Calibration of the OSU setup (LJU diary 5)

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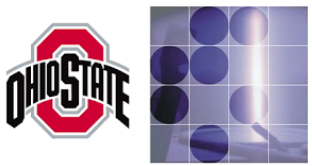
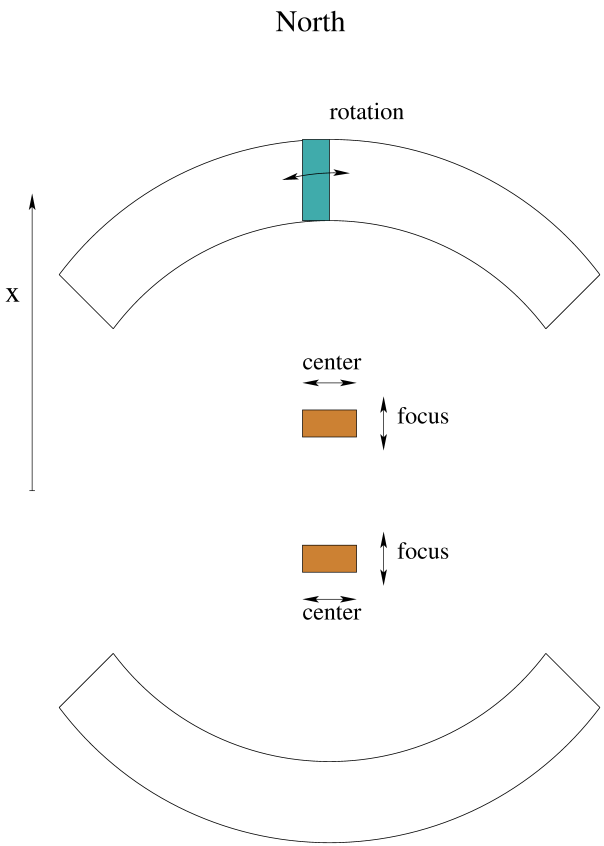


October 12, 2018

PET: layout



- Calibration refers to (micro) positioning of the detectors in the detector model
- A total of 5 parameters to be estimated: x and y of both Si sensors, rotation of the PSPMT module. Distance of PSPMT fixed.
- 4 runs at disposal:

  [20180920/16 si: 32k]

  [20180926/1 sibgo: 29k]

  [20180924/1 silyso: 10.5k]

  [20180928/1 1 lysobgo: 81k]
- Constraints:

  fixed rotation axis, equivalent to source following a sine curve with 0 offset

  focus of the source; exploit parallax to determine axial position of the sensor.
- Parameters corellated.

PET: initial trials

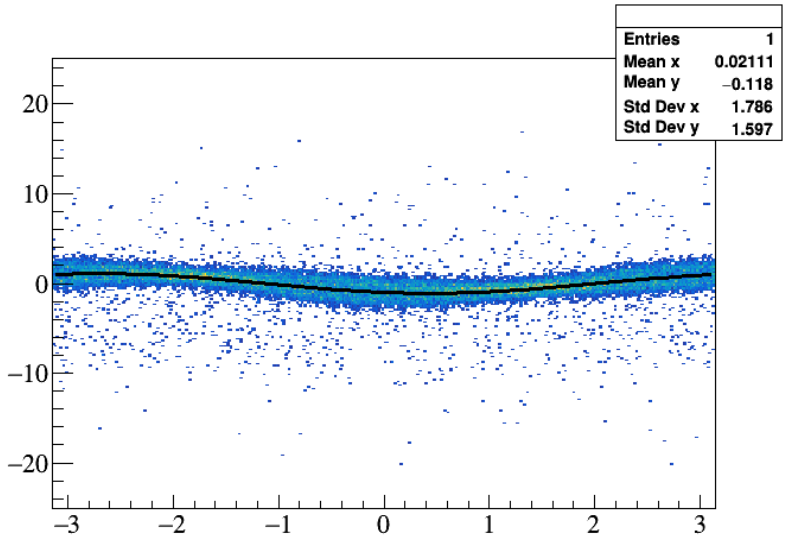
- Couple of false starts:
- Overconstrained model tried first: allow only for y positions + rotation.

