MC Simulations & SiPM Tests

Contalbrigo Marco, Aram Movsisyan
Paolo Lenisa, Luciano Pappalardo, Luca Barion
INFN Ferrara

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MC Simulations

Quantitative Study needs preparatory phase

- Exact geometry → use same configuration files of data runs
- Measured aerogel characteristics → Luciano talk
- Mirror alignment and nominal optical qualities → Vincenzo talk
- Gem tracking → Evaristo talk

Direct Light @ 8 GeV

- N p.e.
- Cherenkov angle resolution at n=1.04, 1.05 and 1.06
  - Radius RMS: Dispersion law
  - Off-cone runs: Rayleigh scattering
- Pion detection efficiency and rejection factor
  - Threshold Cherenkov into the trigger
  - Focalize light onto R8900 as reference

Reflected Light @ 6 GeV

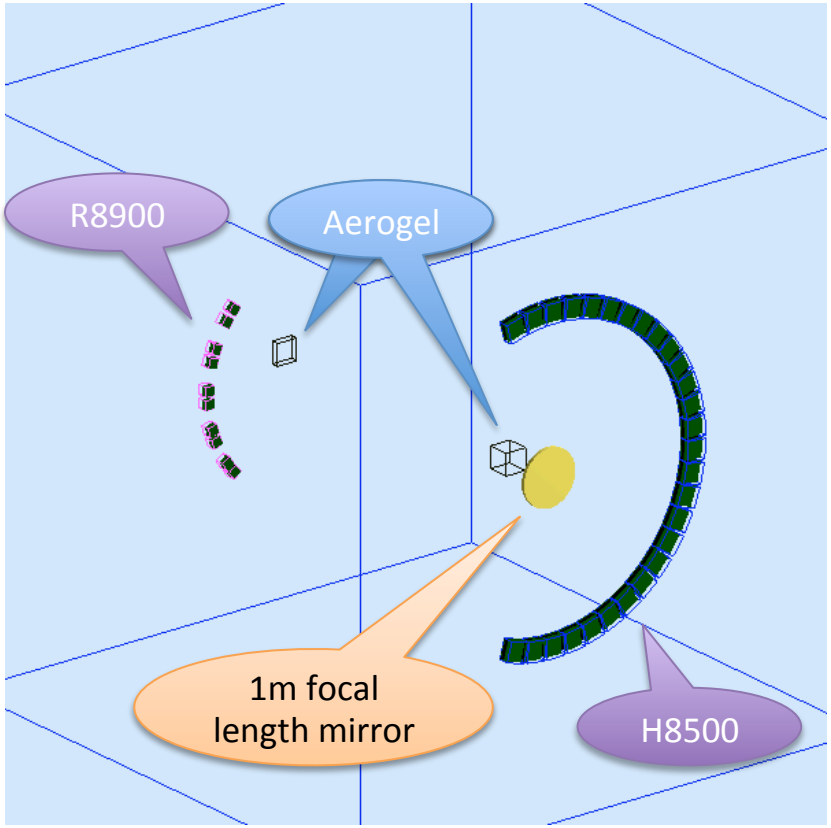
- N p.e. with second reflection on
  - Only mirrors
  - Mirrors + 2 cm thick aerogel
  - Mirrors + 3 cm thick aerogel
- Pion detection efficiency and rejection factor
  - Threshold Cherenkov into the trigger
  - Focalize light onto R8900 as reference

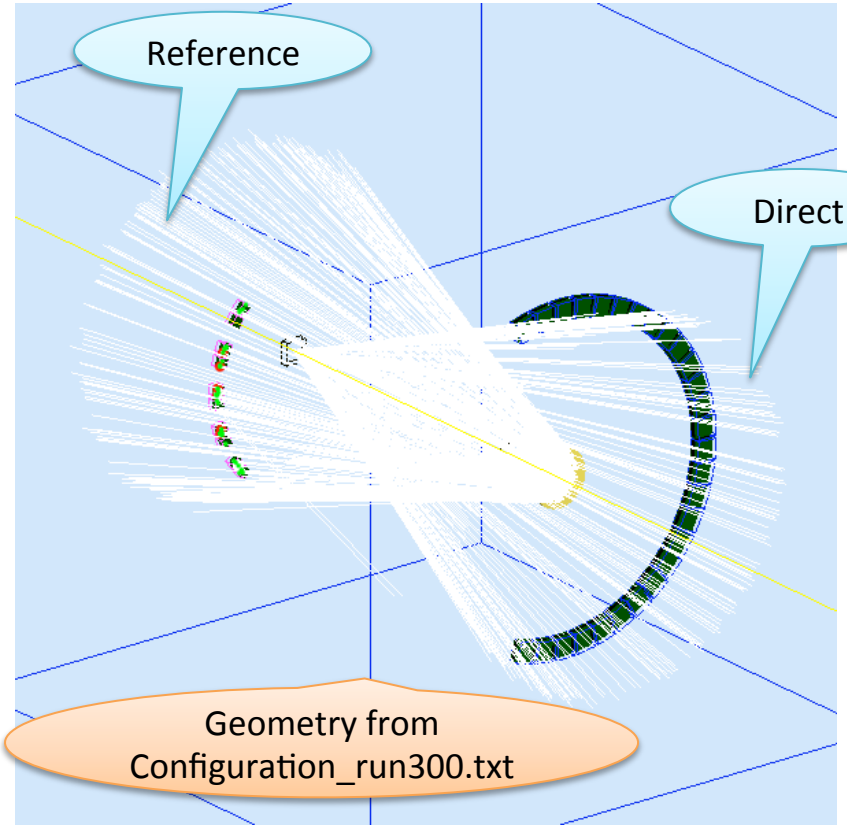
Direct Ring

Goal: test the RICH response at maximum momentum
Verify Cherenkov Angle Resolution and Rayleigh Background

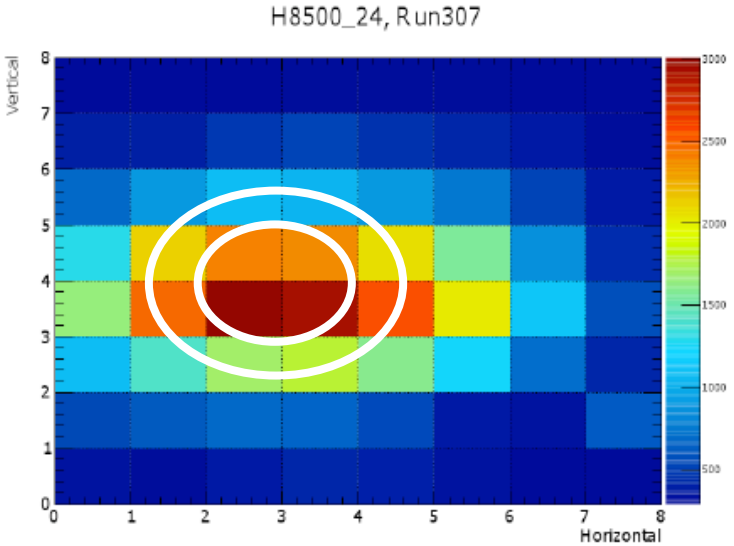
Reference (ideal):
n=1.04-1.06, 6 cm thick aerogel
Focalizing mirror
R8900 designed for single photon

Proximity focusing RICH (realistic):
N=1.04-1.06, 2 cm thick aerogel
100 cm gap
H8500 as photon detector

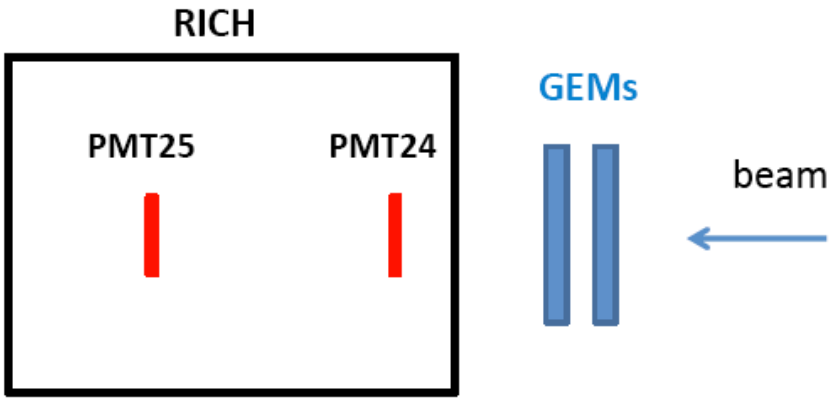




Beam Profile

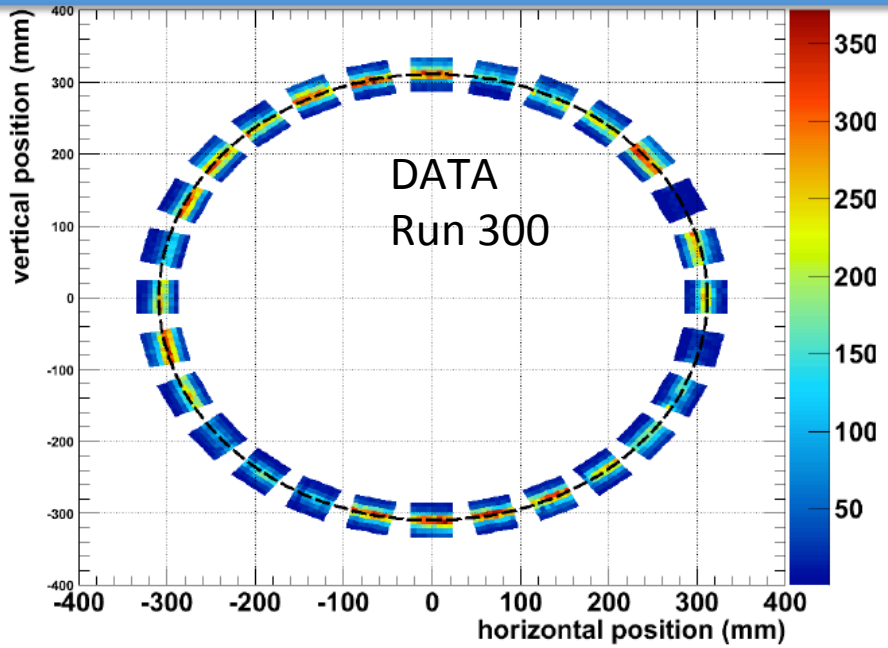


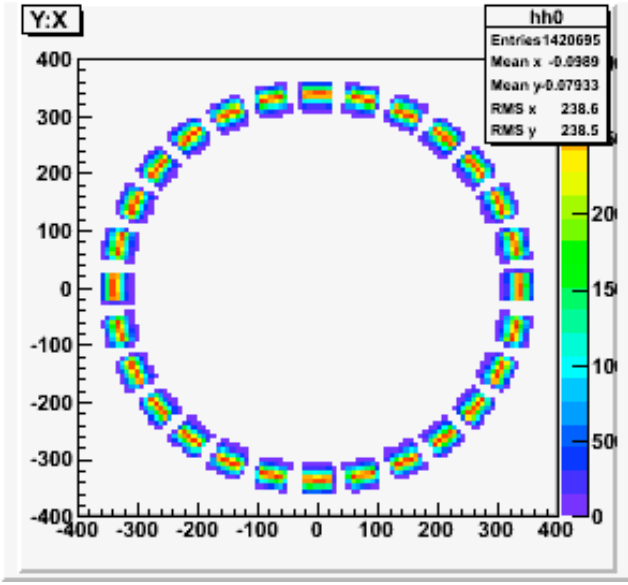
Beam profile measured inside the RICH box with two H8500

