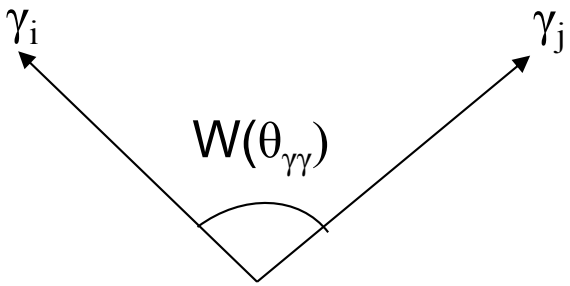
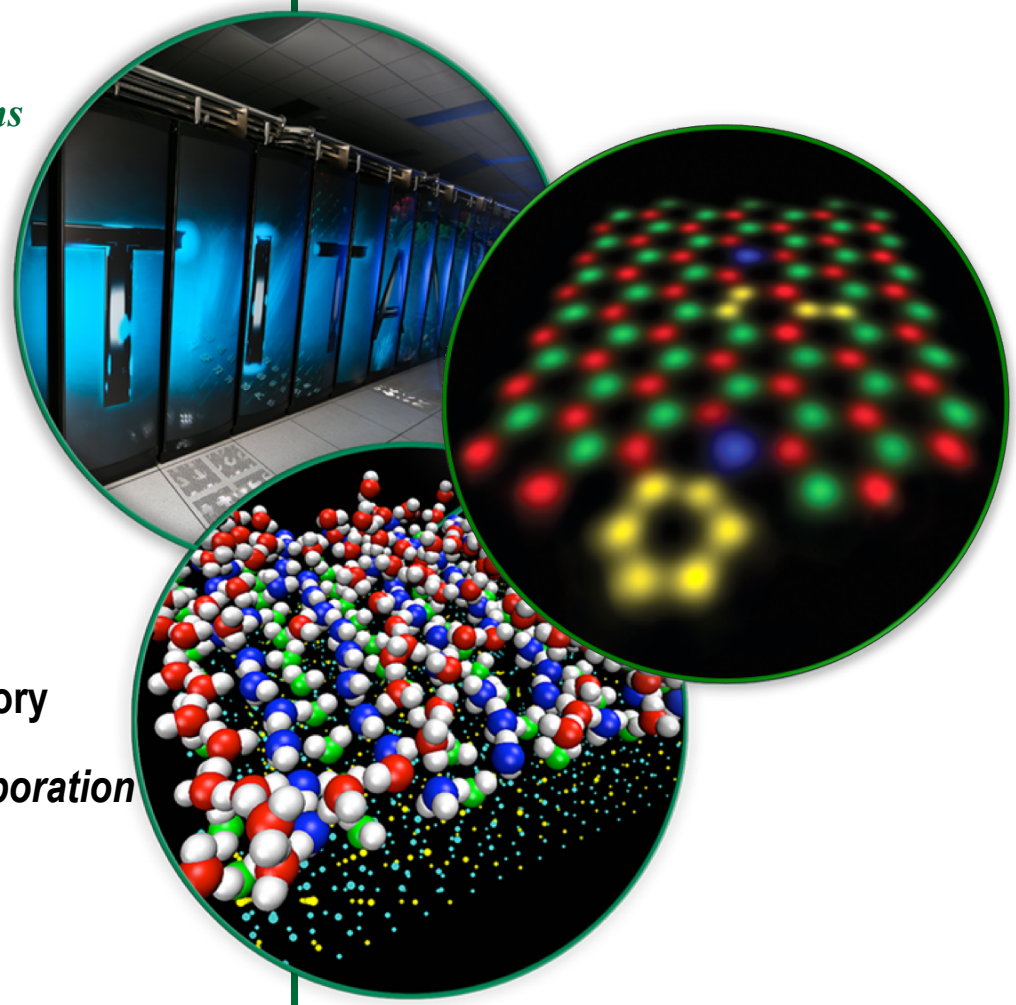
γ-γ Angular Correlations with GRETINA *and*

what they may say about low-energy position distributions





James Mitchell Allmond

Physics Division – Oak Ridge National Laboratory

Second AGATA-GRETINA tracking arrays collaboration meeting – April 2018

U.S. DEPARTMENT OF ENERGY

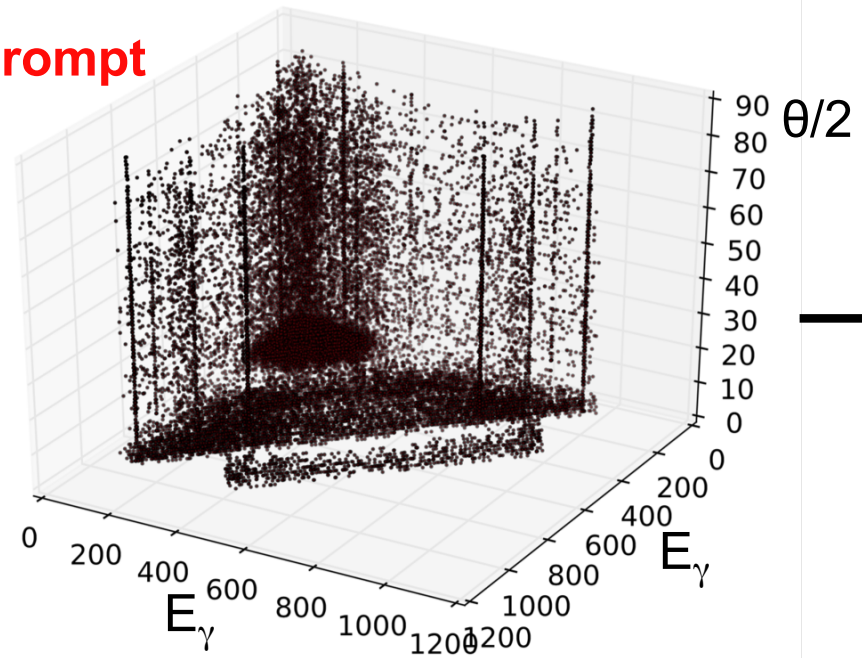
OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

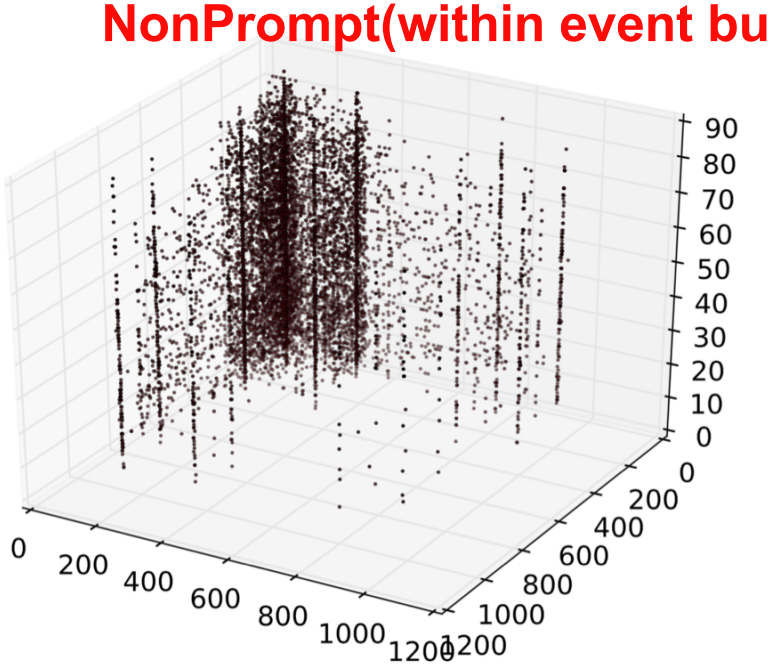
E_γ-E_γ-θ Cube

The angular correlations were constructed from three cubes

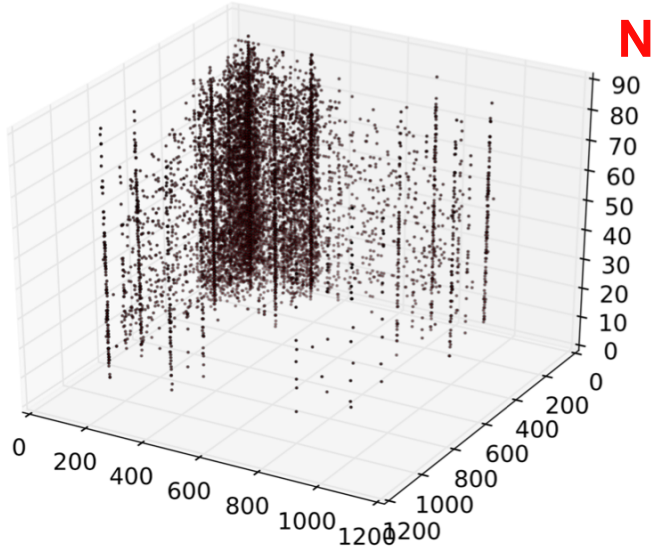
Prompt



NonPrompt(within event build)



NonPrompt(mixed events)

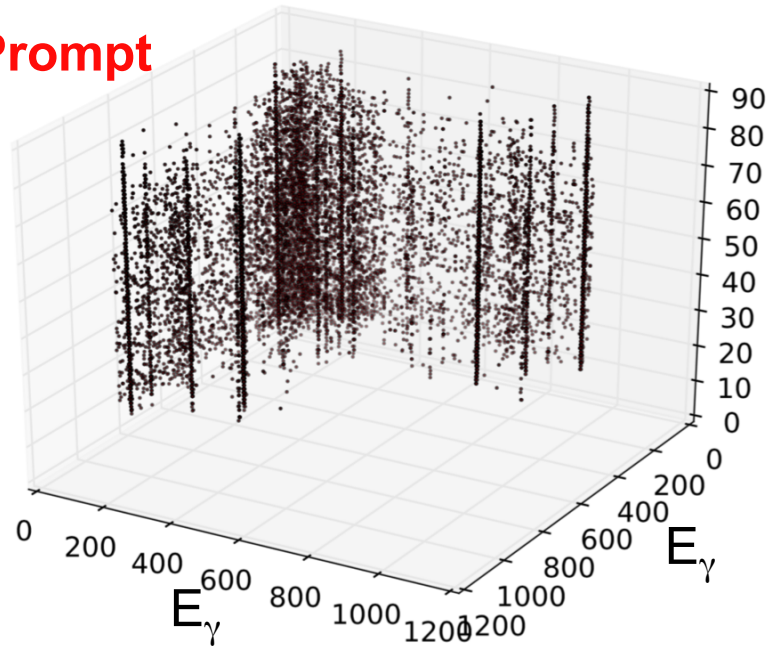


Filter: N > N_{max}/100 & N_{max} Random(0,1)*

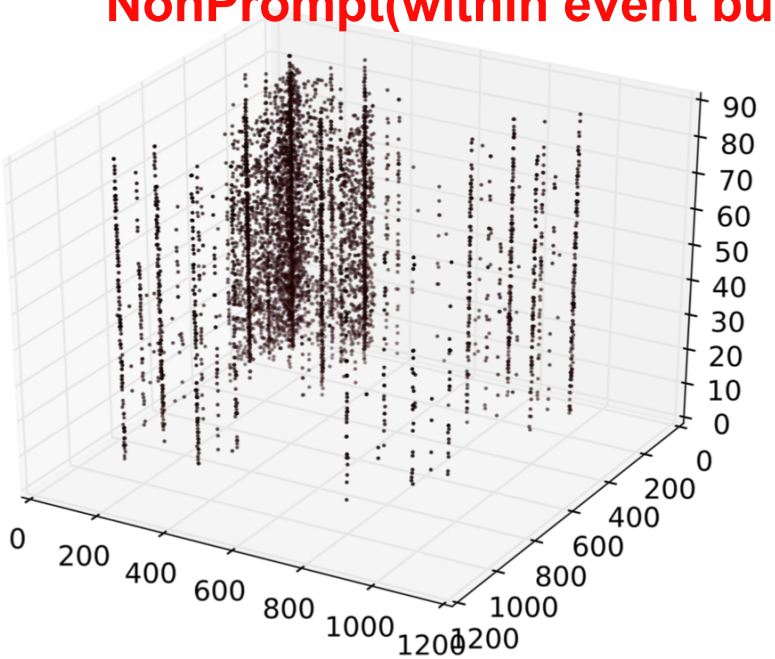
E_γ-E_γ-θ Cube (with Tracking)

