

Lumi Analysis for HAPPEX III / PREX

Presented by:

Luis Mercado

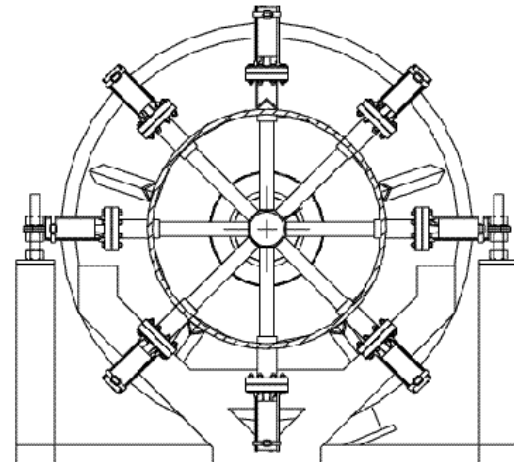
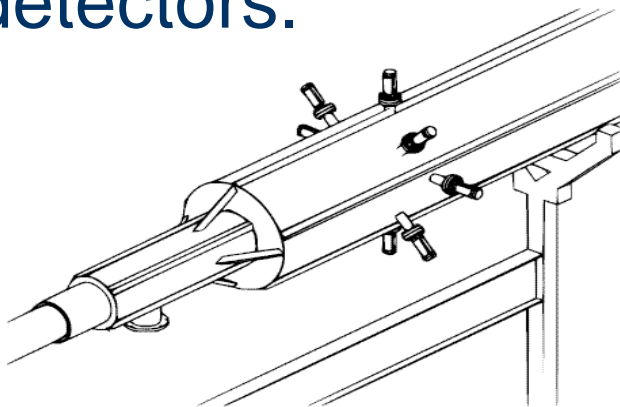
UMass - Amherst

5/18/2007



“Lumi” Setup

- Used as diagnostic for experimental setup (beam-line, instrumentation and target).
- Located 7m from the target.
- Consists of eight symmetrically placed detectors.



Reason for Analysis

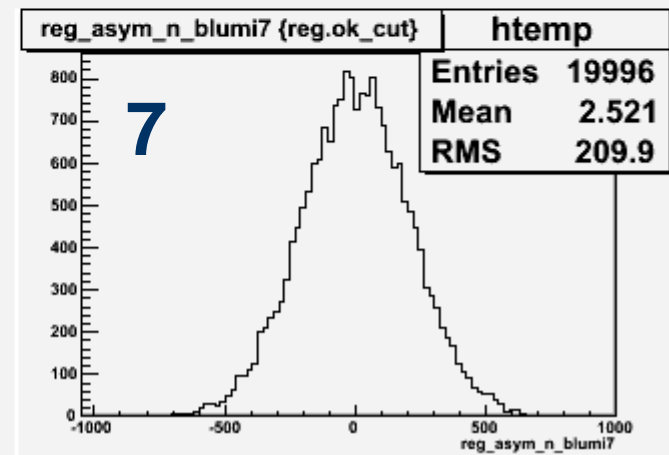
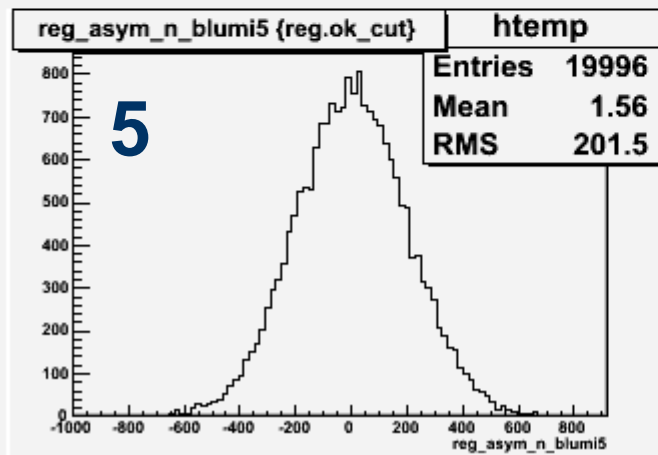
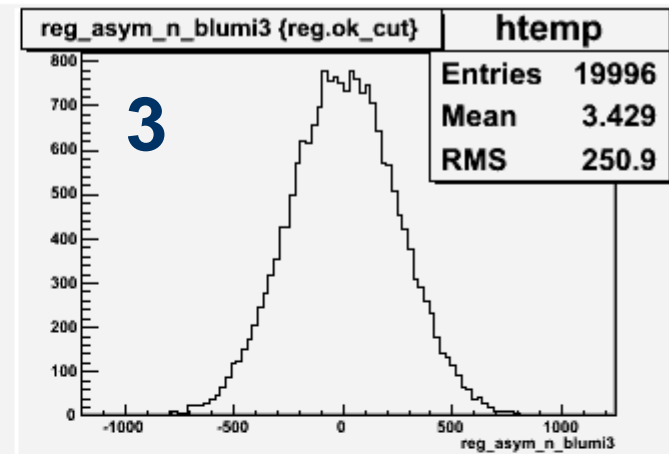
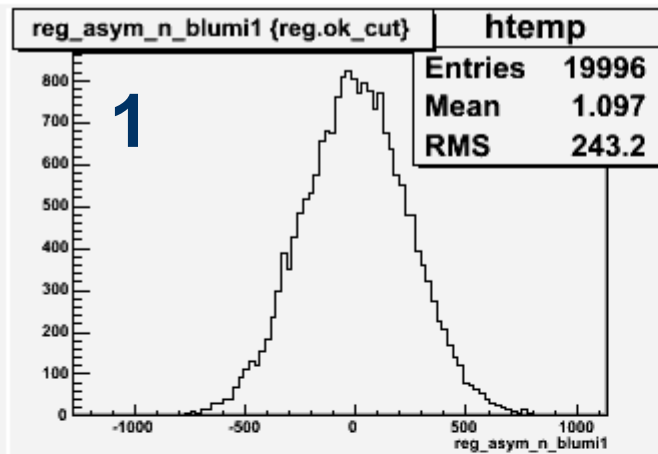
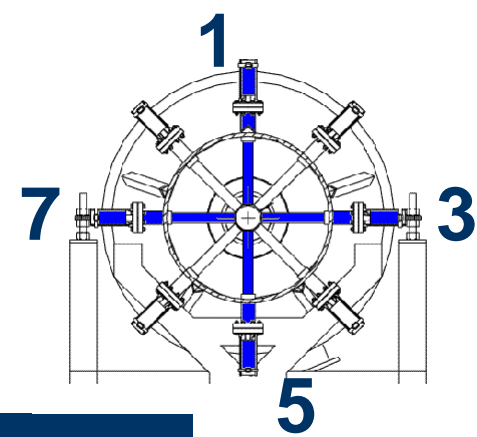
- Lumis are sensitive to very small scattering angles ($\sim 0.5^\circ$), where any measured asymmetries should go to zero.
- Width of integrated signal gives an idea of the intrinsic noise of the experimental setup.
- Want noise to be $< 100\text{ppm}$. Noise is defined as width of asymmetry distribution for 15Hz pulse pair.