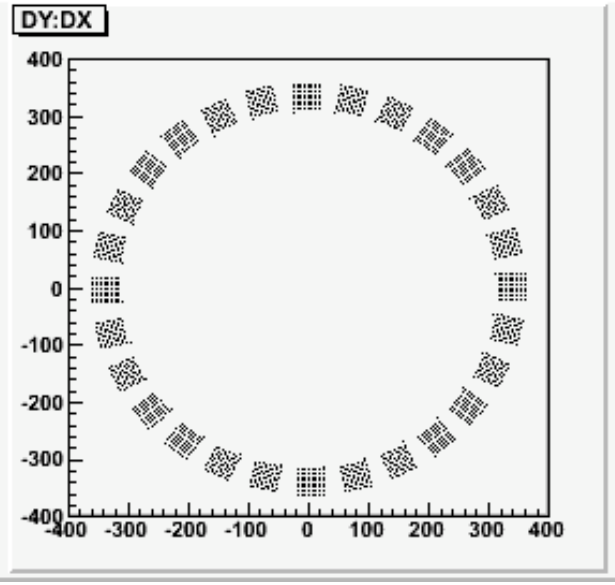


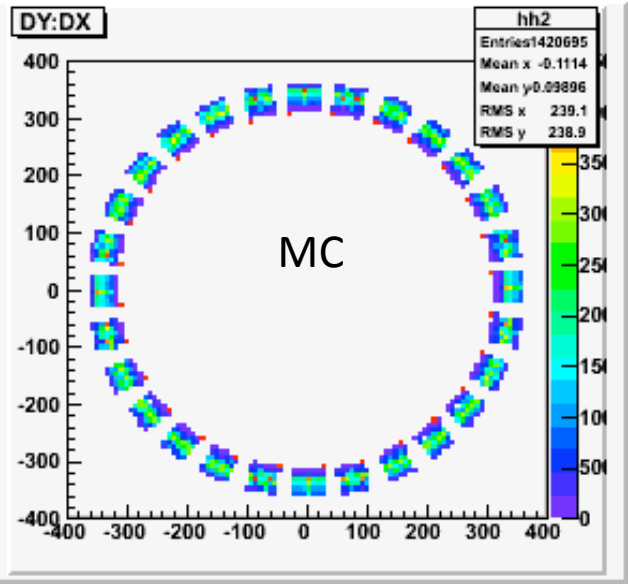
2 cm radius
beam spread

Event Display

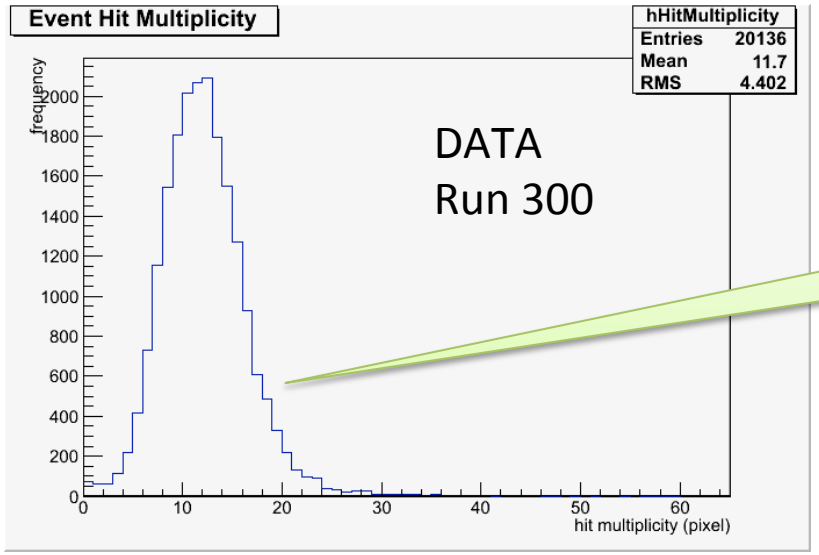


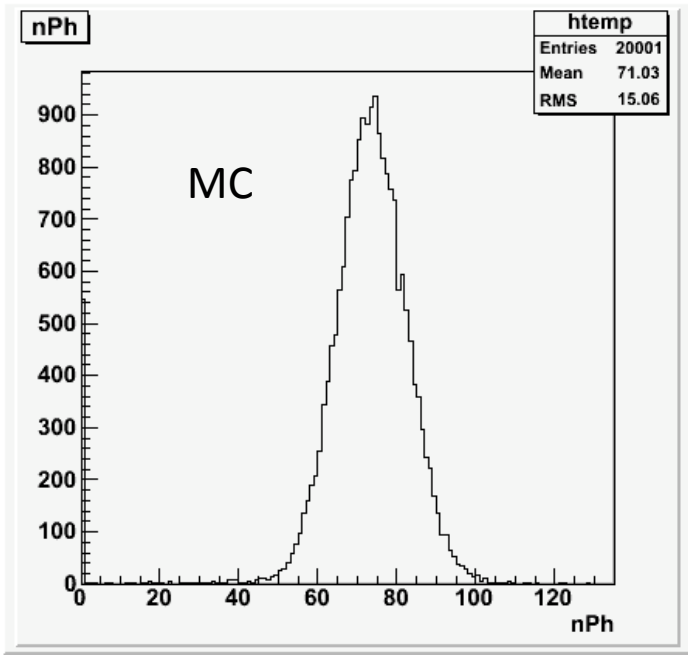


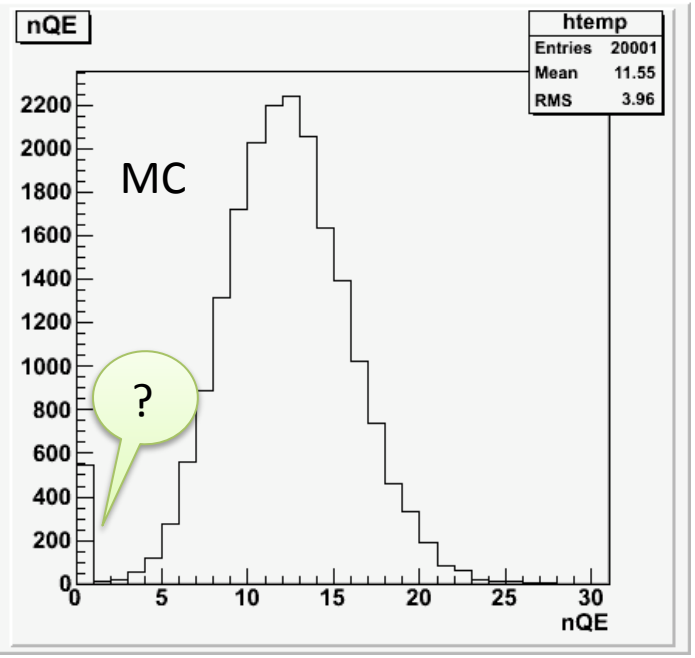




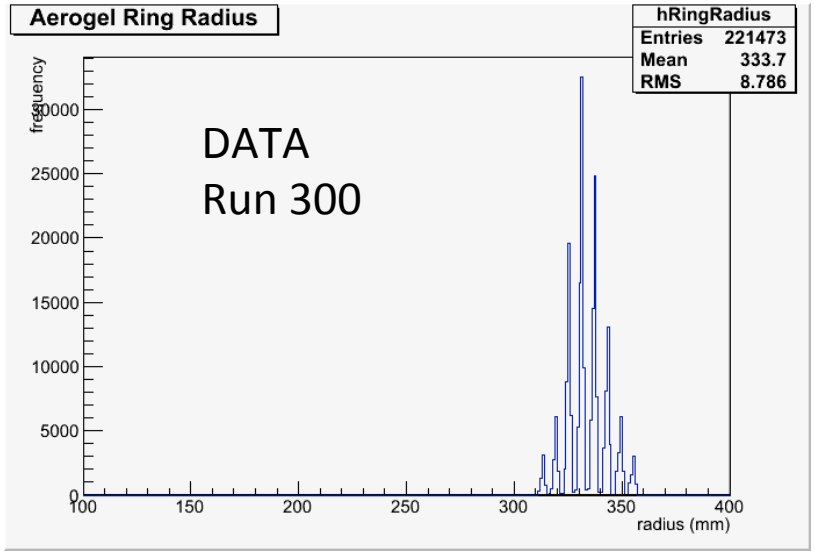
Event Multiplicity

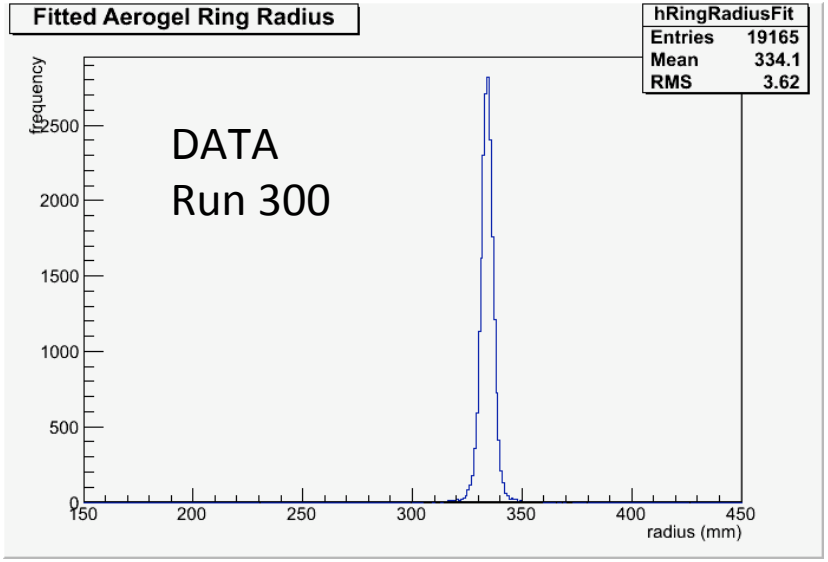


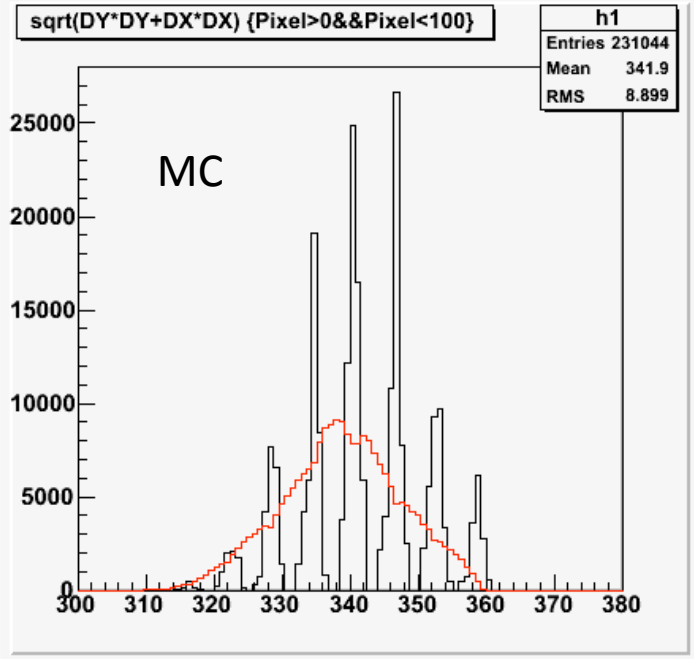


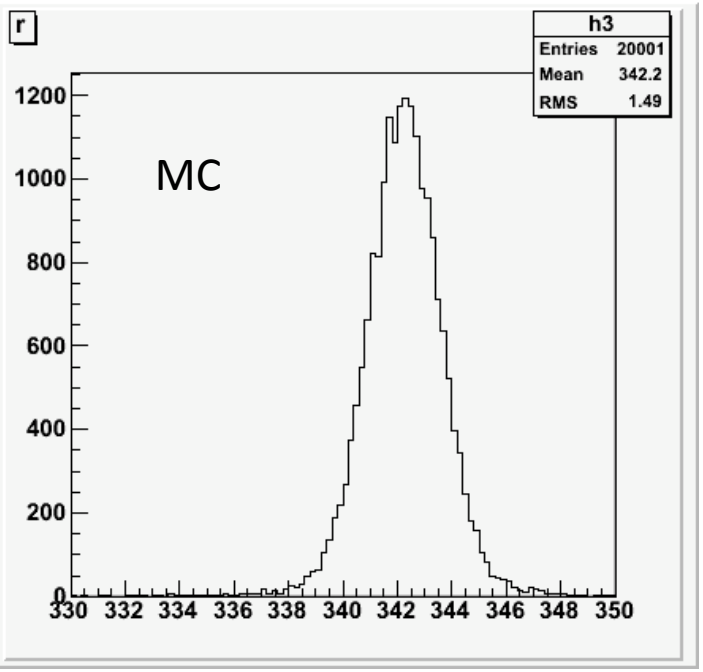