The angular correlations were constructed from three cubes

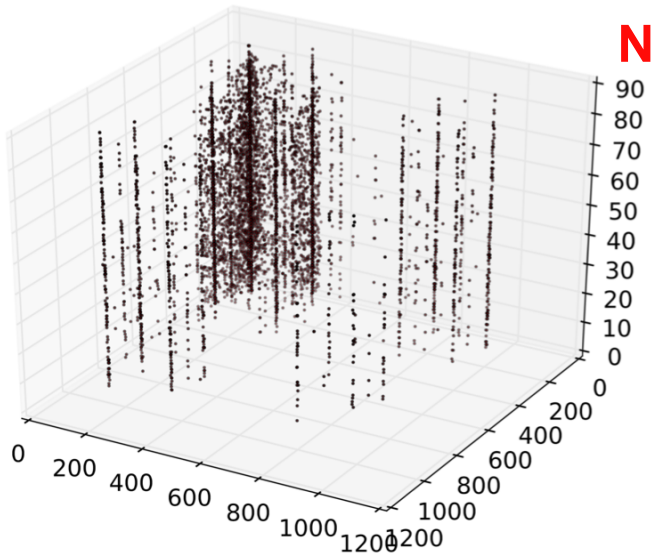
Prompt



NonPrompt(within event build)



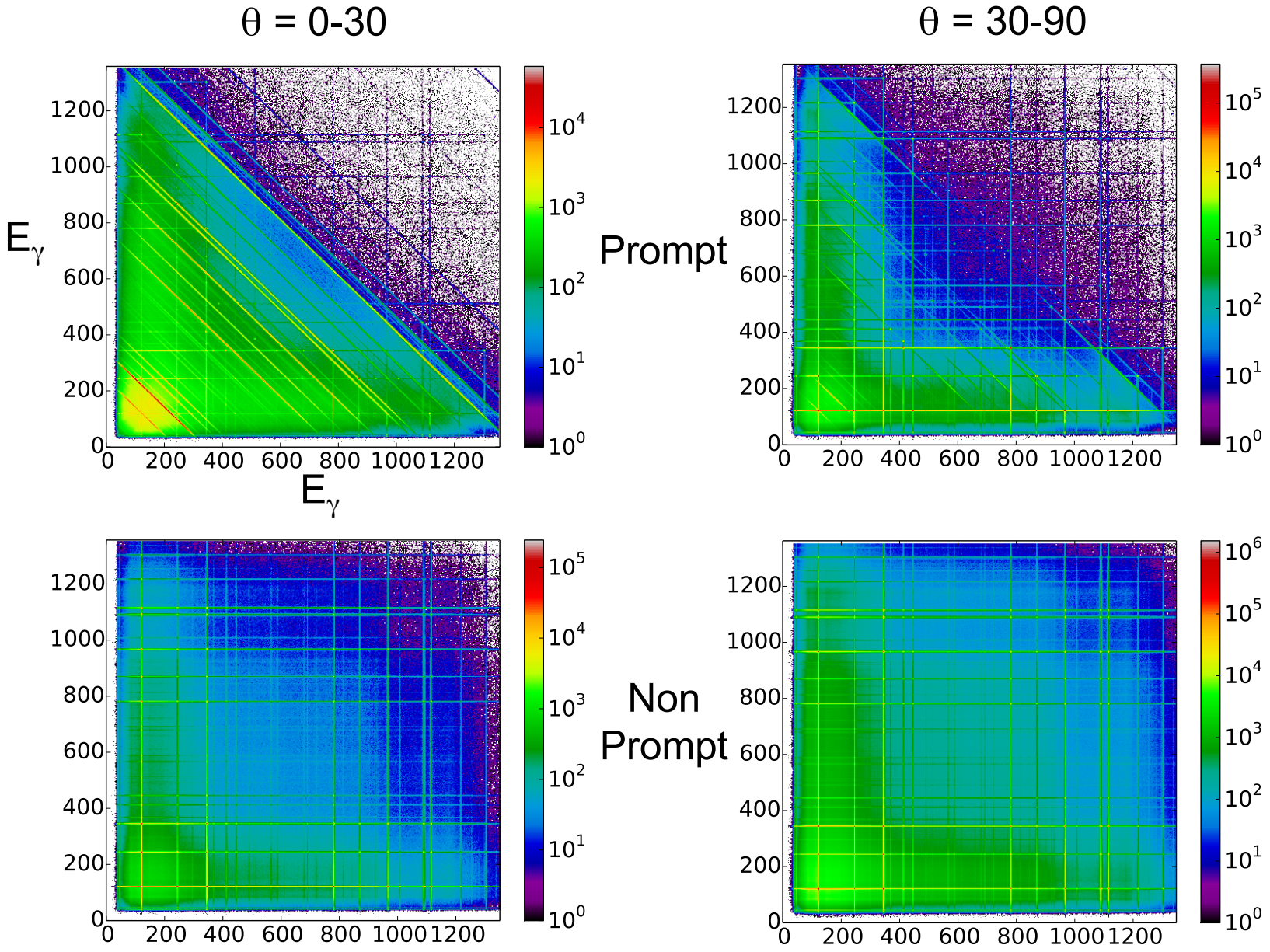
NonPrompt(mixed events)



Filter: N > N_{max}/100 & N_{max} Random(0,1)*

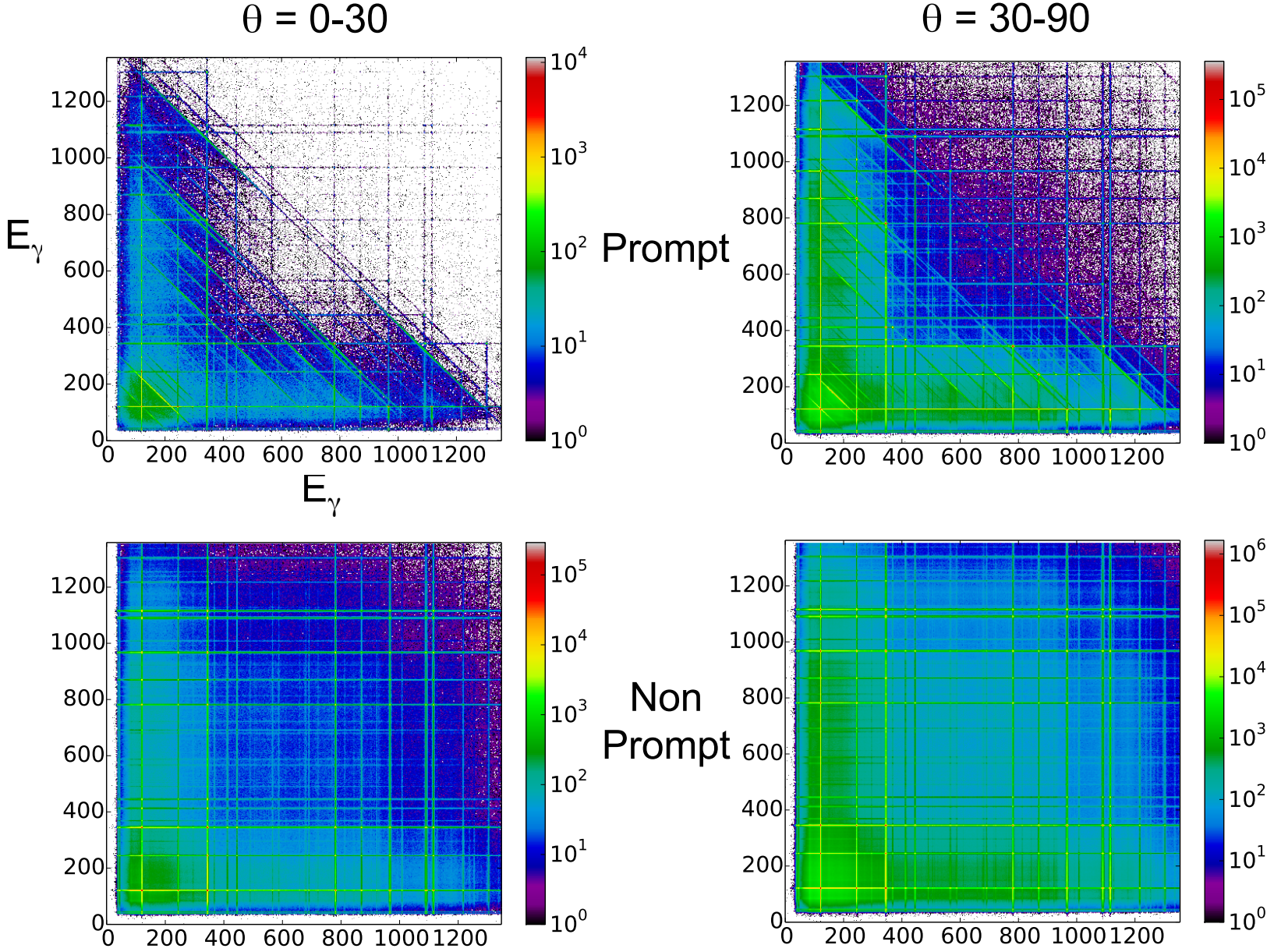
E_γ-E_γ

Compton cross scatter seen only in prompt data and mostly at small angles



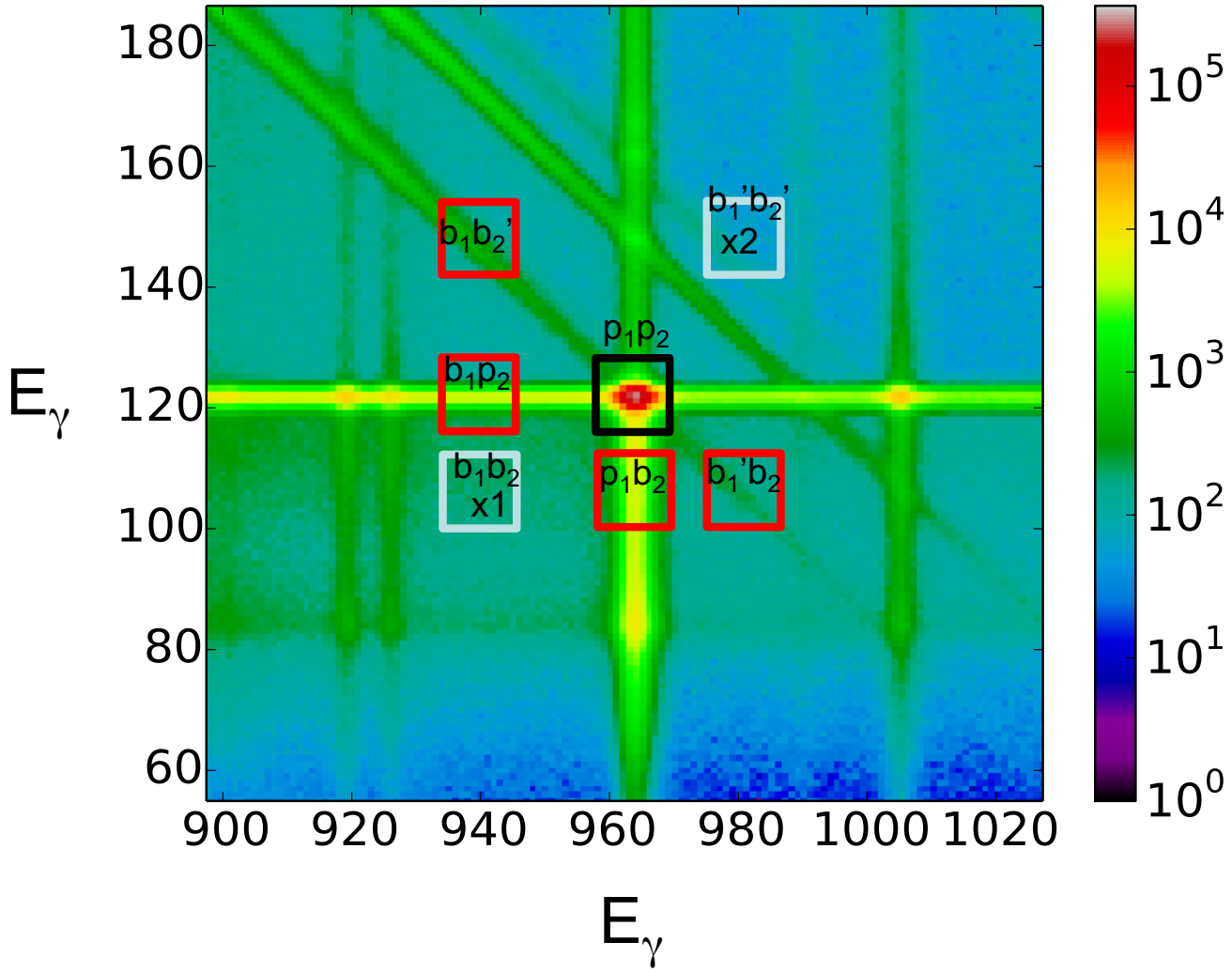
E_γ-E_γ (with Tracking)

