Coherent Bremsstrahlung

Ken Livingston
GlueX Collaboration Meeting, Jlab May 2015

Coherent Bremsstrahlung

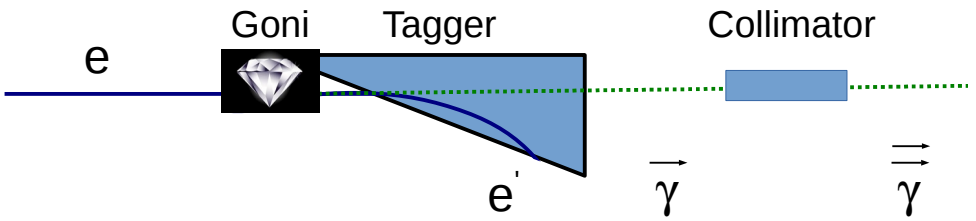
Hardware, Software

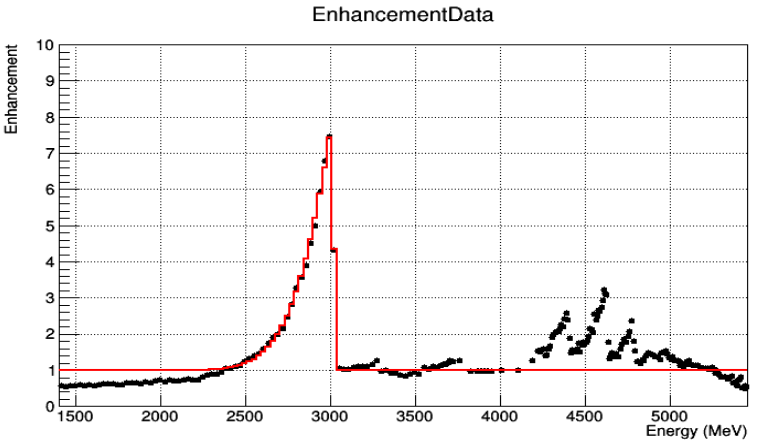
Alignment

Coherent Peak

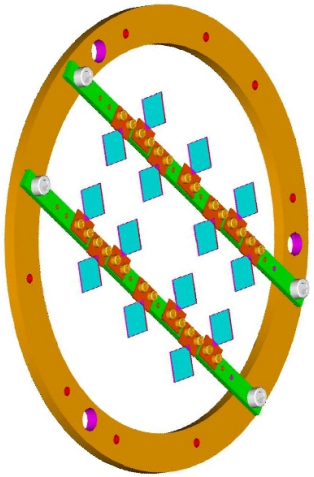
Reliability

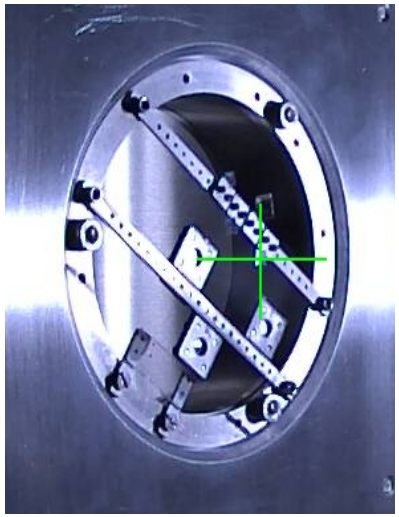
Towards 12GeV

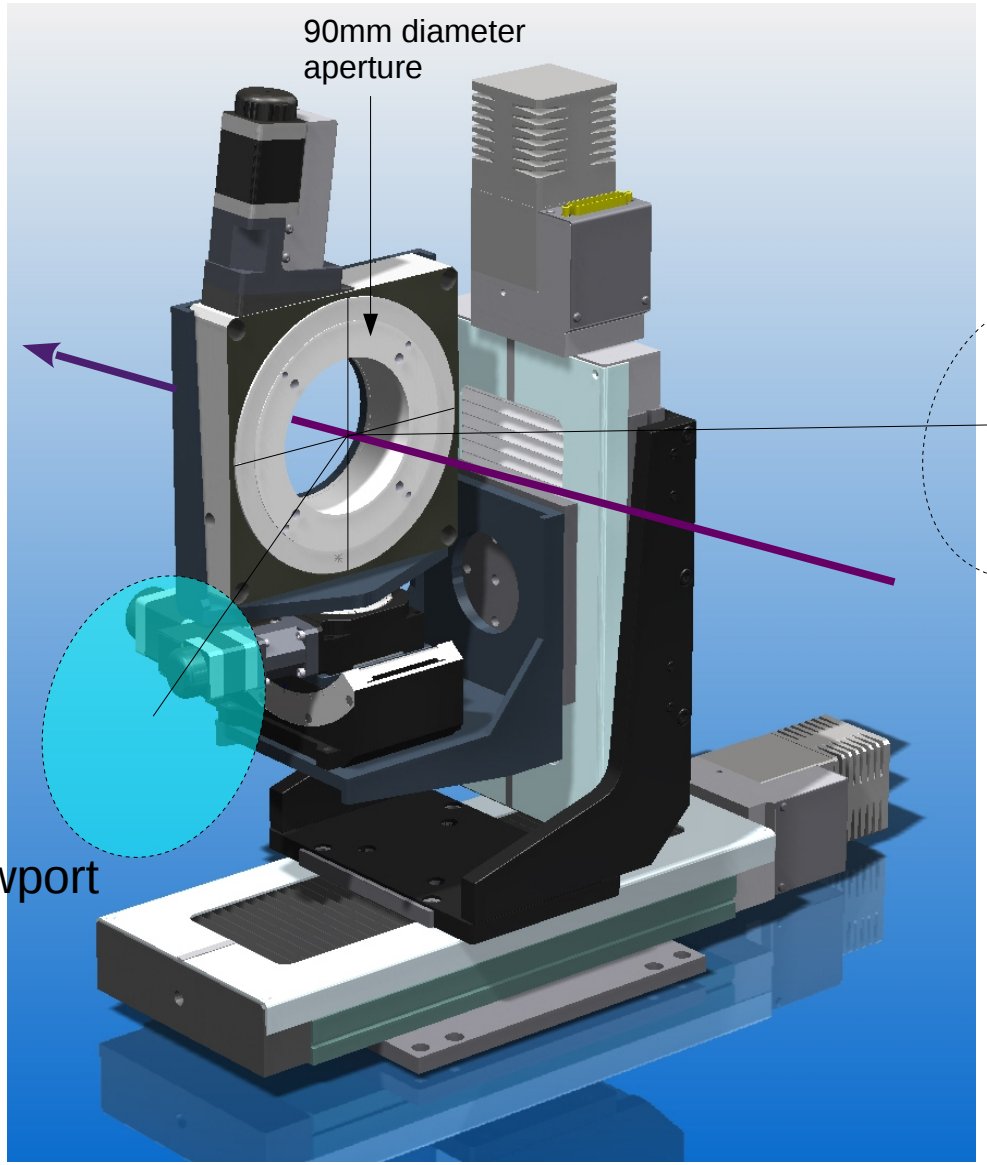




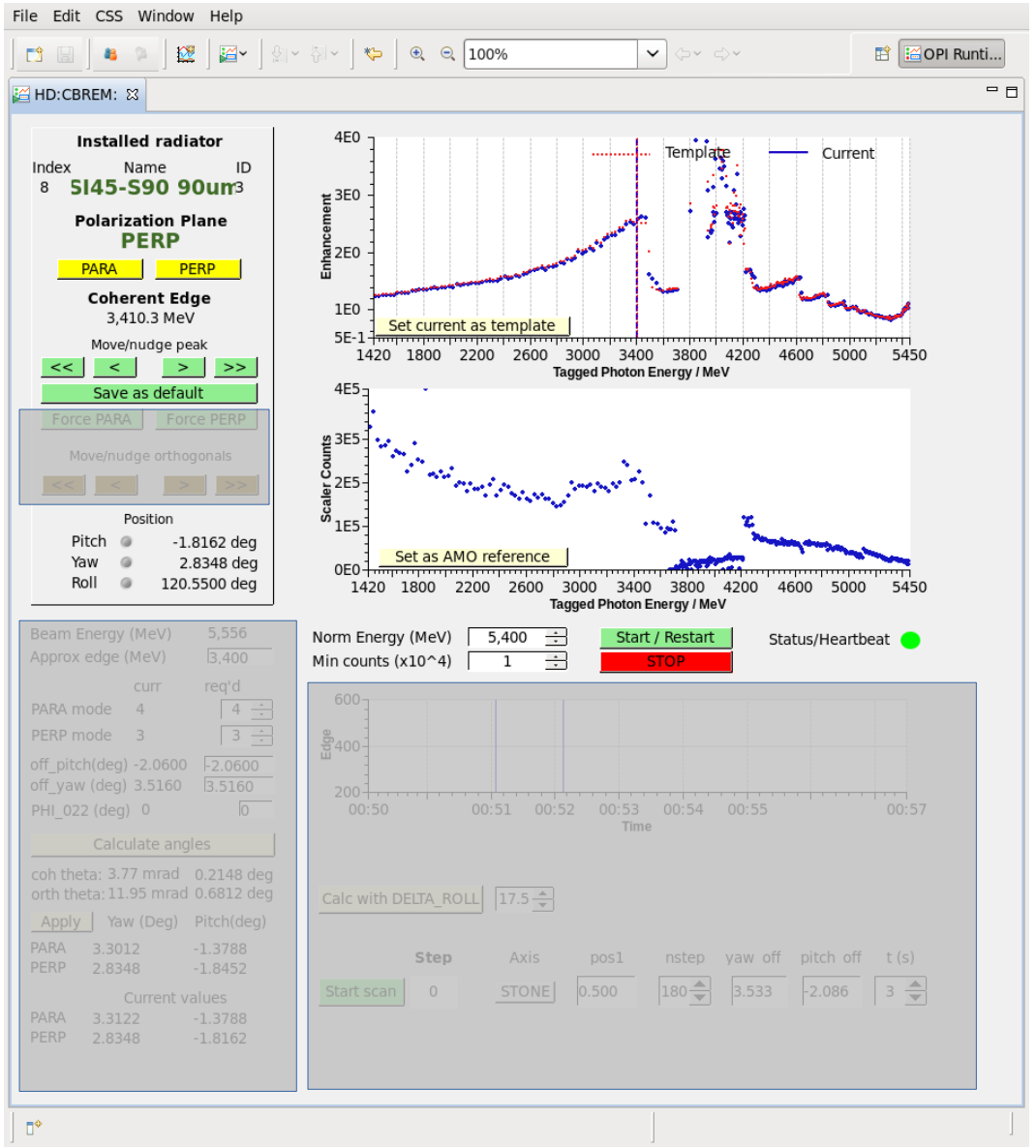
Hardware





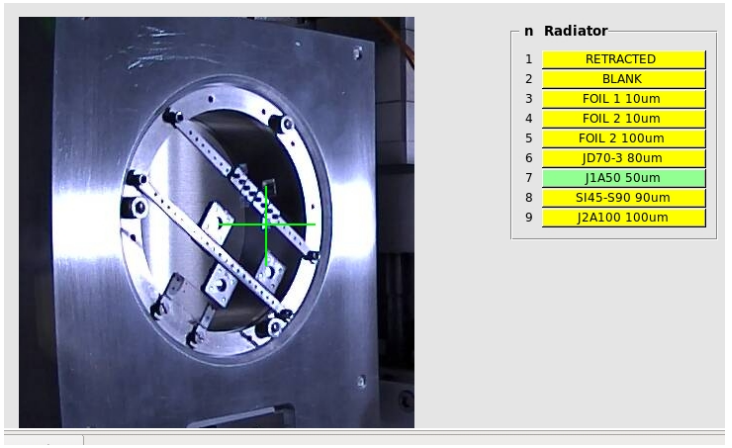


Software



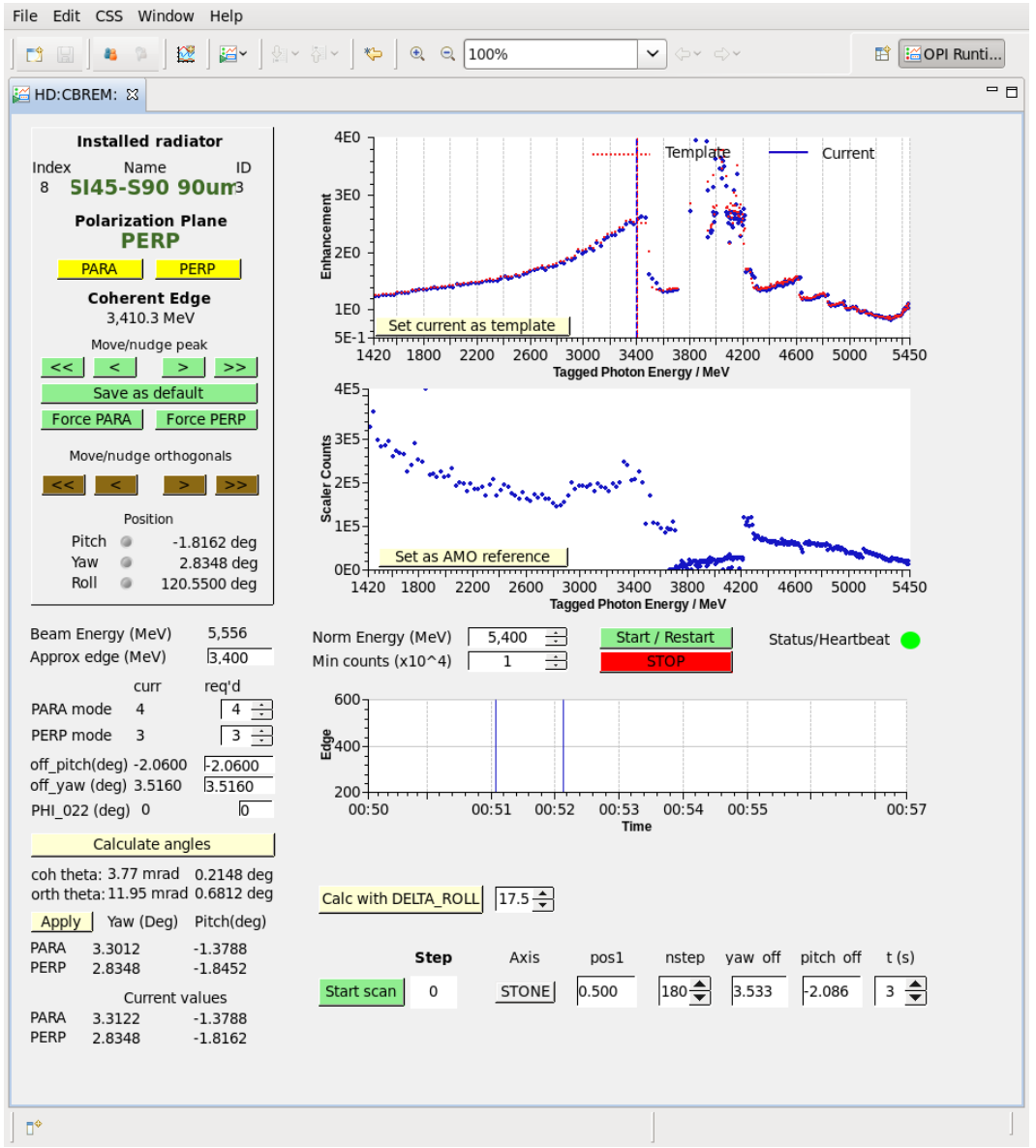
EPICS
Shell scripts
ROOT macros

User GUIs



CSS GUI
Live goniometer camera image
Moveable cross to mark beam spot (with parallax)

Software



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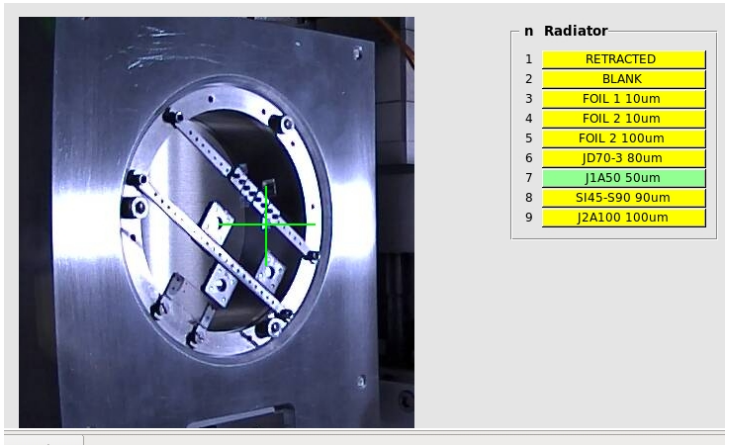
Expert GUI



