

PQB Meeting

BCMS, BPMS, SAMs

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What Monitors/Detectors do we have?

- **BPMS**

- 4a,4b,8,12 (will get 14)
- (will get 3 Musson triplets X,Y)

- **BCMs**

- 1MHz ubcm,dbcm1x,dbcm3x,dbcm10x
- New Musson Ubcm, Dbcm
- (will get 3 Musson triplets Q)

- **HALO monitors**

- Halo1,Halo2,Halo3,Halo4→scaler channels

- ▶ **SAMs**

- ▶ 2,4 – unity gain, 50M Ω
- ▶ 1,5 – High gain base, 100k Ω
- ▶ 3,7 -High gain base, 36k Ω
- ▶ 4,8 - High gain base, 36k Ω

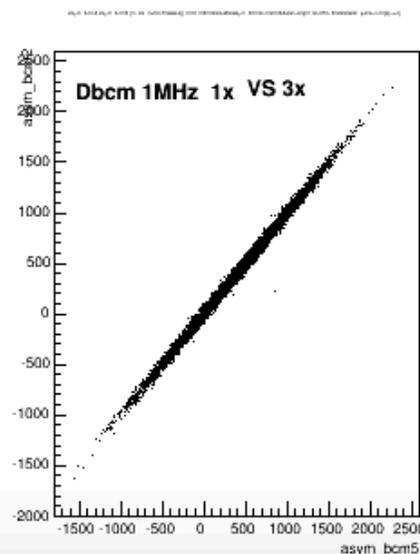
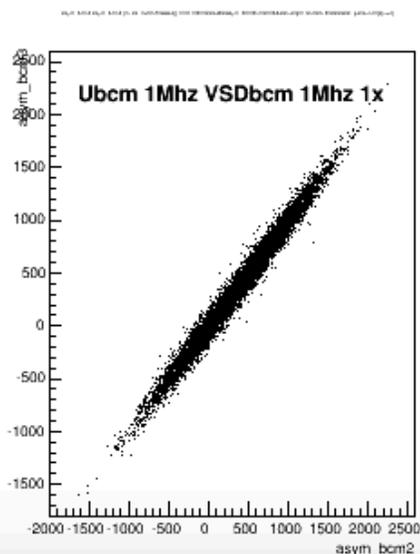
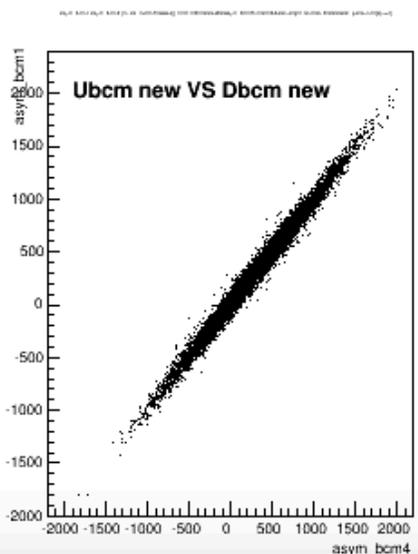
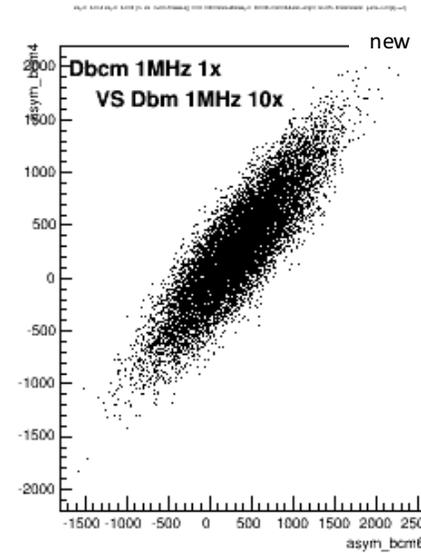
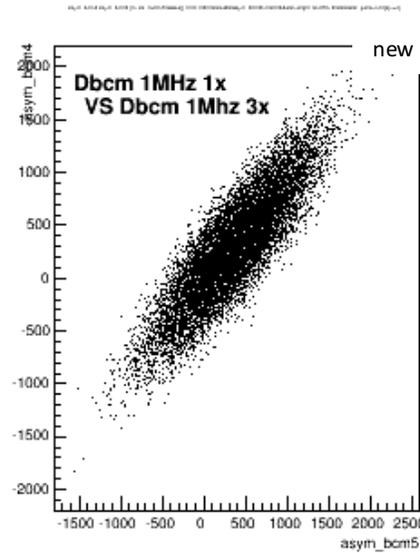
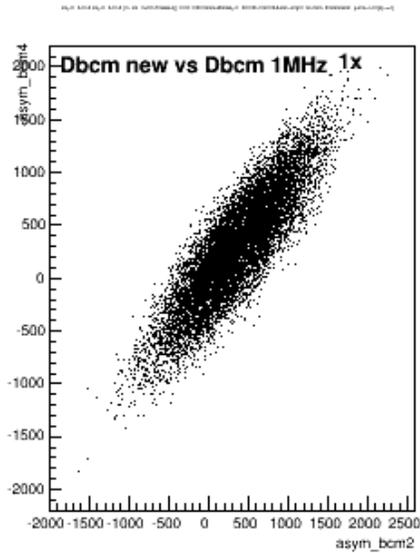
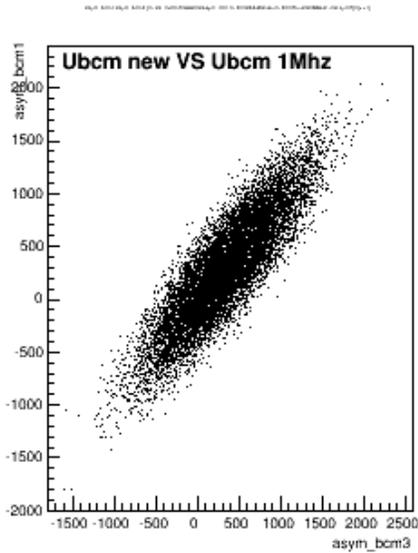
- ▶ **EPICS**