Tracking removes much but not all of the Compton cross scatter (e.g., at low E, large σ_z)



$E_\gamma(\text{gate1})$-$E_\gamma(\text{gate2})$-θ

The following two gate- and background-subtraction methods were considered



Eq. (1):

$p_1p_2 - p_1b_2 - b_1p_2 + b_1b_2$

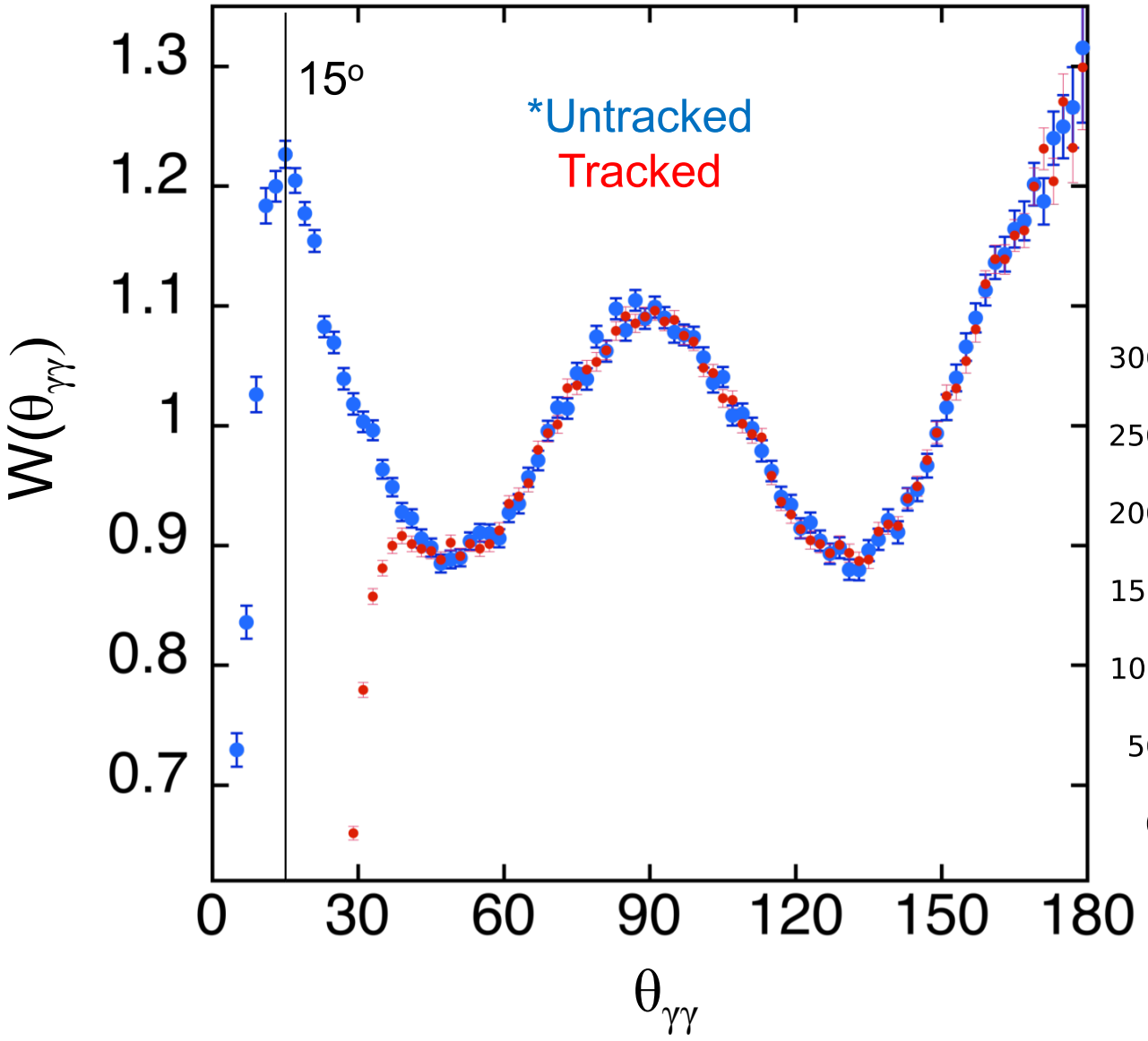
Eq. (2):*

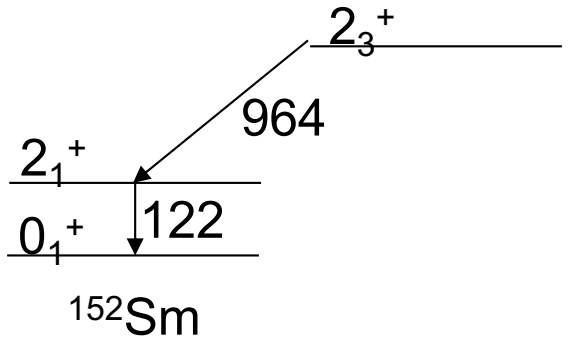
$p_1p_2 - p_1b_2 - b_1p_2 + b_1b_2 + 0.5*[- b_1b_2' - b_1'b_2 + 2b_1'b_2']$

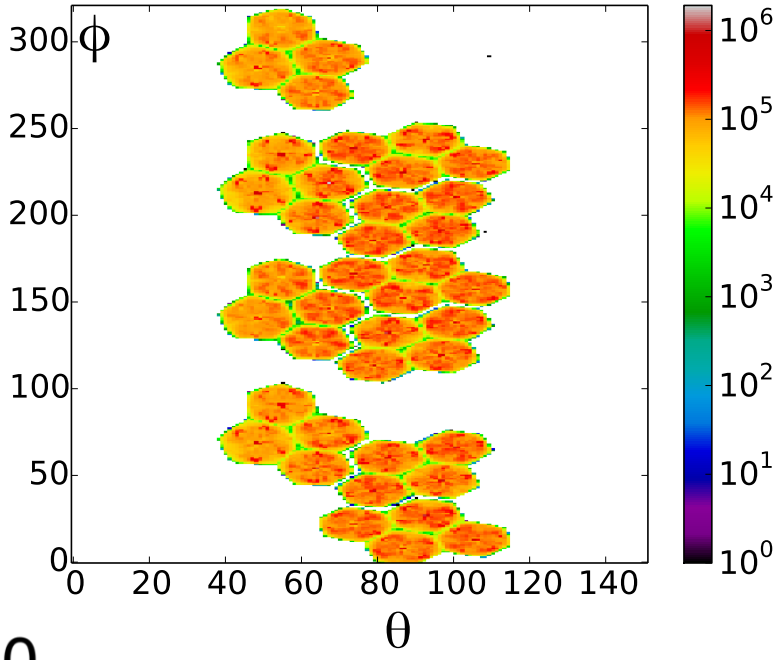
**Correlated background mostly impacts small $\theta_{\gamma\gamma}$ and weak $I(\gamma\gamma)$*

γ-γ Angular Correlation: 2-2-0

Angular correlation similar between tracked and untracked beyond "cluster angle" effect



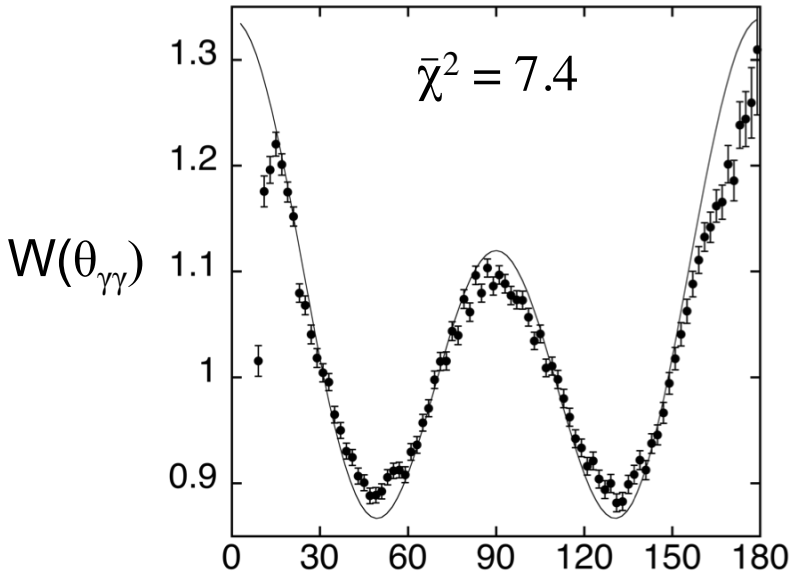


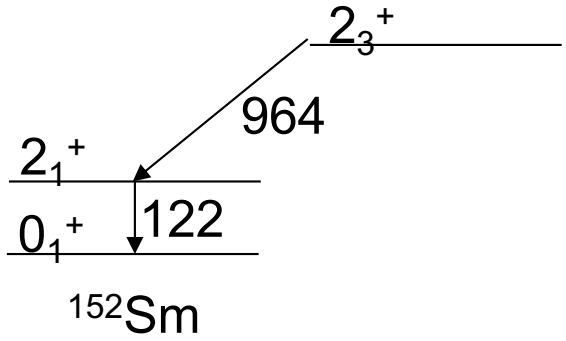


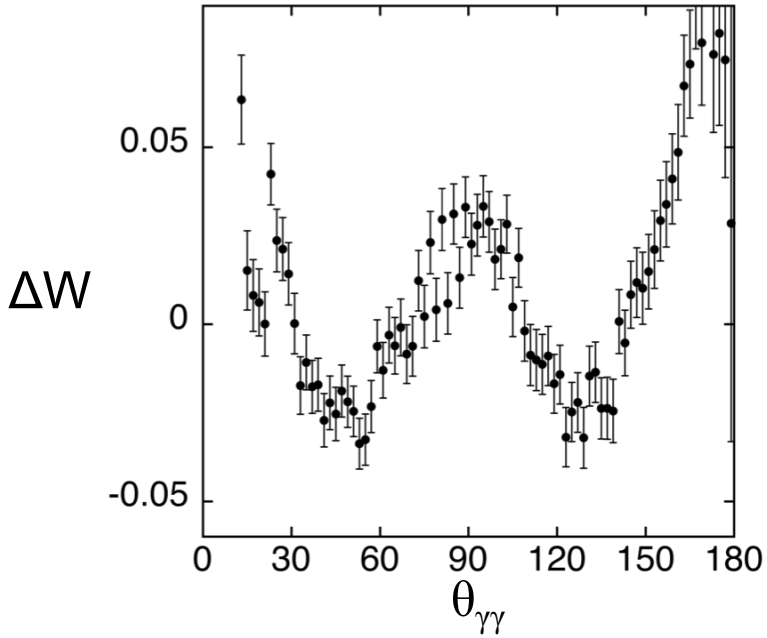
**1st interaction is from largest E for $E_{tot} > 515$ and E-weighted position otherwise*

