DIRC alignment
Closure Tests

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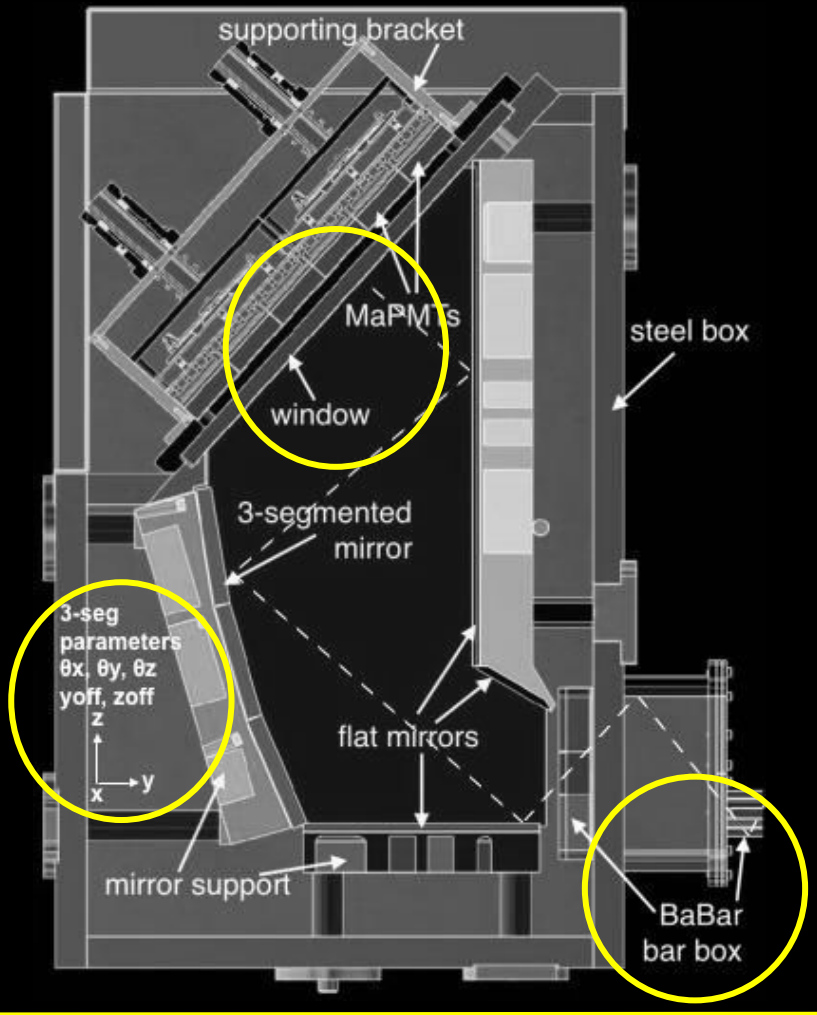
Updated on 11.18.2018

Misalignments

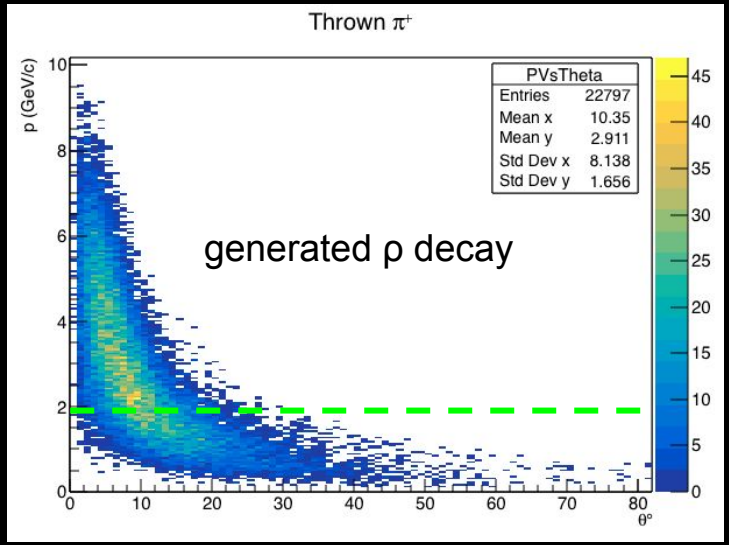


- After installation the optical box will be filled by distilled water (refraction index close to bars).
- Optical box made by several components, system for calibration.
- During data-taking this becomes a black-box problem with many non-differentiable terms.
  - relative alignment of the tracking system with the location and angle of the bars
  - mirrors shifts cause parts of the image change
  - other offsets
- These aspects make seemingly impossible to analytically understand the change in PMT pattern

