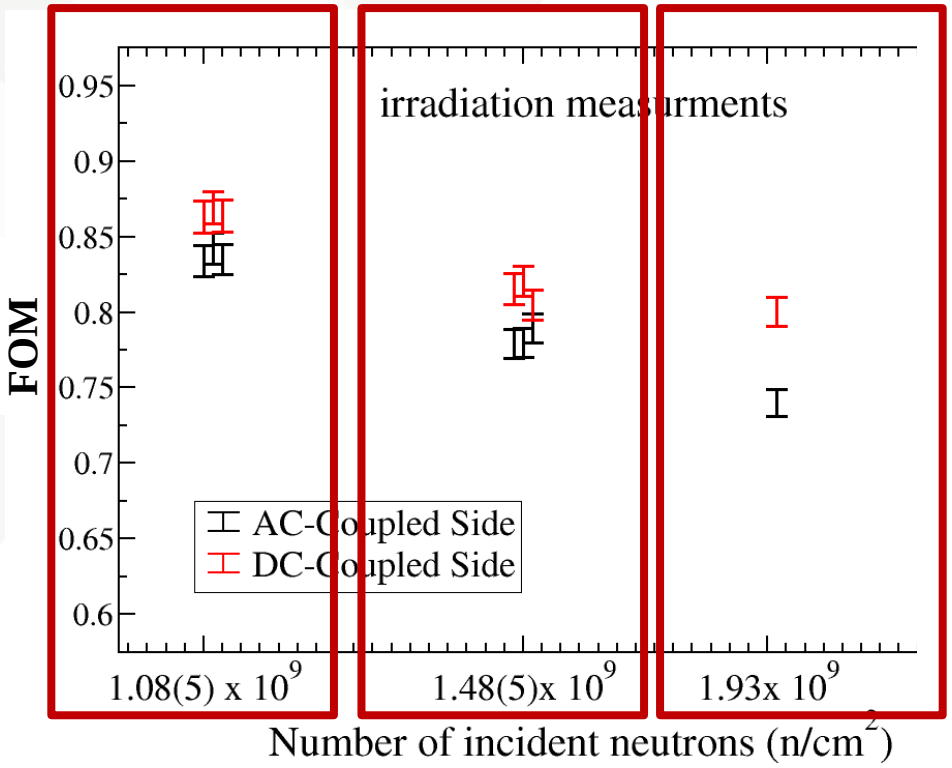


FOM per Strip

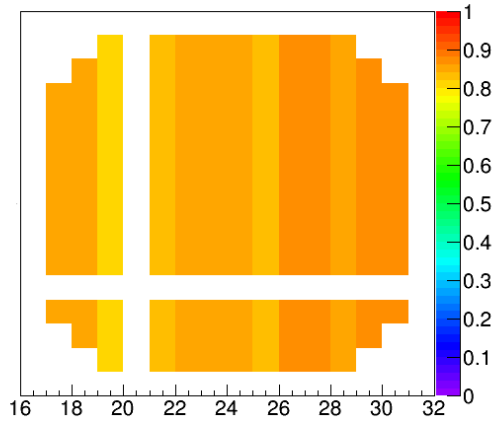




Strip FOM for Irradiation Stages



FOM = 0.83



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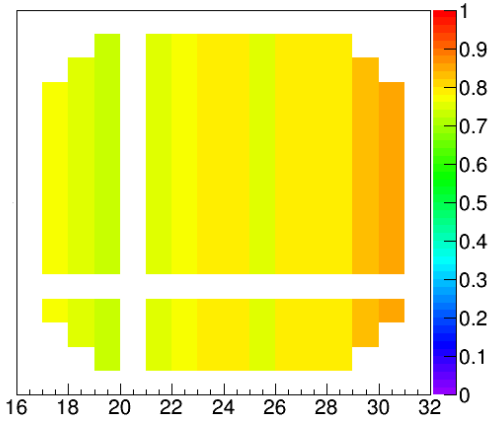

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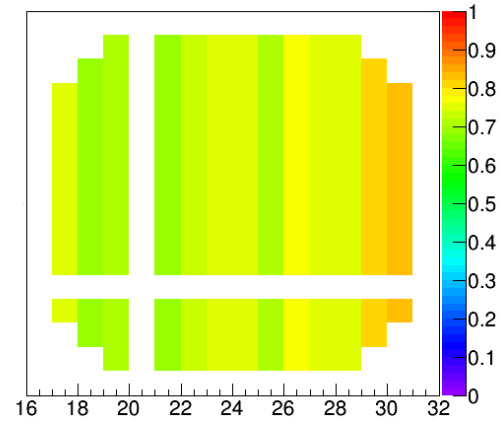

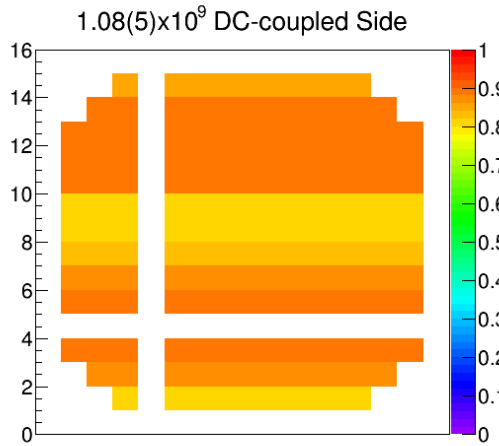

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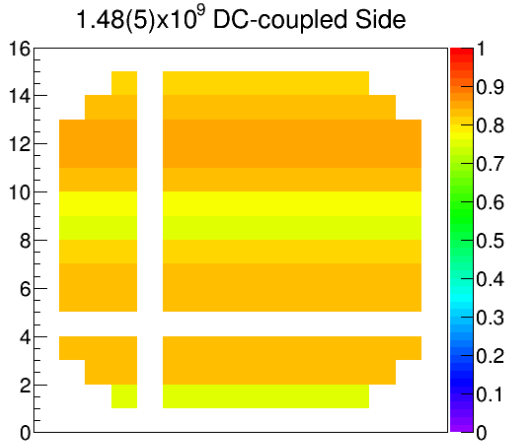

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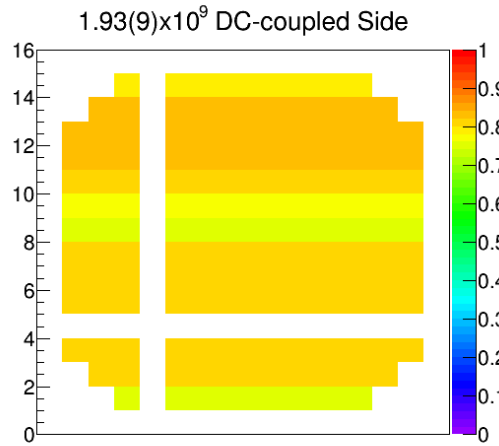
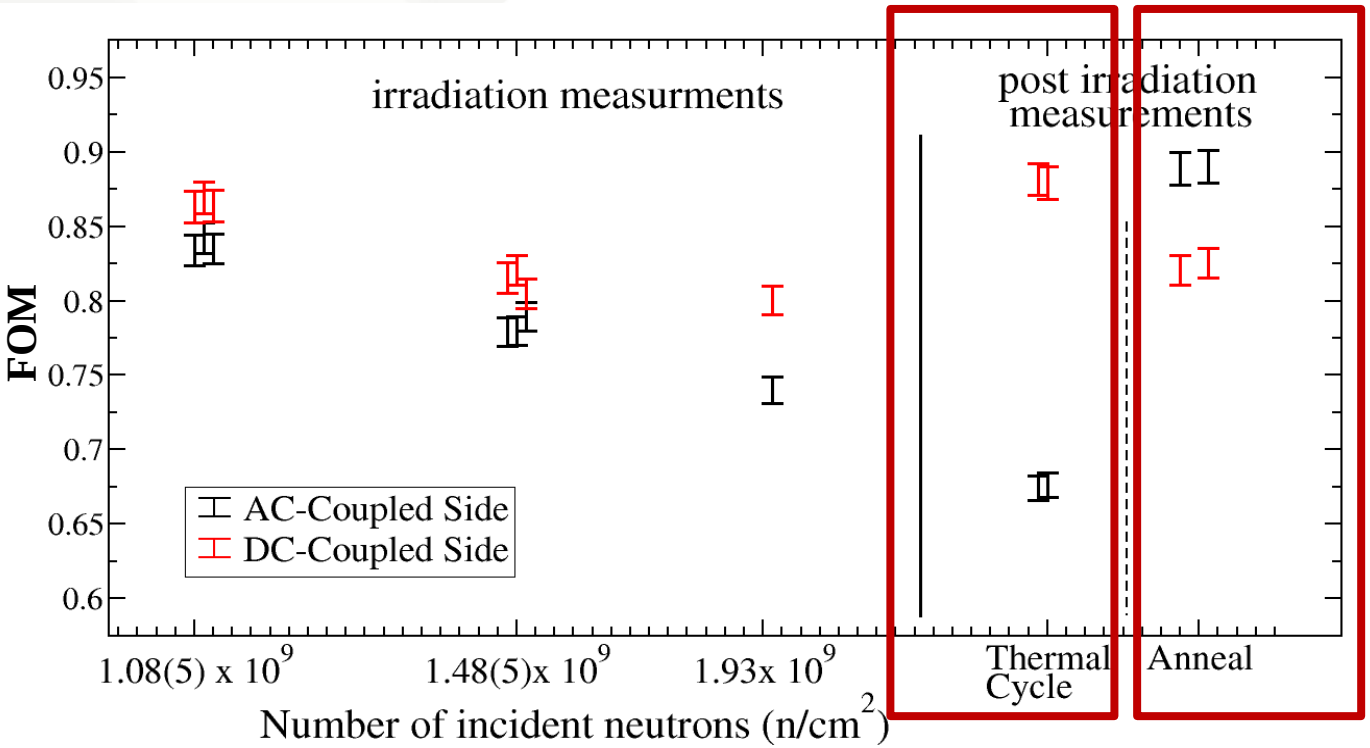


