Target Boiling Studies Using the Luminosity Monitor Detector

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Hall A Analysis Workshop

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Introduction

- Upcoming Hall A Parity Experiments
- Lumi Detector
- June Beam Test
  - Density Fluctuations
  - Bulk Boiling (Density Reduction)
- Fall Beam Tests
- Summary

Upcoming Hall A Parity Experiments

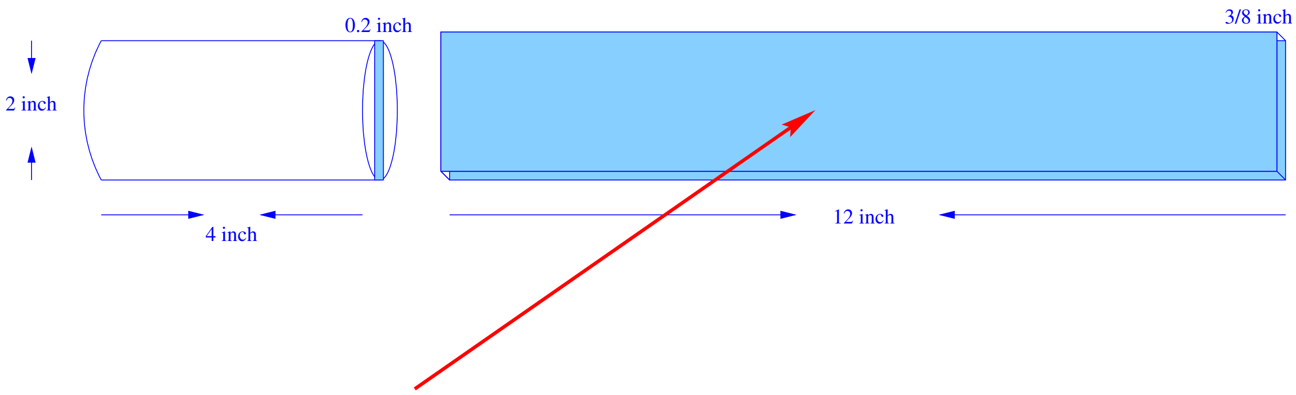
- *Statistical Error per pair:* $\sigma_{\rm stat}(A_{\rm pair}) = \frac{1}{\sqrt{N_s}}$

	$\sigma_{\rm stat}(A_{\rm pair})$
HAPPEX I	3600 ppm
HAPPEX II	350 ppm
HAPPEX ^4He	834 ppm
Lead	100 ppm

- *HAPPEX I limit on target boiling fluctuations:* < 200 *ppm*

Lumi Detector

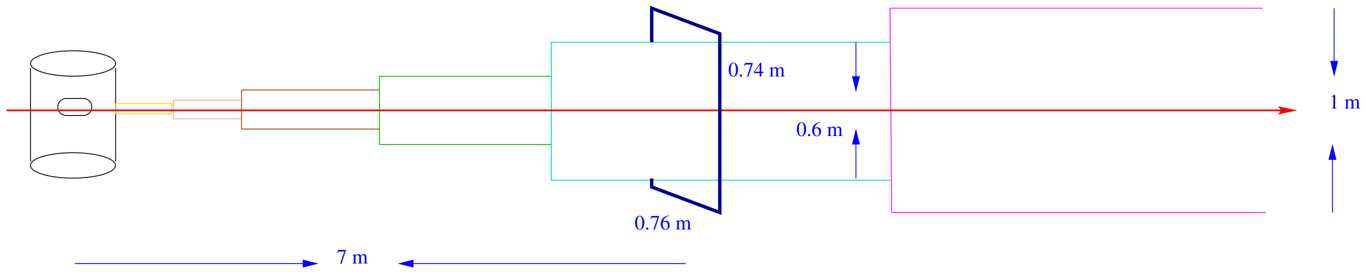
Lucite: UVT Acrylic Plastic (Bicron BC-800)



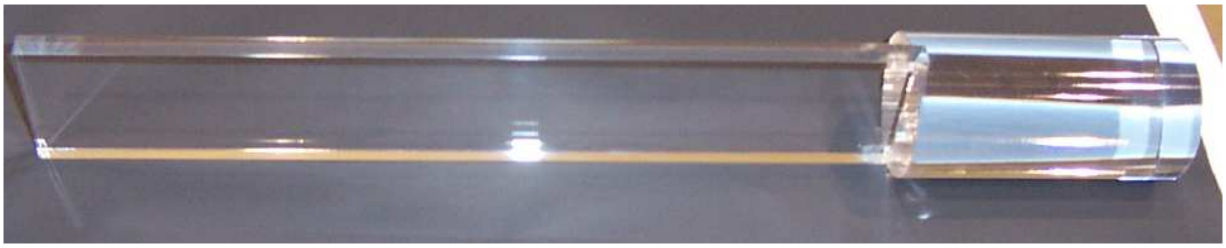
- Hamamatsu R329-02

- 12 Stages 2 inch PMT

- PMT Hybrid Assembly H7195



- Scattering Angle: $\theta \sim 3.2^\circ$




SIEMENS
06/30/2002

Liquid Deuterium

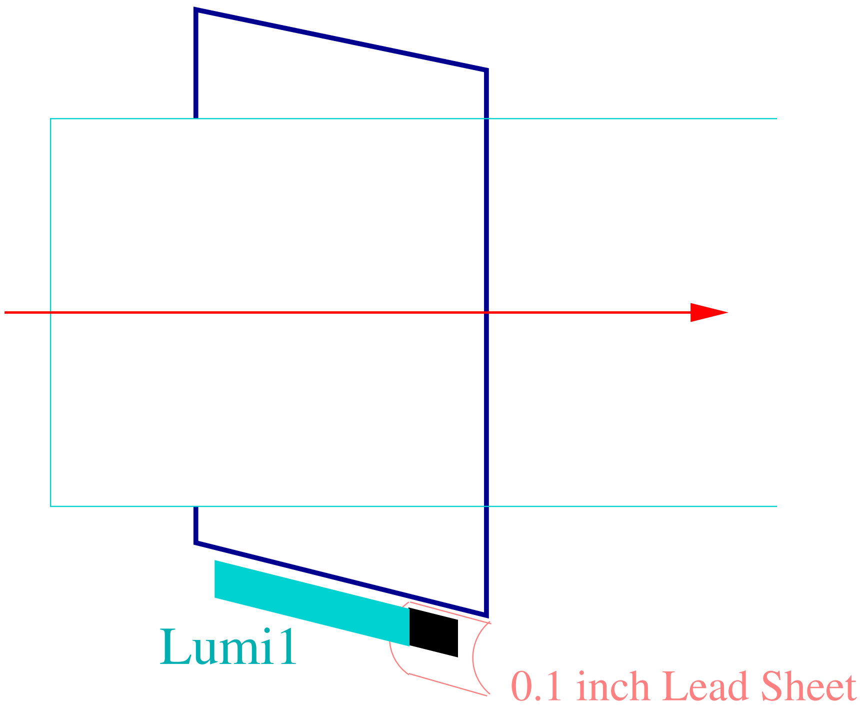
- Beam Energy: 4712.9 MeV

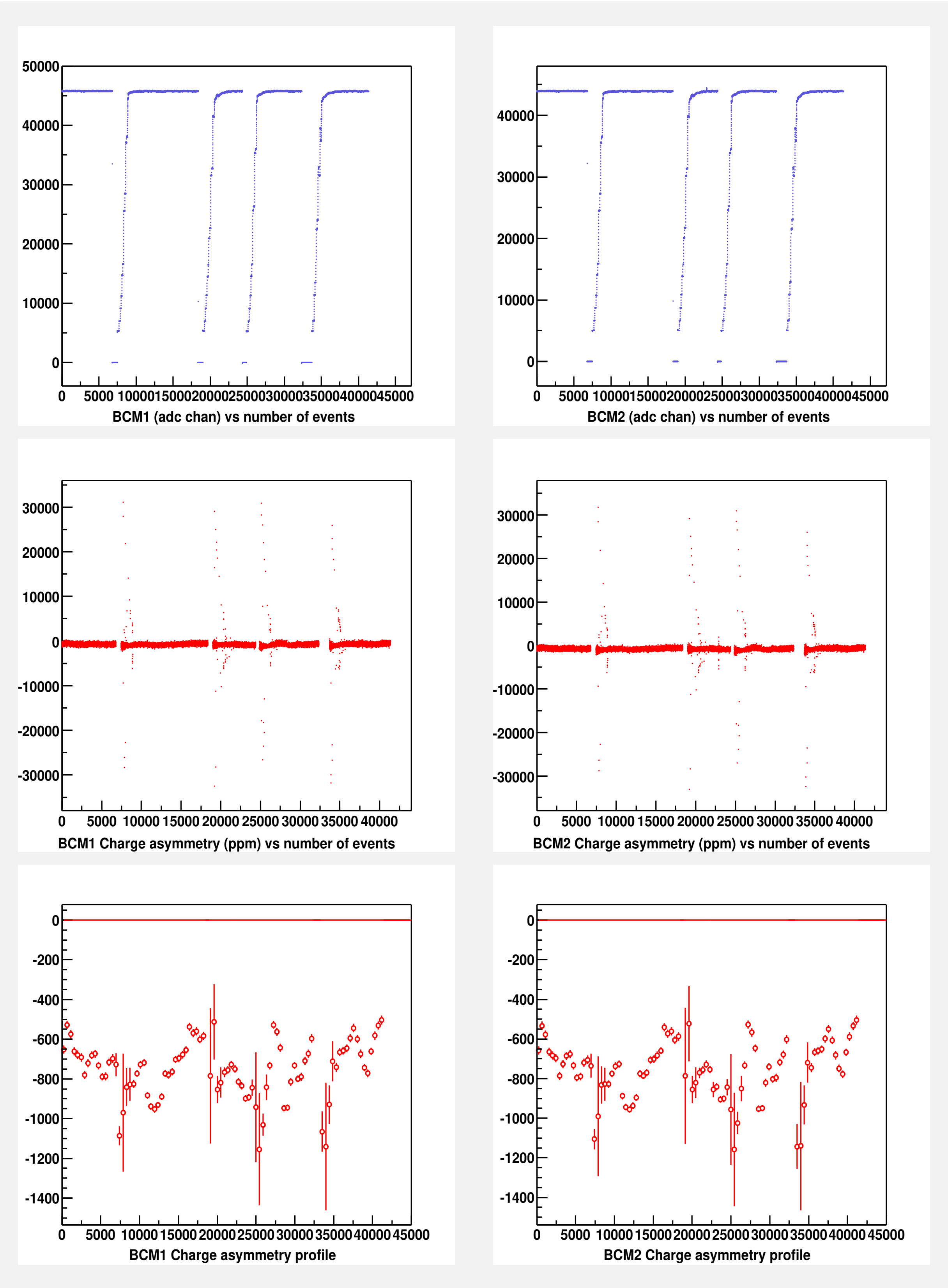
- Beam Current $100\ \mu$A on 15 cm LD_2