- ▶ Unser, hac_bcm_average

- ▶ **DAQ**

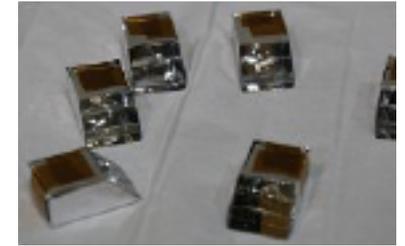
- ▶ Have Hall A DAQ alone
- ▶ Have Injector DAQ alone

How are the BCMs doing? BCM correlations

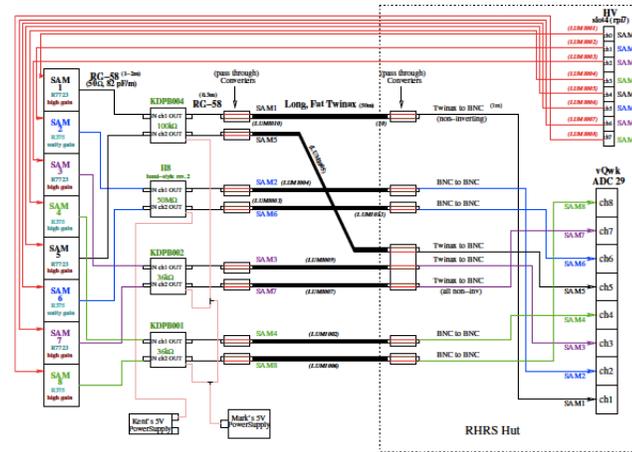


- Double differences on 1MHz receivers
- double difference is small
- Double difference on New Musson receivers
- small
- But if compare between receivers on same cavity
- two readouts disagree
- but can't tell which bcm is noisy
- **Need something which breaks this degeneracy**
- **use SAMs**

8 Small Angle Monitors (SAMs)



SAM configuration (Jan 2016)



- high sensitivity to helicity-correlated beam parameters
- 8 quartz detectors with light guides placed symmetrically around beam line downstream of pivot
- Symmetric 8 piece design helps **disentangle beam position and angle HCBP's**

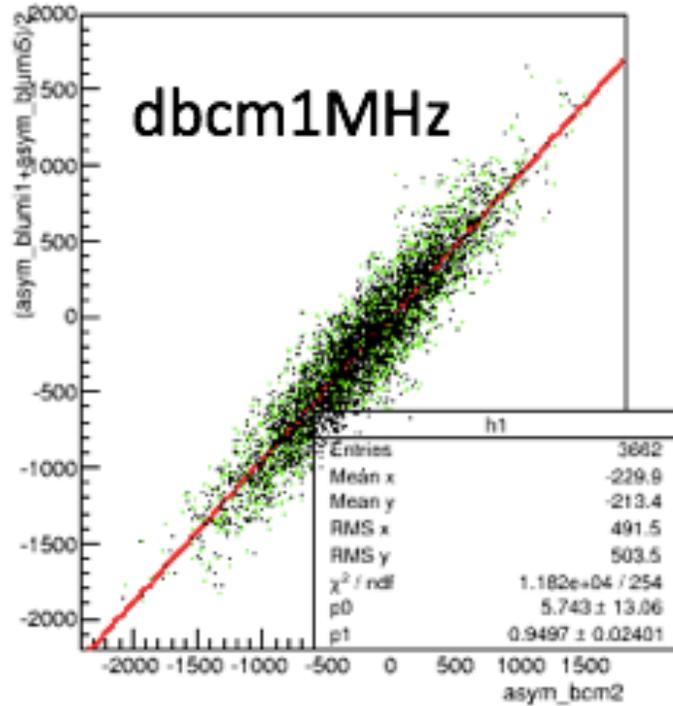
Are the BCMs OK? Which BCM is least noisy?

- Use SAMs as independent measure of beam current noise to establish BCMs working
- Is one bcm more correlated with the SAMs than another?
- Use correlations between SAMs and bcms to establish which bcm is least noisy

Comparison of old/new BCMs using SAMs



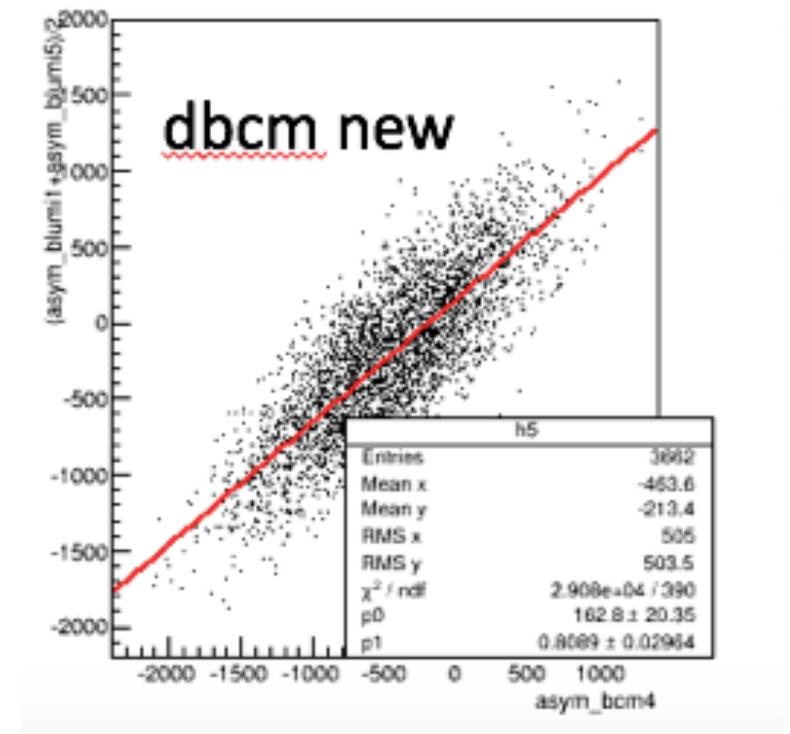
<SAM pair 1,5>



Downstream BCM – 1MHz



<SAM pair 1,5>



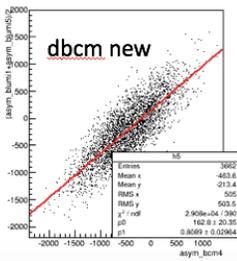
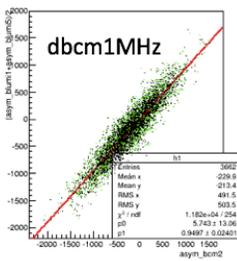
Downstream BCM – NEW