FOM = 0.80

Strip FOM for Post Irradiation Stages



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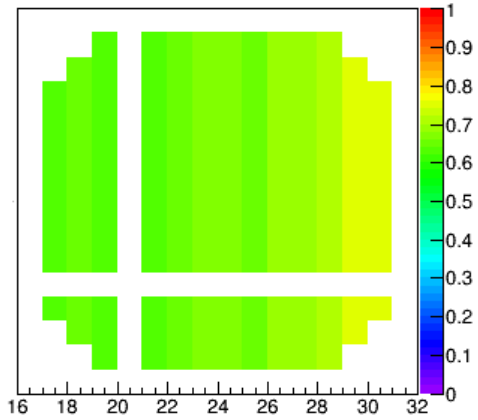

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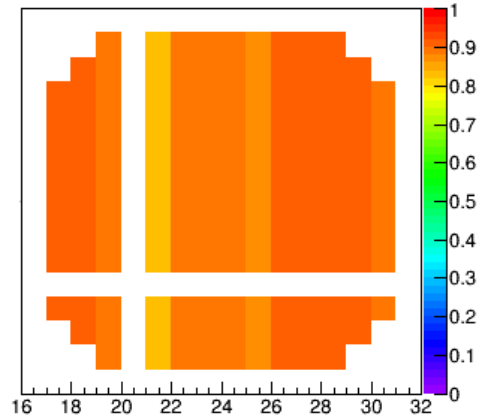

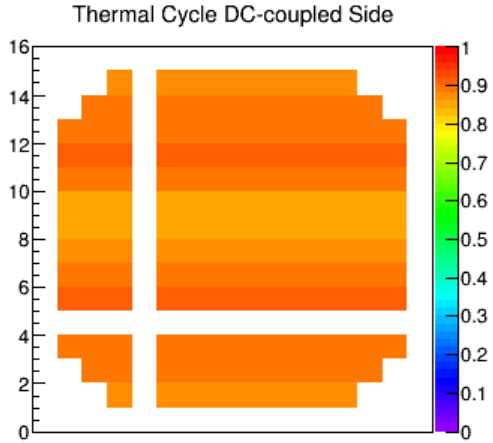

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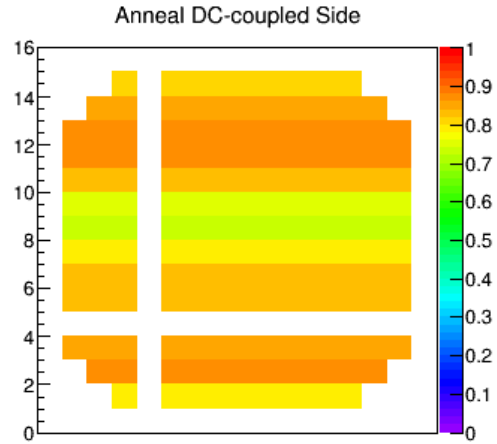

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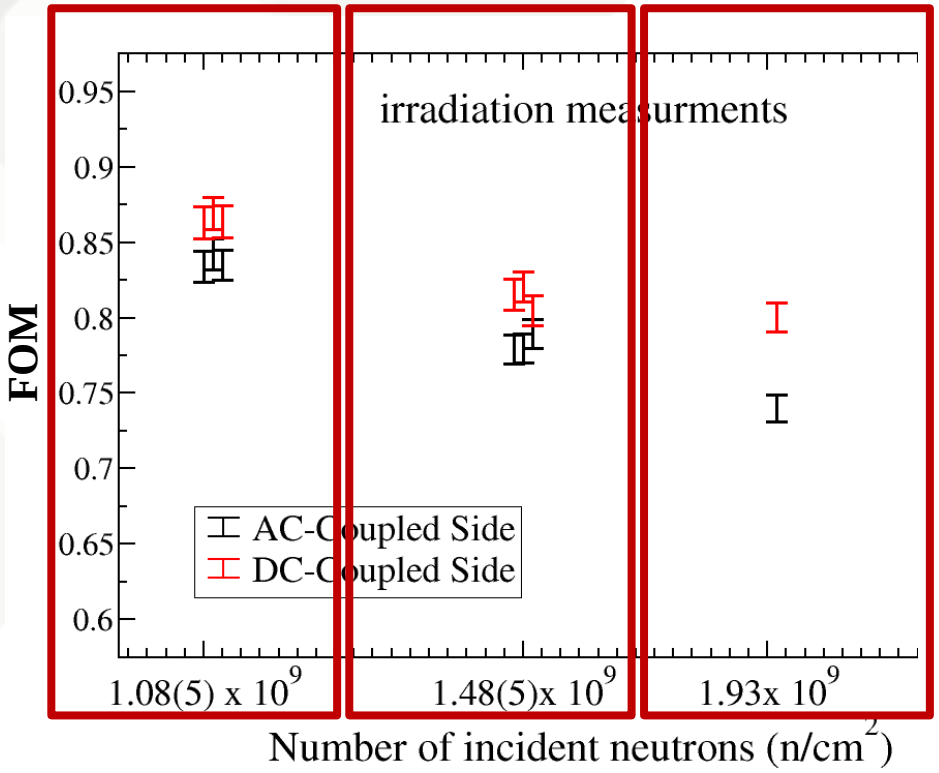
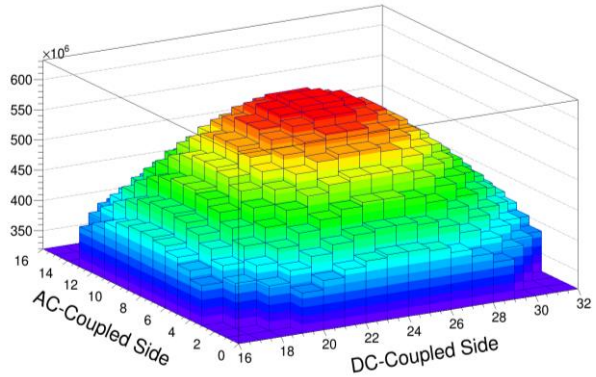
Pixel FOM for Irradiation Stages