Analysis of '05 Run #5637

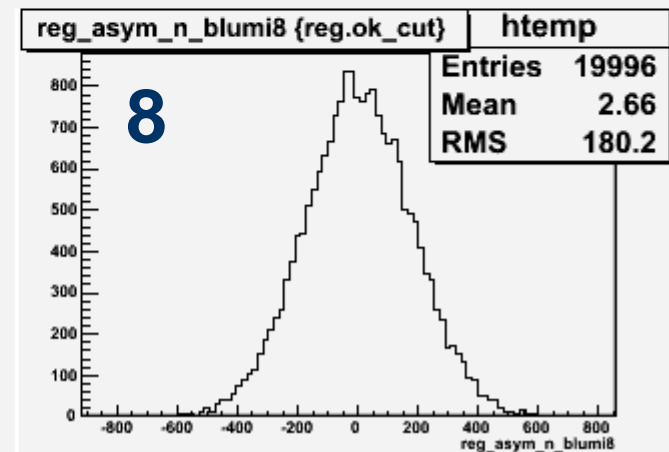
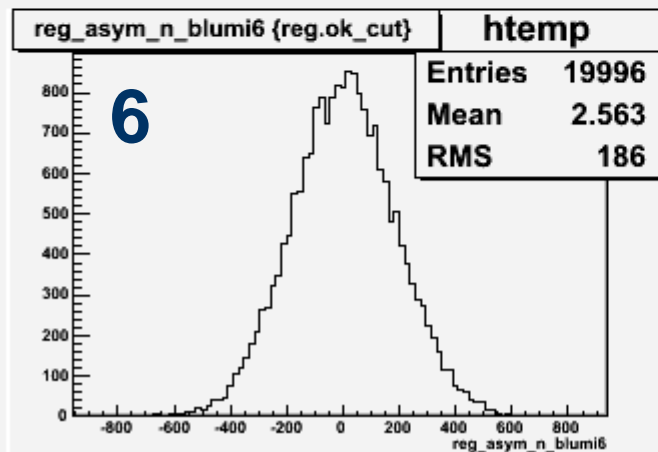
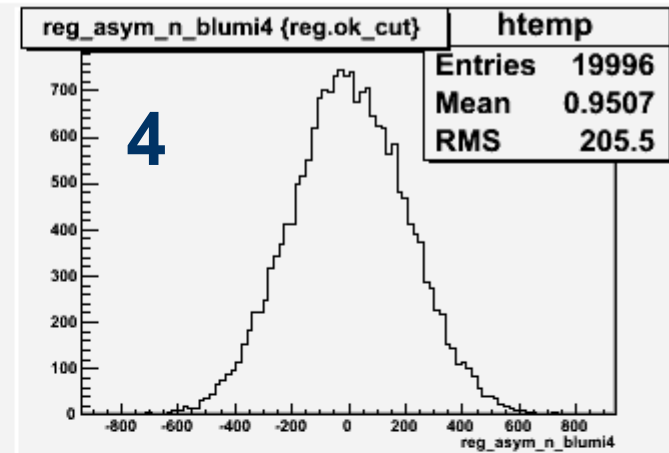
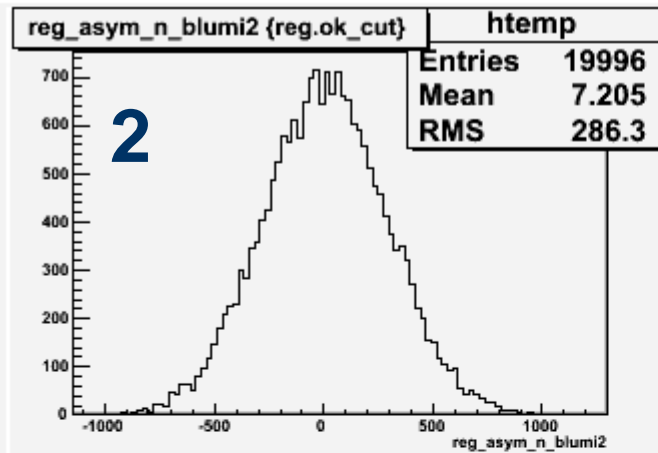
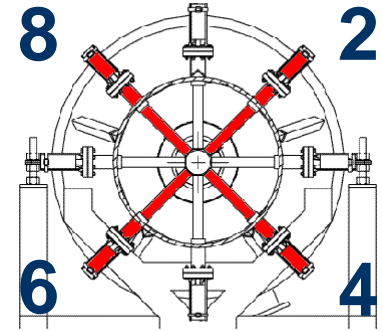
- Data acquired on 10/17/05 with beam current of 40uA on a LH2 target.
- RMS values are regressed with respect to position and current.

