Ge-DSSD Neutron Damage

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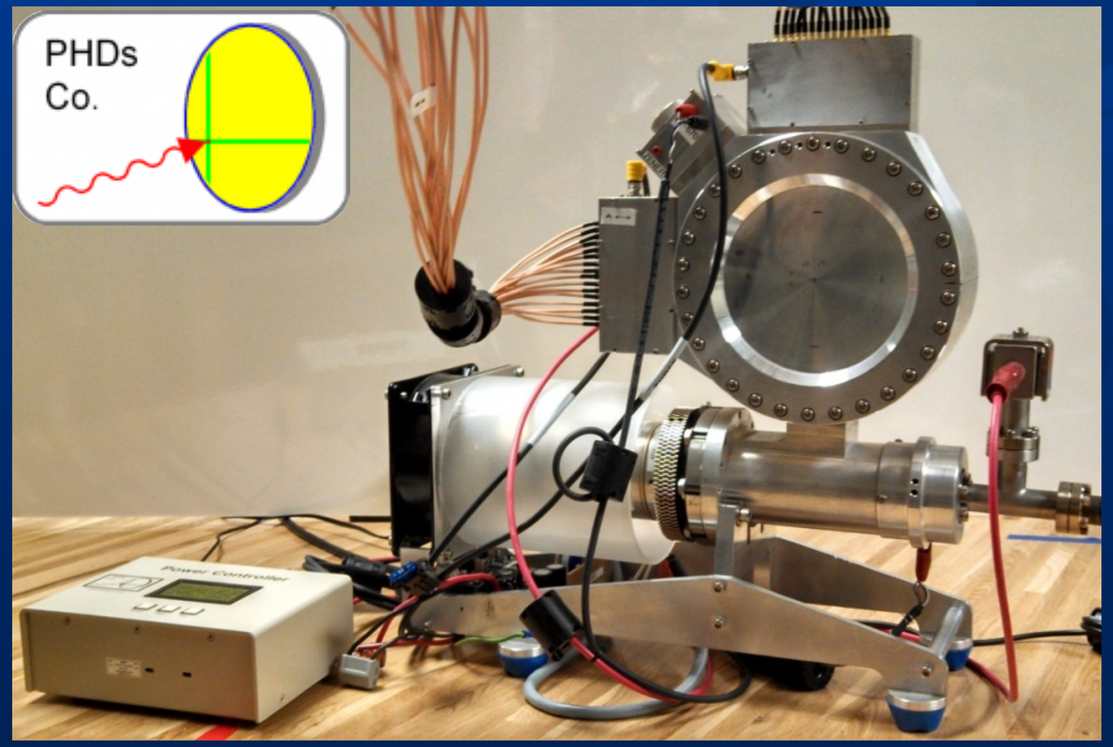
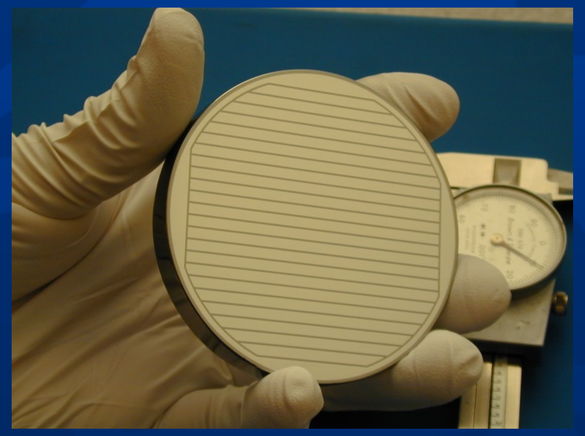
University of Massachusetts Lowell

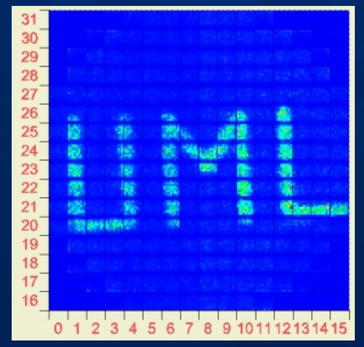
AGATA-GRETINA Collaboration Meeting 2018

GeDSSD : 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

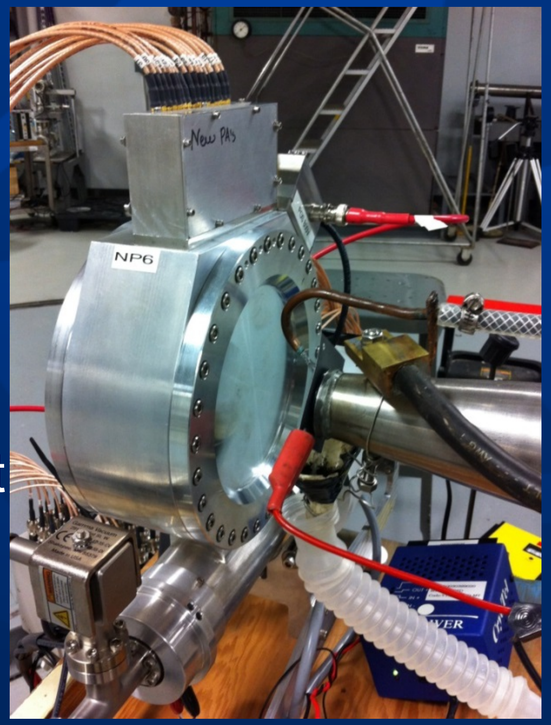






Neutron Damage & Recovery Studies

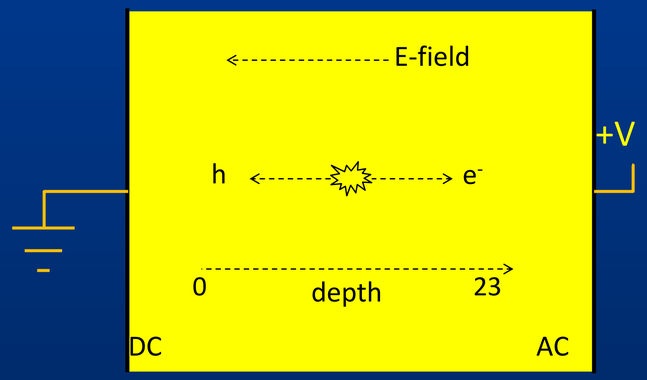
- Compact mechanically cooled planar GeDSSD
- 90 mm dia, 10 mm thick
- 16 x 16 5 mm strips, 0.25 mm inter-strip spacing
- Digital DAQ with Imager32
- Amorphous Ge contacts

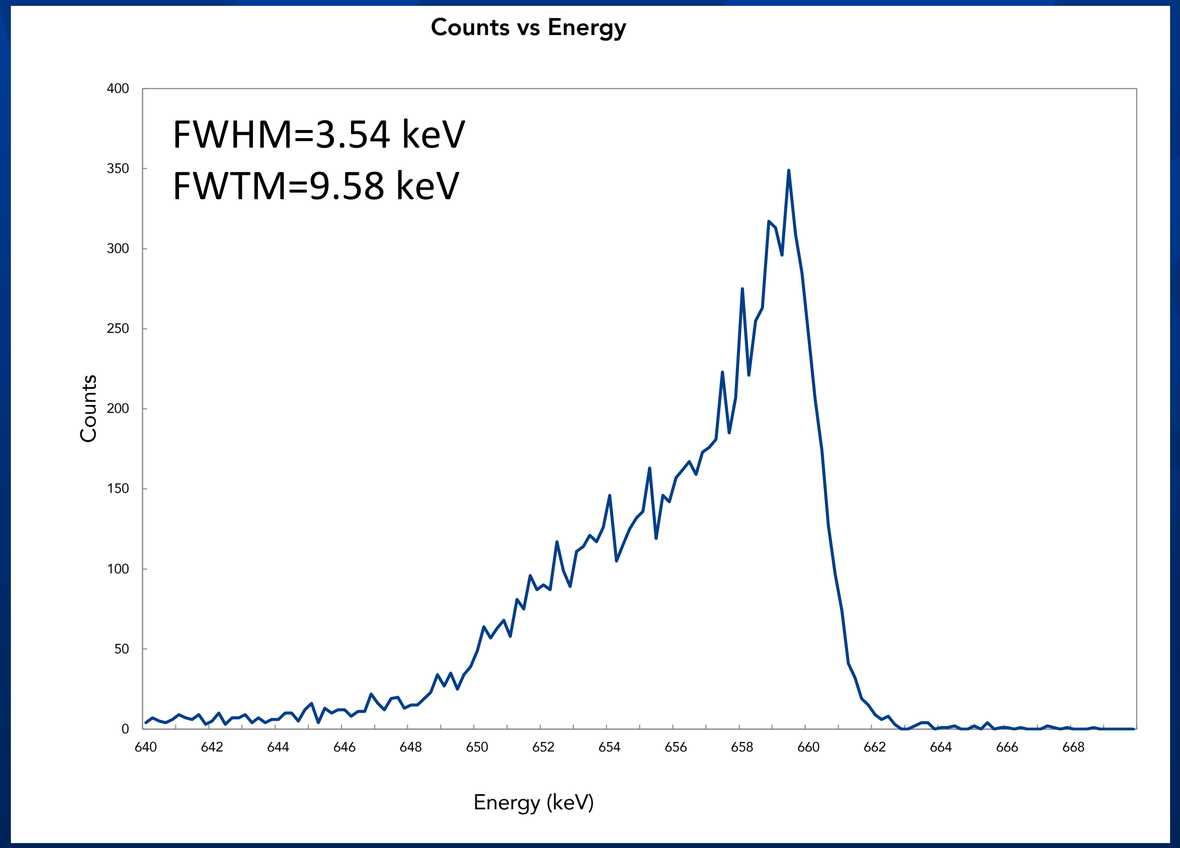


Can contacts survive annealing following neutron damage?

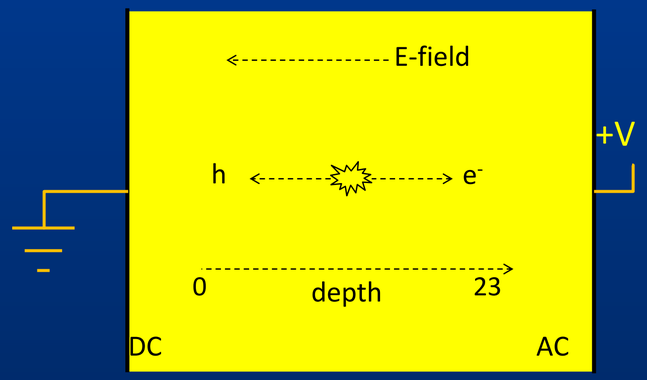
- Neutrons generated from the $^{7}Li(p,n)^{7}Be$ reaction at the UMass Lowell 5.5 MV Van-de-Graaff accelerator
- Proton beam ≈ 3.7 MeV, neutrons ≈2MeV
- Flux between 10^5 and 10^6 neutrons/sec/cm^2
- Calibrated neutron dose from post-irradiation assay of ^{7}Be (53 day half-life)