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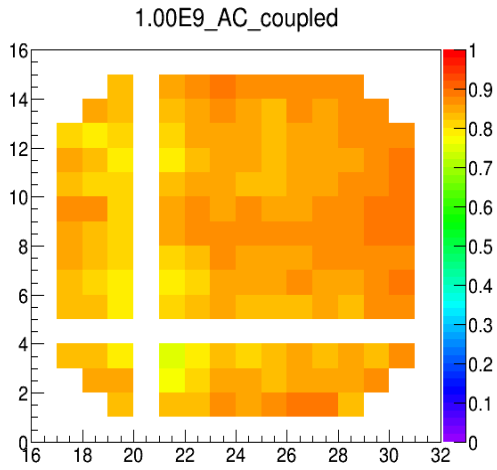

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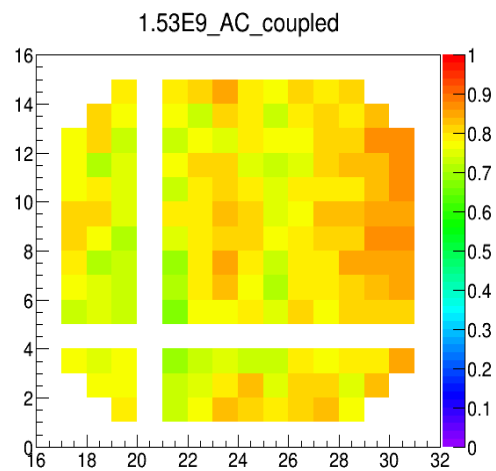

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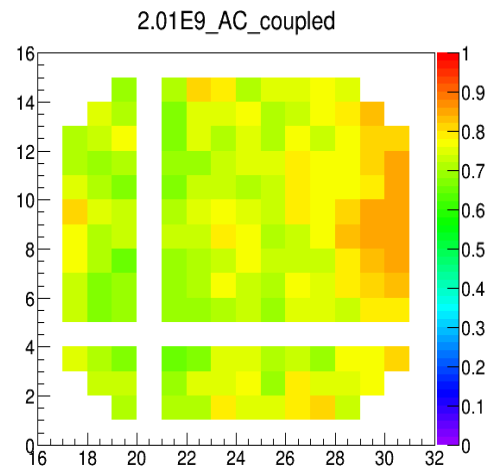

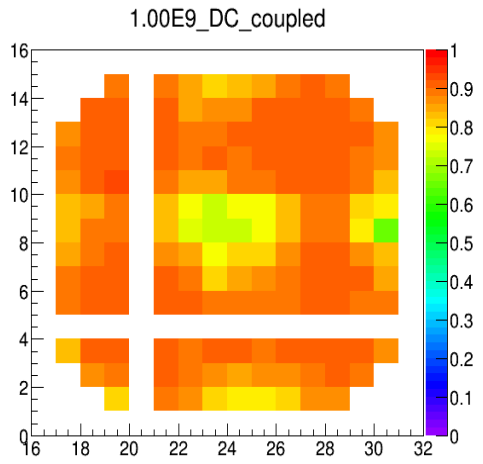

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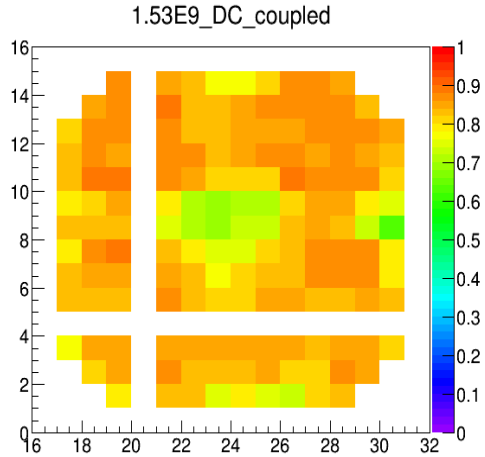

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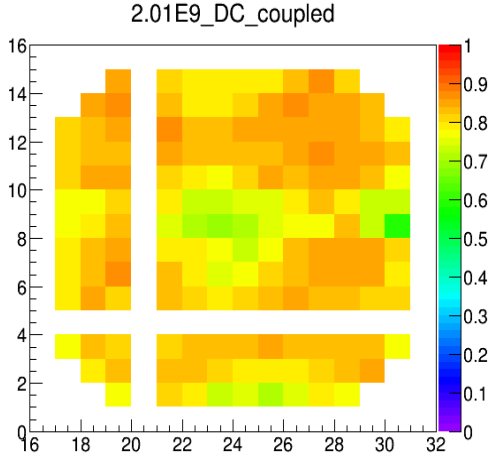
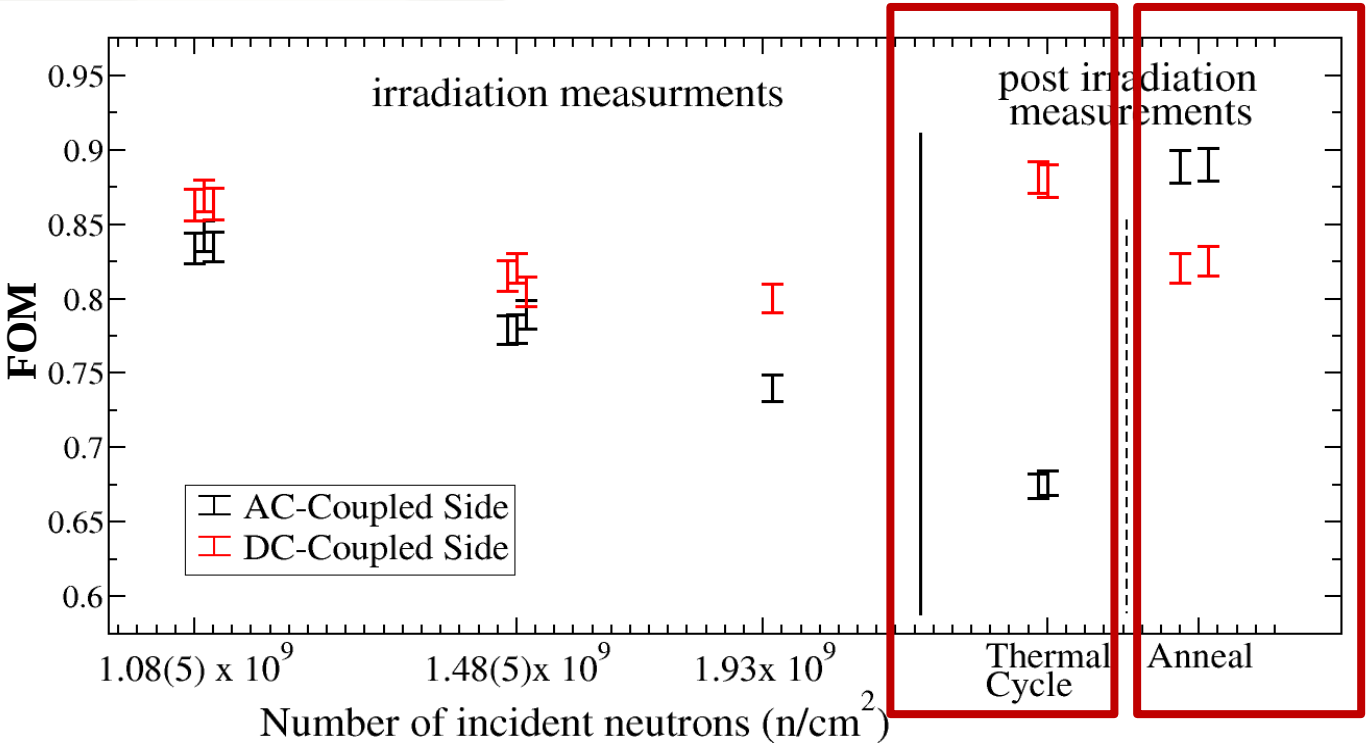