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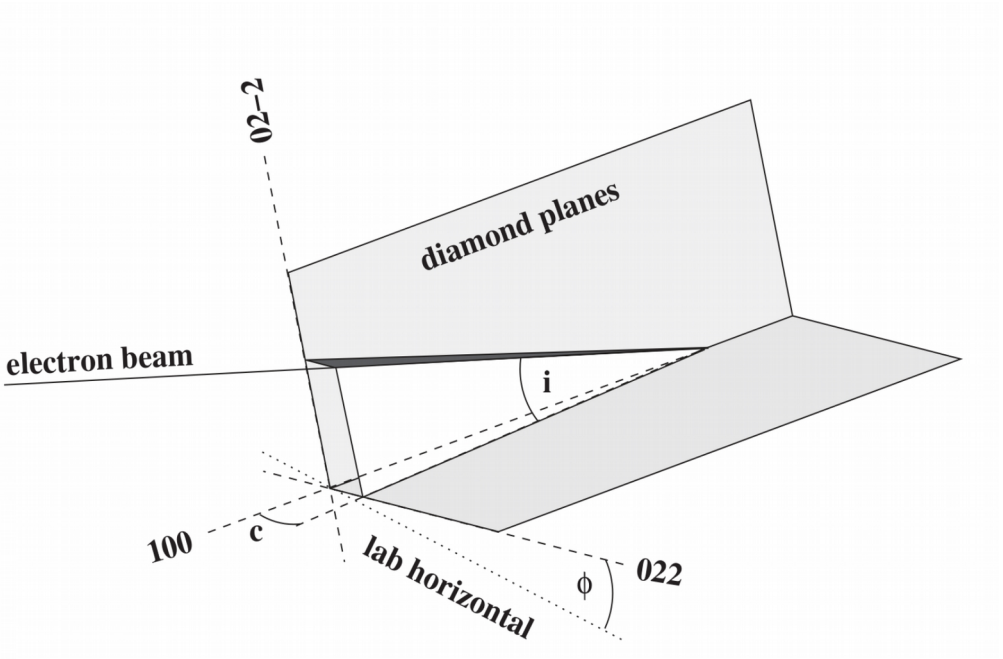
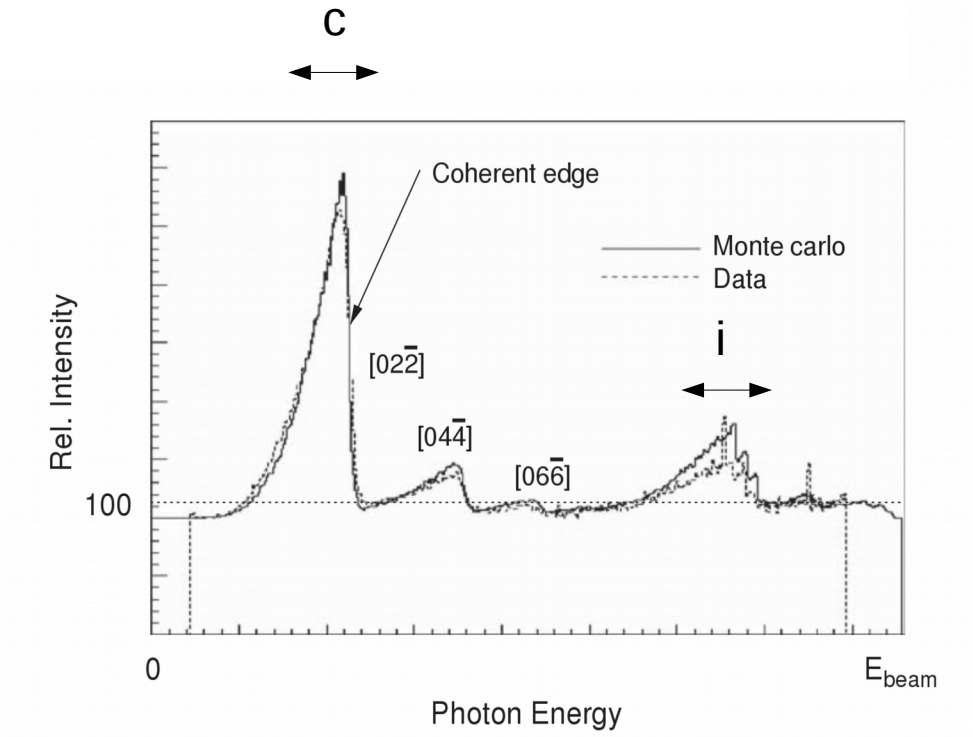
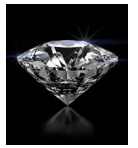

02–2
diamond planes
electron beam
i
100
c
lab horizontal
ϕ
022


c
Coherent edge
Monte carlo
Data
i
[022̄]
[044̄]
[066̄]
Rel. Intensity
100
0
E_beam
Photon Energy

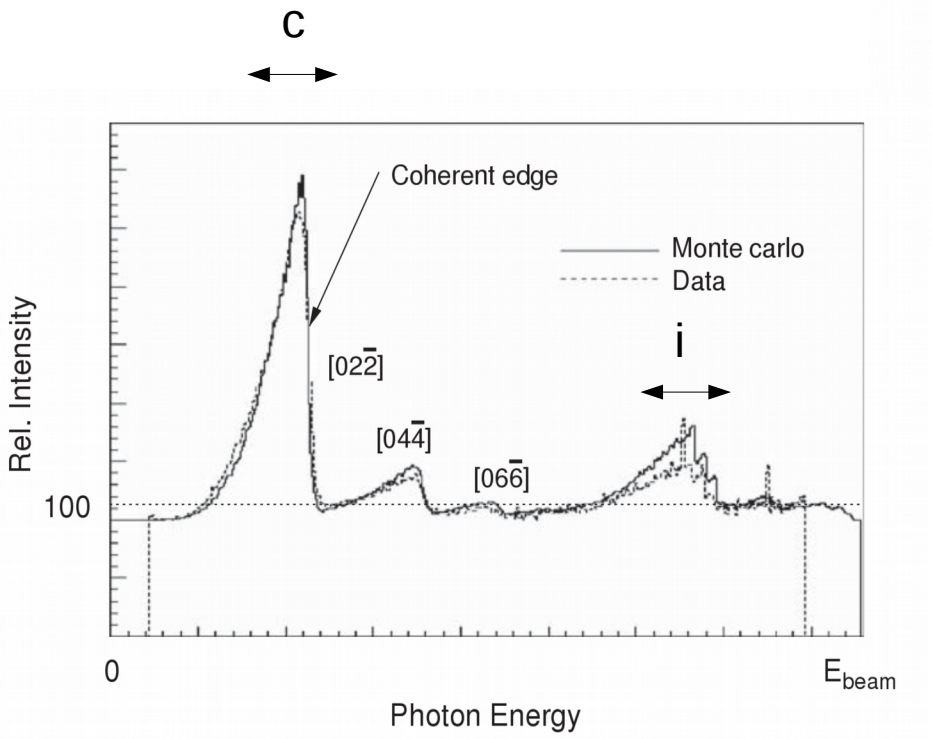
Alignment

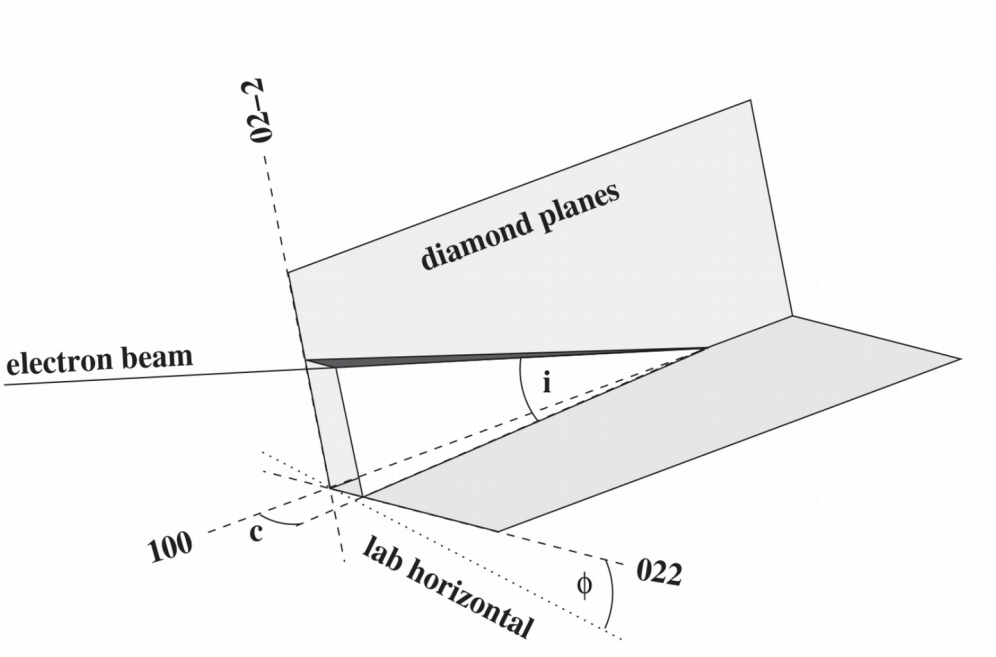


Bookmakers Odds:

Phi: 1/45, I: 1/60 c: 1/60

Chance of good pos: 1/162000
(Chance of knowing its good: 0)

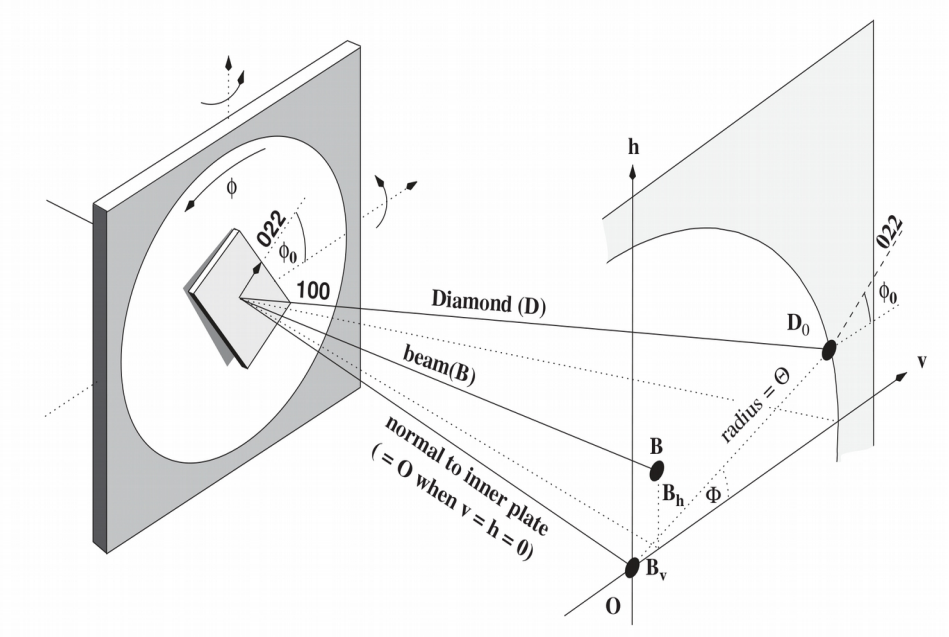


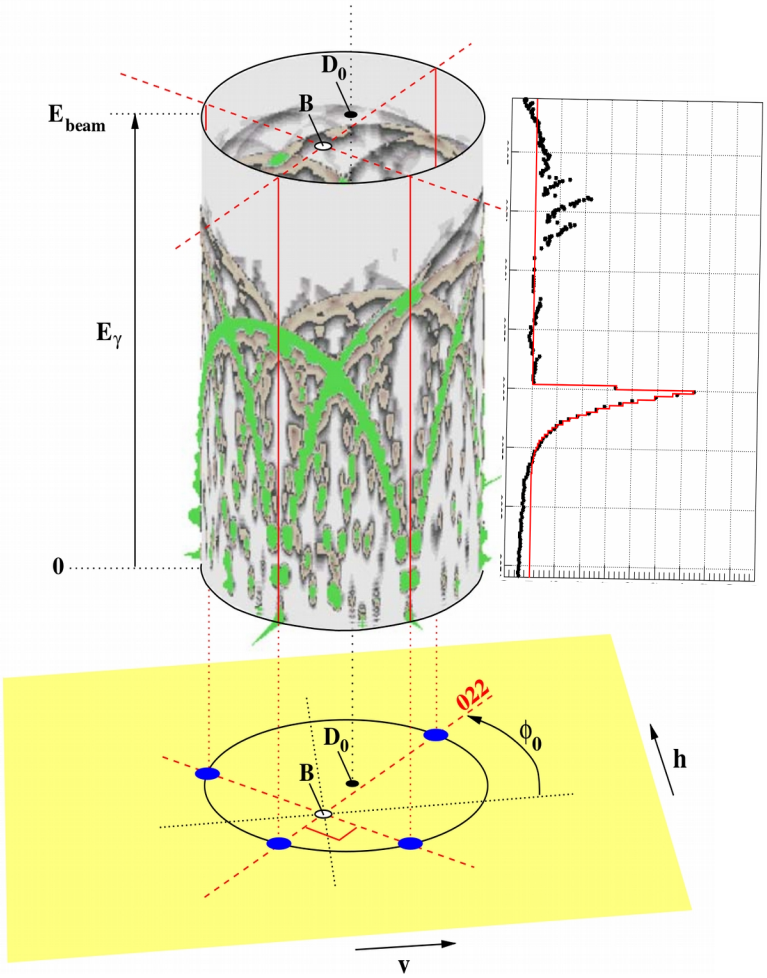


Need a method of finding the orientation fo the crystal relative to the beam.

An exercise in 3D trig and coherent brem.

Alignment





Stonehenge Technique

Scan

Move diamond round in a cone: R cos v, R sin h

Hope the cone includes the beam.

For each step make an enhancement

Plot them all somehow.

Figure out phi 022, and offsets v_off, h_off

Set phi 022 as required – **orientation of the pol plane**

Repeat scan until v_off and h_off are precise enough

Now can put the coherent peak approximately where reqd.

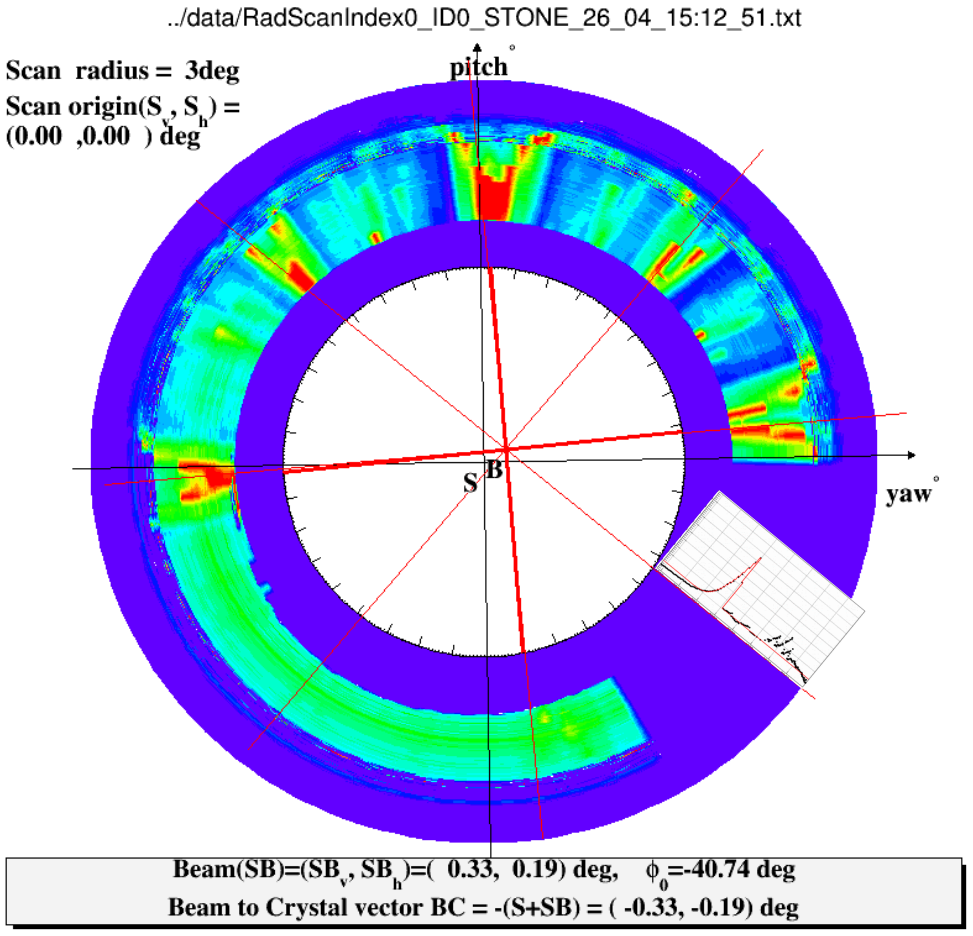
Tweak until it's exact.

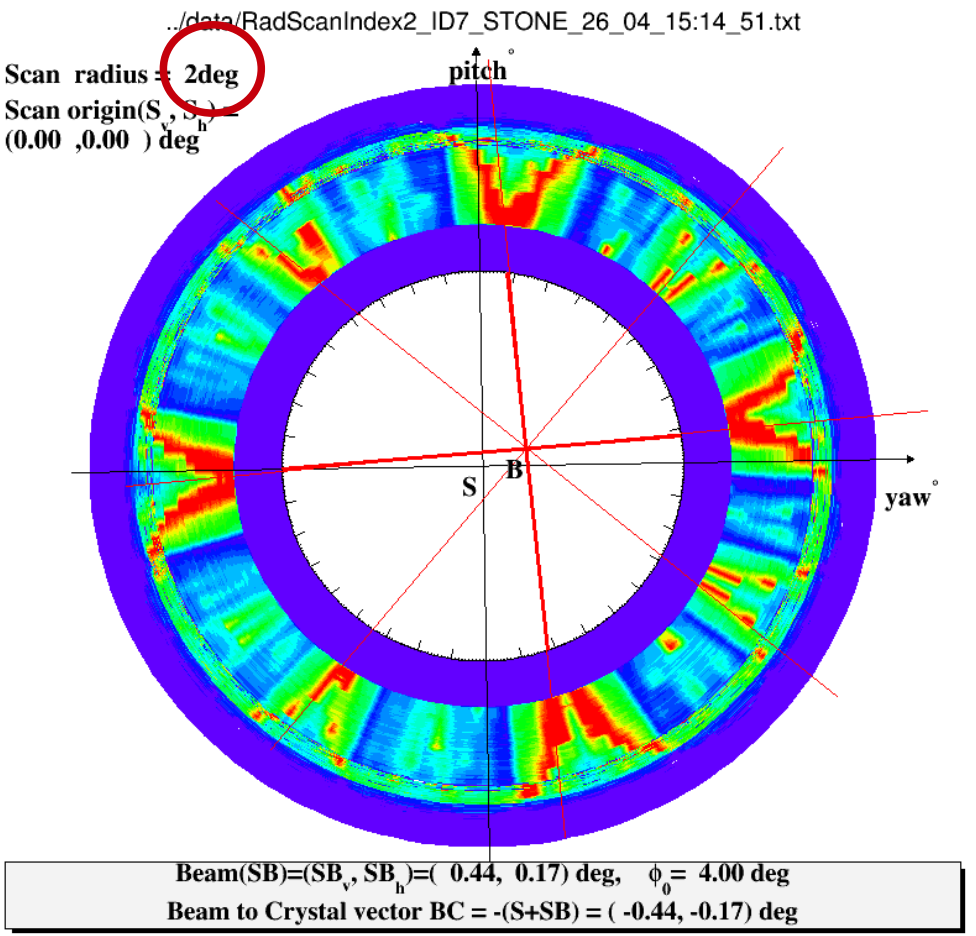
K. Livingston. The Stonehenge technique. A method for aligning coherent bremsstrahlung radiators. NIM A 603 (2009) 205–213

[Also see D. Luckey, R.F. Schwitters, NIM 81 (1970) 164]

Alignment

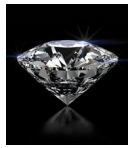
Try the best diamond: J1A 50um



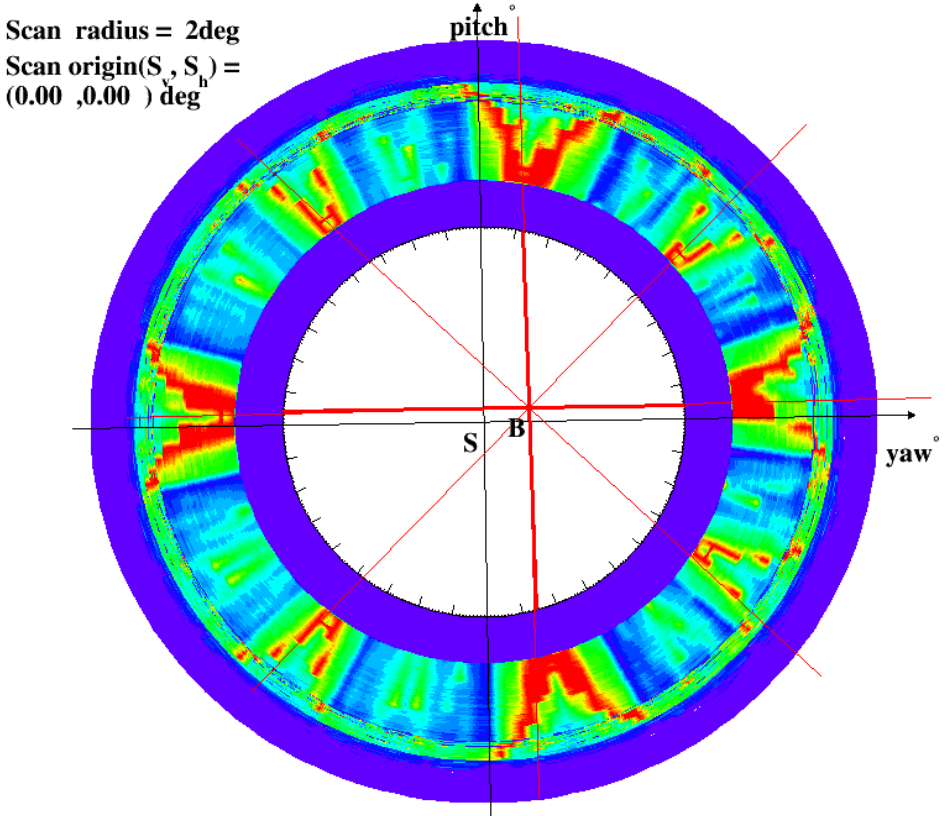


Good enough to predict offsets, but beam moved off Diamond at -ve pitch. Find a better spot.