Examine plot of Asam vs Aq (different bcms)

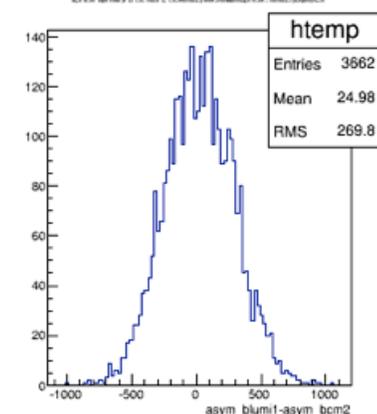
-see more noise in new Musson receivers than in old 1MHz system

Which BCM is least noisy?

- Is one bcm more correlated with the SAMs than another?
- Qualitative - examine plot of Asam vs Aq (different bcms)
 - see more noise in new Musson receivers than in old 1MHz system
- Quantitative - examine Asam - Aq(different bcms) RMS - see that 1MHz system gives smaller widths than new Musson receivers(when working)
- Double check- compare asymmetry double difference between 1MHz and new Musson bcms with quadrature difference of SAM asymmetries normalized wrt 1MHz and new Mussons. See that the numbers are close meaning that most of the width comes from the new musson receiver compared with the old.

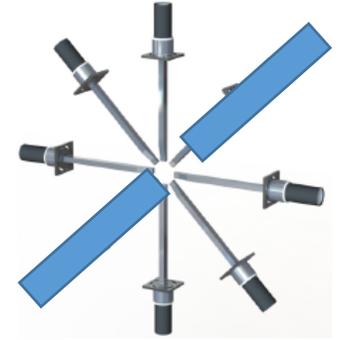


Run2333	SAM1,5	SAM3,7
<SAM pair1,5>-Dbcm1MHz RMS	185ppm	175ppm
<SAM pair1,5>-DbcmNew RMS	309ppm	305ppm
Sqrt([<SAMs pair1,5>-DbcmNew]^2-[<SAMs pair 1,5>-Dbcm1MHz]^2)	247ppm	250ppm



Double difference Dbcm1MHz-DbcmNew RMS	258ppm
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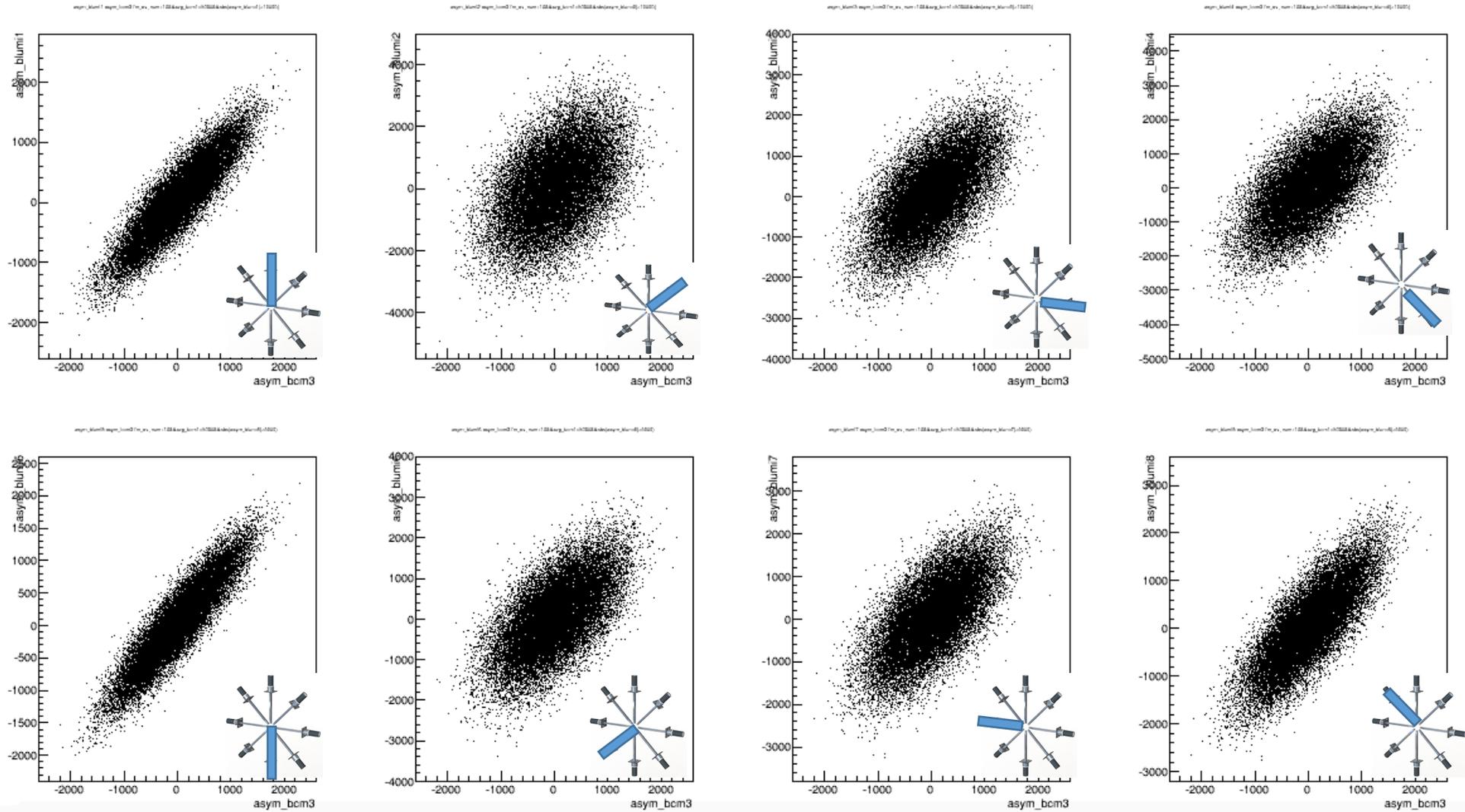
SAMs