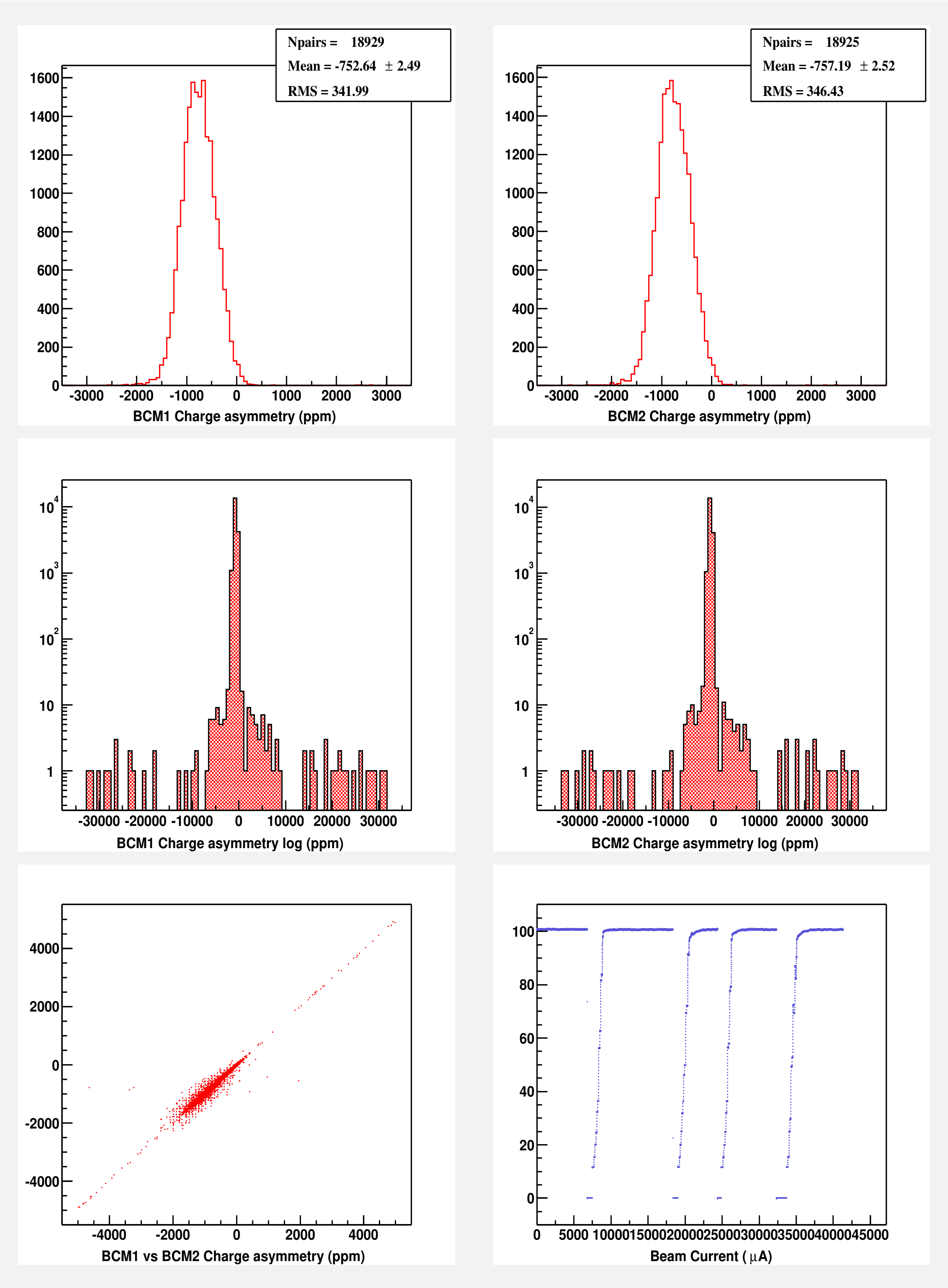
- Raster Size: 1.7 mm $\times$ 2.0 mm (x, y)

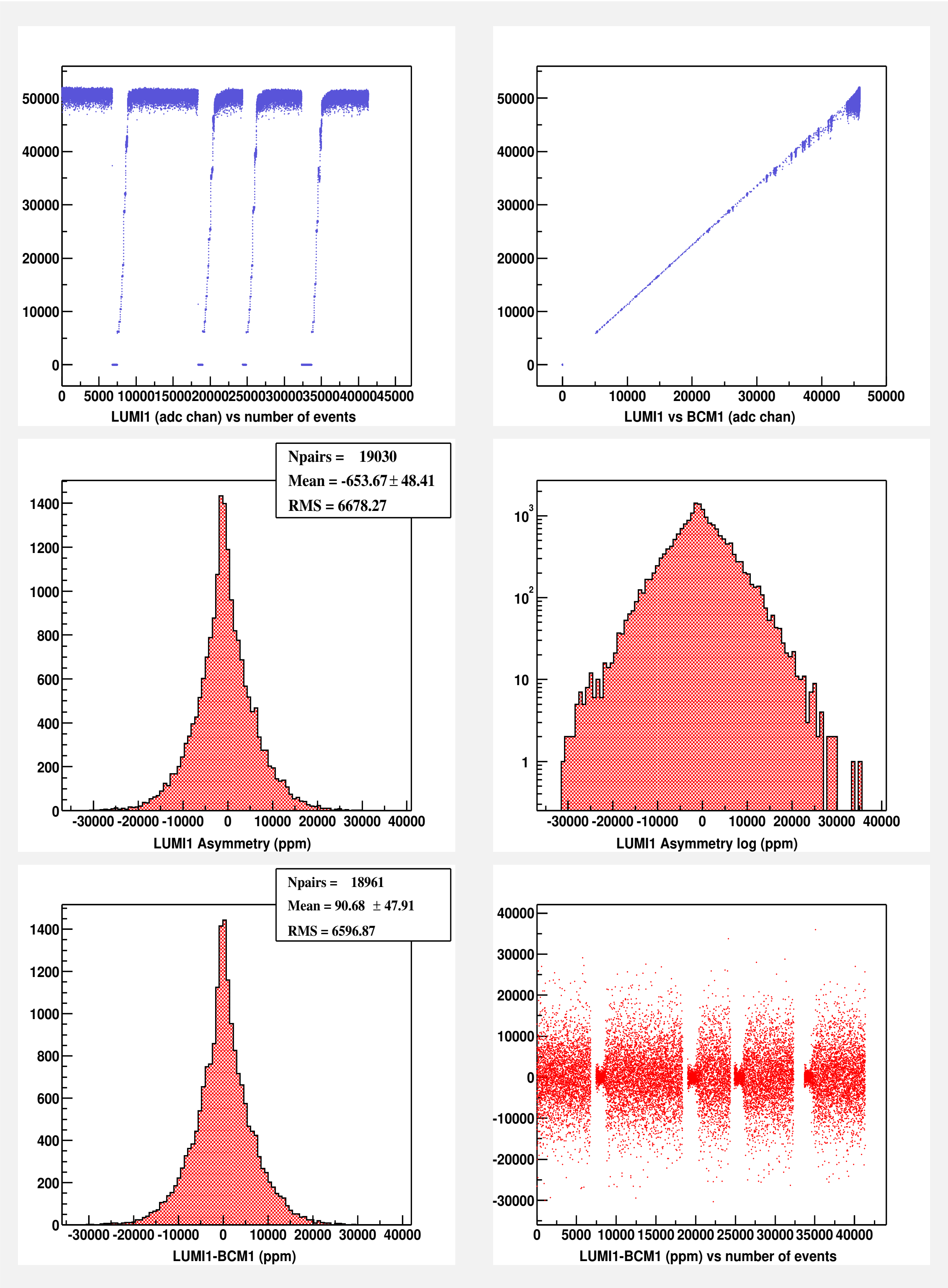
- *INTEG_TIME = 7000*, *OVERSAMPLE = 1*

- Lumi1 HV = -750 V, Anode Current $\sim -10\ \mu$A




BCM1 (adc chan) vs number of events
BCM2 (adc chan) vs number of events
BCM1 Charge asymmetry (ppm) vs number of events
BCM2 Charge asymmetry (ppm) vs number of events
BCM1 Charge asymmetry profile
BCM2 Charge asymmetry profile
0 5000 10000 15000 20000 25000 30000 35000 40000 45000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-200
-400
-600
-800
-1000
-1200
-1400