Alignment

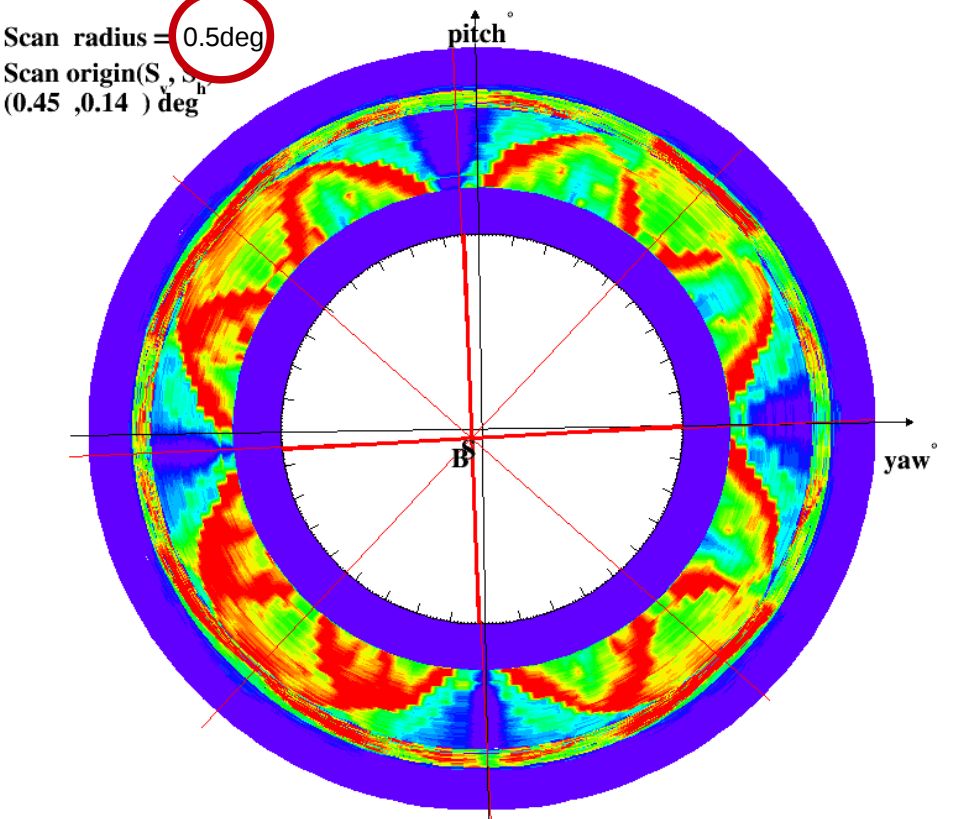


../data/RadScanIndex2_ID7_STONE_26_04_15:15_26.txt



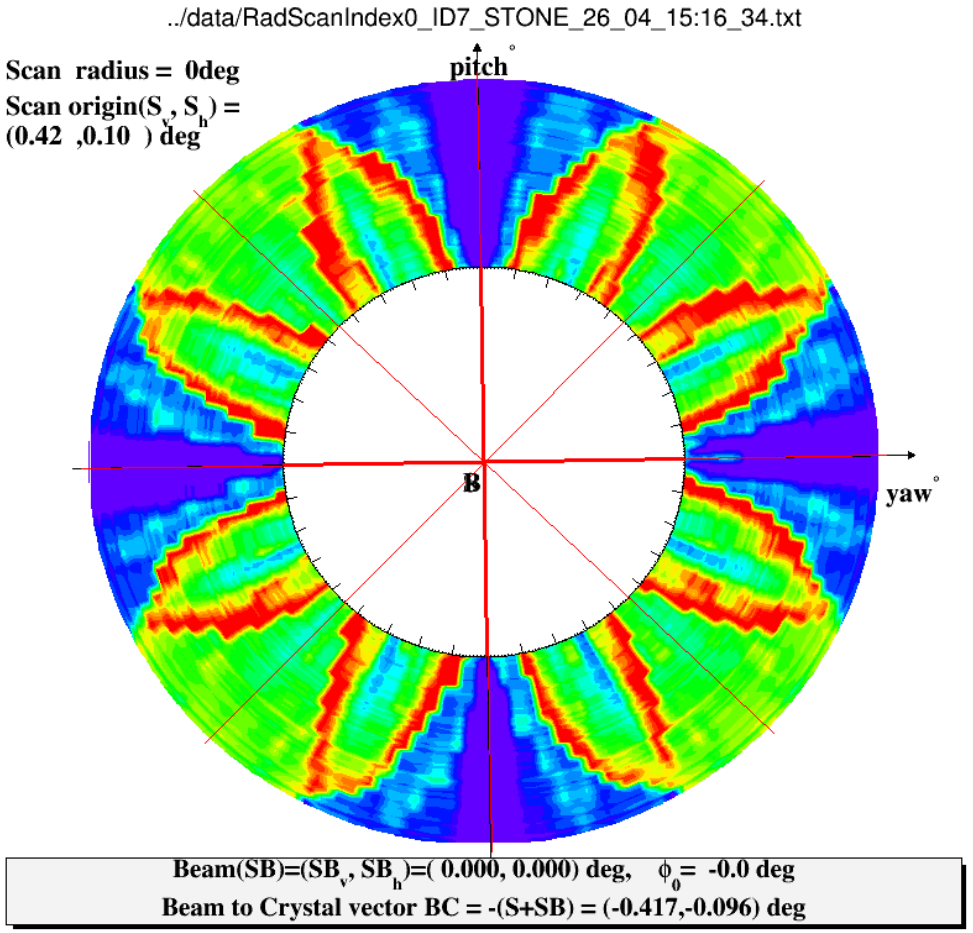
Beam(SB)=(SB$_v$, SB$_h$)=(0.45, 0.14) deg, ϕ_0 = -0.00 deg
Beam to Crystal vector BC = -(S+SB) = (-0.45, -0.14) deg

../data/RadScanIndex2_ID7_STONE_26_04_15:15_52.txt



Beam(SB)=(SB$_v$, SB$_h$)=(-0.025,-0.023) deg, ϕ_0 = 2.5 deg
Beam to Crystal vector BC = -(S+SB) = (-0.425,-0.117) deg

Alignment



Scan can be done with Hall-D setup.

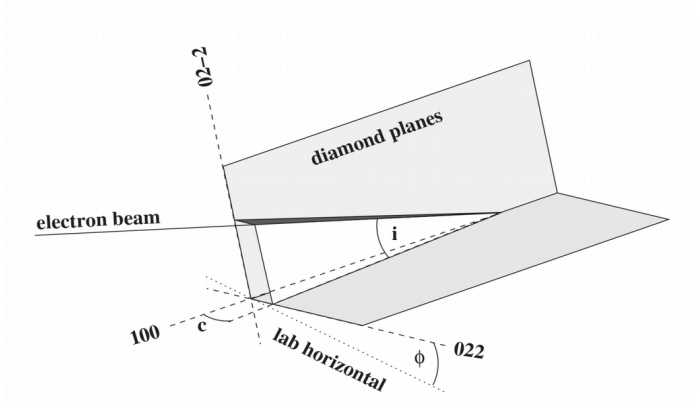
Did not use prior info on Diamond.

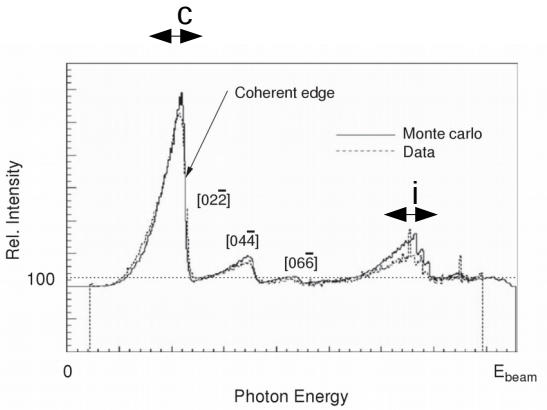
Easy to interpret because the crystal was mounted to within ~0.5 deg of beam.

Try so set up coherent peak in PARA and PERP with peak in reasonable position.

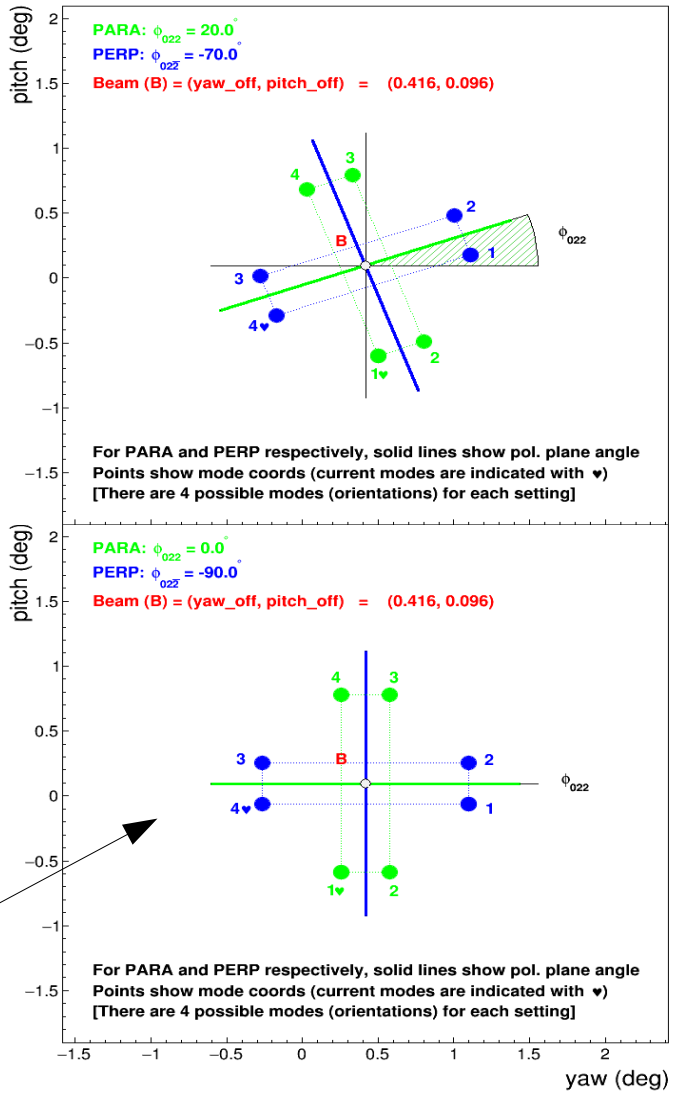
Coherent Peak

A reminder of the scattering angles





Coherent bremsstrahlung modes



4 possible modes for PARA and PERP

Small angle (c) with one set of planes.
Adjust this to change the position of the coherent peak.

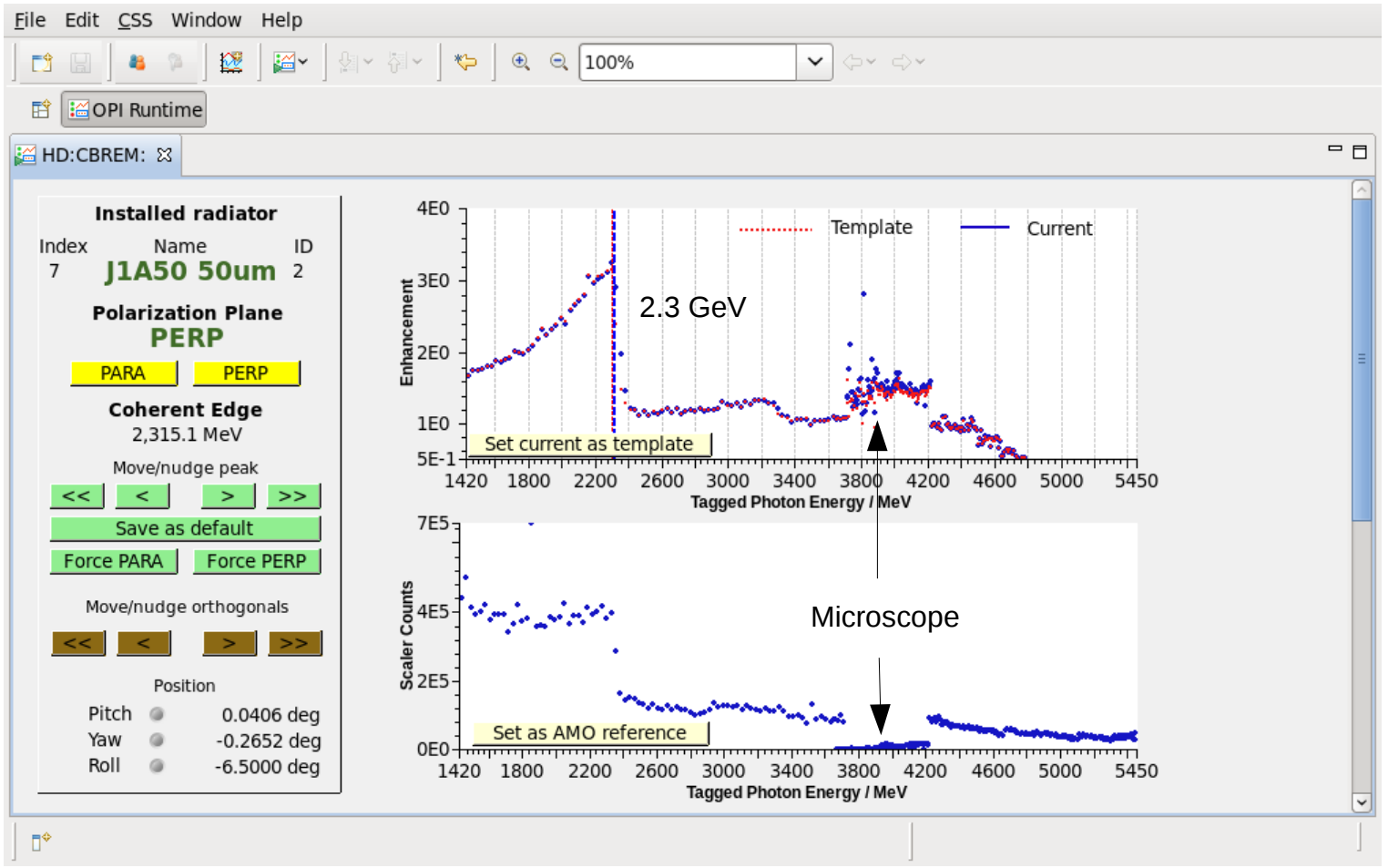
Larger angle (I) with orthogonal planes
Adjust this to adjust to move the orthogonals away

For general phi022
Need to move yaw and pitch to adjust I or c

For phi022 = 0 deg
Yaw and pitch map directly to c and I for.

By adjusting phi022 to 0 deg, we've choose this setting:
Select the modes that are closest to the goniometer origin. PARA 1, PERP 4.