Digitized and Fitted Ring Radius









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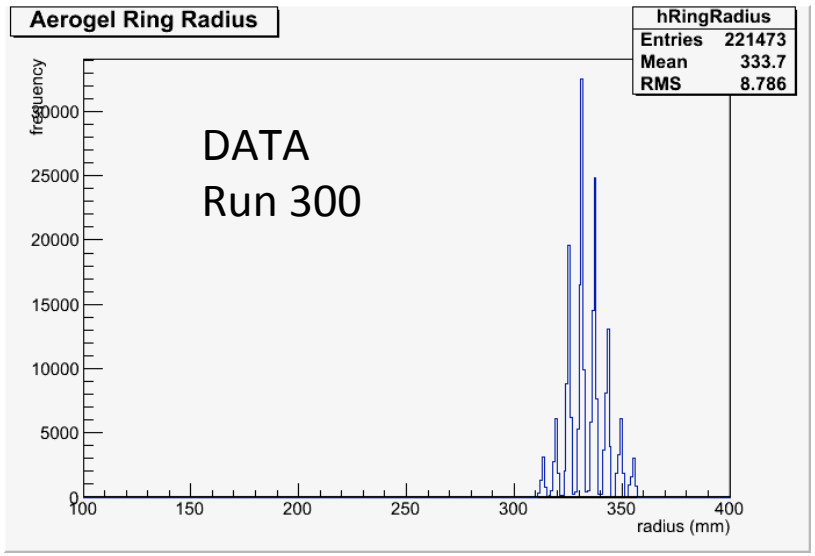
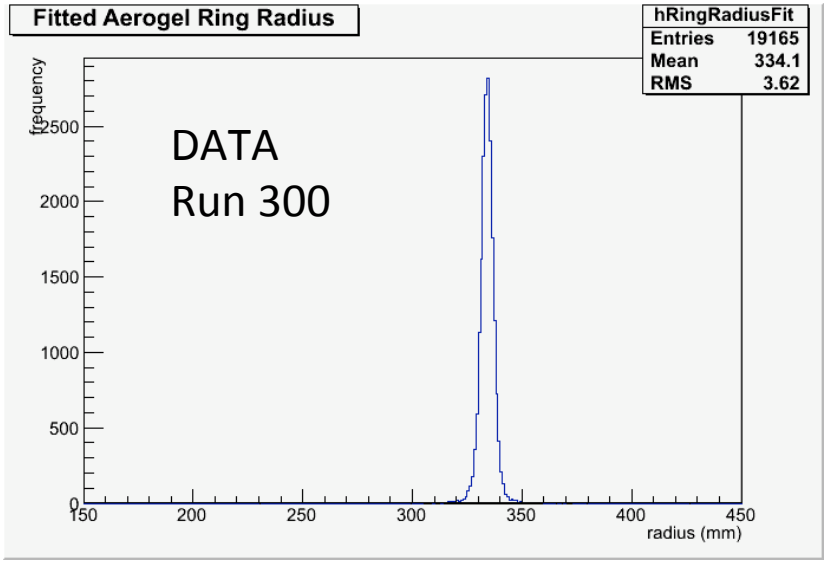
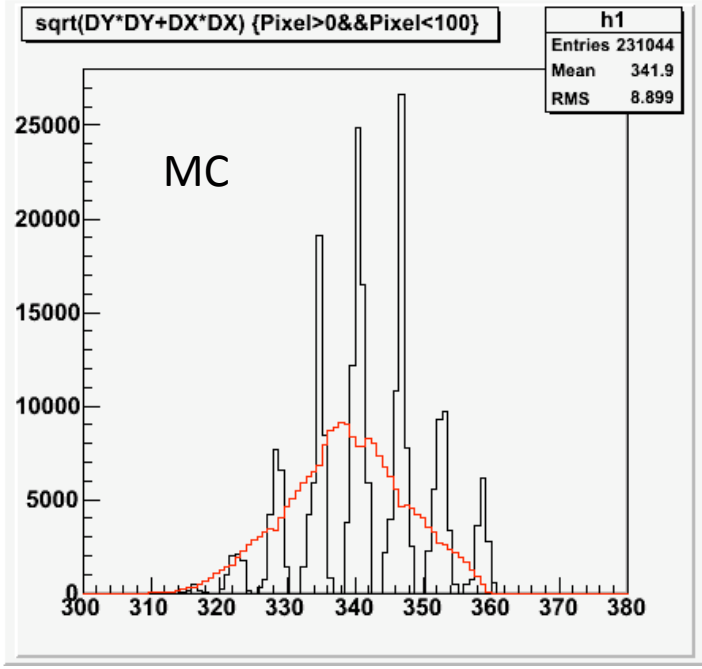
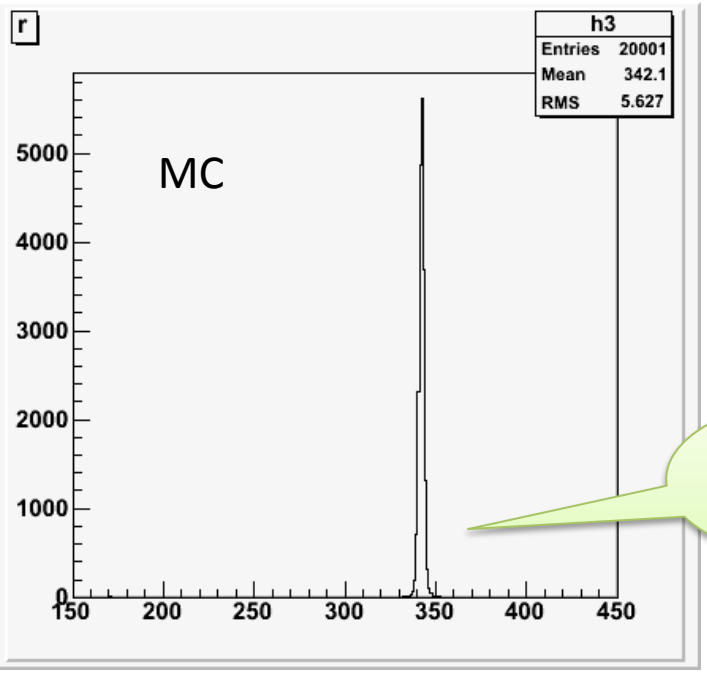


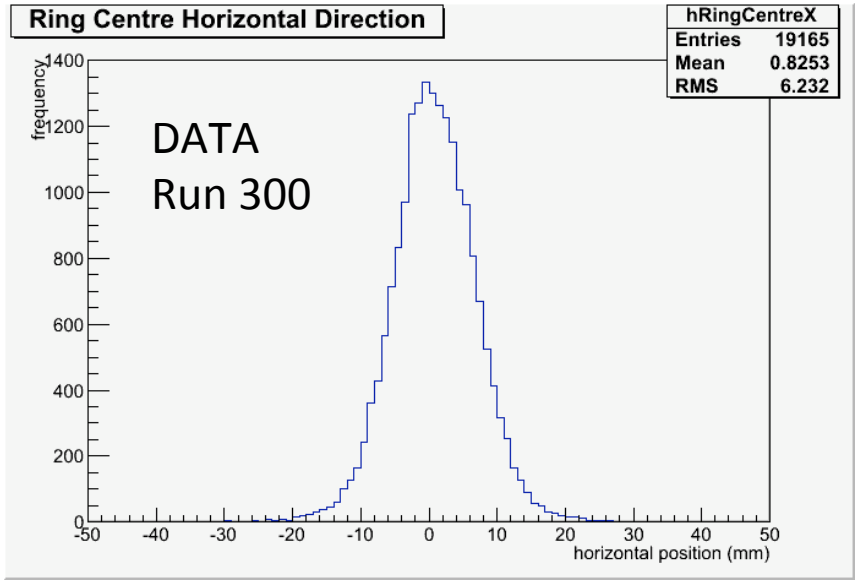


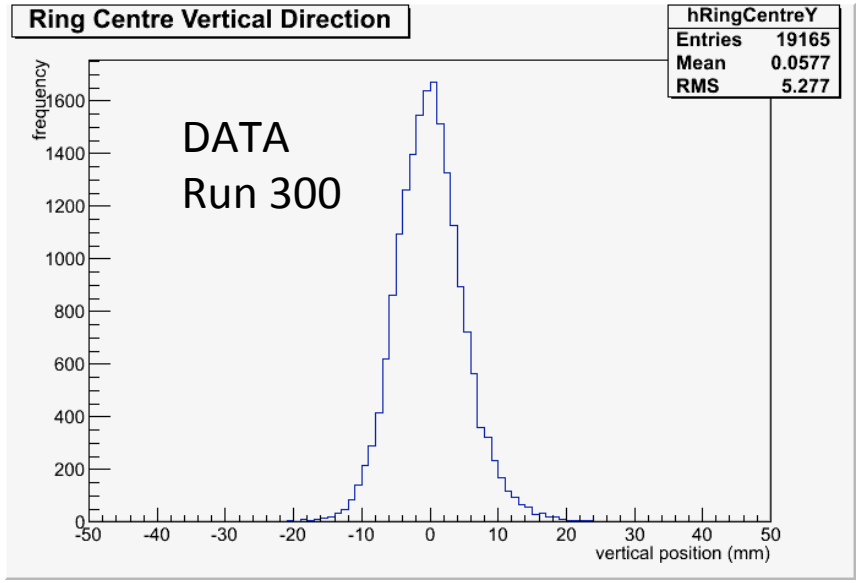


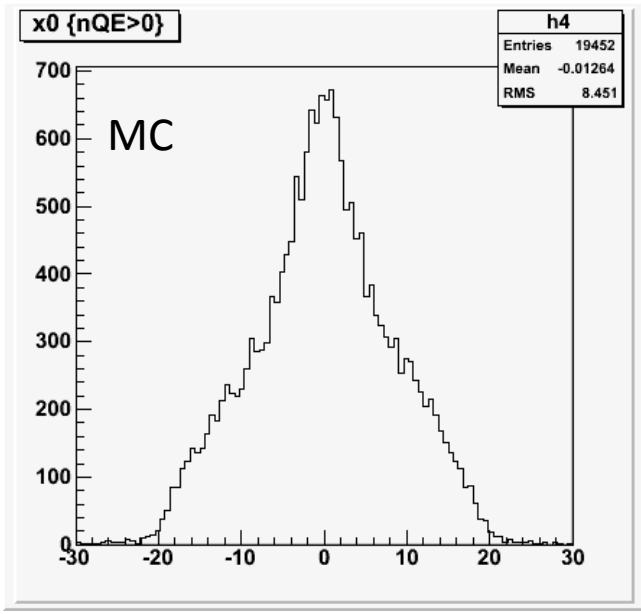


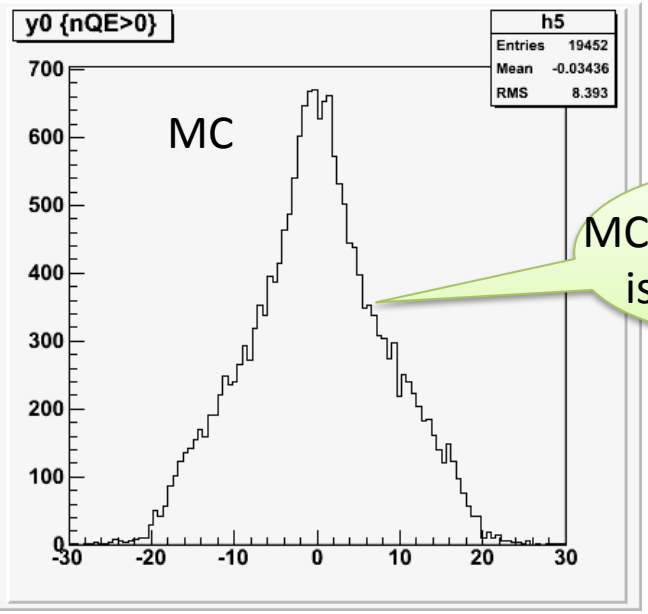
Binning effect ?