  Used sibgo run to fix si-north,

  si run to fix si-south

  si-lyso to determine rotation and compare to

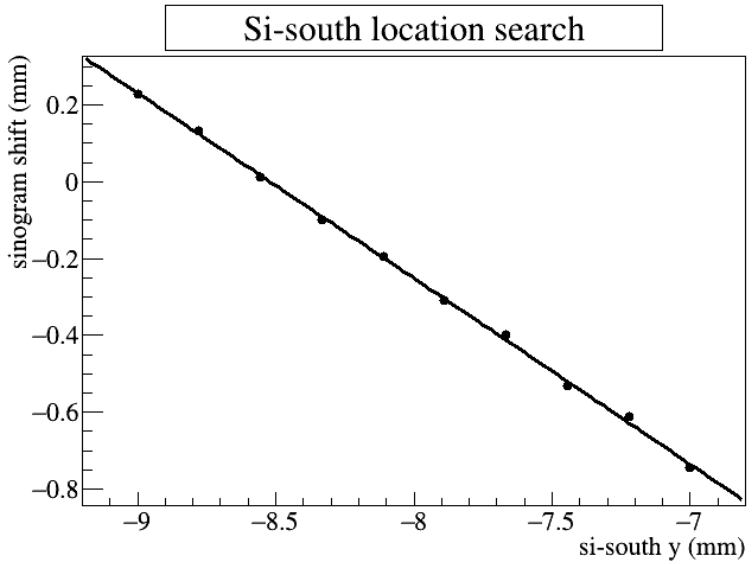
  bgo-lyso rotation
- Rotations were 0.034 mrad (si-lyso) to 0.039 mrad (lyso-bgo) .



- Improve sine offset modelling. Go from sinogram mean y to two step approach: divide sinogram to horizontal angular segments and measure most probable offset per segment. Fit sine to most probable segment values and determine offset of sine curve.
- Got 0.041 mrad (si-lyso) 0.039 mrad (lyso-bgo). For individual detectors, si-north was shifted by 40 μm, si-south by 300 μm.

PET: initial trials

- Very little noise in location search plots
- replaced binary search with data fitting. Binary search works well with sinogram mean y, but fitting noise may overwhelm the method at short steps.
- based on the slope and variation, expected accuracy is in μm.



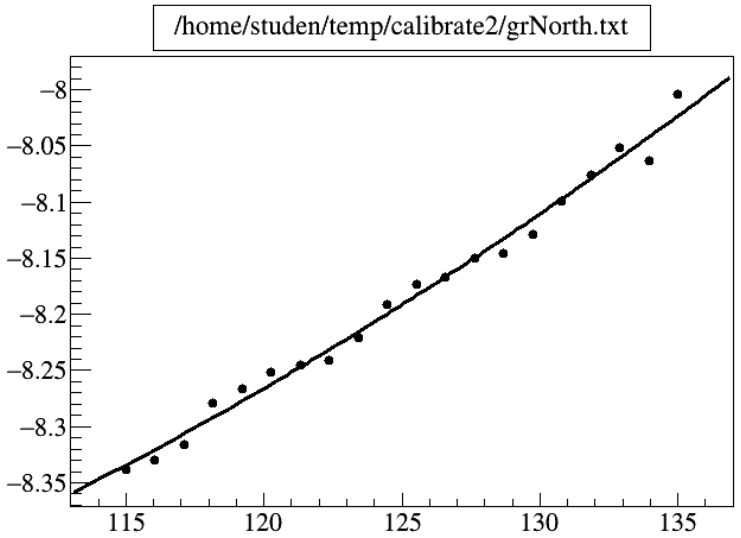
- Discrepancy in PSPMT angle (remember: one arm goes through si-bgo, si-si and si-lyso, the other through lyso-bgo) is alleviated if I allow axial (along x) shift of si detectors.
- incorporate x-searching into calibration algorithm