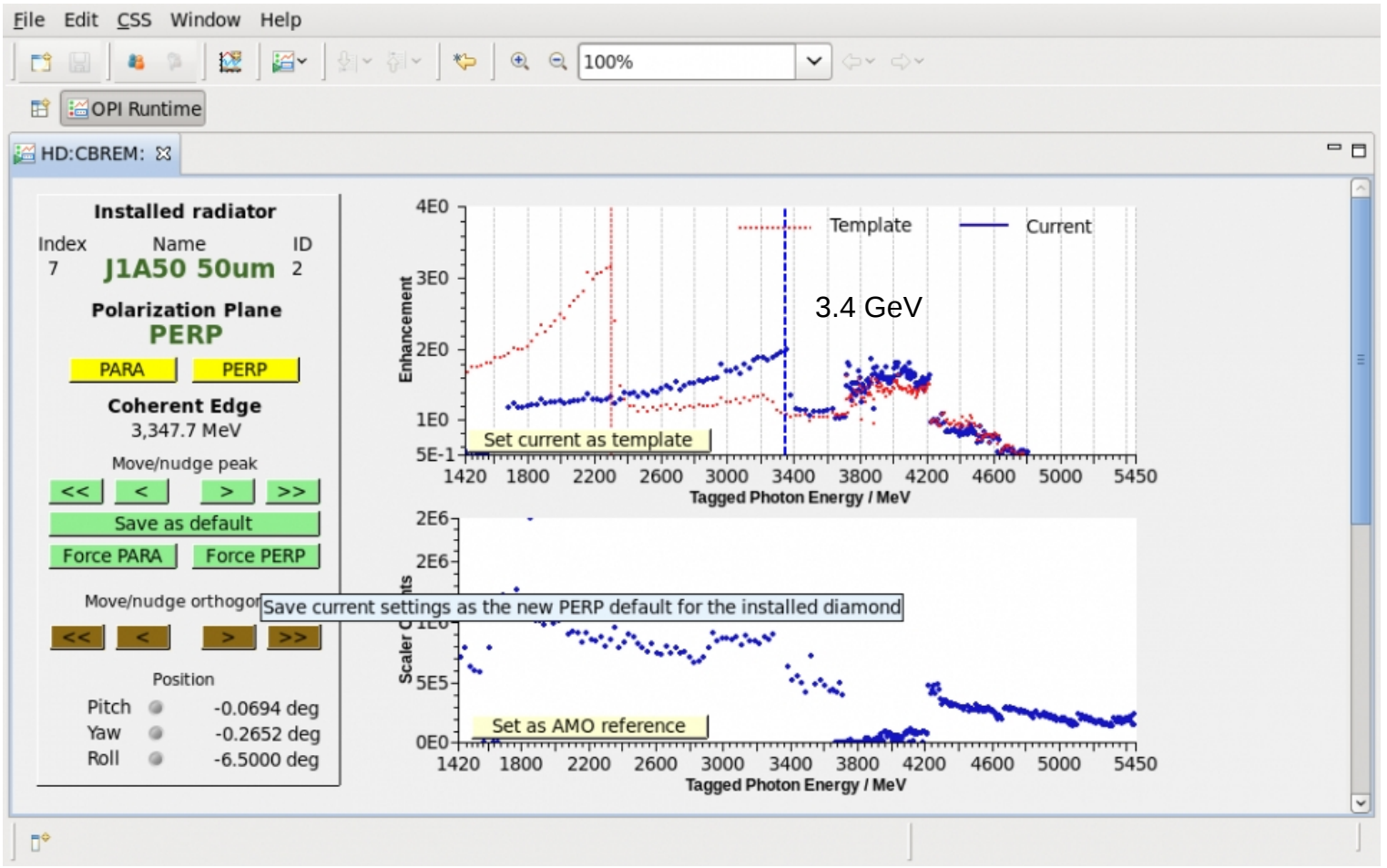
Coherent Peak



User interface for Coherent Bremsstrahlung.

Calculate the approximate settings for PARA and PERP with the peak at the required energy.
Fine tune using the adjustment buttons.
Save as default settings.

Coherent Peak



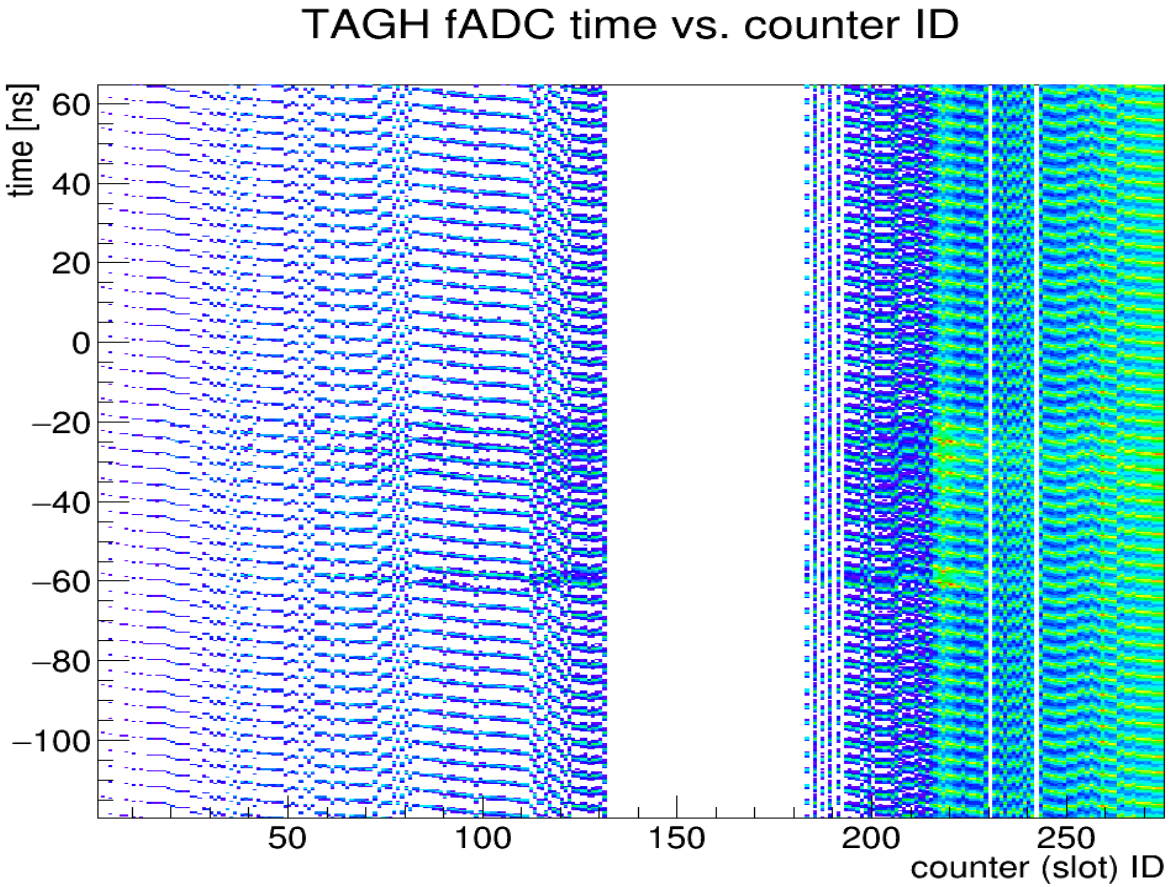
Peak closer to microscope region

Results based on free running HODO/MICRO scalers. Ie No timing coincidence.
Can be noisy, even as a ratio.
No effect of collimation. Look at events which make it through the collimator.
PS, Tagger, or Detector

Coherent Peak

Look for timed coincidences in the event by event data.
Nathan suggested slicing up TAGH fADC time vs counter ID

Try runs hd_root_003185.root (diamond) and hd_root_003180.root (amorphous)



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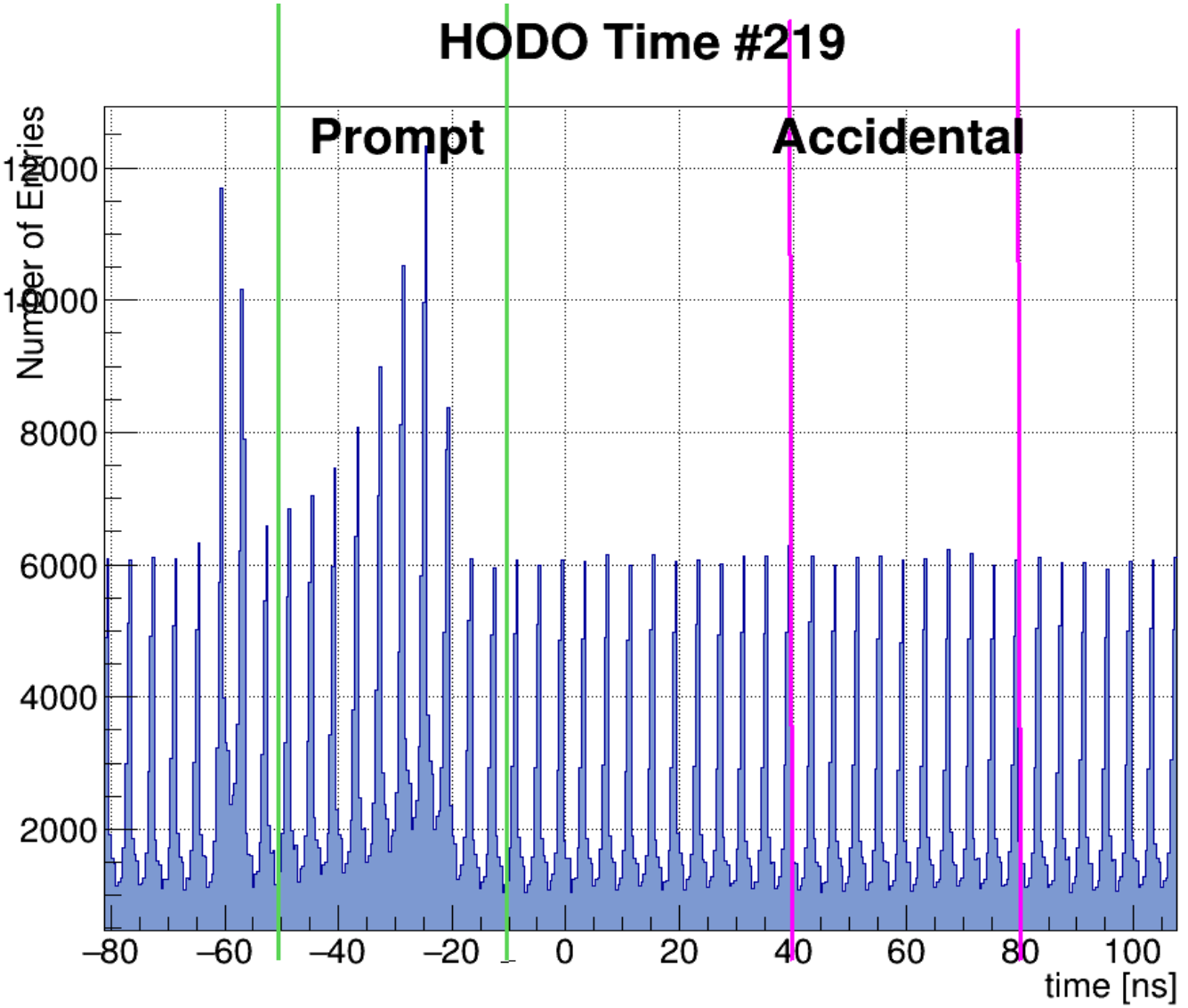

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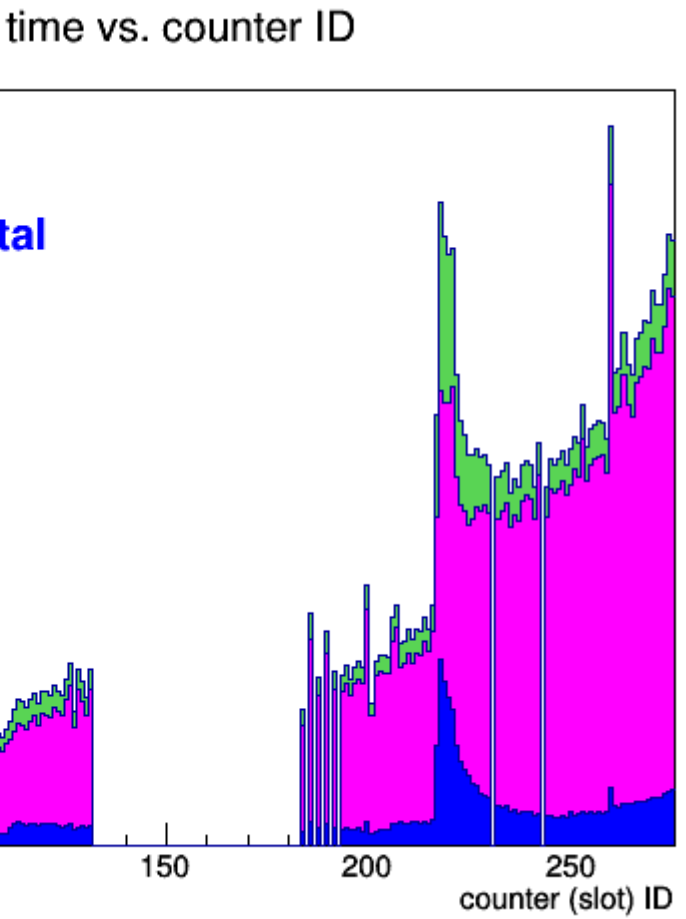

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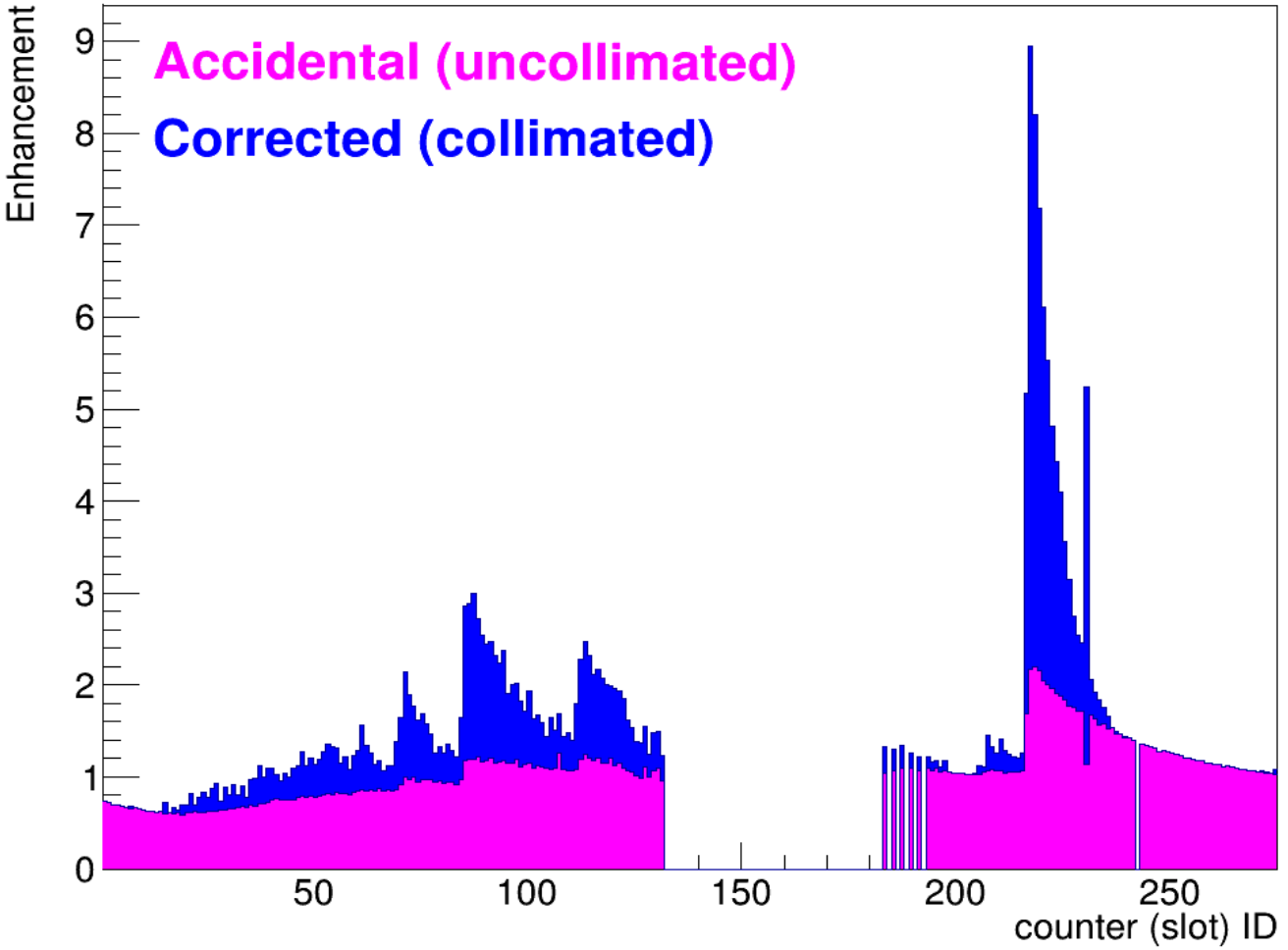

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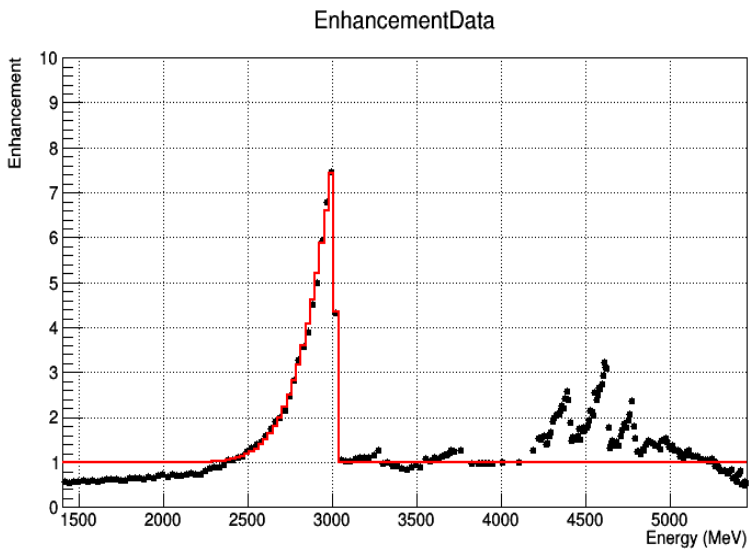
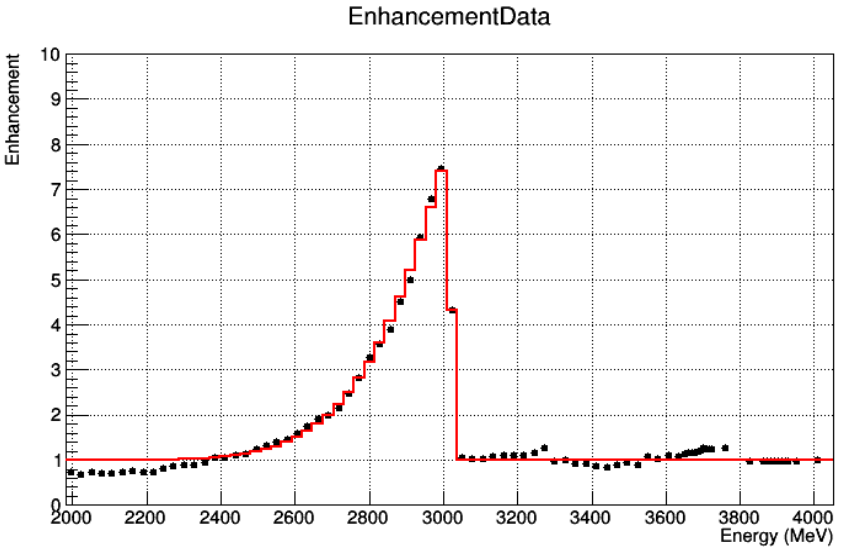
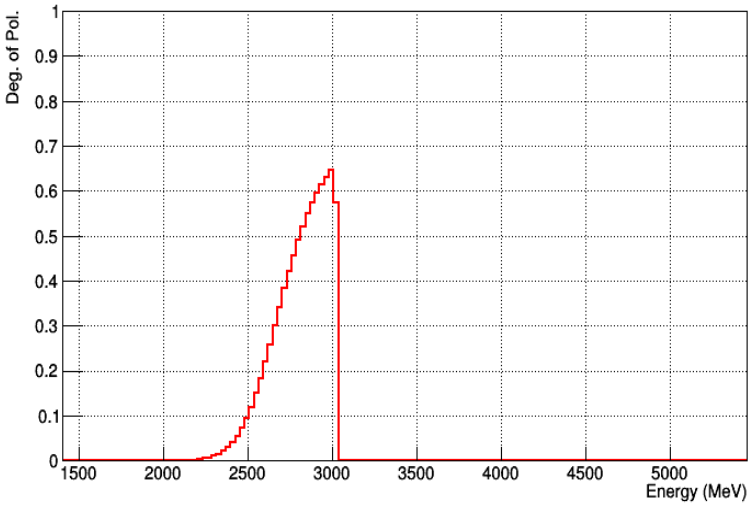
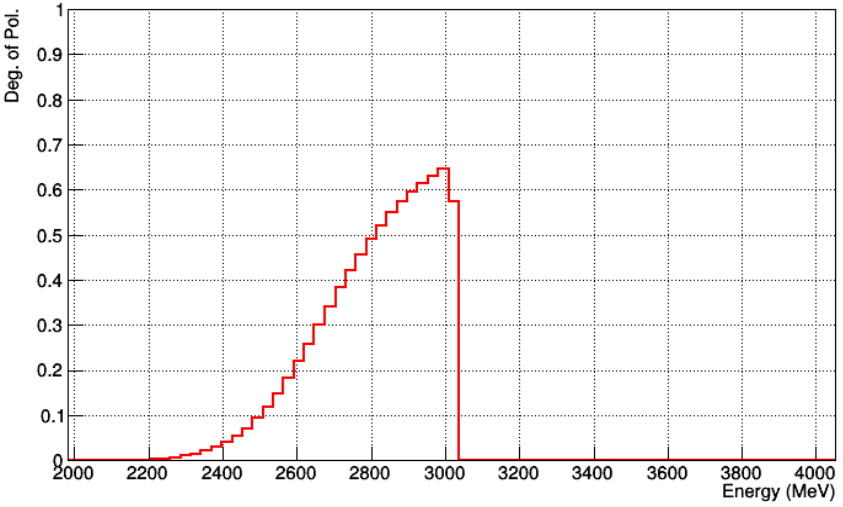




