Analysis of cosmic runs for the AMS RICH prototype.

Carlos Delgado

Outline

- Data and MC description.
- Event selection.
- Resolution and photon yield results.
- Other results.
- Summary and conclusions.

Runs in this analysis

Run	Date	Pedestal date	Radiator	Drift	Foil	MC
12	July 29th	July 26th	1.03 3cm	416.5	Yes	Yes
20	Aug. 5th	Aug. 5th	1.03 3cm	416.5	No	Yes
27	Aug 13th	Aug 13th.	1.03 3cm	416.5	Yes	$\equiv 12$
15	July 31st	July 31st	1.05 2cm	326.5	No	Yes
16	Aug 2nd	July 31st	1.05 2cm	326.5	No	$\equiv 15$
22	Aug 9th.	Aug. 7th	1.05 3cm	326.5	Yes	Yes
24	Aug 9th.	Aug. 7th	1.05 3cm	326.5	No	Yes
25	Aug 12th.	Aug. 7th	1.05 3cm	326.5	No	$\equiv 24$
48	Sept. 2nd	Sept. 2nd	Mixed[a]	416.5	No	Yes

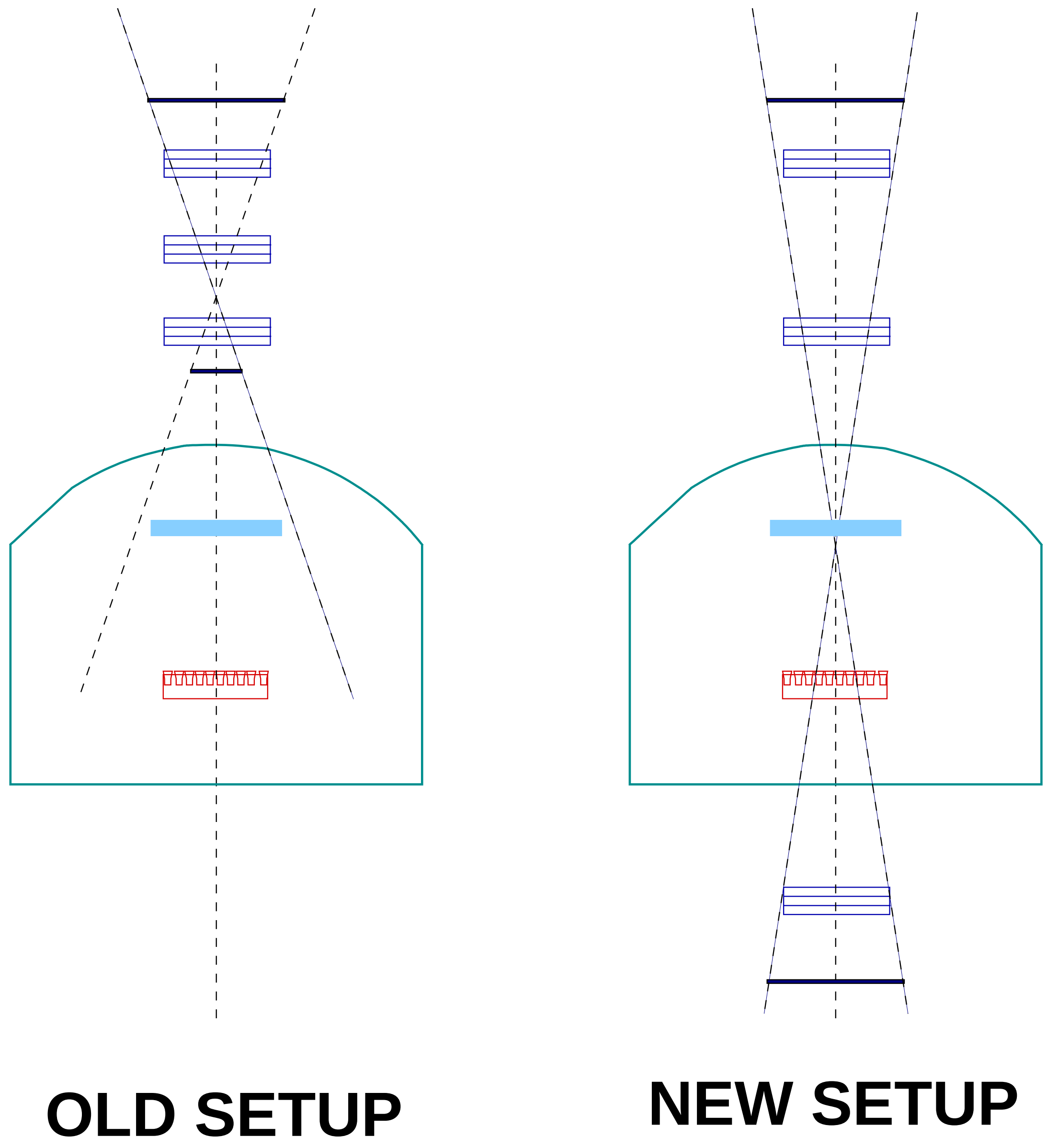
[a] 2cm of 1.03, 2cm of 1.05 and 3cm of Novorsibisk sample.