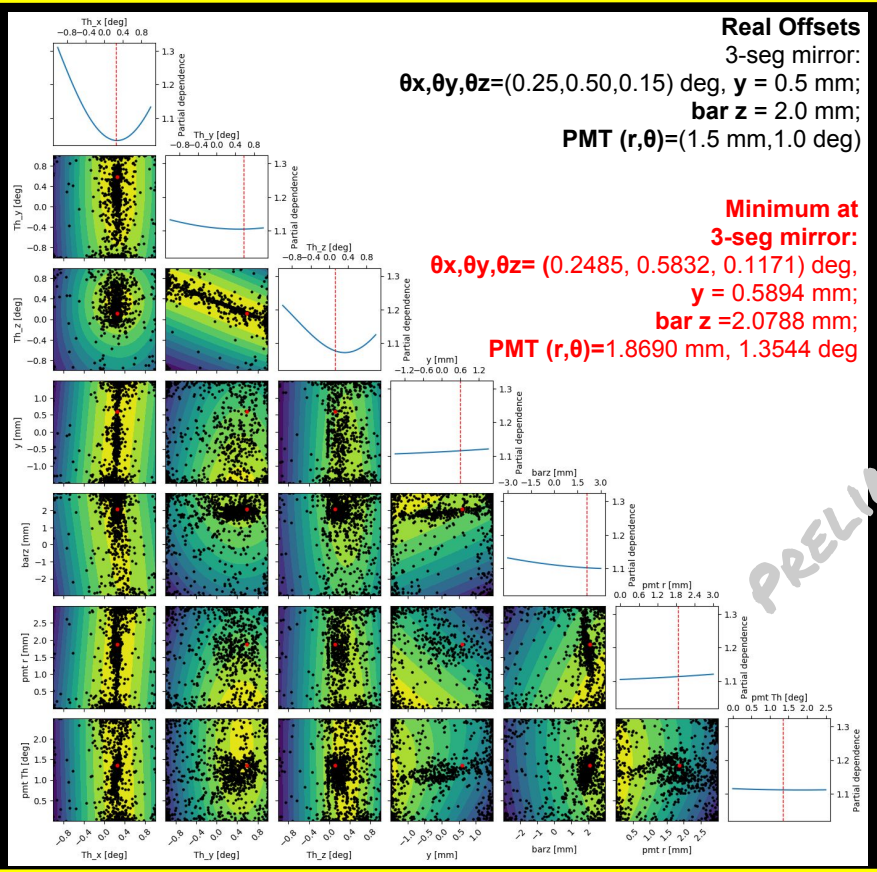
 # offsets $\gtrsim$ O(10)

Pure sample of particles for alignment

- The idea is to use pure sample of pions produced by abundant channels like ρ decays
- At low momentum they are well identified by current GlueX PID capabilities.
- Use these pions as candles for alignment.
- Test alignment with one bar first and for a subrange of kinematics (momentum, angles, and position in the bar) - *proof of principle*
- Generalize technique (to kaons, other bars, etc.)



7D with main offsets - preliminary



Real Offsets
3-seg mirror:
θx,θy,θz=(0.25,0.50,0.15) deg, **y** = 0.5 mm;
bar z = 2.0 mm;
PMT (r,θ)=(1.5 mm,1.0 deg)

Minimum at
3-seg mirror:
θx,θy,θz= (0.2485, 0.5832, 0.1171) deg,
y = 0.5894 mm;
bar z =2.0788 mm;
PMT (r,θ)=1.8690 mm, 1.3544 deg

