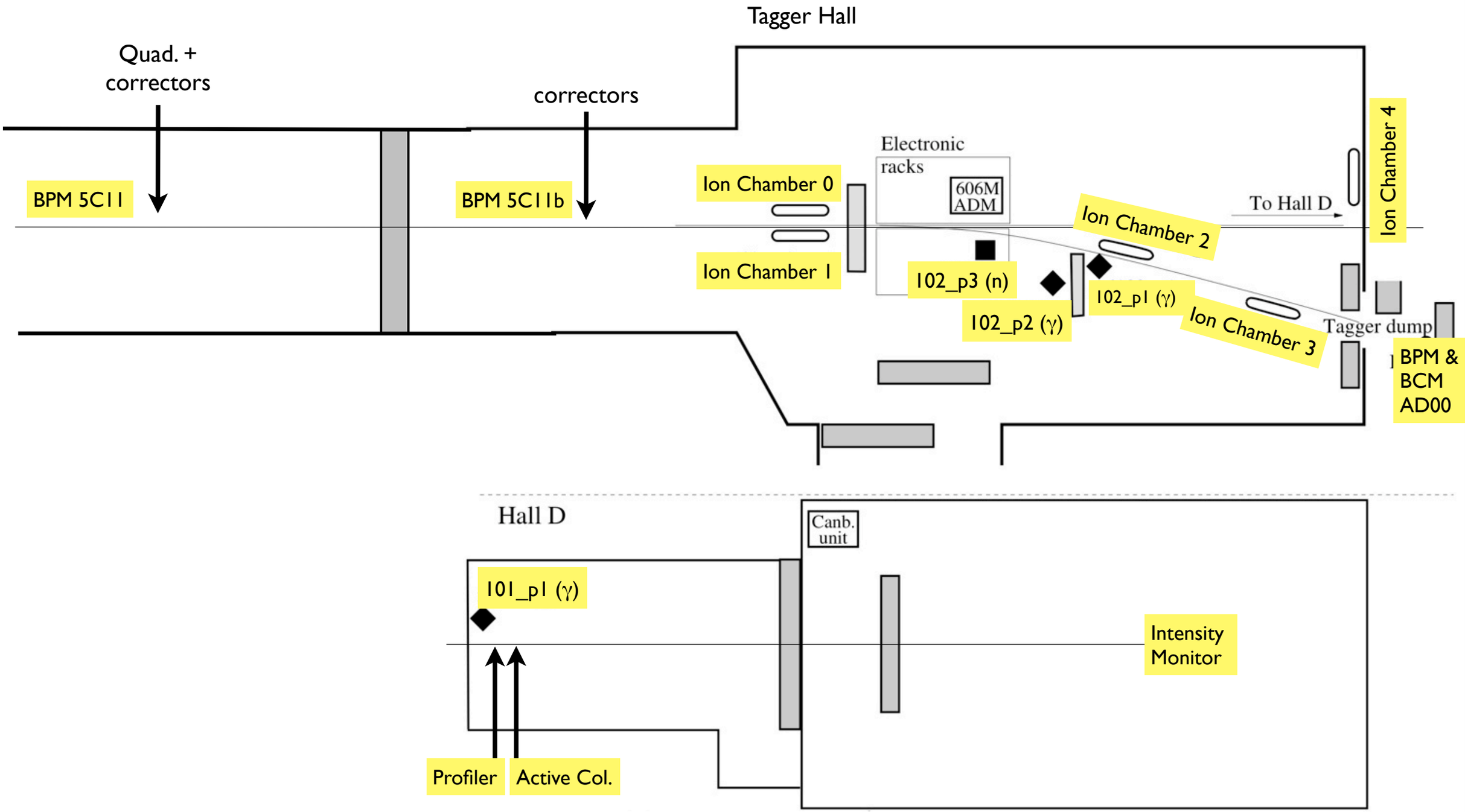
Hall D beam line analysis for the Spring 2015 run.

A. Deur

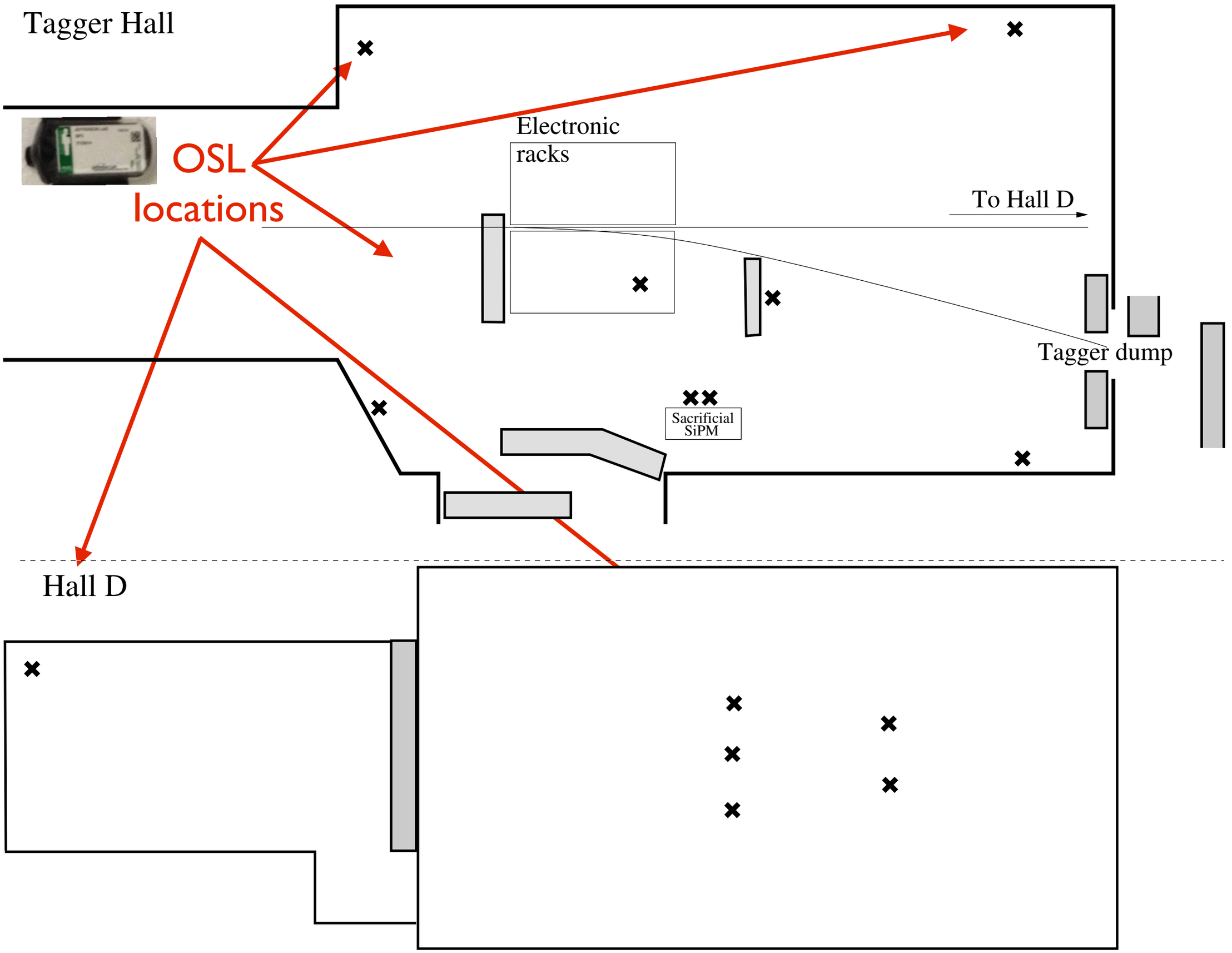
Goals:

- Verify that all beam line devices worked properly;
- Analyze radiation data;
- Compare measurements to CASA's expectations. Validate/ improve beam line transport model (work done with T. Satogata);
- Verify the calibrations of beam line devices;

Devices relevant to this analysis

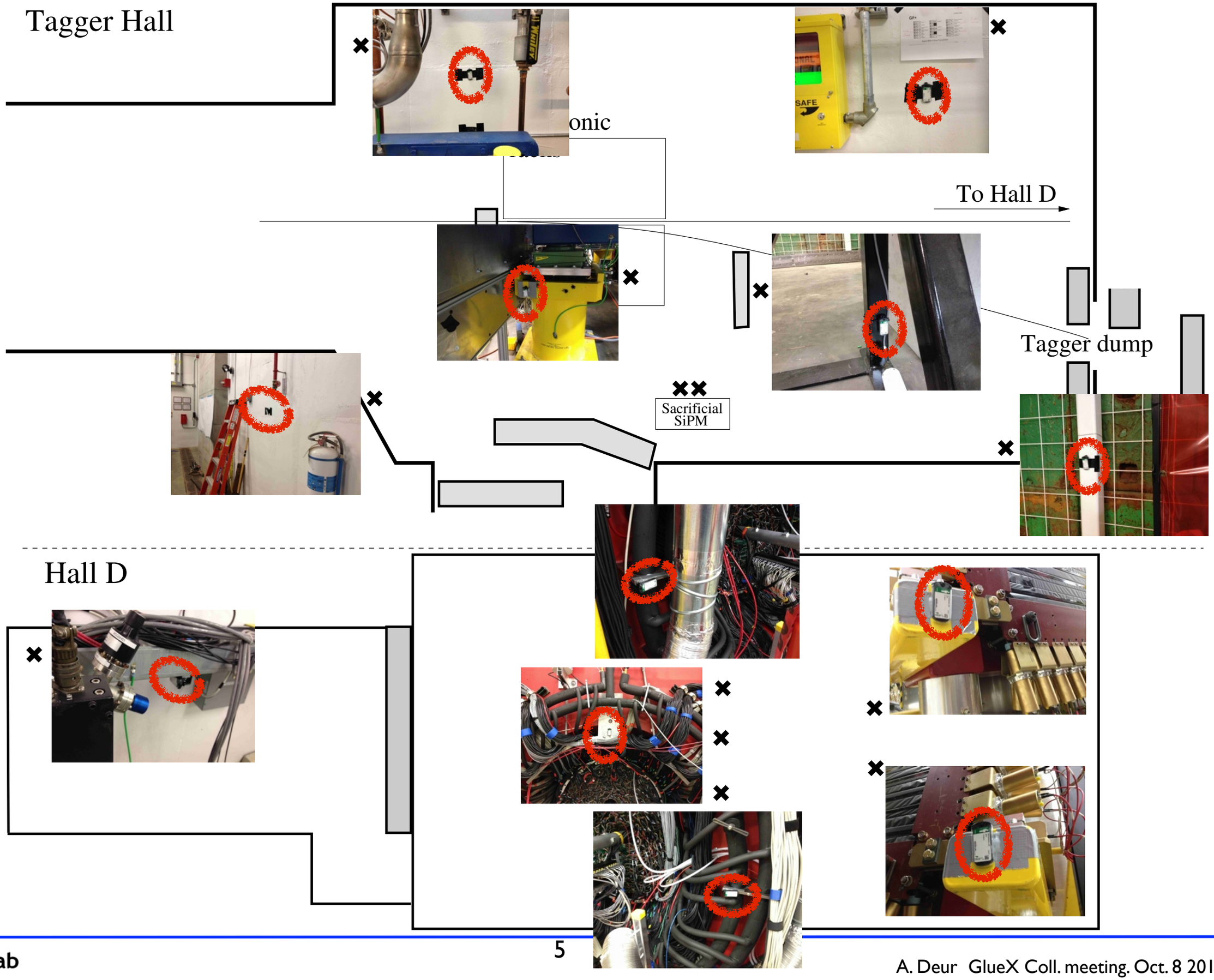


Late Fall 14 radiation report (before discussing Spring 15)