Fitted Ring Center



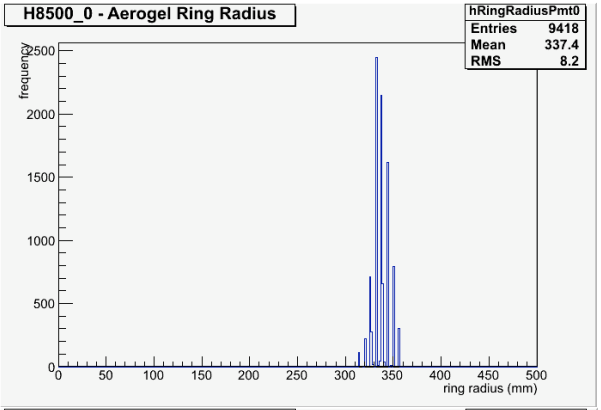


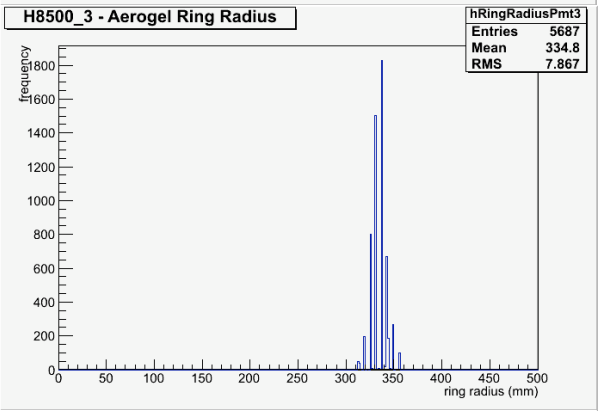


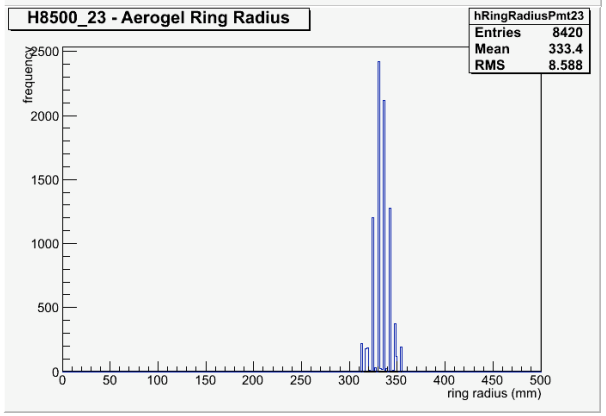


MC beam profile is cylindrical

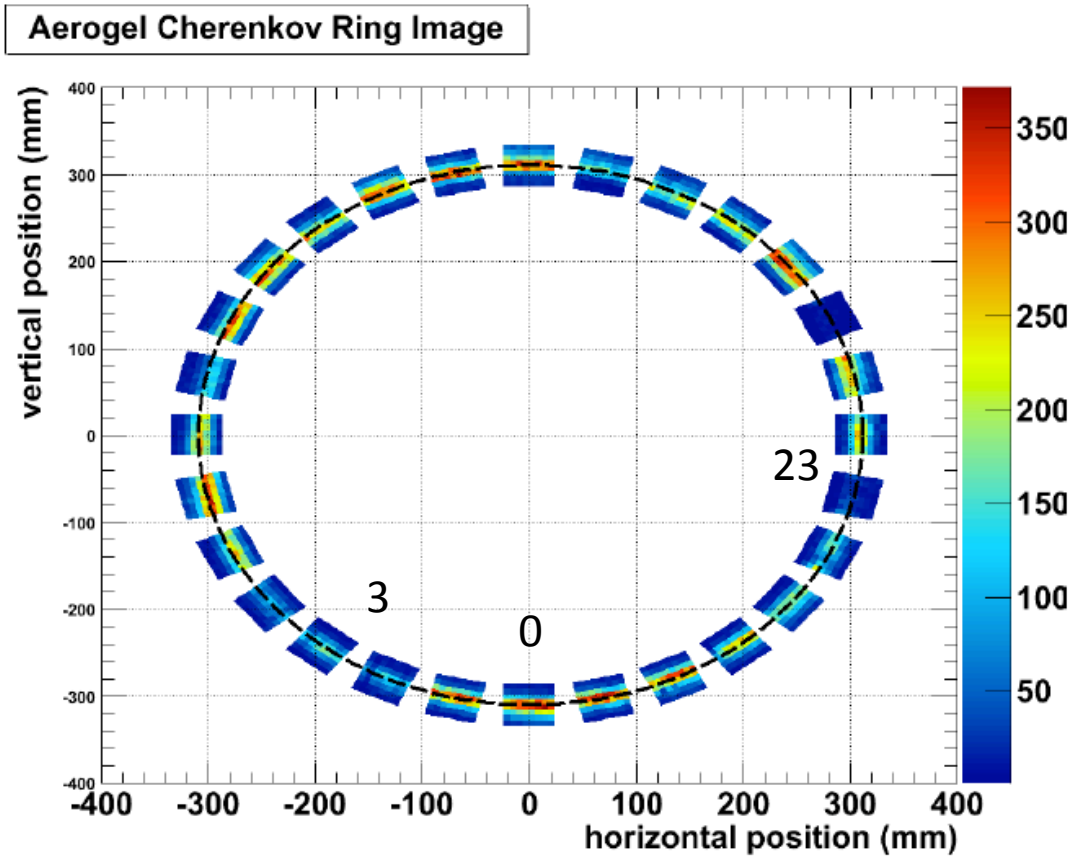
Hit Distribution







DATA
Run 300



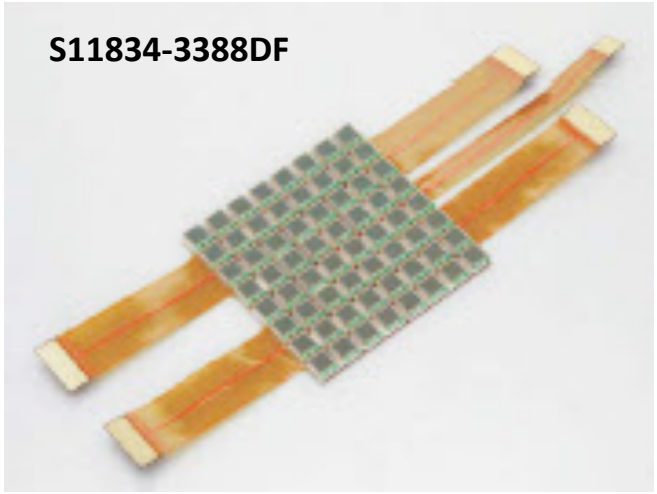
SiPM Option

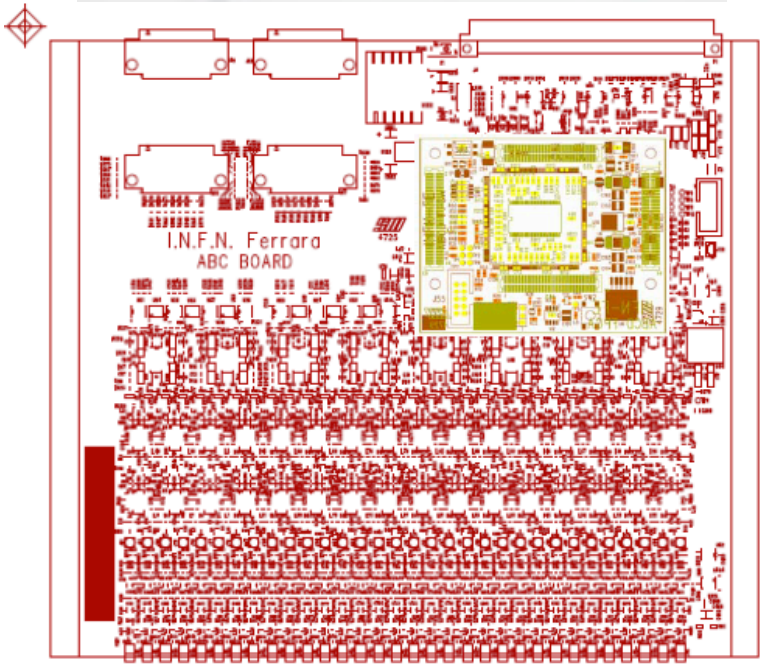
Test feasibility of the single photon detection in the CLAS12 framework

- Light, flexible and robust device
- Fast development (dark count reduced by 10)
- Await cost-effective solutions