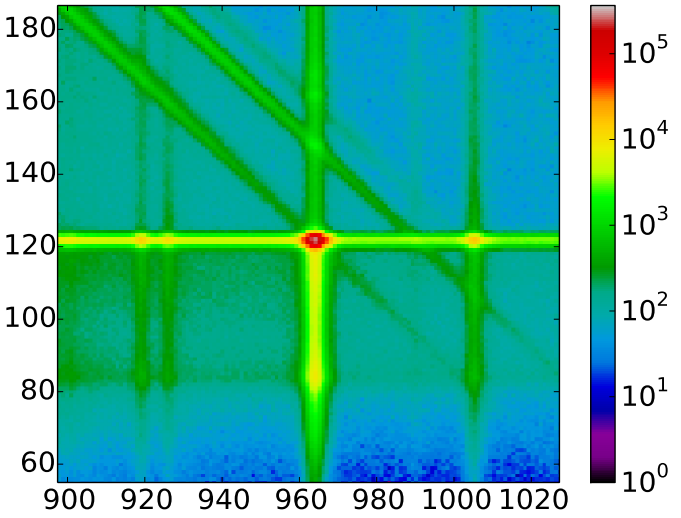
γ-γ Angular Correlation: 2-2-0

Systematic deviation looks like the result of attenuation or an isotropic component