Lumi ID	Reg. RMS [ppm]
1	243
2	286
3	251
4	206
5	202
6	186
7	278
8	192

'05 RMS Values I



'05 RMS Values II

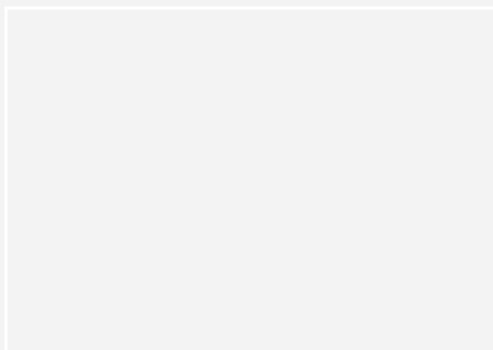
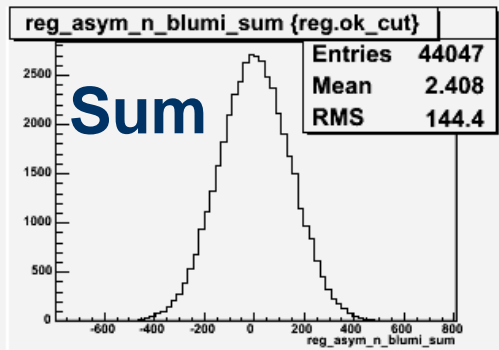
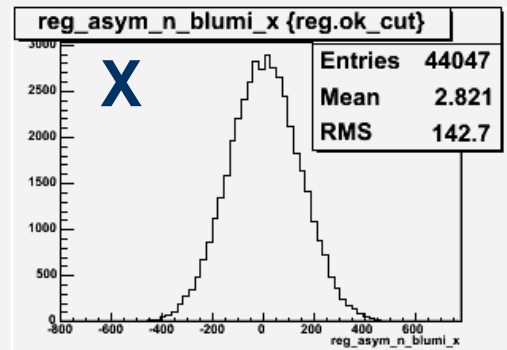
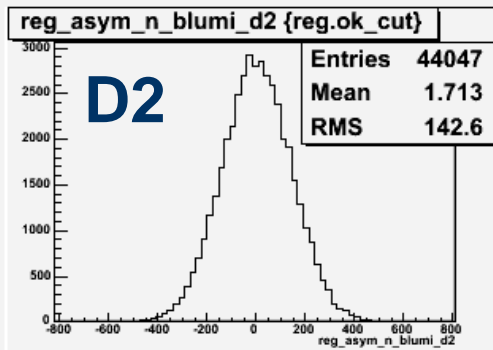
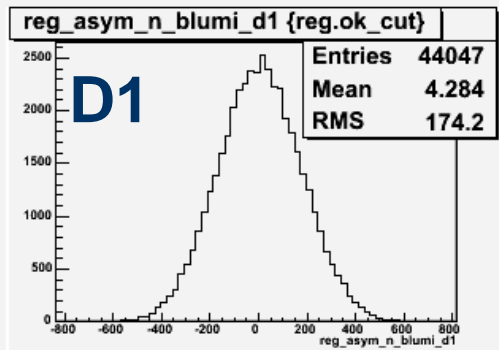
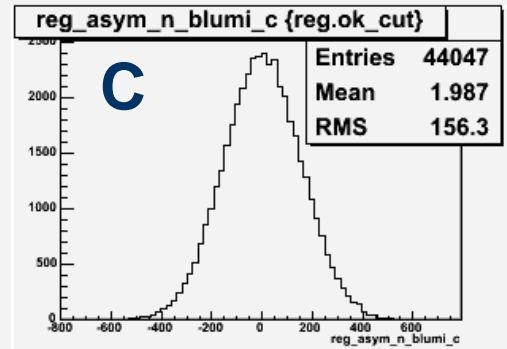
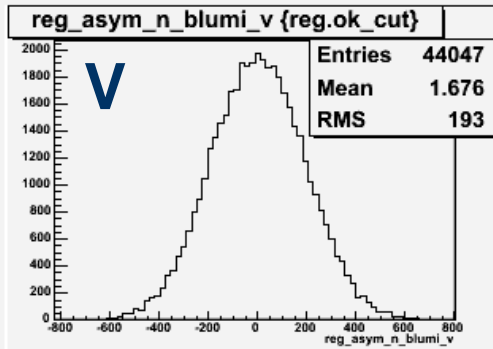
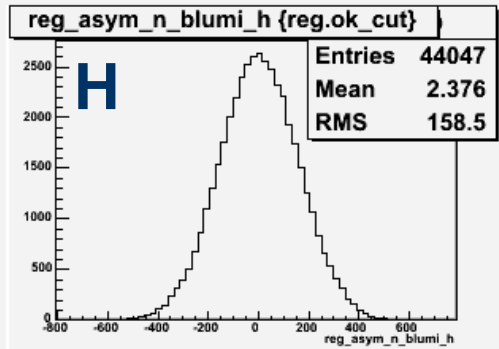


Weighed Combinations

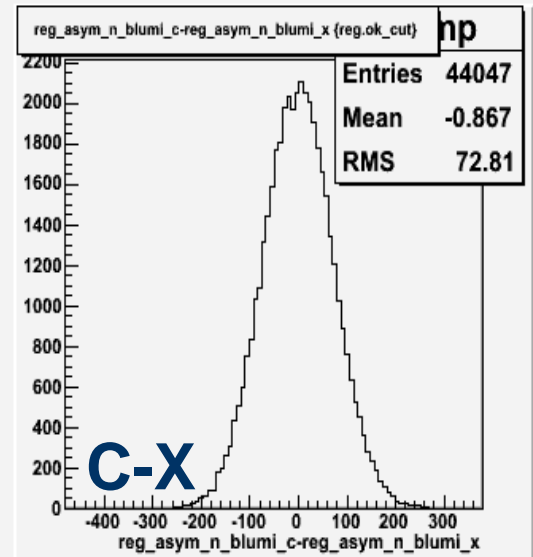
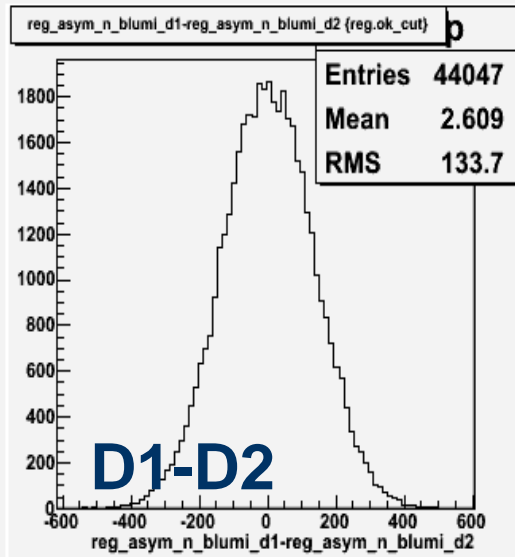
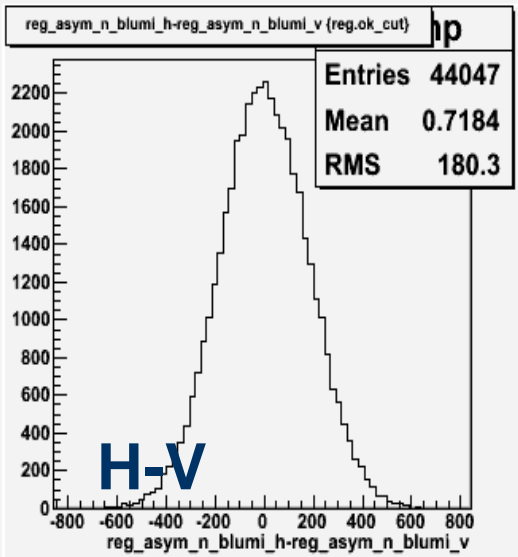
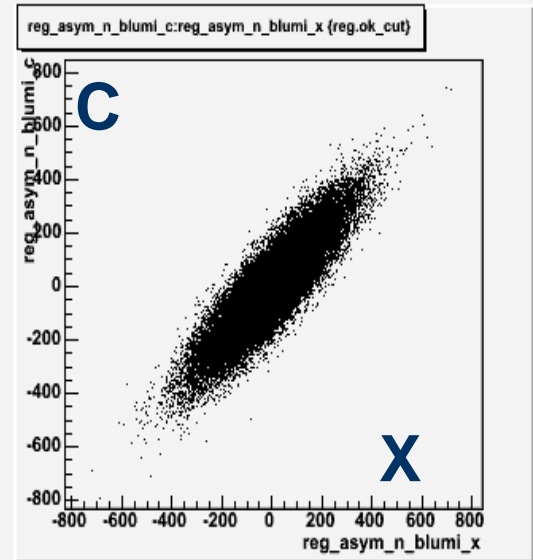
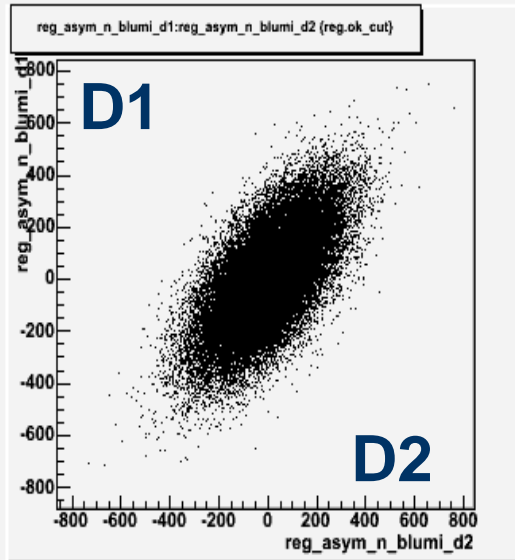
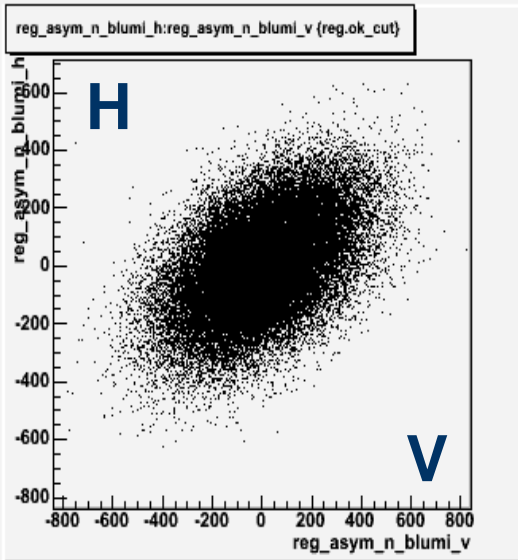
$$w_i = \frac{1}{\left\langle \frac{S_i}{BCM} \right\rangle} \bullet \sigma_i^2$$