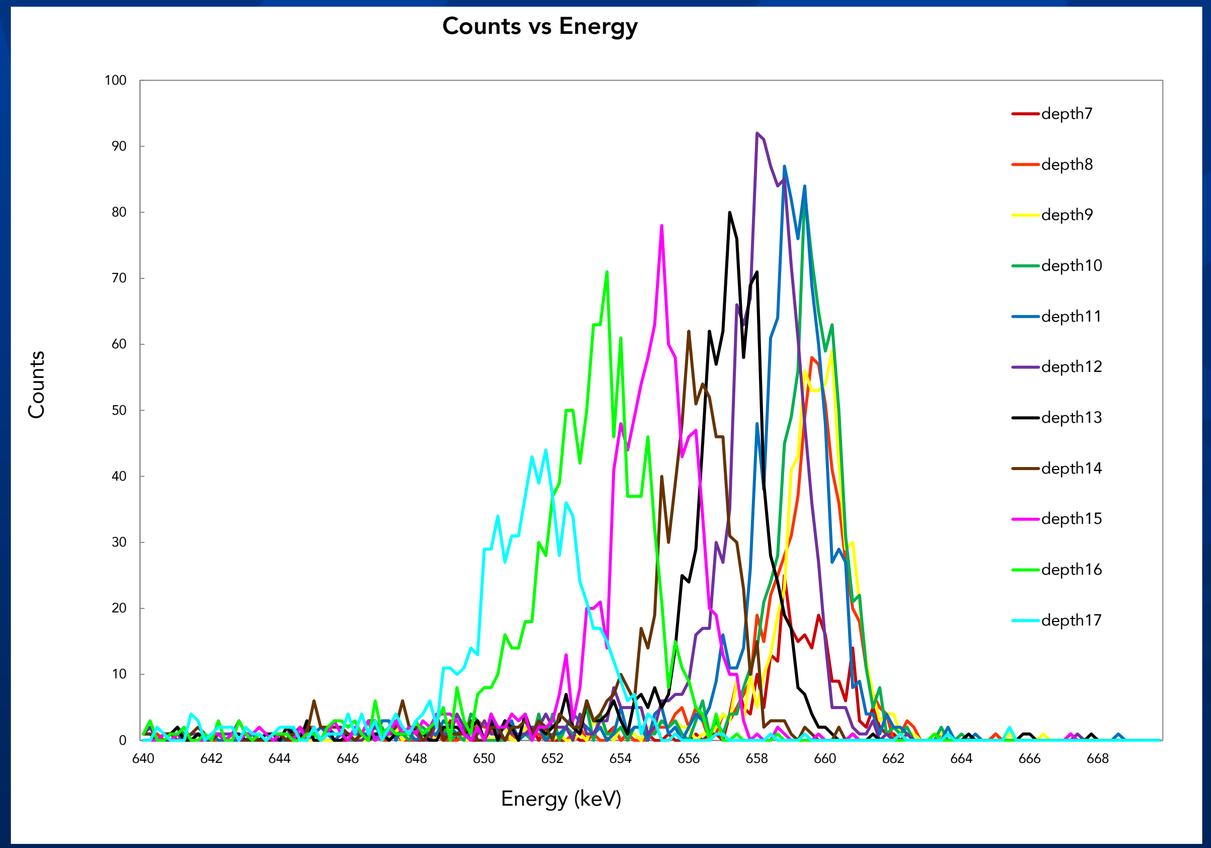
Hole Trap Correction Algorithm





Hole Trap Correction Algorithm





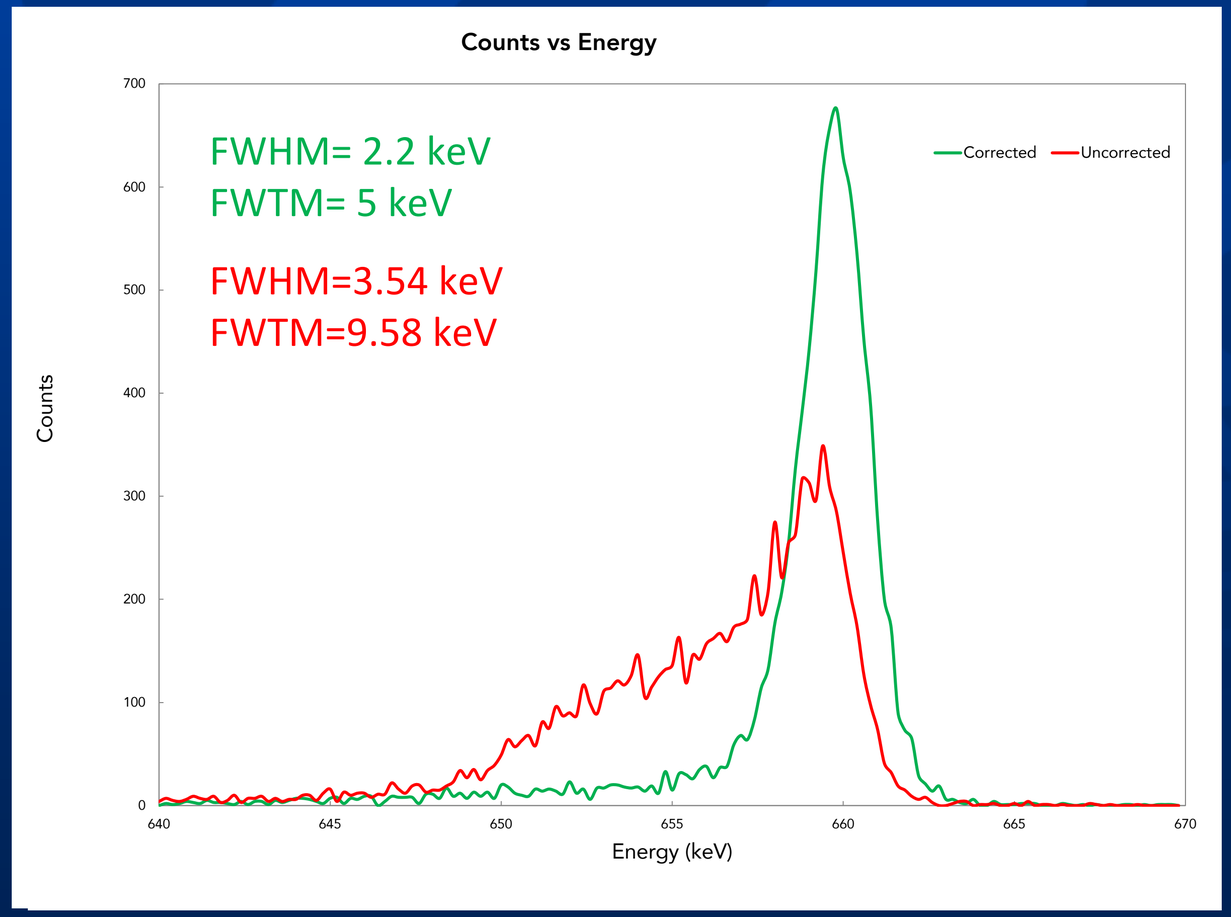
Hole Trap Correction Algorithm

"Software" corrector makes significant improvement to neutron damage

Powerful tool for mapping crystal defects and charge trapping centers in any position-sensitive Ge detector

Voxel-by-voxel energy calibration can map charge-trapping centers

Improved resolution possible even for undamaged detectors



Fast Forward

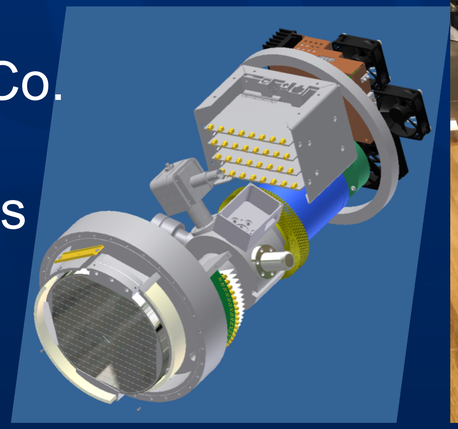
Emily Jackson, (M.S. thesis, 2013) *"Evaluation of a New Contact Technology for a Planar High-Purity Germanium Double-Sided Strip Detector"*

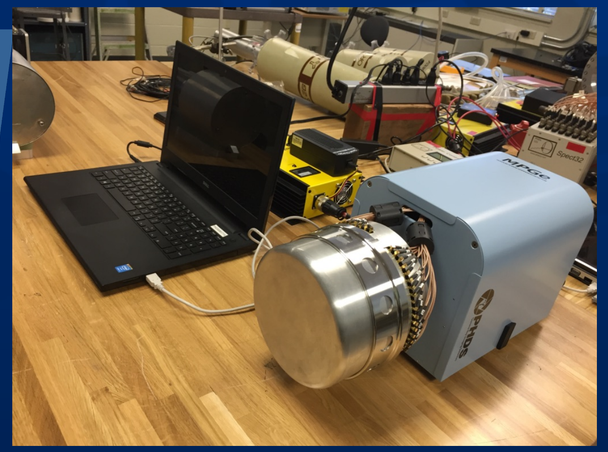
Emily Jackson, (Ph.D. thesis, 2015) *"Evaluation of Segmented Amorphous-Contact Planar Germanium Detectors for Heavy-Element Research"*

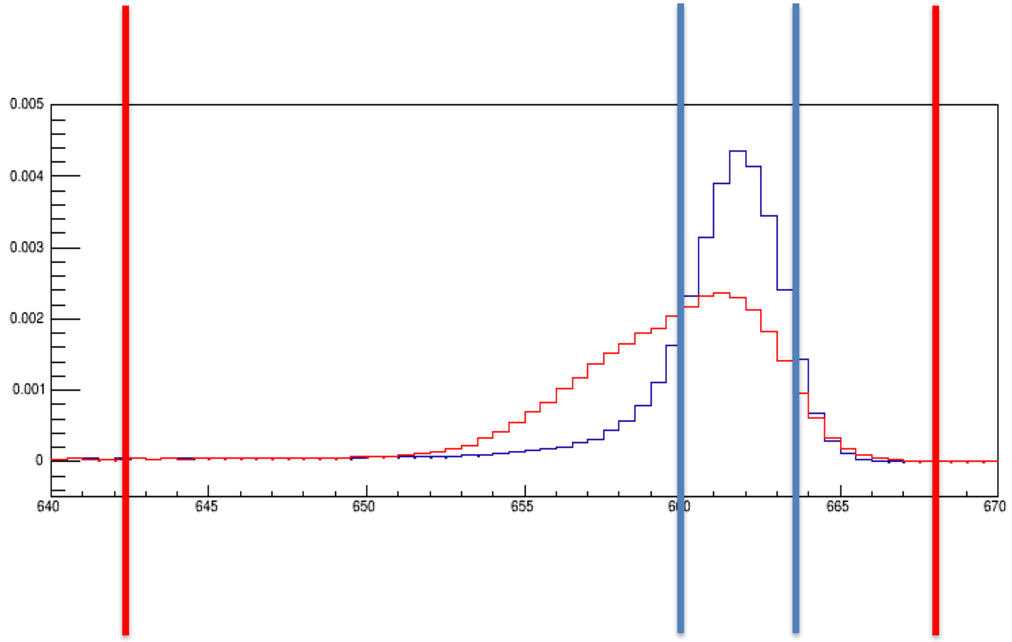
E.G. Jackson, E.L. Hull, C.J.Lister, R.H. Pehl, , "Ameliorating neutron damage in orthogonal-strip planar germanium detectors", *Nuclear Instr. and Meth. Phys. Res.* A774 (2015) *34.*

E.L. Hull, E.G.Jackson, C.J.Lister, R.H. Pehl, "*Charge trap correction and radiation damage in orthogonal-strip planar germanium detectors," Nuclear Instr. and Meth. Phys. Res.* A762 (2014) *125.*

- SBIR Phase2 grant with PHDS Co.
- streamlined cryostat
- towards an array tailored towards "in-beam" spectroscopy of superheavy elements



