First look at the RICH Prototype test beam data

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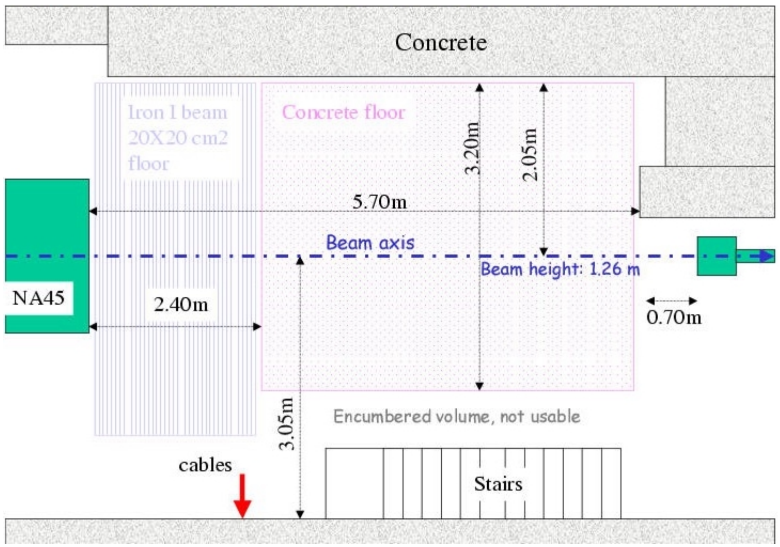
RICH MEETING, CERN, 04/12/2002

OUTLINE

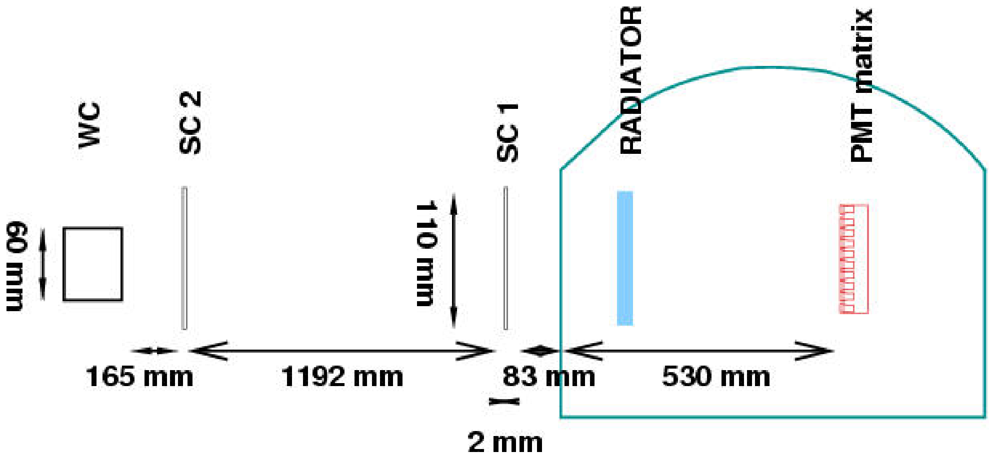
- Setup description
- Data sample
- Calibration procedure
- Event selection
- Preliminary results
- Next steps
- Conclusions

EXPERIMENTAL SETUP

H8 Experimental area



RICH Prototype



DATA SAMPLE

- Data sample taken 18/10-19/10 (WC quality, event shift…)
- Proton, ^{3}He, A/Z=2 runs selected
- Maximum 50k events/run processed

New Matsushita 1.03 2x10 mm

RUN	DAY	INIT	END	DRIFT	B\rho	#EVENTS	BEAM TYPE
292	18/10	06:58	08:00	417.4	40	171135	A/Z=2
295	18/10	11:45		417.4	11	52000	p

New Matsushita 1.05 2x10 mm

RUN	DAY	INIT	END	DRIFT	B\rho	#EVENTS	BEAM TYPE
302	18/10	15:35		375	13	39961	p
304	18/10	16:15		375	9	16390	A/Z=2
308	18/10	19:24	19:53	375	40	85023	A/Z=2 / Q15=0.2

Novosobirsk-hydrophil. 1.03 30 mm

RUN	DAY	INIT	END	DRIFT	B\rho	#EVENTS	BEAM TYPE
310	18/10	21:24	21:40	417.4	40	74252	A/Z=2
312	18/10	21:54	21:59	417.4	30	71690	A/Z=3/2 He3
313	18/10	22:09	22:26	417.4	13	33688	p

Novosobirsk-hydrophob. 1.03 30 mm

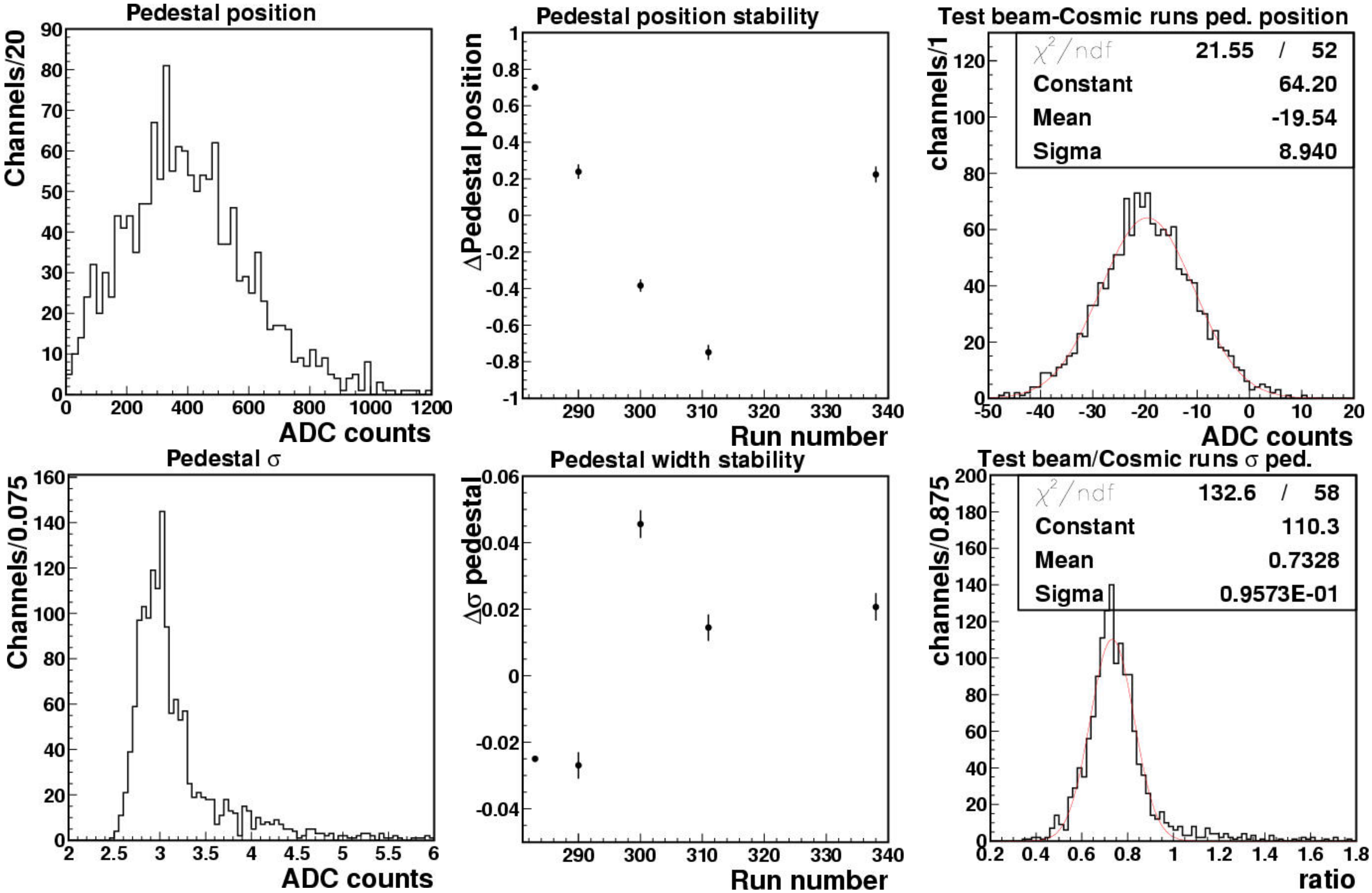
RUN	DAY	INIT	END	DRIFT	B\rho	#EVENTS	BEAM TYPE
285	17/10	23:00		417.4	40	117737	A/Z=2
325	19/10	07:16	07:25	417.4	13	30546	p
326	19/10	07:33	07:43	417.4	30	132132	A/Z=3/2 He3
327	19/10	07:54	08:	417.4	40	118633	A/Z=2

Old Matsushita 1.03 3x10 mm

RUN	DAY	INIT	END	DRIFT	B\rho	#EVENTS	BEAM TYPE
319	19/10	02:55	03:13	417.4	13	35310	p
320	19/10	02:32	03:36	417.4	30	130557	A/Z=3/2 He3
321	19/10	03:46	04:25	417.4	40	135225	A/Z=2