- Will also look at lumi combinations.
- By calculating weights, RMS values for combos goes down.
- Noise of combos and differences provide info on experimental setup.
- Removes common mode noise.

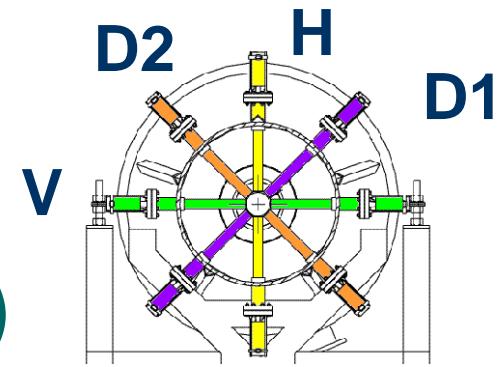
'05 Combo Noise



'05 Combo Diffs



Analysis of '05 Run (cont.)



- $H-V=181$ | $D1-D2=134$
 $C-X=73$
- Statistics for 4-Lumi combos is ~ 50 ppm
- For each Lumi, noise should be ~ 100 ppm, but we get much higher.

Lumi ID	Reg. RMS [ppm]
H	151
V	193
D1	156
D2	174
C	143
X	143
Sum	144
Ave	145

Why Extra Noise?

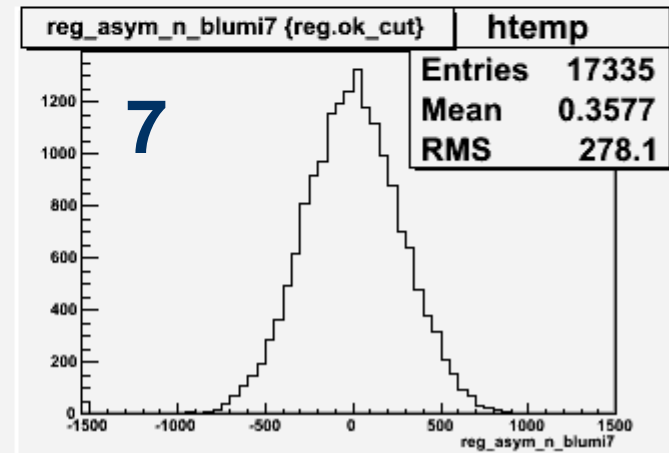
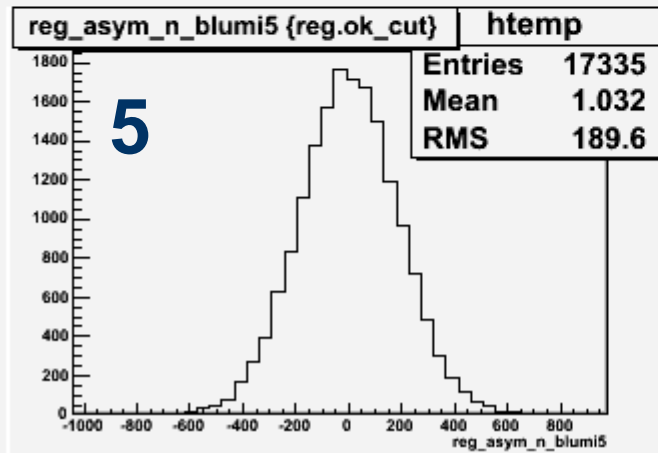
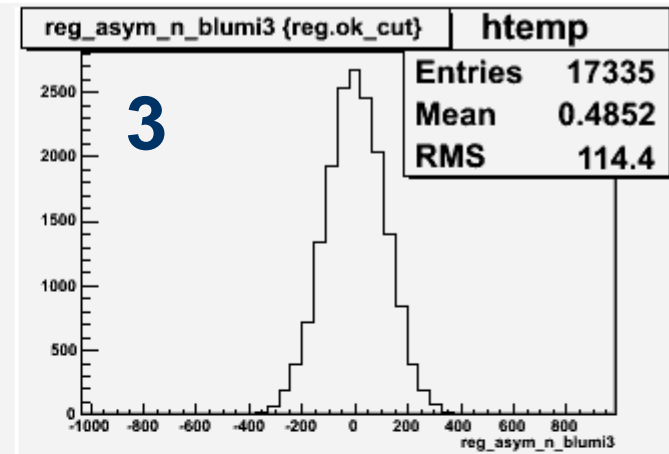
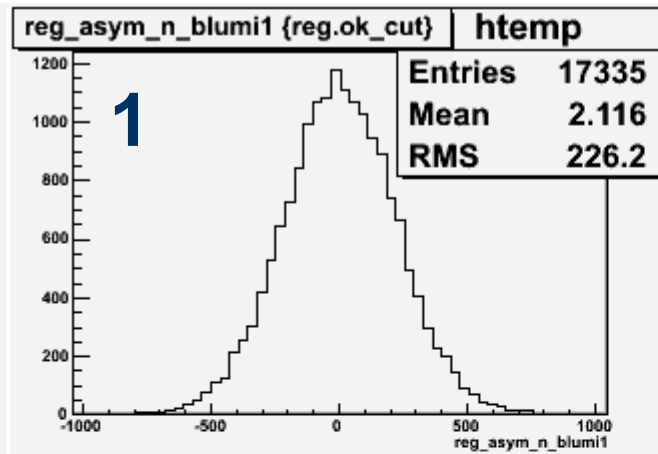
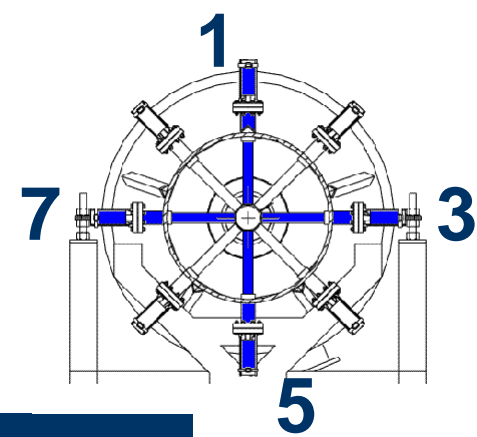
- Electronics noise in BPM and BCM.
- Unaccounted Beam Noise.
- Possible Higher order effects.
- Can try looking at cavity monitors.
- Also try Dithering analysis.