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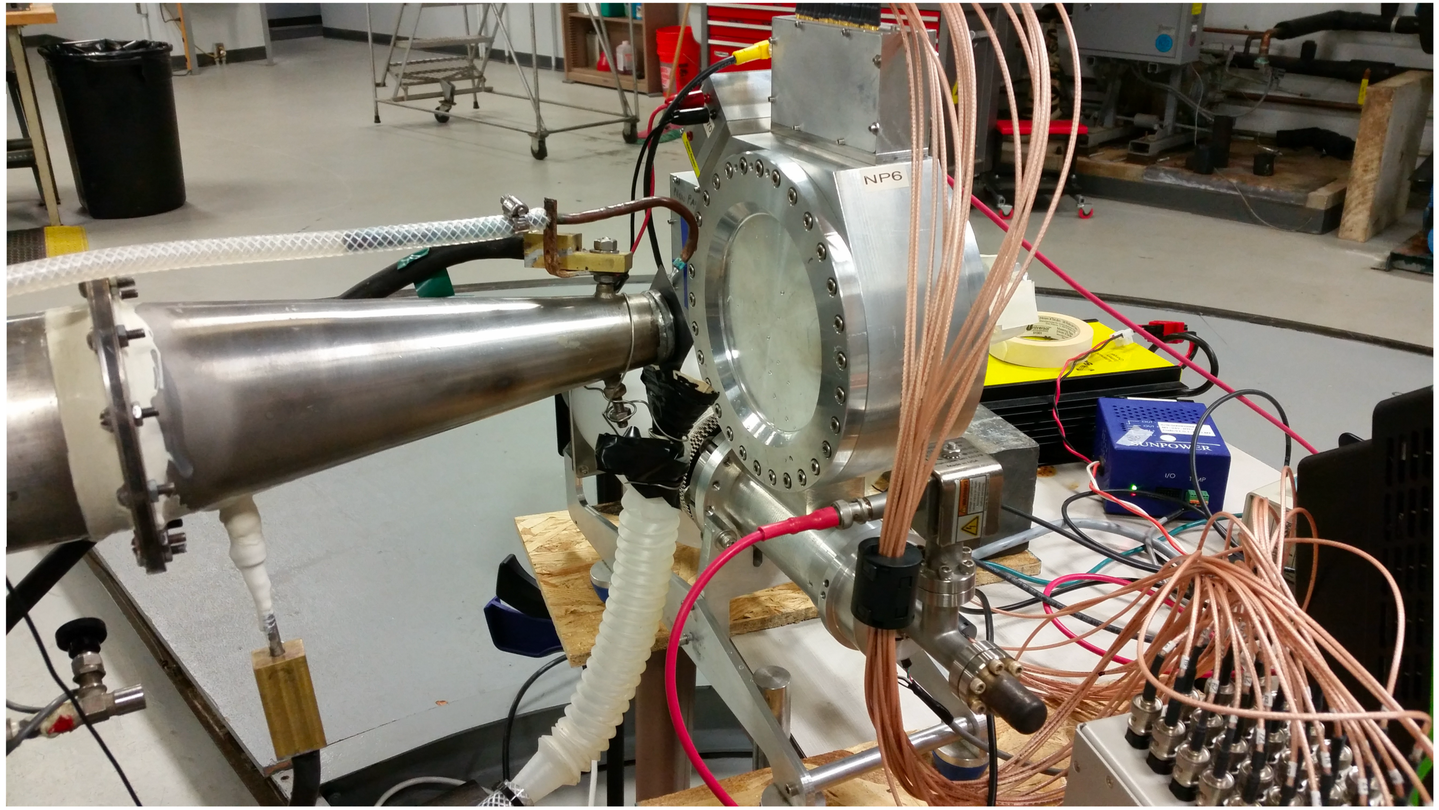
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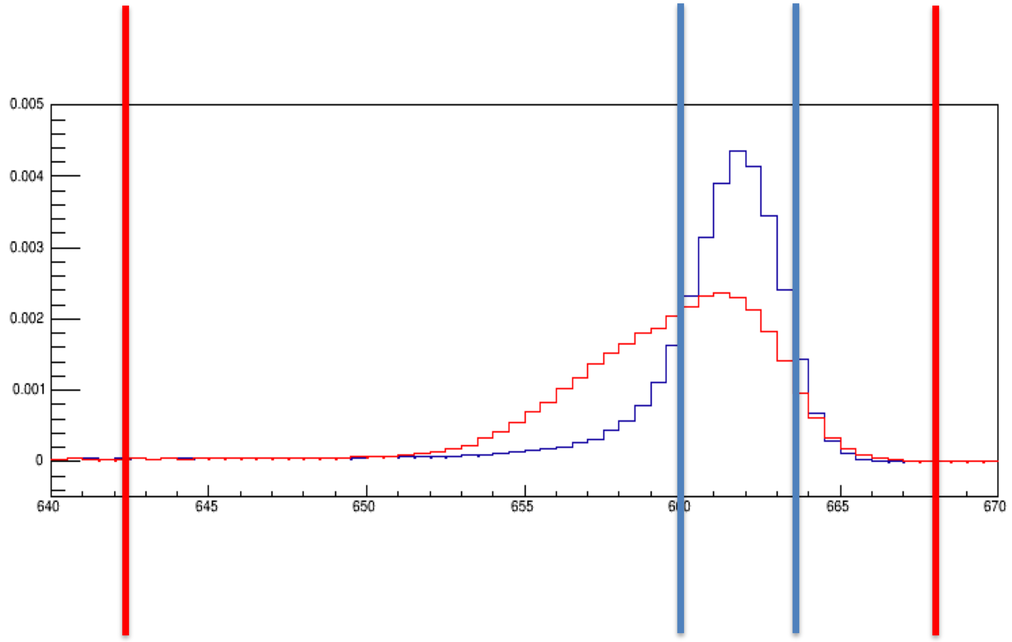
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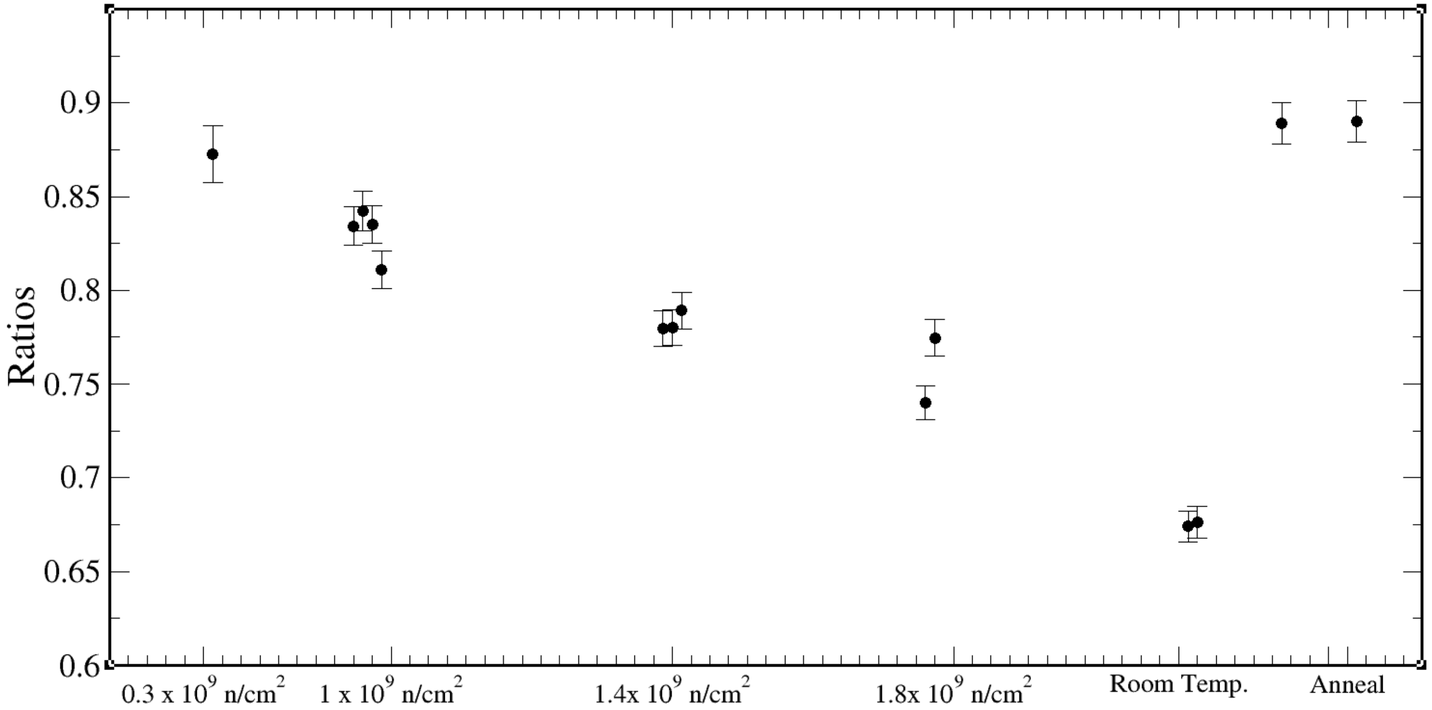
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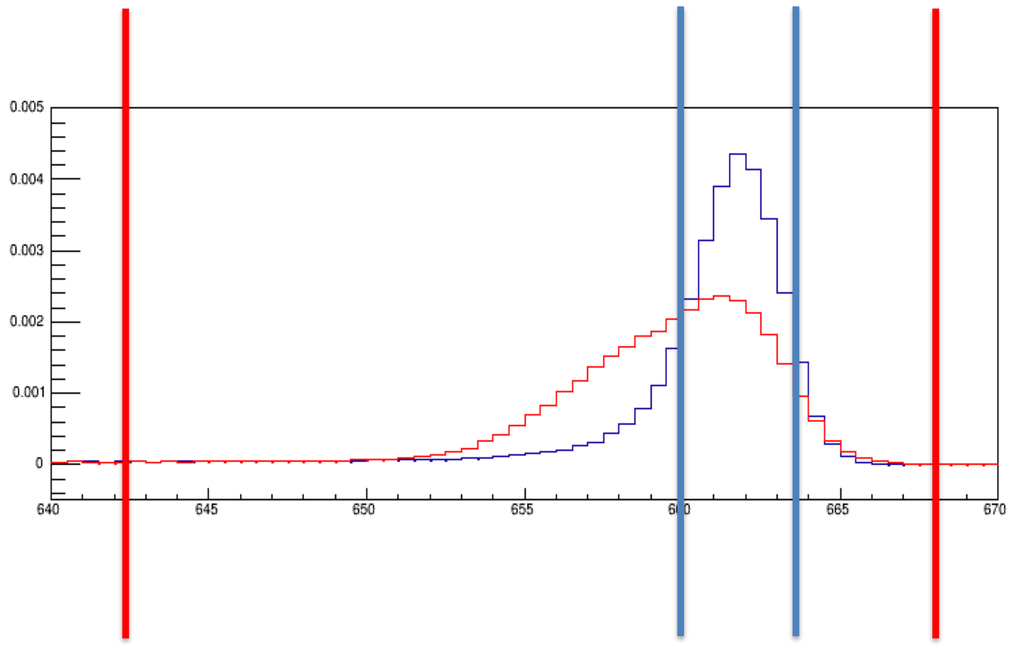
Room Temp.
Anneal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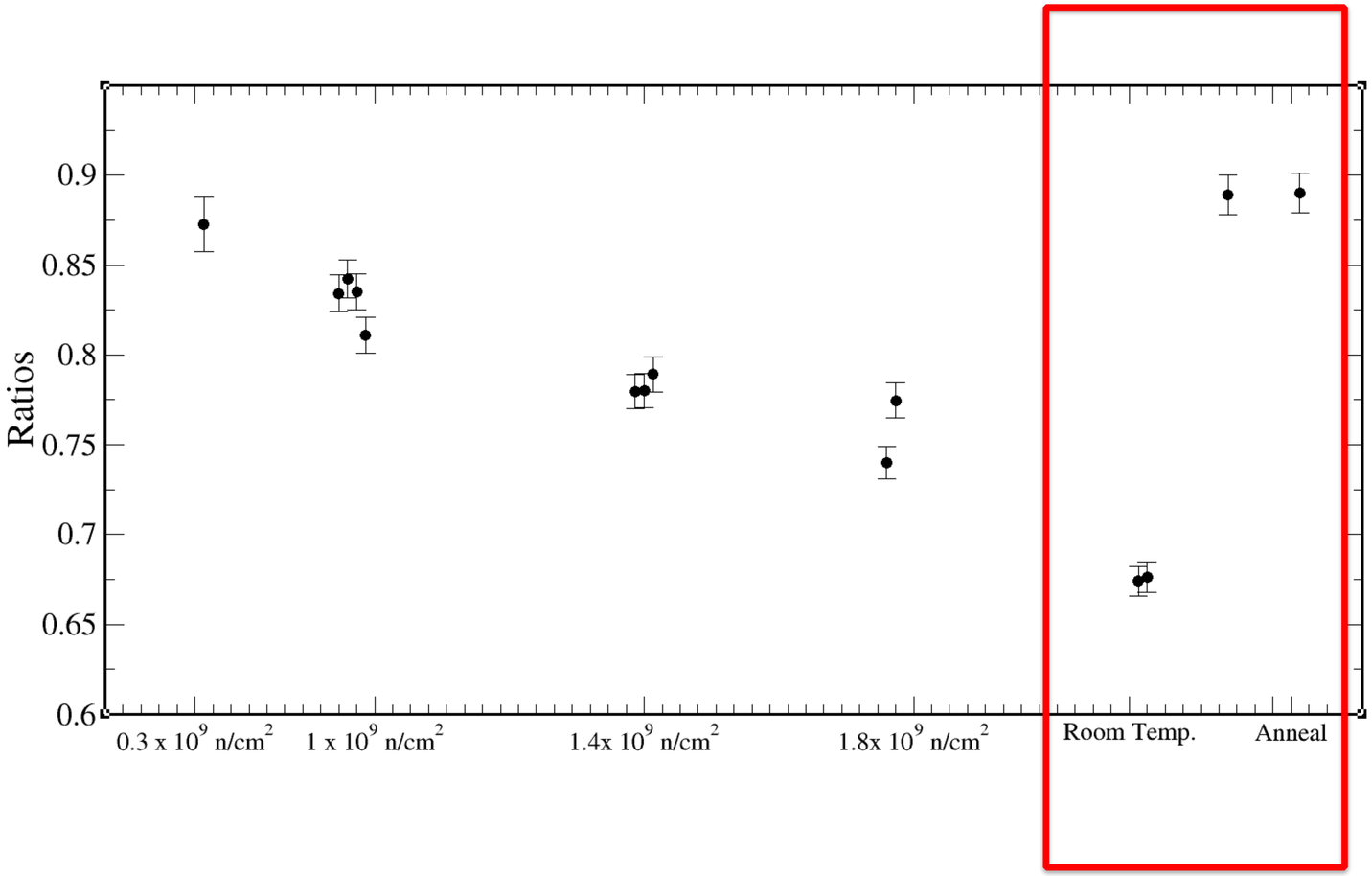
Ratios