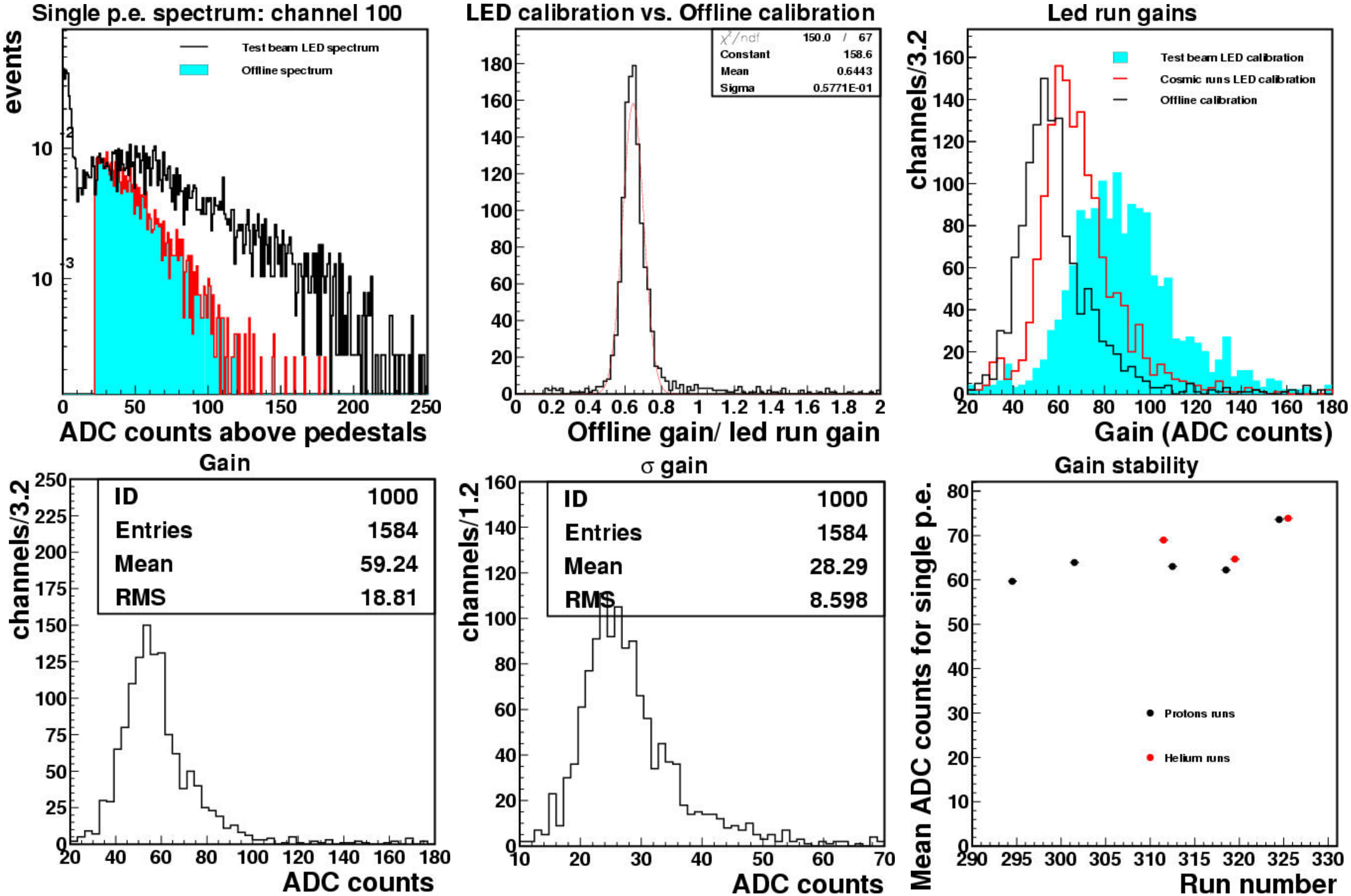
PMT CALIBRATION

- **Pedestals: 5 pedestal runs along the selected period**



PMT CALIBRATION

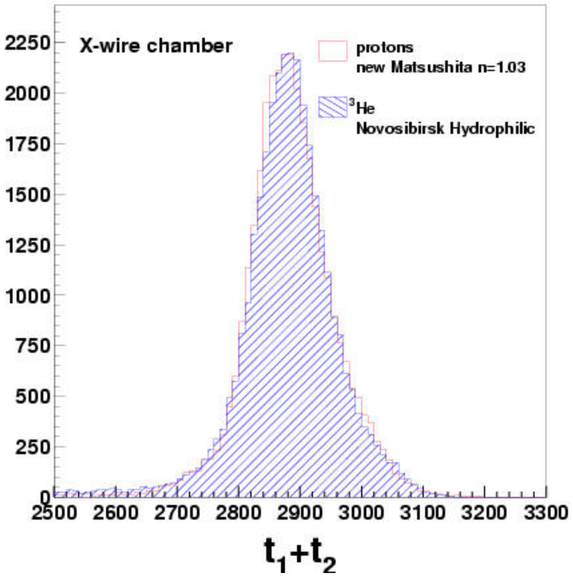
➢ Gain: 5 data runs along the selected period