Prelim: Peak polarization ~ 65%

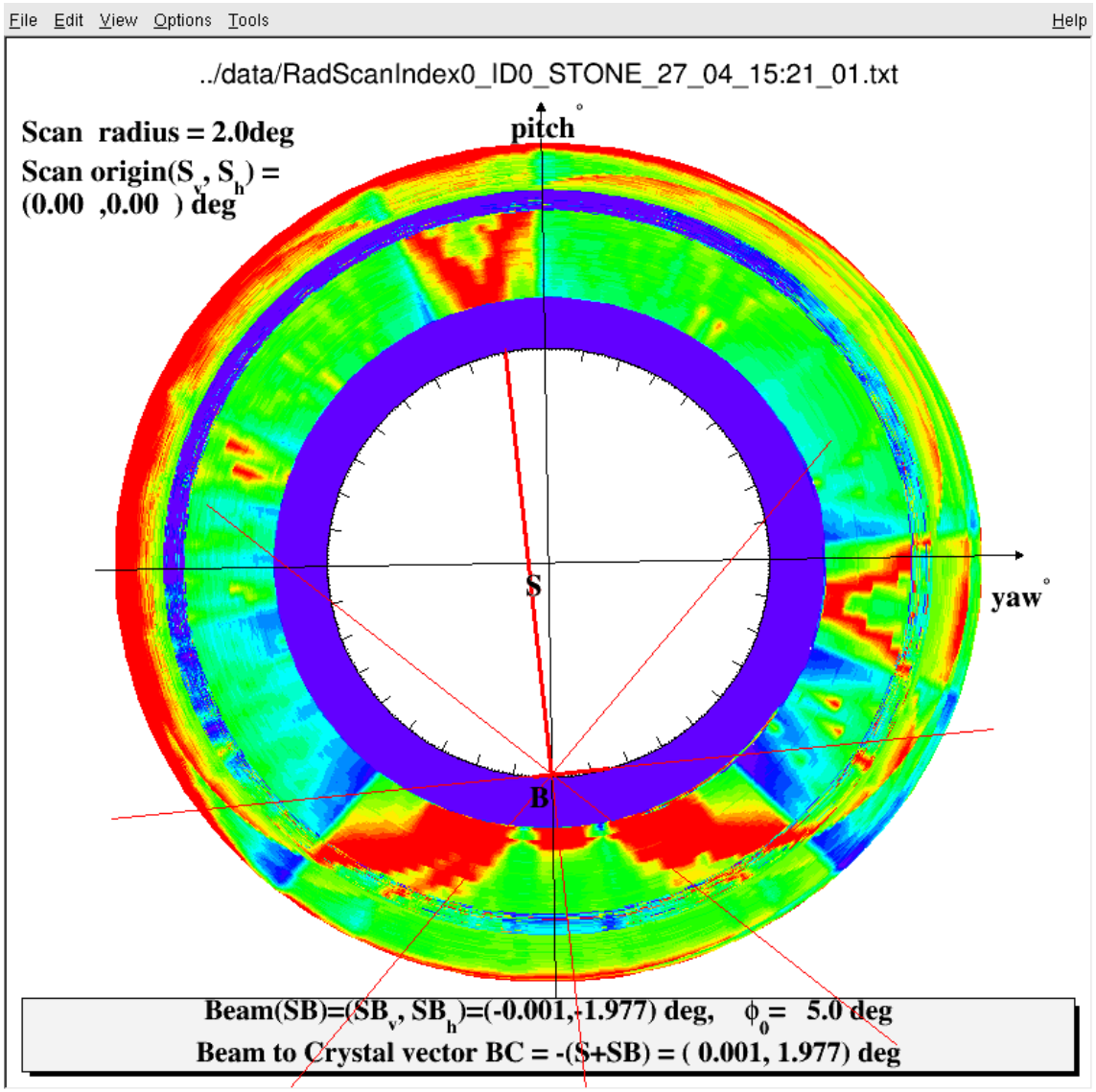




Reliability

Try another diamond.
[Hovanes and Paul M]

Local understanding of the Slow Controls and method.



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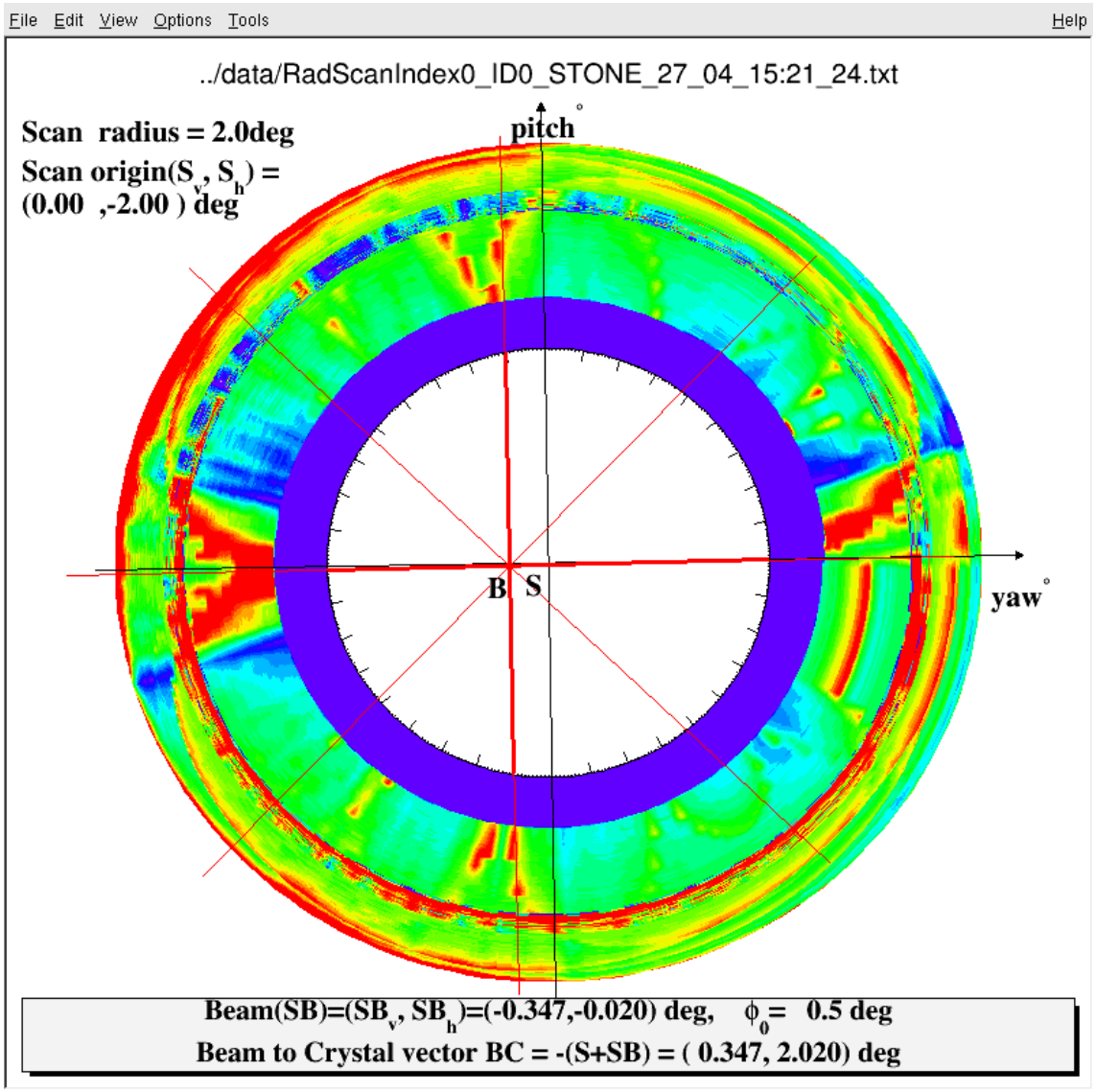

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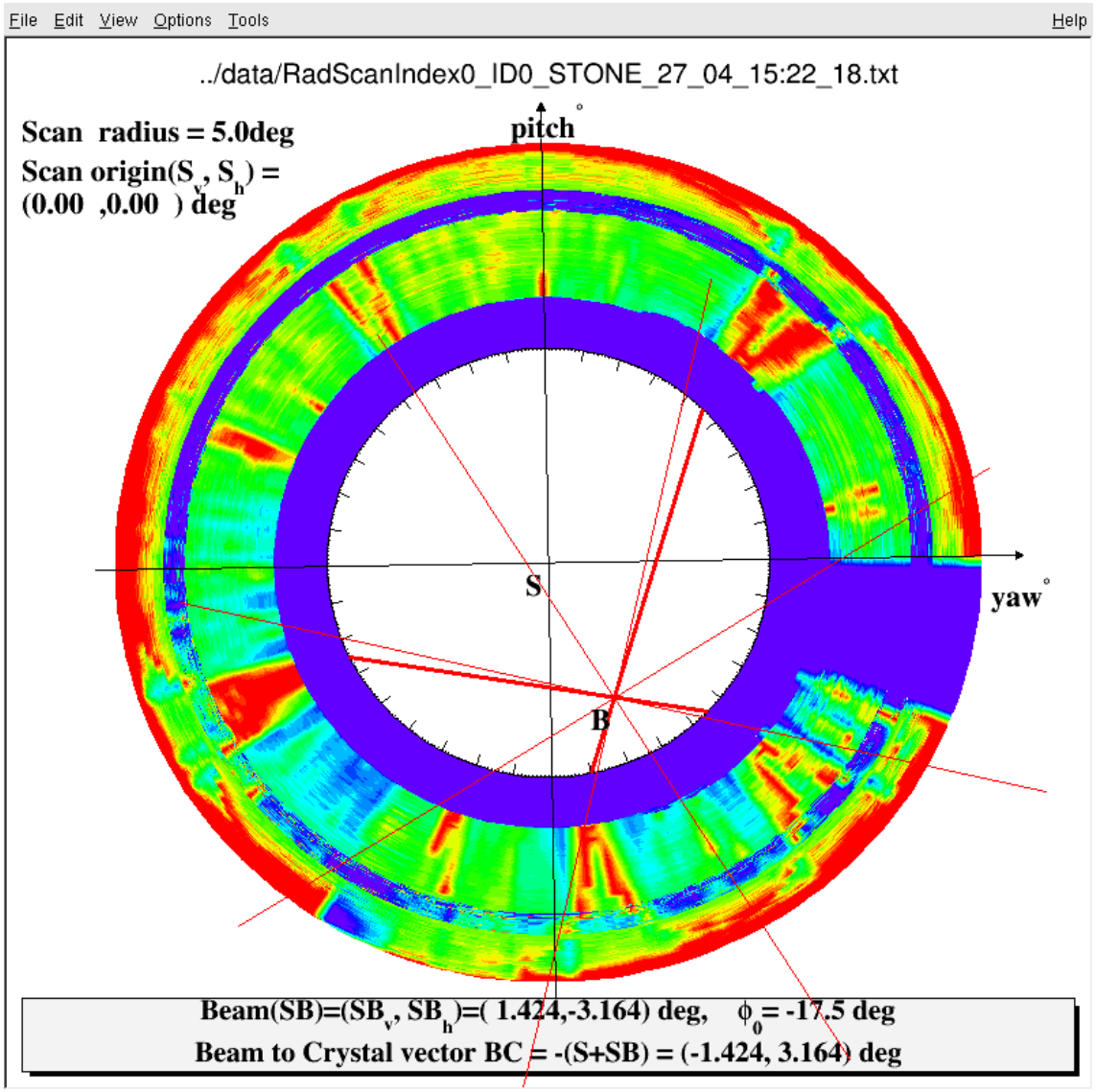

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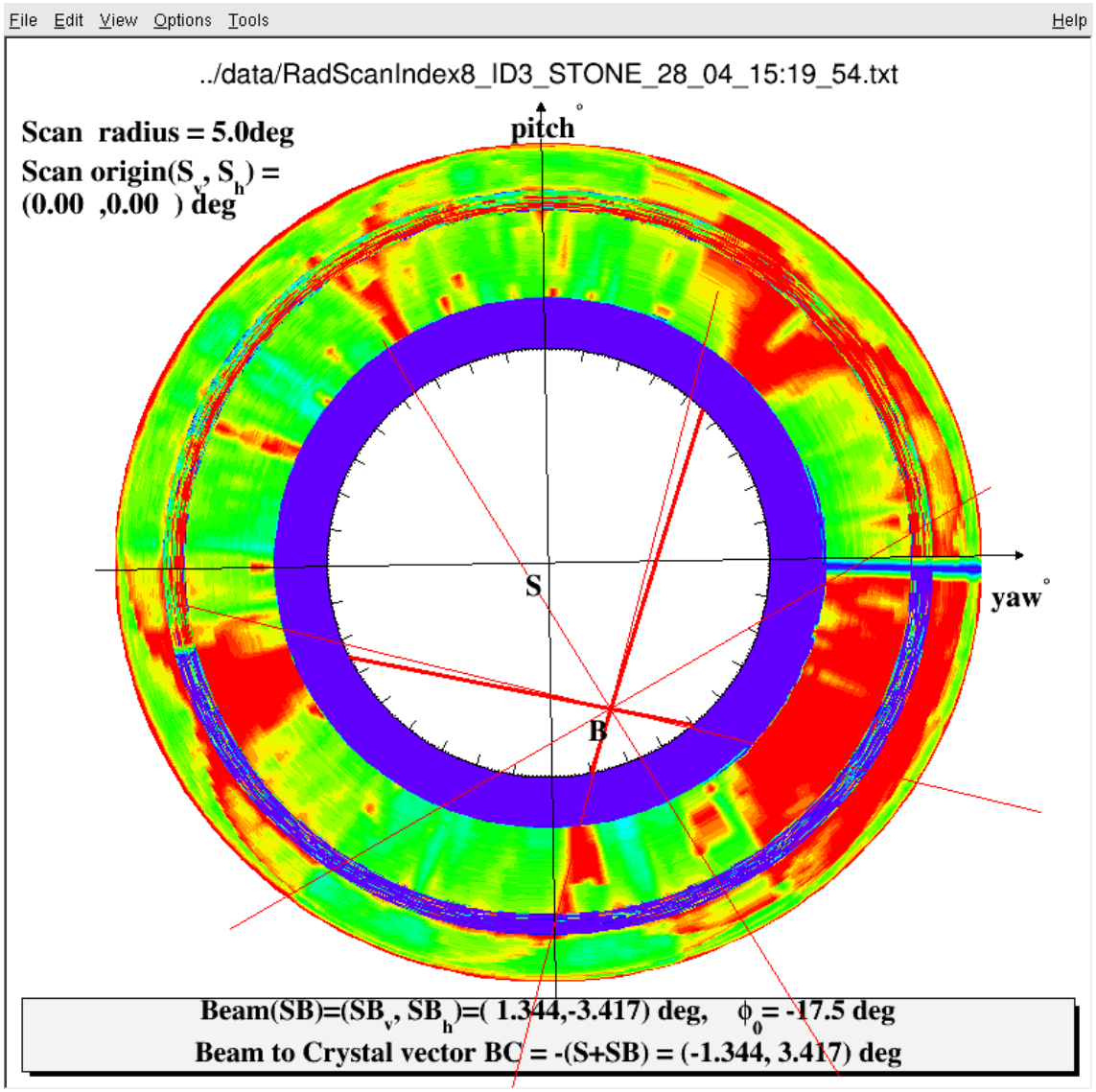