Clarities and abs. length

Radiator	Clarity ($\mu m^4 cm^{-1}$)	Abs. length (cm)
1.03	0.0110 ± 0.0003	$6 \pm 3cm$
1.05	0.0193 ± 0.0002	$9 \pm 1cm$
Novosibirsk	0.0064	100.

- The values for the Matsushita aerogel are obtained from measurements at CIEMAT.
- The value for Novosibirsk sample is only tentative.

Setup geometry



adapted from B. Bruny

Event selection

More efficient cuts especific designed to deal with data:

- General cuts:
  - Track reconstructed.
  - Track $\chi^2/ndof \leq 9$.
  - 3 or more hits in the ring.
- Hitted PMTs identification.
  - $\boxed{\longrightarrow}$ Geometrical based: reconstruction without using the reconstructed track direction.
  - $\boxed{\longrightarrow}$ PMT collected charge based: identify particle crossed PMTs.
  - $\boxed{\longrightarrow}$ Kolgomorov test with the expected distribution of hits along the ring.
- $\boxed{\longrightarrow}$ Geometrical acceptance cut: number of expected photons large enough.

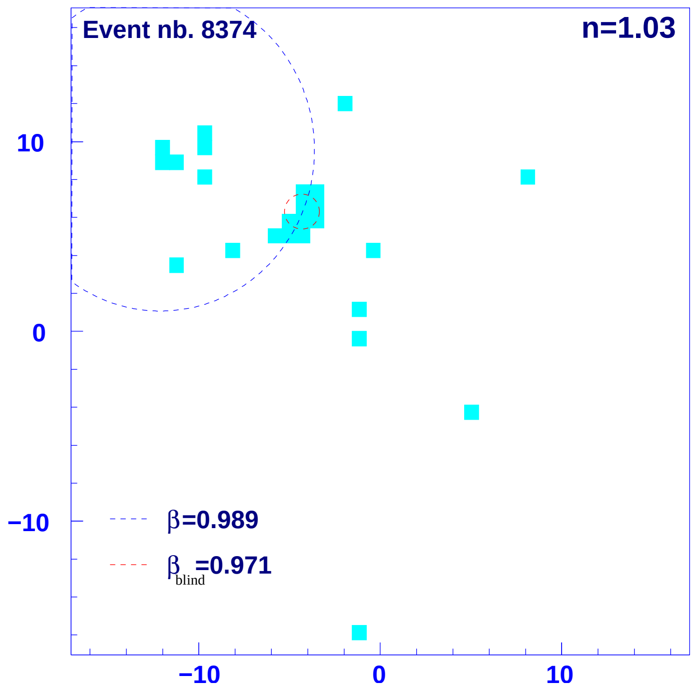
Reconstruction without using the track direction