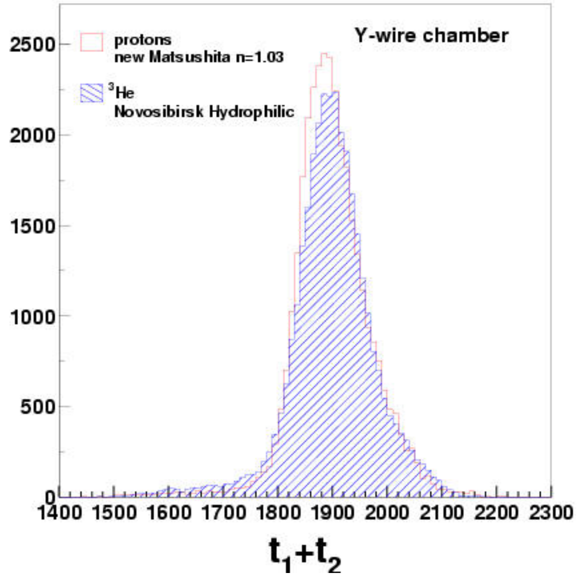


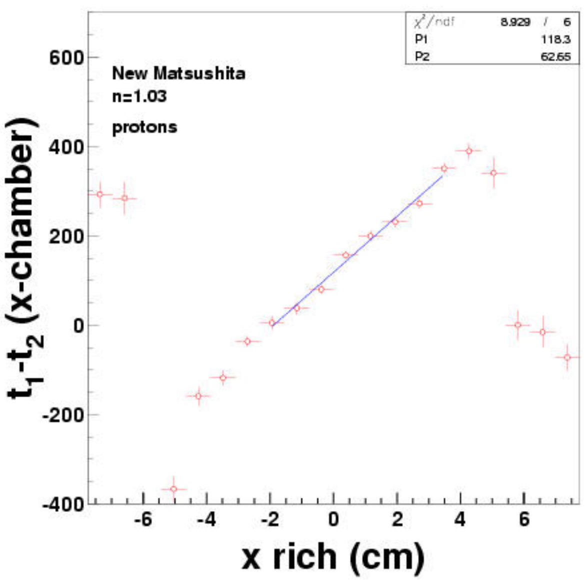
WC CALIBRATION

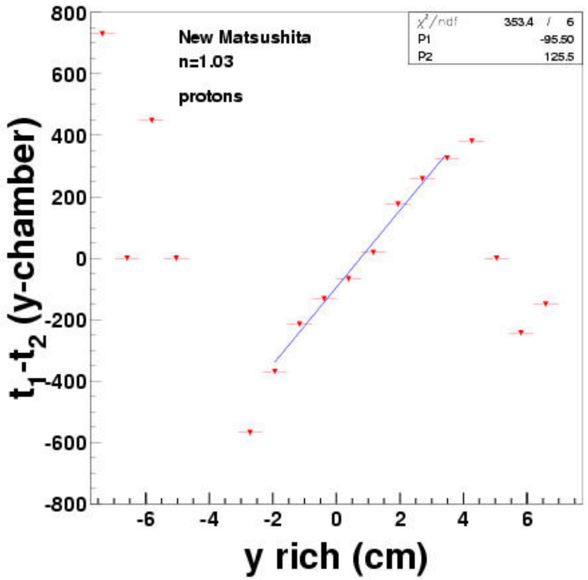
$$2500 < t_1^x + t_2^x < 3250$$

$$1400 < t_1^y + t_2^y < 2400$$









$$t_1^x - t_2^x = 116 + 64\, x_{RICH}$$

$$t_1^y - t_2^y = -95 + 127\, y_{RICH}$$

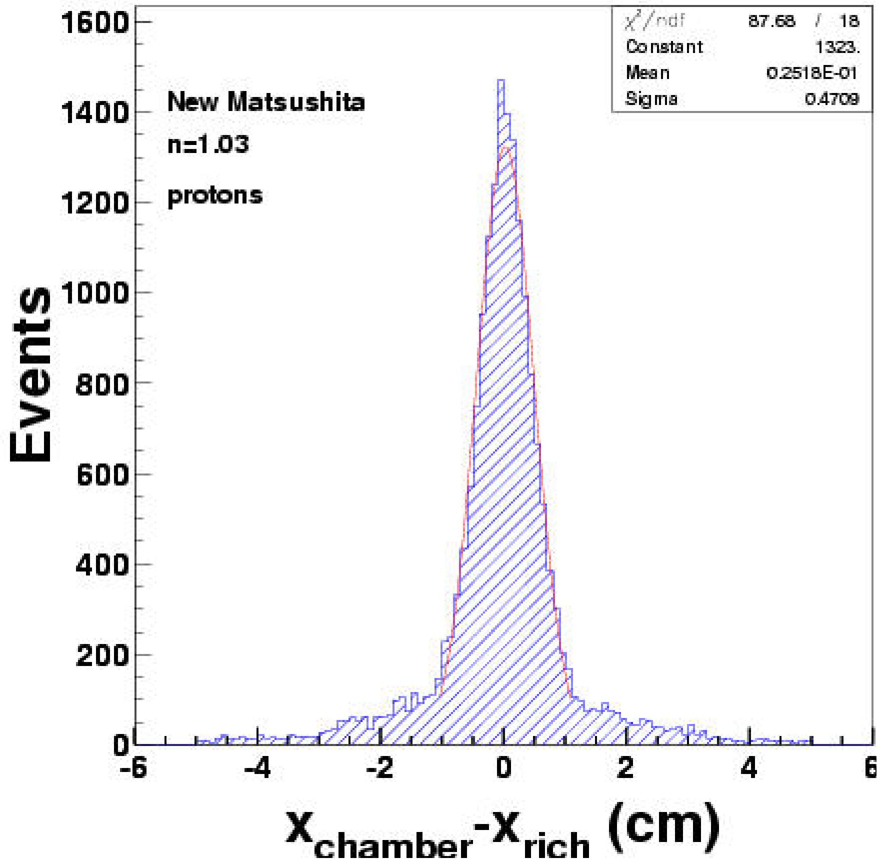
WC CALIBRATION

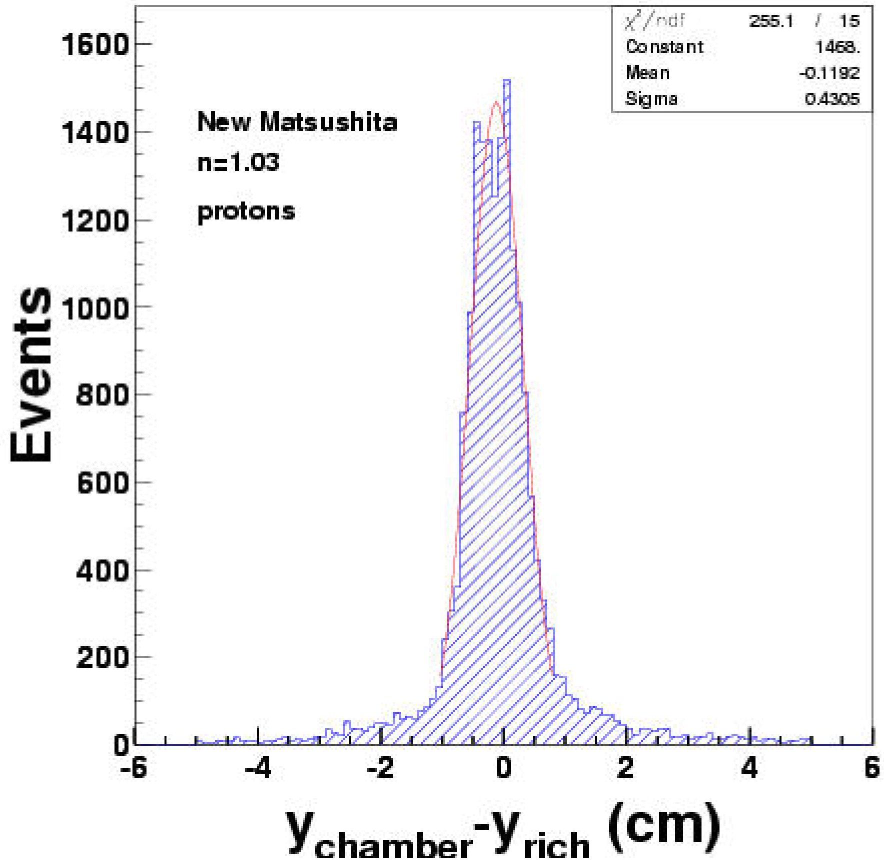
WC – RICH position residues (4.5 mm):

1. same in x & y axes

2. similar to those obtained @ ISN with cosmics (6mm)

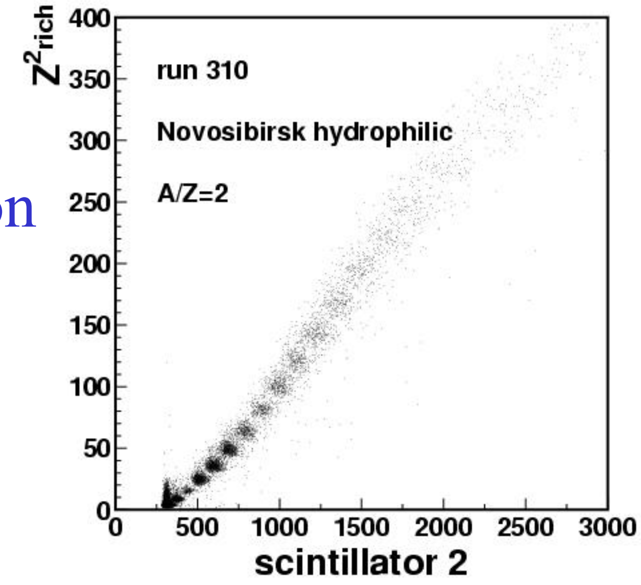
(RICH pixel contribution ≈ 3.5 mm)