Analysis of '07 Runs

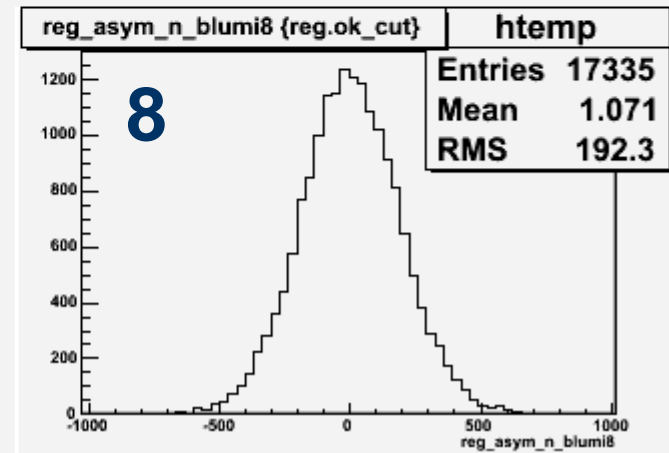
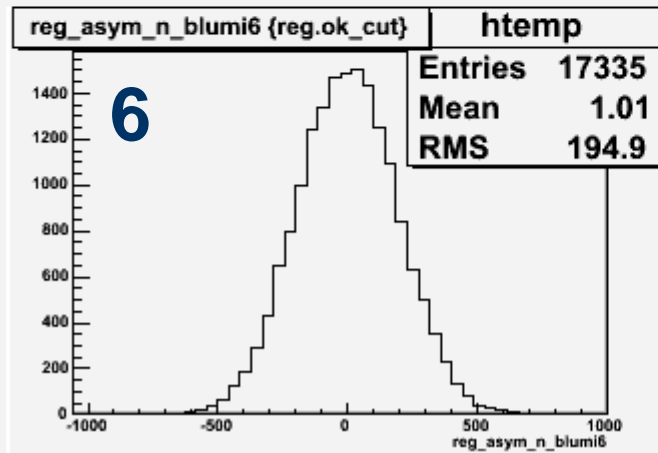
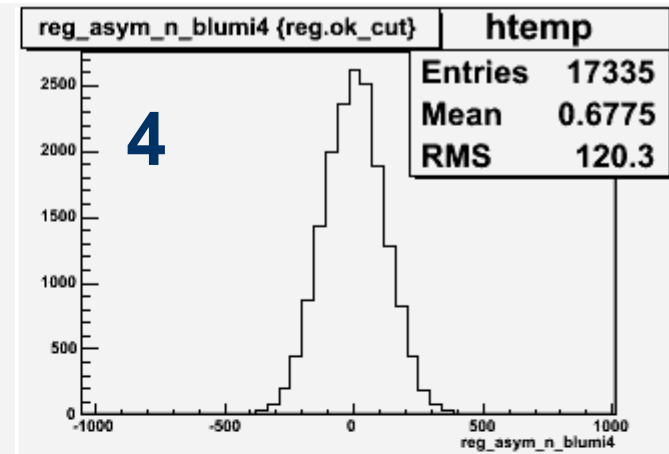
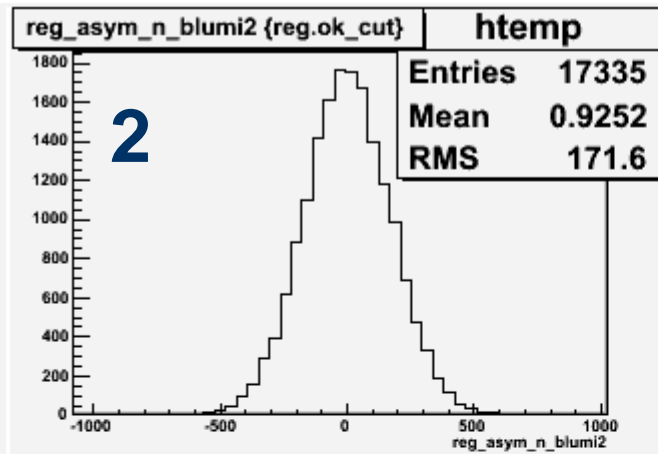
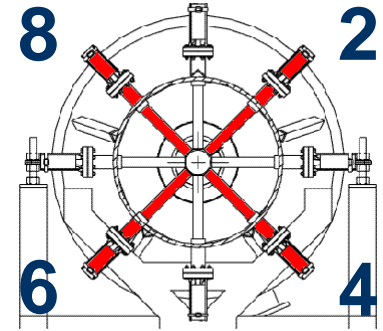
- First good run was #7807 on 3/6/07 with beam current of ~50uA on Lead target.
- HV values are not known.
- Rest of runs at 75uA.