OSL Installed:

Late Fall 14 radiation report (before discussing Spring 15)



Doses for Fall 14 (in mrem)

10/08-10/28: 1.3 10^3 (ɣ) 3.2 10^3 (n)
10/28-11/11: 2.4 10^3 (ɣ) 400 (n)
11/11-11/19: 1.6 10^3 (ɣ) 380 (n)
11/19-12/02: 2.6 10^3 (ɣ) 490 (n)

10/08-10/28: 1.2 10^3 (ɣ) 870 (n)
10/28-11/11: 5.1 10^3 (ɣ) 930 (n)
11/11-11/19: 1.1 10^3 (ɣ) 170 (n)
11/19-12/02: 7.9 10^{3**} (ɣ) 1.5 10^3 (n)

Ele
racks

10/08-10/28: 3.1 10^3 (ɣ) 790 (n)
10/28-11/11: 420 (ɣ) 100 (n)
11/11-11/19: 38 (ɣ) 0 (n)
11/19-12/02: 320 (ɣ) 120 (n)

10/08-10/28: 1.0 10^4 (ɣ) 910 (n)
10/28-11/11: 1.9 10^3 (ɣ) 240 (n)
11/11-11/19: 1.3 10^3 (ɣ) 90 (n)
11/19-12/02: 4.1 10^3 (ɣ) 580 (n)

Tagger dump

10/08-10/28: 8.3 10^3 (ɣ) 1.3 10^3 (n)
10/28-11/11: 1.5 10^3 (ɣ) 170 (n)
11/11-11/19: 1.1 10^3 (ɣ) 140 (n)
11/19-12/02: 1.4 10^3 (ɣ) 260 (n)

sacrificial SiPM box, 10/08-10/28
inside: 1.1 10^4 (ɣ) 990 (n)
outside: 3.5 10^4 (ɣ) 3.5 10^3 (n)

10/08-10/28: 9.0 10^4 (ɣ) 4.6 10^3 (n)
10/28-11/11: NA (saturated?)

11/11-11/19: 1.8 10^4 (ɣ) 860 (n)
11/19-12/02: 8.7 10^4 (ɣ) 7.1 10^3 (n)

Hall D

10/08-10/28: 9.8 10^3 (ɣ) 7.7 10^3 (n)
10/28-11/11: 3.7 10^3 (ɣ) 2.7 10^3 (n)
11/11-11/19: 3.0 10^3 (ɣ) 2.0 10^3 (n)
11/19-12/02: 1.8 10^4 (ɣ) 1.3 10^4 (n)

10/08-11/11: 0 (ɣ) 0 (n)
11/19-12/02: 26 (ɣ) 0 (n)

10/08-11/11: 0 (ɣ) 0 (n)
11/19-12/02: 48 (ɣ) 0 (n)

10/08-11/11: 0 (ɣ) 0 (n)
11/19-12/02: 27 (ɣ) 0 (n)

10/08-11/11: 0 (ɣ) 0 (n)
11/19-12/02: 0 (ɣ) 0 (n)

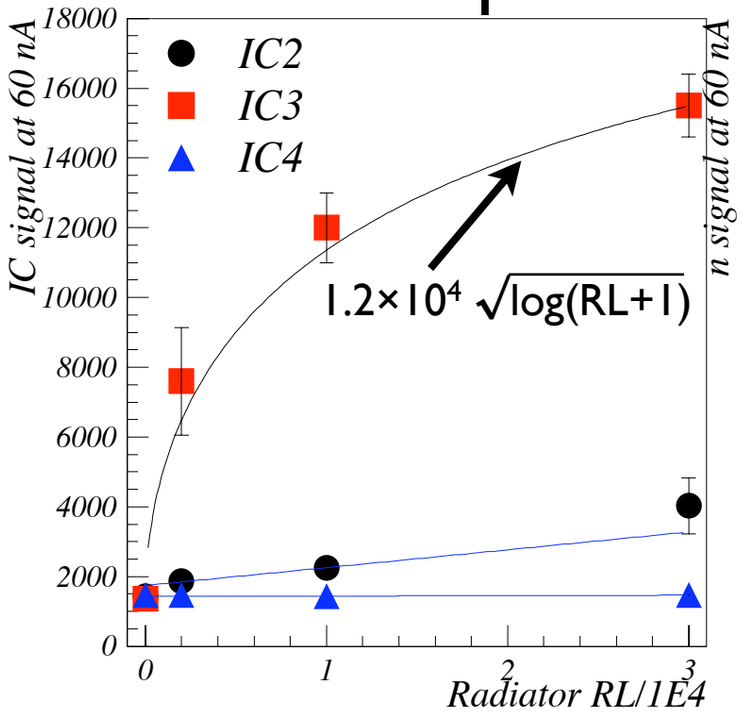
10/08-11/11: 0 (ɣ) 0 (n)
11/19-12/02: 0 (ɣ) 0 (n)

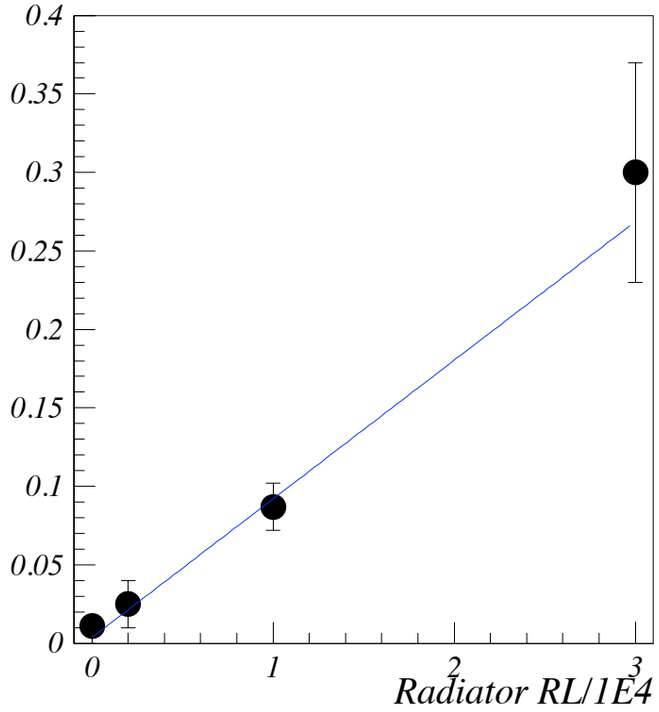
Spring 15 radiation monitoring results

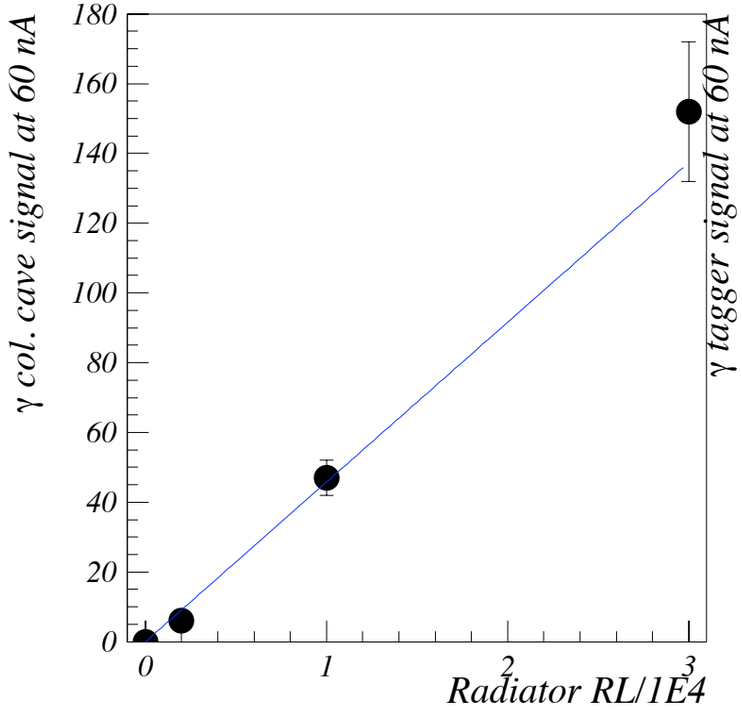
- Studied early radiation check data (Apr. 24th).
- Split the run period (Apr. 27th - May 4th) in 14 12h periods.
  - Studied time dependence of beam line devices and rad. monitors for each periods.
    - Found nothing special in the beam line data that could have triggered the solenoid quench.
  - Looked at most important correlations between devices for each periods
  - Looked at all correlations between for 4 periods.

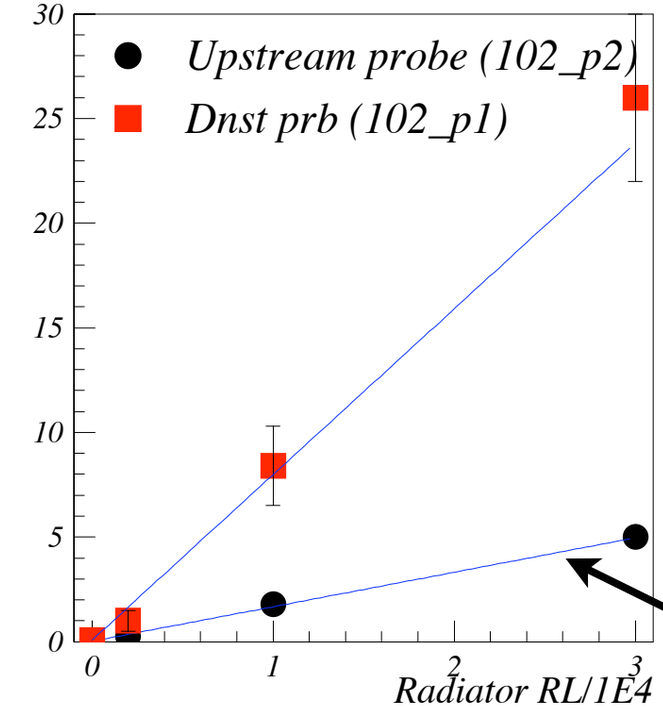
Early radiation test done on Apr. 24th

Rad. monitor dependences with radiator thickness









- See expected linear dependence with RL for γ and n probes.