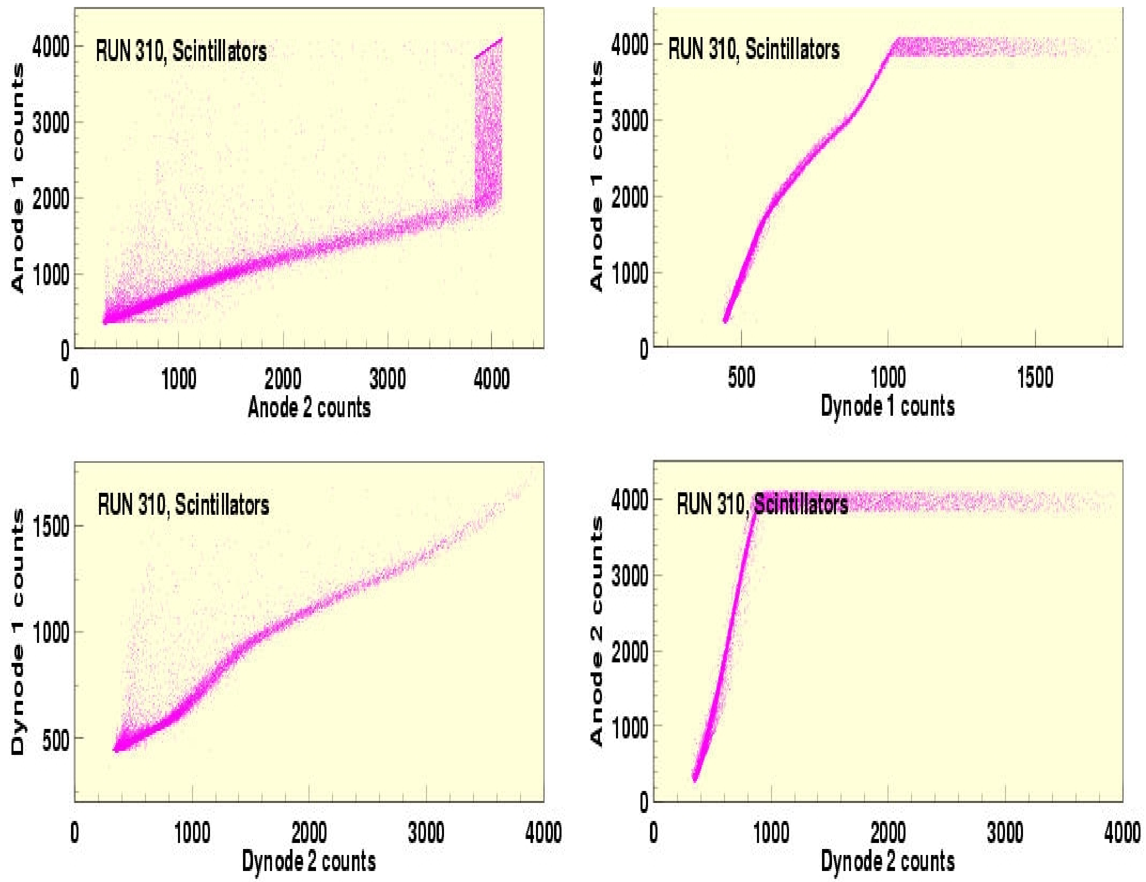


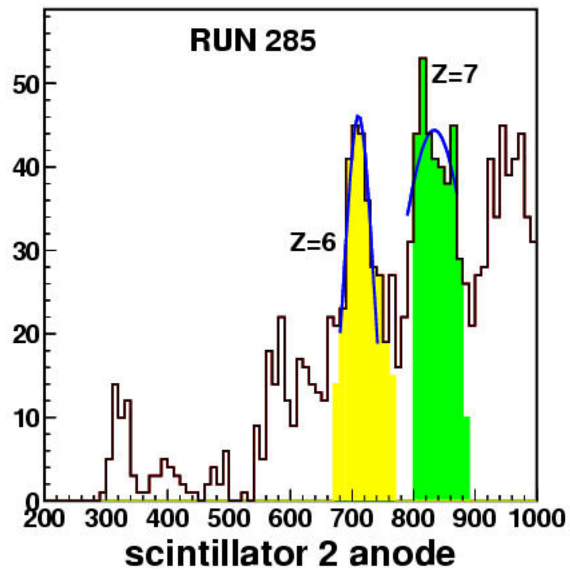


SCINT CALIBRATION

- Good correlation observed btwn SC1 & SC2
- Non linearities in anode & dynode signals
- Scint response calibrated using RICH selection





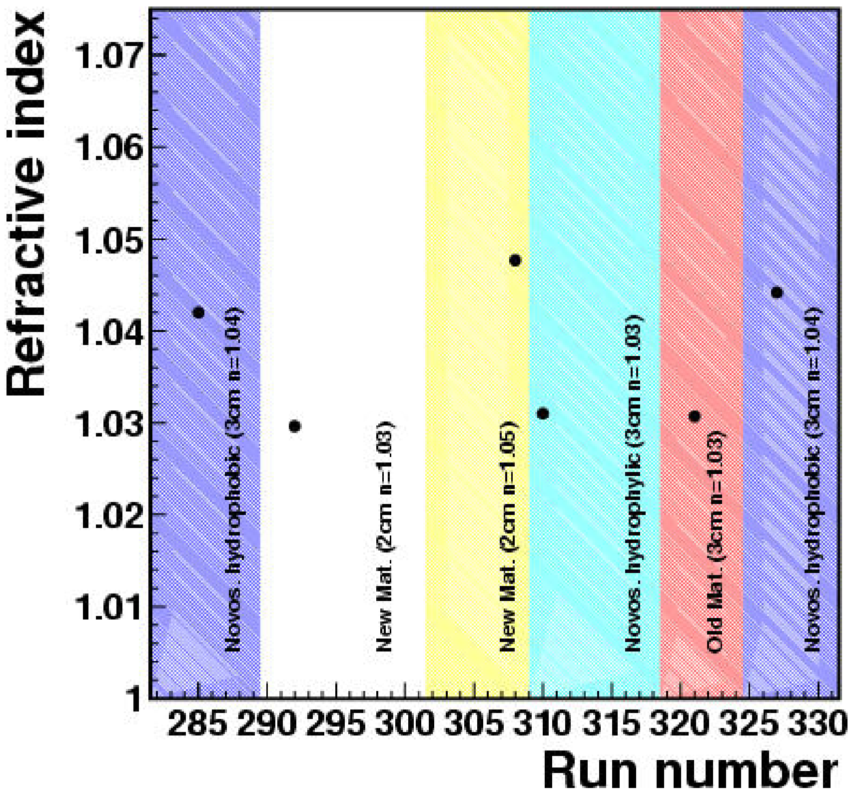


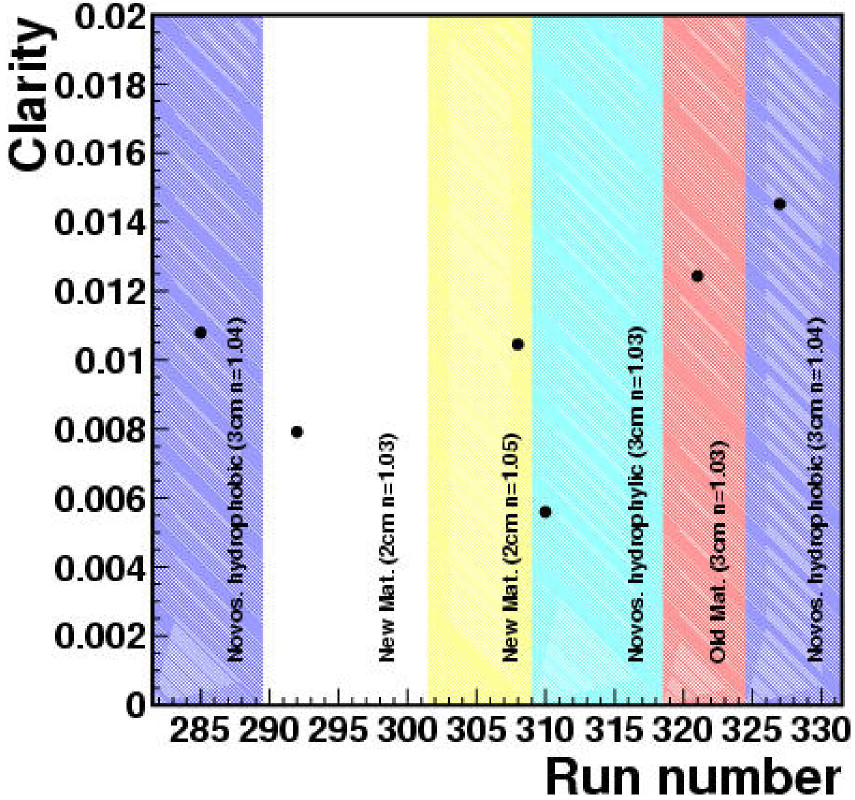
RADIATOR PARAMETERS

Optical parameters can be (ambiguously!) tuned from the RICH velocity and charge reconstruction:

ß ⇒ Refraction index (or expansion length)

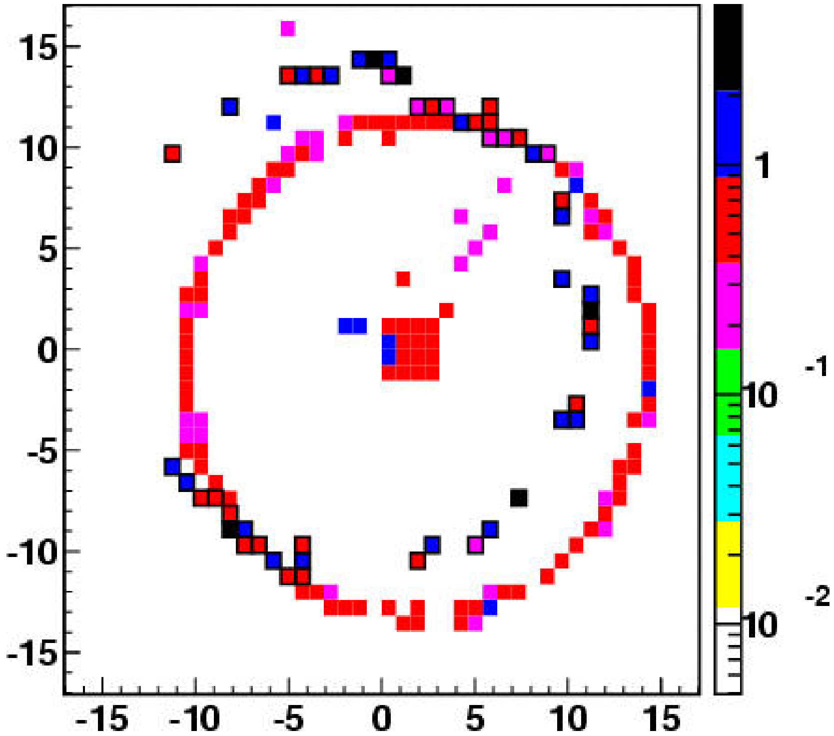
Z ⇒ Clarity (or absorption length)