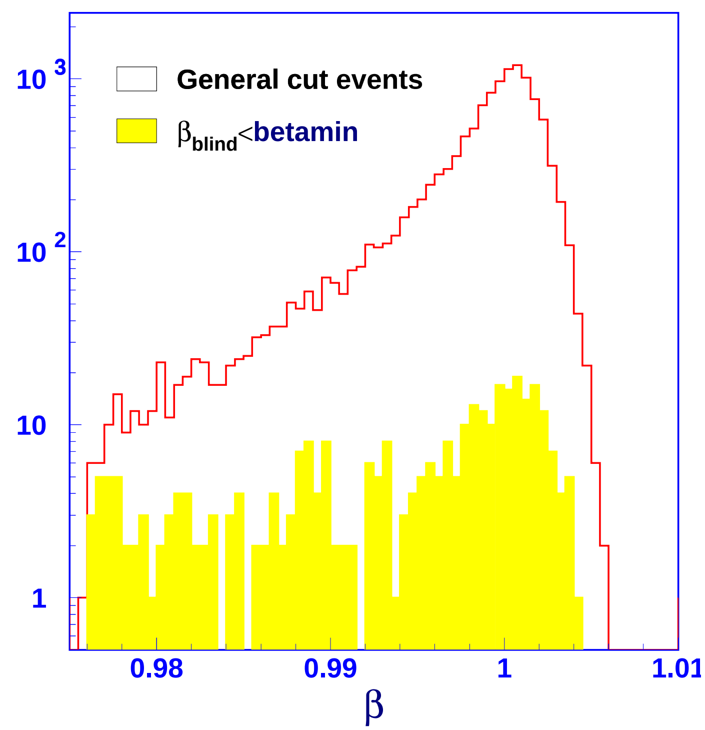
Obtained by minimizing the next chi^2 respect $\vec{w}$ and β_{blind}, after the reconstruction:

$$\chi^2 = \sum_{i \equiv used\ hits} \left(\frac{1}{n\beta_{blind}} - \vec{v}_i \cdot \vec{w}\right)^2$$

where $\vec{v}_i$ is the reconstructed emision direction for each used hit in the general reconstruction, and the condition $|\vec{w}| = 1$ must be imposed.

β_{blind} is sensitive to clusters over the ring in a geometrical basis:



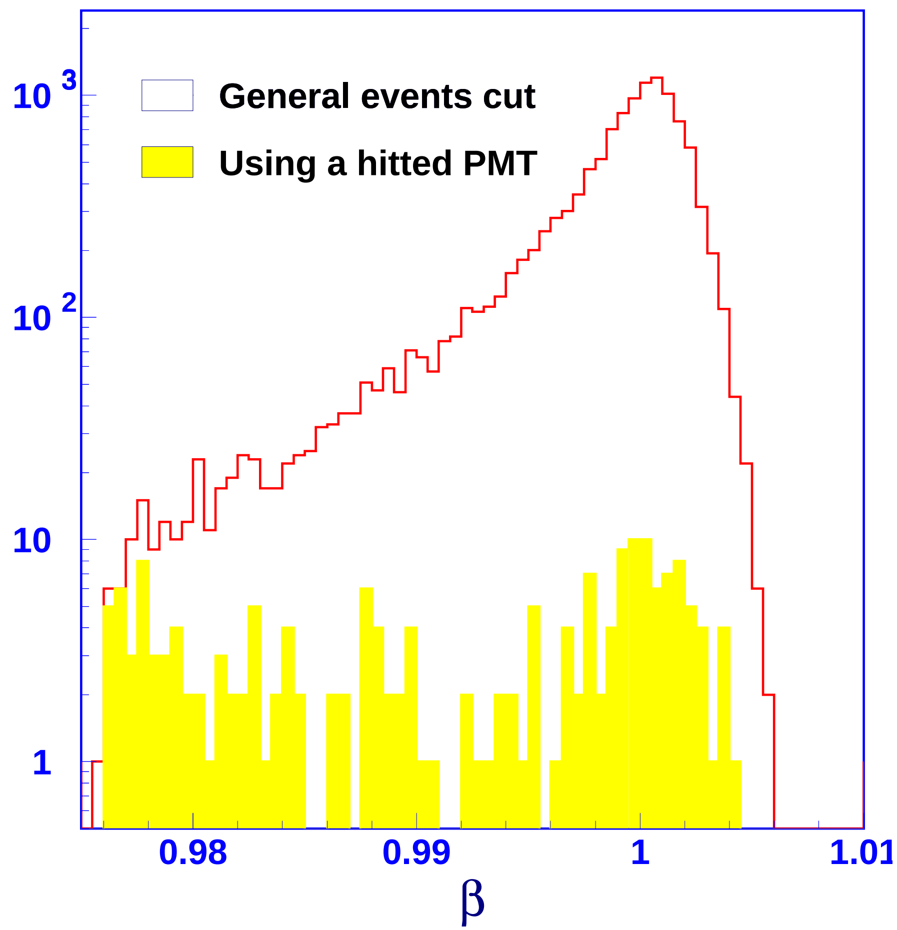


Collected charged cut

Events with a hit in the ring belonging to a crossed PMT are discarded:

- Definition: A PMT is crossed if one of its channels has a charge compatible with more than 5 p.e.

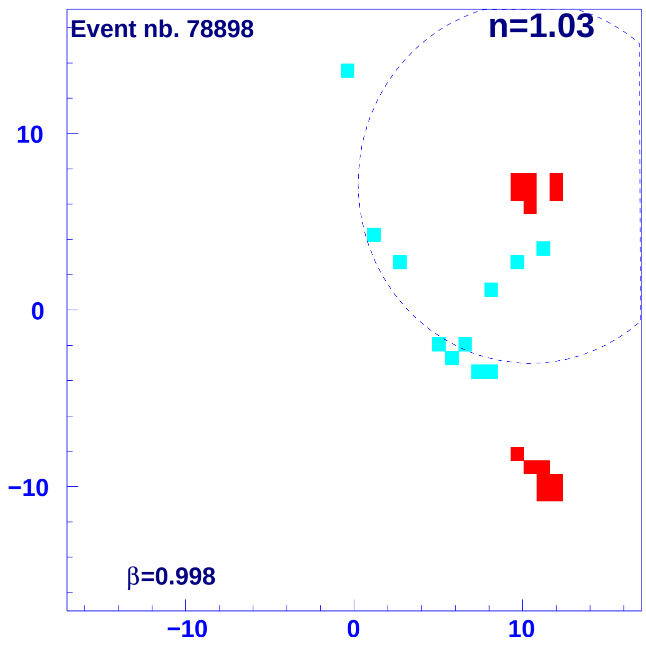
This cut has a functionality similar to β_{blind} cut.

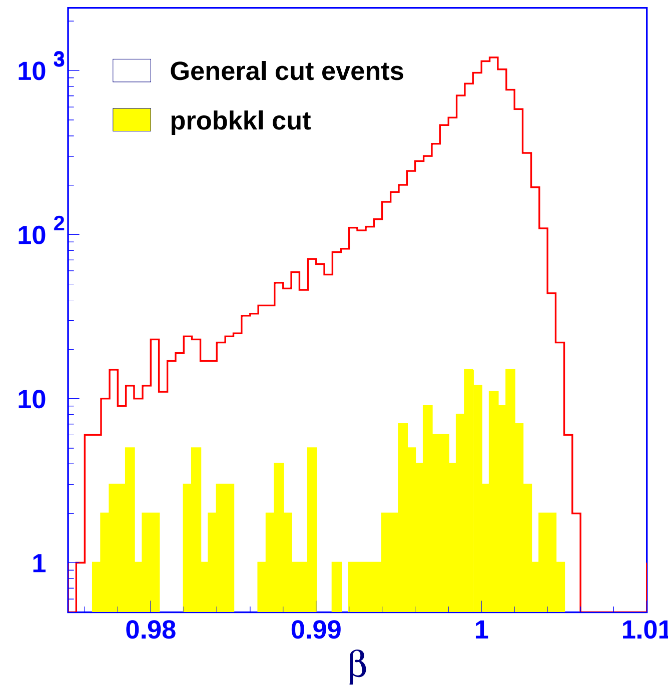


Kolgomorov test cut

Cuts based in the expected photon distribution from the β reconstruction.

- `Previous step:` Ray tracing to compute the expected photon yield and ring distribution[a].
- `Kolgomorov test:` Compare the photon distribution over the ring with the detected one using $probkl^b$.