- See expected log dependence for IC3. IC2 seems linear (this is seen with I_{beam} dep. too). Probably because exposed to low rates.

- IC0, IC1 and IC3 are insensitive to RL or beam current (unless the beam is not well tuned).

- During Fall14 run, 102_P2 was independent of RL, (unless shielded from the tagger with a steel plate).

Now, we see the expected RL dependence (no steel plate: removed 01/13/15).

Early radiation test done on Apr. 24th

Hard to compare with Fall 14 run: different shielding config., 5.5 vs 10.1 GeV, different beam tune.

We can compare data normalized to a probe (e.g. 102_p1: downstream γ-probe):

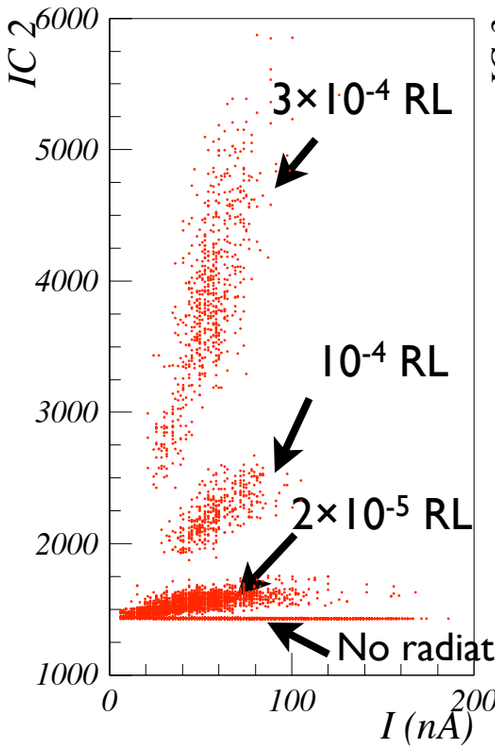
- 102_p2/102_p1 was 10% higher in Fall14 compared to Spring15 (102_p2 is linear with RL when iron roof shielding is present: end of Fall14 & Spring15 configs.).

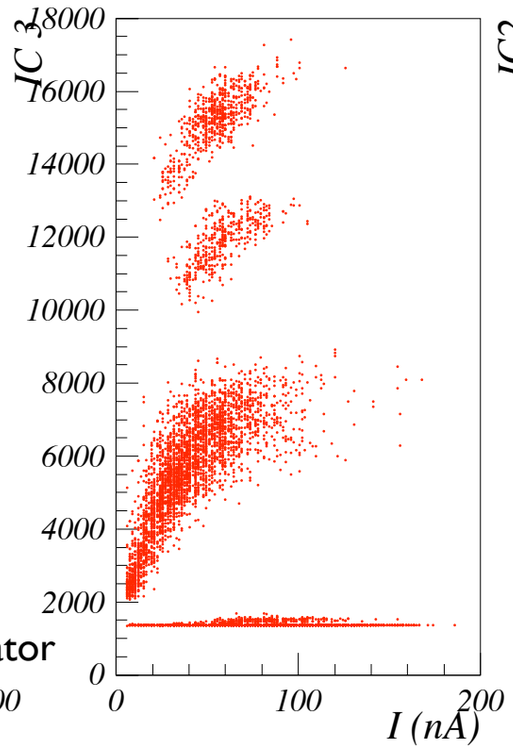
- 101_p1/102_p1 was 20-50% higher in Fall14 compared to Spring15.

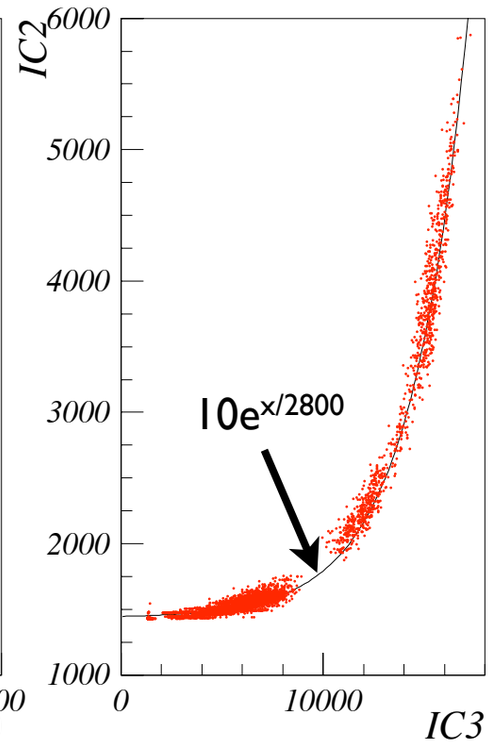
- 102_p3/102_p1 was a factor 6 higher in Fall14 compared to Spring15 (data without polyethylene shielding). Due to beam dump wall polyethylene addition?

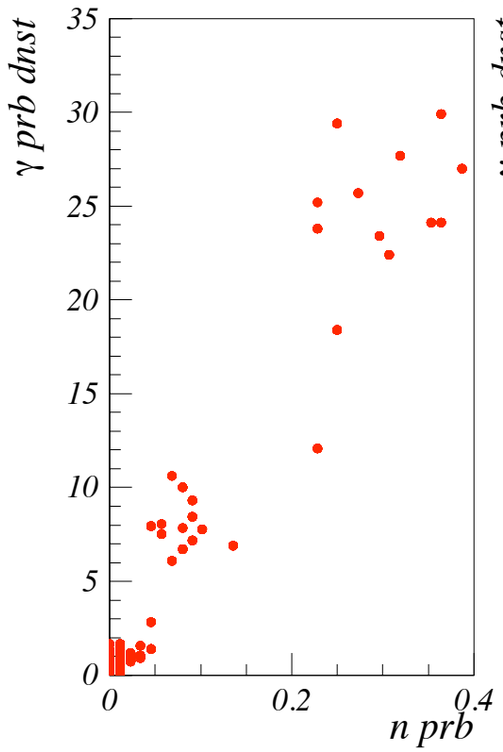
Early radiation test done on Apr. 24th

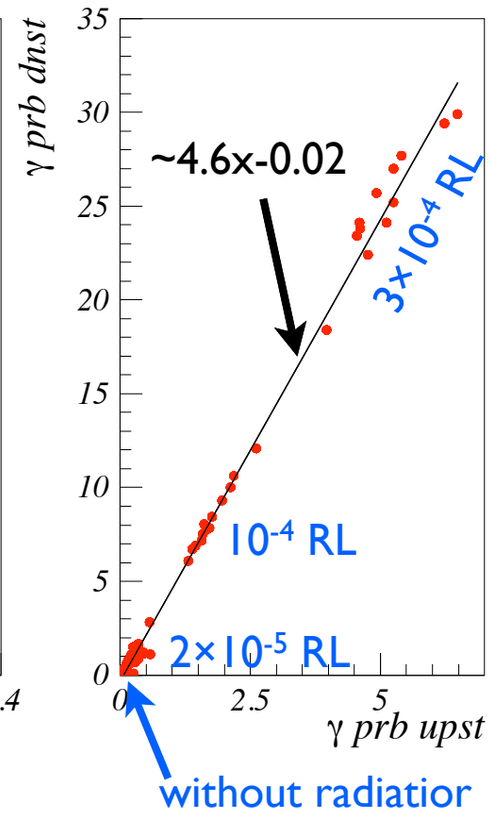
Rad. monitor dependences with I_{beam} and radiator thickness