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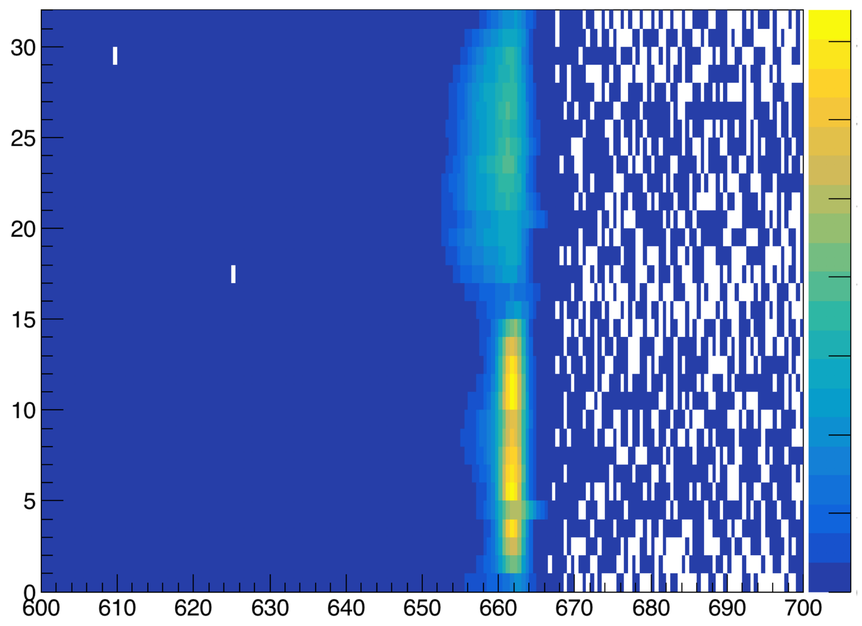
Room Temp.
Anneal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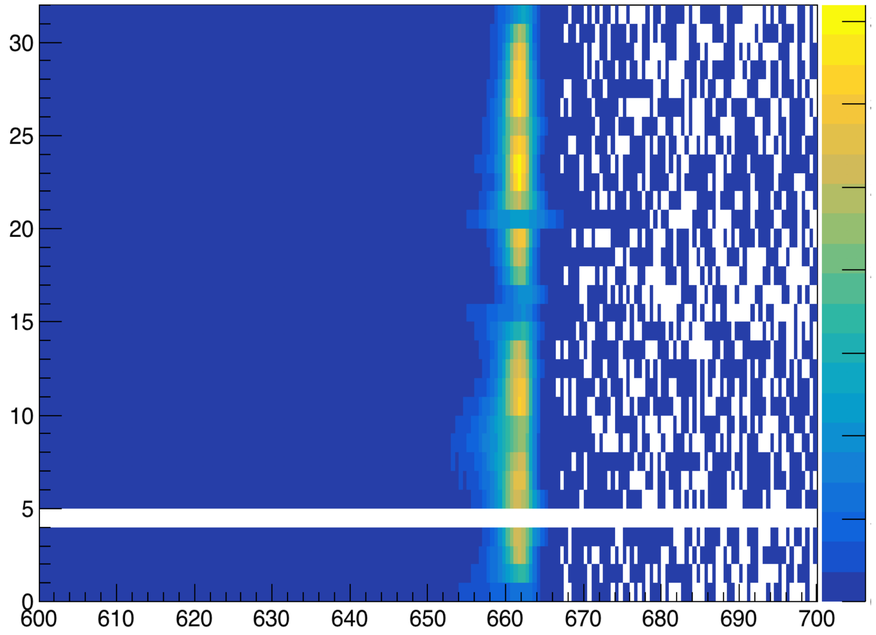
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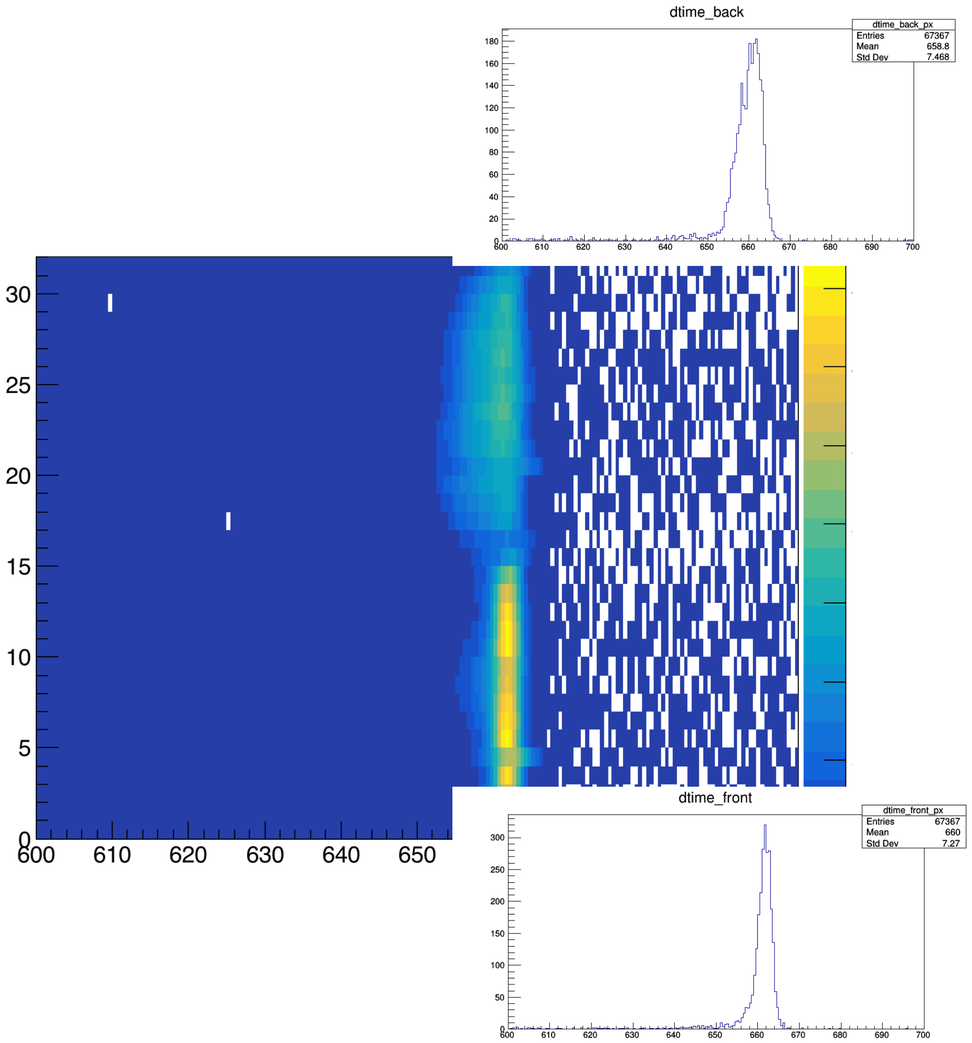
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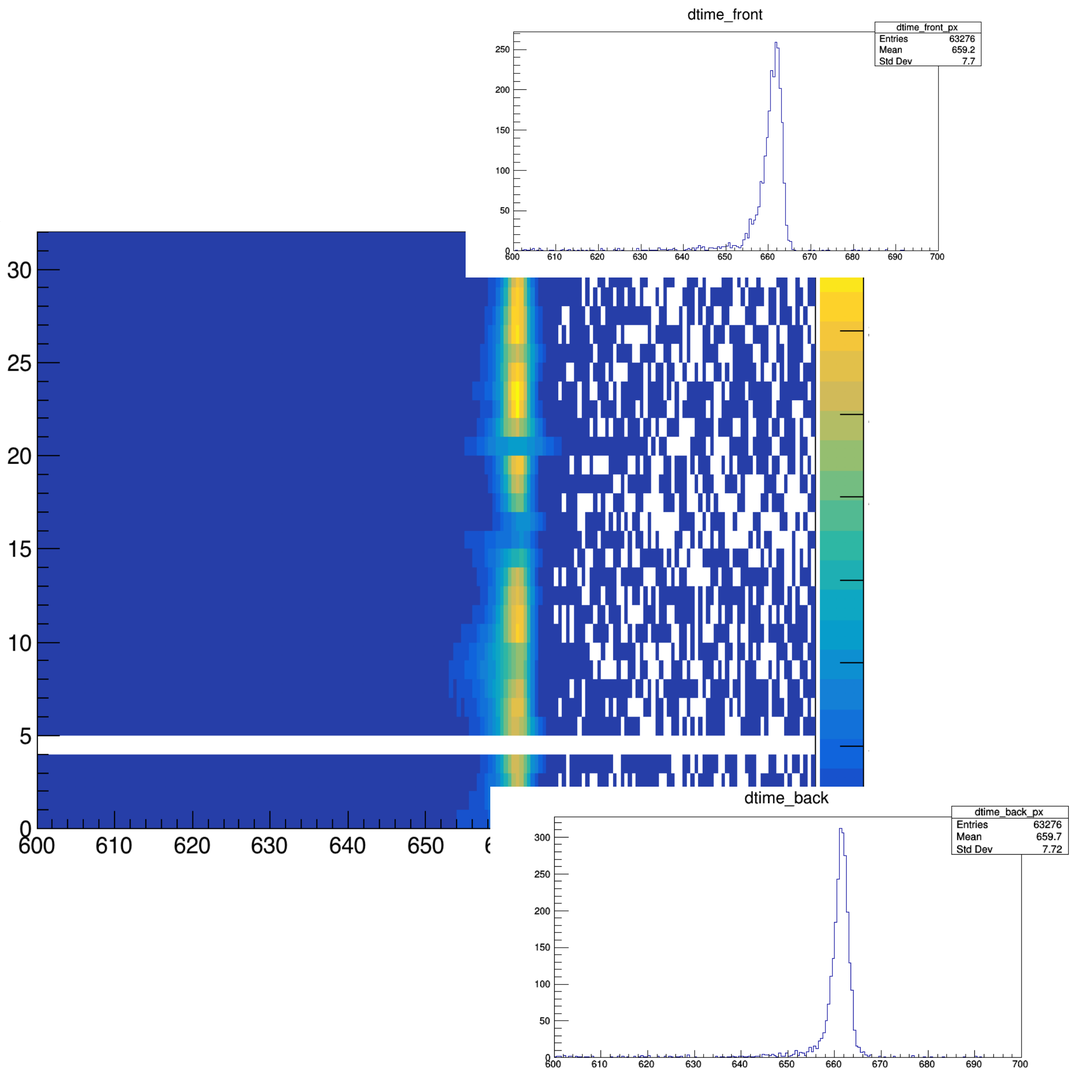
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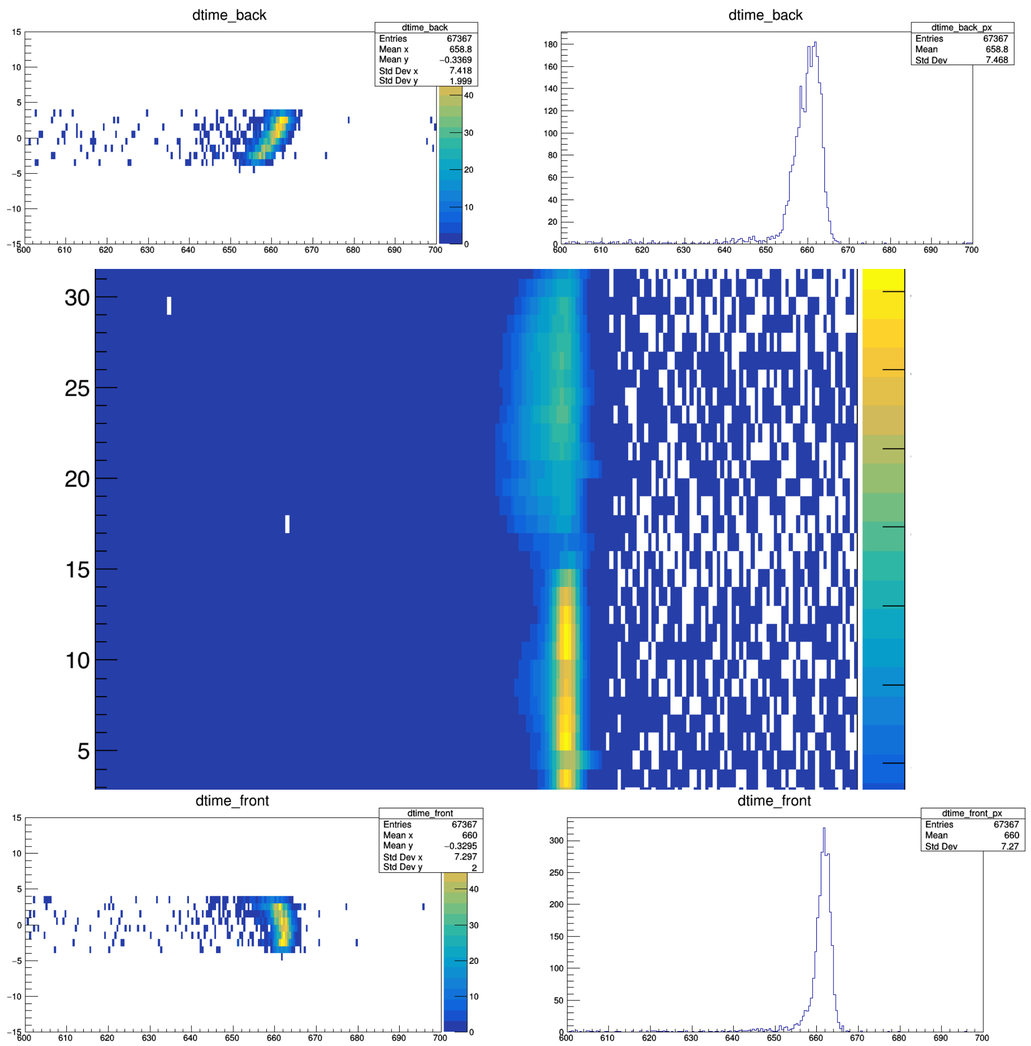
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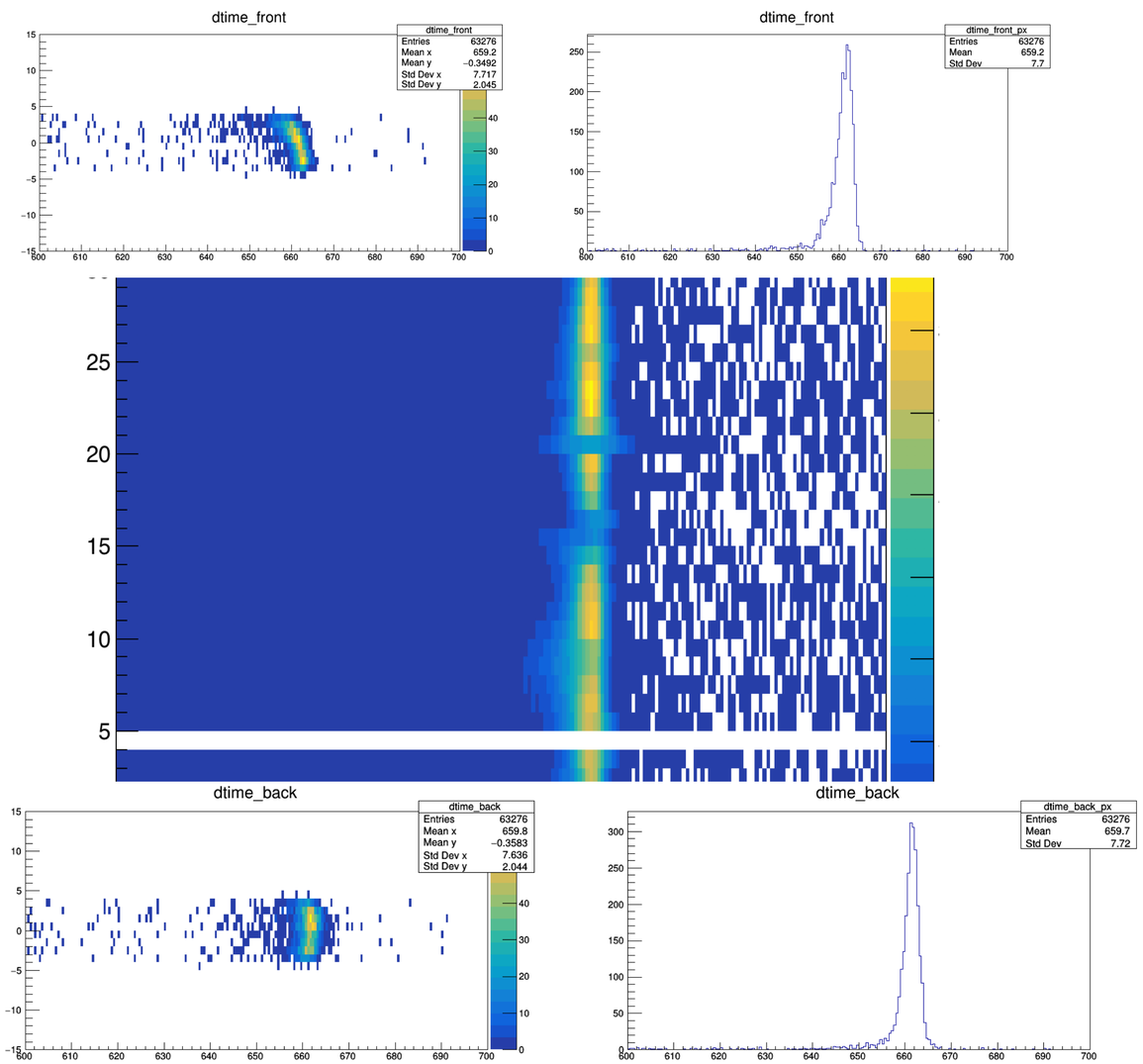