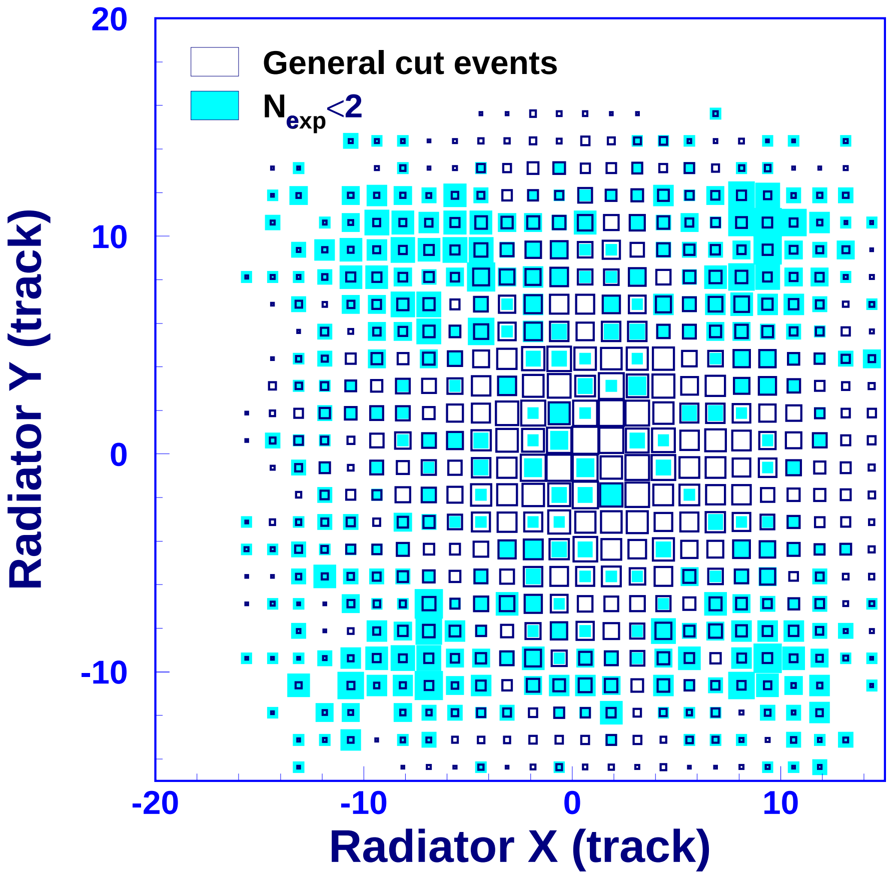


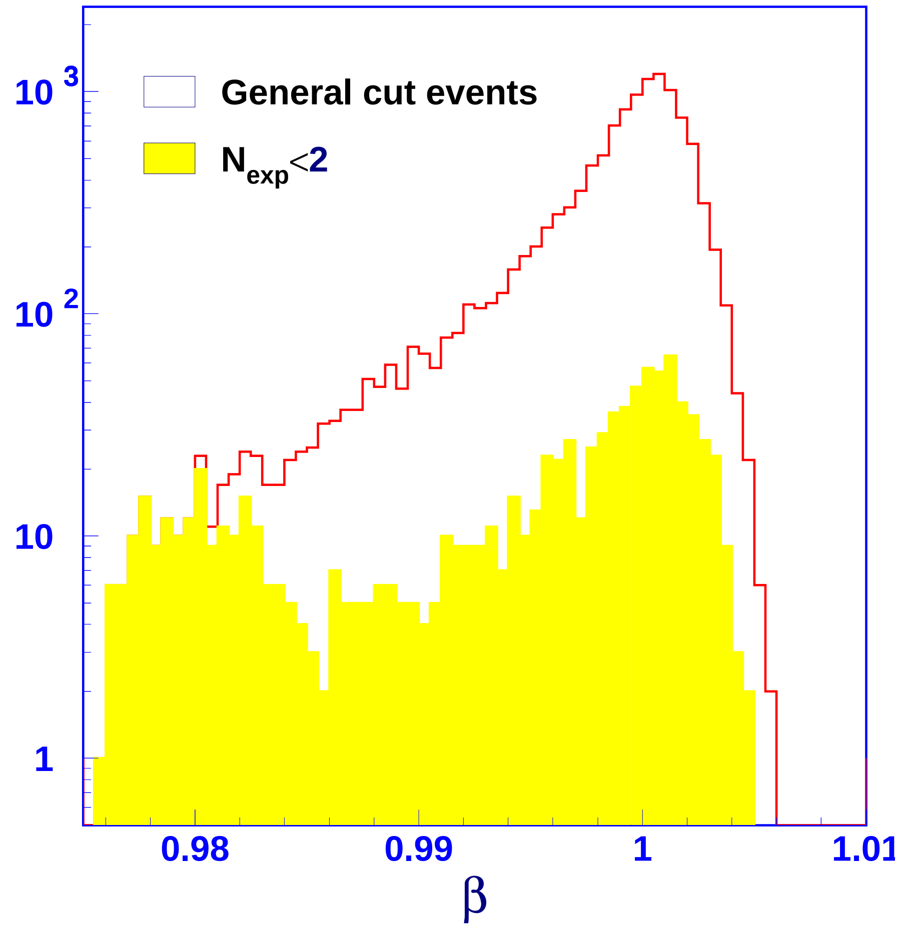
[a] See Lanciotti talk about charge reconstruction for the ray tracing procedure.