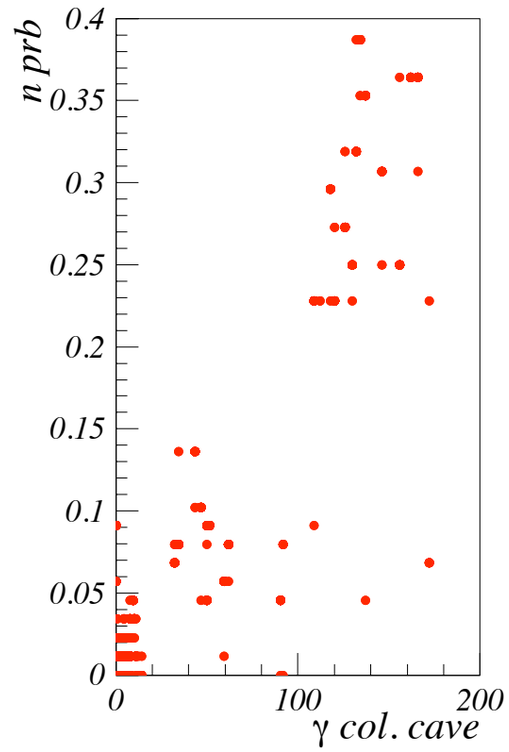








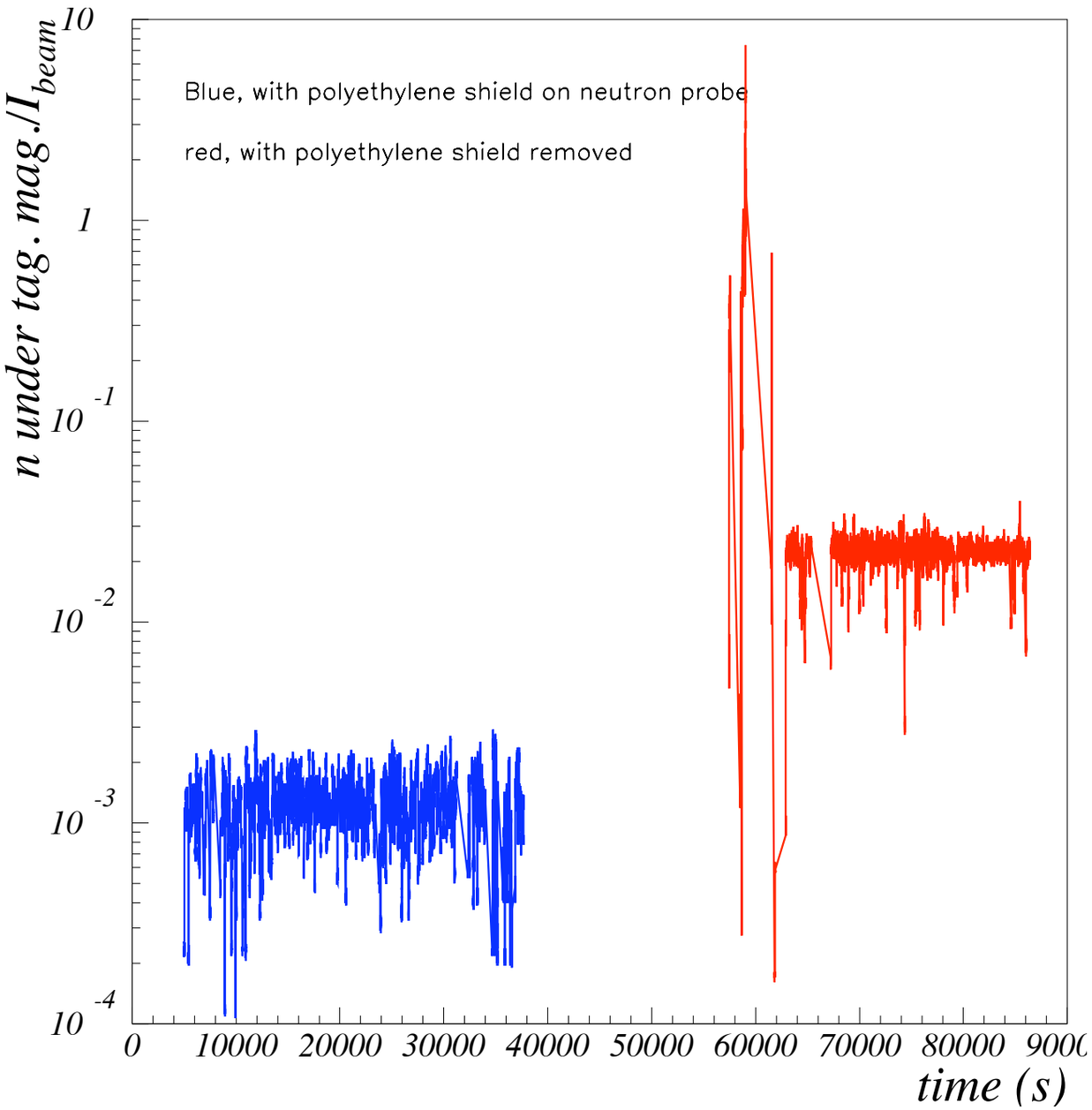




- See expected dependence with RL and I_{beam}.
- See expected correlations between rad. monitors due to their common dependence with I_{beam} and RL.
- Fit coef. for 102_p1 vs 102_p2 depends sigthly on RL:
  - 3.15±0.27 without radiator
  - 3.28±0.23 for 2×10^{-5} RL
  - 4.73±0.18 for 10^{-4} RL
  - 4.89±0.09 for 3×10^{-4} RL

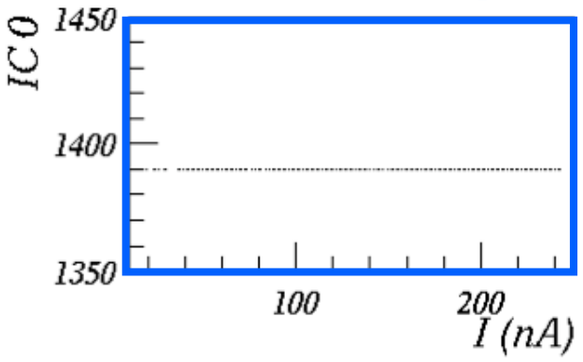
Detailed analysis shows that this is due to a small remnant of the RL-independent background.

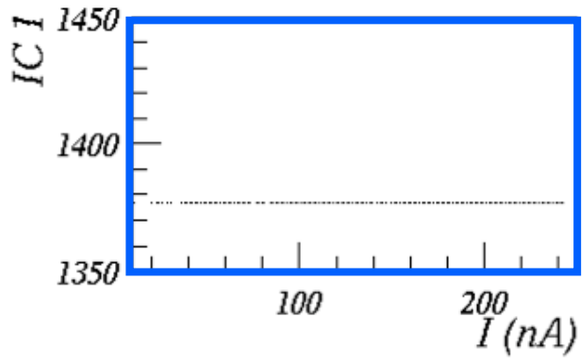
Effects of shielding

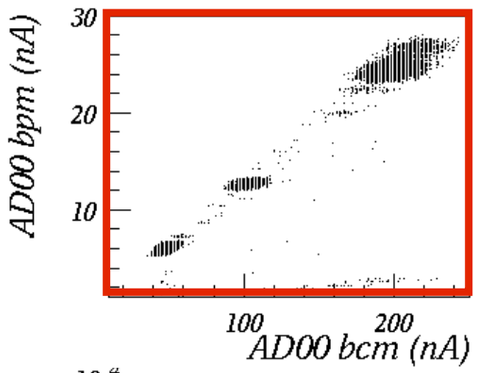


- 10cm thick borated polyethylene shield decreases n probe signal by factor ~18.
- Also: Effect of 2.85cm-thick steel shield box on ɣ-probe (collimator cave): ~factor 2.

Data from May 1st, afternoon: I_{beam} varies, Beam pos. stable ⇒ Check dependence with I_{beam}.



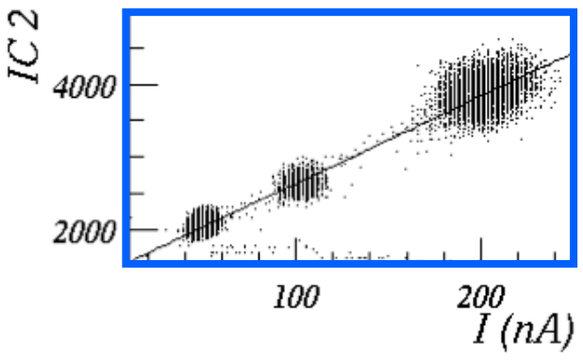


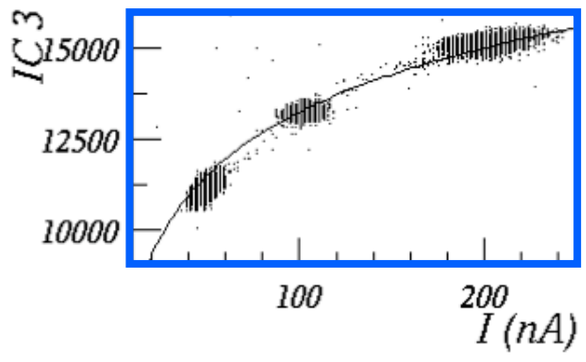


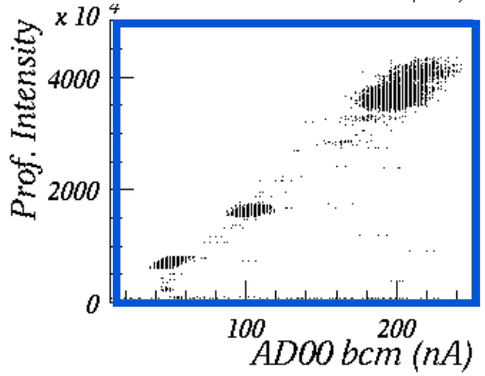
Blue: Expected

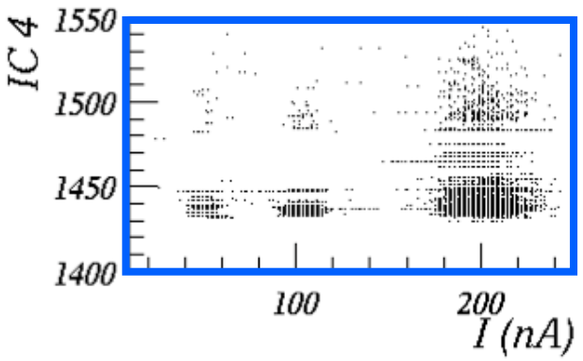
Red: unexpected

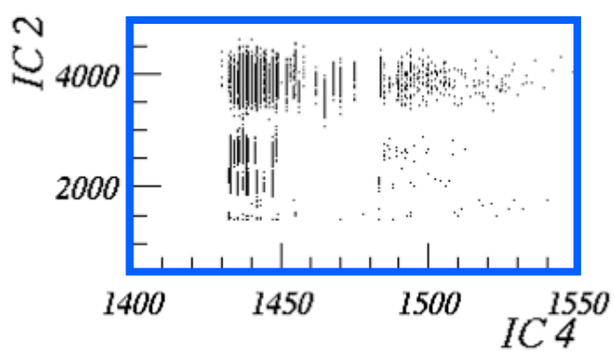
Beam current measurements:
AD00 BPM not calibrated.
AD00 BCM several times noisier.