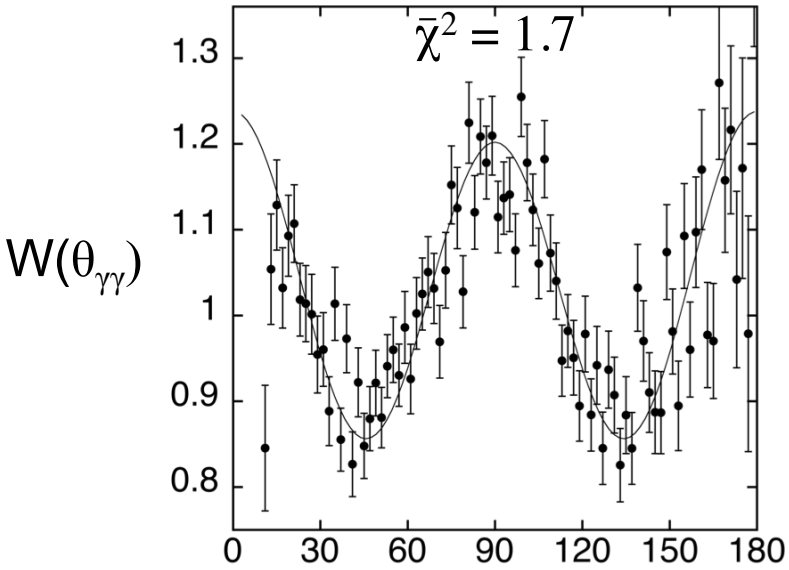


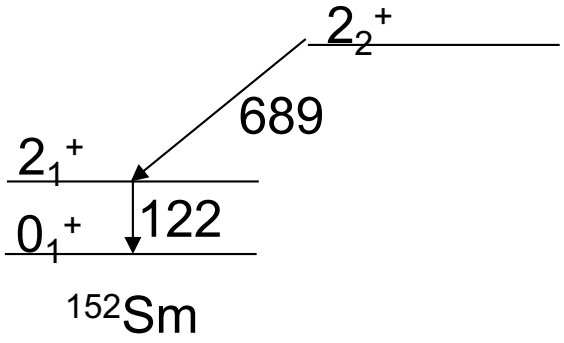


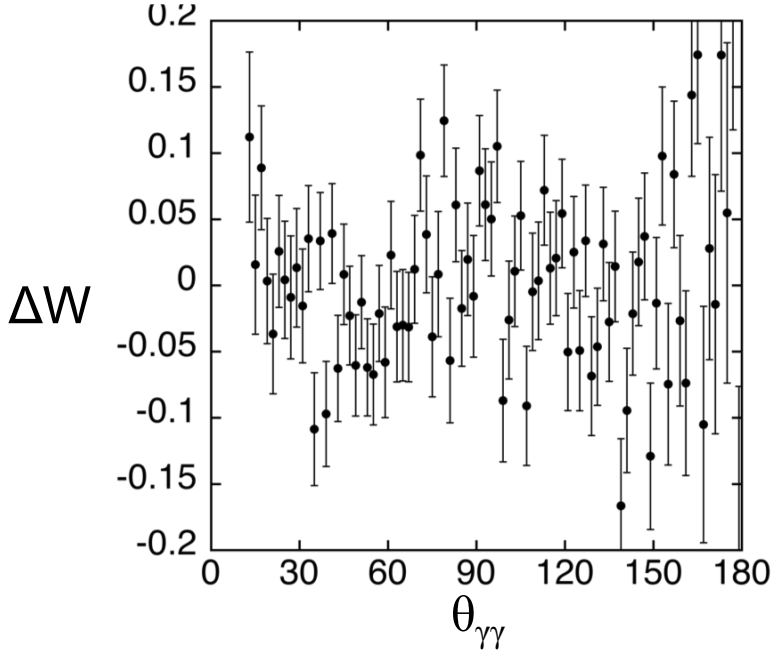


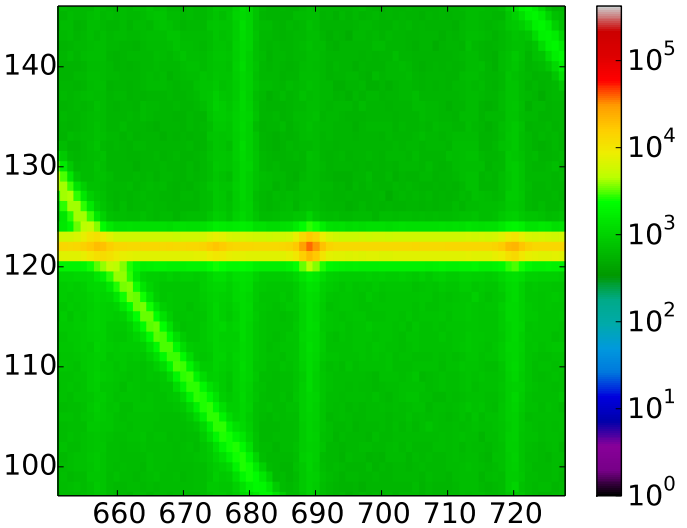


γ-γ Angular Correlation: 2-2-0

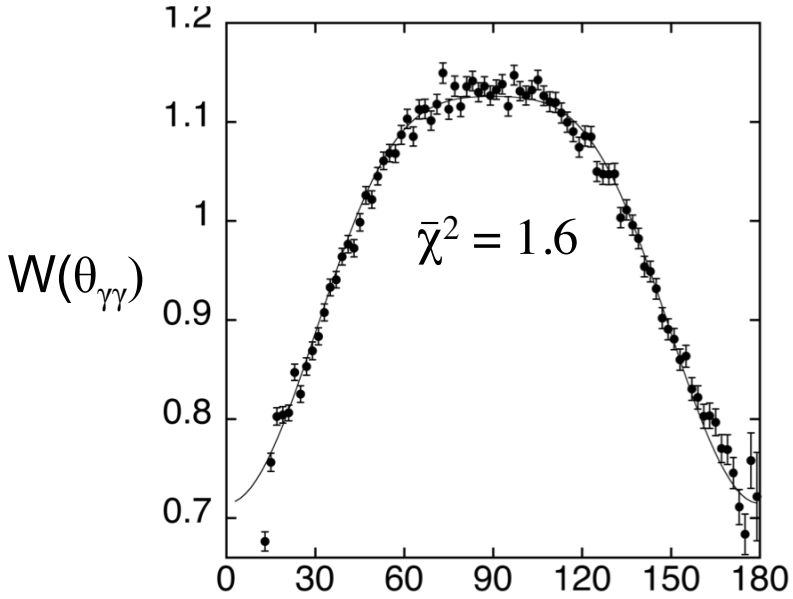


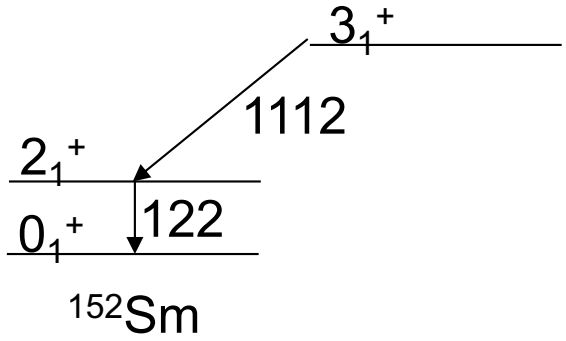


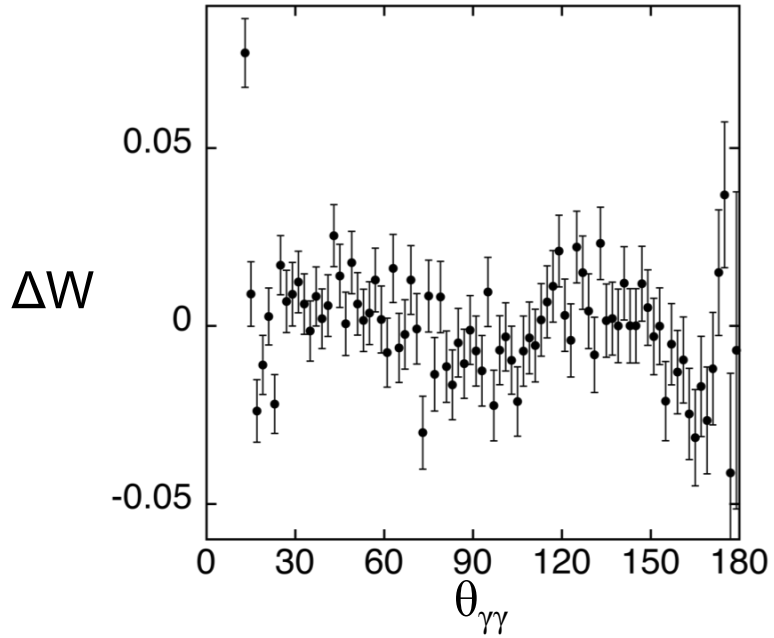


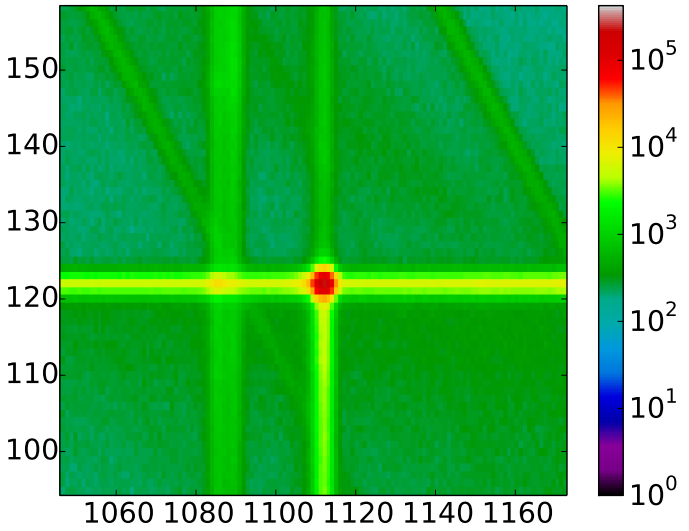


γ-γ Angular Correlation: 3-2-0

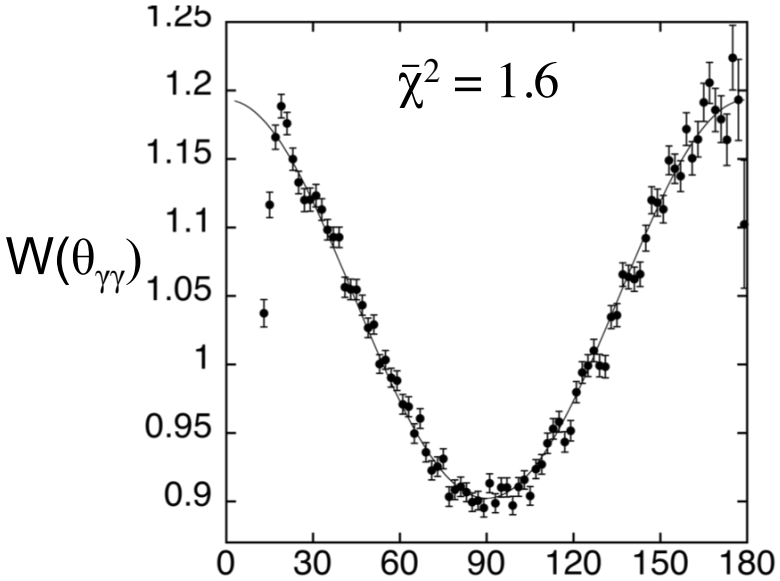


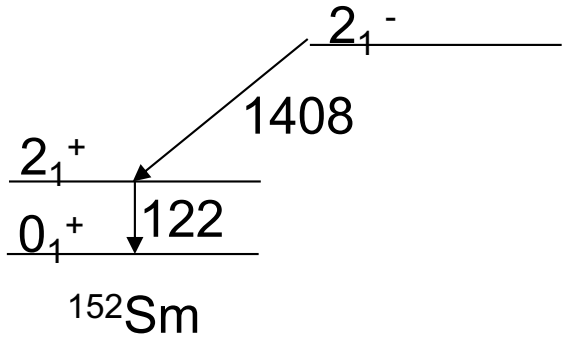


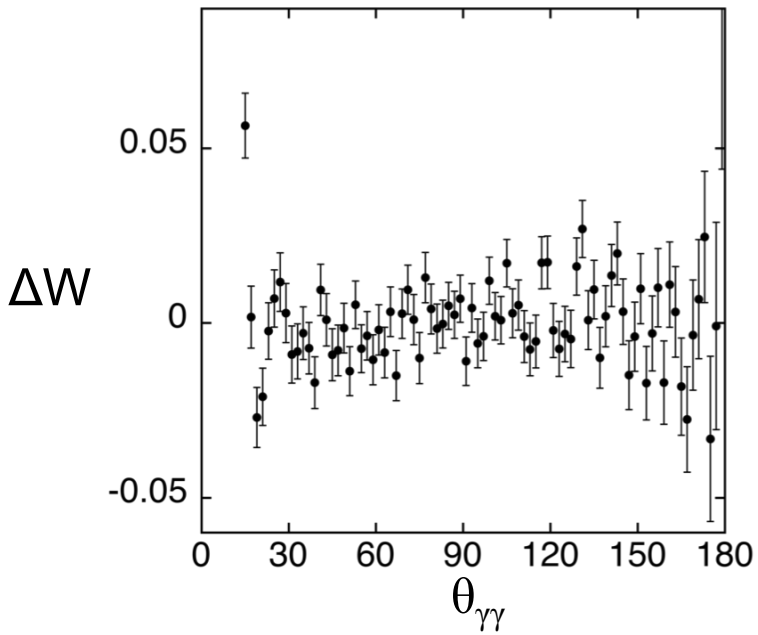