[b] Standard CERNLIB routine.

Acceptance cut

The previously computed number of expected detected photons in the ring[a] is used as a geometrical acceptance cut

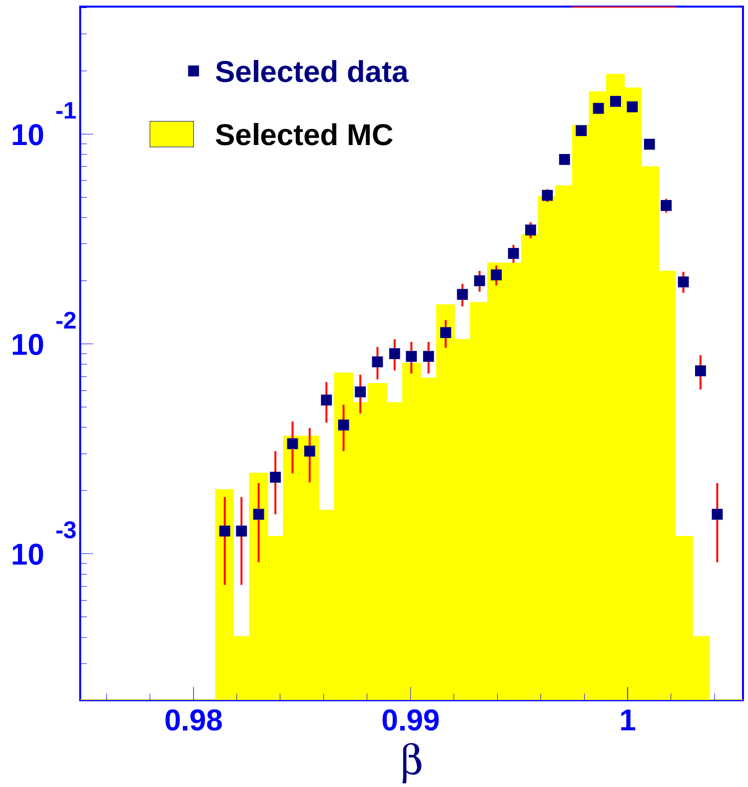




[a] N_{exp} in what follows

All cuts[a]