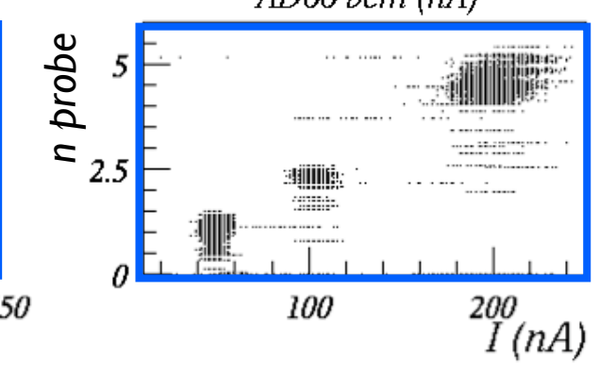


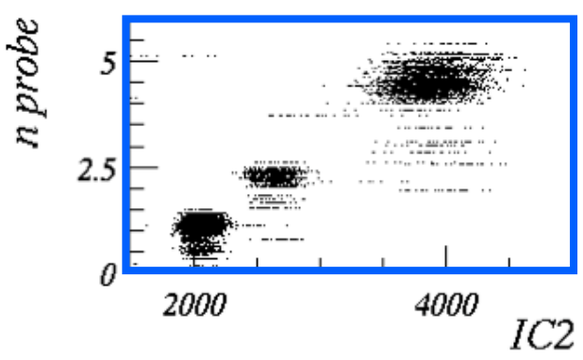


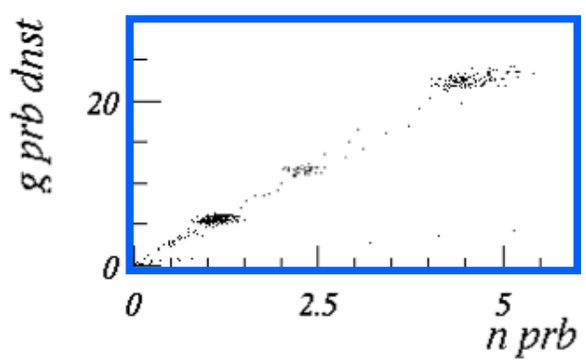


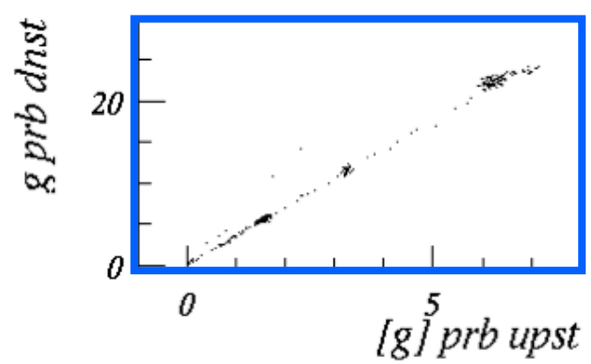


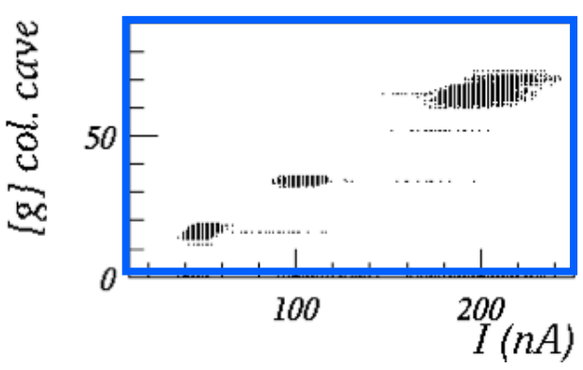


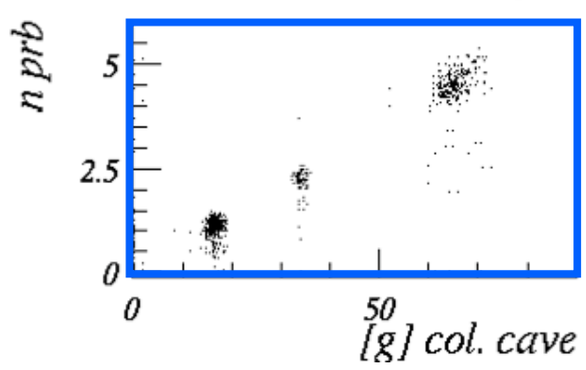












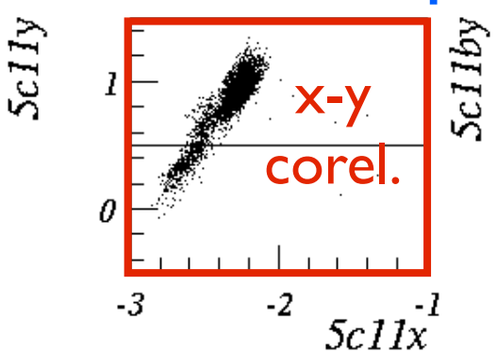
Data from May 1st, afternoon

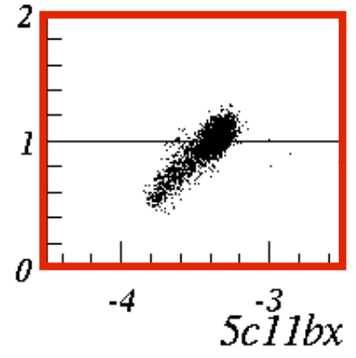
Blue: Expected Red: unexpected Magenta: I don't know

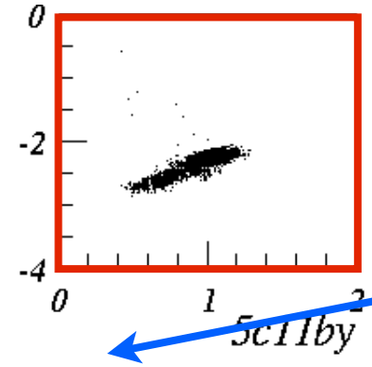
	I beam	IC0	IC1	IC2	IC3	IC4	n prb	γ prb dwstr	γ prb upstr	γ col cave	Int. Mon	5c11 x	5c11 y	5c11b x	5c11b y	AD00 x	AD00 y	A.C.x	A.C.y	Prof.x	Prof.y	γ x-ang	γ y-ang
I beam	c	ns	ns	c	c	ns	c	c	c	c	c	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
IC0		c																					
IC1			c																				
IC2				c	c	ns	c	c	c	c		nc	nc			nc	nc					nc	nc
IC3					c							nc	nc			nc	nc					nc	nc
IC4						c	ns	ns	ns	ns	ns	nc	nc			nc	nc					nc	nc
n probe							c			c		nc	nc			nc	nc					nc	nc
γ prb dwstr								c	c													nc	nc
γ prb upstr									c			nc	nc			nc	nc					nc	nc
γ col cave										c						nc	nc	nc	nc				
Int. Mon.											c	c	c					c for I>150na nc I<150	c for I<80na nc I>80			c for I>150na nc I<150	c for I<80na nc I>80
5c11 x												c	small corel.	c	small corel.	nc		nc					
5c11 y													c		c	nc			nc				
5c11b x														c	small corel.	nc							
5c11b y															c		c						
AD00 x																c	nc	nc					
AD00 y																	c		c				
A.C.x																		c	nc	small c		c	nc
A.C.y																			c		c	nc	c
Prof.x																				c			
Prof.y																					c		
γ x-ang																						c	
γ y-ang																							c

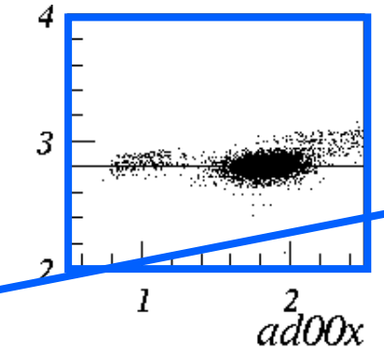
NS: No signal above threshold when beam is well tuned

Data from Apr 28th, morning: I_{beam} stable, Beam pos. varies ⇒ Check dependence with beam pos.

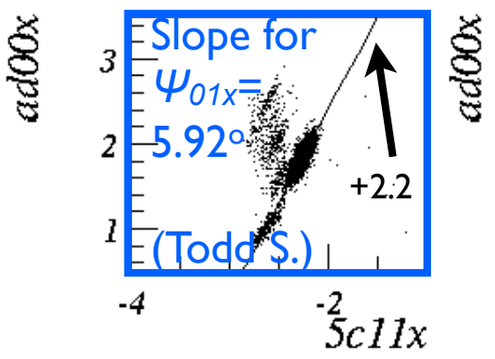


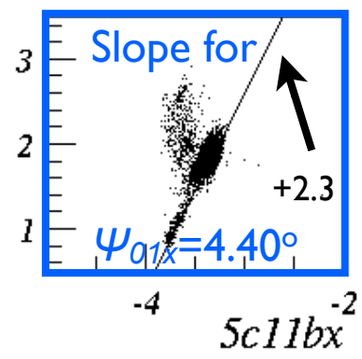


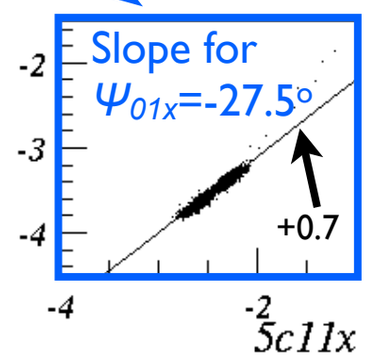


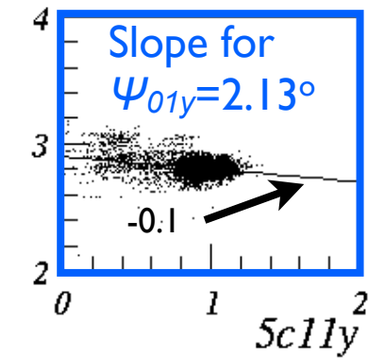


The Ψ_{01} may be inconsistent (?) but slope sign is right.

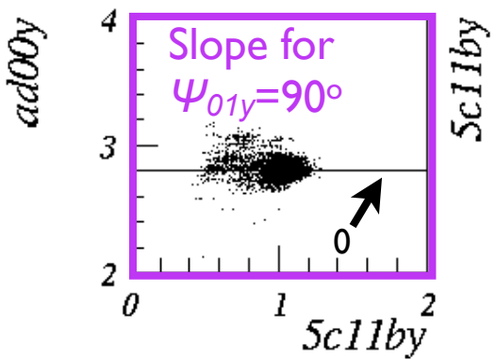


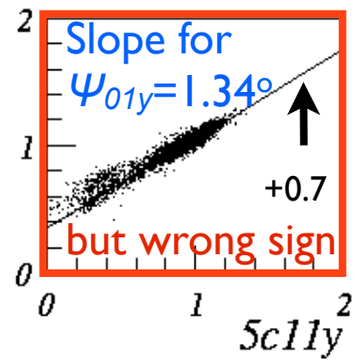


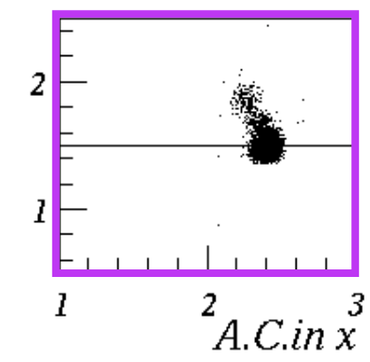


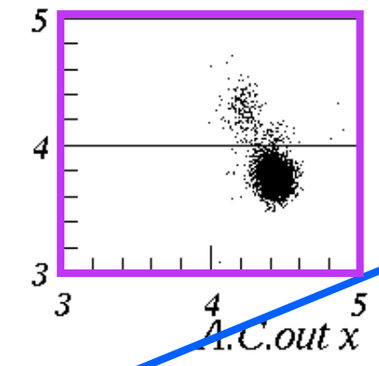


No correl. expected if e⁻ beam is y-focused on tagger dump.