FOM = 0.80

Strip FOM for Post Irradiation Stages



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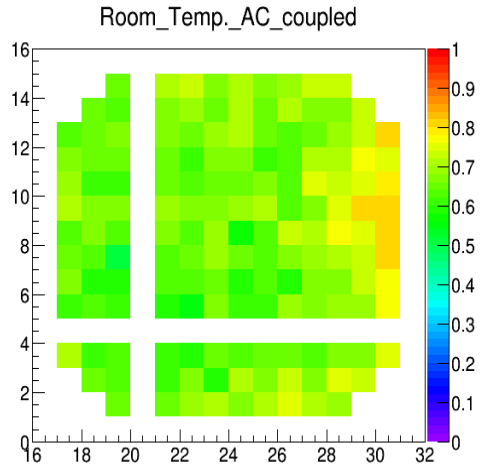

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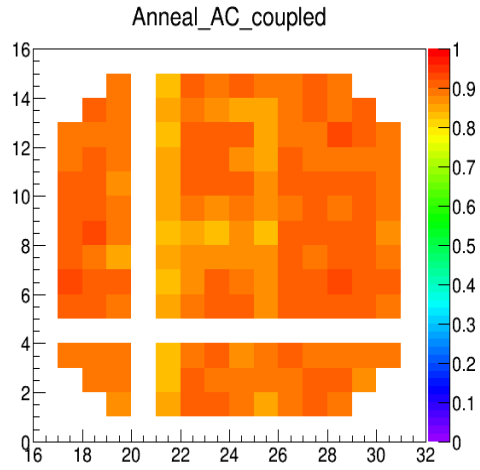

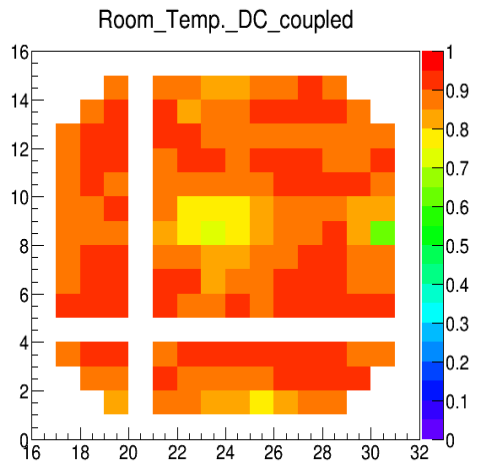

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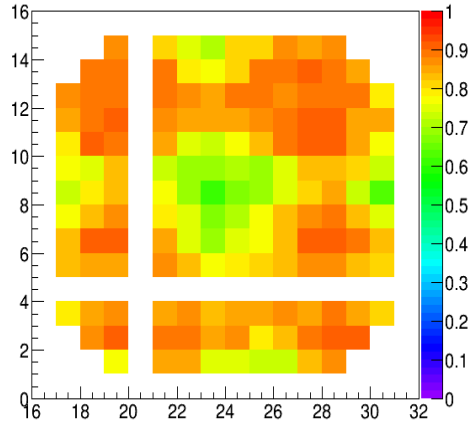
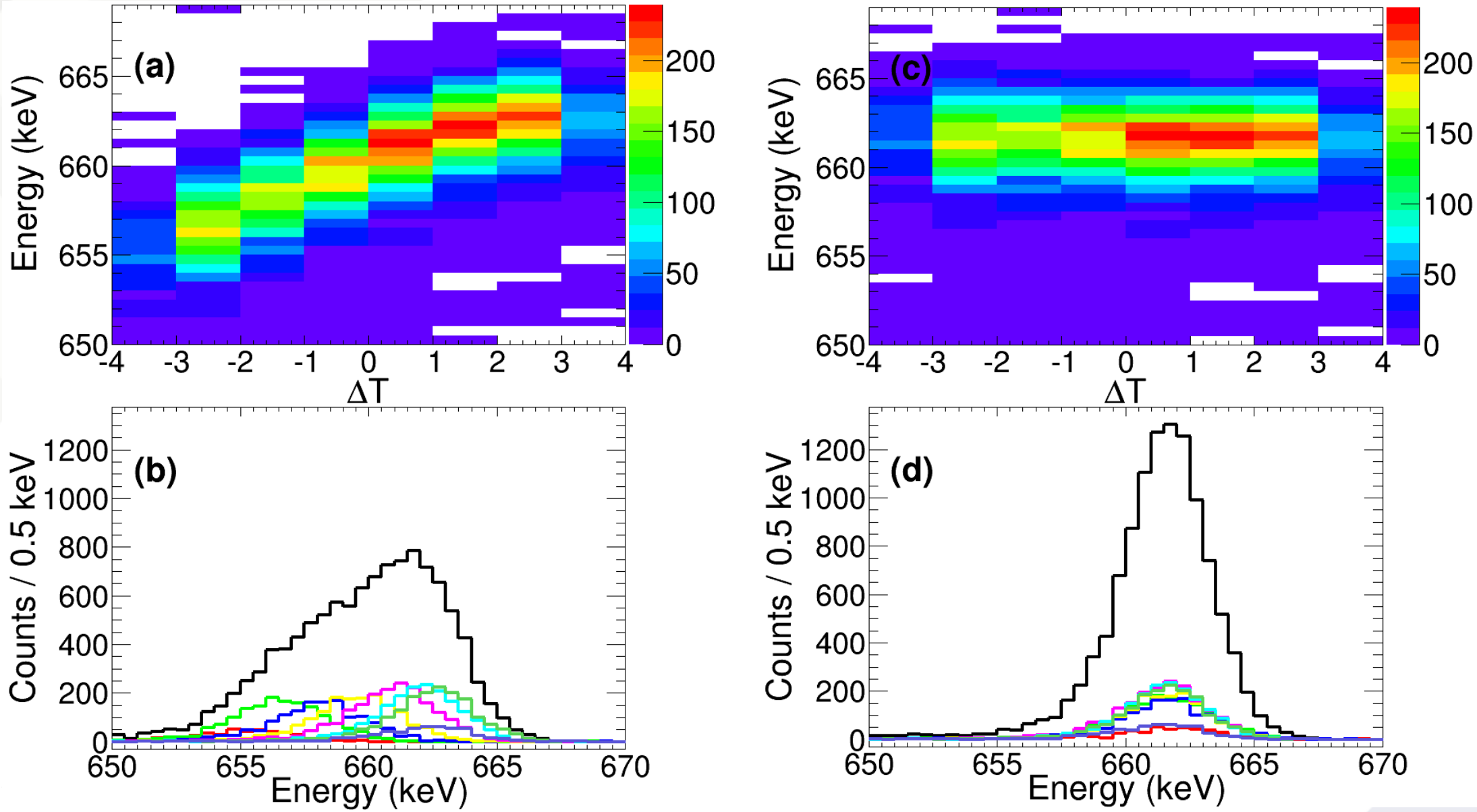
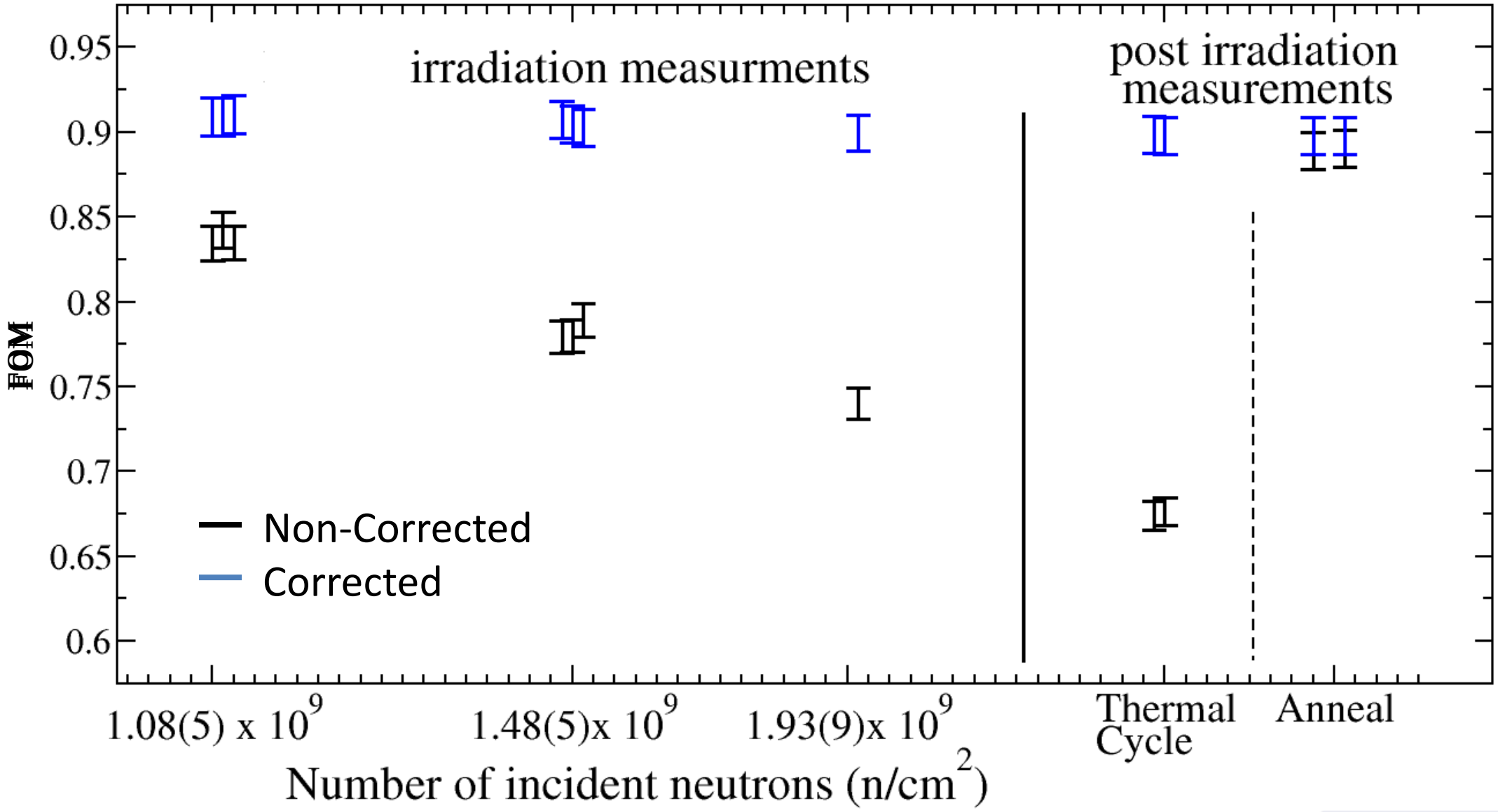