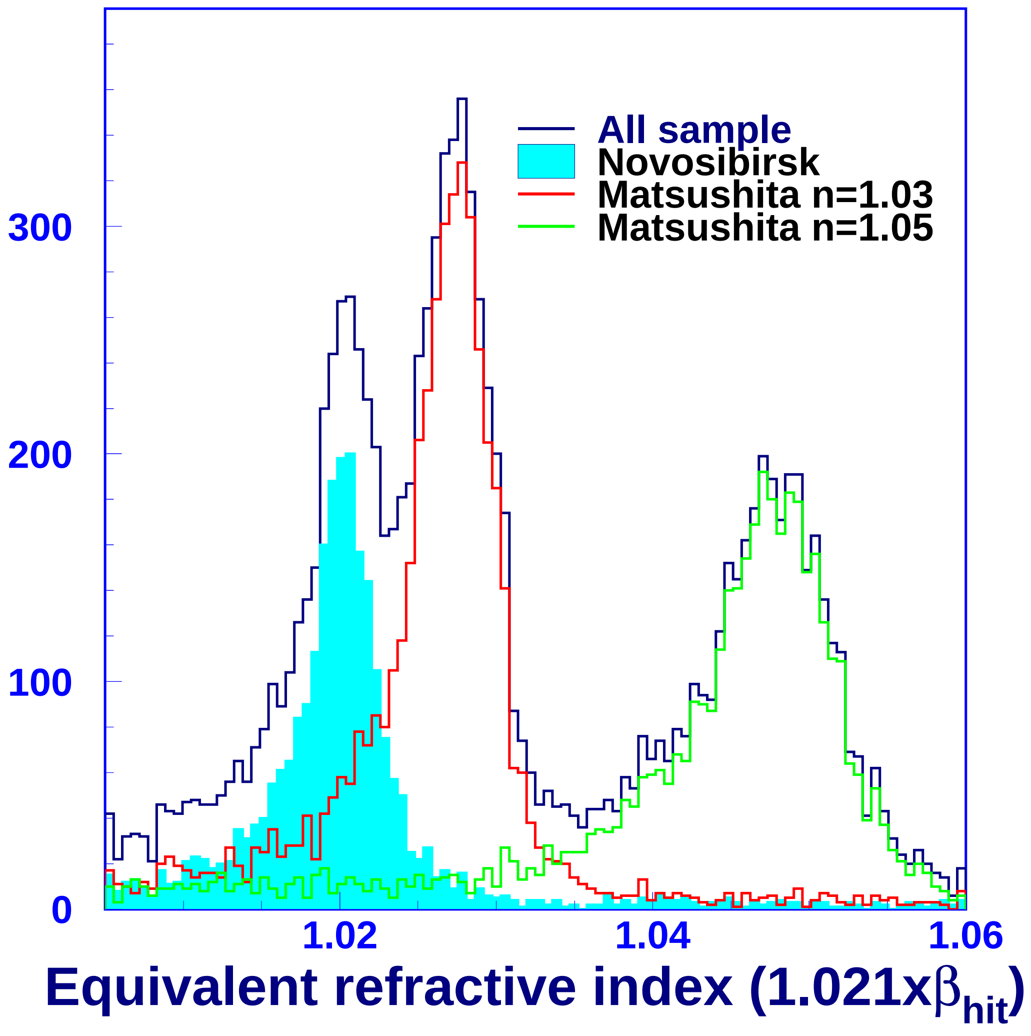
	Data (eff)	MC (eff)
General cuts	4330(100%)	2740(100%)
$N_{exp} > 2$	4024(93%)	2535(93%)
$probkl > 0.01$	3974(98%)	2522(99%)
$\beta_{blind} > \beta_{min}$	3913(99%)	2492(99%)
$No\ crossed\ PMT$	3891(99%)	2489(100%)
total	89%	91%