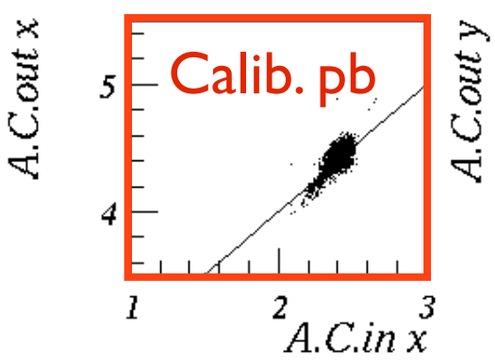


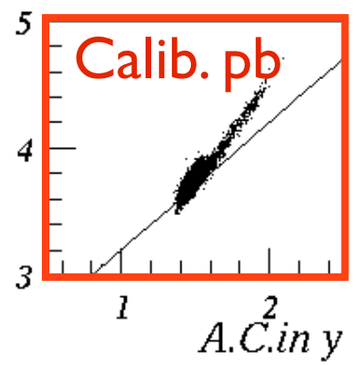


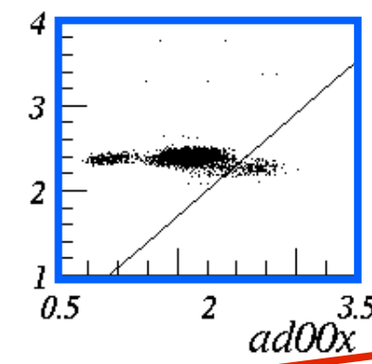


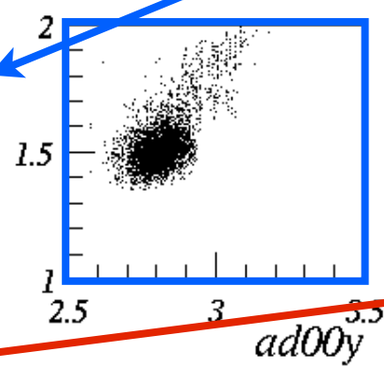


No correl. expected if ɣ-beam is x-focused on A.C. (but shouldn't we expect a y-focused beam?)

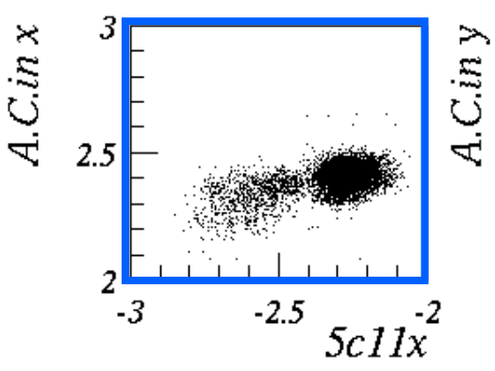


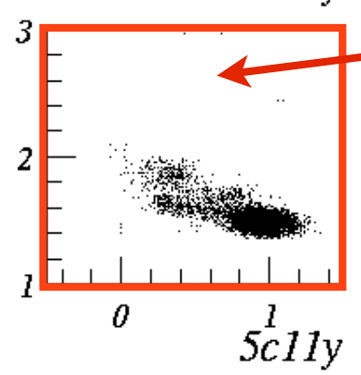


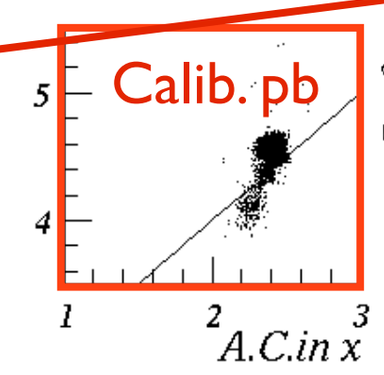


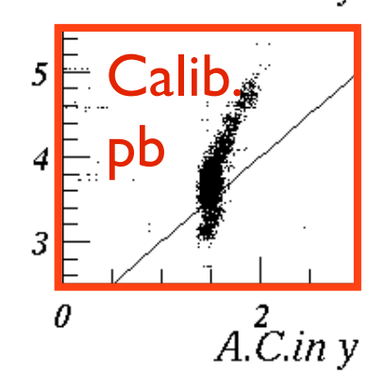


Anti-correl. may be explained by overfocusing ɣ-beam but this is not compatible w/ a x-focused beam