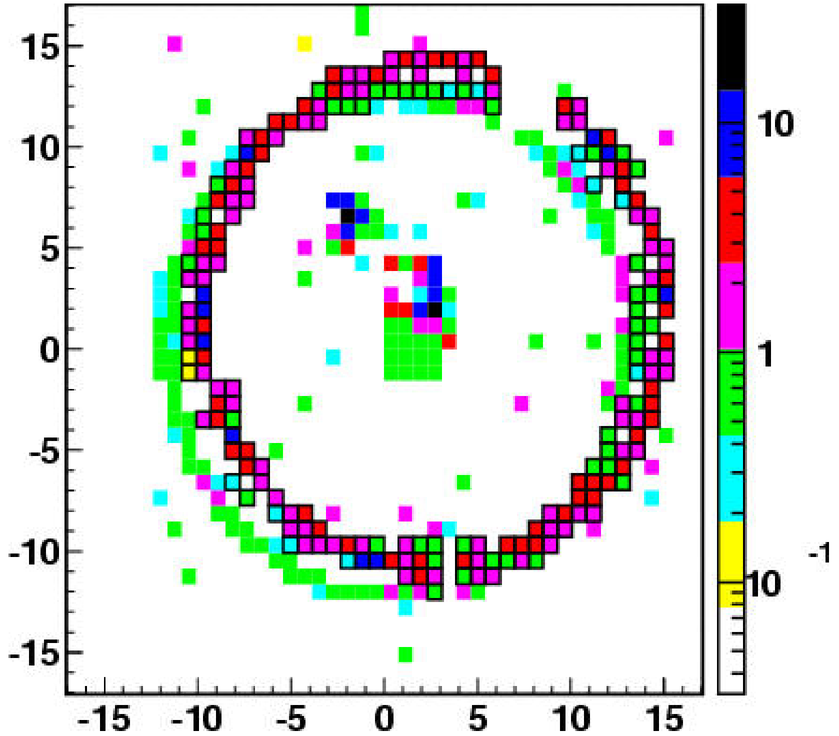




EVENT SELECTION

- Reconstructed WC-track
- Loose WC-beam and WC-RICH matching
- $N_{USED} > 2$, $N_{EXP} > 2$
- Multi-particle event rejection
  - Multi-Ring (Charge/ChargeInRing < 1.75)
  - Multi-Track (ChargeSingleHit < 2.3 x ChargeInRing + 2.7)





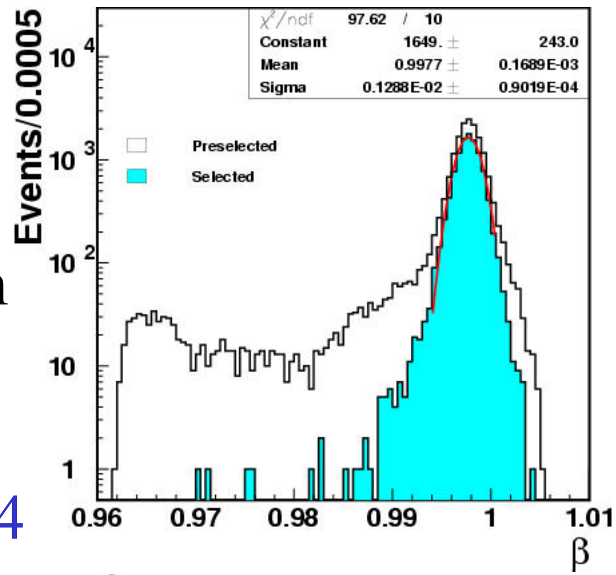
PRELIMINARY RESULTS

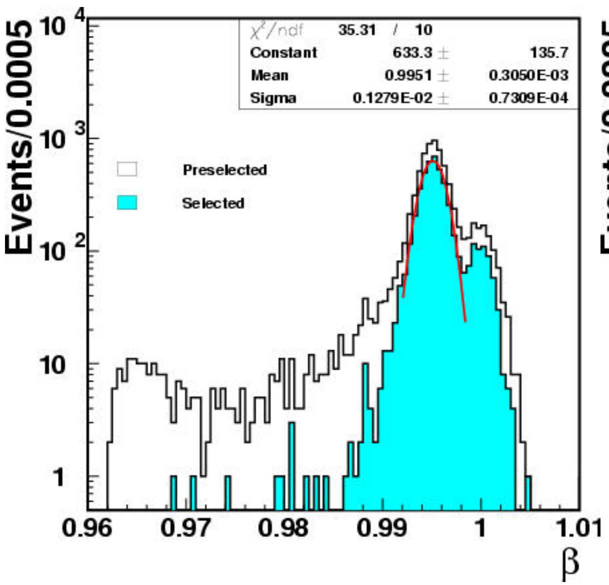
ß determination

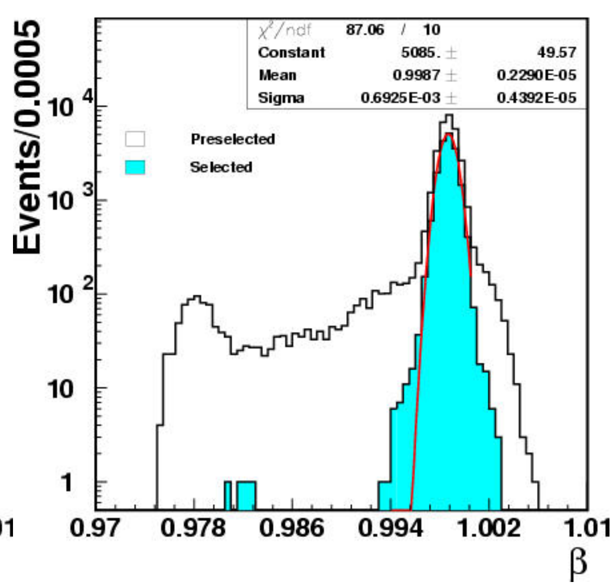
After selection, tails are mainly coming from multi-particle events and beam contamination

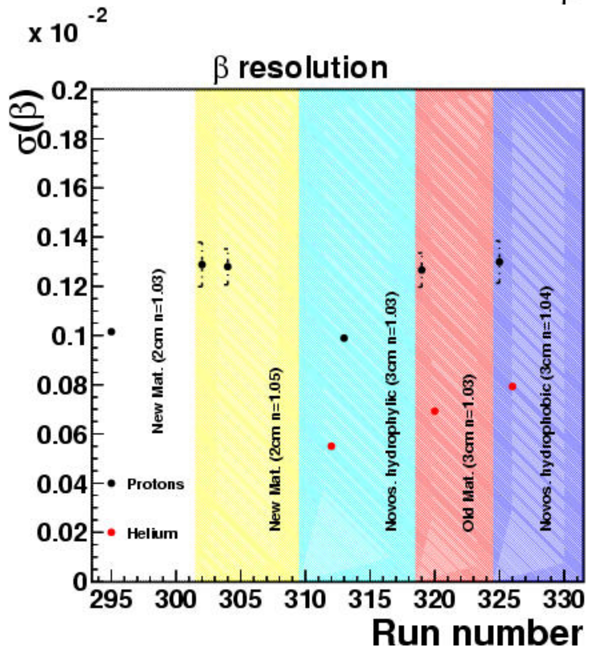
σ(ß)/ß ≈ 1.0‰ : NM 1.03, NV 1.03

σ(ß)/ß ≈ 1.3‰ : NM 1.05, OM 1.03, NV 1.04





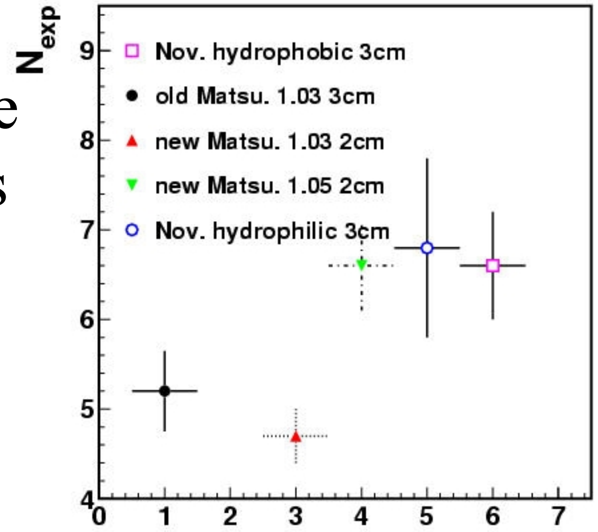




PRELIMINARY RESULTS

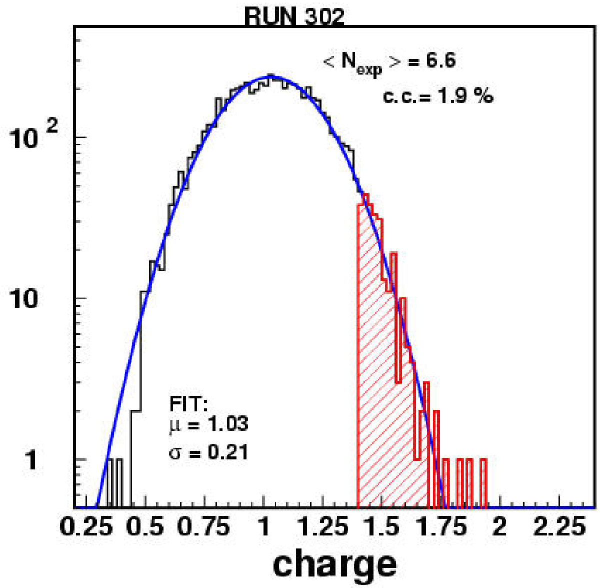
Z determination

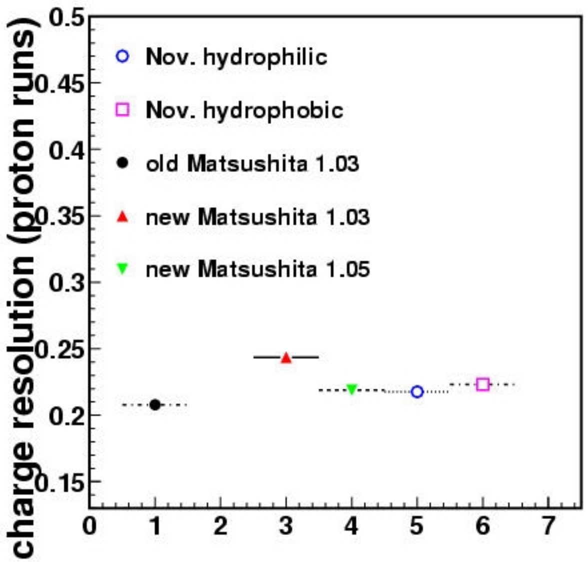
Since the rings are completely contained in the PMT matrix, the optimum charge resolution is obtained for every radiator.