PET: calibration strategy 2.0

- Start with well defined sensors: bgo
- Use runs that collect bgo data to calibrate others: sibgo for si, lysobgo for PSPMT.
- For sibgo a y/x pairing plot can be made - assume si-north is at a particular axial location x, the fixed axis requirement yields a corresponding y. Range between -130 and -120 should suffice.
- The lysobgo run should yield a definitive lyso rotation.
- Once PSPMT rotation is known, similar plot as for si-north can be made using si-lyso data, again using only the fixed axis requirement.
- Then, si-north/si-south correlation can be made. At a particular distance of one detector module (say si-north) the fixed axis requirement will yield a particular si-south distance/offset combination.
- The si-north/si-south pairings will all yield a particular source focus on the si-si sinogram. The one with lowest spread/best resultion will be selected as the micro-positioning optimum.

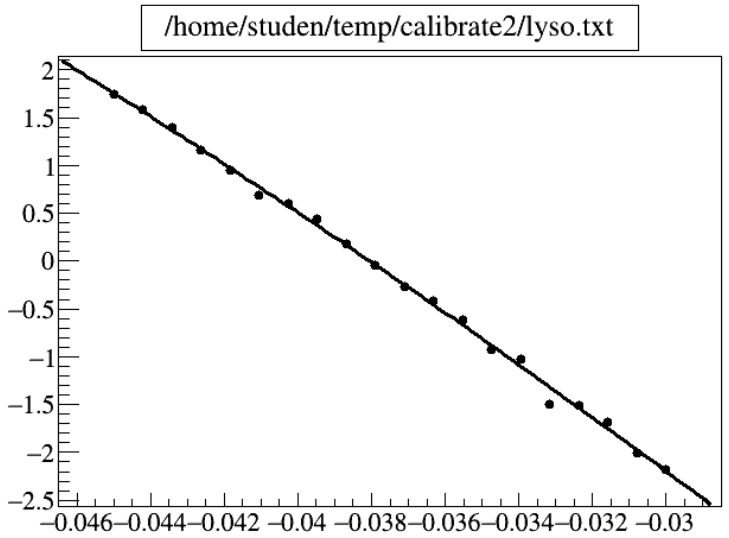
Calibration 2.0: si-north

- Calibration of Si-north position, relation of x/y coordinates requiring fixed rotation axis with si-north, based on the si-bgo run.
- Careful checks on fit results with bad fits removed from further stages



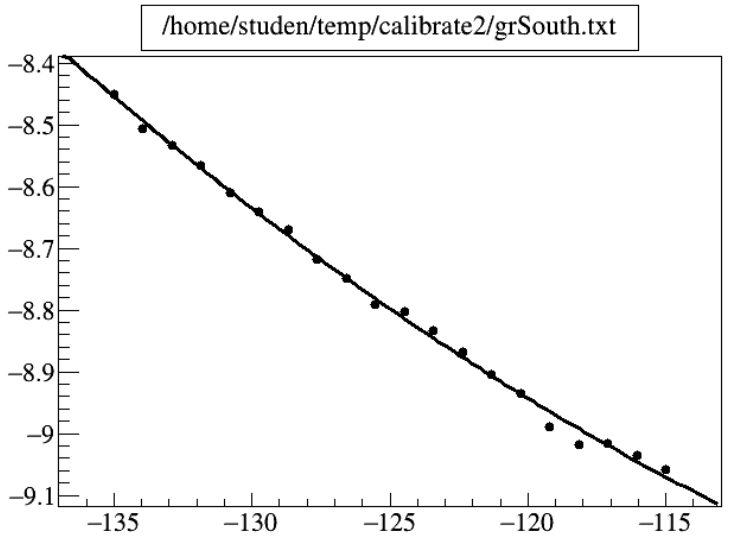
Calibration 2.0: lyso rotation

- Calibration of PSPMT module rotation, just a single parameter; angle. Inferred from the lyso-bgo run.