FOM = 0.82

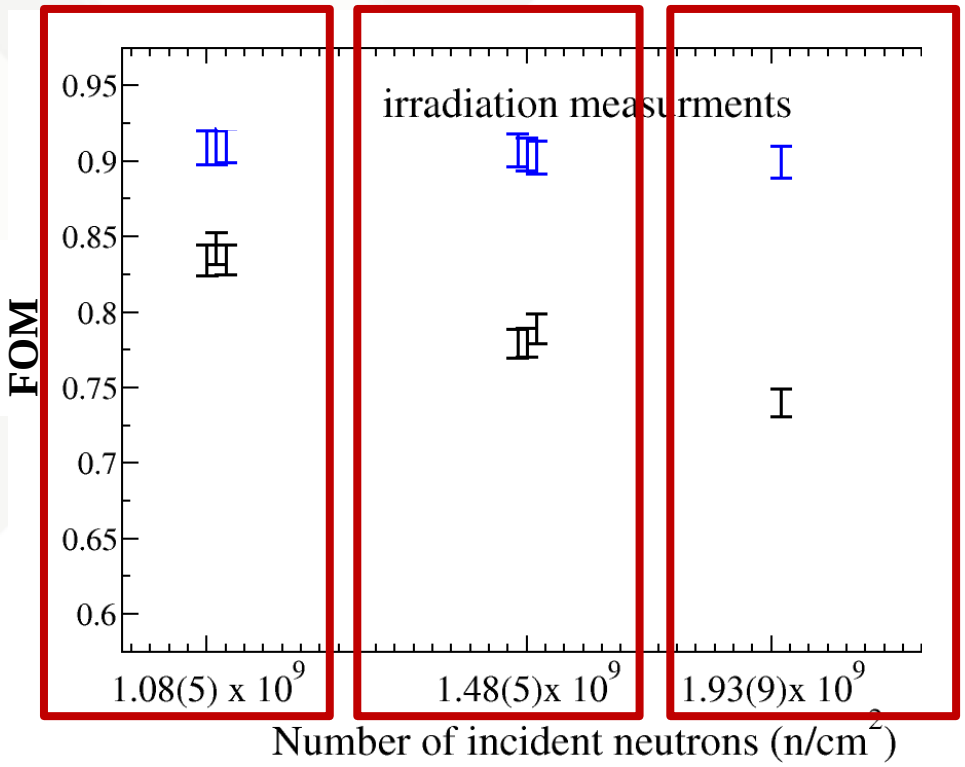
Charge Collection vs Depth: Revisited



Corrected AC-Coupled Side FOM



AC Pixel FOM for Irradiation Stages: Corrected



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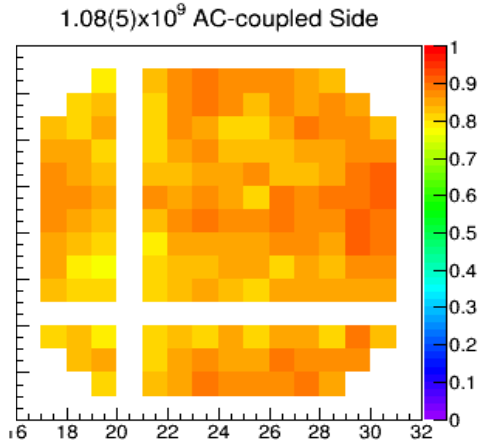

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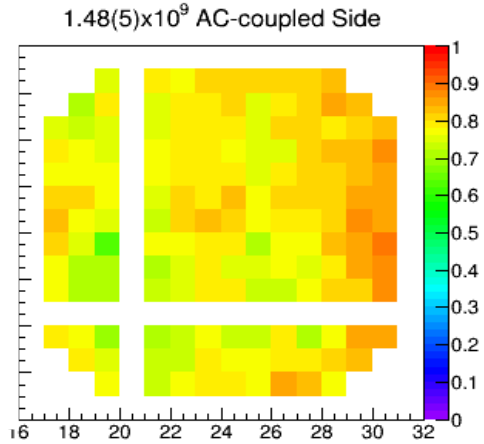

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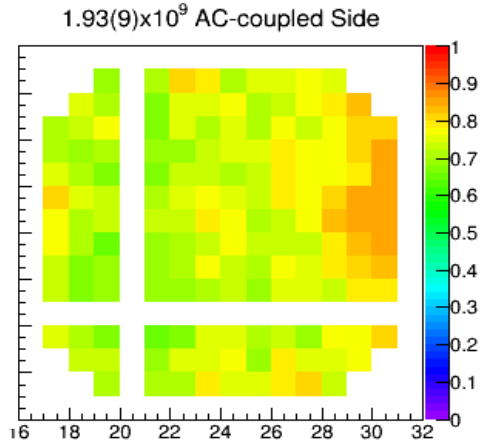
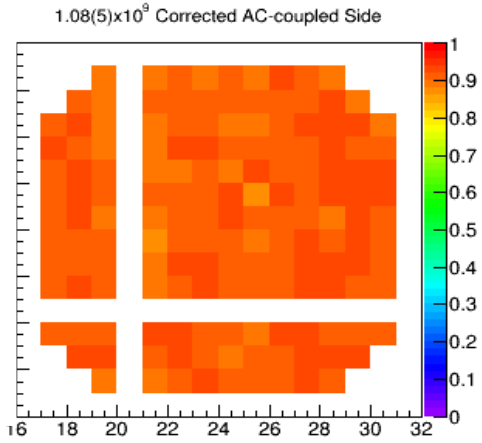
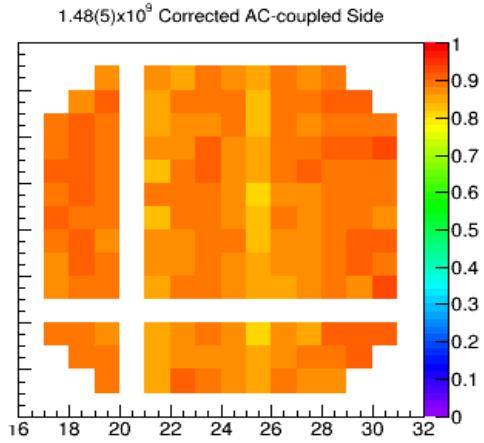