Start with the SuperB board developed in Ferrara

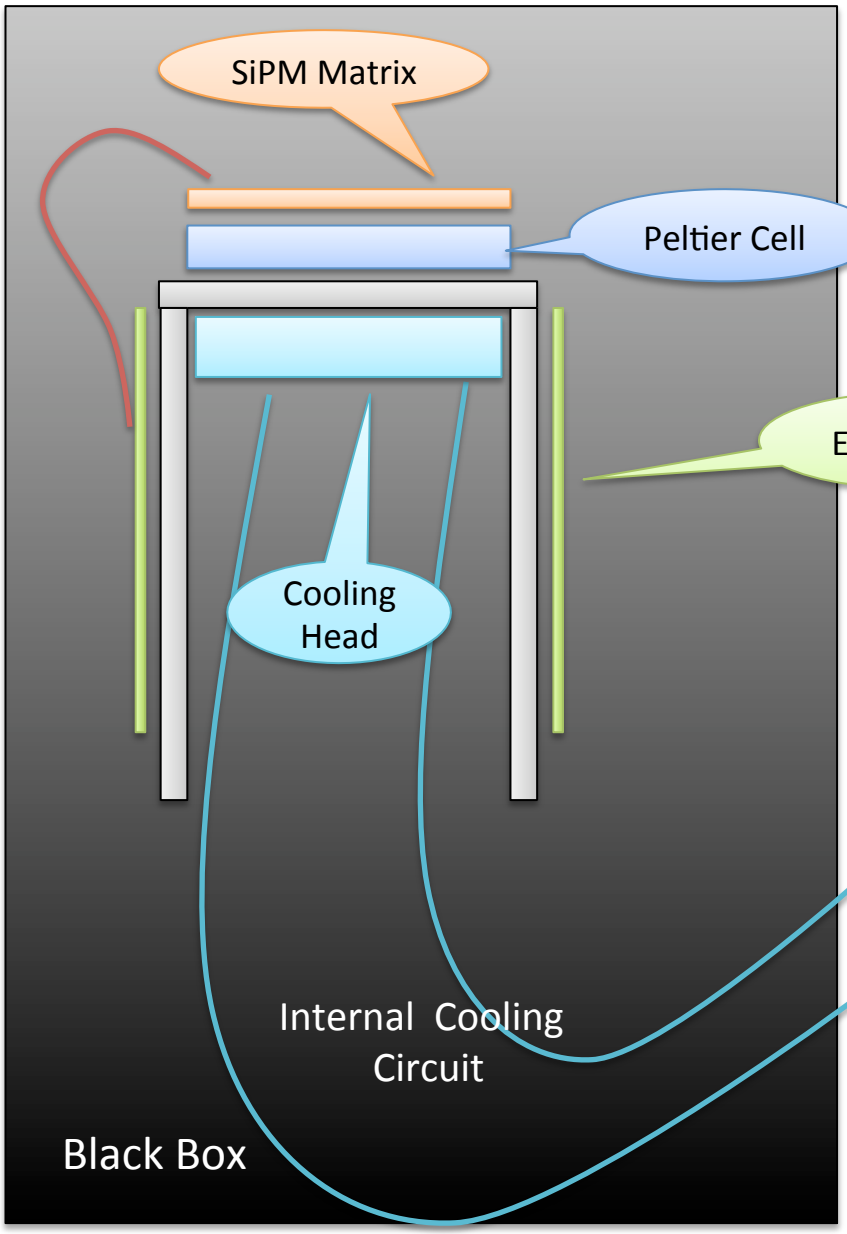
- 32 channels
- Programmable bias voltage for each channel
- Programmable discriminating threshold for each channel
- Time resolution dominated by the signal rise-time variations
  (goal: keep it of the order of 1 ns)
- Digital output to TDC as standard
- Analogic output to sampling digitalizer for background studies