- Analyze rates and widths
- 2 SAMs have unity gain tubes – can estimate rates from them (assuming 5pe's per hit)
- Examine SAM pairs and correlations with bcm, bpms, and with each other
- Try to understand asymmetry widths and scaling with energy
- Have data for LH2 target at 2.2GeV, 4.4GeV, 8.8GeV 10-20uA

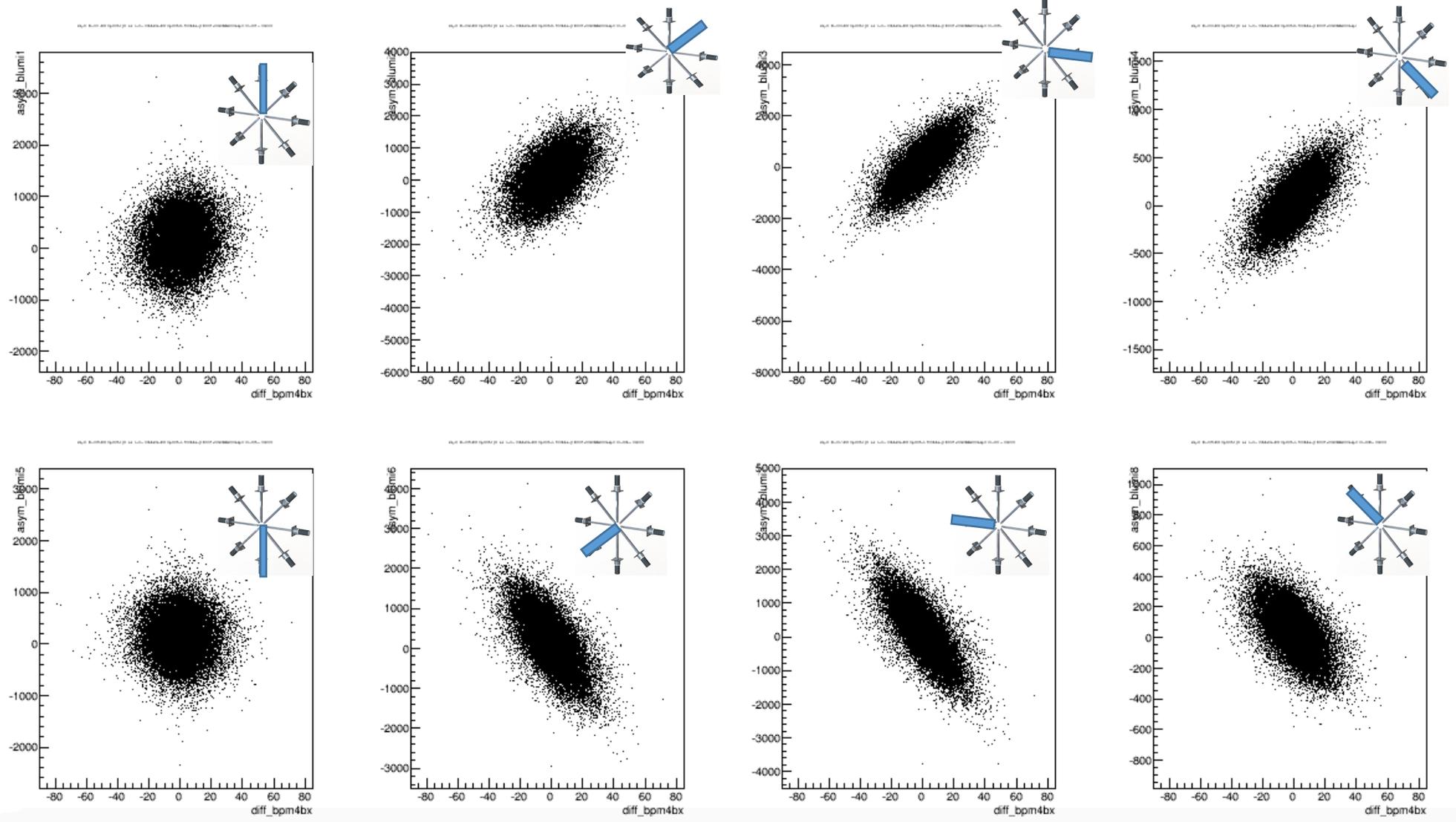
Run2333, 12uA, 15cm LH2 HV 1/5=-650V,2/6=-75V,3/7=-800V,4/8=-500V