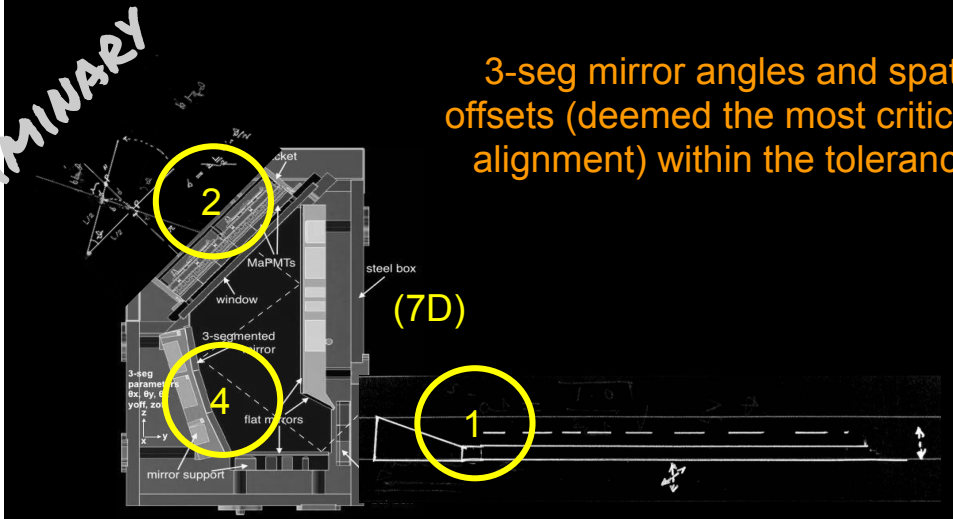
Recipe: For each call of the optimizer, M offset points are explored using N different particles (for each call). The total number of calls is T

T=120 M=10 N=125

Particles used = 15000

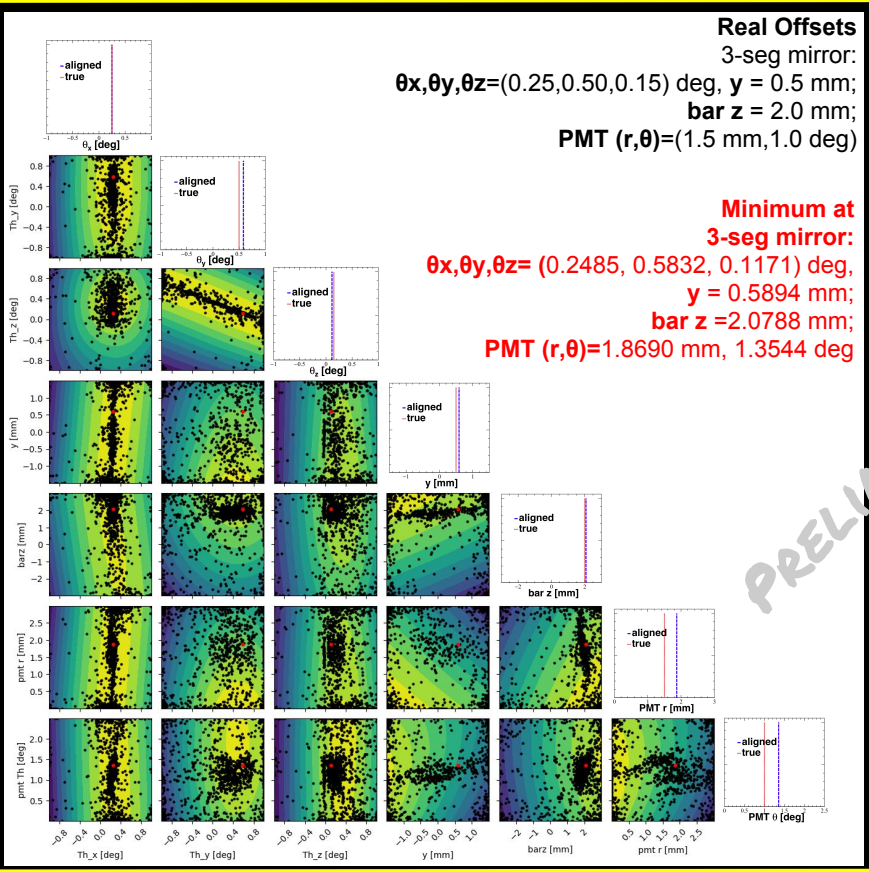
Points explored = 1200

FoM = LogL normalized to a default alignment



3-seg mirror angles and spatial offsets (deemed the most critical for alignment) within the tolerances.