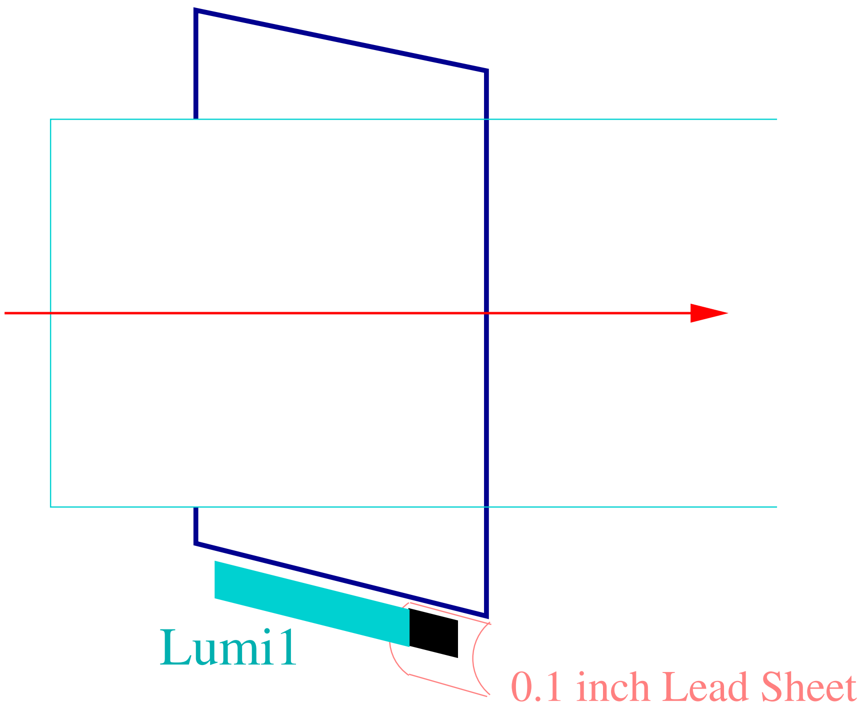

Npairs = 18929
Mean = -752.64 ± 2.49
RMS = 341.99
BCM1 Charge asymmetry (ppm)
Npairs = 18925
Mean = -757.19 ± 2.52
RMS = 346.43
BCM2 Charge asymmetry (ppm)
BCM1 Charge asymmetry log (ppm)
BCM2 Charge asymmetry log (ppm)
BCM1 vs BCM2 Charge asymmetry (ppm)
Beam Current (μA)

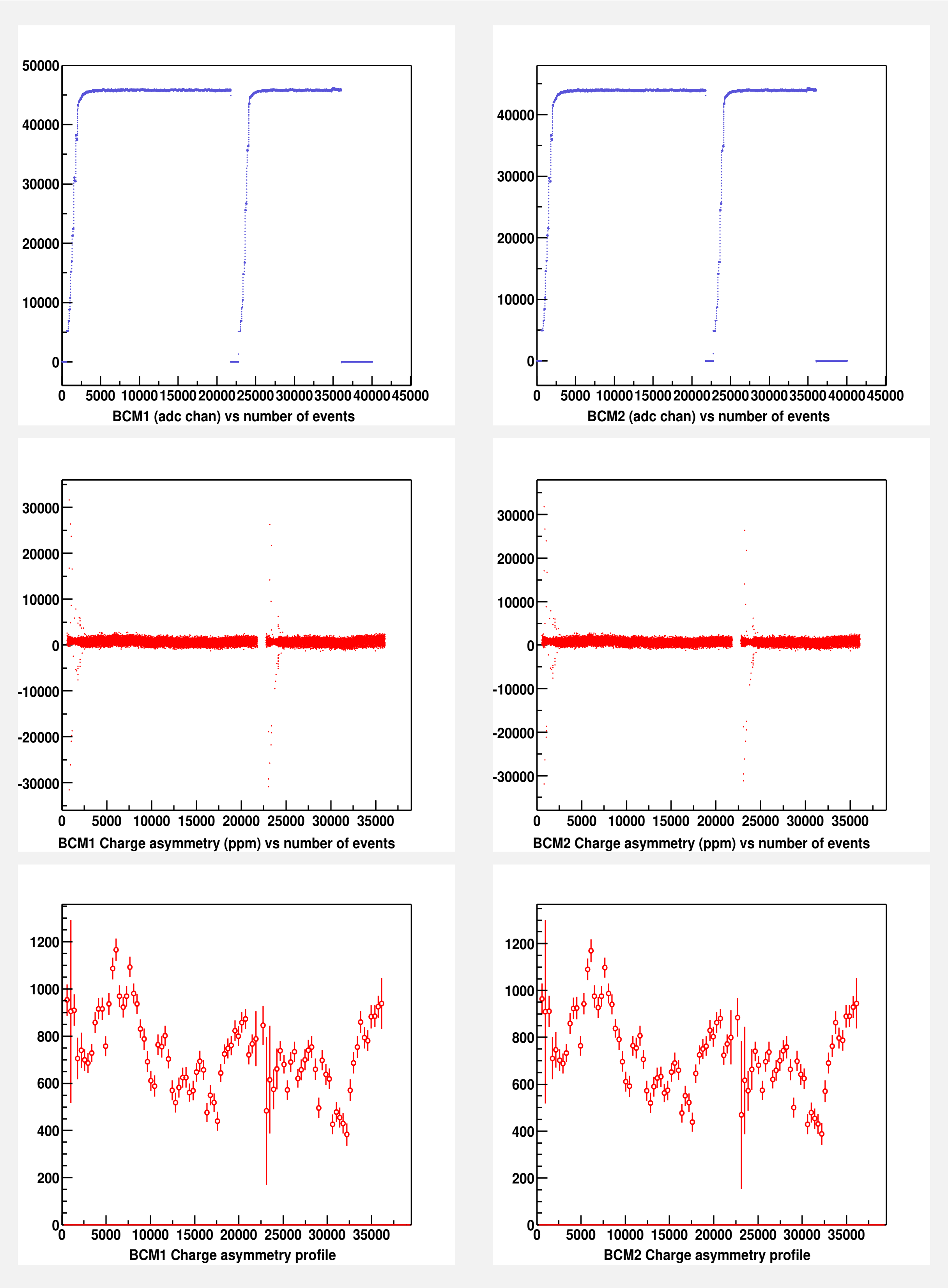


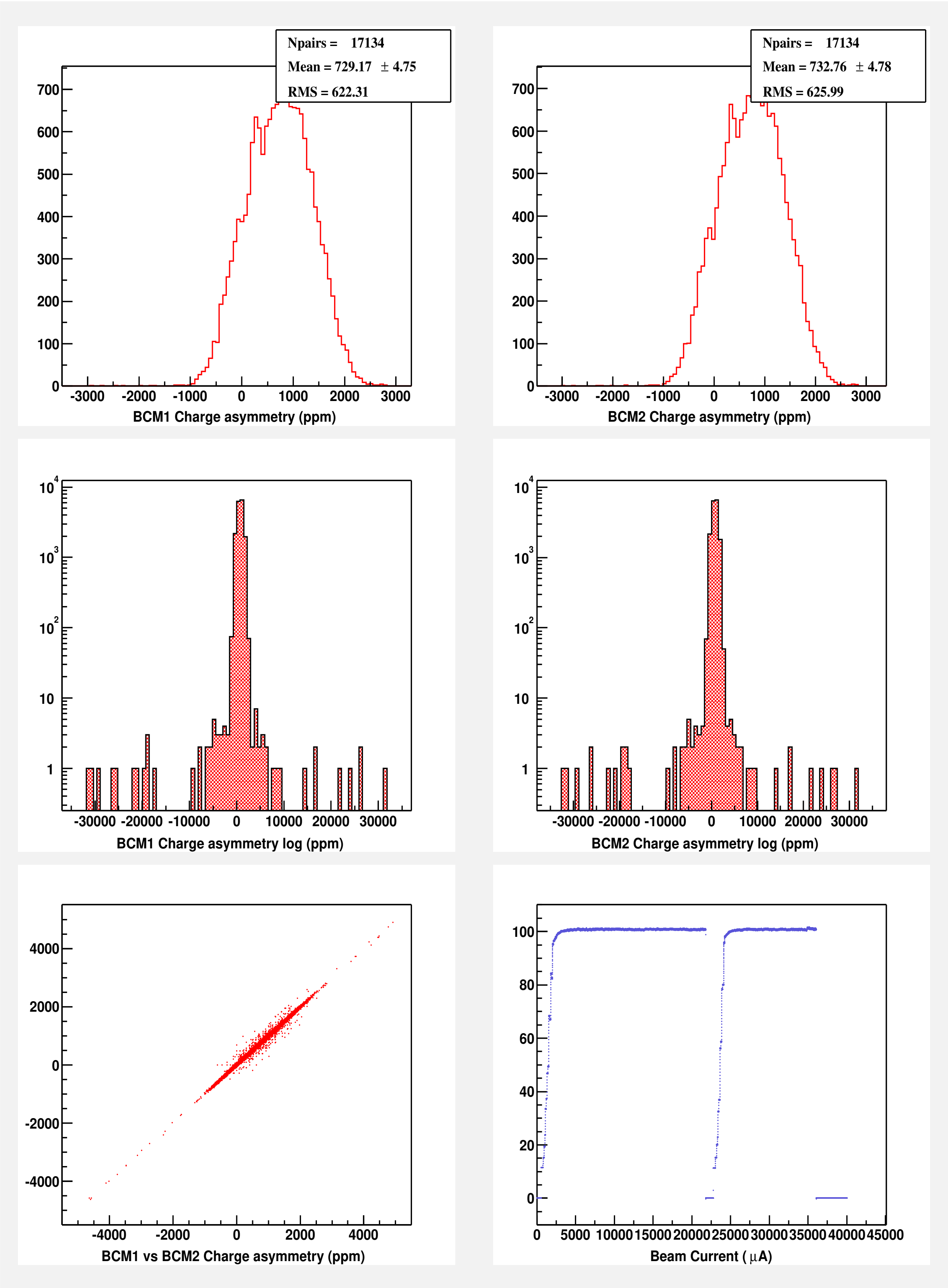
LUMI1 (adc chan) vs number of events
LUMI1 vs BCM1 (adc chan)
Npairs = 19030
Mean = -653.67 ± 48.41
RMS = 6678.27
LUMI1 Asymmetry (ppm)
LUMI1 Asymmetry log (ppm)
Npairs = 18961
Mean = 90.68 ± 47.91
RMS = 6596.87
LUMI1-BCM1 (ppm)
LUMI1-BCM1 (ppm) vs number of events