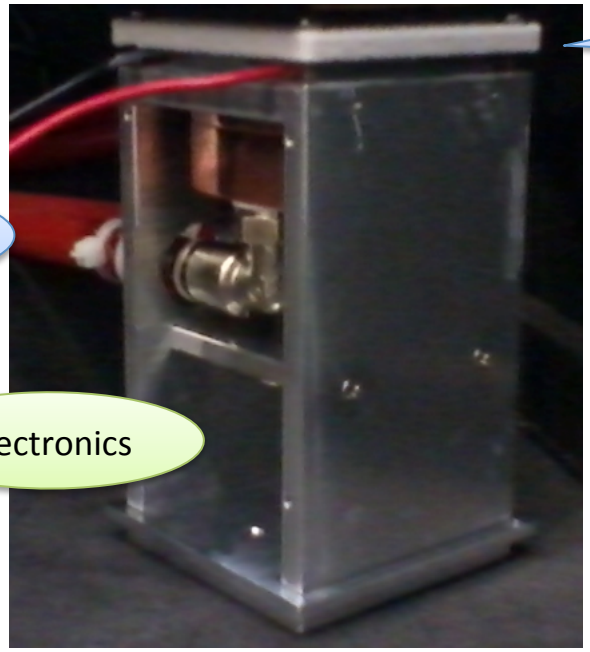




"IFR_ABCD" mother board

SiPM Cooling System

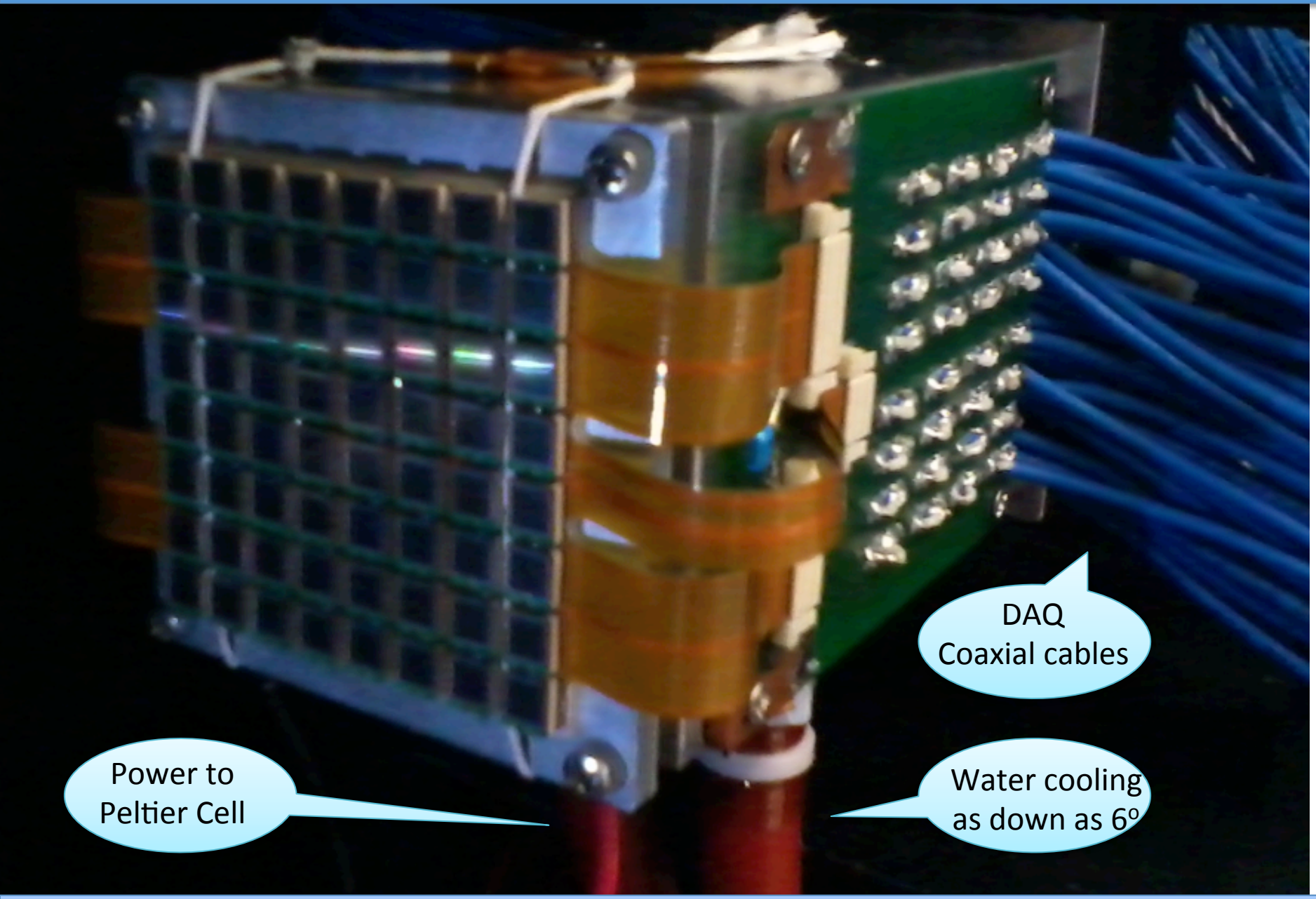




Chiller

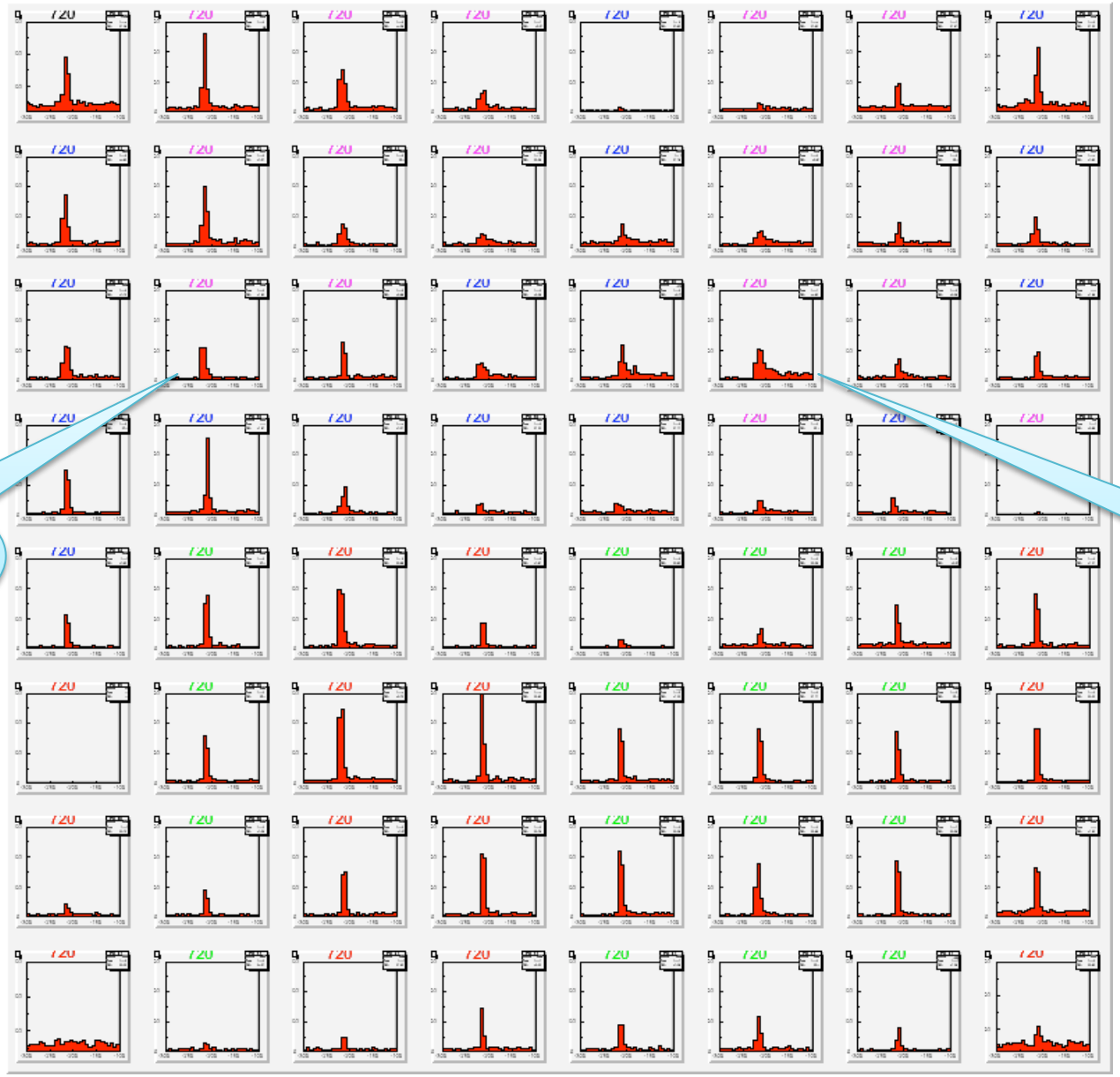
External Cooling Circuit

SiPM Matrix


DAQ
Coaxial cables
Power to
Peltier Cell
Water cooling
as down as 6°

Run 275: Matrix on Beam

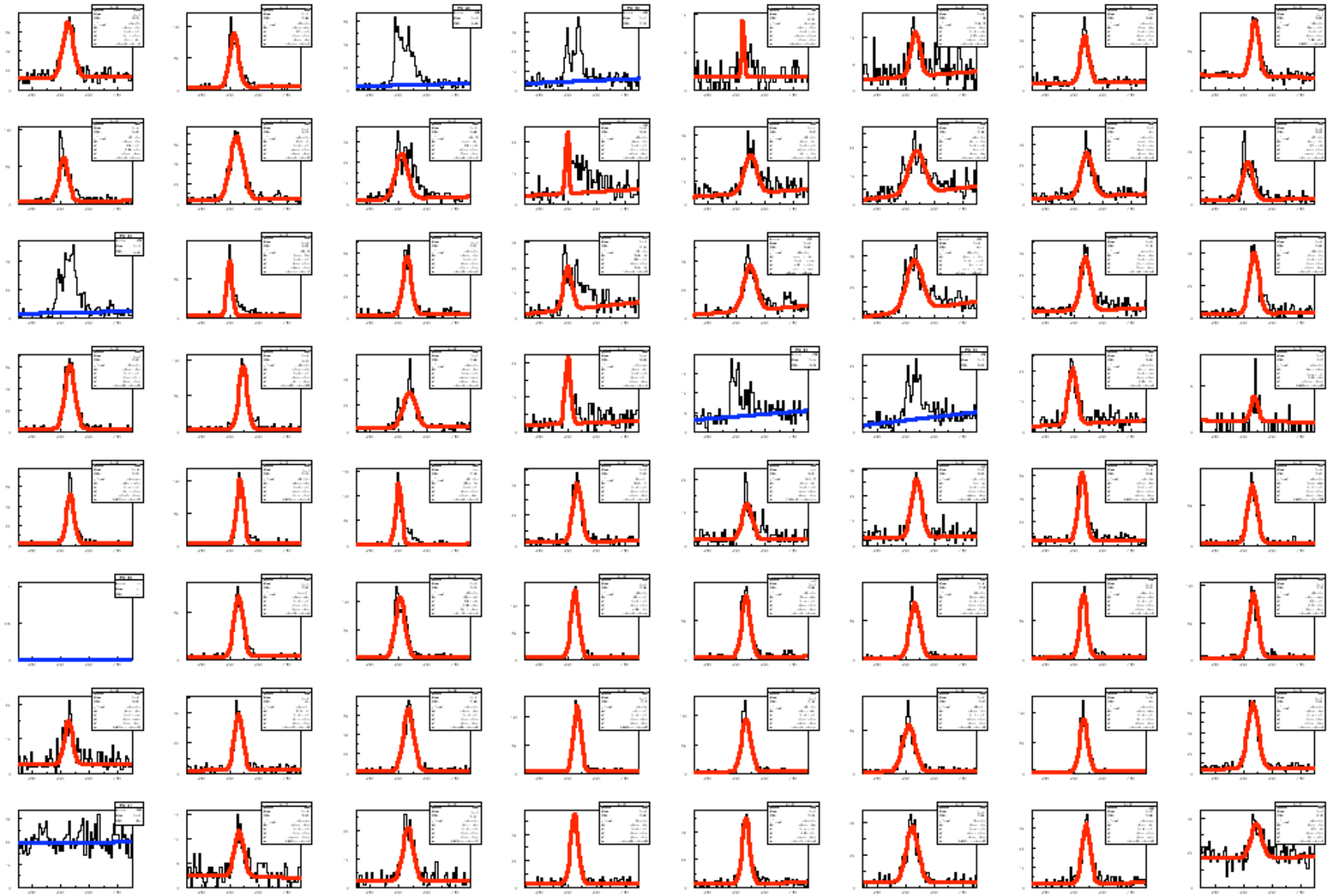