7D with main offsets - preliminary



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PRELIMINARY

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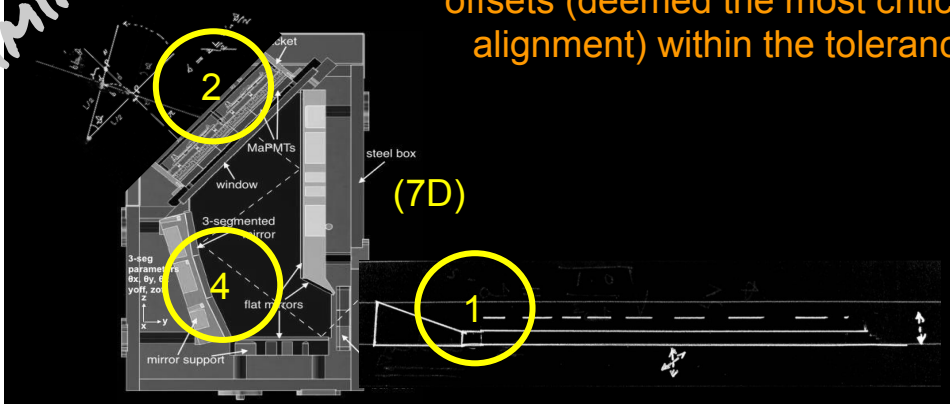

3-seg mirror angles and spatial offsets (deemed the most critical for alignment) within the tolerances.

Resolutions Vs Offsets

correct

3-seg mirror:
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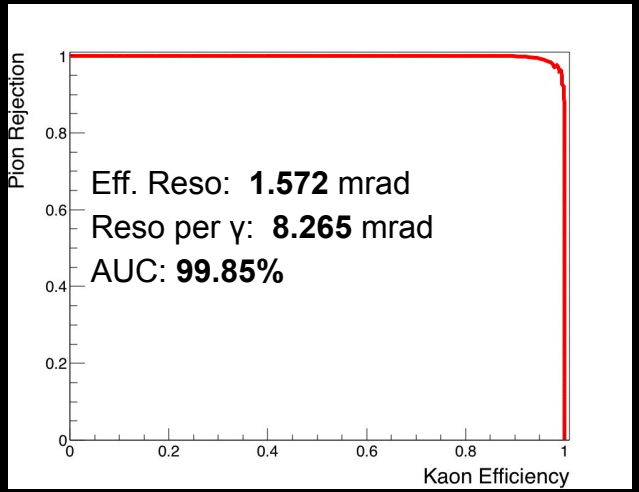
y = 0.5 mm;
bar z = 2.0 mm;
PMT (r,θ)=(1.5 mm,1.0 deg)



calibrated

3-seg mirror:
θx,θy,θz=(0.2485, 0.5832, 0.1171) deg,
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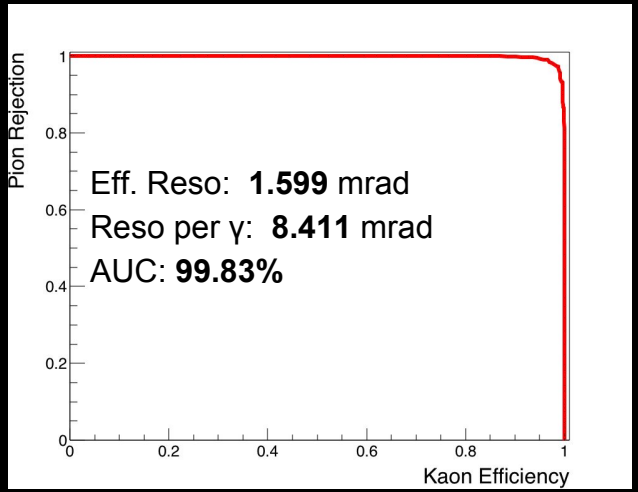
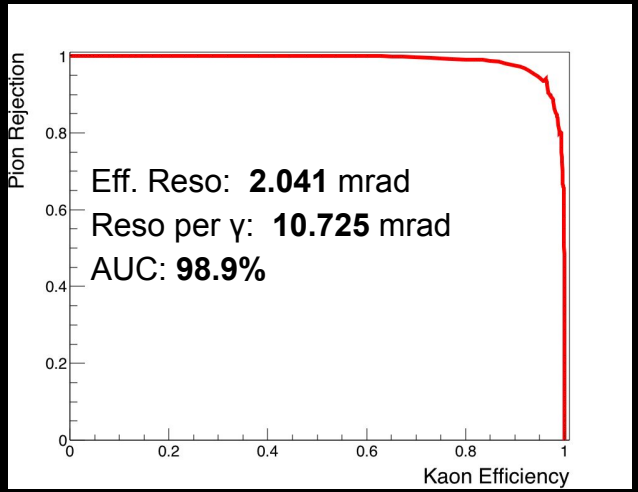