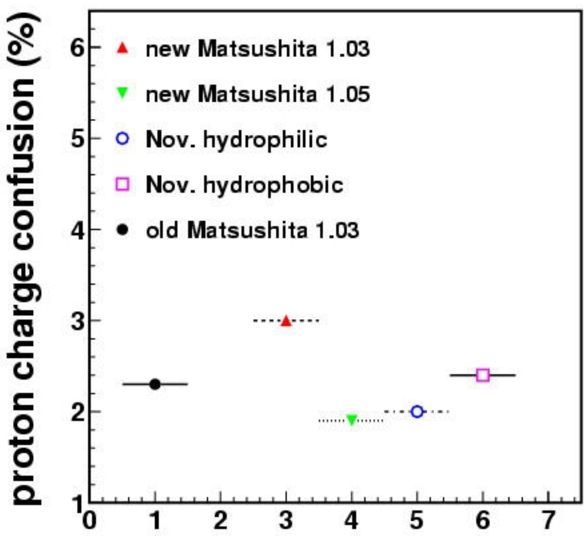


$N_{EXP} \approx 7$: NM 1.05, NV 1.03, NV 1.04

$N_{EXP} \approx 5$: NM 1.03, OM 1.03



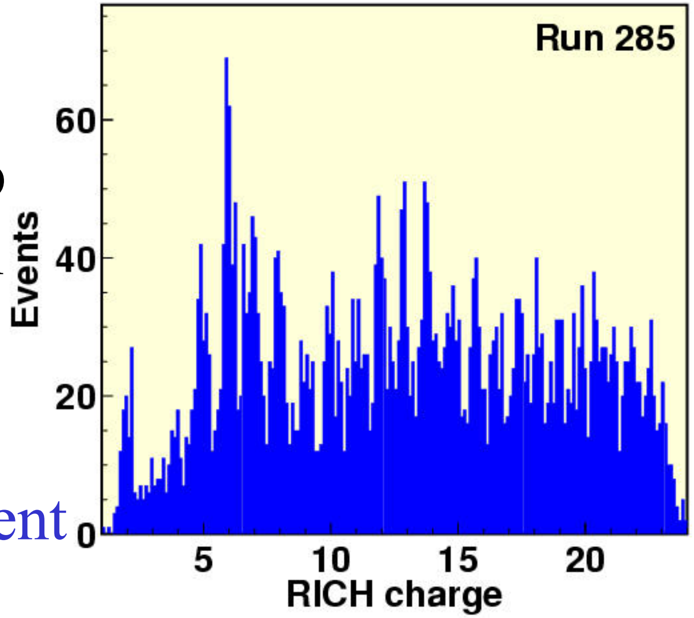




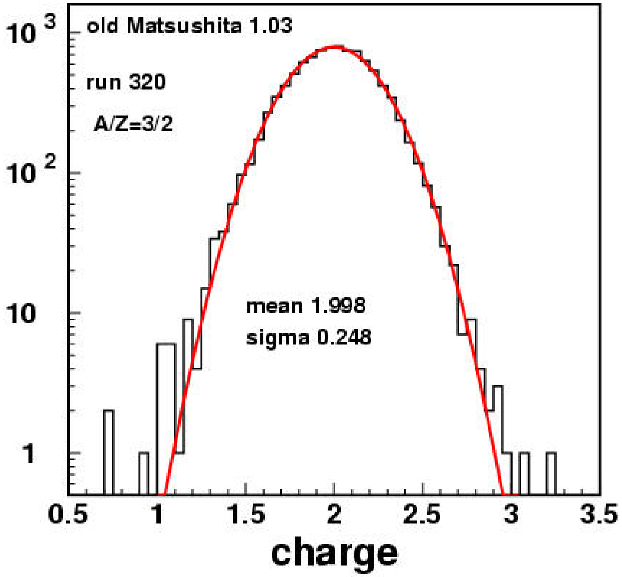
PRELIMINARY RESULTS

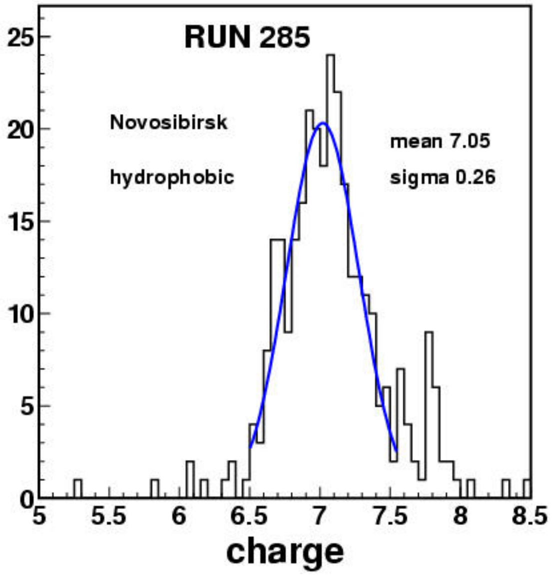
Z determination

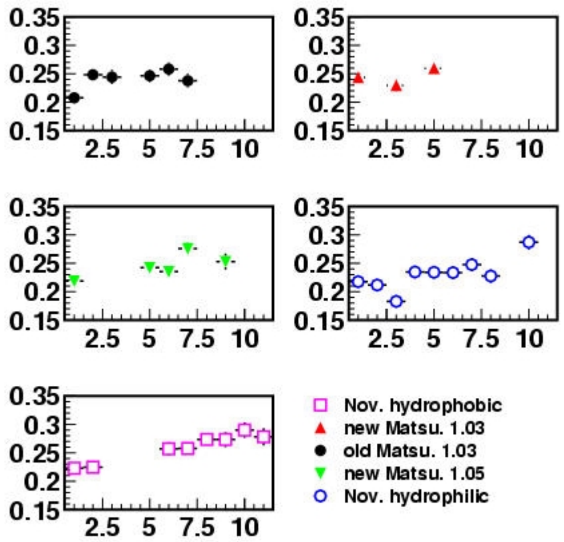
Although RICH charge peaks are visible up to Z ≈ 20, scintillator charge determination limits a precise determination of RICH charge resolution & confusion for high Z.