SAMs & Upsteam BCM 1MHz correlations



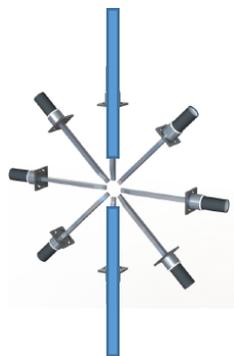
NORMALIZE SAMs TO A BCM TO ELIMINATE BCM CORRELATED NOISE

BPM(4eX)/SAM correlations

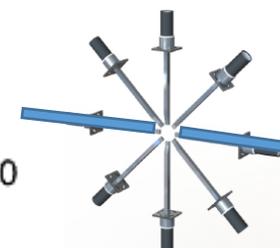
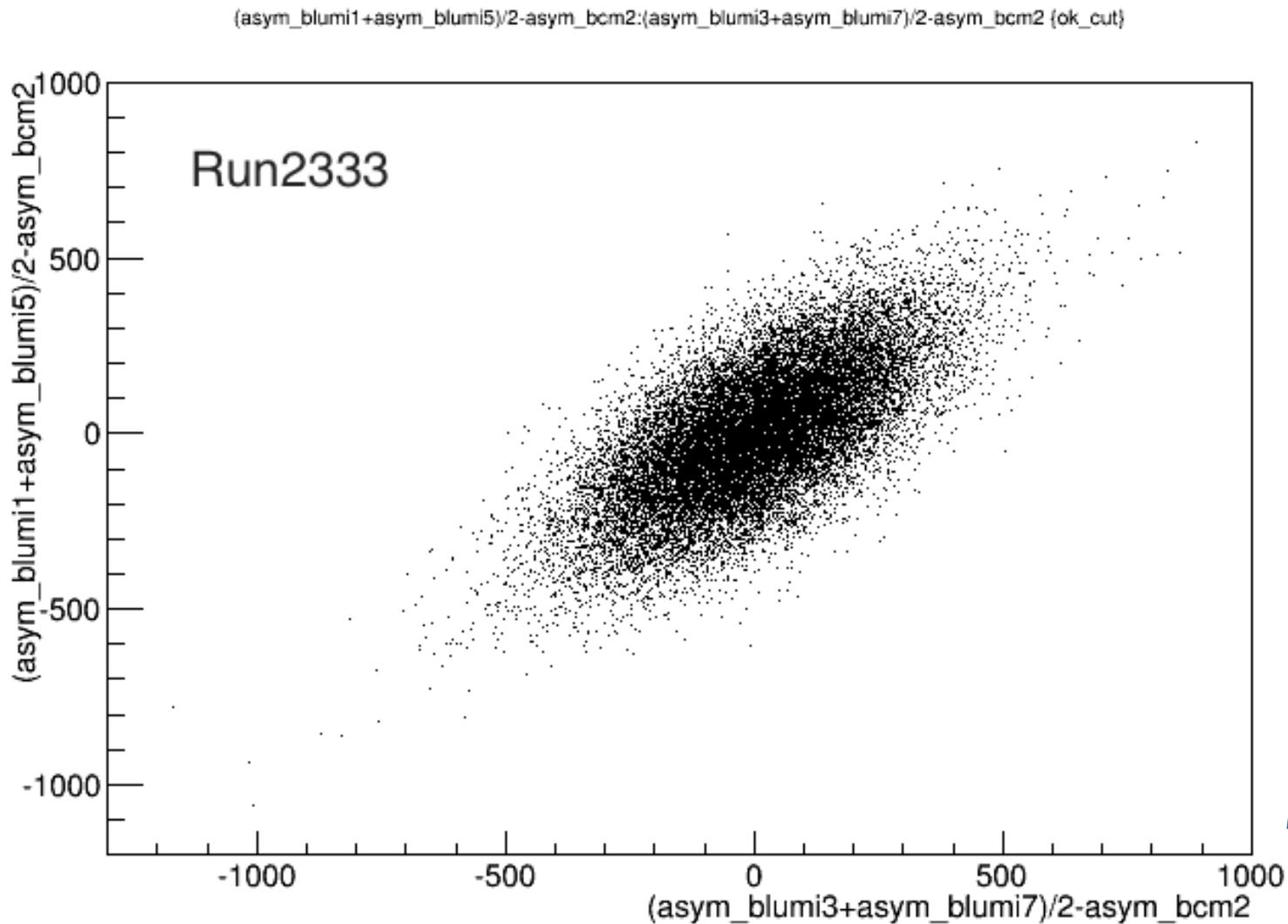


TAKE COMBINATIONS OF SAM PAIRS TO ELIMINATE BPM CORRELLATED NOISE

Additional Common Mode Noise – i.e. Target Boiling



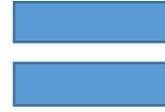
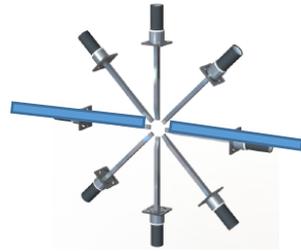
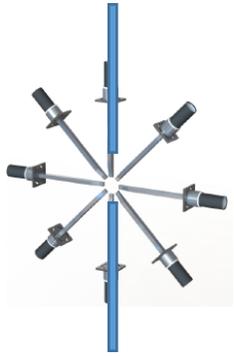
SAM pair 1,5
normalized to
DBC(1MHz 1x)



SAM pair 3,7
normalized to
DBC(1MHz 1x)

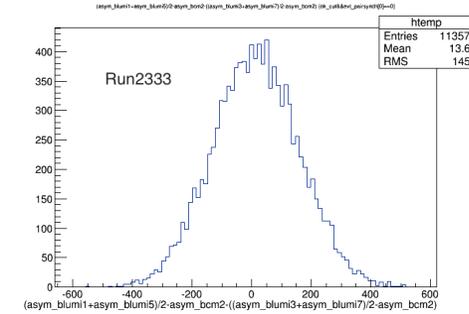
Eliminate common mode noise between SAM pairs by taking pair DIFFERENCE

Run2333- 4.4GeV, 12uA HV1/5=-650V, HV2/6=-75V, HV3/7=-800V, HV4/8=-500V



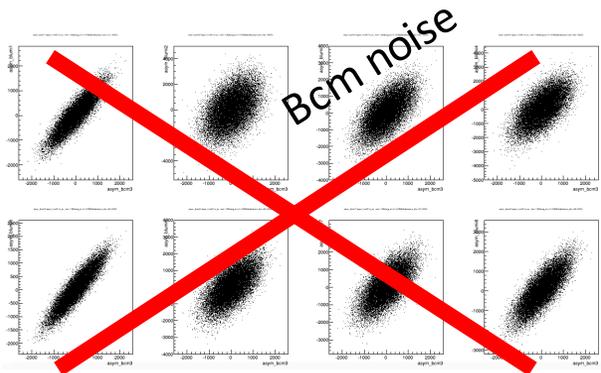
SAM pair 1,5
normalized to
DBCM(1MHz 1x)

SAM pair 3,7
normalized to
DBCM(1MHz 1x)