TDC time vs trigger



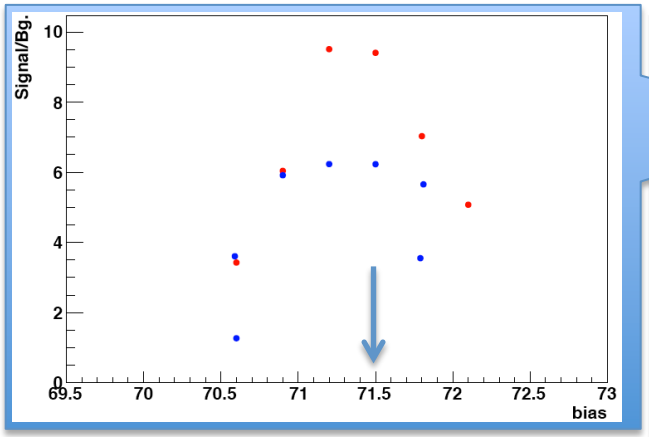
Cherenkov Ring

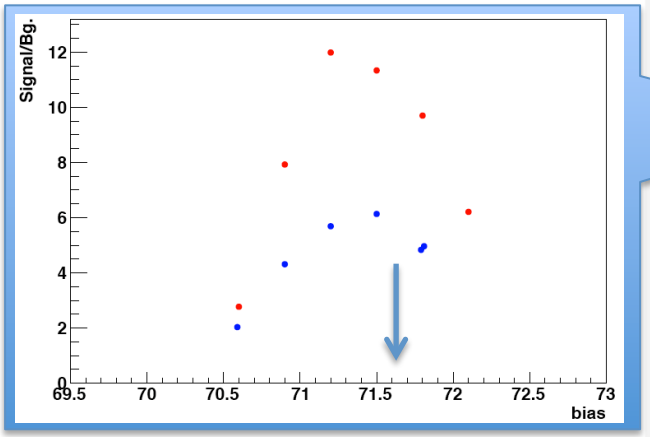
Beam

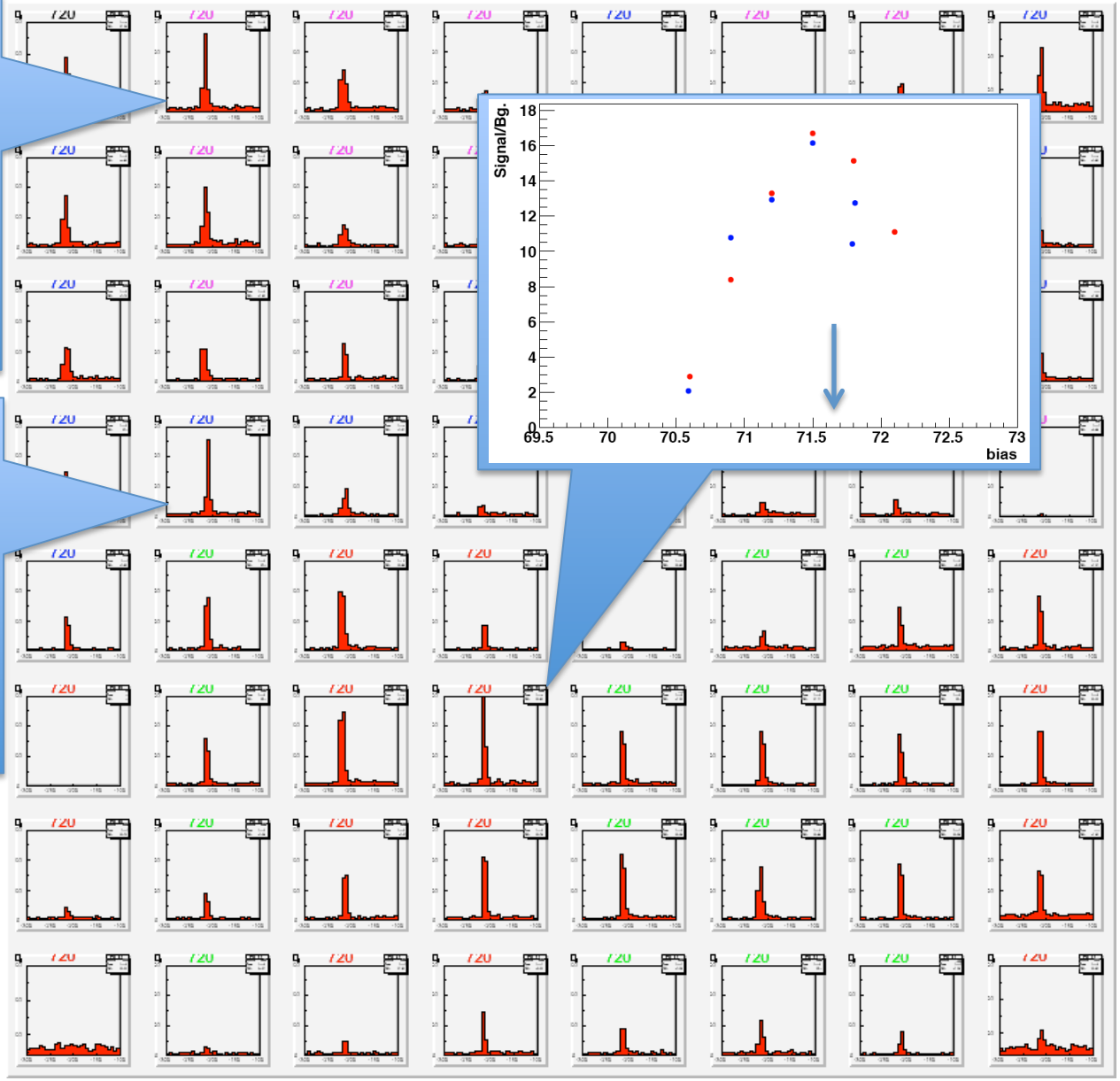
Run 275: Matrix on Beam



Vbias Scan

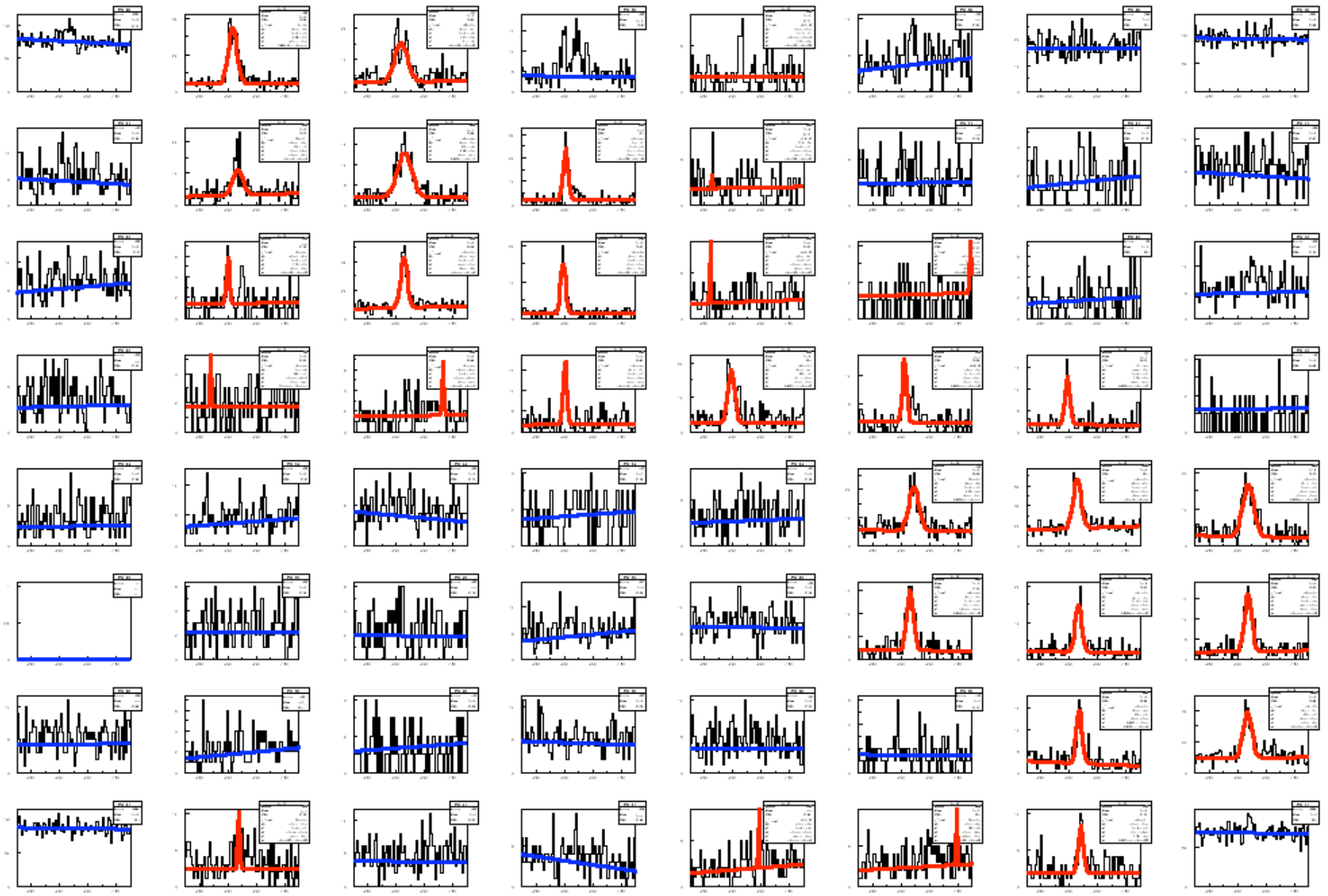




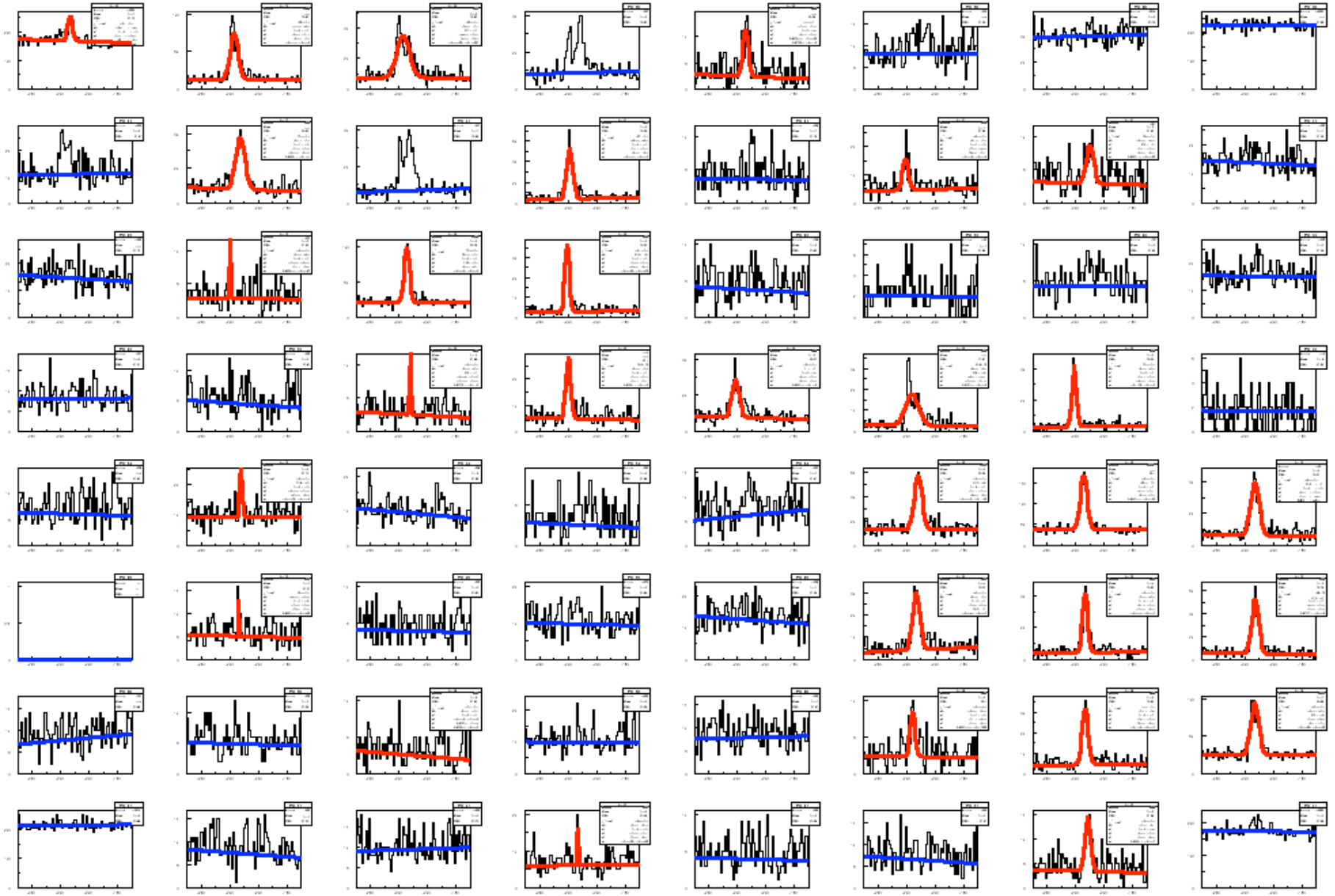


- Vbias scan @ 25 mV threshold
- Vbias scan @ 20 mV threshold
- Vbias given by Hamamatsu