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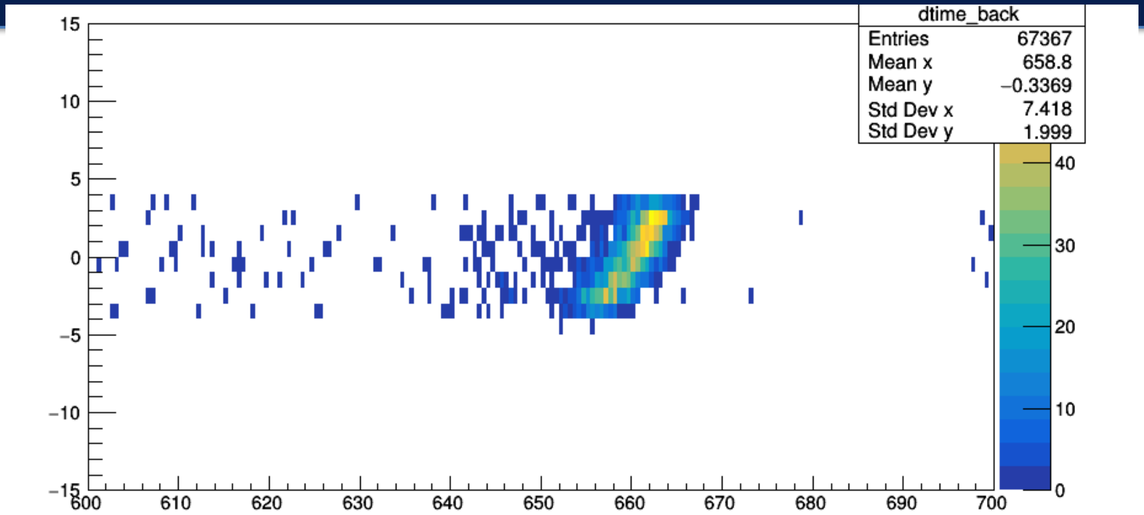
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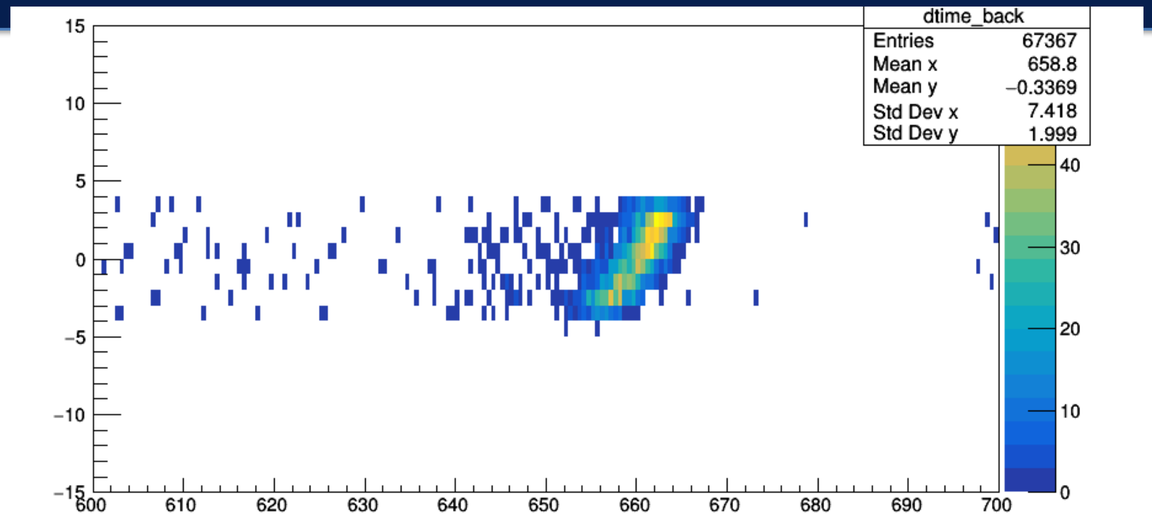
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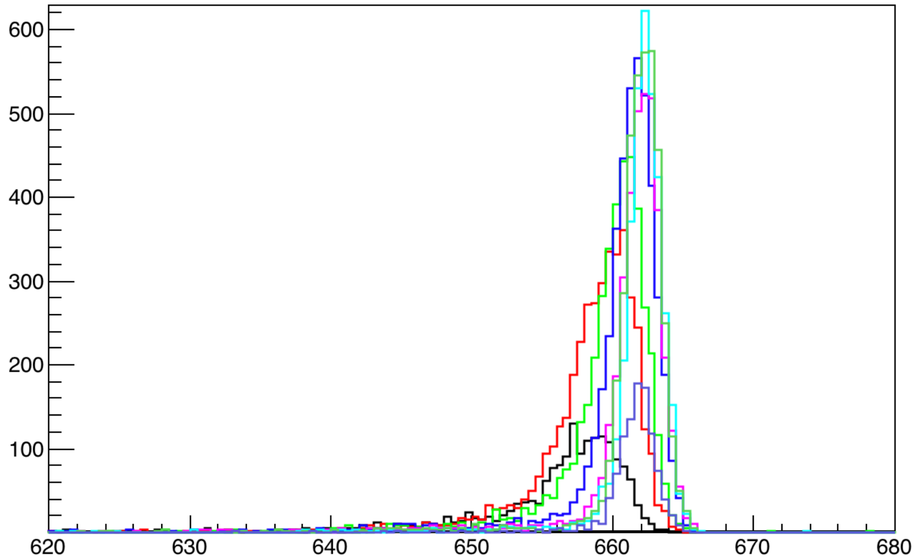
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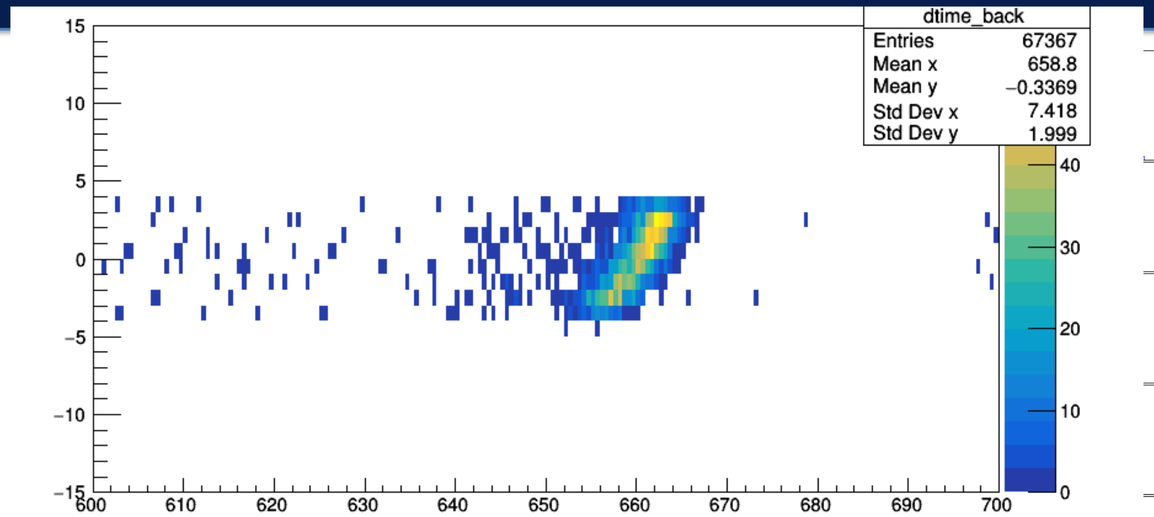
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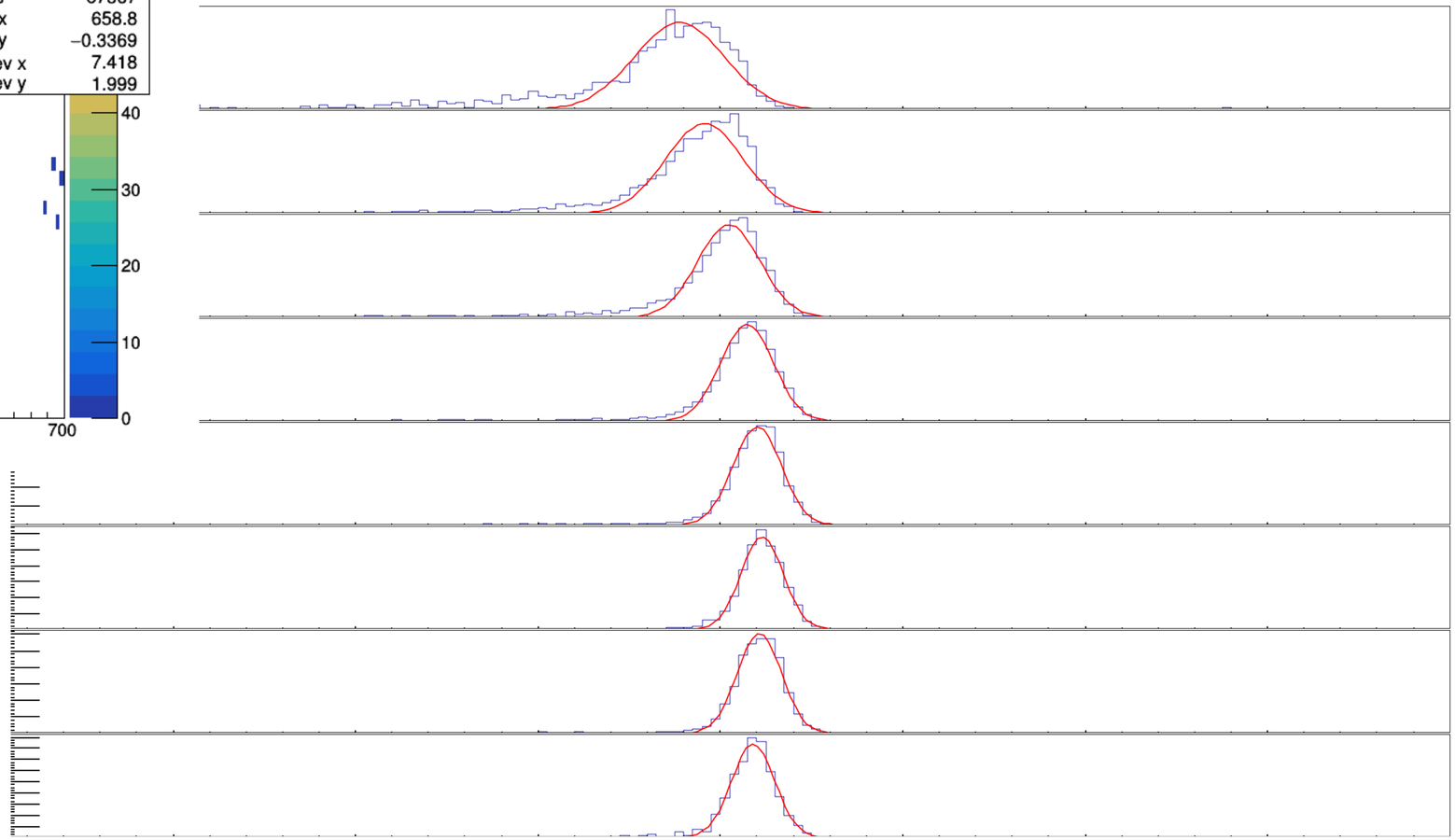