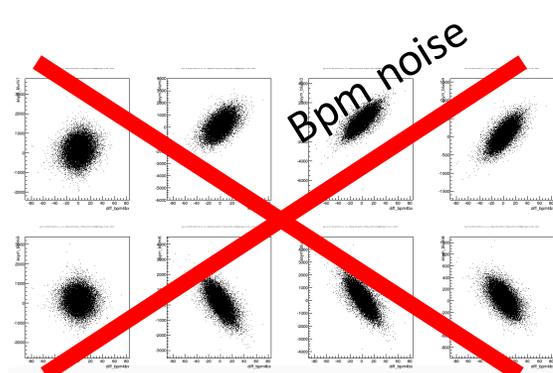


Asymmetry Width
w/o common mode noise (target boiling)
w/o beam position/angle noise
w/o beam current noise

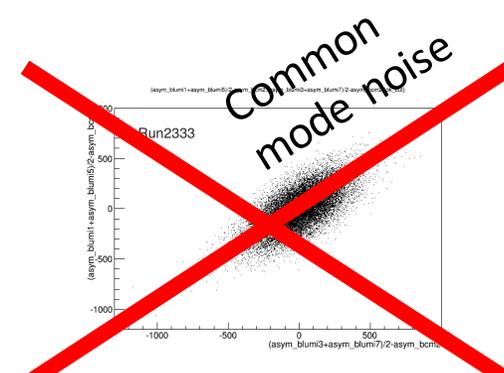
Normalize SAMs to BCM



Combine SAM pairs



Take SAM pair differences



Summary of SAM widths

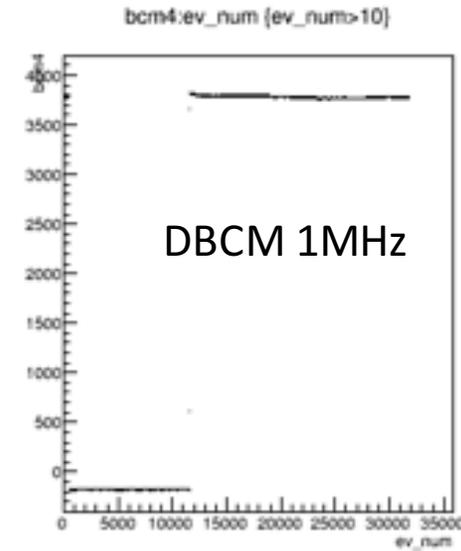
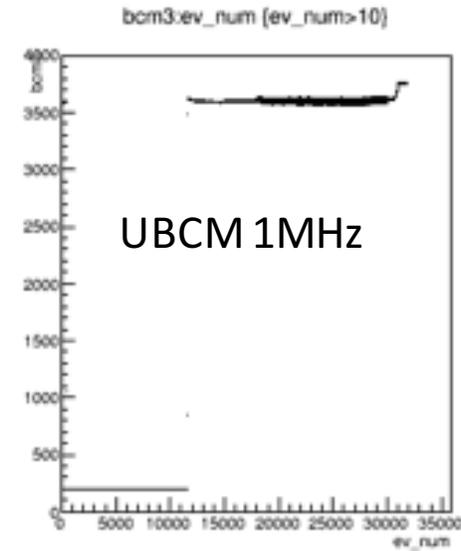
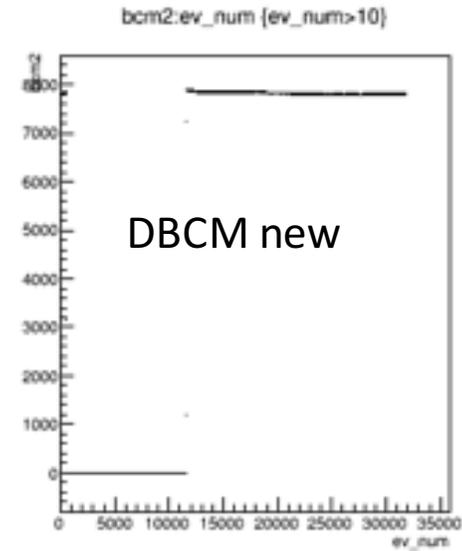
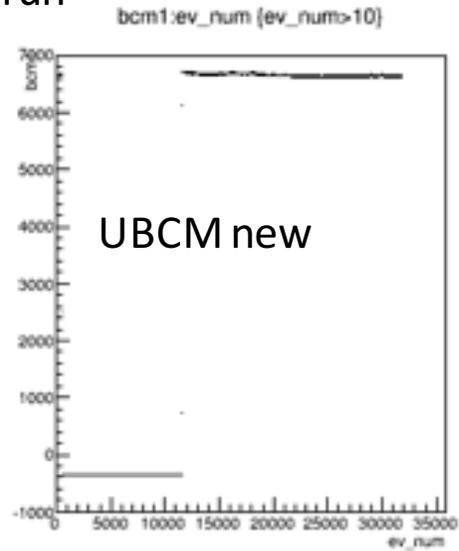
- LH2 target , 2.2GeV, 4.4GeV, 8.8GeV, 10-20uA

- Guess at the rate with unity gain sams – assuming 5pe's/count
- If use rate estimate, estimate counting statistics for SAMs
- Widths after we eliminate common mode noise don't quite agree with counting statistics estimate
- That relationship doesn't scale with energy like we thought it would
- There are things to learn here – we are still processing it.