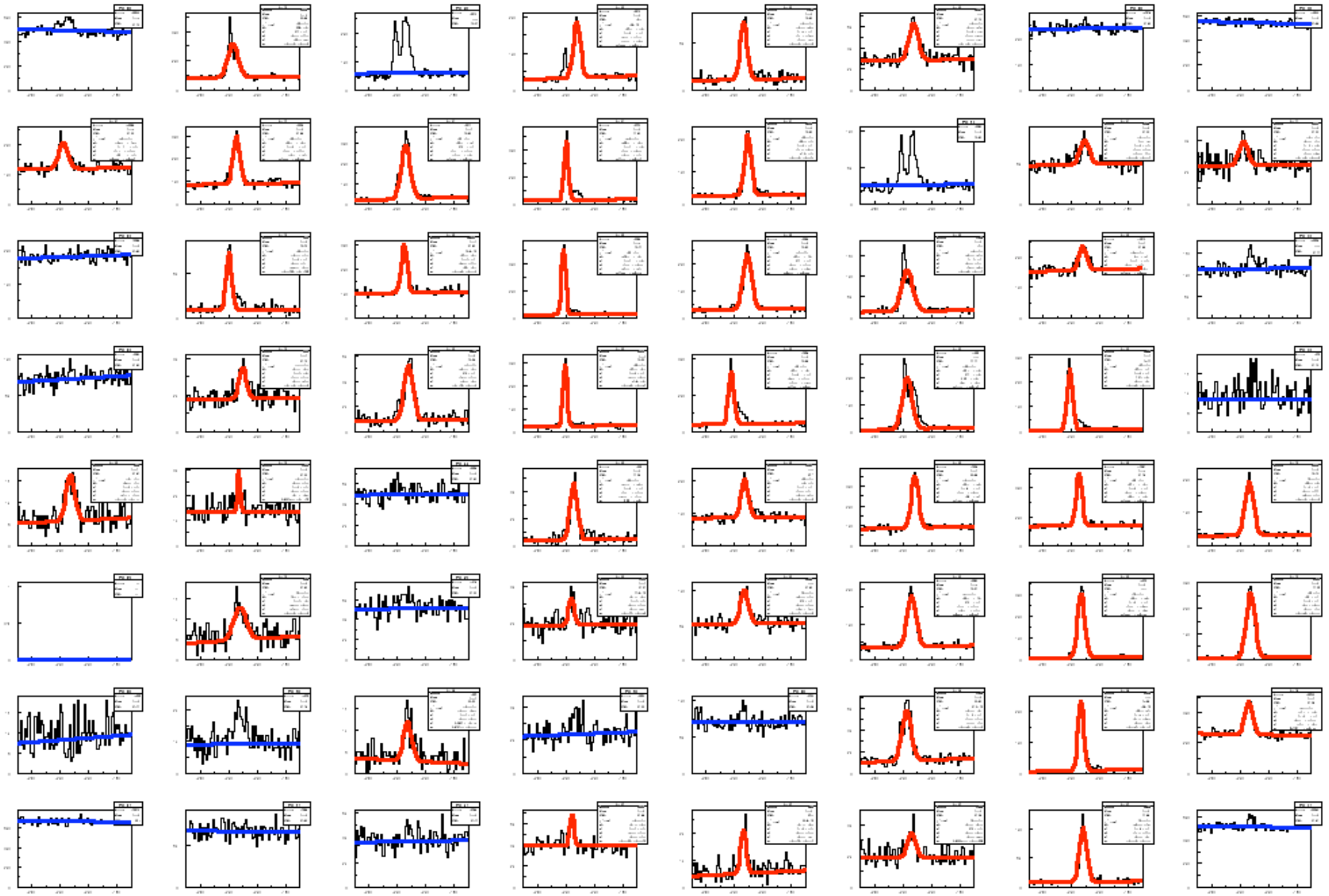
Run 2924: Matrix on 12-cm Ring, T=25°



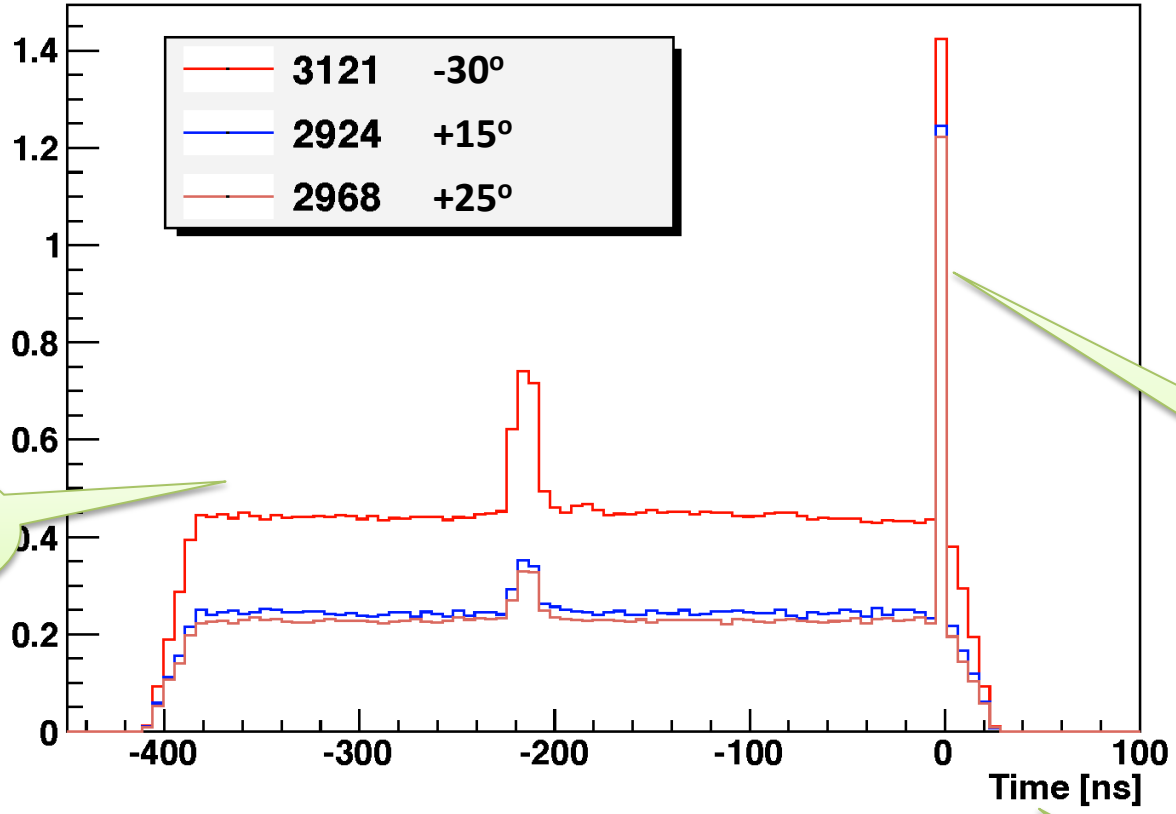
Run 2968: Matrix on 12-cm Ring, T=15°



Run 3121: Matrix on 12-cm Ring, T=-30°



Signal/Background vs T



All hits together

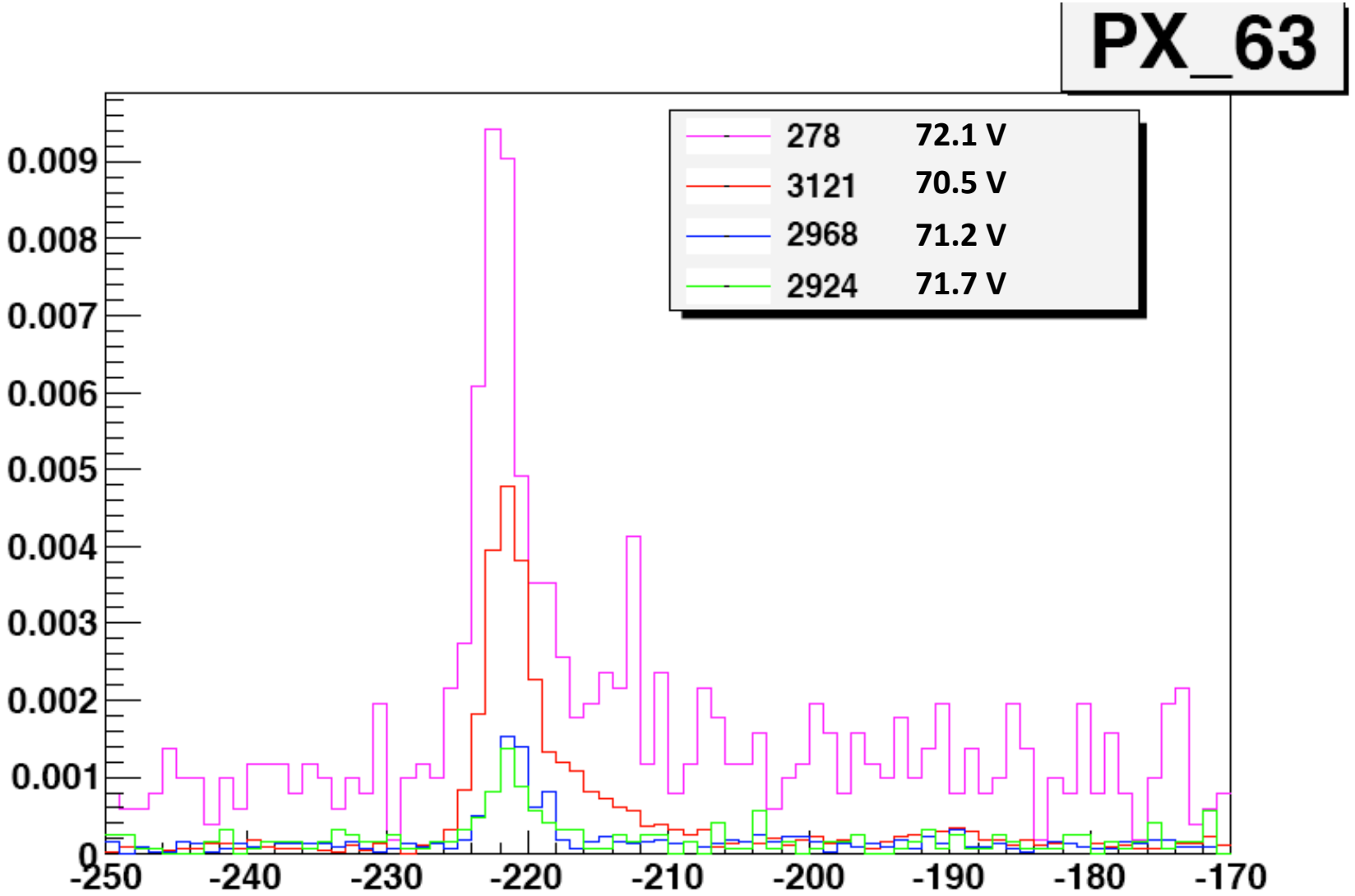
Trigger

Time difference with Trigger

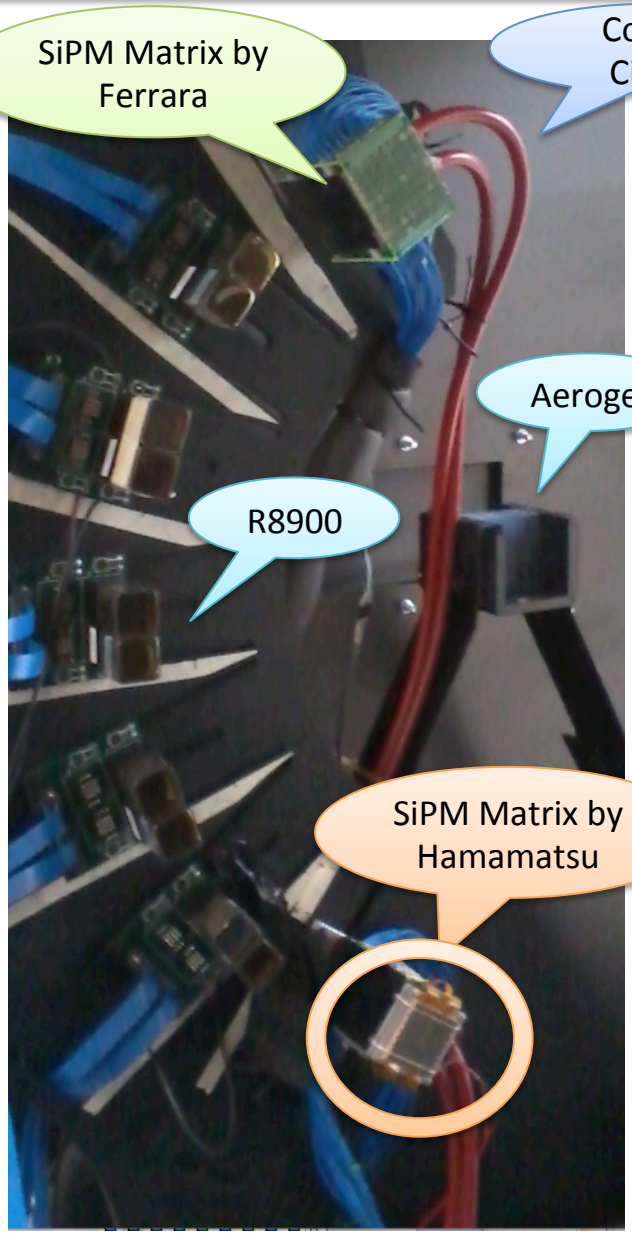
Assumed Vbias scales as - 3 mV/degree

Probably overvoltage is not the same

Signal/Background vs Vbias

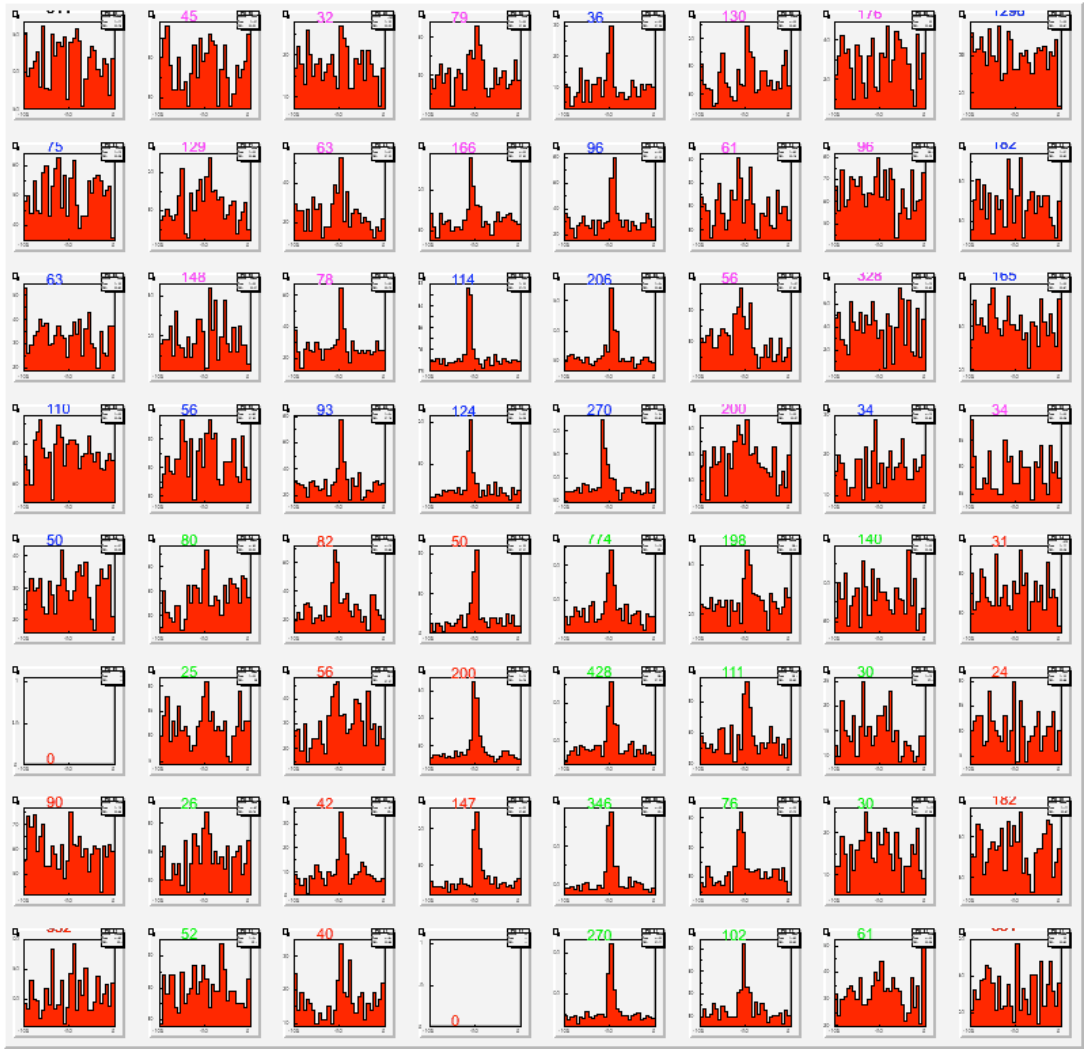


SiPM Test



Floating scale

TDC time vs trigger @ 0°



Average Number of Hits per Event

Run	Position	T	Vbias	V thr	Hits *	Hits **
275	On beam	25°	71.8 V	25 mV	4.67	2.75
285	On beam	25°	71.8 V	20 mV	5.56	3.27
2924	Small proto	25°	from Hamamtsu	25 mV	0.20	0.15
2968	Small proto	15°	As above – 3mV/degree * 10	25 mV	0.21	0.14
3121	Small proto	-30°	As above – 3mV/degree * 50	25 mV	0.67	0.46
425	Big proto	0°		25 mV	0.11	0.08

* from a fit in a +/- 3 sigma range of the gaussian peak
** from bin contents in 5ns window around maximum

Correspond to ~10 hits in a full ring

SiPM Outlook

Characterization

- Optimize Vbias
- Improve time resolution
- Investigate double peaks
  - Picosecond pulsed laser
  - Cosmic stand
  - Flash ADC

R&D

- Prea-mplification stage close to SiPM
- Realistic cooling system

Goal for December tests

- Quantitative comparison with H8500