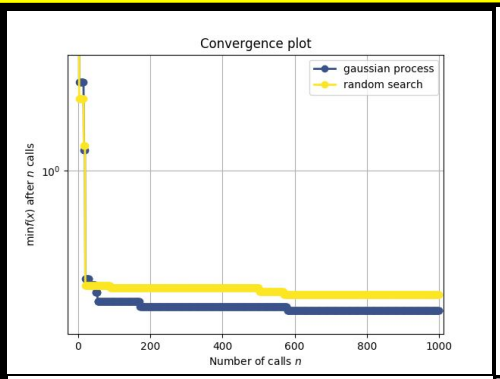
nominal

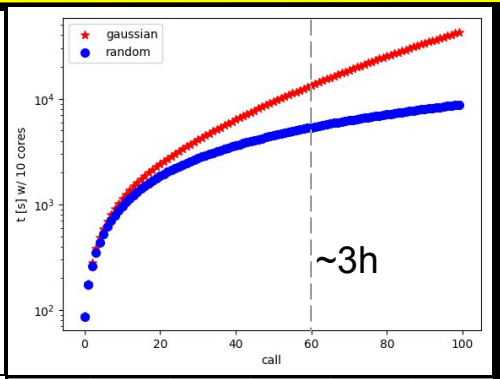
3-seg mirror:
θx,θy,θz=(0., 0., 0.) deg,
y = 0. mm;
bar z = 0. mm;
PMT (r,θ)=(0. mm, 0. deg)

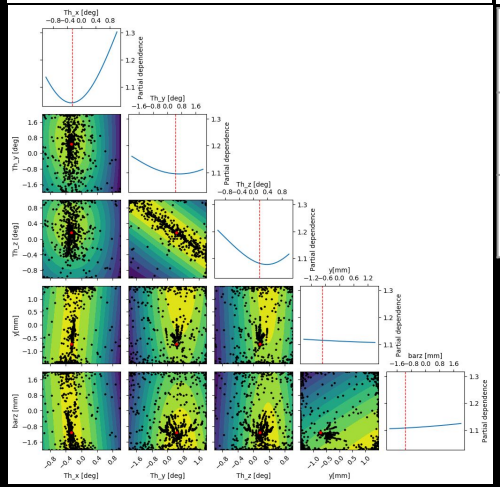


Kinematics: (E , θ, φ): (4 GeV, 4 deg, 40 deg)

Extending to more bars







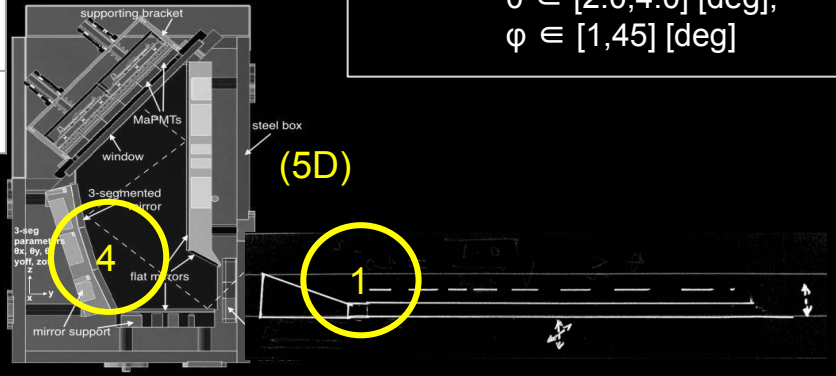
	θx [deg]	θy [deg]	θz [deg]	y [mm]	bz [mm]
real	**-0.25**	**0.50**	**0.15**	**-0.5**	**-0.9**
calib	**-0.26**	**0.46**	**0.16**	**-0.7**	**-1.1**