RICH charge resolution for Z<10 is consistent with the expectations

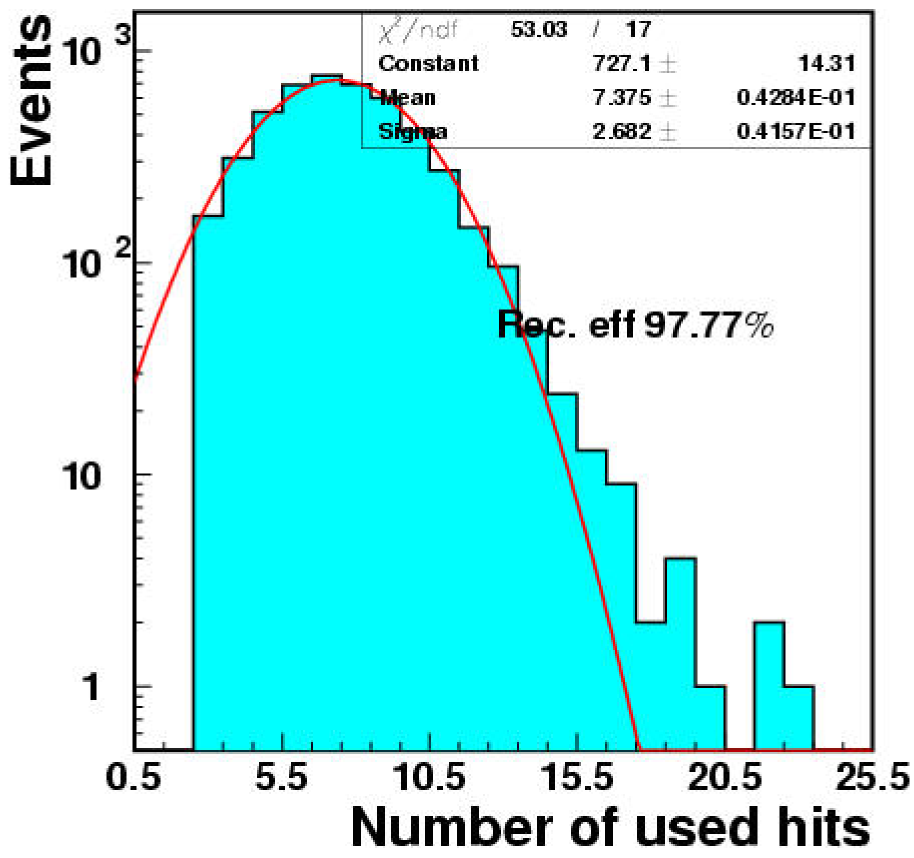


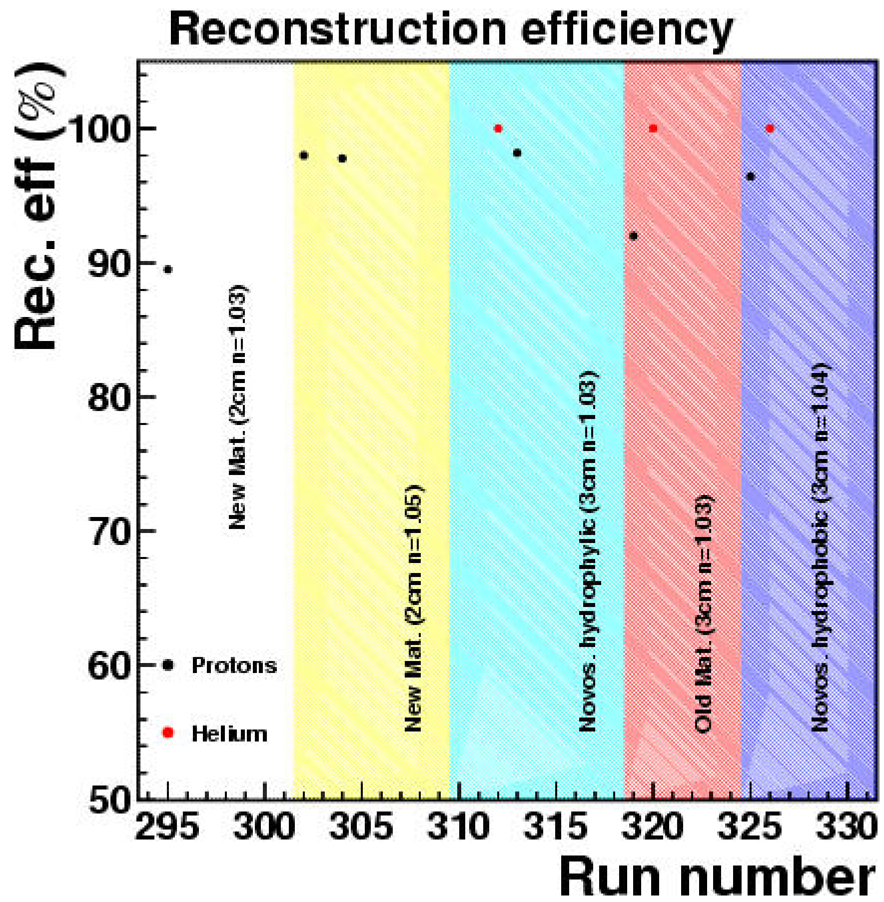




PRELIMINARY RESULTS

A first estimation of the RICH reconstruction efficiency can be derived from the extrapolation of the spectrum of used hits, which can be described to a good approximation by a Poisson distribution.



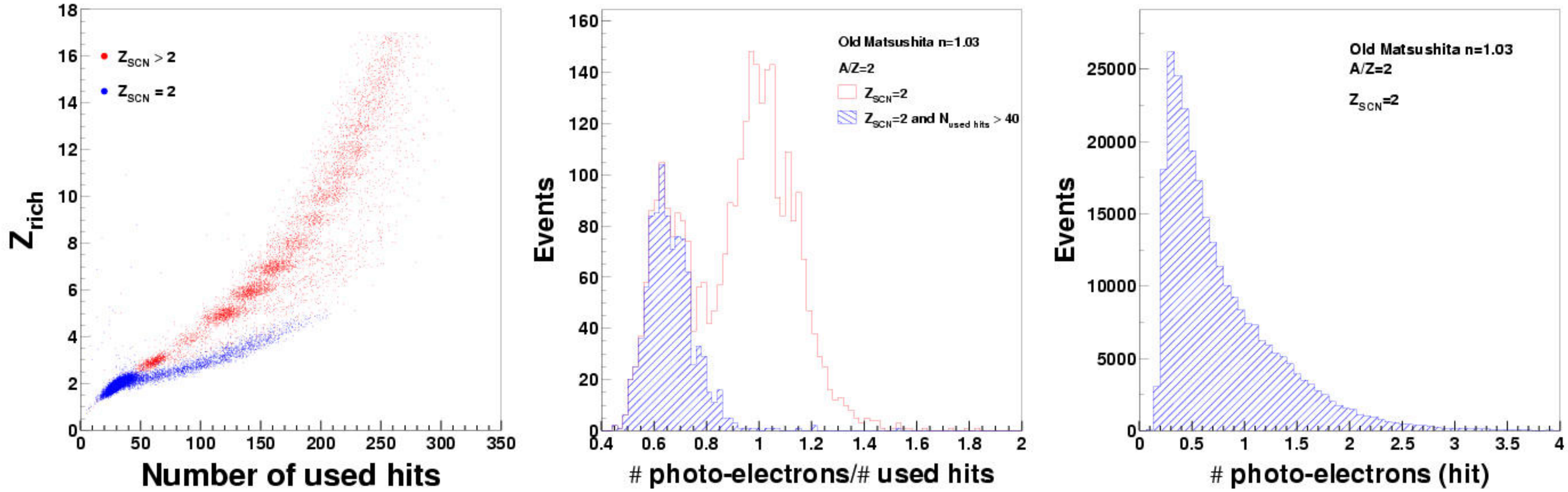


STRANGE EVENTS

In Z_{SCNT}=2 sample (A/Z = 2 runs) 2 different types of RICH events:

- Standard Helium ($N_{HitsInRing} < 40$, $Q_{HitInRing} \approx 1$ p.e.)
- $N_{HitsInRing} > 40$, $Q_{HitInRing} < 1$ p.e.)

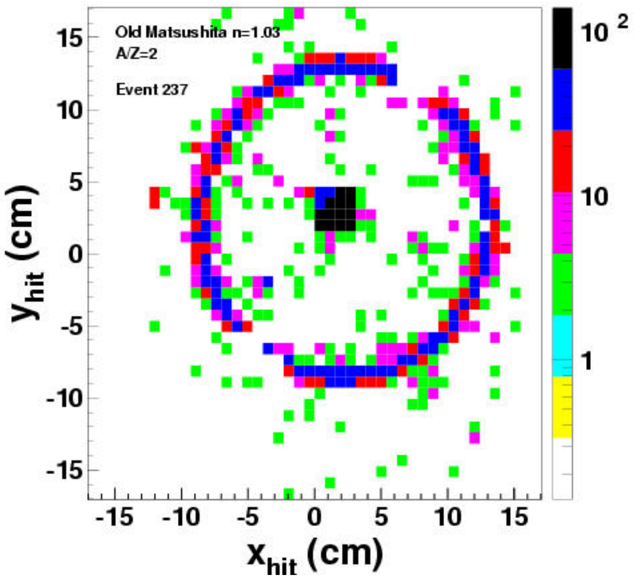
Actually, in sample B, Q_{hit} spectrum peak is below 1 p.e. !

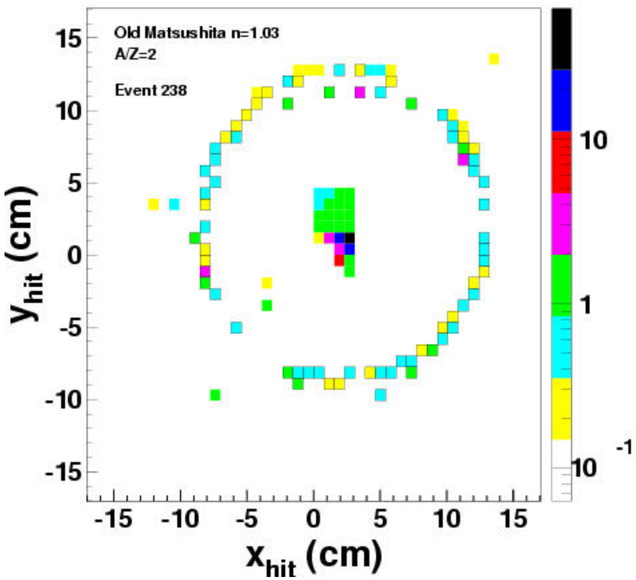


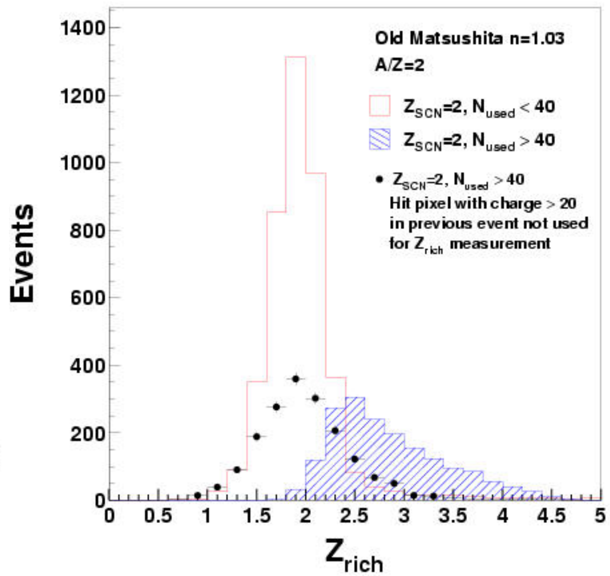
STRANGE EVENTS

- By comparing with previous trigger we see that the fired pixels in sample B are correlated with high charge hits in the previous event.