FOM = 0.91



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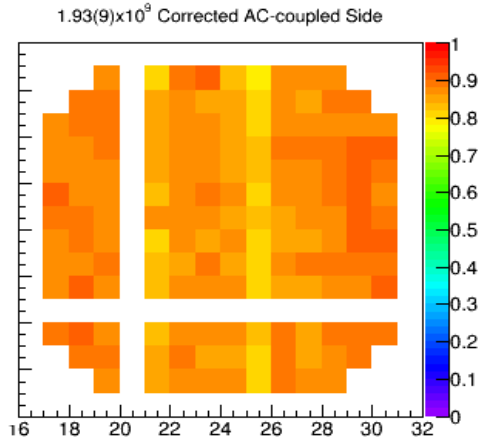
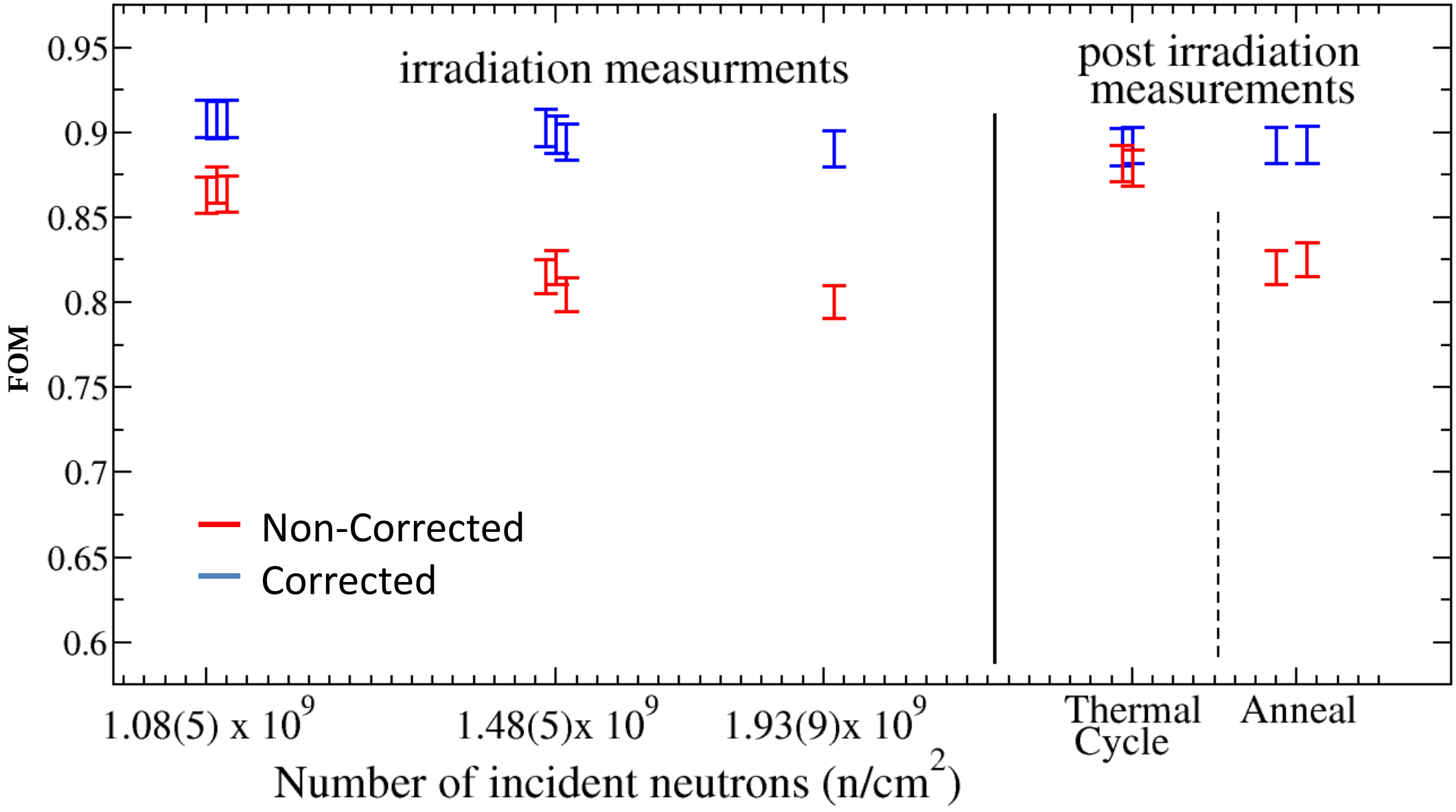
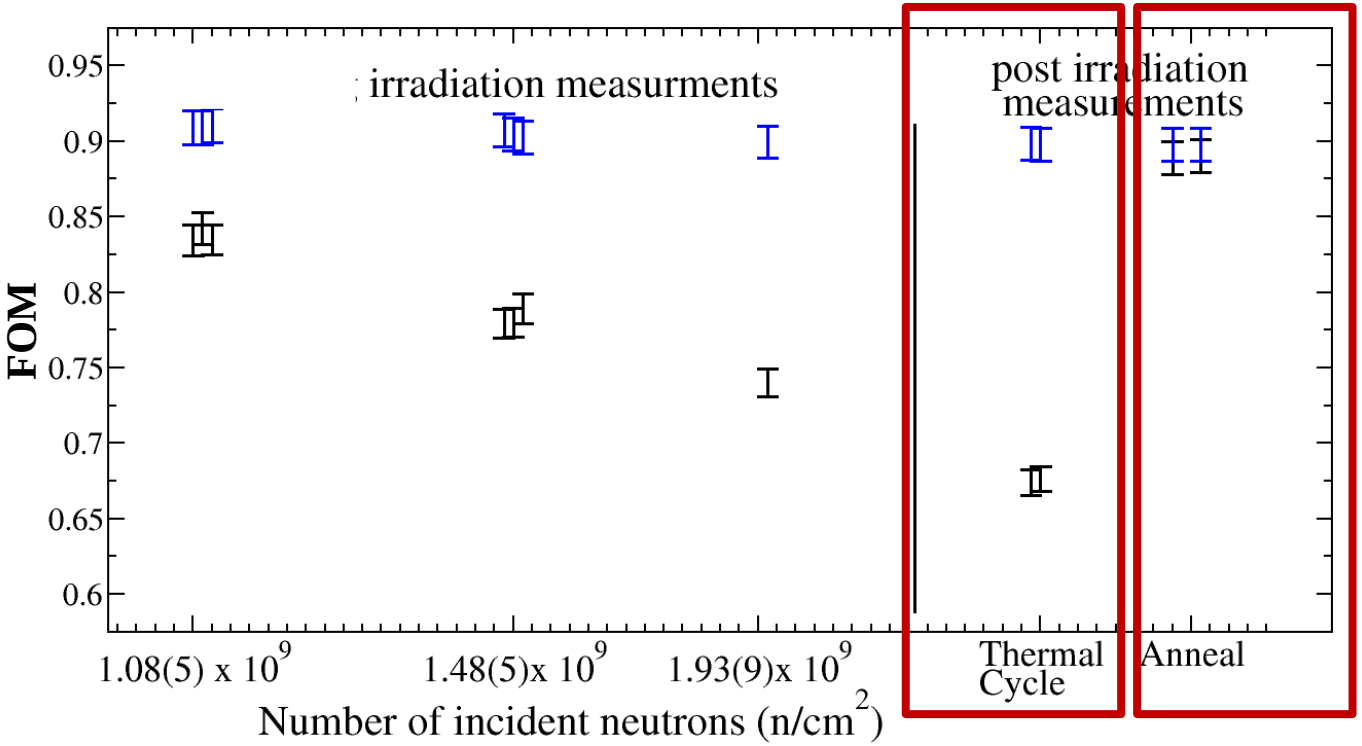