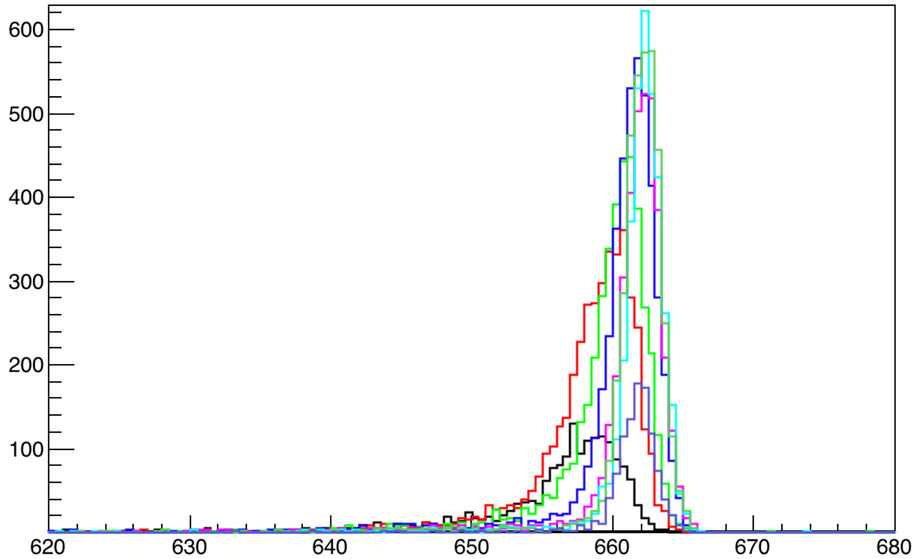

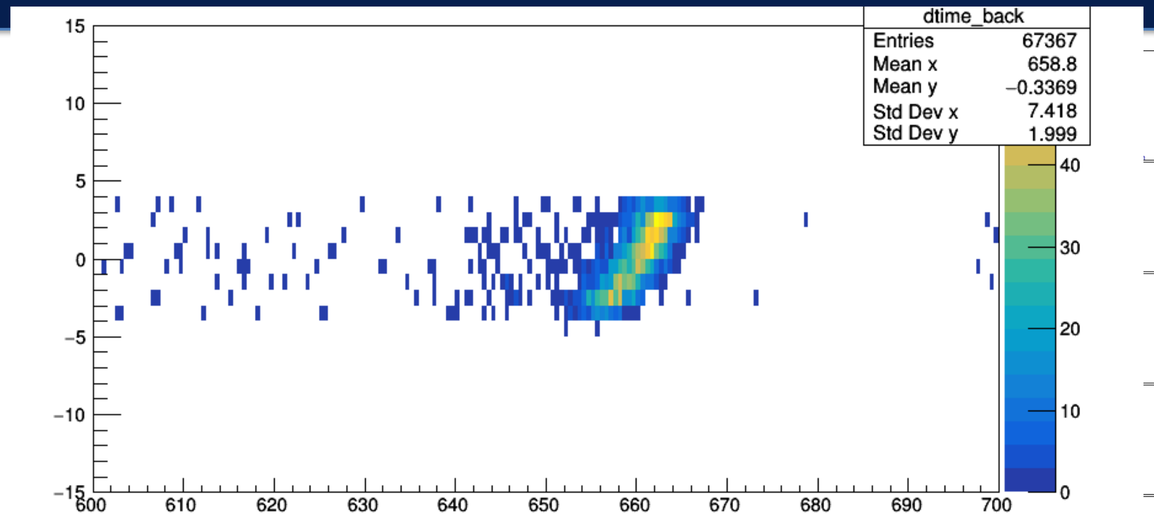
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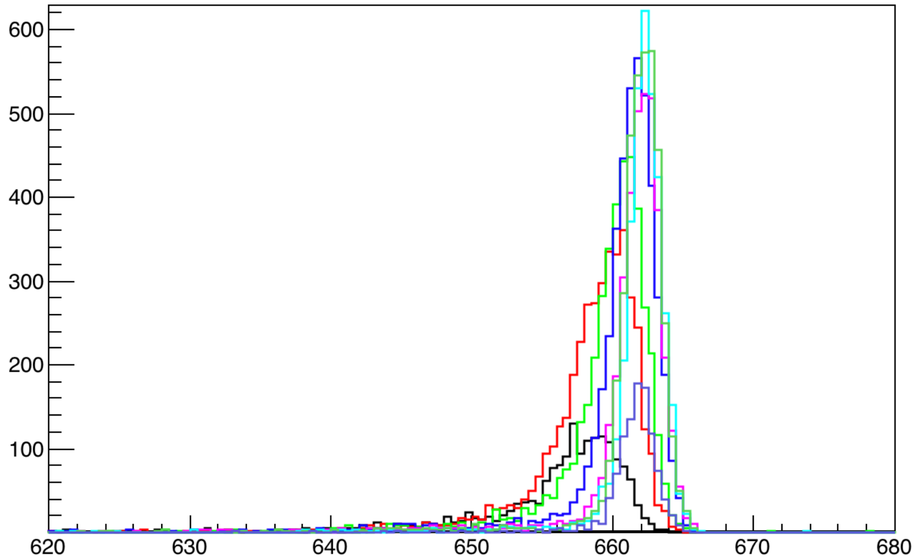