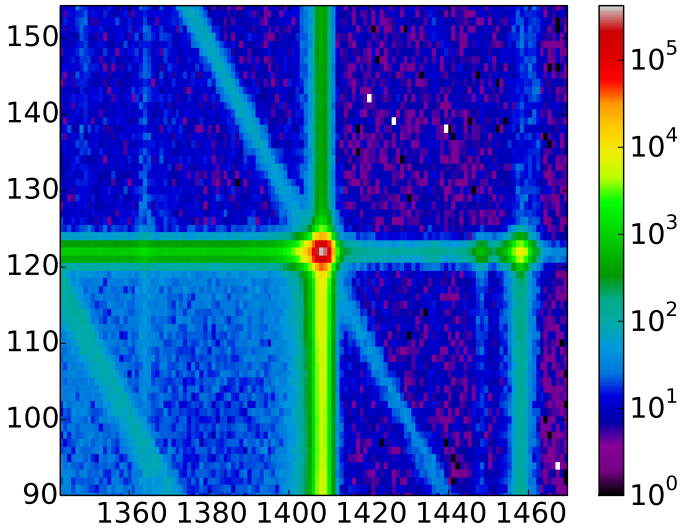


γ-γ Angular Correlation: 2-2-0

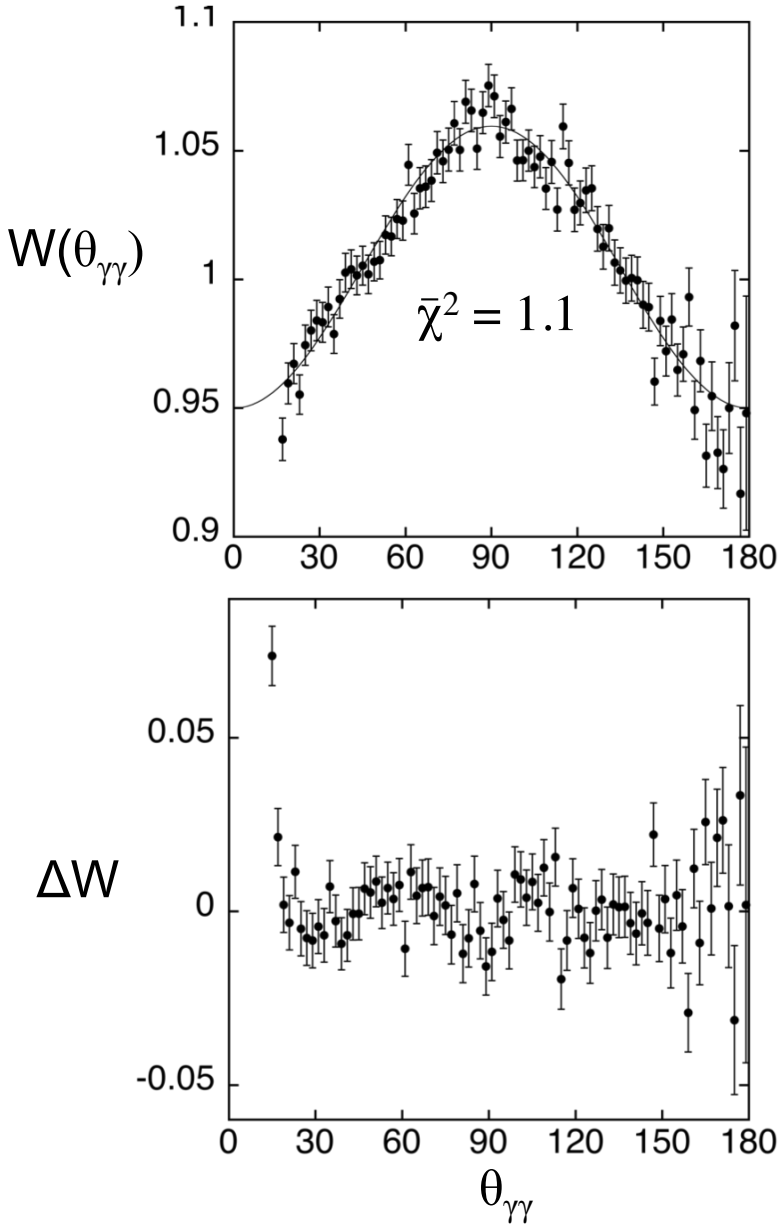


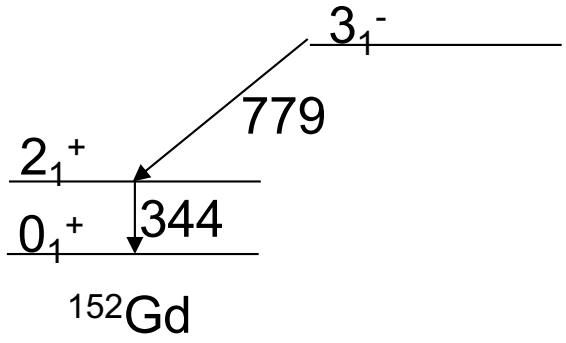


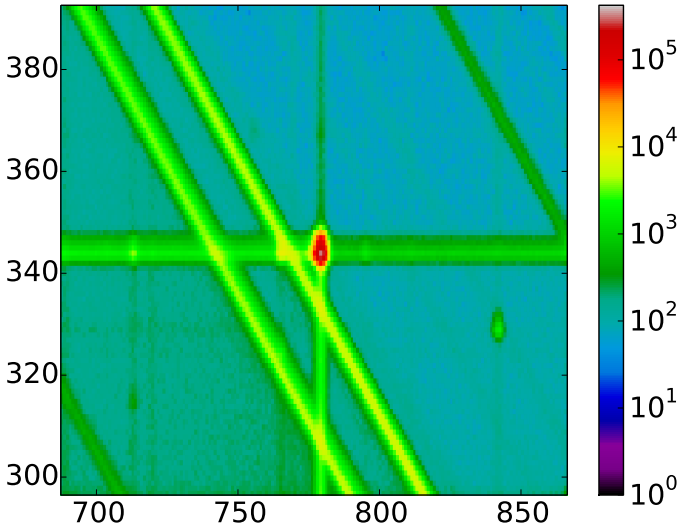




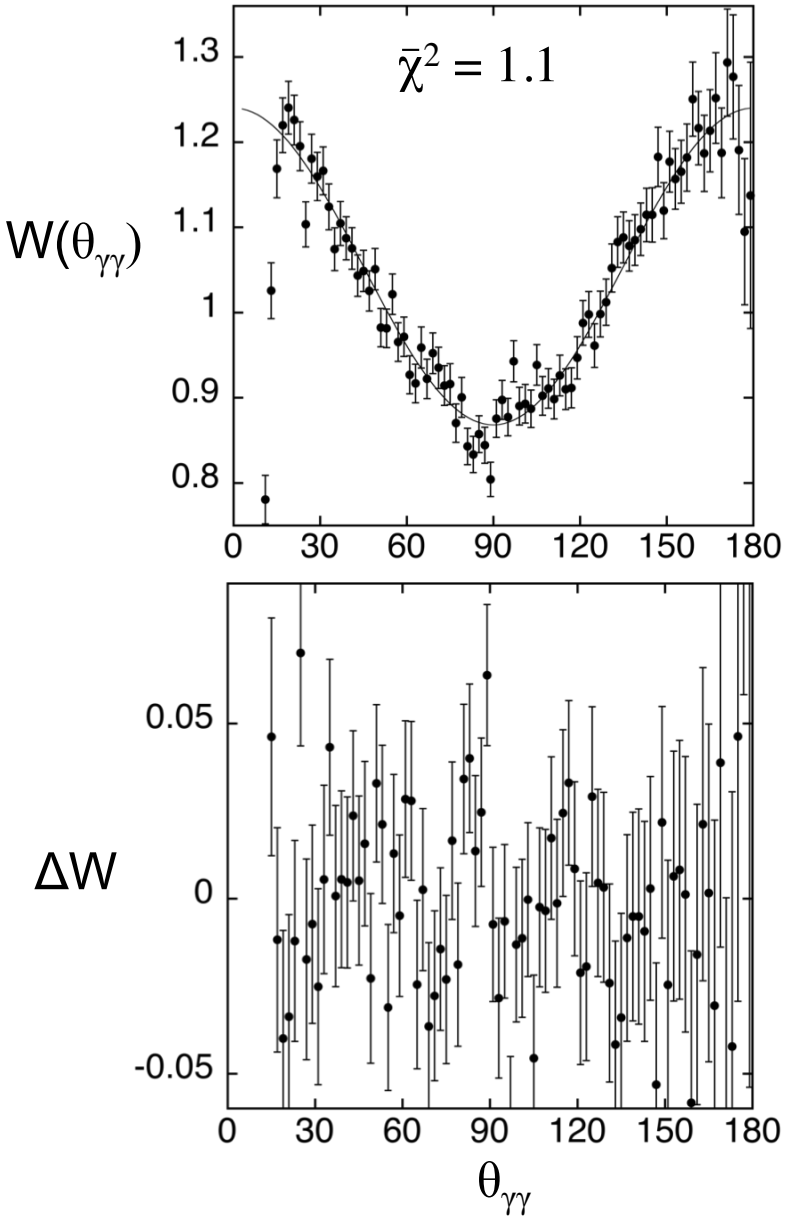
γ-γ Angular Correlation: 3-2-0

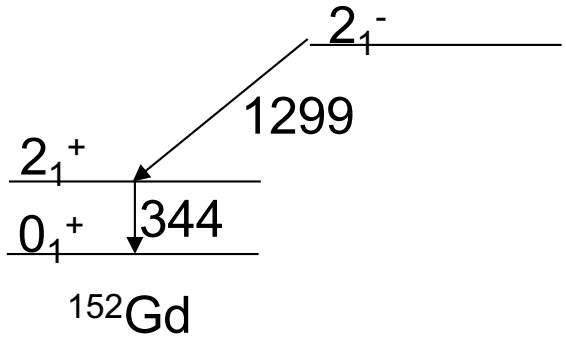


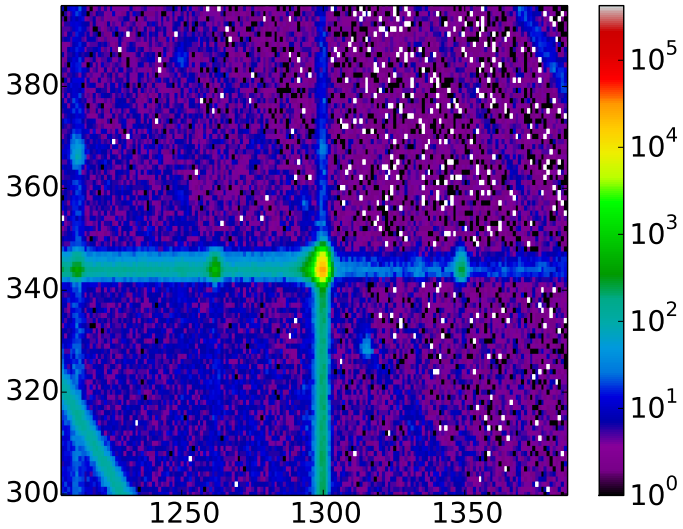




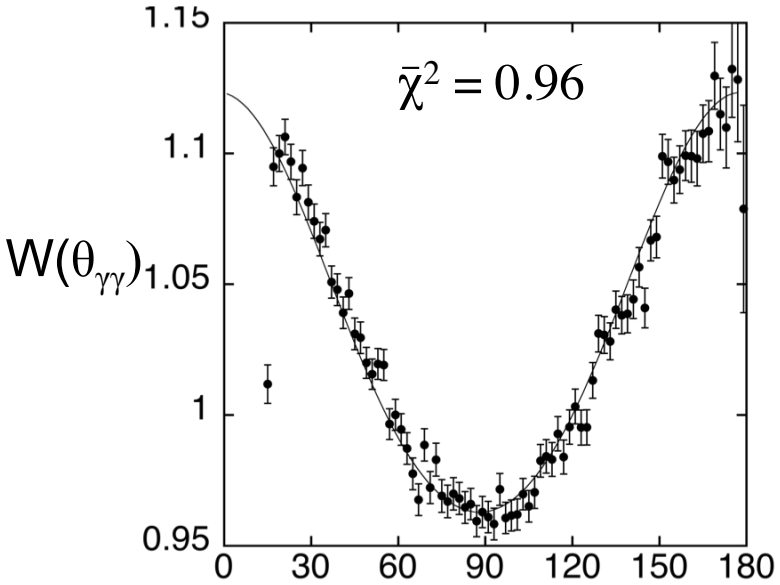
γ-γ Angular Correlation: 2-2-0

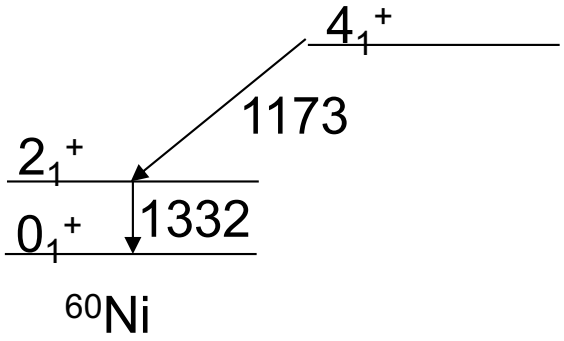


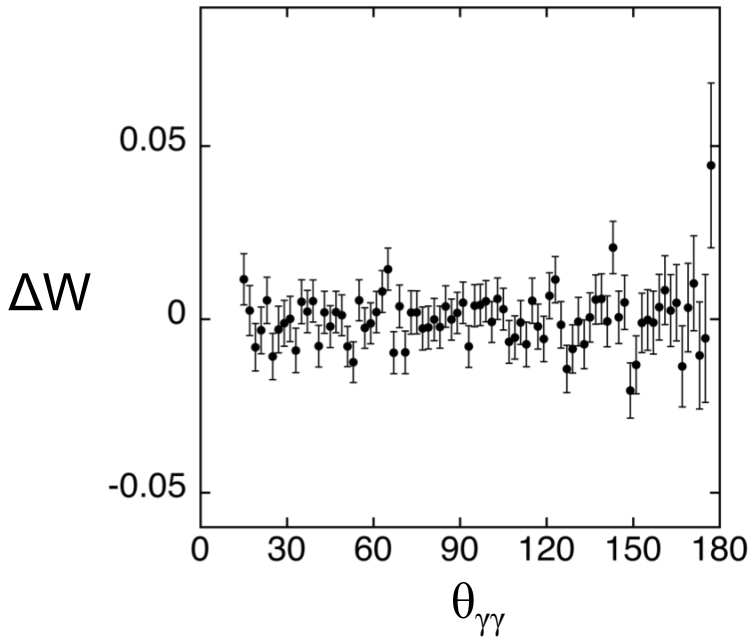