Liquid Hydrogen

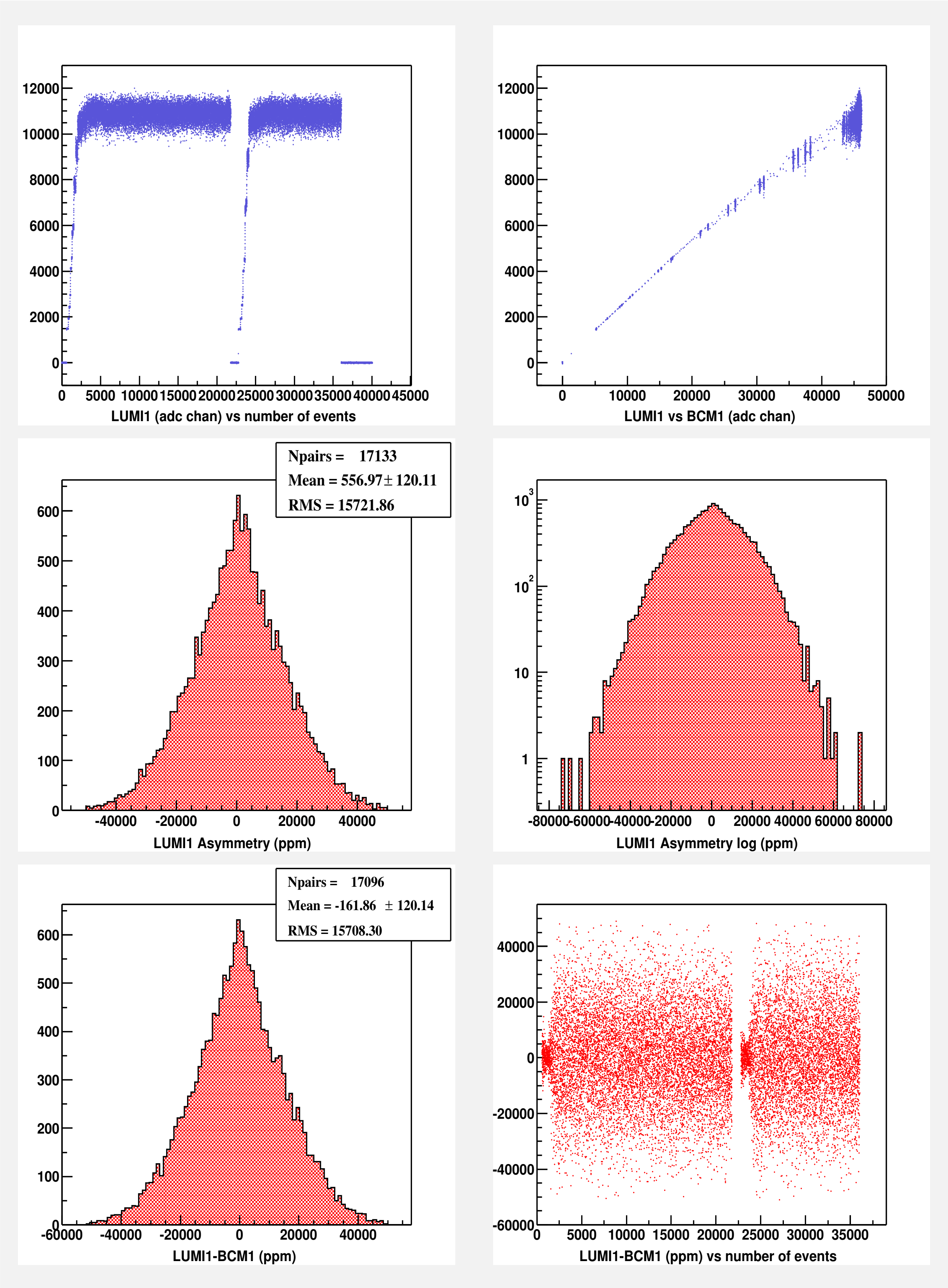
- Beam Energy: 4712.9 MeV
- Beam Current 100 μA on 15 cm LH_2
- Raster Size: 1.7 mm $\times$ 2.0 mm (x, y)
- *INTEG_TIME = 7000*, *OVERSAMPLE = 1*
- Lumi1 HV = -675 V, Anode Current ~ -2 μA



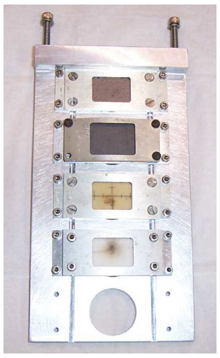

BCM1 (adc chan) vs number of events
BCM2 (adc chan) vs number of events
BCM1 Charge asymmetry (ppm) vs number of events
BCM2 Charge asymmetry (ppm) vs number of events
BCM1 Charge asymmetry profile
BCM2 Charge asymmetry profile



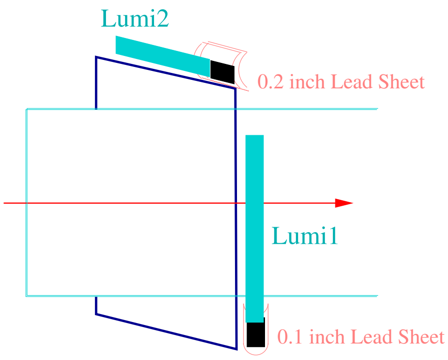
Npairs = 17134
Mean = 729.17 ± 4.75
RMS = 622.31
BCM1 Charge asymmetry (ppm)
Npairs = 17134
Mean = 732.76 ± 4.78
RMS = 625.99
BCM2 Charge asymmetry (ppm)
BCM1 Charge asymmetry log (ppm)
BCM2 Charge asymmetry log (ppm)
BCM1 vs BCM2 Charge asymmetry (ppm)
Beam Current (μA)