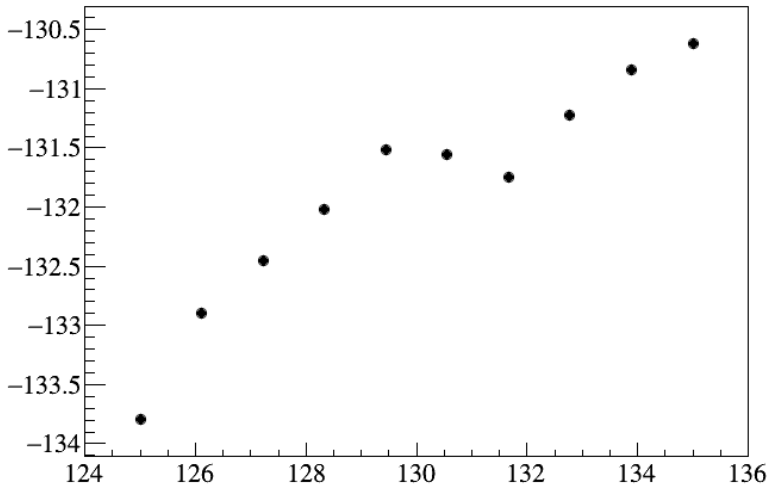
Calibration 2.0: si-south

- Calibration of Si-south position, relation of x/y coordinates requiring fixed rotation axis with si-north, based on the si-lyso run.
- Careful checks on fit results with bad fits removed from further stages
- Steeper shift in y per shift in x than si-north (SOUTH: 0.7 mm/20 mm NORTH: 0.35 mm/20 mm)



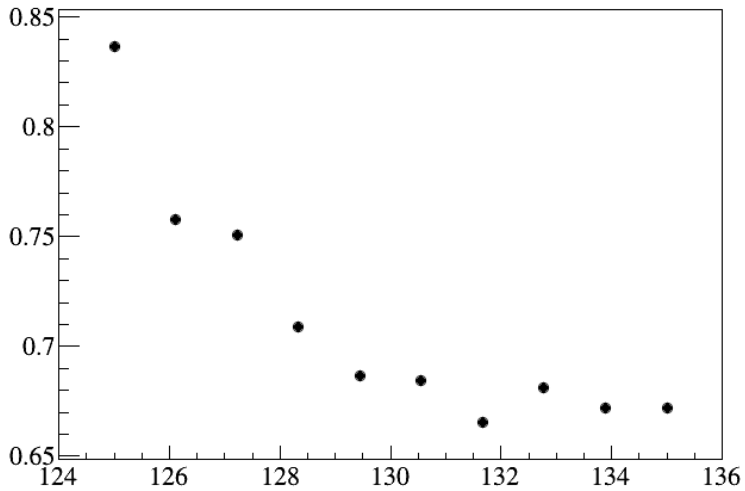
Calibration 2.0: matching of si

- Finding best fit of si-north and si-south in si-si data
- Requiring fixed rotation axis
- At small x(NORTH), values of x(SOUTH) are out of probed range so x(NORTH) range is adjusted
- Strange shape at 130-132 range. Related to si segmentation?



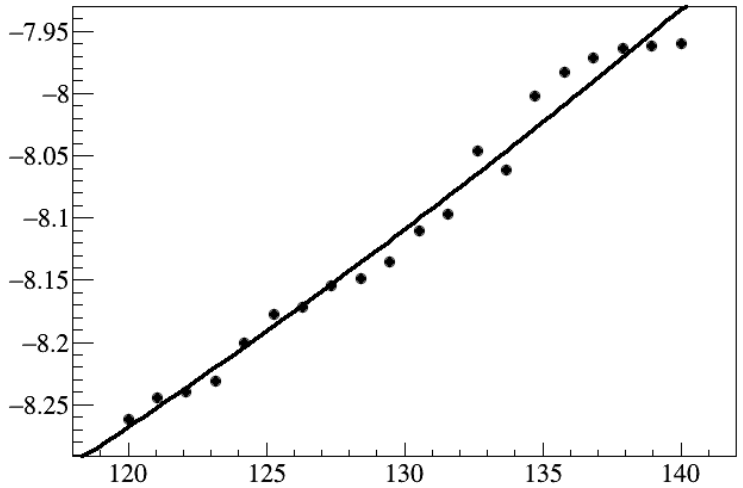
Calibration 2.0: finding best resolution

- Using best fit of si-north and si-south in si-si data
- Plotting average sinogram resolution in tangential coordinate, grouping together to $\pi/10$ bins
- Minimum at the boundary - resetting the positioning range. Require recalculation of siNorth and siPairs/siResolution graphs.