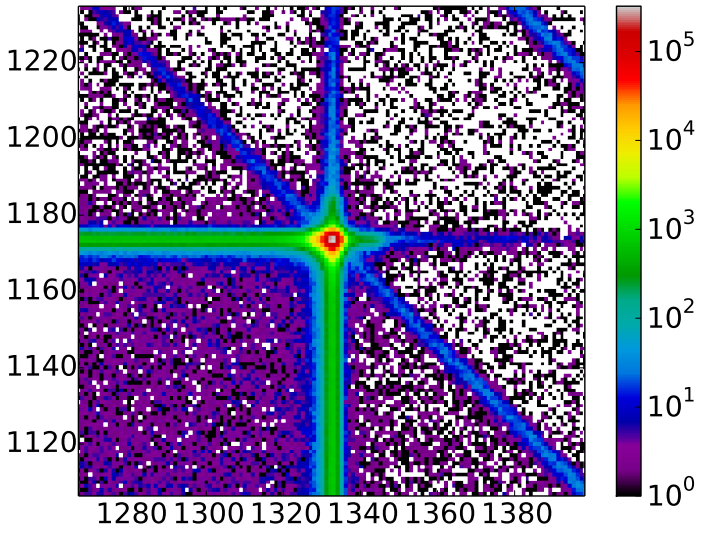


γ-γ Angular Correlation: 4-2-0



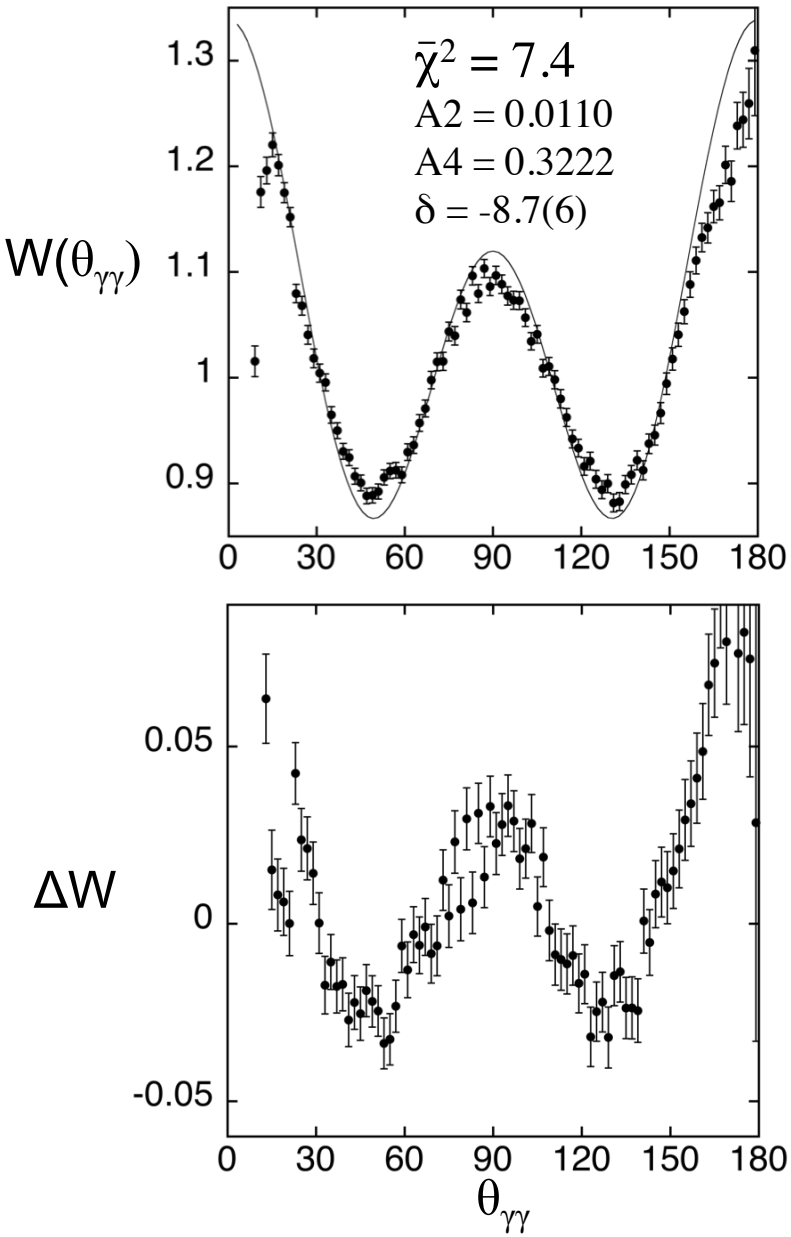




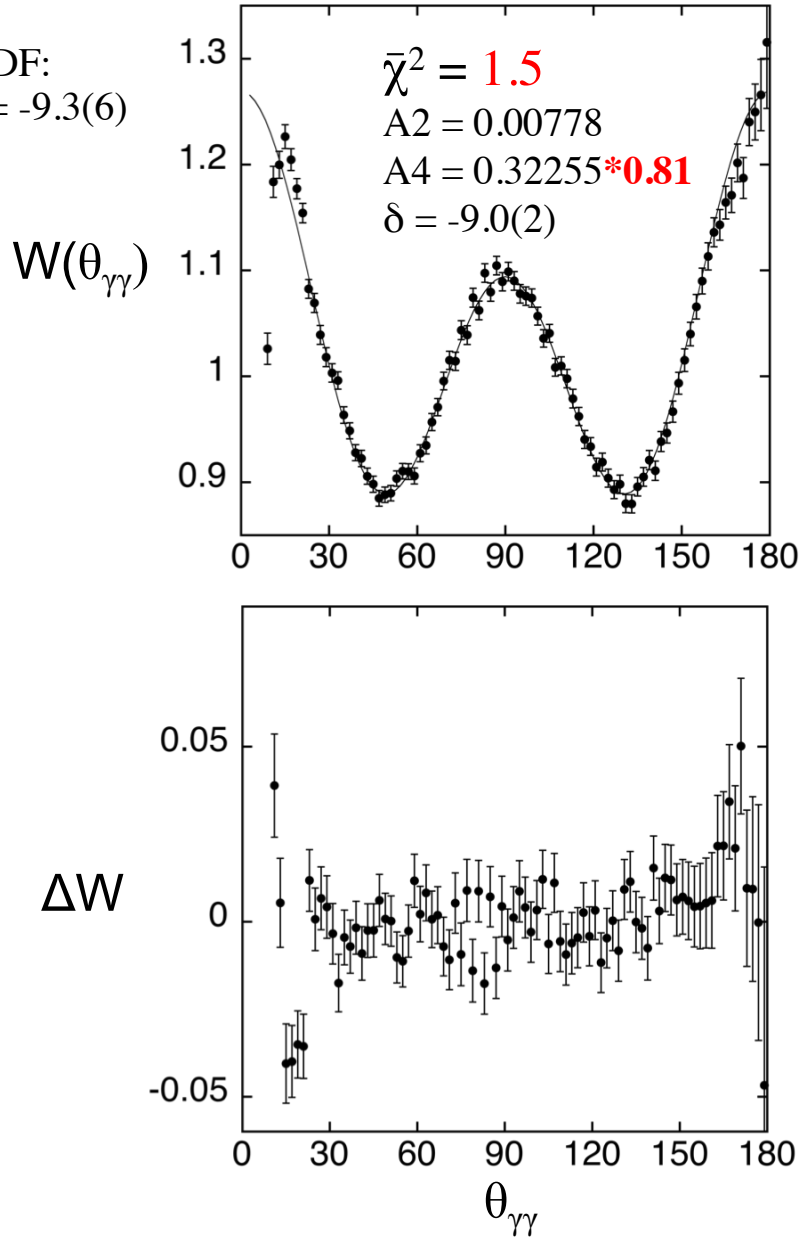


γ-γ Angular Correlation: 2-2-0

Attenuation impacts A4 term the most; 0.81*A4 can account for systematic deviation

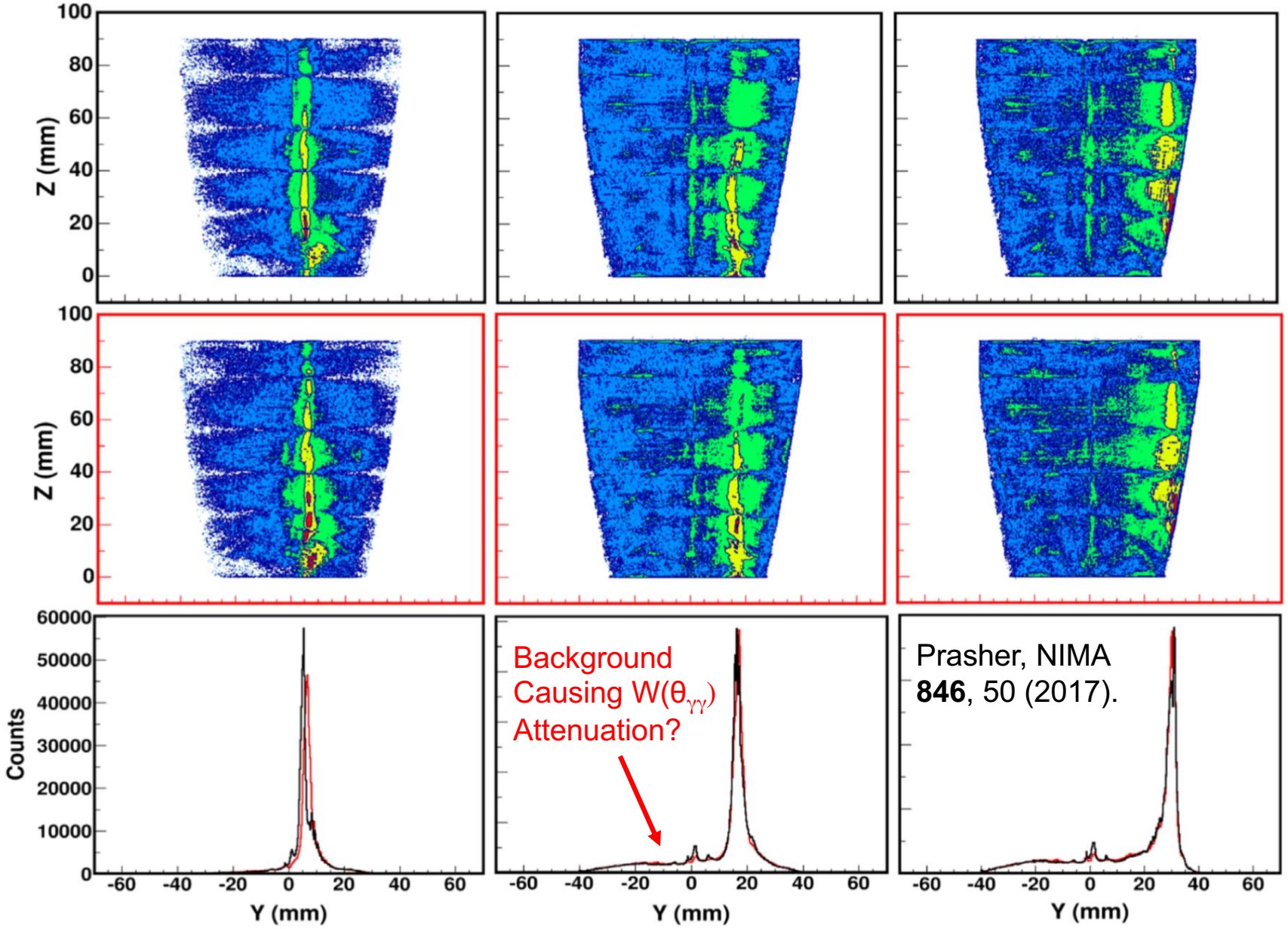


ENSDF:
$\delta(2_2\text{-}2_1) = -9.3(6)$



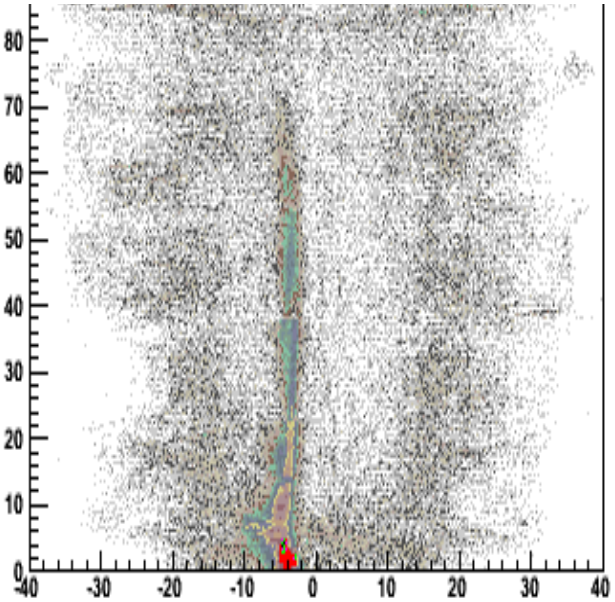
Pencil Beam: Position Distribution

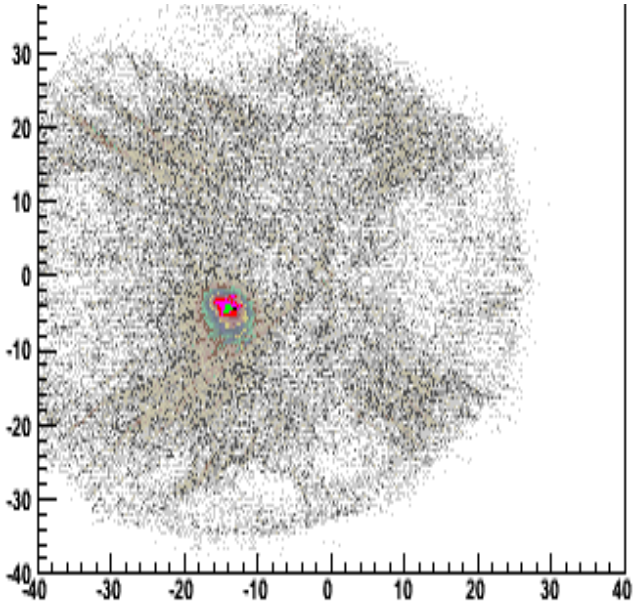
Position distribution doesn't look Gaussian. More Lorentzian?