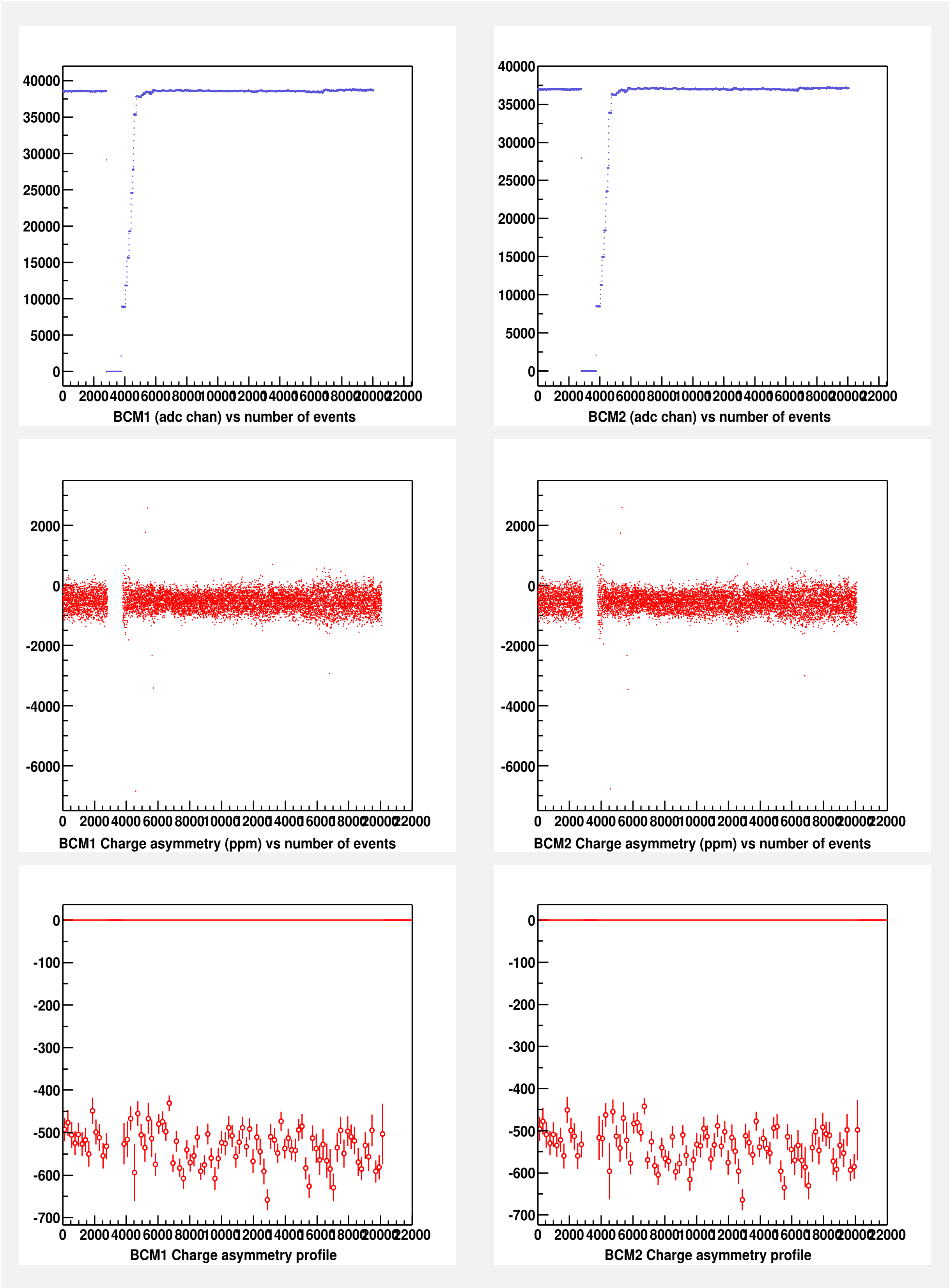

LUMI1 (adc chan) vs number of events
LUMI1 vs BCM1 (adc chan)
Npairs = 17133
Mean = 556.97 ± 120.11
RMS = 15721.86
LUMI1 Asymmetry (ppm)
LUMI1 Asymmetry log (ppm)
Npairs = 17096
Mean = -161.86 ± 120.14
RMS = 15708.30
LUMI1-BCM1 (ppm)
LUMI1-BCM1 (ppm) vs number of events