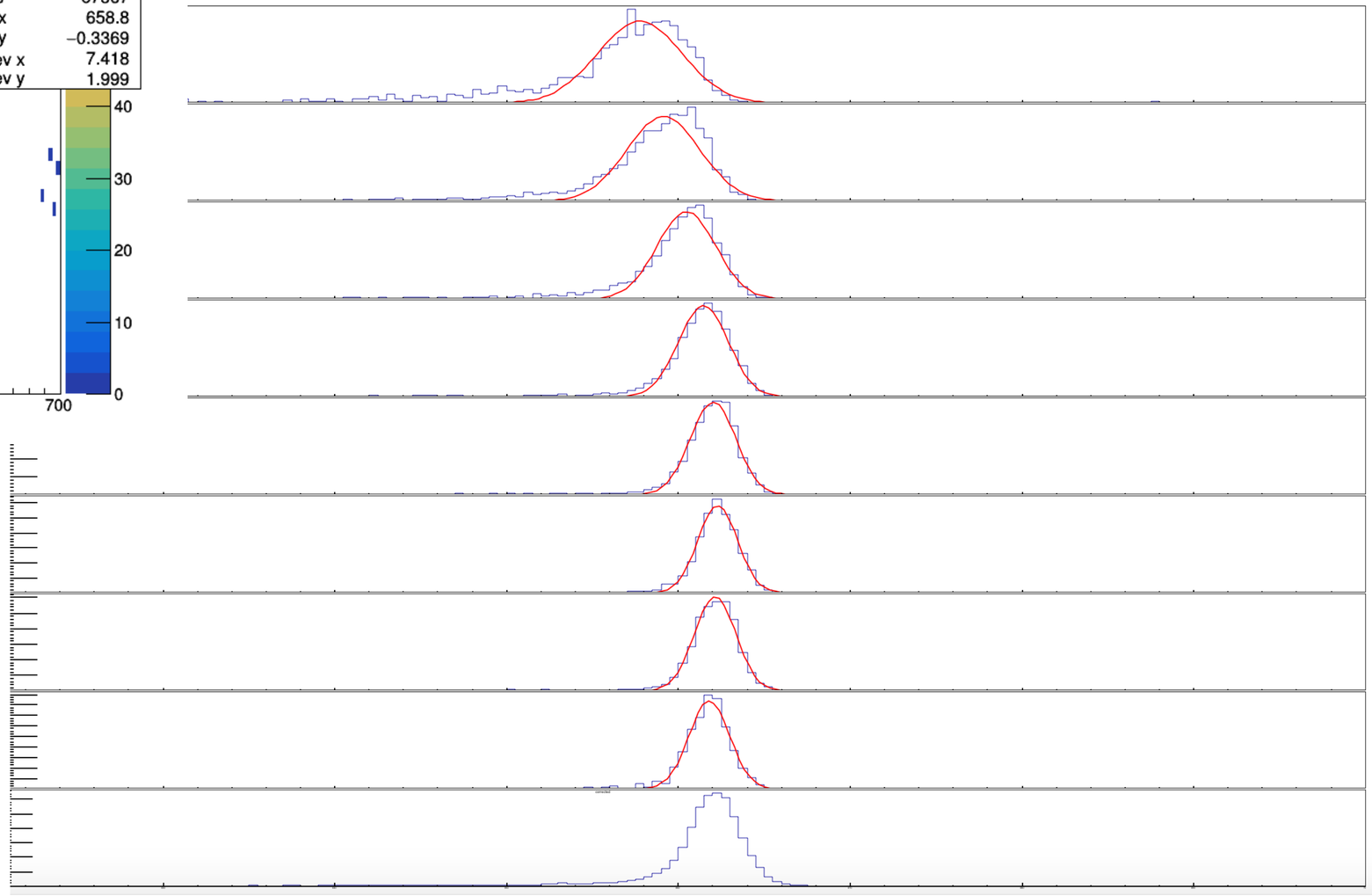

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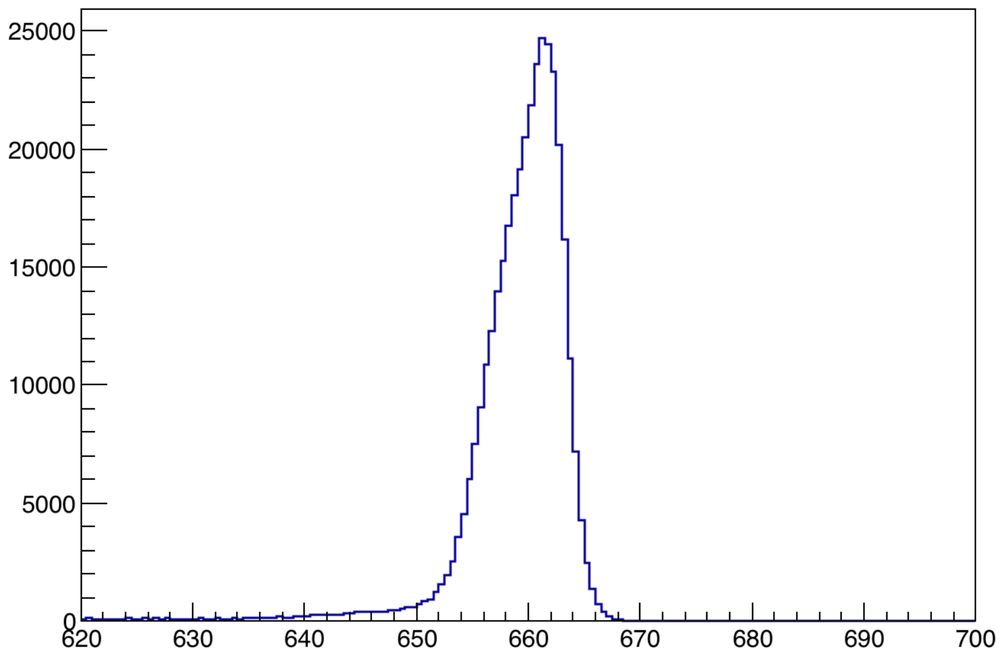

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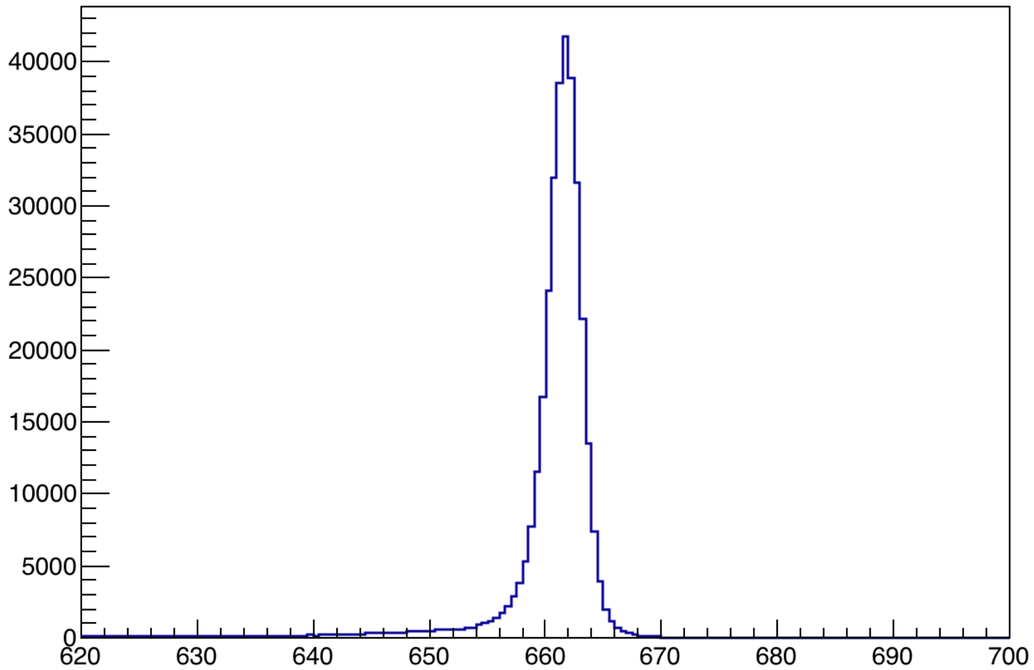

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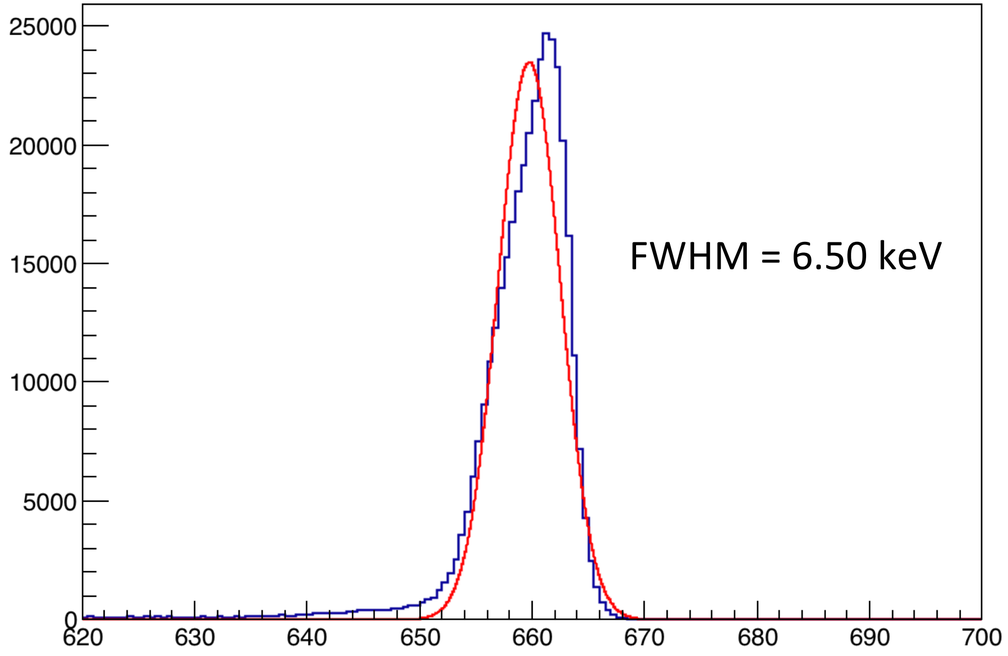

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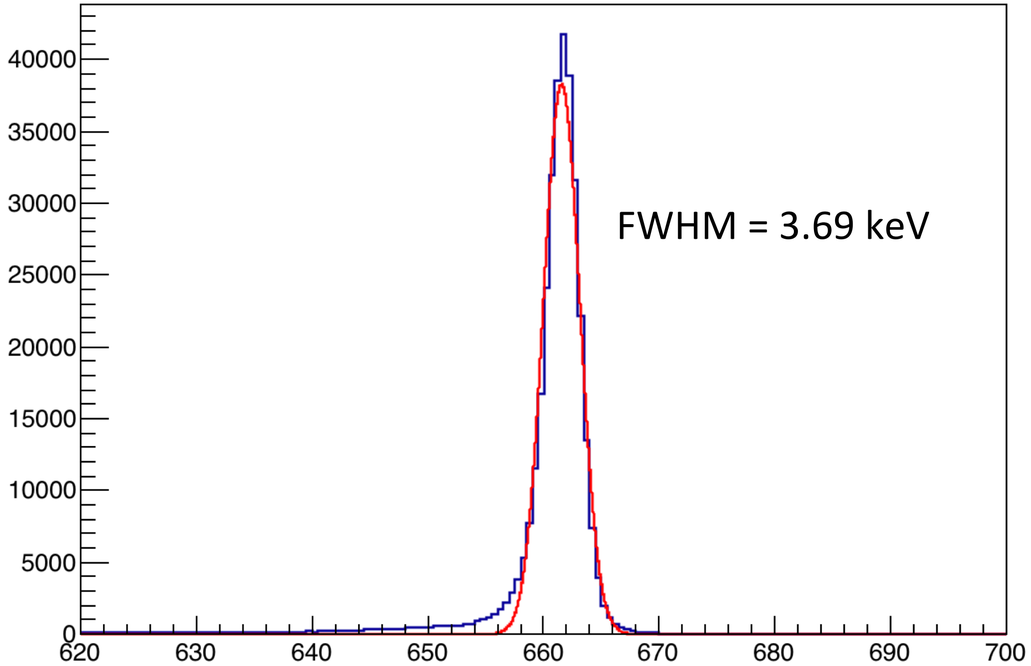