Lumi ID	Reg. RMS [ppm]
1	227
2	172
3	114
4	120
5	190
6	195
7	276
8	192

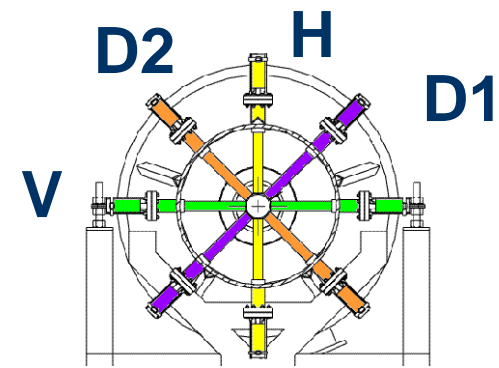
'07 RMS Values I



'07 RMS Values II



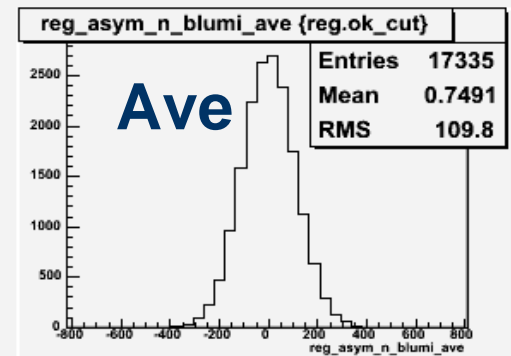
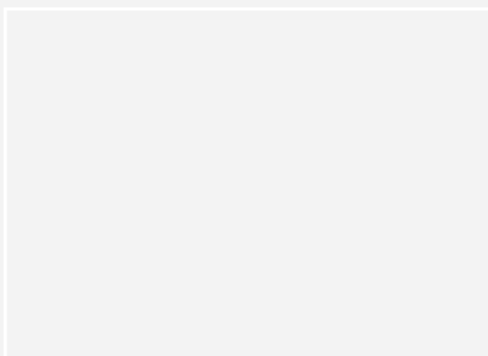
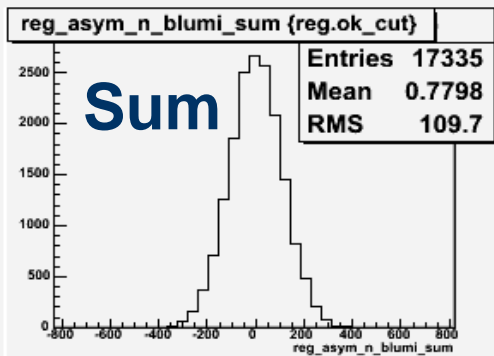
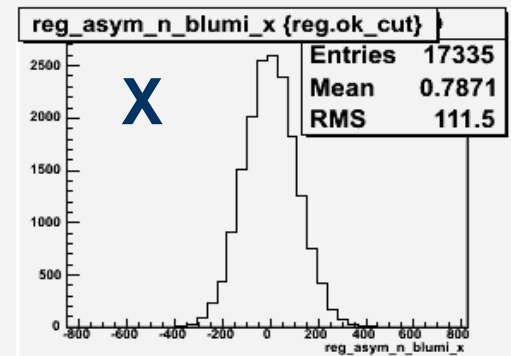
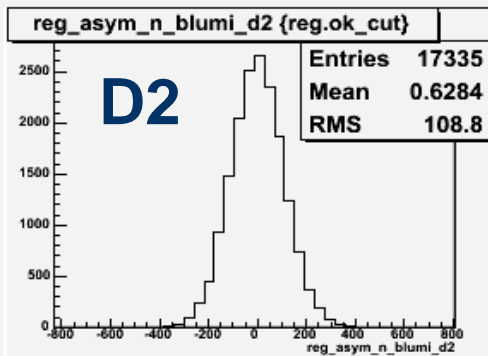
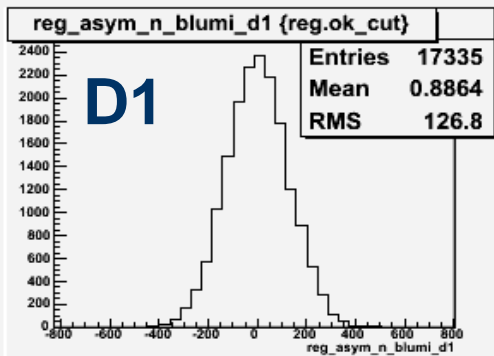
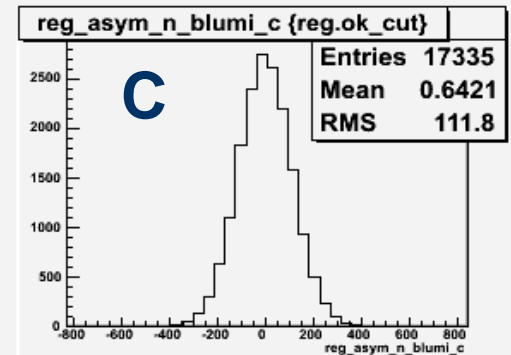
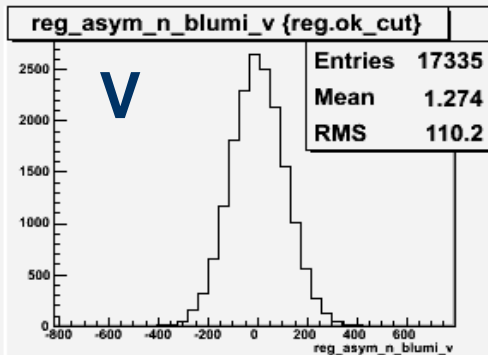
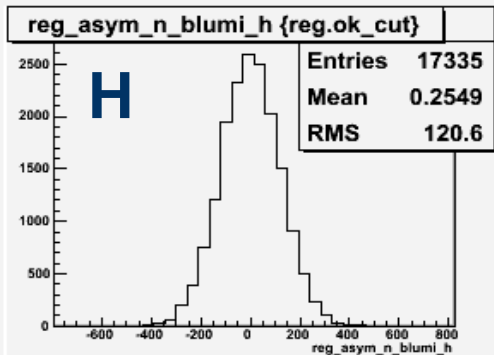
More on run #7807