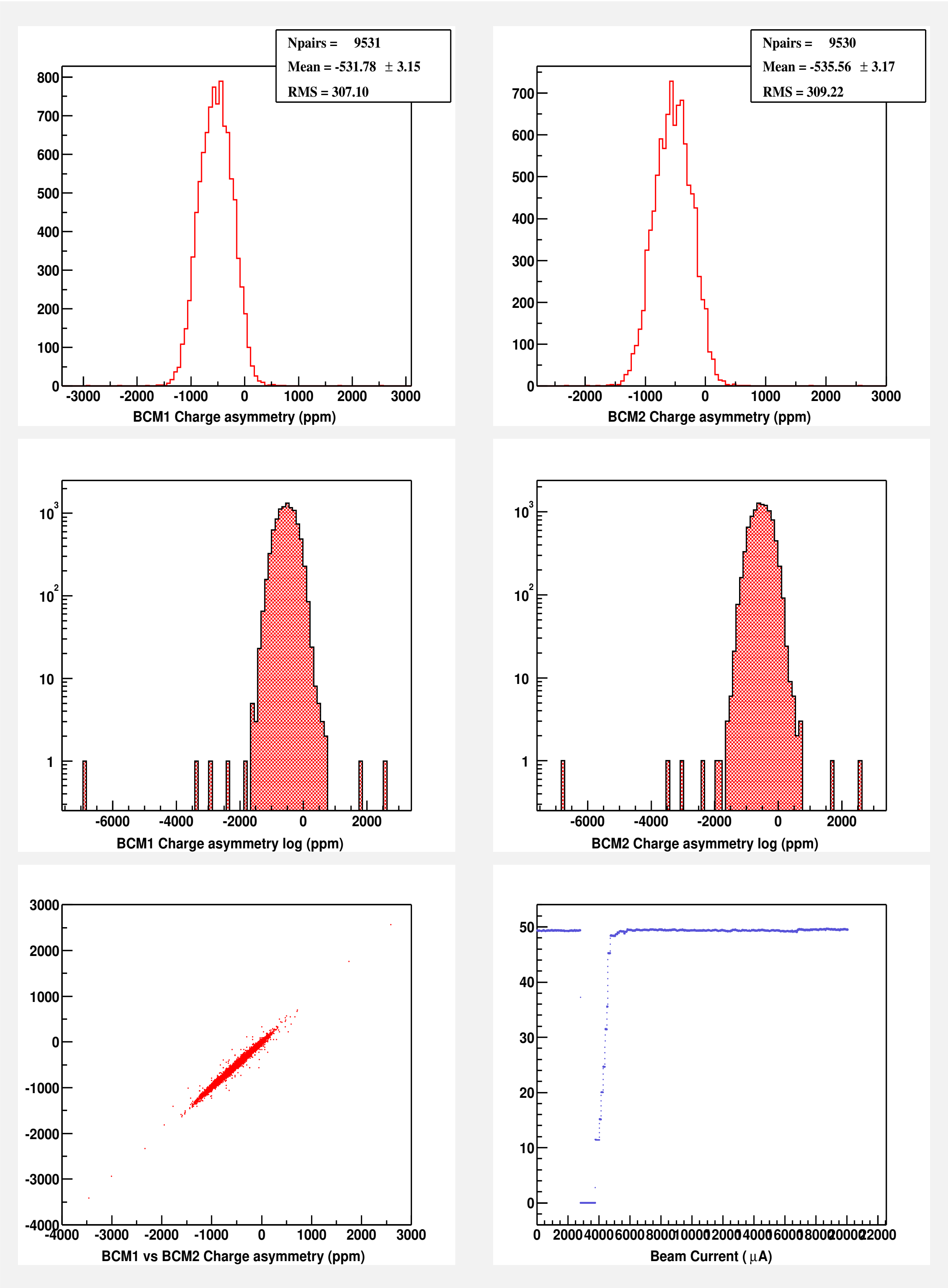
Thick Carbon

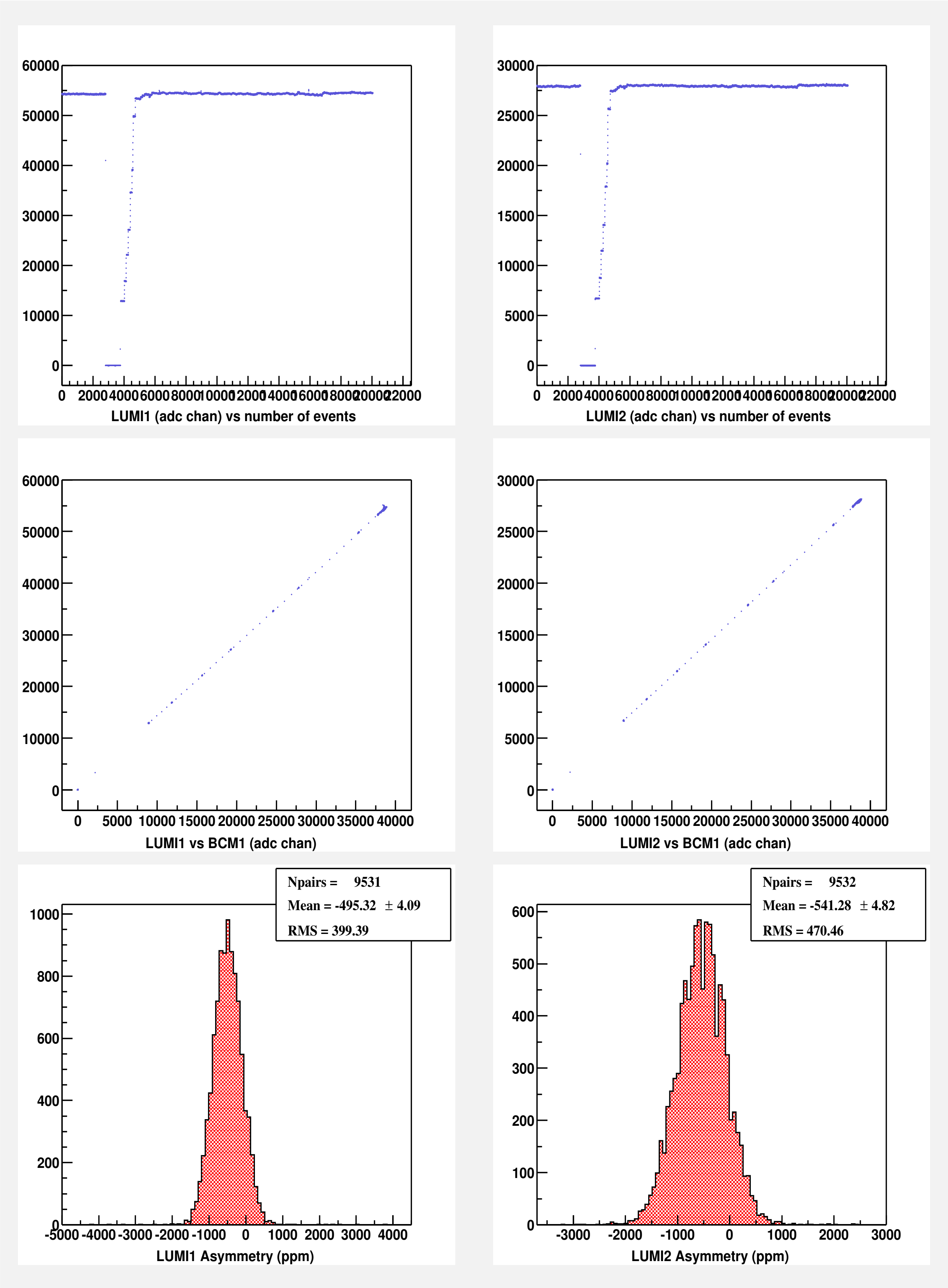


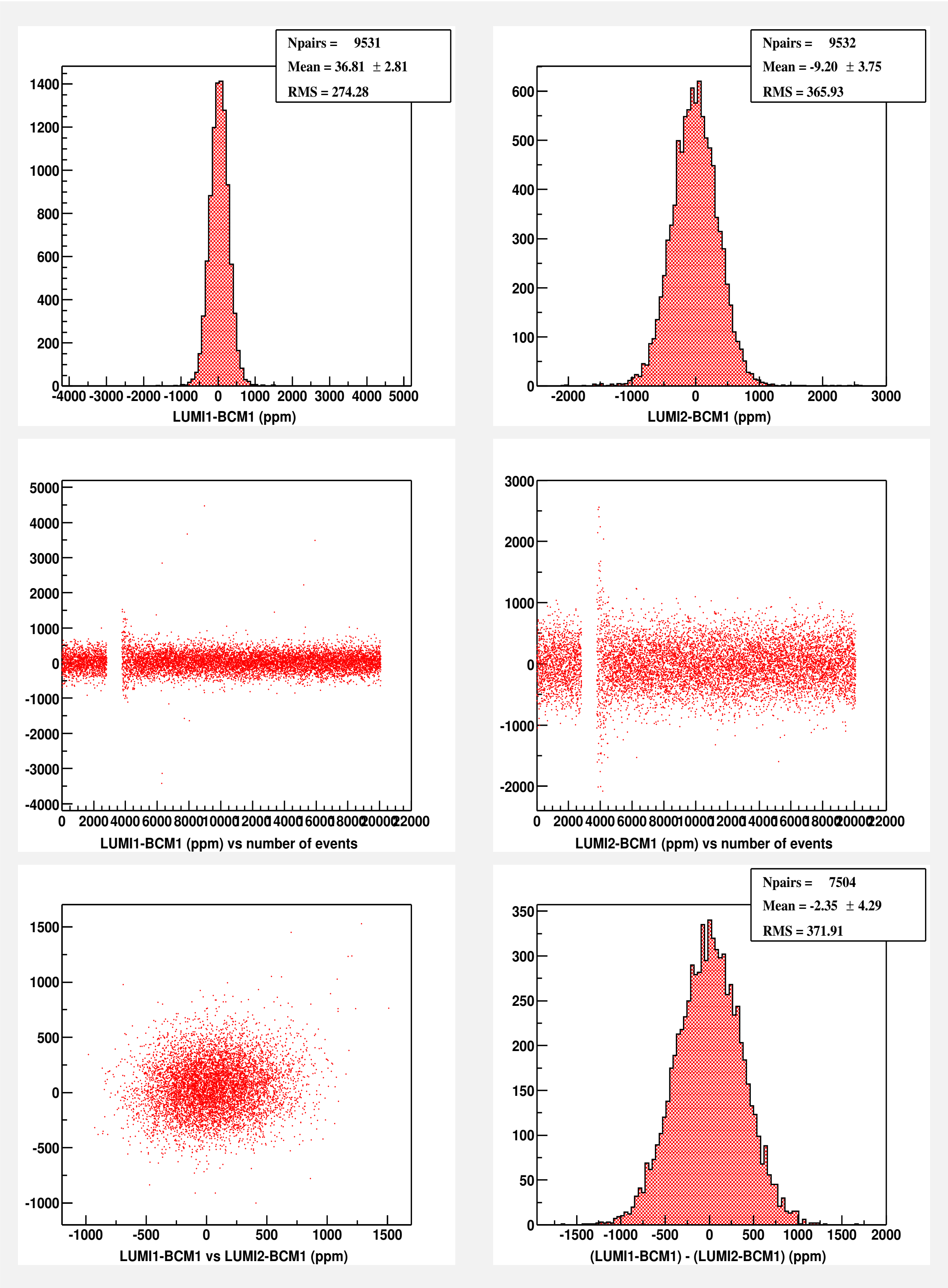
- Beam Energy: 2848.04 MeV
- Beam Current $50\ \mu$A on 594 mg/cm^2 C
- No Raster
- *INTEG_TIME = 12000*, *OVERSAMPLE = 1*
- Lumi1 HV = -850 V, Anode Current $\sim -6\ \mu$A
- Lumi2 HV = -750 V, Anode Current $\sim -3\ \mu$A




BCM1 (adc chan) vs number of events
BCM2 (adc chan) vs number of events
BCM1 Charge asymmetry (ppm) vs number of events
BCM2 Charge asymmetry (ppm) vs number of events
BCM1 Charge asymmetry profile
BCM2 Charge asymmetry profile

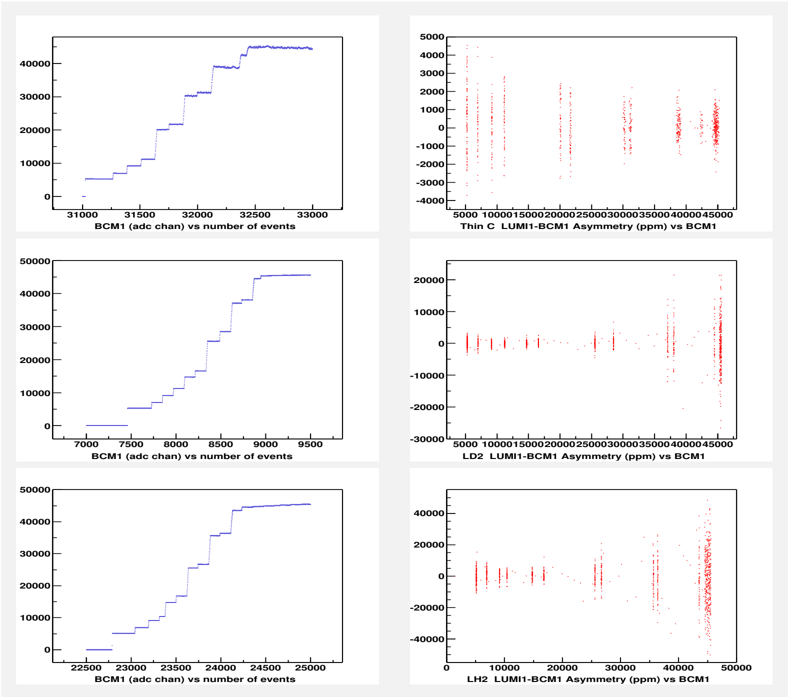

Npairs = 9531
Mean = -531.78 ± 3.15
RMS = 307.10
BCM1 Charge asymmetry (ppm)
Npairs = 9530
Mean = -535.56 ± 3.17
RMS = 309.22
BCM2 Charge asymmetry (ppm)
BCM1 Charge asymmetry log (ppm)
BCM2 Charge asymmetry log (ppm)
BCM1 vs BCM2 Charge asymmetry (ppm)
Beam Current (μA)

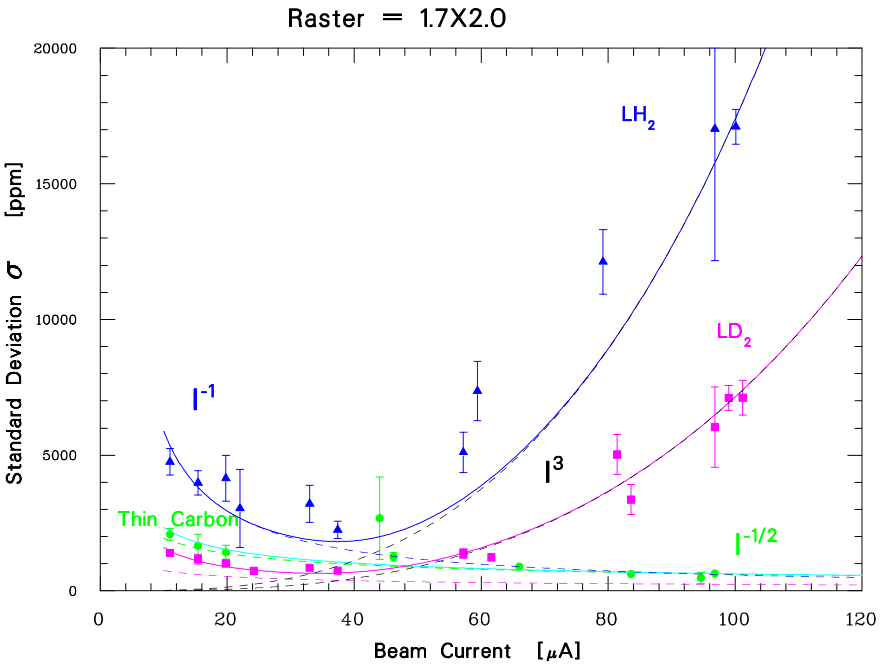

LUMI1 (adc chan) vs number of events
LUMI2 (adc chan) vs number of events
LUMI1 vs BCM1 (adc chan)
LUMI2 vs BCM1 (adc chan)
Npairs = 9531
Mean = -495.32 ± 4.09
RMS = 399.39
LUMI1 Asymmetry (ppm)
Npairs = 9532
Mean = -541.28 ± 4.82
RMS = 470.46
LUMI2 Asymmetry (ppm)