T=100 M=10 N=100
Particles used = 10000
Points explored = 1000

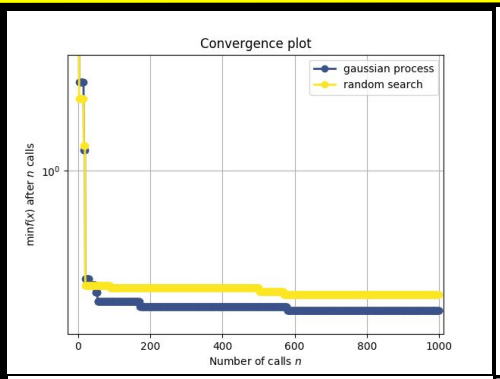
FoM = LogL normalized to a default alignment

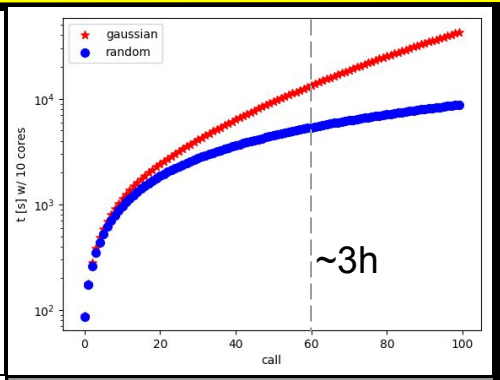
10 bars from 1 bar box

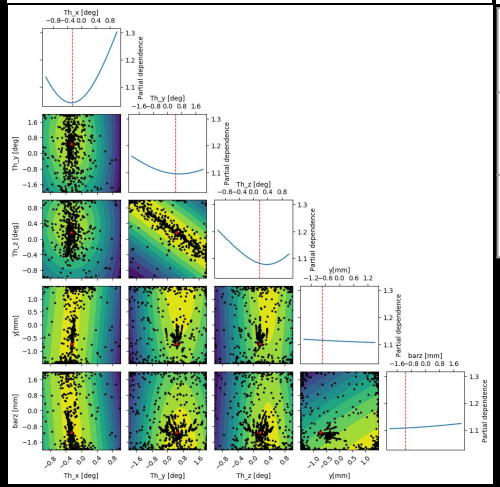
x ∈ [16,50] cm
y ∈ [-50,50] cm
E ∈ [2.5,3.0] [GeV]
θ ∈ [2.0,4.0] [deg],
φ ∈ [1,45] [deg]



Extending to more bars







	θx [deg]	θy [deg]	θz [deg]	y [mm]	bz [mm]
real	**-0.25**	**0.50**	**0.15**	**-0.5**	**-0.9**
calib	**-0.26**	**0.46**	**0.16**	**-0.7**	**-1.1**

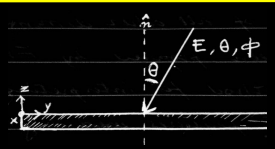
	eff. res [mrad]	res/γ [mrad]	AUC (%)
real	**1.42**	**7.53**	**99.9**
calib	**1.42**	**7.53**	**99.9**
non-corr	**1.85**	**9.83**	**99.4**

Kinematics:
(E , θ, φ): (4 GeV, 4 deg, 40 deg)

Backup

3D combining different particles

Toy-model: sampling 100 pions/call in range
E [GeV], θ [deg], φ [deg]: [2.5,3.0], [2,4], [1,45]



Recipe: For each call of the optimizer, M offset points are explored using N different particles (for each call). The total number of calls is T

T=20 M=10 N=100
Particles used = 2000
Points explored = 200

FoM = ΔlogL (with respect to a default alignment)
(and normalized to default)