FOM = 0.90

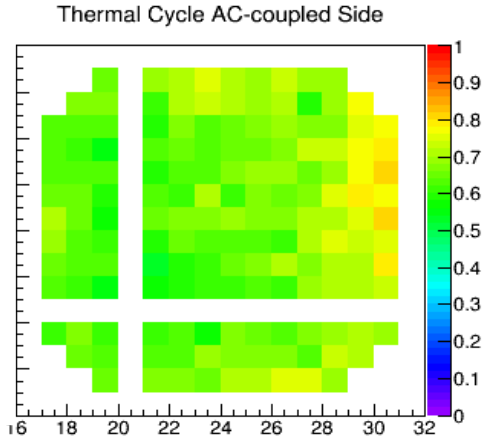
Corrected DC-Coupled Side FOM



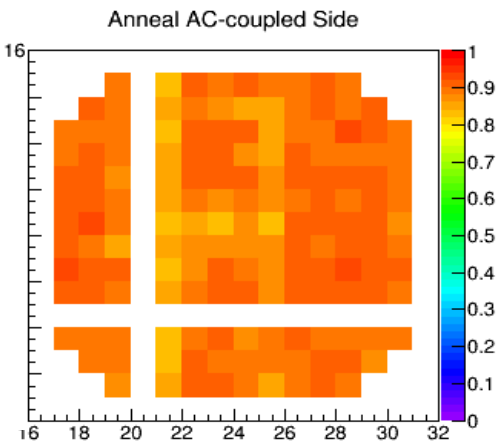
AC Pixel FOM for Post Irradiation Stages: Corrected