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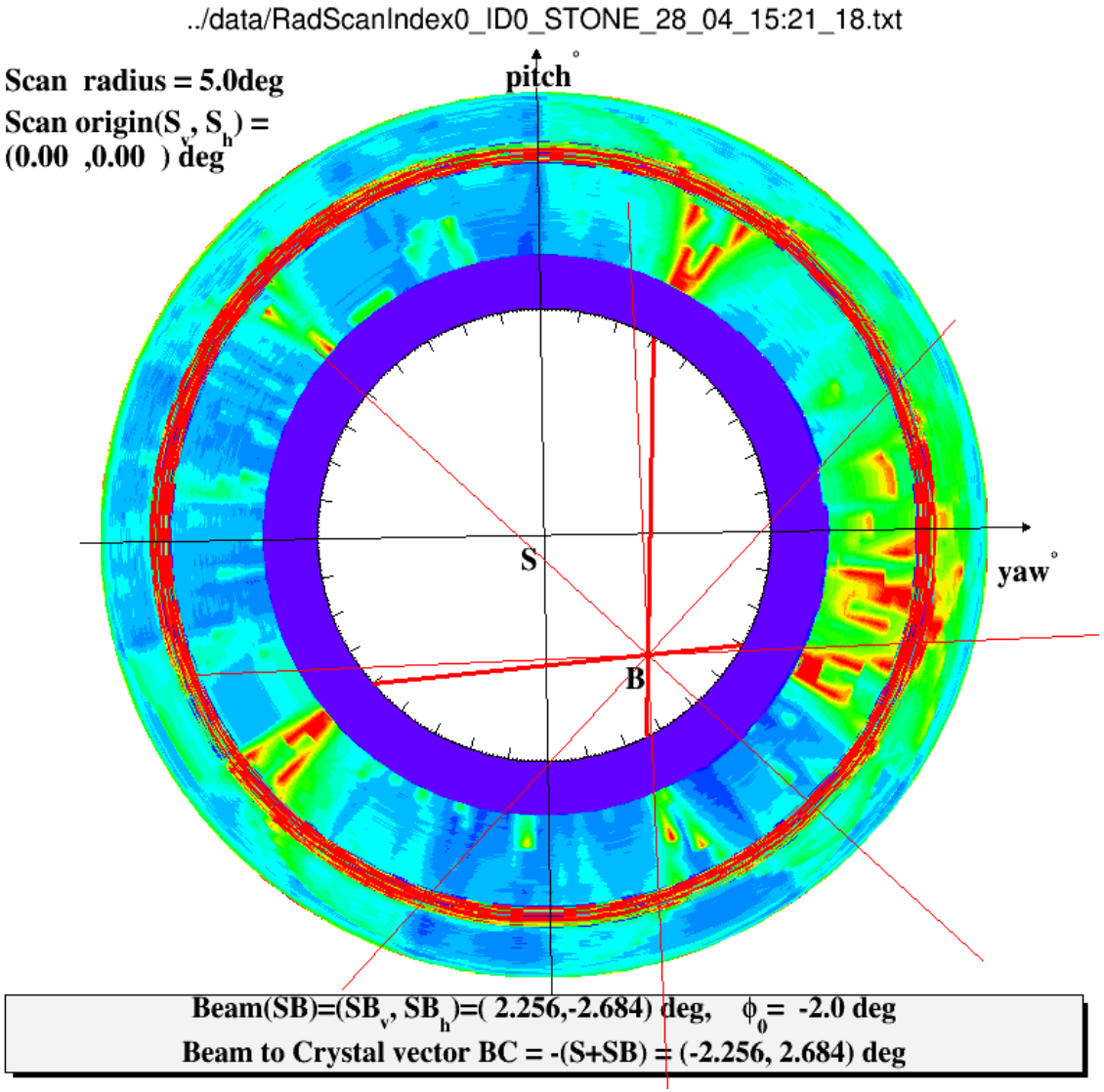

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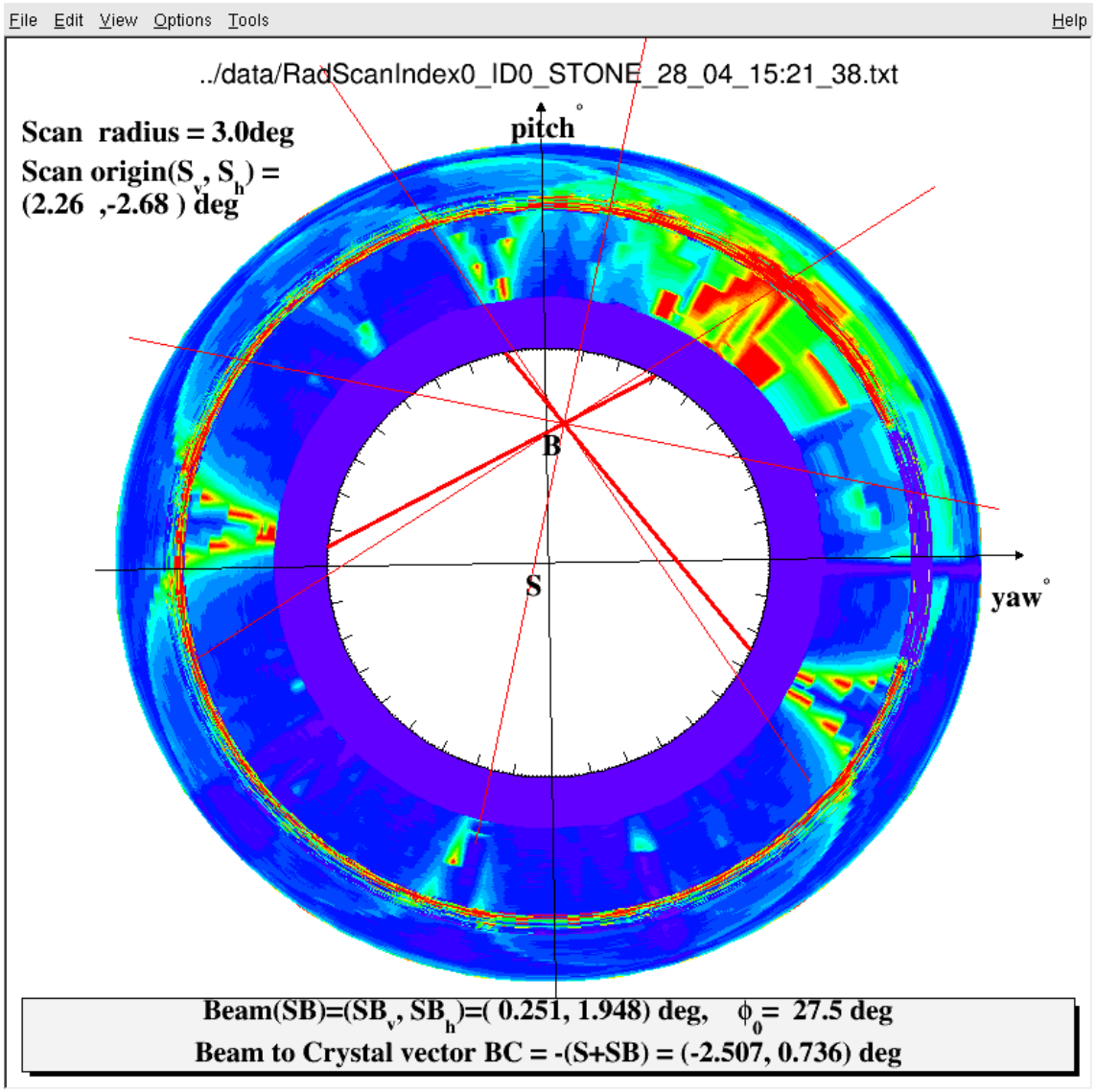

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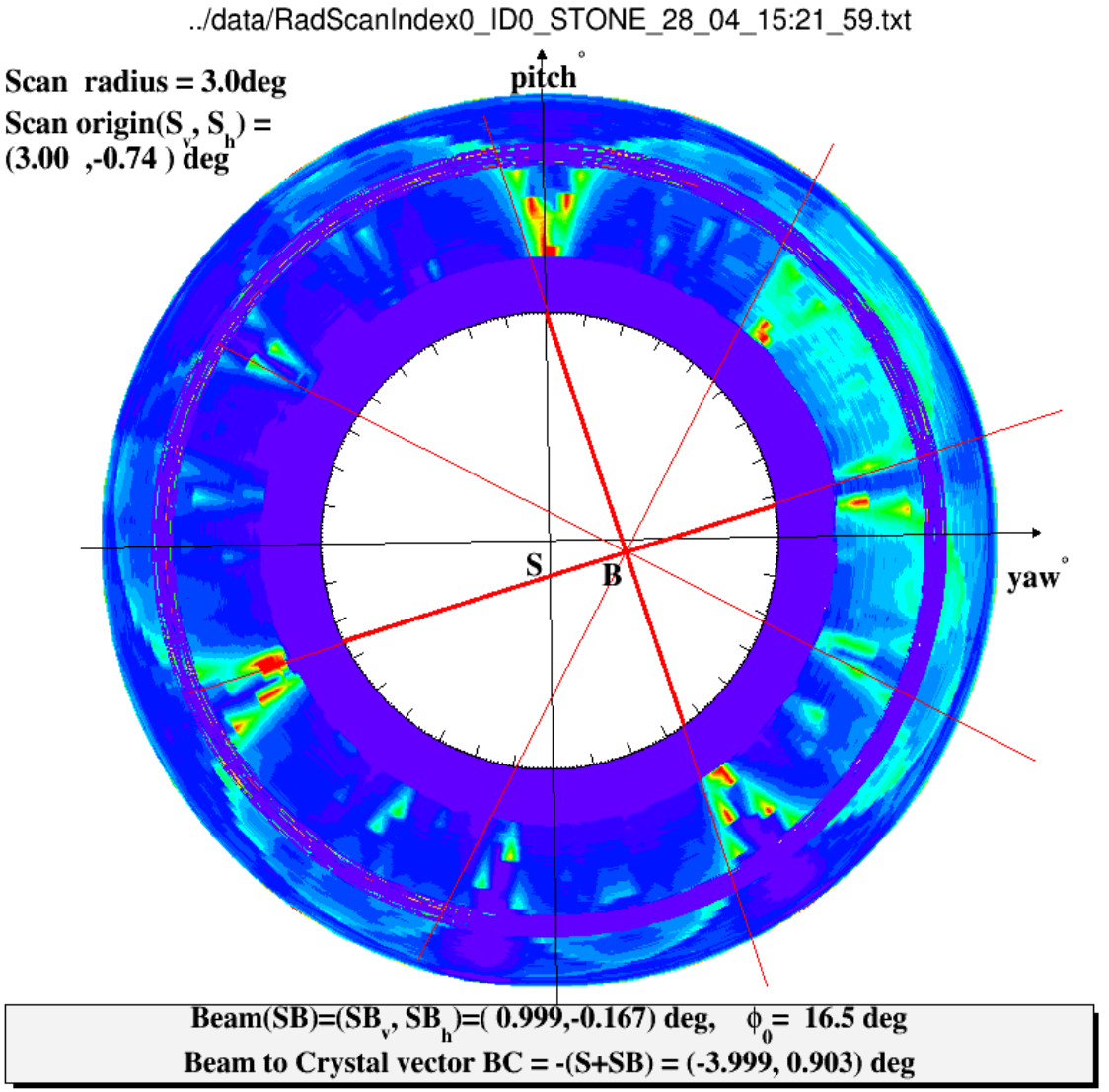

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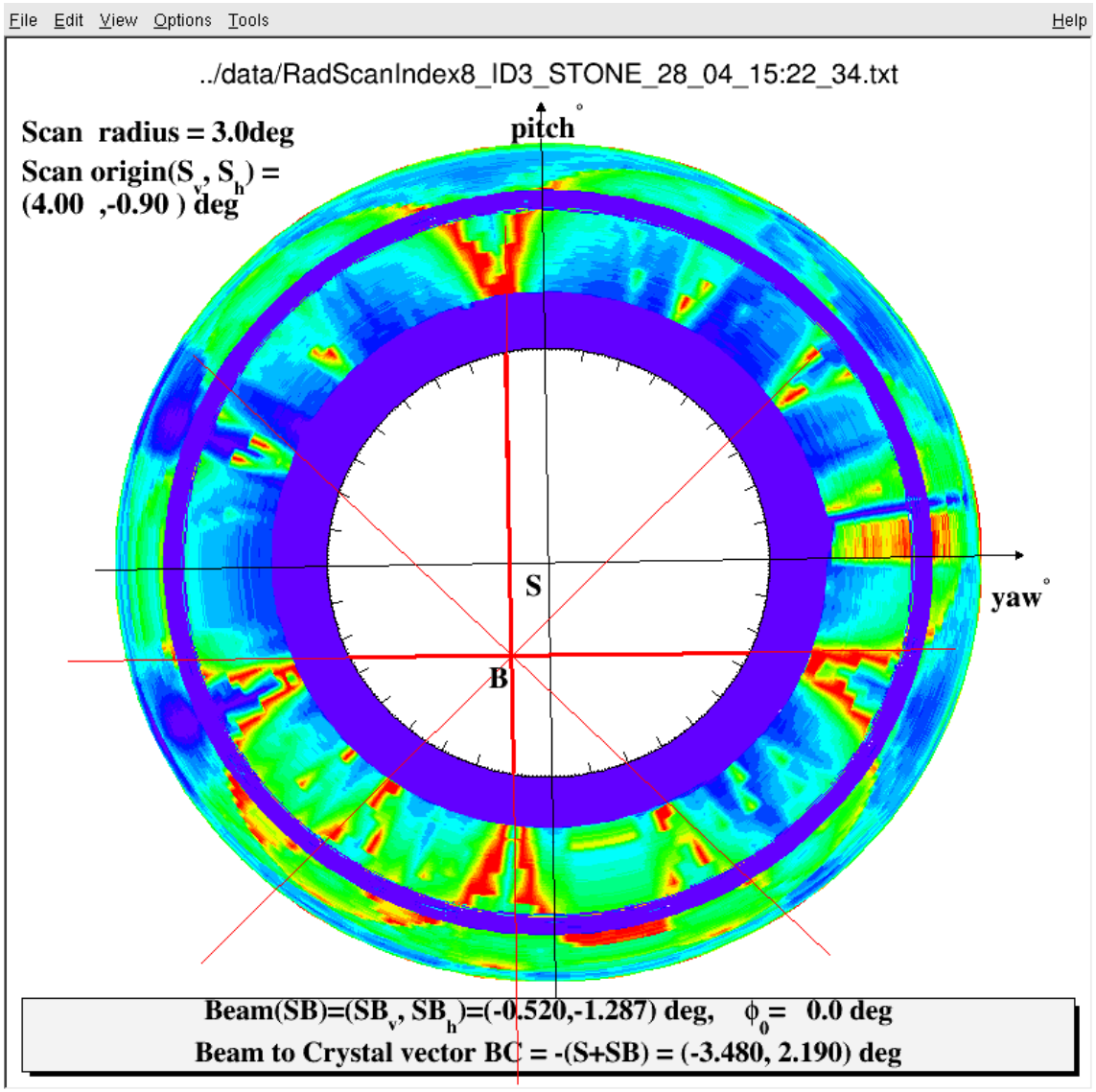

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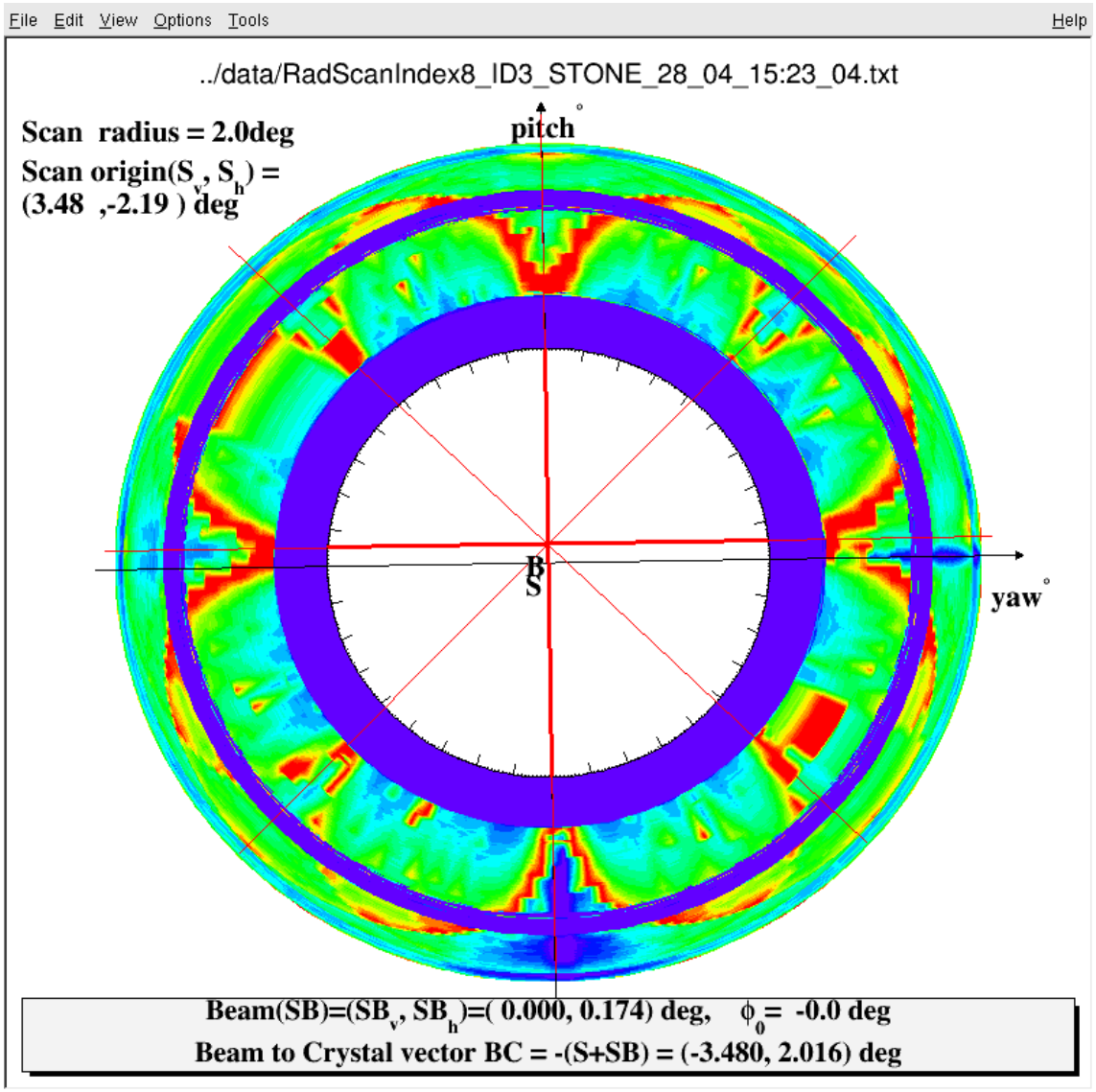