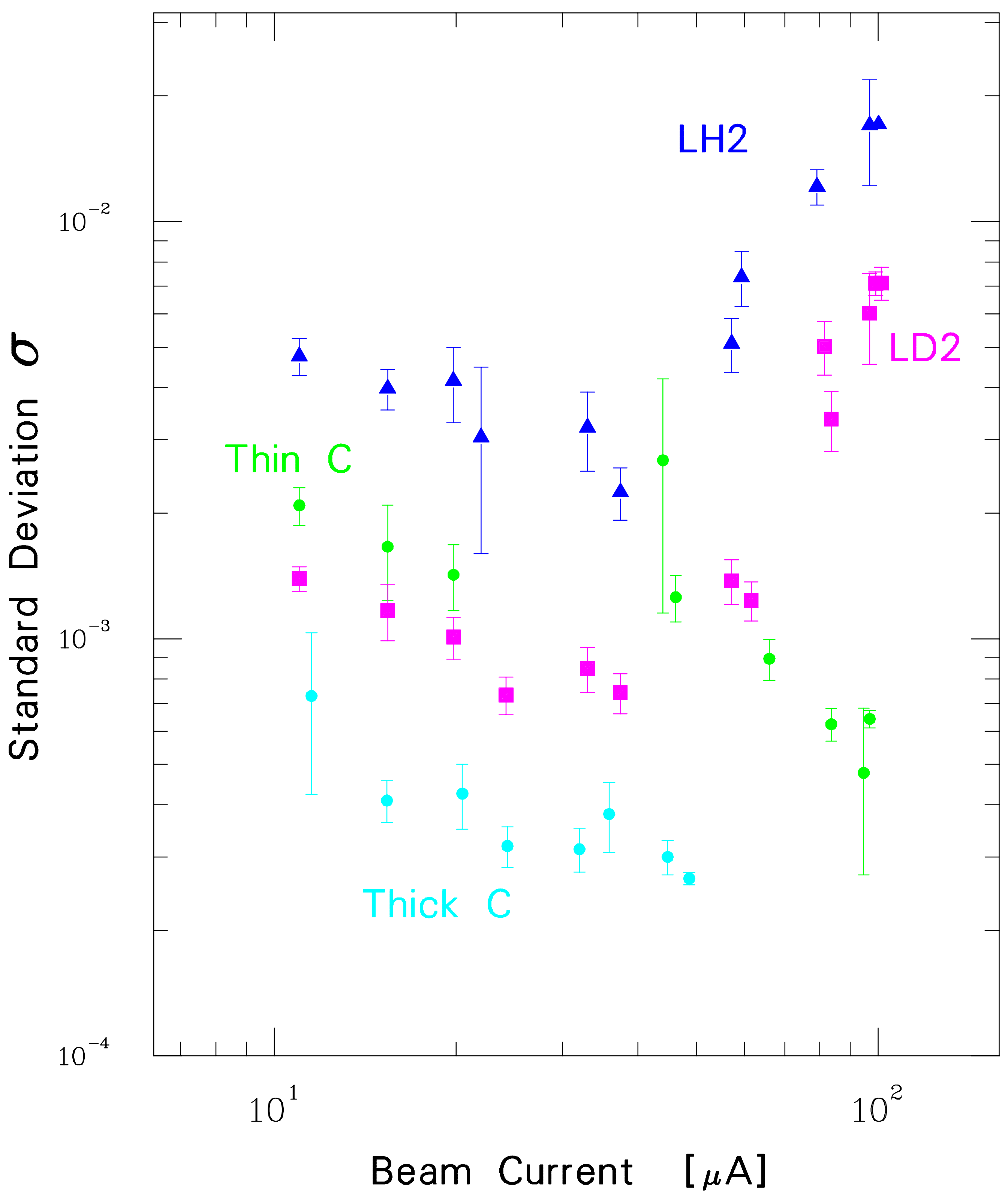


Npairs = 9531
Mean = 36.81 ± 2.81
RMS = 274.28
LUMI1-BCM1 (ppm)
Npairs = 9532
Mean = -9.20 ± 3.75
RMS = 365.93
LUMI2-BCM1 (ppm)
LUMI1-BCM1 (ppm) vs number of events
LUMI2-BCM1 (ppm) vs number of events
LUMI1-BCM1 vs LUMI2-BCM1 (ppm)
Npairs = 7504
Mean = -2.35 ± 4.29
RMS = 371.91
(LUMI1-BCM1) - (LUMI2-BCM1) (ppm)

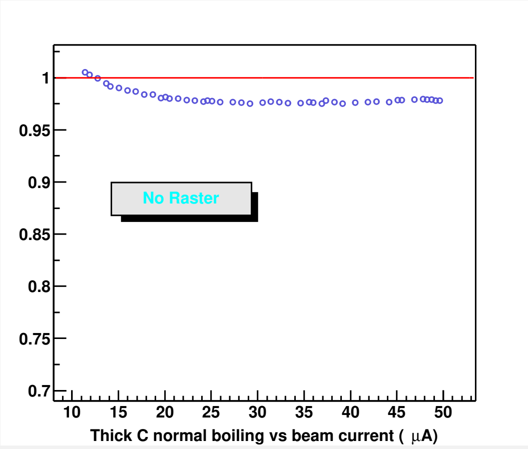
Deuterium & Hydrogen Boiling

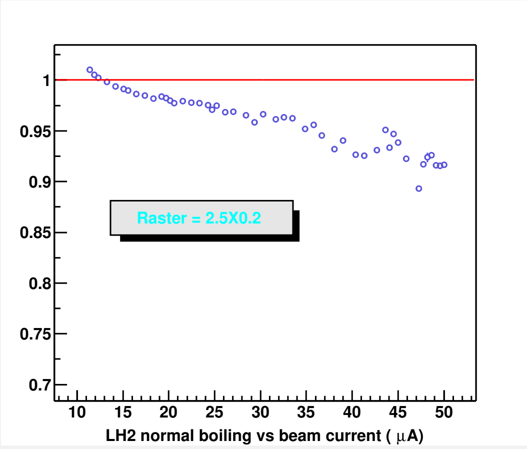


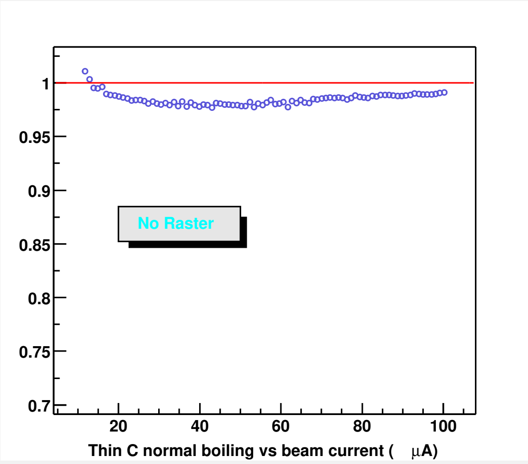


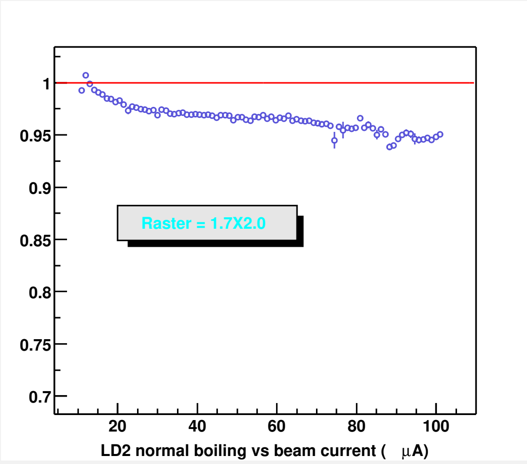

LH2
LD2
Thin C
Thick C
Standard Deviation σ
Beam Current [μA]
10^{-2}
10^{-3}
10^{-4}
10^{1}
10^{2}