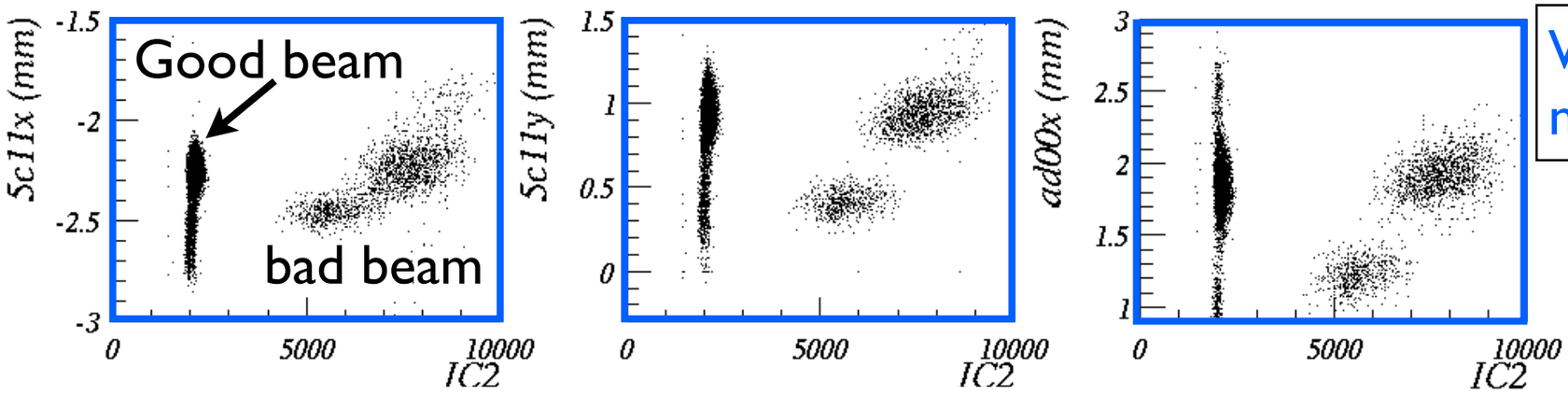




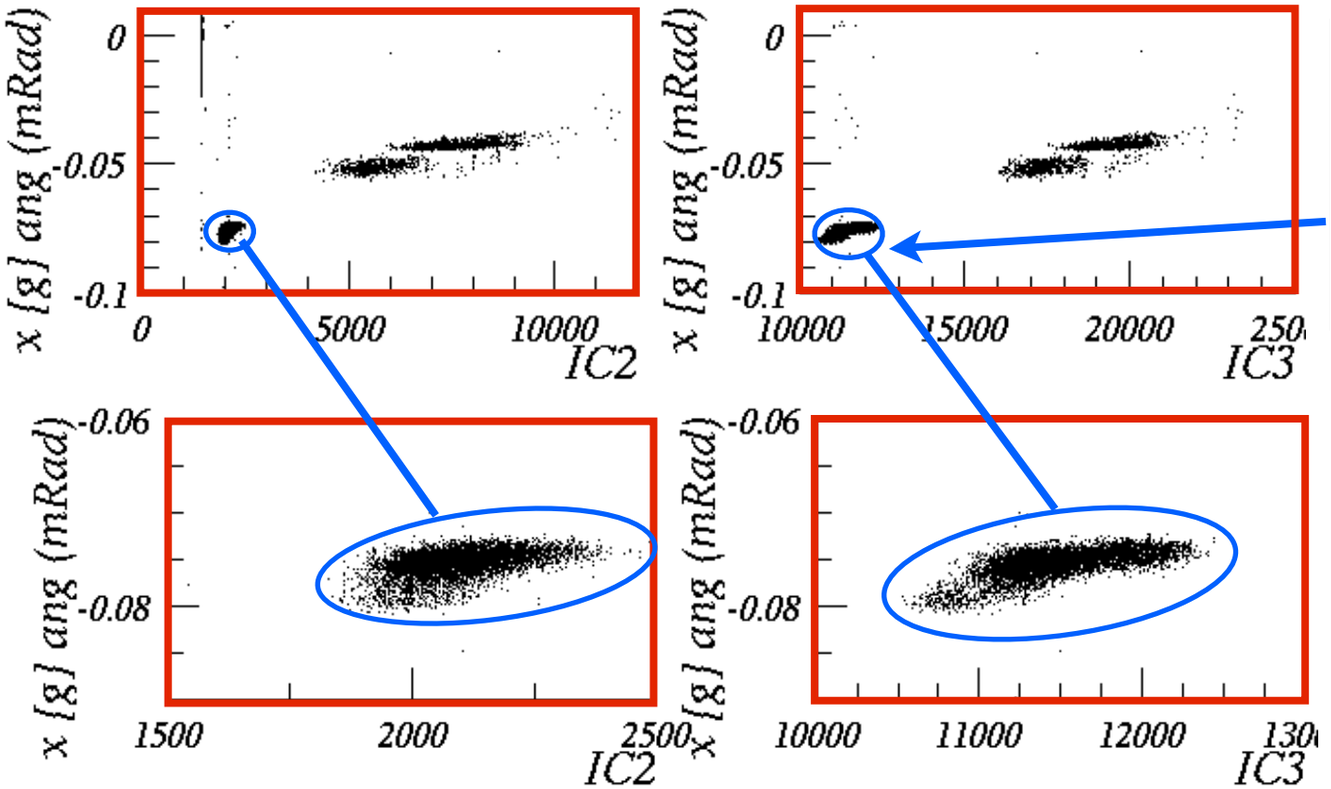




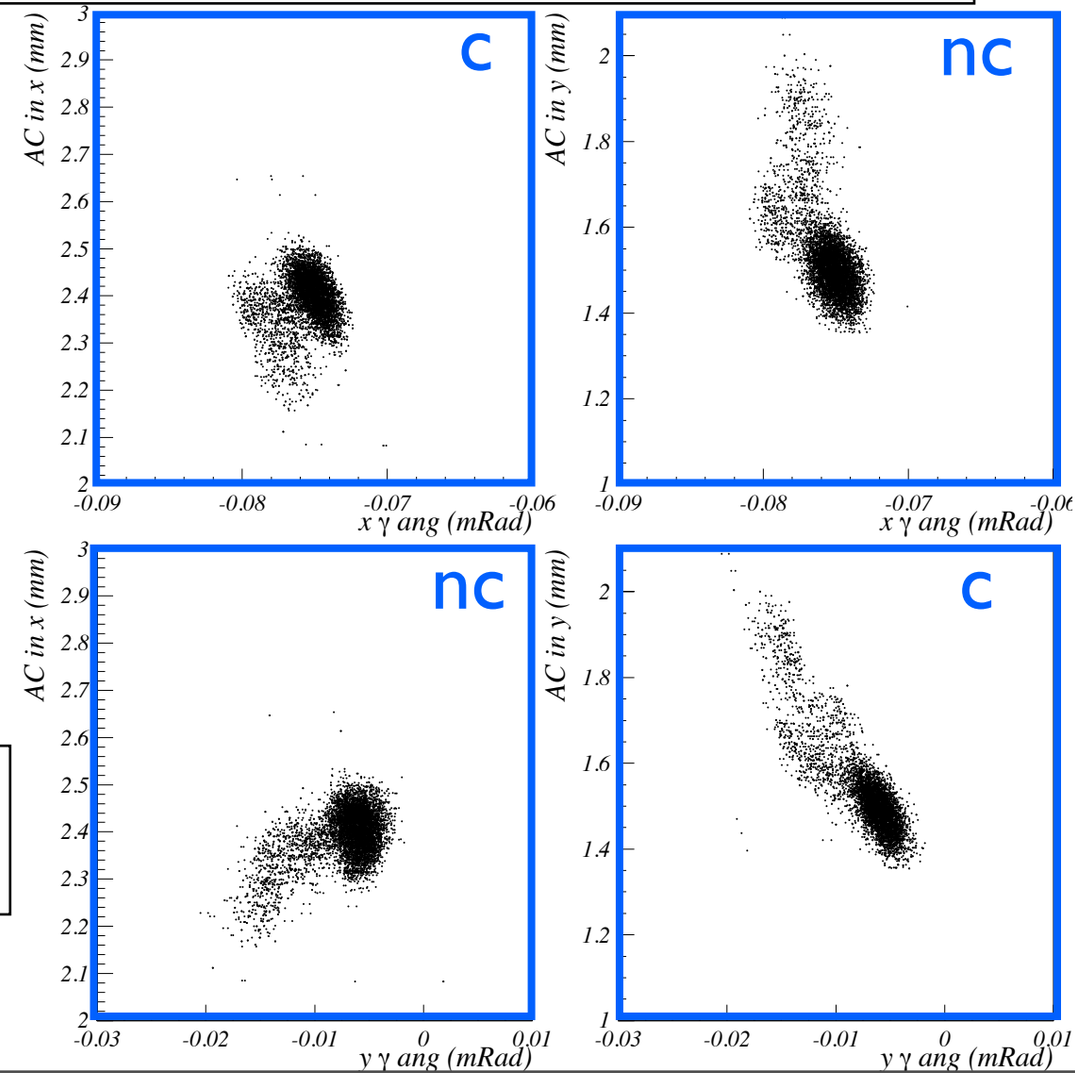
Data from Apr 28th, morning: I_{beam} stable, Beam pos. varies ⇒ Check dependence with beam pos.



When beam is good, rad. mon. are not correlated with beam positions.



Some correlation between IC levels and ɣ-beam angle, even with good beam.
(y-correlation is much smaller)



Correlations between A.C and ɣ- beam angle.

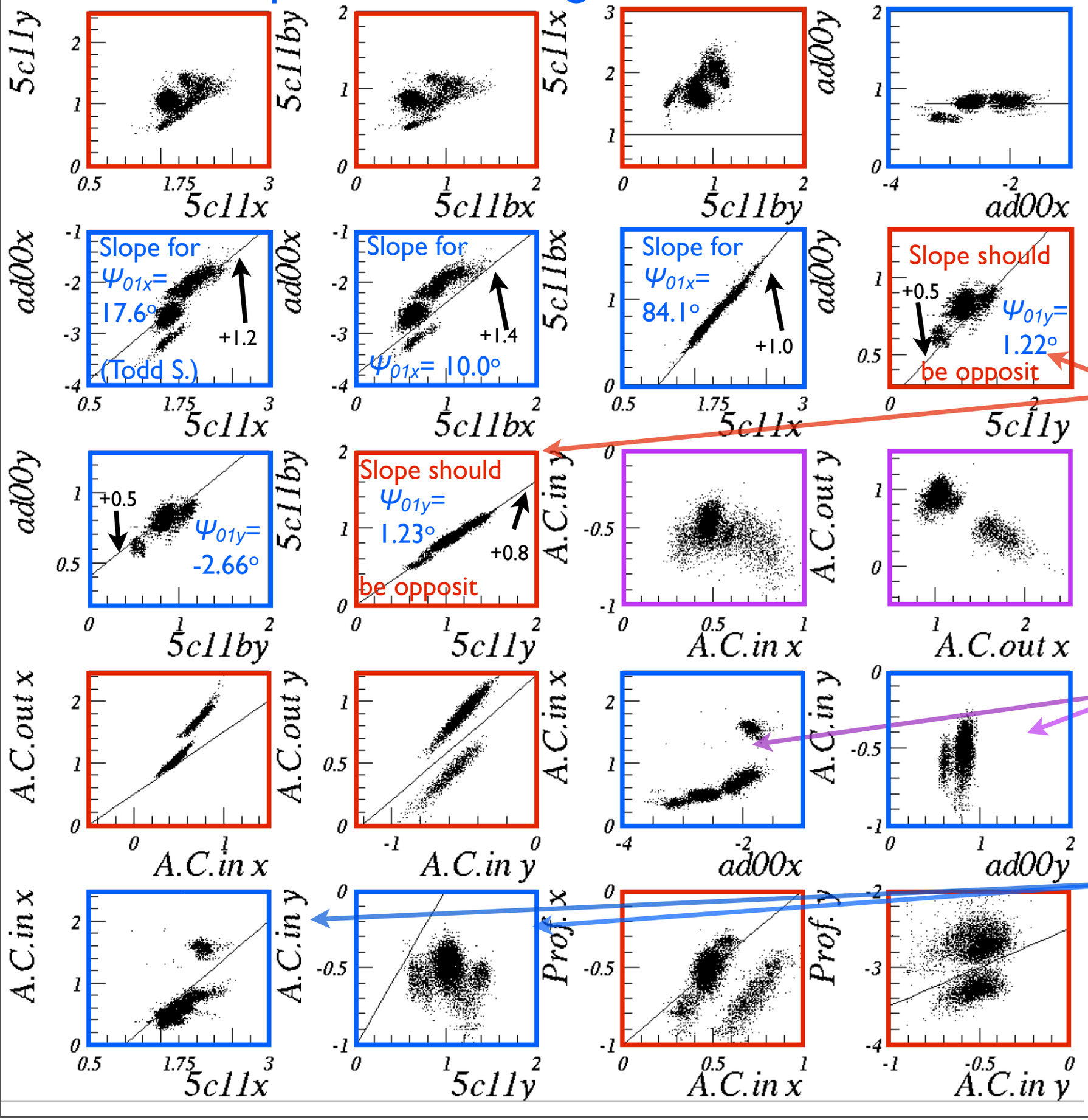
Data from Apr 28th, morning:

Blue: Expected Red: unexpected Magenta: I don't know

	I beam	IC0	IC1	IC2	IC3	IC4	n prb	γ prb dwstr	γ prb upstr	γ col cave	Int. Mon	5c11 x	5c11 y	5c11b x	5c11b y	AD00 x	AD00 y	A.C.x	A.C.y	Prof.x	Prof.y	γ x-ang	γ y-ang
I beam	C	ns	ns	C	C	ns	C	C	C	C	NA	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc	nc
IC0		C																					
IC1			C																				
IC2				C	C	ns	C	C	C	C	NA	nc	nc			nc	nc					C	C
IC3					C						NA	nc	nc			nc	nc					C	C
IC4						C	ns	ns	ns	ns	NA	nc	nc			nc	nc					nc	nc
n probe							C			C	NA	nc	nc			nc	nc					nc	nc
γ prb dwstr								C	C		NA											nc	nc
γ prb upstr									C		NA	nc	nc			nc	nc					nc	nc
γ col cave										C	NA					nc	nc	nc	nc				
Int. Mon.											C	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5c11 x												C	C	C	C	C		C					
5c11 y													C		C		C		C				
5c11b x														C	C	C							
5c11b y															C		C						
AD00 x																C	nc	nc					
AD00 y																	C		C				
A.C.x																		C	??	C		C	C
A.C.y																			C		C	C	C
Prof.x																				C			
Prof.y																					C		
γ x-ang																						C	
γ y-ang																							C

NS: No signal NA **above threshold when beam is well tuned**

Data from Apr 29th, morning: I_{beam} stable, Beam pos. varies ⇒ Check dependence with beam pos.



Confirm Apr. 28 data except:

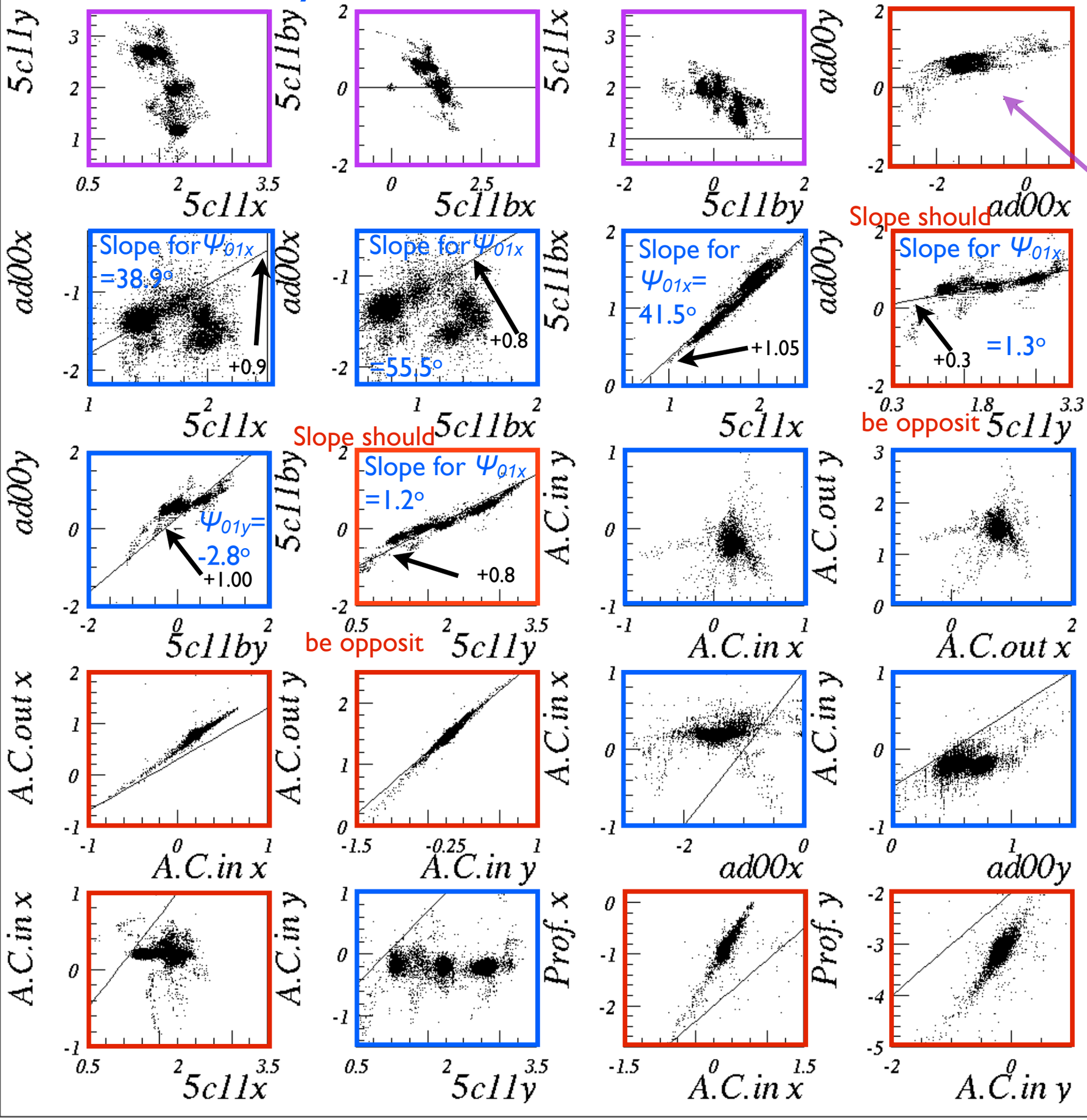
- wrong sign for y BPM correlations, except AD00 vs 5c11b

- Now ad00x and ACx are correlated, but not y.