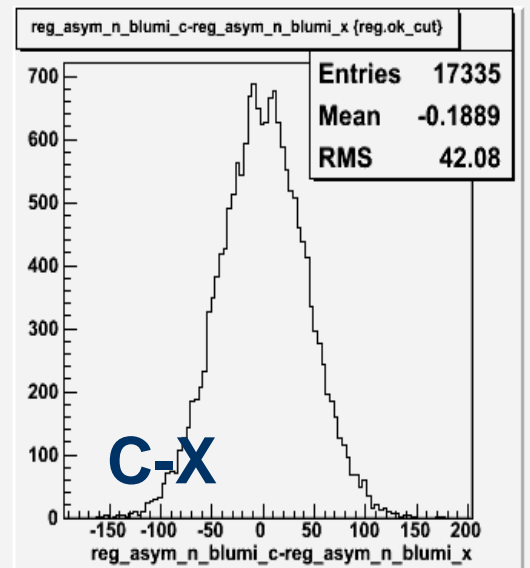
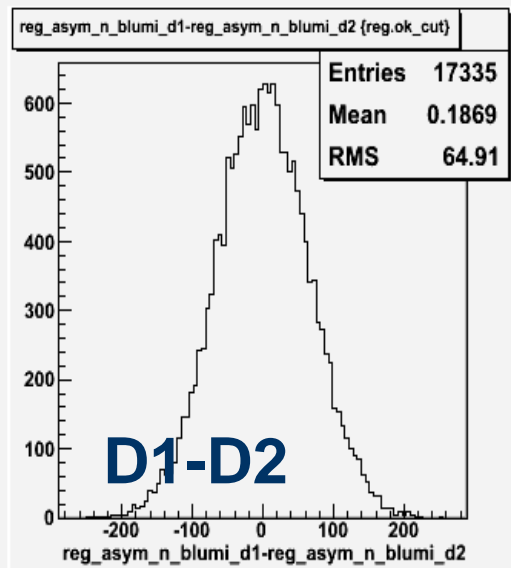
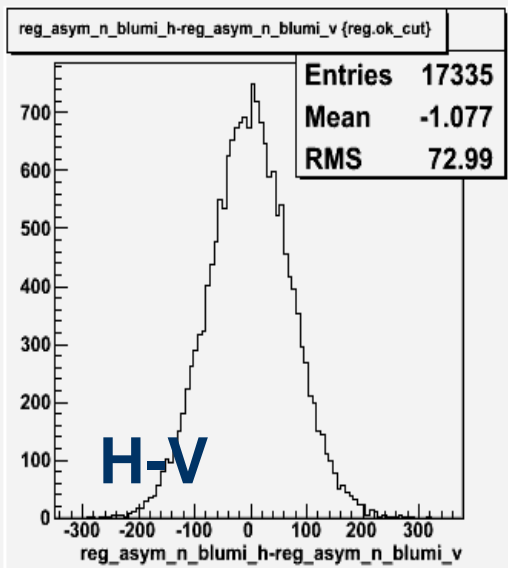
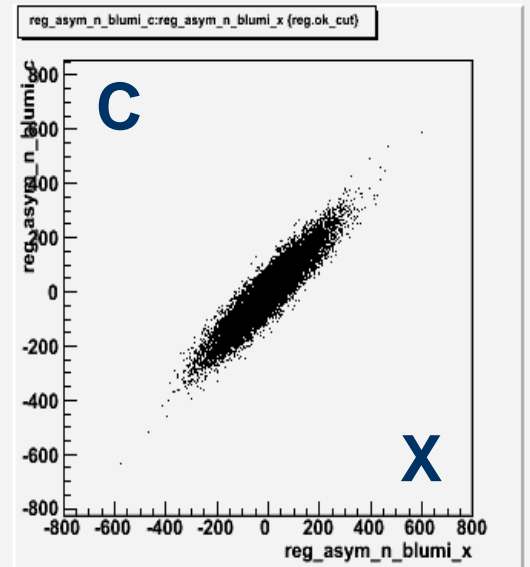
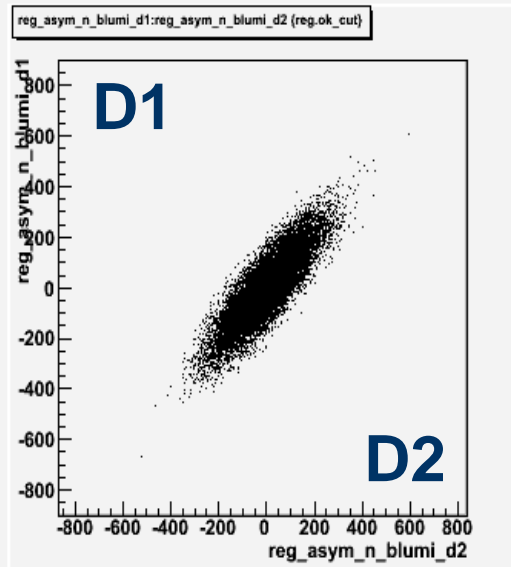
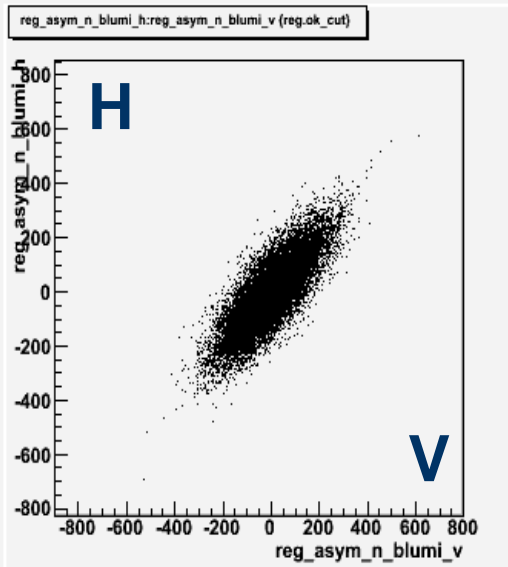
- Noise of Lumis and Combos are even lower than for 2005 run.
- $H-V=73$ | $D1-D2=65$
 $C-X=42$
- For each Lumi, noise should be ~ 60 ppm, and it is.

Lumi ID	Reg. RMS [ppm]
H	122
V	111
D1	113
D2	128
C	110
X	113
Sum	111
Ave	111

'07 Combo Noise



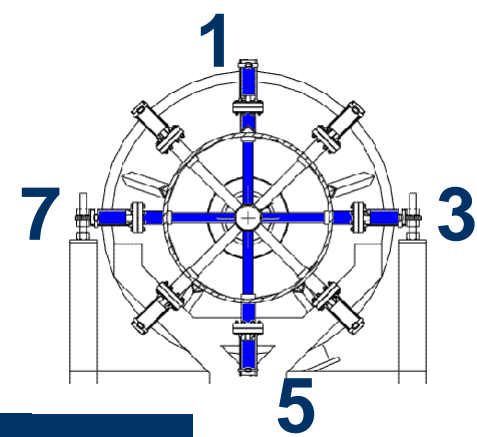
'07 Combo Diffs



18-bit ADC board

- The ADC18 was connected on 3/13/07.
- Lumi 1,3,5 & 7 were left on old board.
- Lumi 2,4,6 & 8 were connected to the new board.
- Software was functional by 3/17/07.
- Only good runs were taken between March 17-19.
- All later runs have very high noise caused by scraping of the beam in the beam-line.

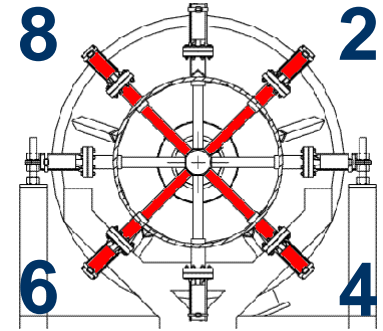
Bad Results – Run #7980



- Example of beam scraping RMS values.