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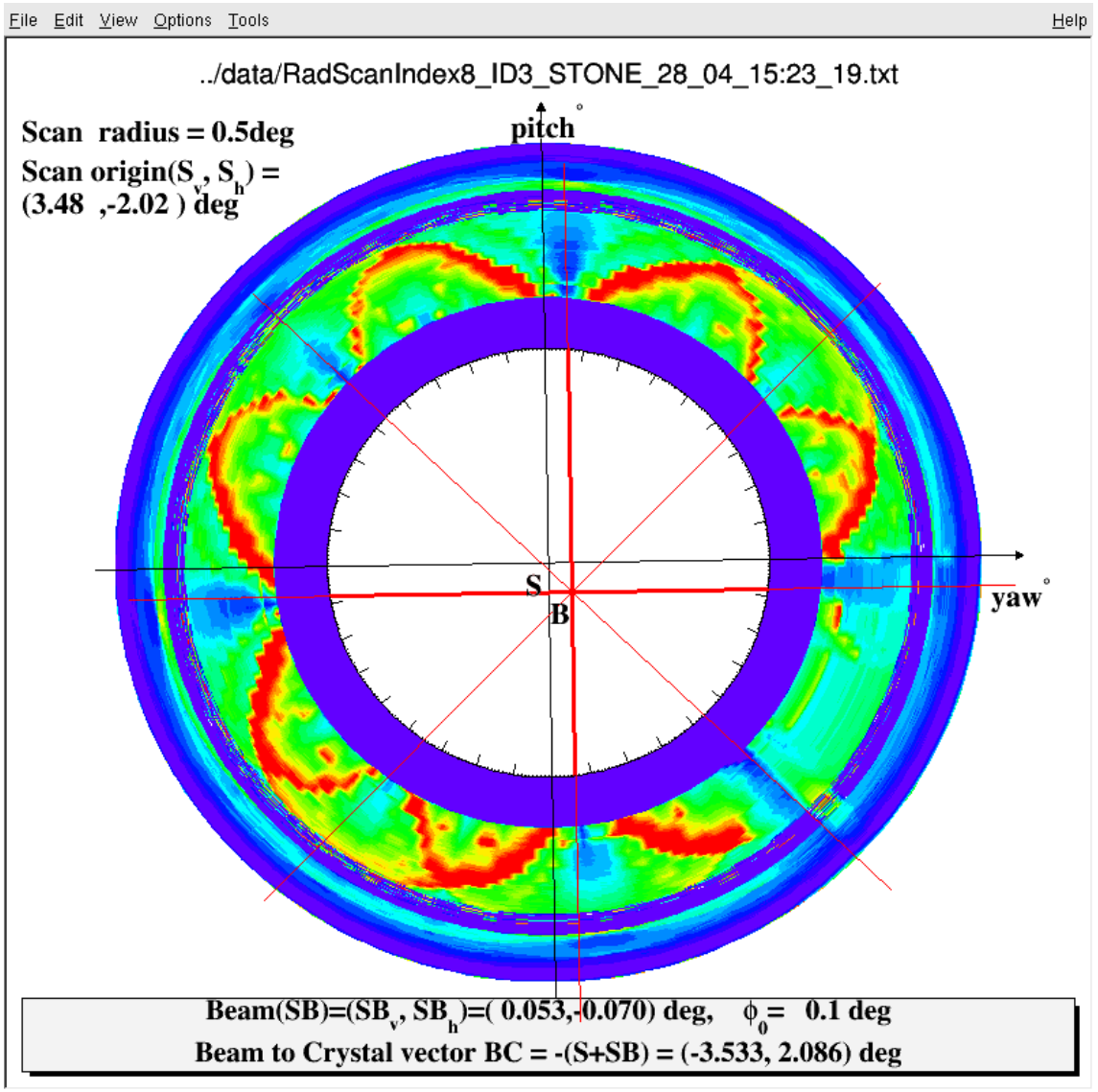

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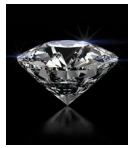

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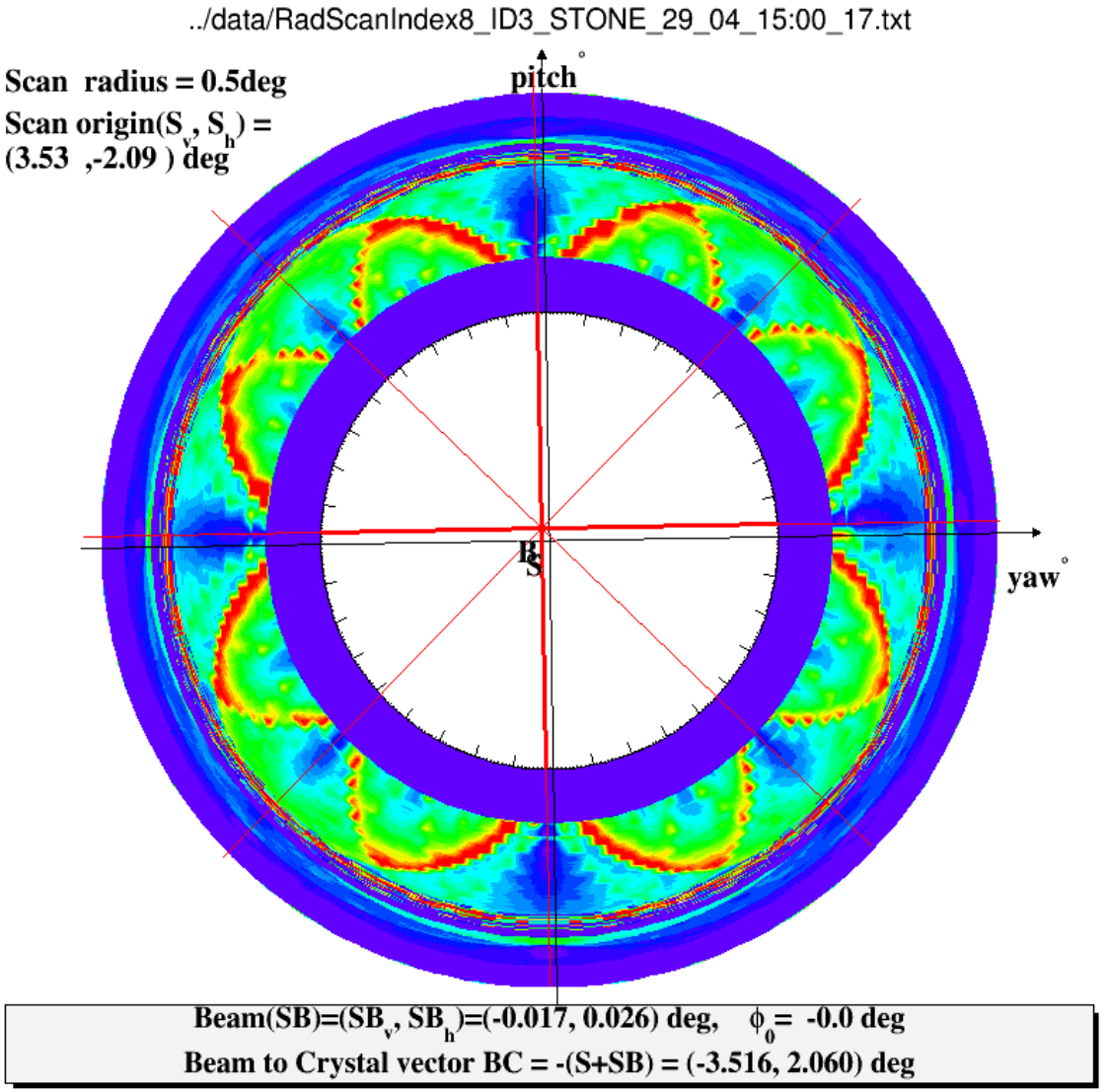

Reliability

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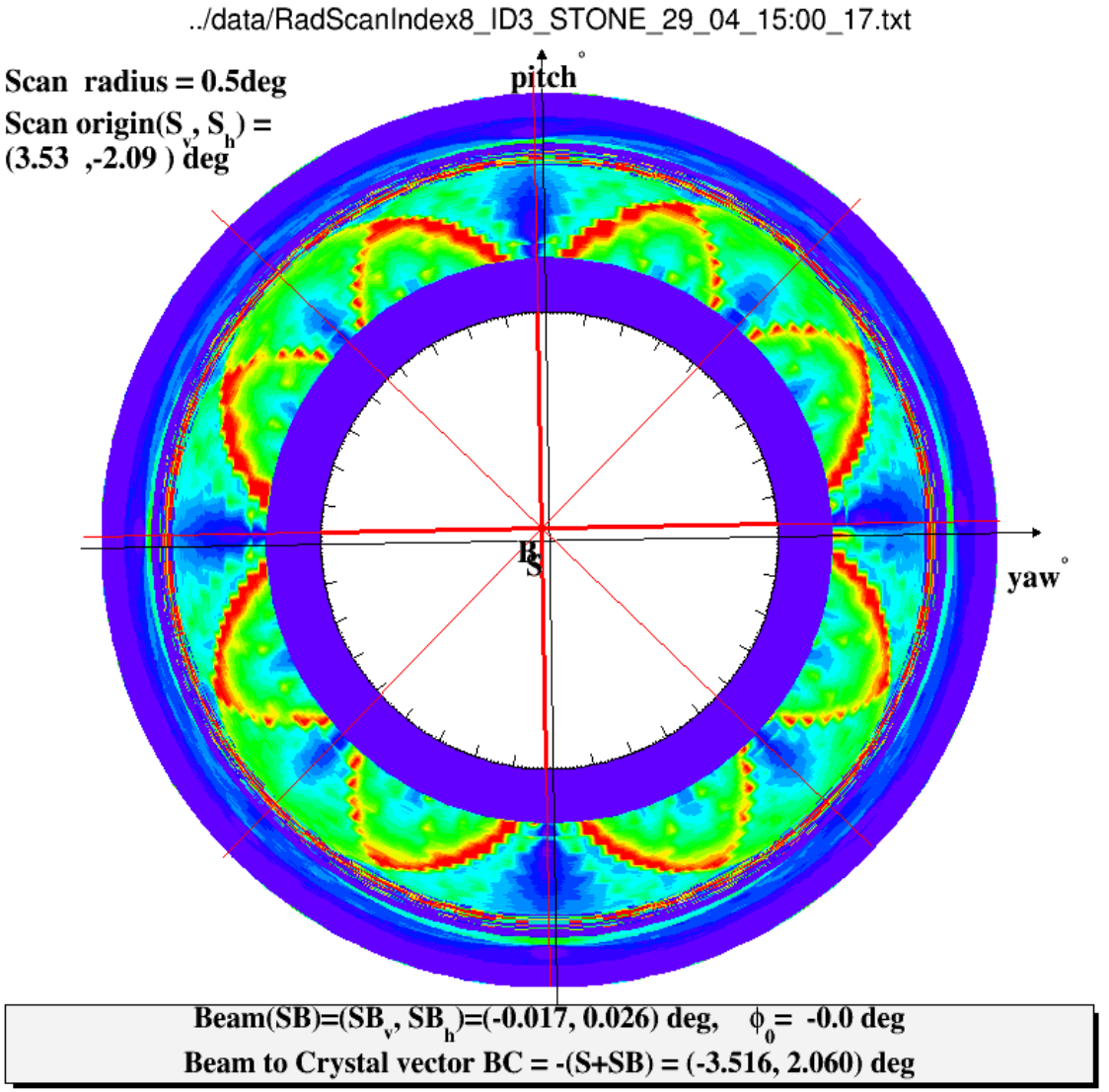
Local understanding of the Slow Controls and method.

Congratulations!
Got there in the end.

Offsets: 3.5, 2.1 deg.
Lattice > 4 deg from beam.



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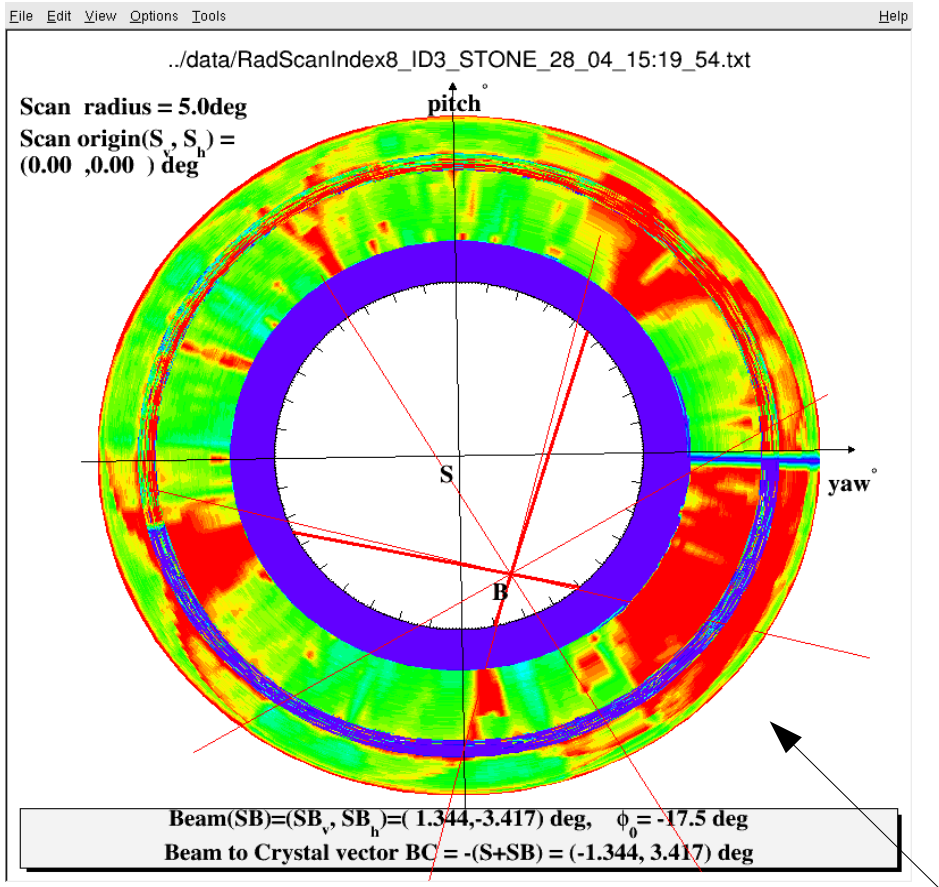
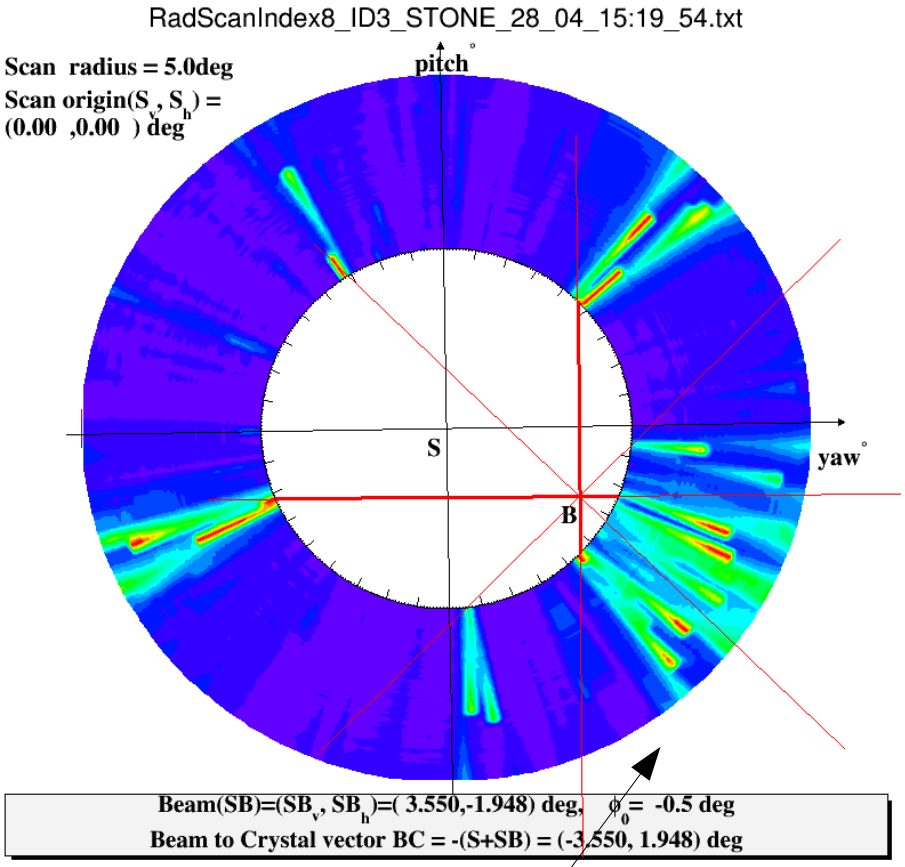




1st 5 deg scan was wrongly interpreted. **This should have been this.**

Hindsight is a wonderful thing.

Lesson: Try to survey crystals as well as possible before scanning.

Towards 12 GeV: Alignment and setup.

Try to know as much about the diamonds before scanning.

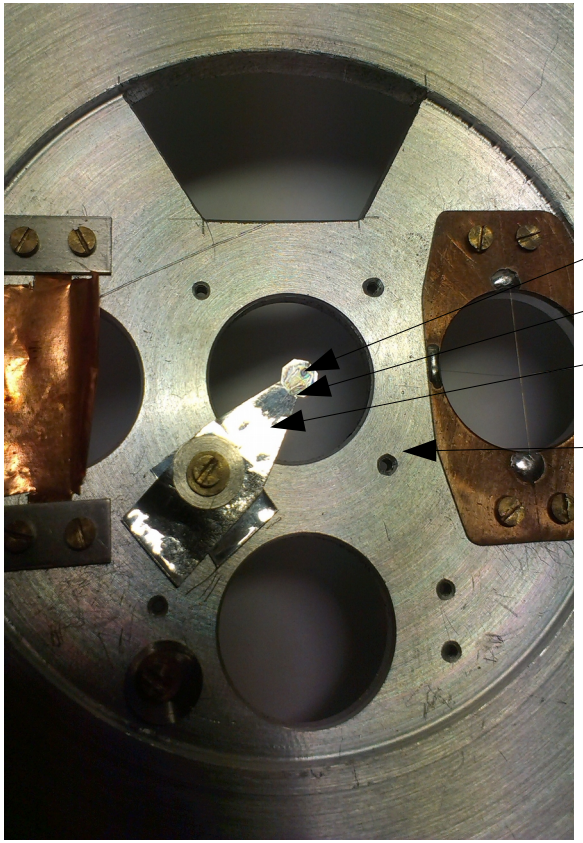
1. Preserve phi022 from CHESS measurements.
2. Survey in situ to get pitch and yaw offsets

Towards 12 GeV: Alignment and setup.

Try to know as much about the diamonds before scanning.