- 5c11 and AC show expected correlations if beam is y-focused on AC.

Data from May 4th:

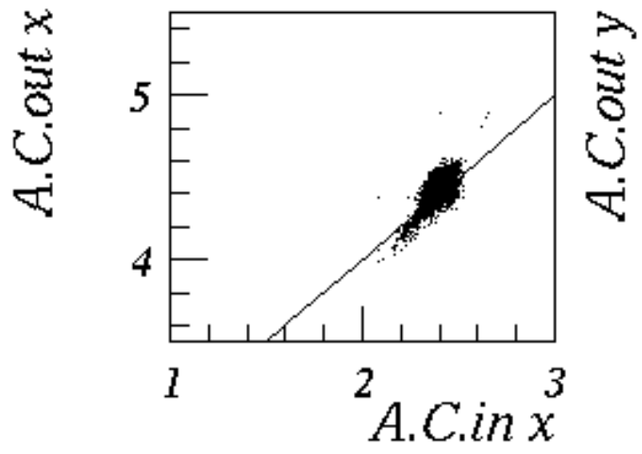
I_{beam} stable, Beam pos. varies ⇒ Check dependence with beam pos.

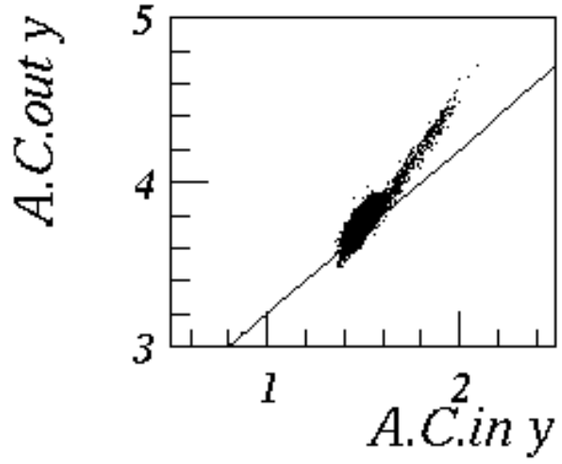


Confirm Apr. 28 data except:

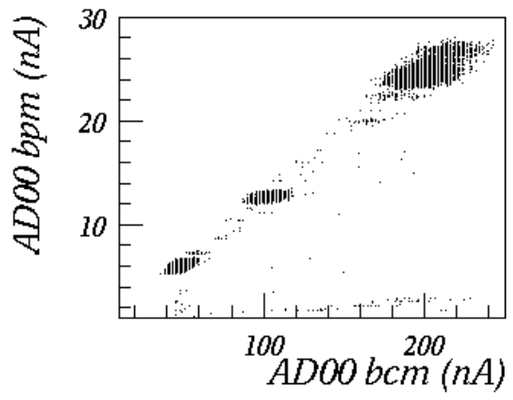
- Unclear if x-y are correlated. If they are, now it is anticorelated except for AD00 which now shows a correlation).

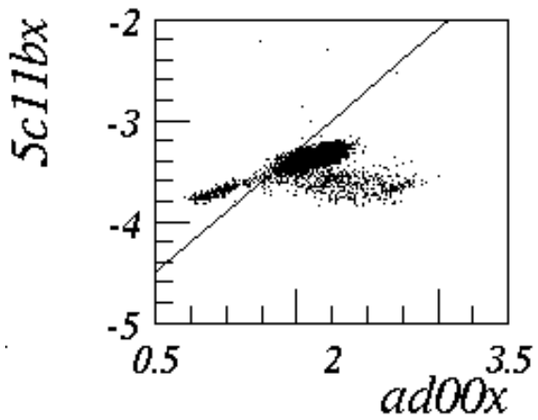
Calibration problems?

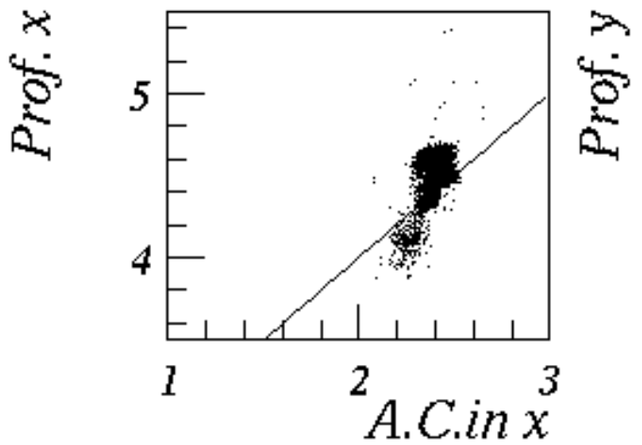


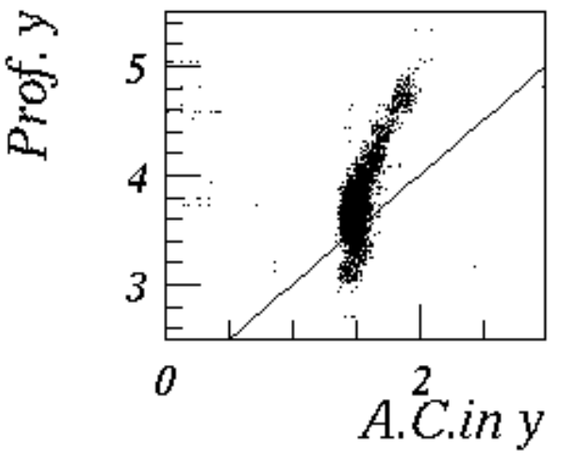


← Origin: Fall 2014 calibration was used during the Spring 2015 run (Alex Barnes/R. Jones).









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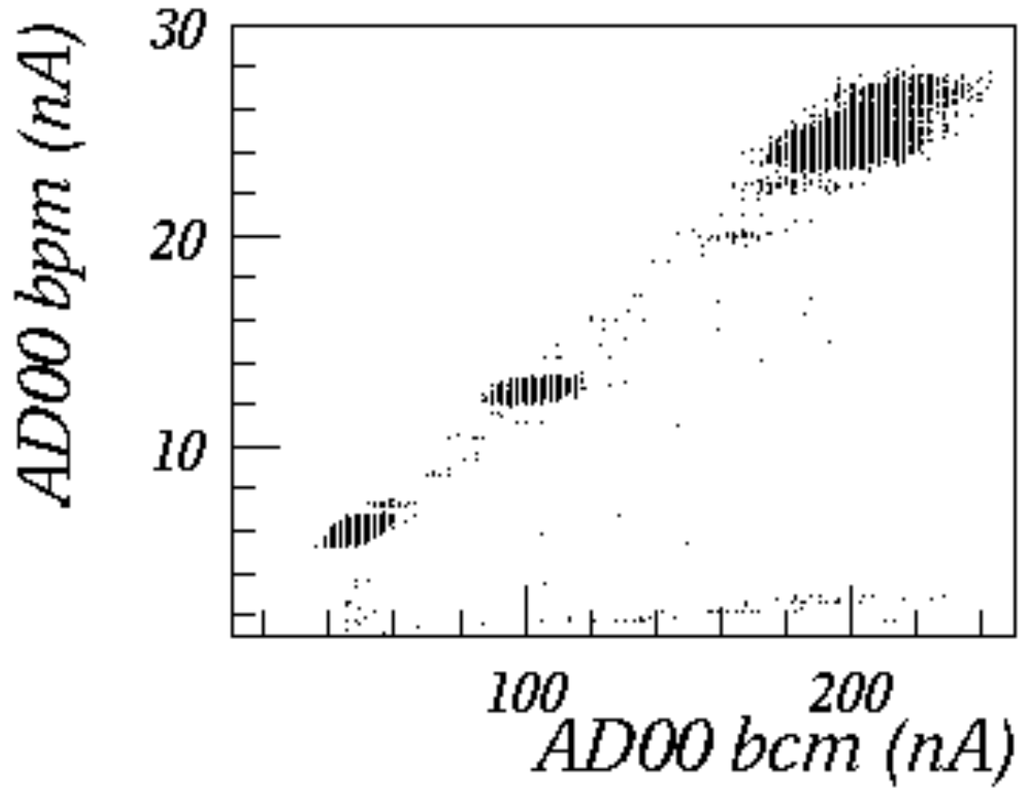

AD00 BPM not calibrated.
AD00 BCM several times noisier.

Conclusions

Radiation data show expected dependence.

It is hard to compare with Fall14 run. Likewise, it will be hard to compare Spring15 run with any other future runs.

Most of beam position correlations seem good, except:

- x-y coupling for 5c11 and 5c11b.
- Some BPM-y slopes seems to have the wrong sign.
- Slope prediction depends sharply on phase parameter Ψ_{01}.

T. Satogata model predicts Ψ_{01}~2.6° but actual values vary widely due to sharp dependence (e.g. in the 5c11x vs 5c11by correlation, the slope changing from 1.0 to 1.05 from Apr. 29th to May 4th makes Ψ_{01} to change by 43°). Ψ_{01} is also time dependent.

- Unexpected correlations seem to depend on beam tuning.
- To really check the model, one needs dedicated tests with controlled beam dithering (*via* correctors). Todd will propose a run plan for such study for the Fall 15 run.

There are some calibrations problems: A.C. Profiler, possibly BPMs.

No precise I_{beam} measurement is available in Hall D: BCM is too noisy, BPM is not calibrated.

Analysis note on all this is nearly ready.

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