Lumi ID	Reg. RMS [ppm]
1	1738
3	2684
5	2744
7	5575
H	3864
V	2188
C	2838
H-V	1837

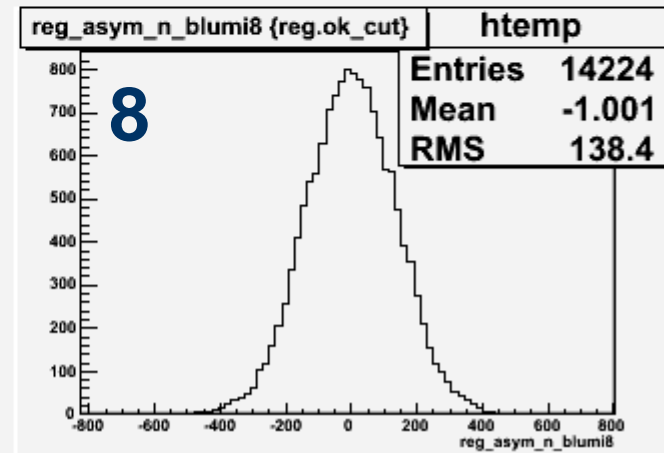
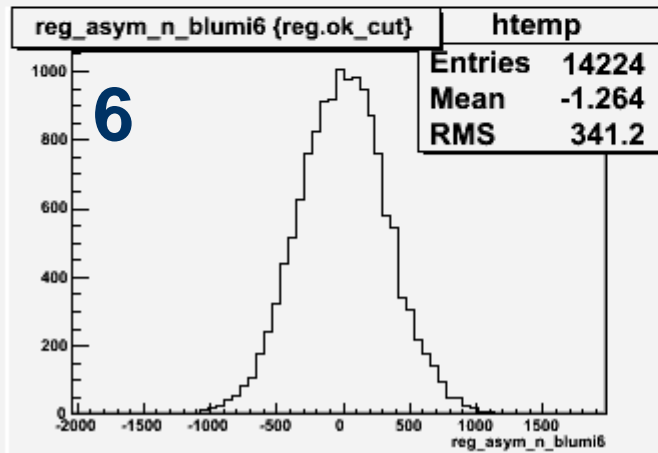
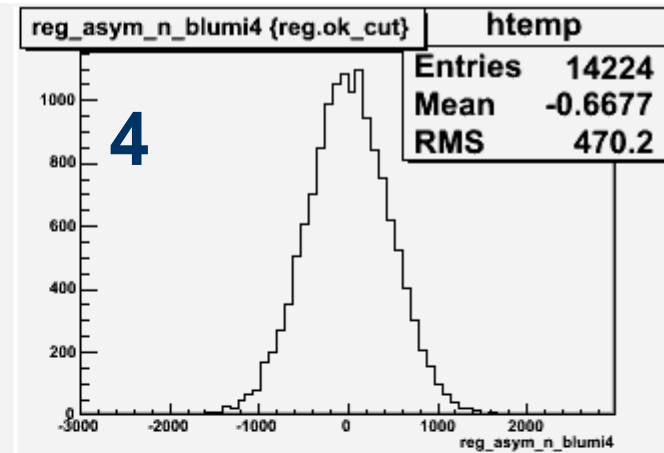
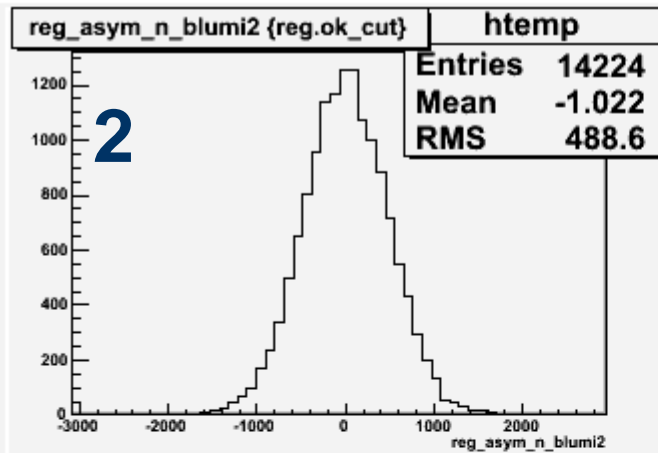
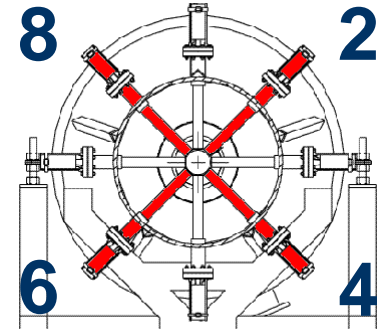
Noise of ADC18 Channels



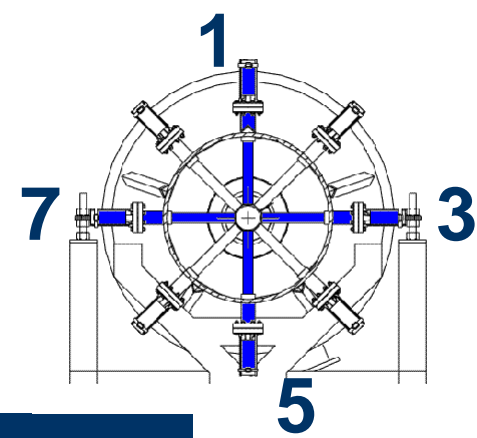
- New board worked properly
- First days of runs, there was a timing issue. Was integrating over HV transition.
- Best results with this problem.
- Last few days, bad data because of scraping.

Lumi ID	Reg. RMS [ppm]
2	489
4	470
6	341
8	138
D1	331
D2	135
X	161
D1-D2	227

Noise of ADC18 Channels



Lowest Noise Results



- Out of 14 good runs, best overall results are from run #7948.
- Current was $\sim 40\mu\text{A}$ on Lead and HV values were 350, 380, 460 & 420.

Lumi ID	Reg. RMS [ppm]
1	143
3	102
5	130
7	248
H	101
V	74
C	82
H-V	67

Summary

- Lumi data is very useful for studying noise.
- Statistics with Lead target during run will be $< 40\text{ppm} / \text{channel}$ (extrapolated to 0.5mm thick target).
- There is about ~ 100 ppm of common-mode noise.
- Did not do over-sampling.
- Could not verify 18-bit ADC performance.

Future Tests

- ADC18 now works. Will be able to study noise on new boards.
- Test PMT Linearity on bench.
- Need further analysis of '05 Hydrogen Lumi data.
- Use information to prepare for next Lead target test.

Acknowledgements

- Robert Michaels
- Kent Pachke
- Krishna Kumar
- HAPPEX Collaboration