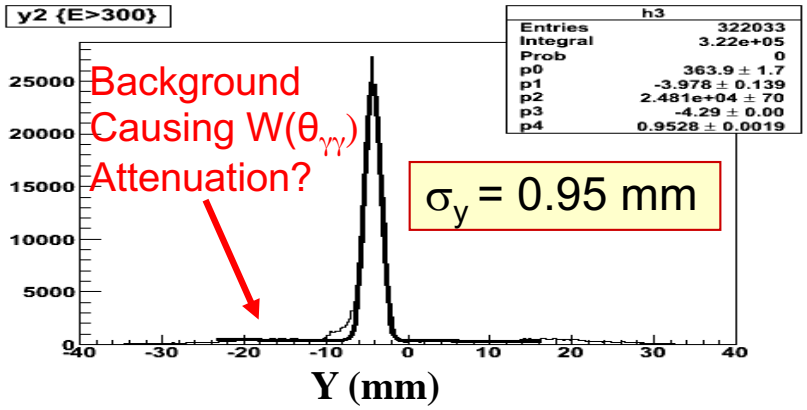


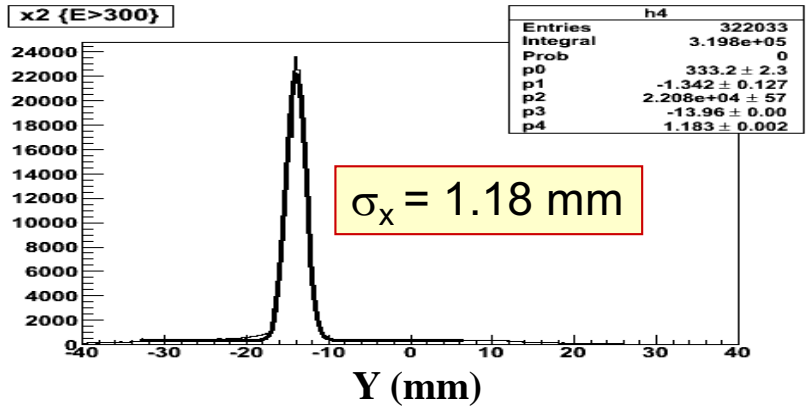
Pencil Beam: Position Distribution

Position distribution looks mostly Gaussian but with a ~uniform background





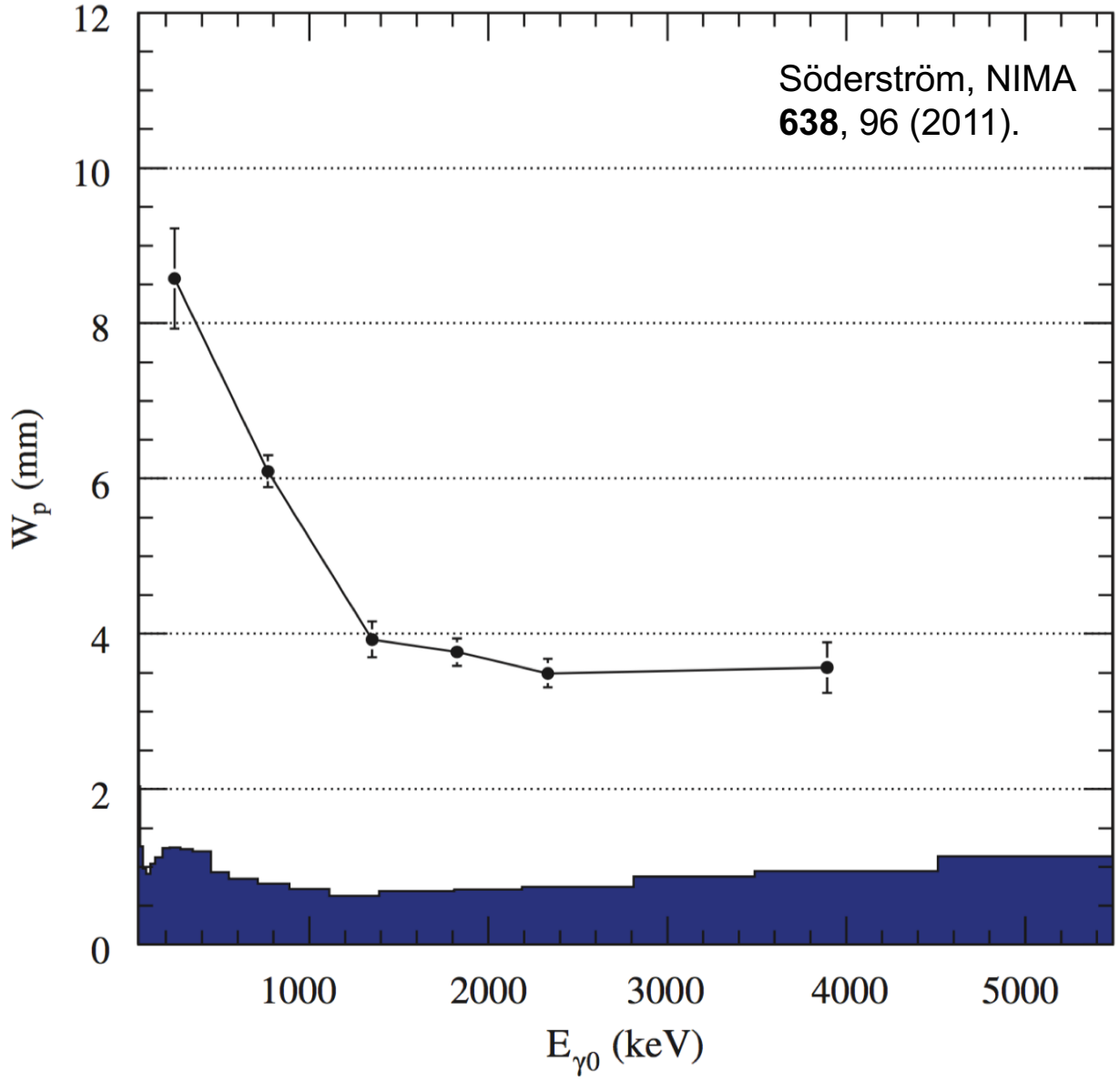




Slide from Radford

AGATA Position Resolution

Position resolution is worse at low energy; what about distribution shape?



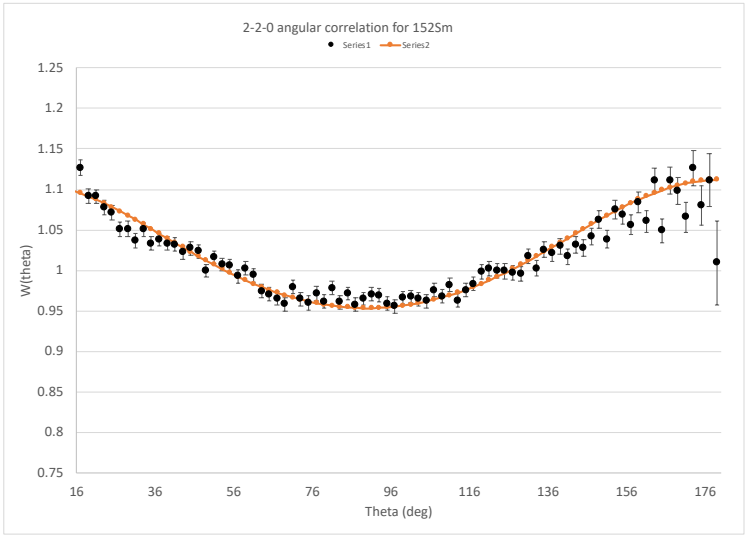
OAK RIDGE National Laboratory

Next Steps

- Investigate a γ-γ angular correlation that involves large energies and a large A4 term
- Investigate position distribution with low-e γ pencil beam data
- Compare GEANT4 γ-γ simulations with data using segment and xtl centers
  - ❖ Need to develop γ-γ simulation capability (i.e., missing from UCGRETINA)
- Investigate angle resolution and distribution with coincident 511 source

Thanks to Dirk for taking the high-statistics Eu and Co data sets and Torben, Shaofei, Heather, David, Jenna, Amel, and others for useful discussions

γ-γ Angular Correlation: 4-2-0



^{152}Sm

$\chi^2 = 1.96 \rightarrow 1.4$

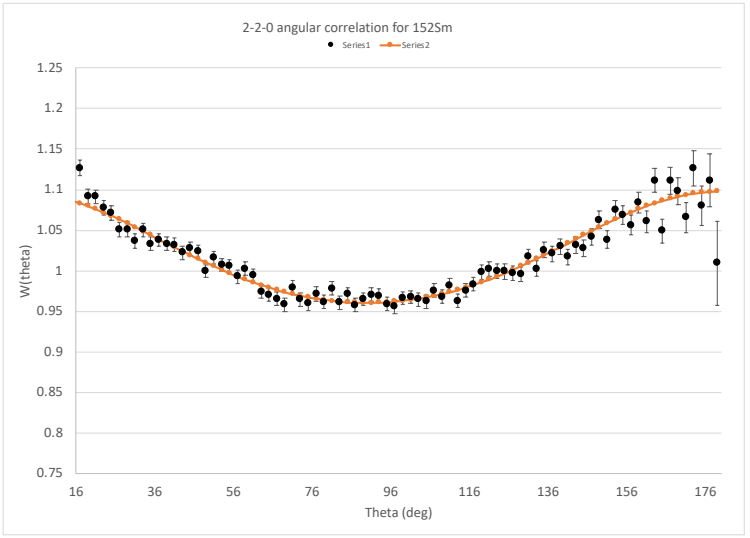
A2 = 0.10204*0.86

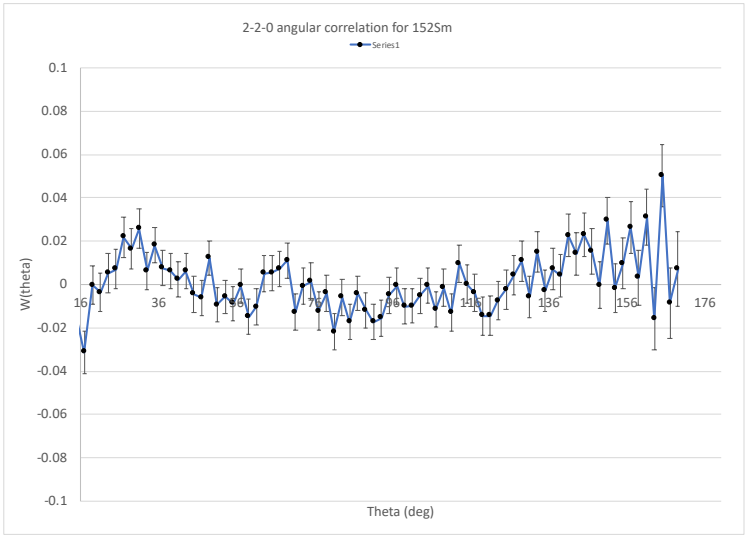
A4 = 0.00907

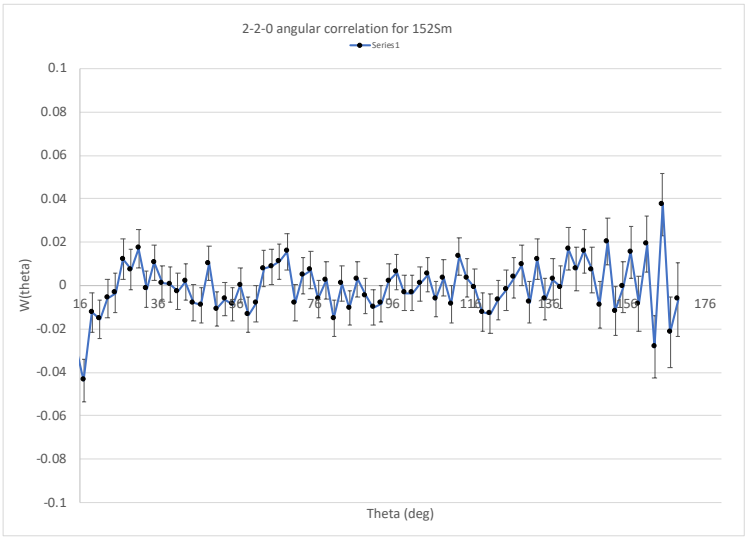
$Q \sim Q_2(122)*Q_2(244)$

$Q_2 \sim 0.93$

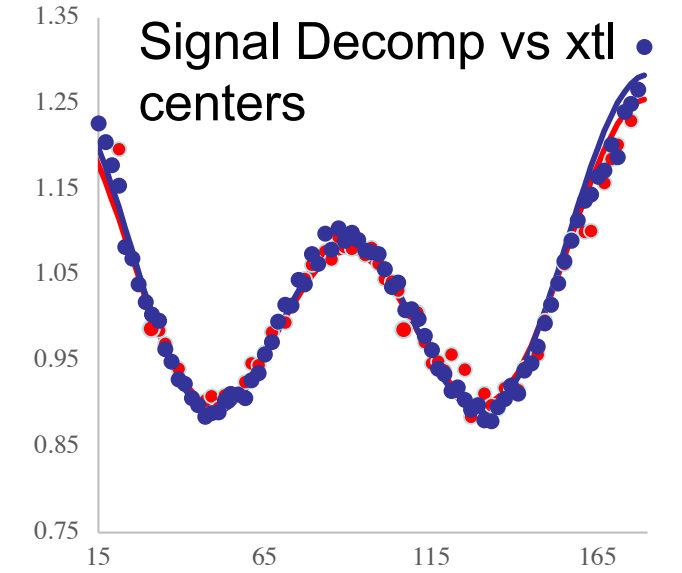
Cf., $Q_4(122) \sim 0.81$

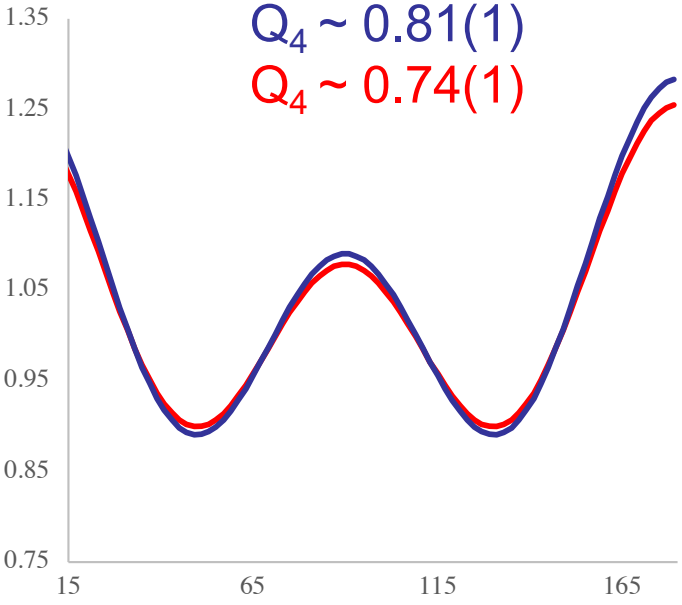






γ-γ Angular Correlation: 2-2-0





^{152}Sm

Attenuation seems large as compared to xtl centers.

Perhaps low-E position resolution/distribution is not much better than segment?