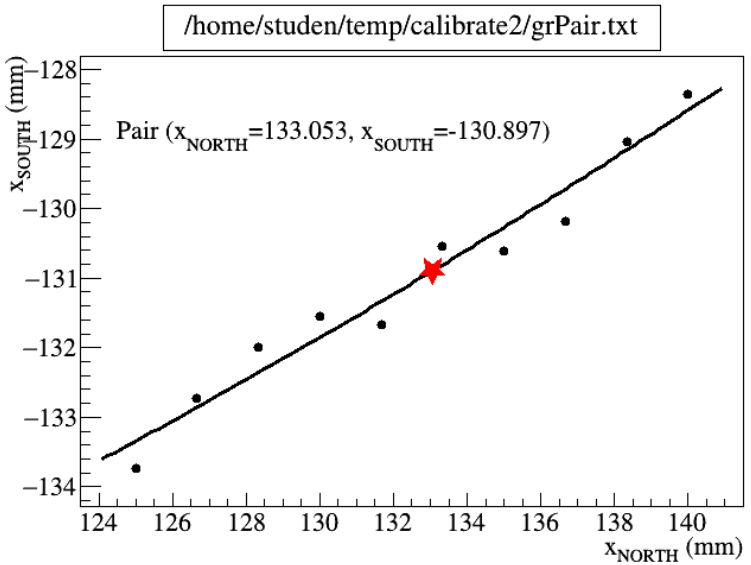
Calibration 2.0: si-north rework

- Extend the probing range to 140 for a better coverage of the interesting range.



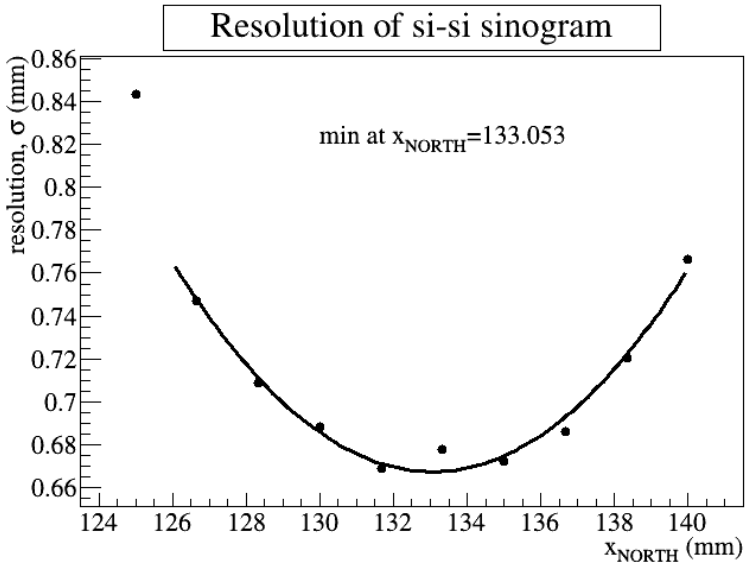
Calibration 2.0: updated matching of si

- Finding best fit of si-north and si-south in si-si data
- Requiring fixed rotation axis
- At small x(NORTH), values of x(SOUTH) are out of probed range so x(NORTH) range is adjusted
- Reworked to a better range. Optimum point (from resolution graphs) is indicated.



Calibration 2.0: finding best resolution

- Using best fit of si-north and si-south in si-si data
- Plotting average sinogram resolution in tangential coordinate, grouping together to $\pi/10$ bins
- Minimum shifted from boundary. Fit with a parabola to get the optimum position.



- Optimum position NORTH: x=133.053, y=-8.05189
- SOUTH x=-130.897, y=-8.60652
- LYSO fa=-0.0380459