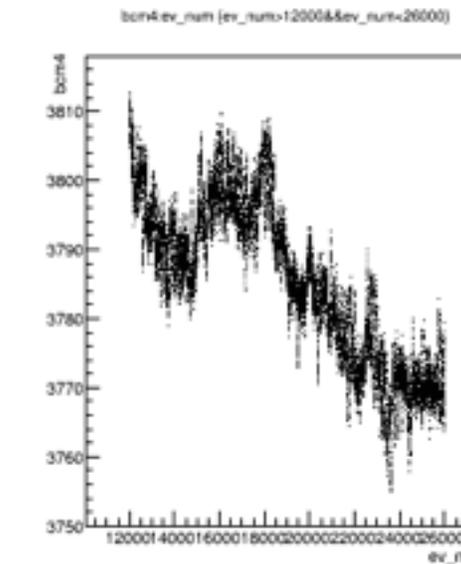
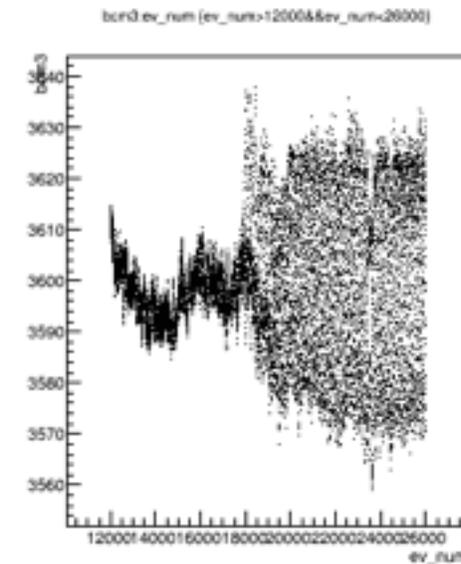
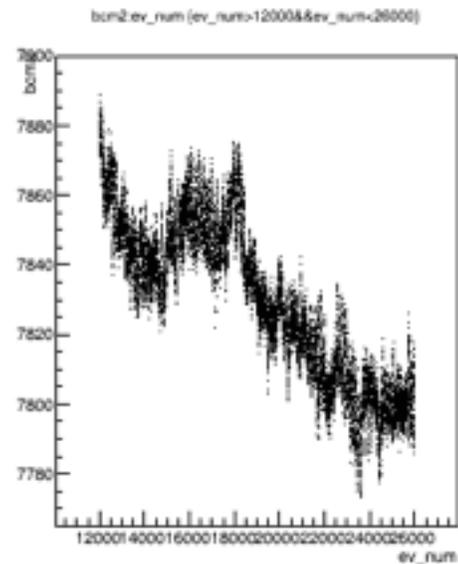
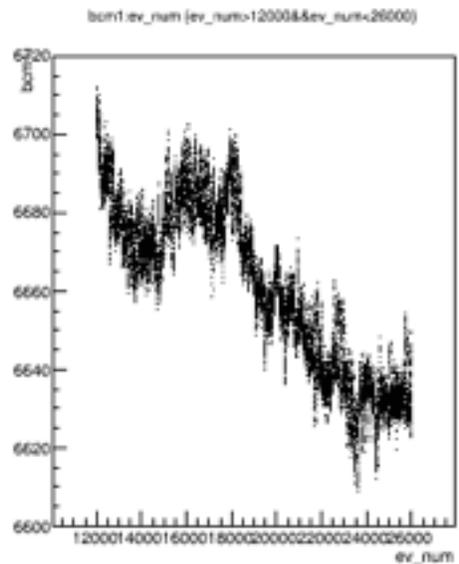
Run	Current uA	Energy GeV	HV	Rate SAM2	Rate SAM6	<Rate> GHz	Unity gain yeild, assume 5pe's	$1e6 * \text{SQRT}(1 + (\text{SQRT}(5)/5)^2) / \text{SQRT}(((\text{rateSAM2} + \text{rateSAM6}) * 1e9) * (1/15))$	ECS SAM pair	ECS SAM pair diff	Measured Asym RMS PS[0]=0 ppm
2333.00	12.00	4.40		0.39	0.75	0.57		177.37	125.42	177.37	145.00
2349.00	20.00	2.20		1.30	2.82	2.06		93.48	66.10	93.48	68.91
2356.00	10.00	2.20		0.65	1.54	1.09		128.25	90.69	128.25	98.29
2356b	10.00	2.20		0.66	1.50	1.08		129.04	129.04	129.04	96.53
2358.00	13.00	8.80		0.45	0.70	0.58		176.76	124.99	176.76	196.70
2359.00	13.00	8.80		0.45	0.70	0.58		176.88	125.07	176.88	192.70