- After removing these coincident hits, sample B events show a nice $Z_{RICH} = 2$ distribution.

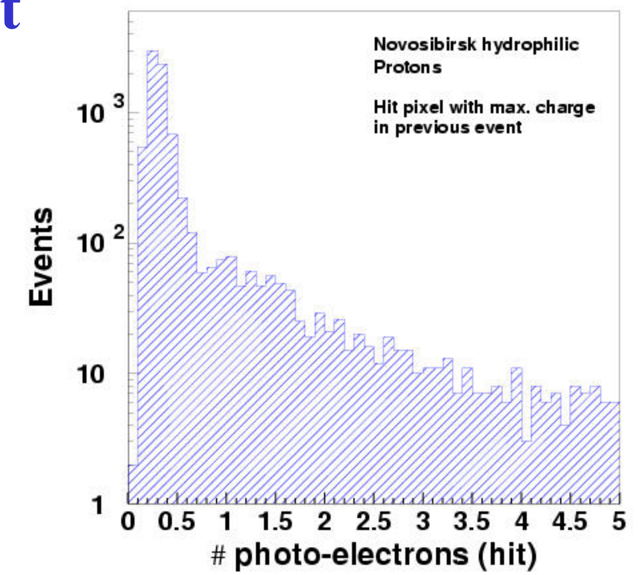






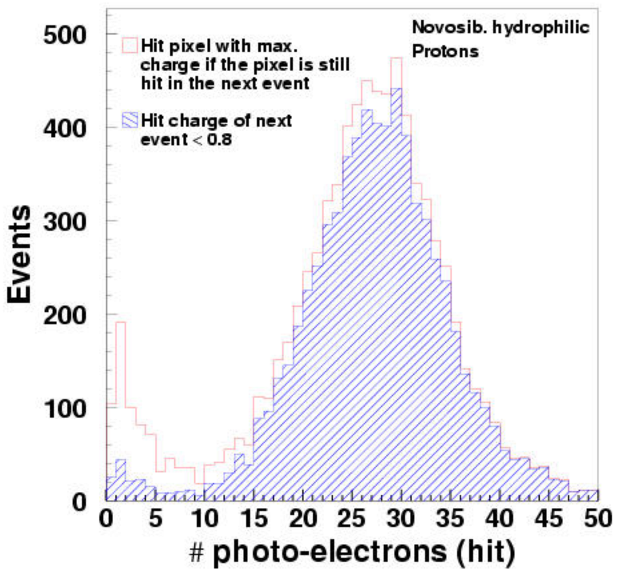
STRANGE EVENTS

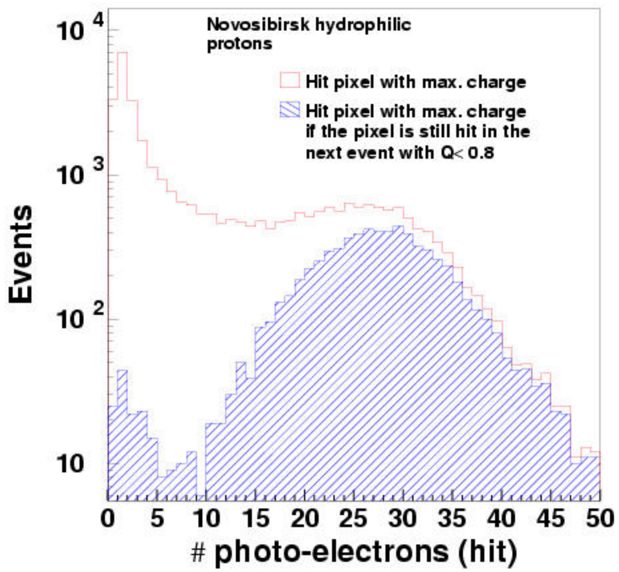
In the proton runs, we select in every event the pixel with the highest Q_{hit} (Q_{hit}^{max}).

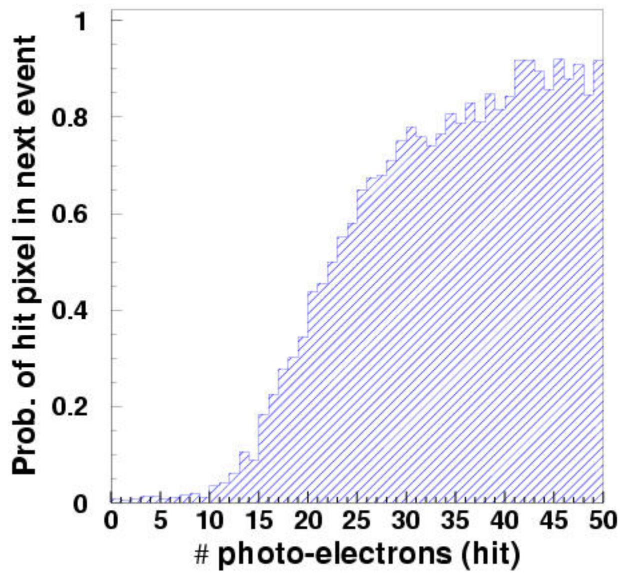


In the next event, the signal of that pixel, when fired, is strongly peaked at $Q_{hit} < 1$.

The probability of having a fired hit with low Q_{hit} increases with increasing Q_{hit}^{max}.

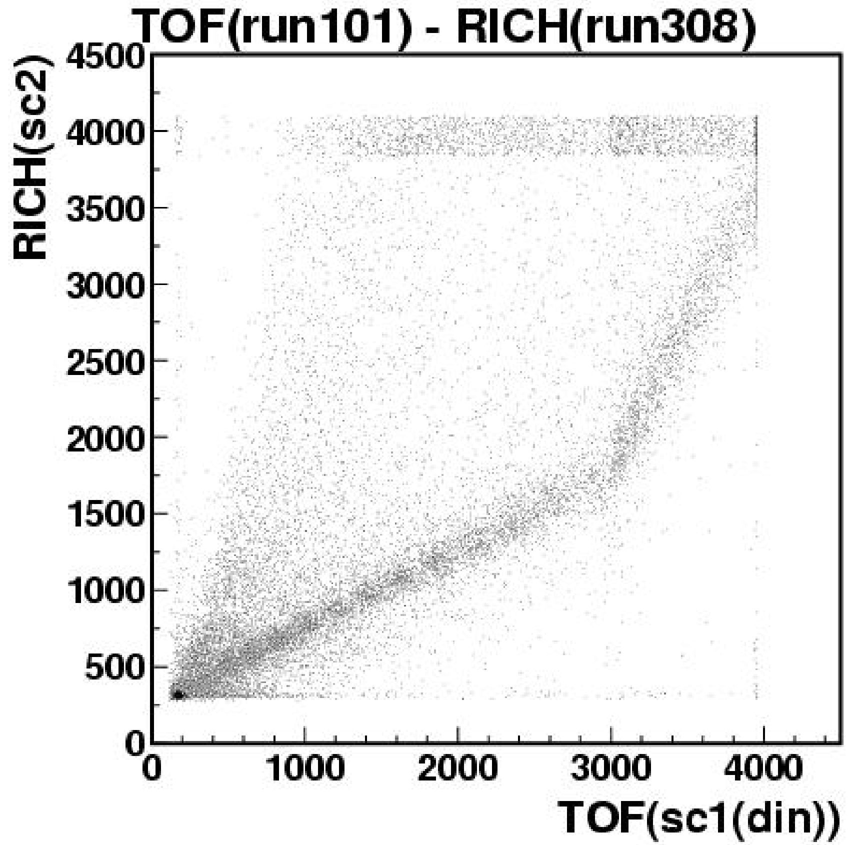






NEXT STEPS

- Calibration verification (WC, SCNT…)
- Ntuple availability
- MC production
- Analysis extension to the full data sample including all the radiators



Additional background rejection and identification capabilities can be obtained by correlating RICH data with Tracker and TOF samples using the common event number.

CONCLUSIONS

- First look at test beam data agrees with the system expected performances regarding velocity resolution and dynamic range.
- Detailed comparison with simulation is needed to perform the final radiator choice.
- Correlation with TOF and Tracker data may be needed to reject backgrounds and to improve signal selection.
- Two unexpected effects have been detected:
  - Inconsistent LED/Offline PMT Gain calibration
  - “Persistent signals” in consecutive events