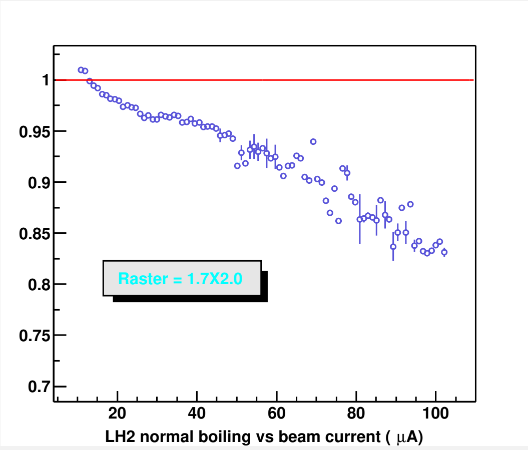
Normal Boiling











Fall Beam Tests

1- **Targets:**

LH_2 15 cm, LH_2 4 cm, LD_2 15 cm, Thick Carbon

2- **Beam current:**

5 - 100 μA

3- **Raster Sizes:**

1.4x1.4, 2.8x2.8, 3.8x3.8, 1.4x3.8, 3.8x1.4

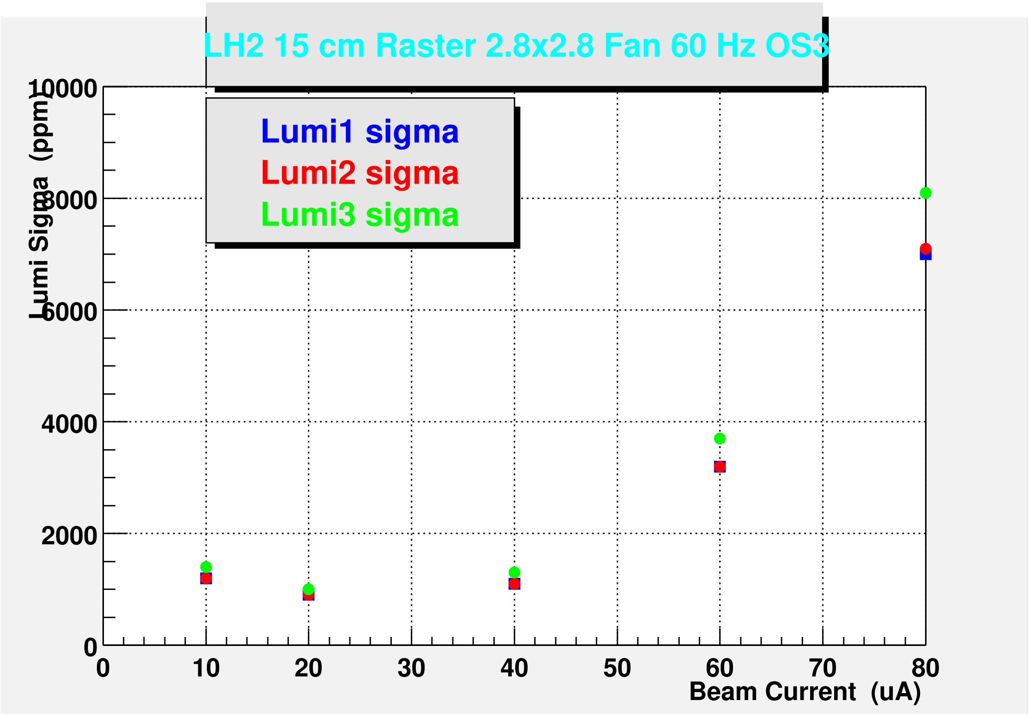
4- **Fan Speed:**

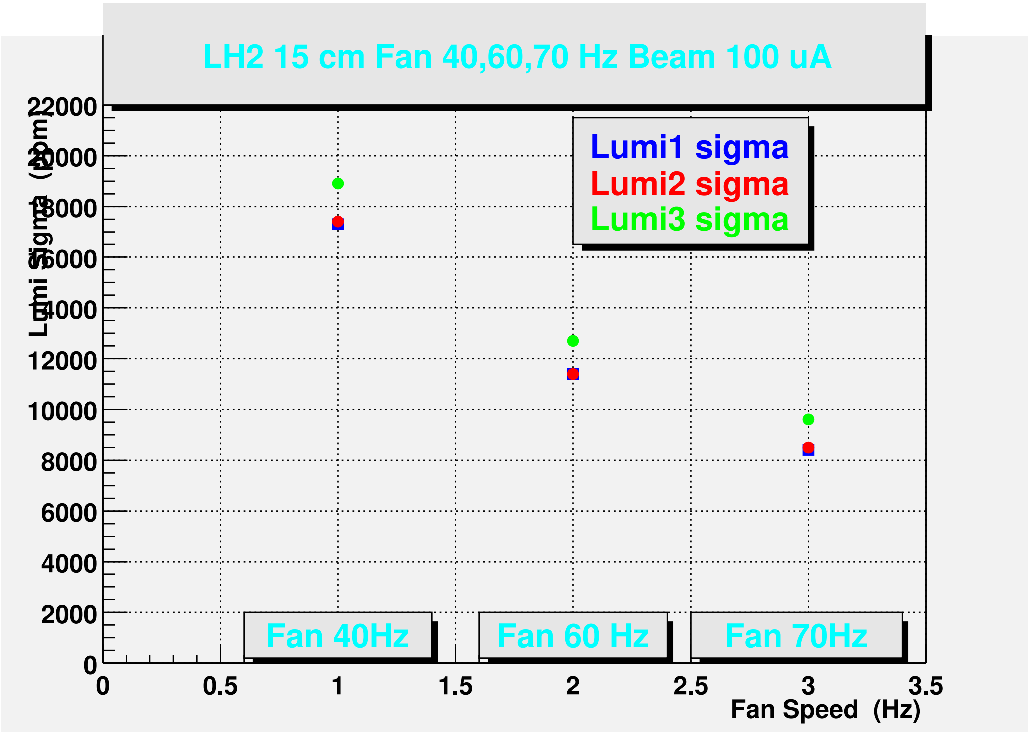
30, 40, 60, 70 Hz

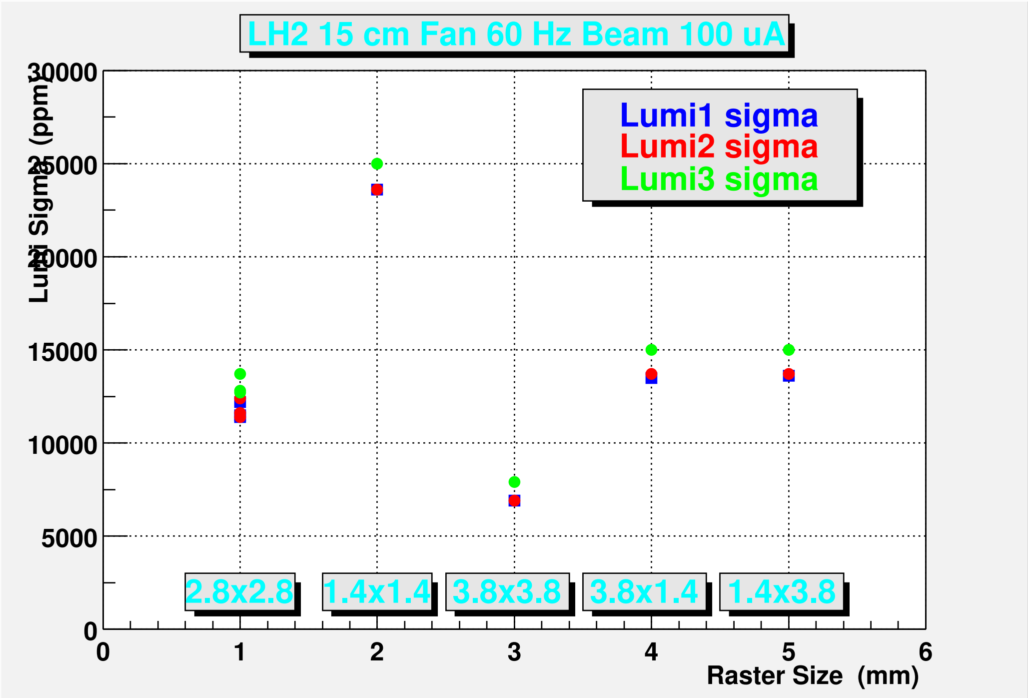
5- **Intrinsic Beam Spot Size:**

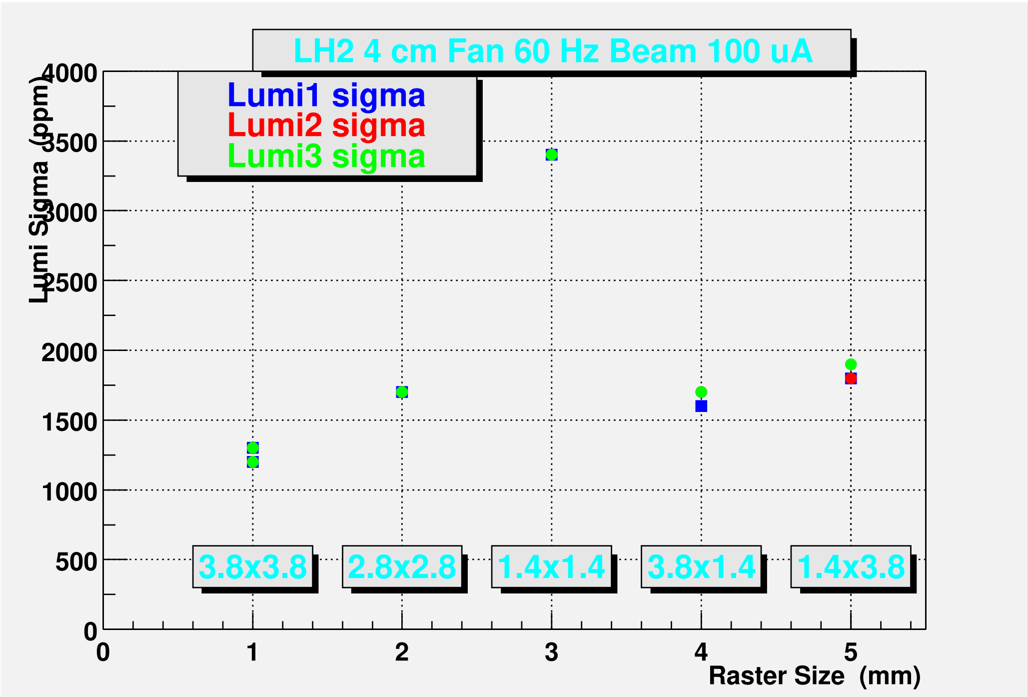
two settings, order of magnitude different areas

.... analysis is underway ...


LH2 15 cm Raster 2.8x2.8 Fan 60 Hz OS3
Lumi1 sigma
Lumi2 sigma
Lumi3 sigma
Lumi Sigma (ppm)
10000
8000
6000
4000
2000
0
0
10
20
30
40
50
60
70
80
Beam Current (uA)


LH2 15 cm Fan 40,60,70 Hz Beam 100 uA
Lumi1 sigma
Lumi2 sigma
Lumi3 sigma
Lumi Sigma (ppm)
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Fan 40Hz
Fan 60 Hz
Fan 70Hz
0
0.5
1
1.5
2
2.5
3
3.5
Fan Speed (Hz)


LH2 15 cm Fan 60 Hz Beam 100 uA
Lumi1 sigma
Lumi2 sigma
Lumi3 sigma
Lumi Sigma (ppm)
30000
25000
20000
15000
10000
5000
0
2.8x2.8
1.4x1.4
3.8x3.8
3.8x1.4
1.4x3.8
0
1
2
3
4
5
6
Raster Size (mm)


LH2 4 cm Fan 60 Hz Beam 100 uA
Lumi1 sigma
Lumi2 sigma
Lumi3 sigma
Lumi Sigma (ppm)
4000
3500
3000
2500
2000
1500
1000
500
0
3.8x3.8
2.8x2.8
1.4x1.4
3.8x1.4
1.4x3.8
0
1
2
3
4
5
Raster Size (mm)

Summary

1- The lumi detector can measure both target density reduction and density fluctuations at the same time

2- A new lumi made of quartz will be installed in February 03