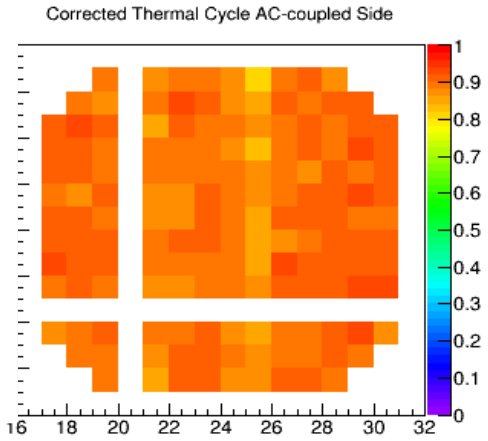


FOM = 0.67

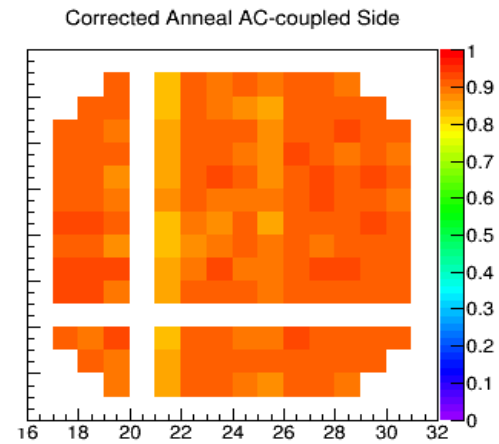


FOM = 0.89



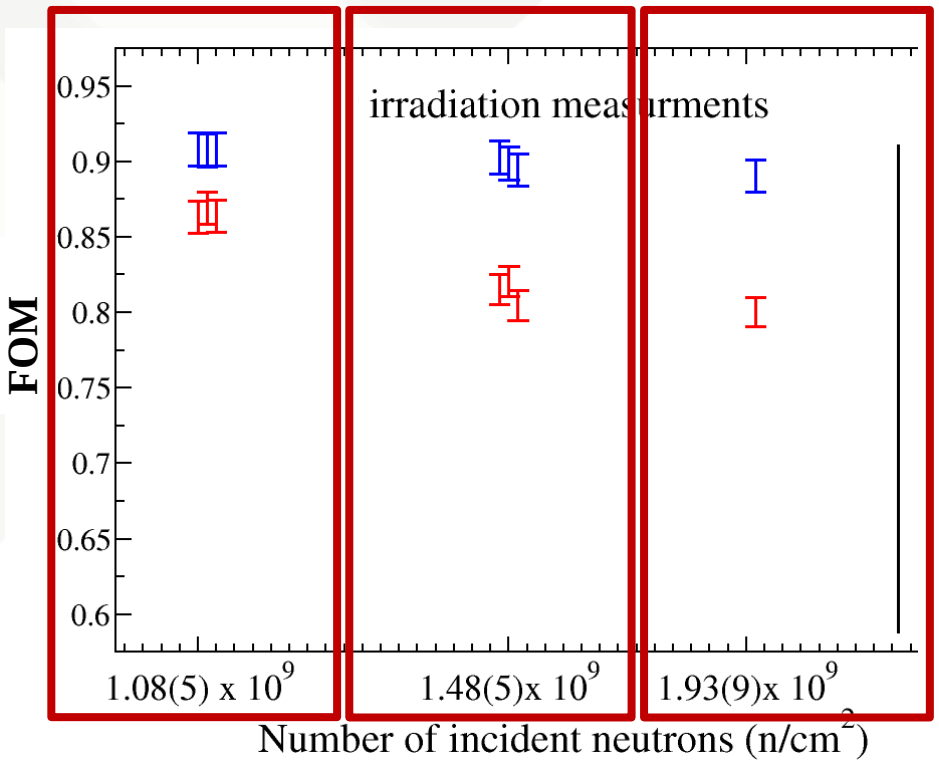


FOM = 0.90

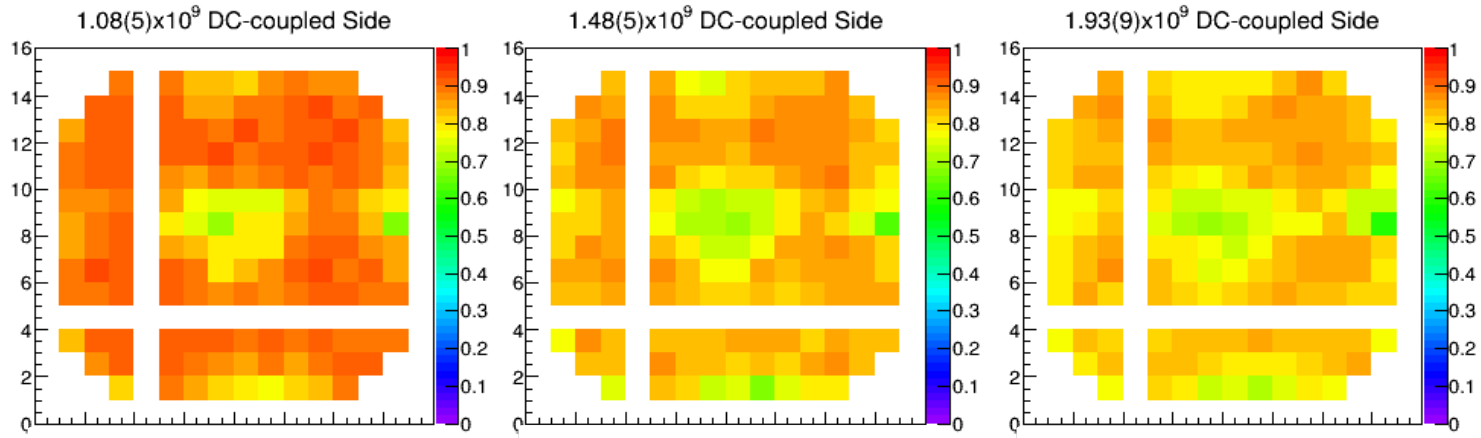


FOM = 0.90

DC Pixel FOM for Irradiation Stages: Corrected

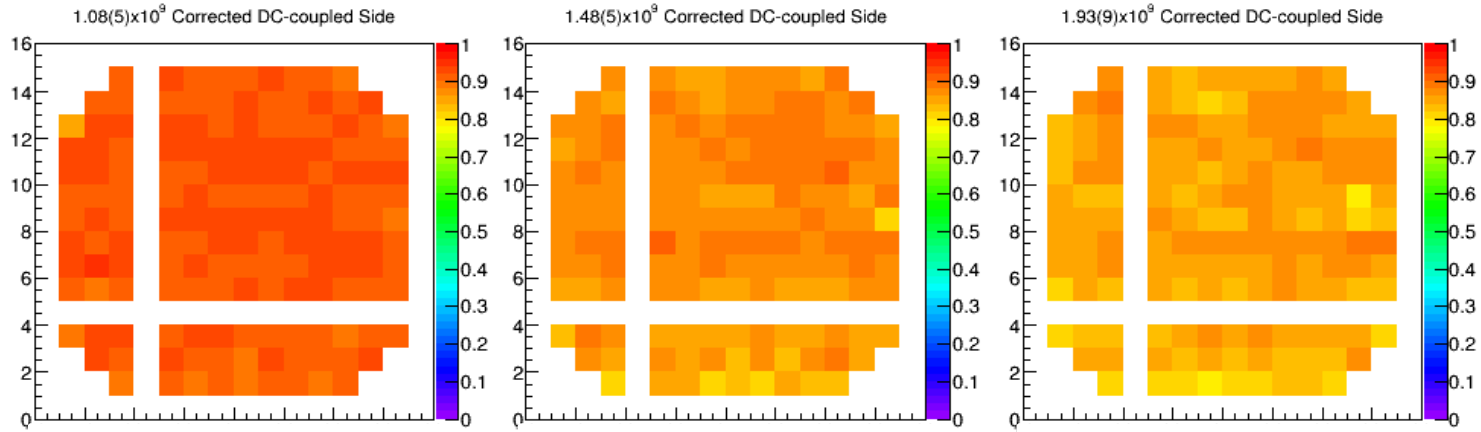


FOM = 0.86



FOM = 0.82

FOM = 0.80

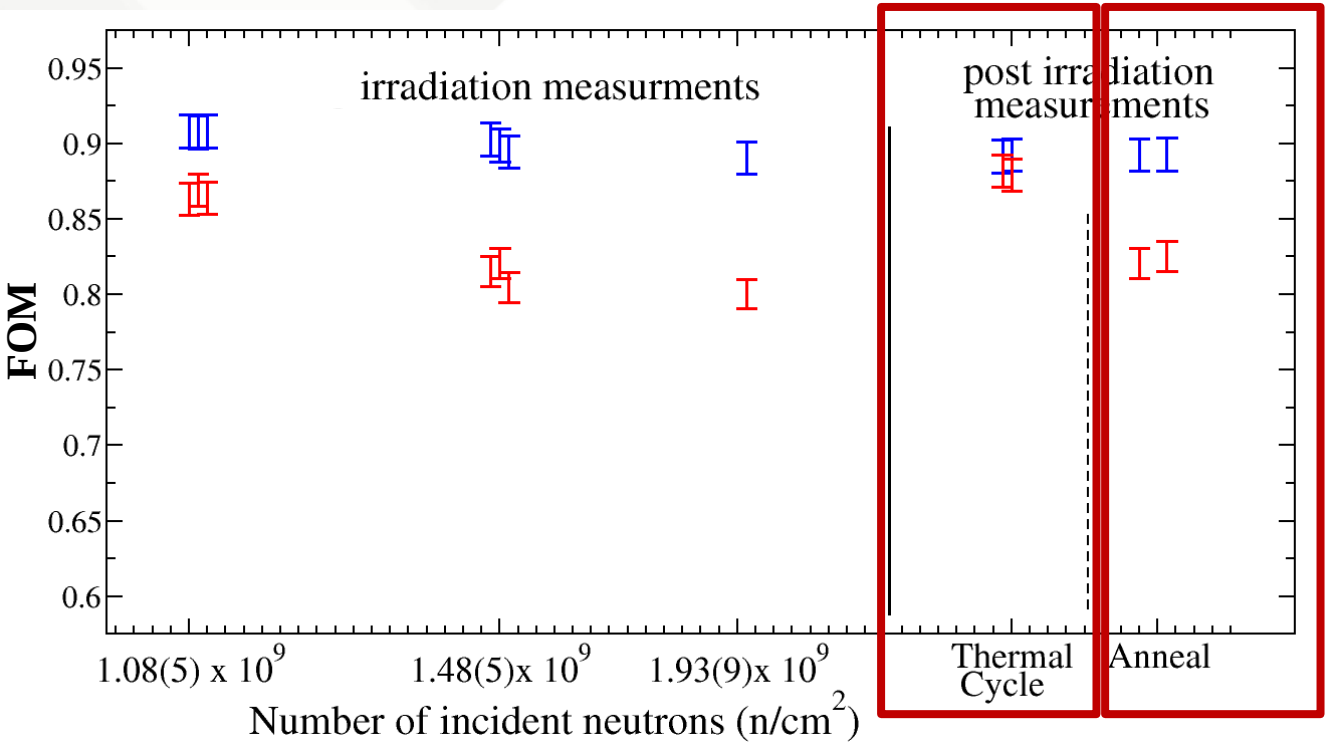


FOM = 0.91

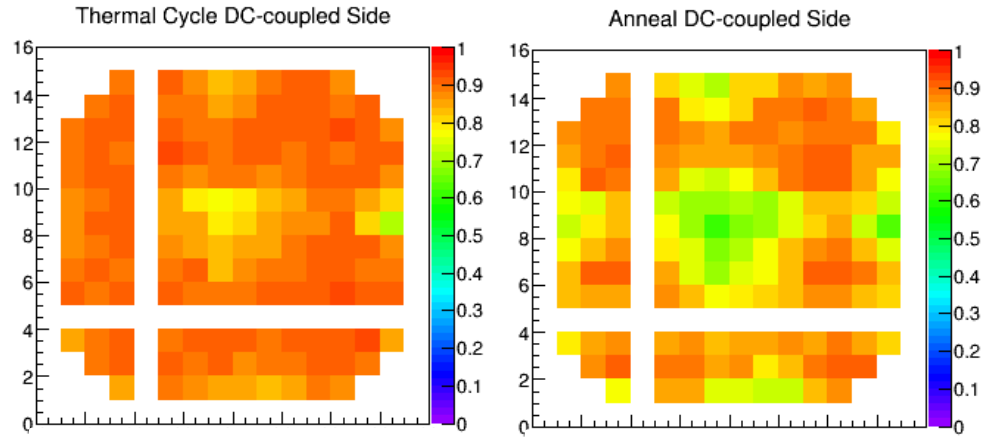
FOM = 0.90

FOM = 0.89

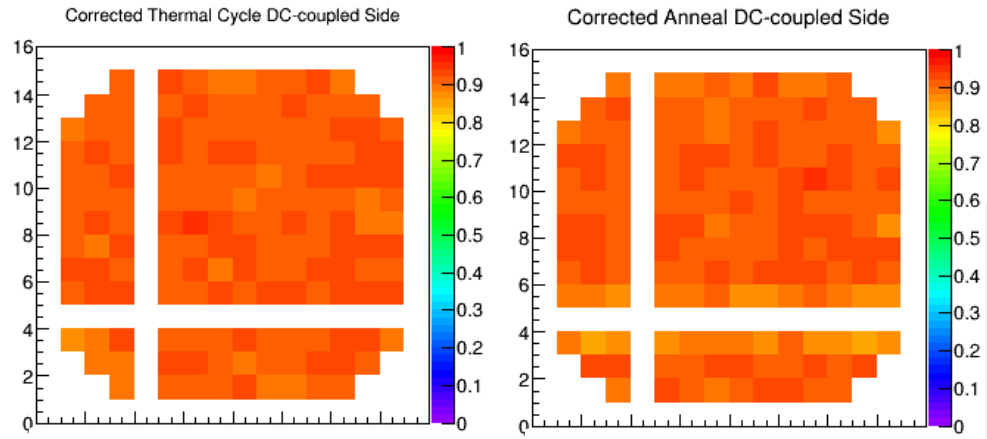
DC Pixel FOM for Post Irradiation Stages: Corrected



FOM = 0.88



FOM = 0.82



FOM = 0.89

FOM = 0.89

Comparison of Corrected AC/DC Charge Collection