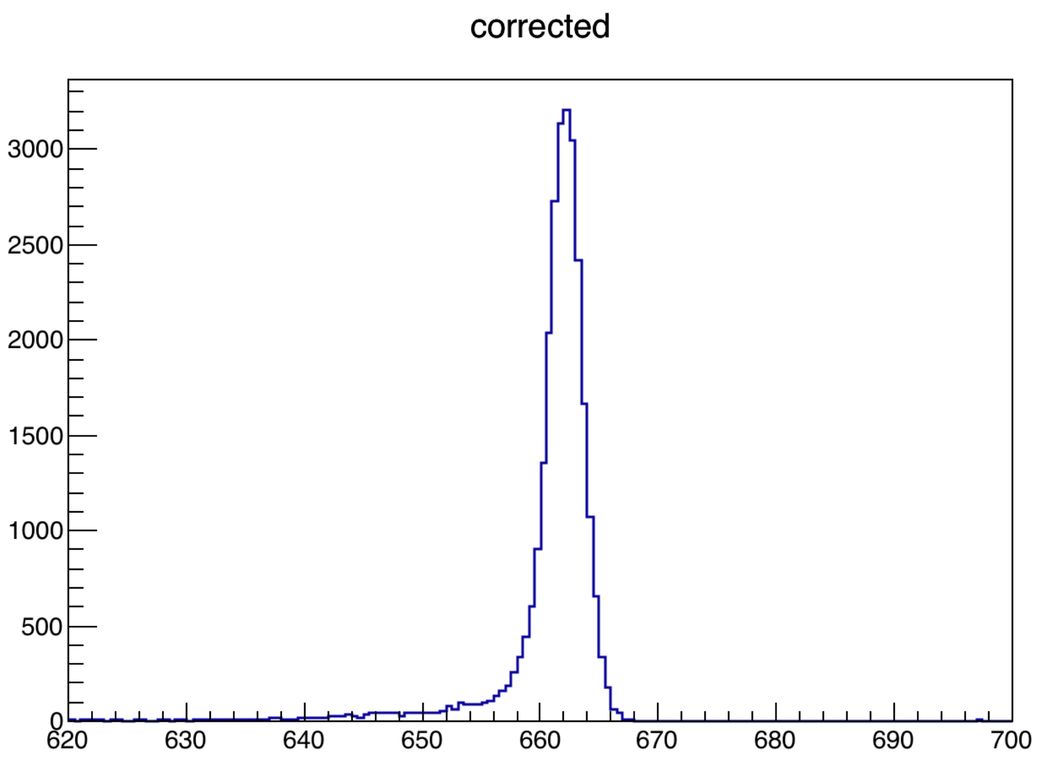
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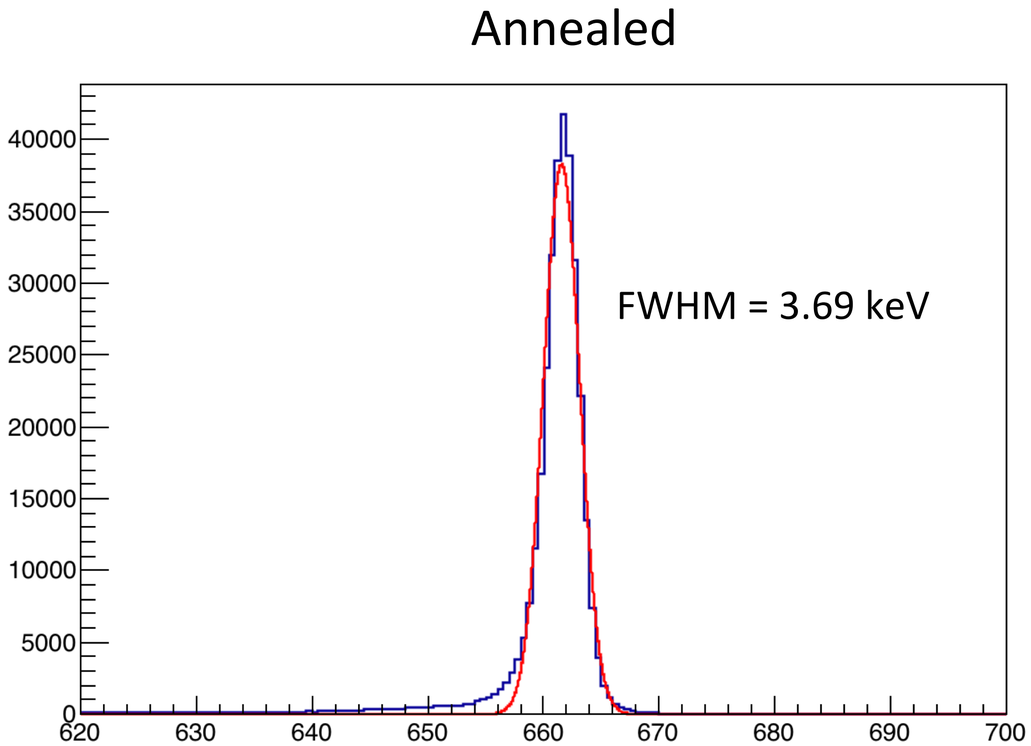
Annealed
FWHM = 3.69 keV
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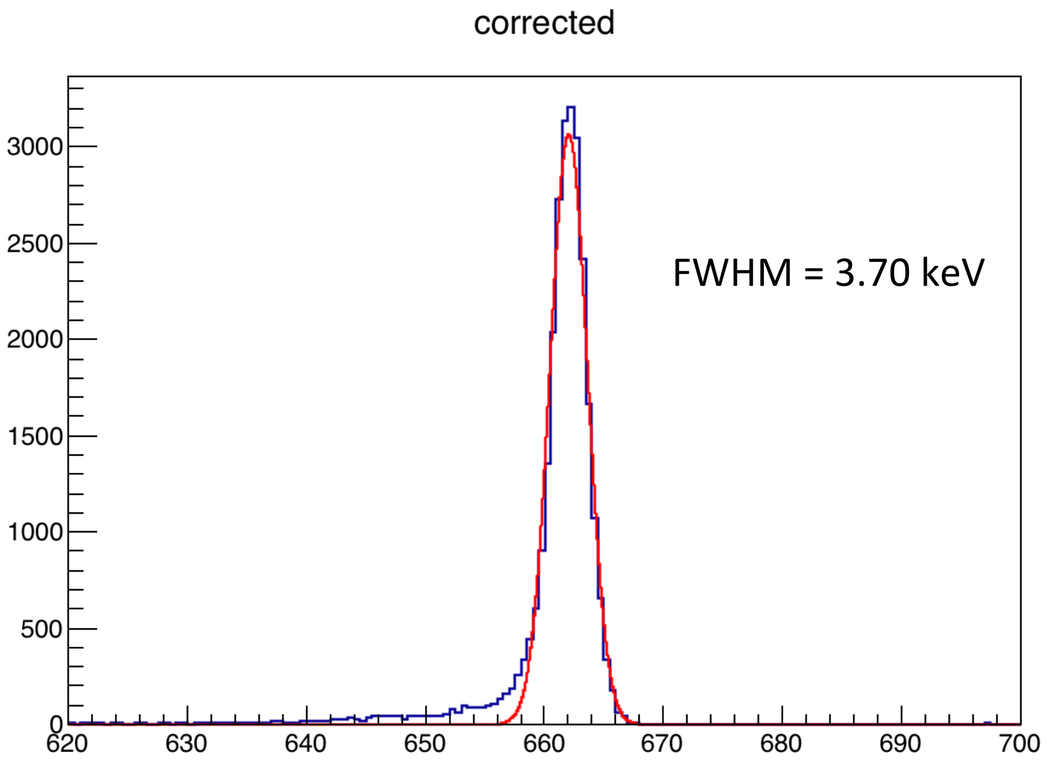
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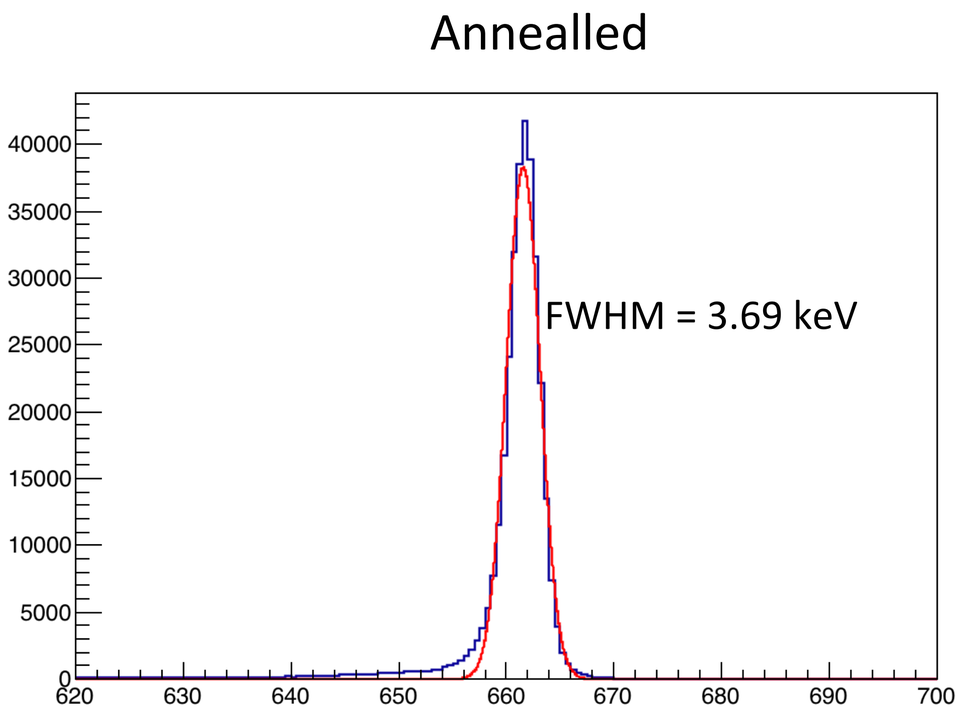
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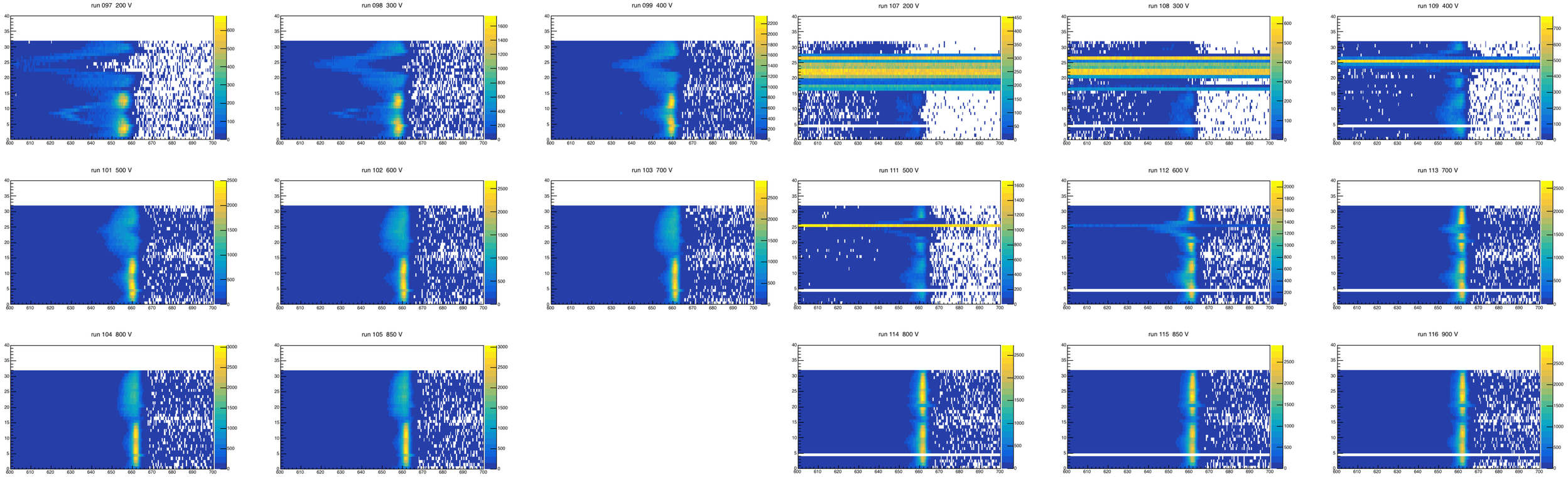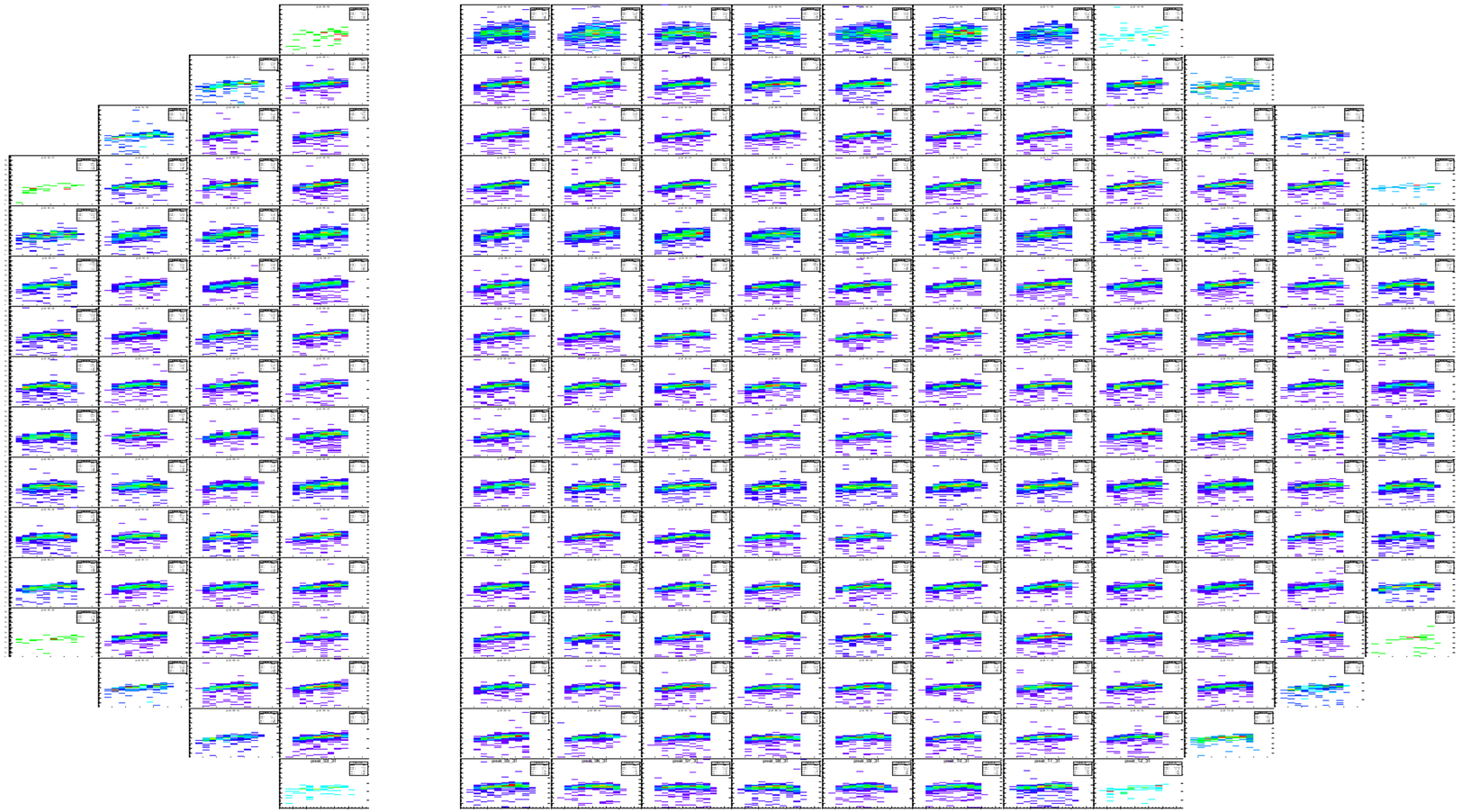
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run 112 600 V
run 113 700 V
run 104 800 V
run 105 850 V
run 114 800 V
run 115 850 V
run 116 900 V