1. Preserve phi022 from CHESS measurements.
2. Survey in situ to get pitch and yaw offsets

Here's an example of my own High Tech alignment method from Mainz



Diamond

Nail varnish

Flexible Al foil

Gonioneter wheel

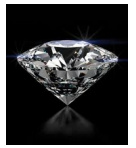
Vice

Laser pointer

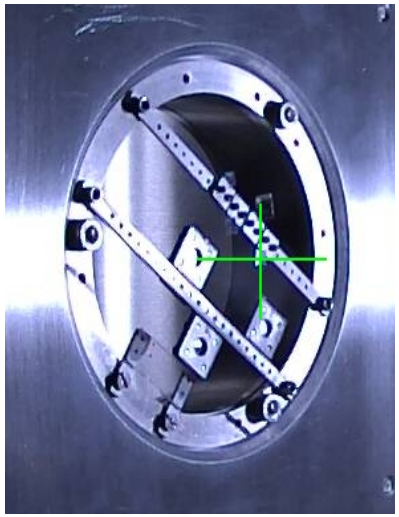
Sticky tape

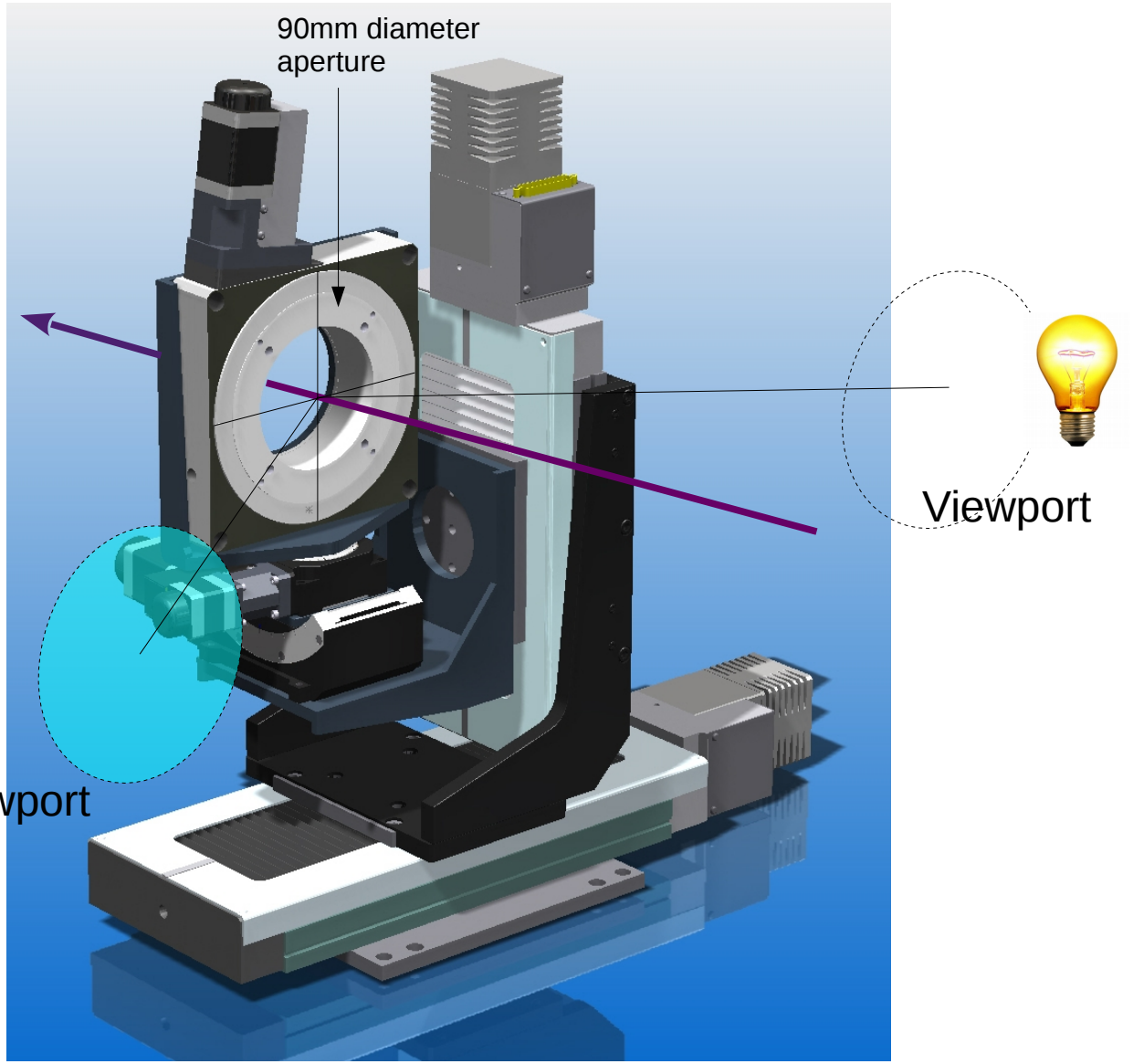
Angle poise lamp

Towards 12 GeV: Alignment and setup.

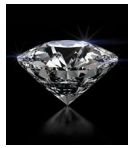


Try a similar alignment here through the chamber viewports.



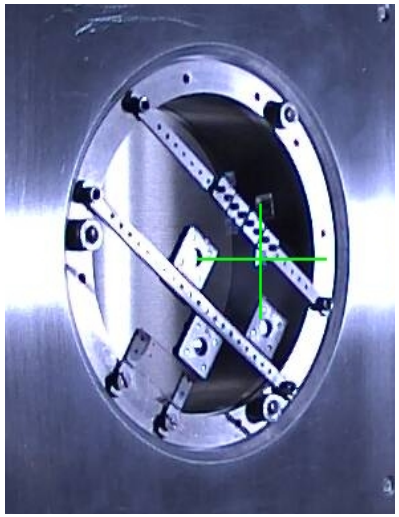


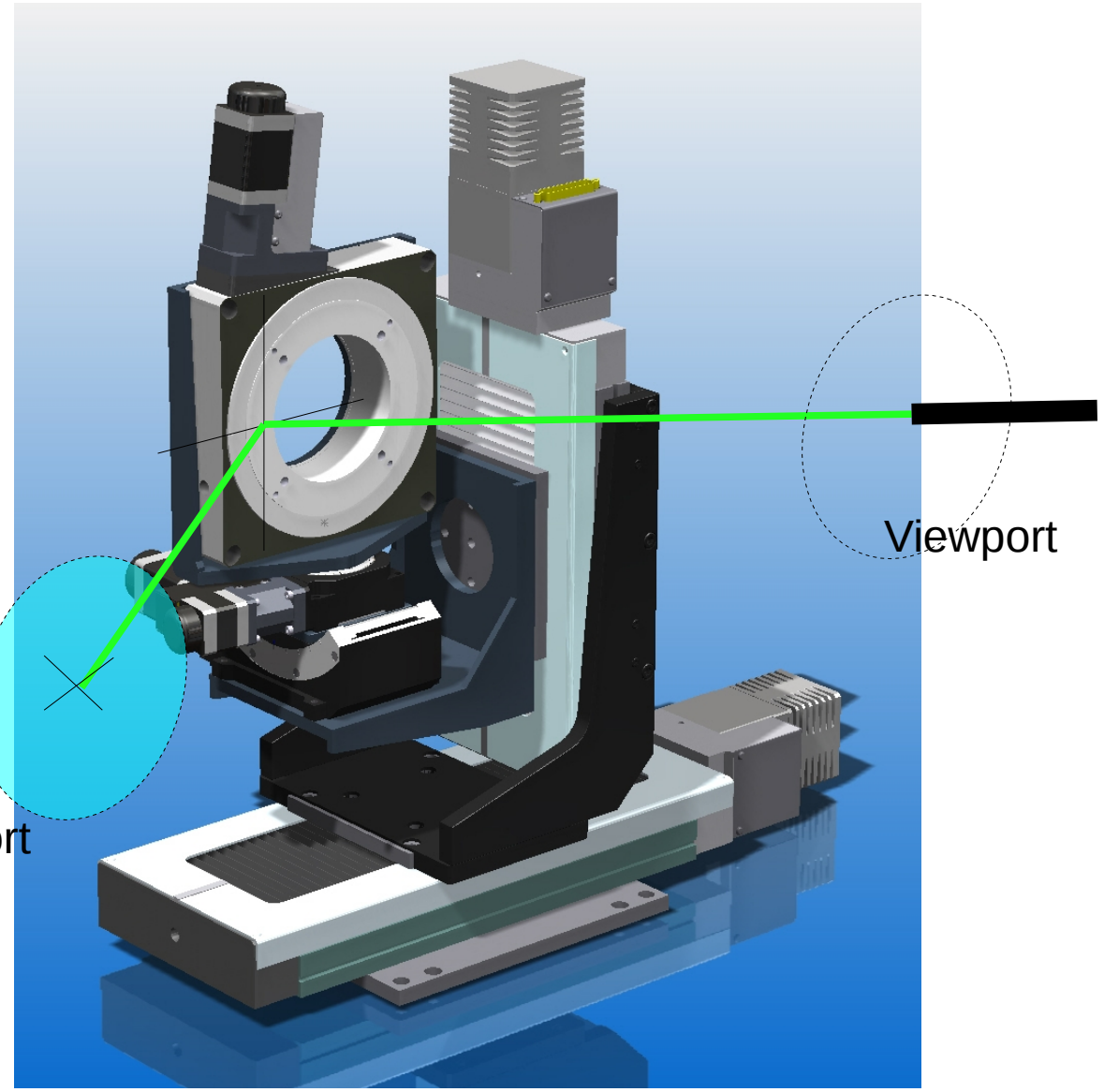
Towards 12 GeV: Alignment and setup.



Try a similar alignment here through the chamber viewports.

We just want to know
Pitch_offset, Yaw_offset
< 1deg





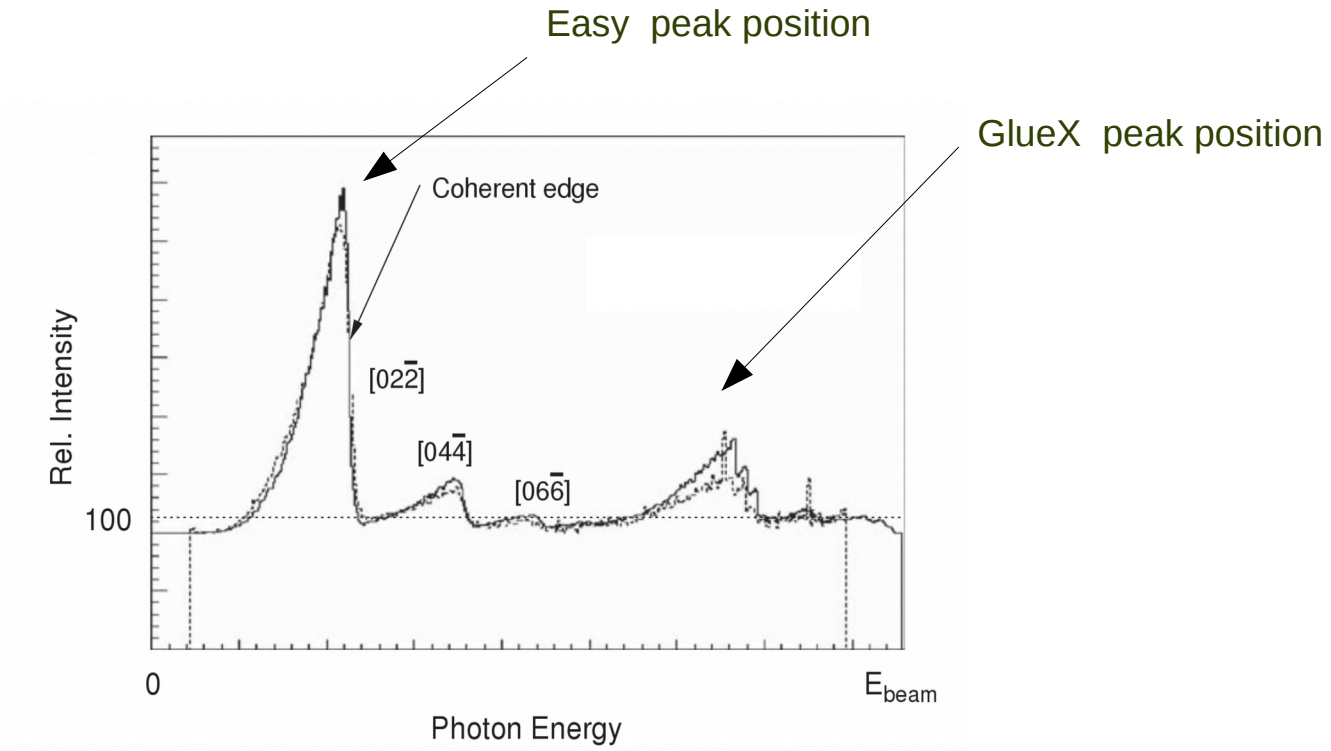
Towards 12 GeV: Coherent peak monitoring.

FP Scalers have high rate, but don't show effect of collimation

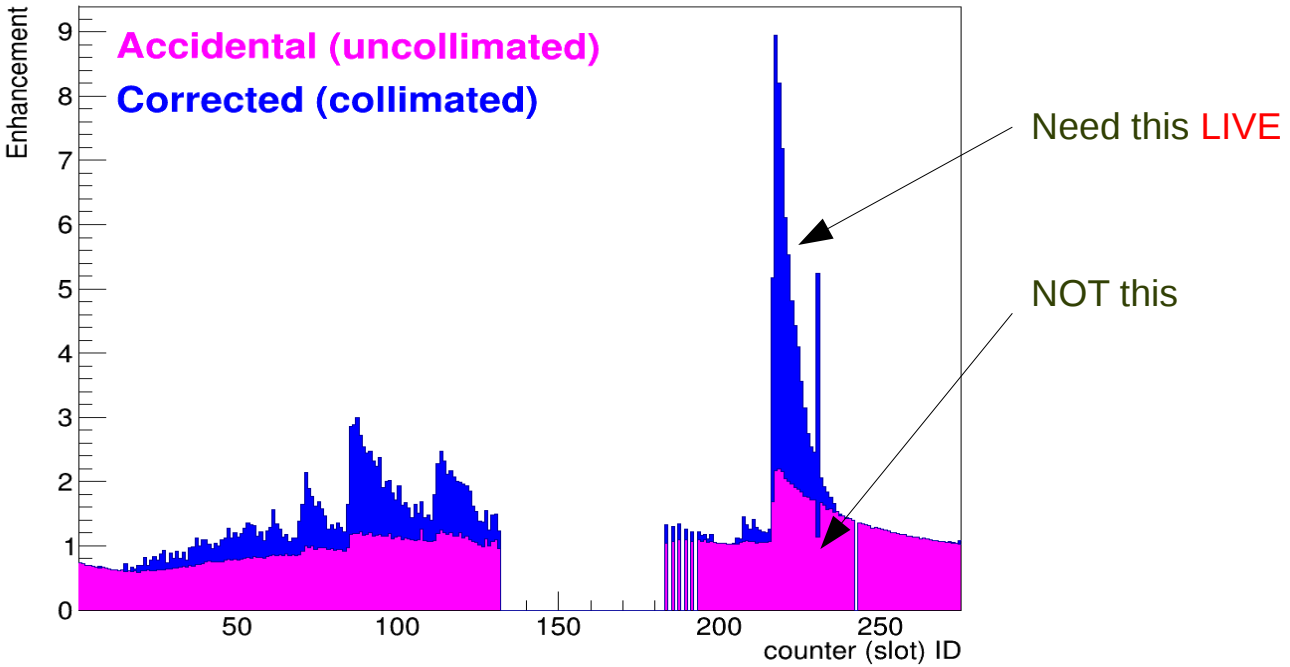
That's OK with peak at <0.5 EP energy

At higher energies peaks all bunch up and tails run into each other

We need to see the collimated enhancement live.



Towards 12 GeV: Coherent peak monitoring.



How to achieve this.

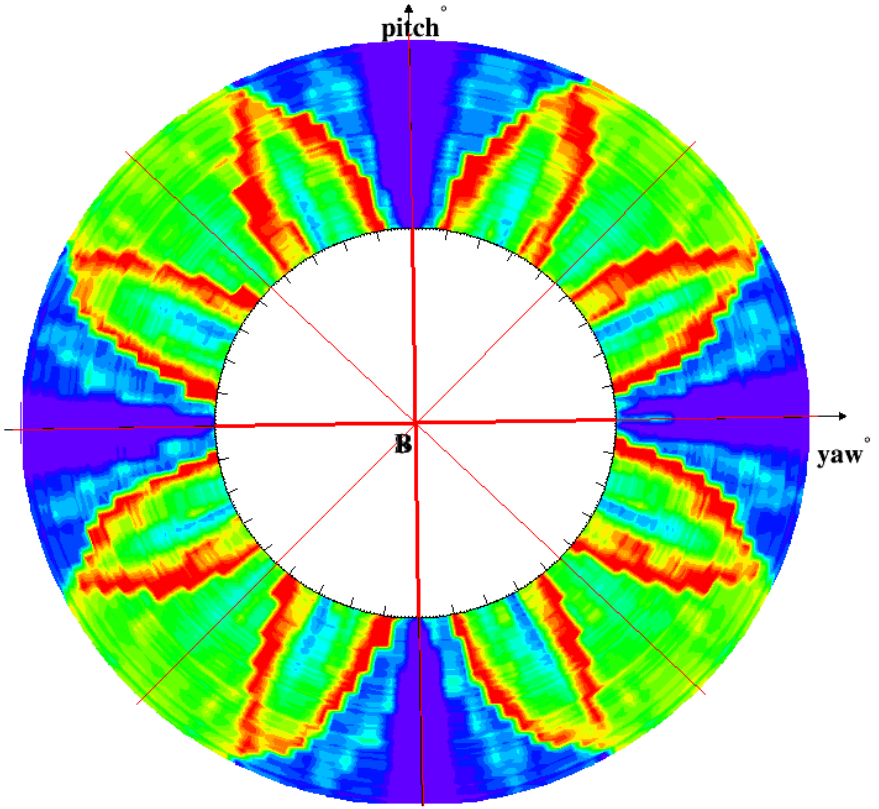
1. Random subtracted HODO / MICRO hits from triggered events.
2. Pair Spectrometer Scalers

Conclusion

Coherent Bremsstrahlung is up and running.

Some details to improve:

- **Initial alignment of diamonds**
- **Feedback on coherent peak for 9/12 GeV.**
- **User and Expert guides and documentation.**



Many in GlueX contributed to this in some way

Hovanes, Paul, Ken:	EPICS, goniometer and alignment
Tim and engineering:	Goniometer, cameras, chamber
Franz, Nathan et al:	Hodoscope
Richard, Alex, Brendan:	Microscope, Diamonds
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