Be aware - Intermittent 1MHz bcm system failure

Feb 25 run



time

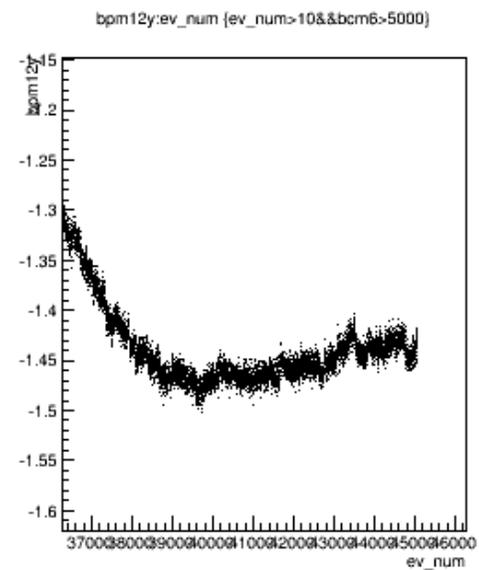
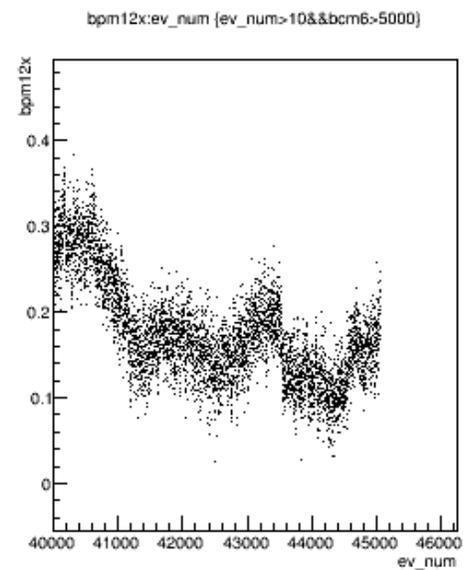
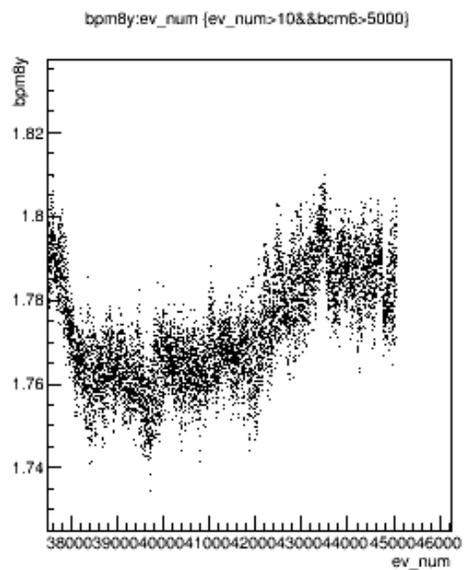
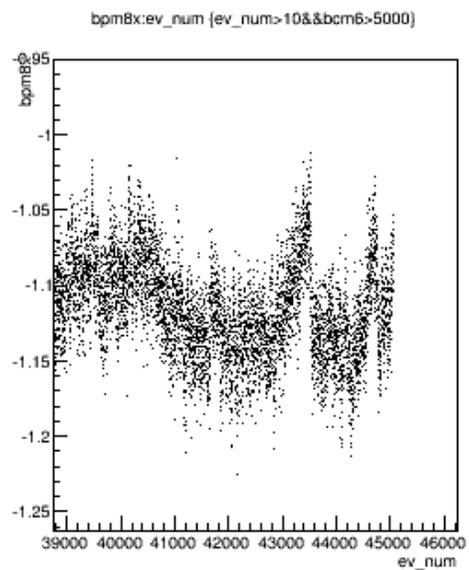
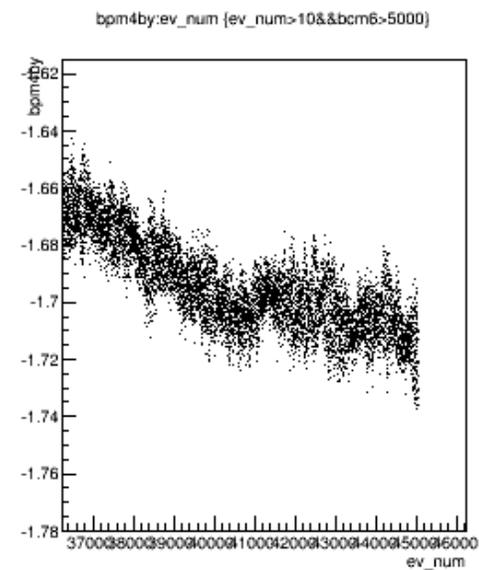
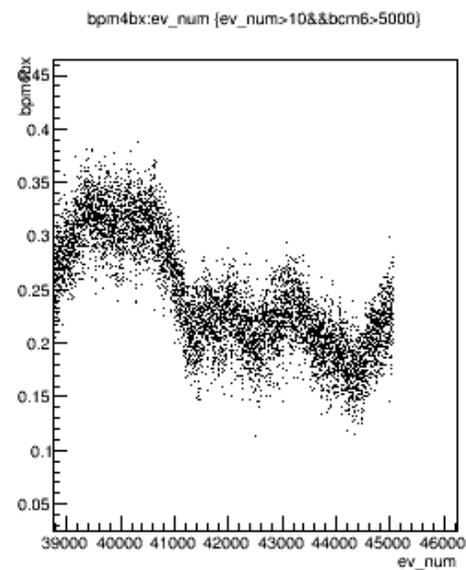
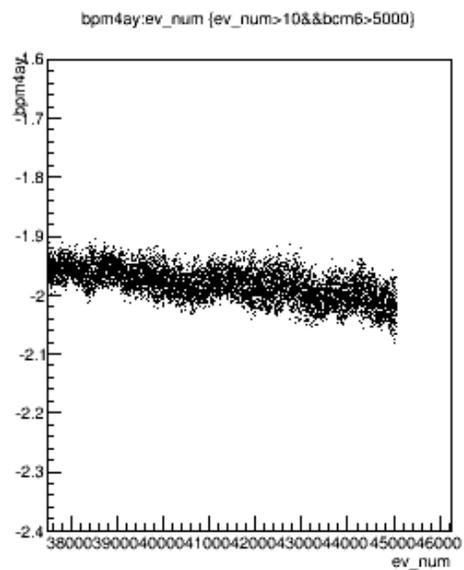
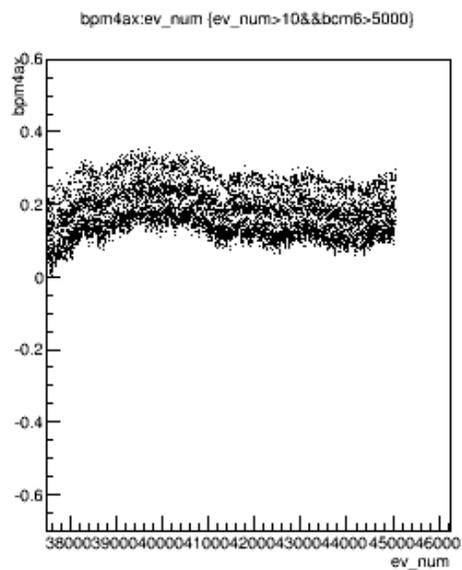


time

Summary

- SAMs - We can estimate rates from unity gain SAMs and analyze how observed widths relate to counting statistics for different beam energies
- Use SAMs as independent measurement to establish how bcms working (aside from intermittent 1MHz system hiccups)
- Correlations between SAMs and bcms – show 1MHz bcms less noisy
- Calibrated our bcms with scaler copy of Unser
- We have the injector daq running, we have data collected with it during bcm scan, and we just need to analyze it
- Further work:
 - Triplets not working – Musson looking into it
 - Bpm4a issue - double level – investigating
 - Pair synch pickup issue - investigating

BPMs – 4a multiple levels



BCM asymmetries – PS pickup Run2349, 20uA