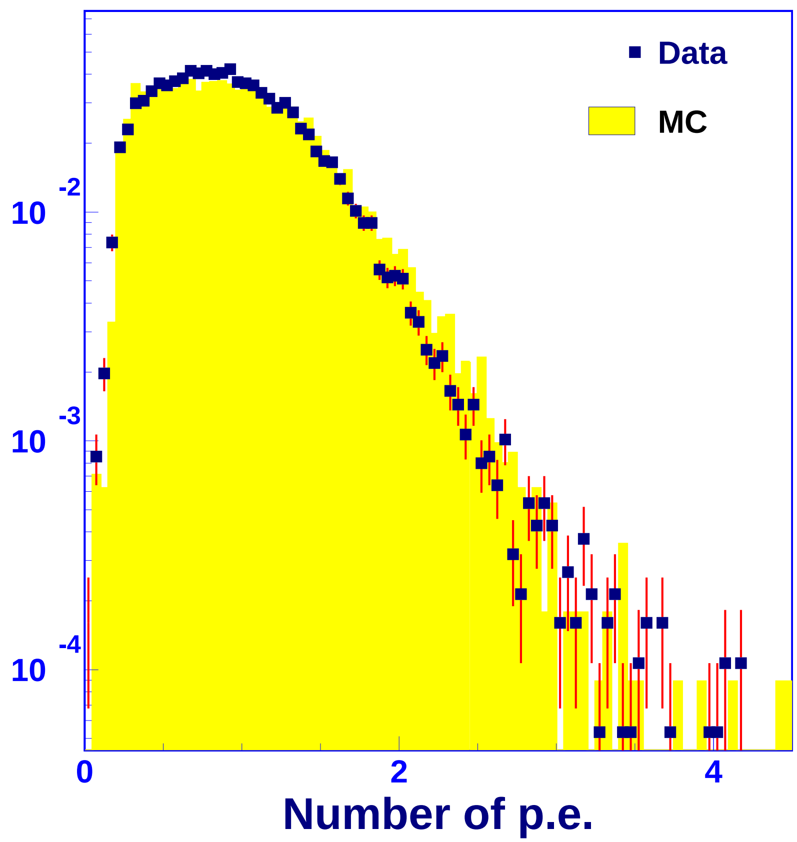
[a] Values for run 12.

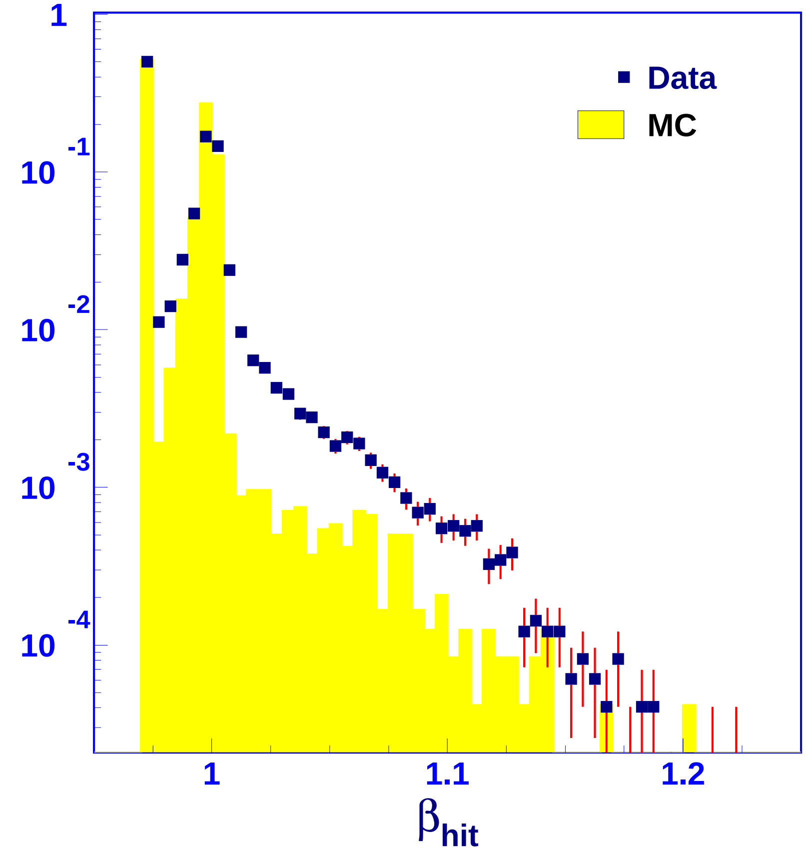
Measurement of Novosibirsk sample n

- Single 3 radiators run ($nb.$ 48)
- Computed by adjusting the β_{hit} spectrum to the expected one.
- The other radiators used as a reference.



Data vs. MC: `All hits`





- Similar single p.e. calibrations.
- Still too many hits far from the Čerenkov ring for data: they do not present any feature[a] different from MC.

[a] Distribution in detection plane, number of p.e., ADC counts...

Data vs. MC: resolution and photon yield

To estimate these quantities we must face the next two problems:

- There is no external reference about β so the resolution must be estimated using the data itself.
- The reconstruction bias the number of hits in the ring.

We chose the next estimators to solve the problems:

- The resolution per hit is computed with the estimator

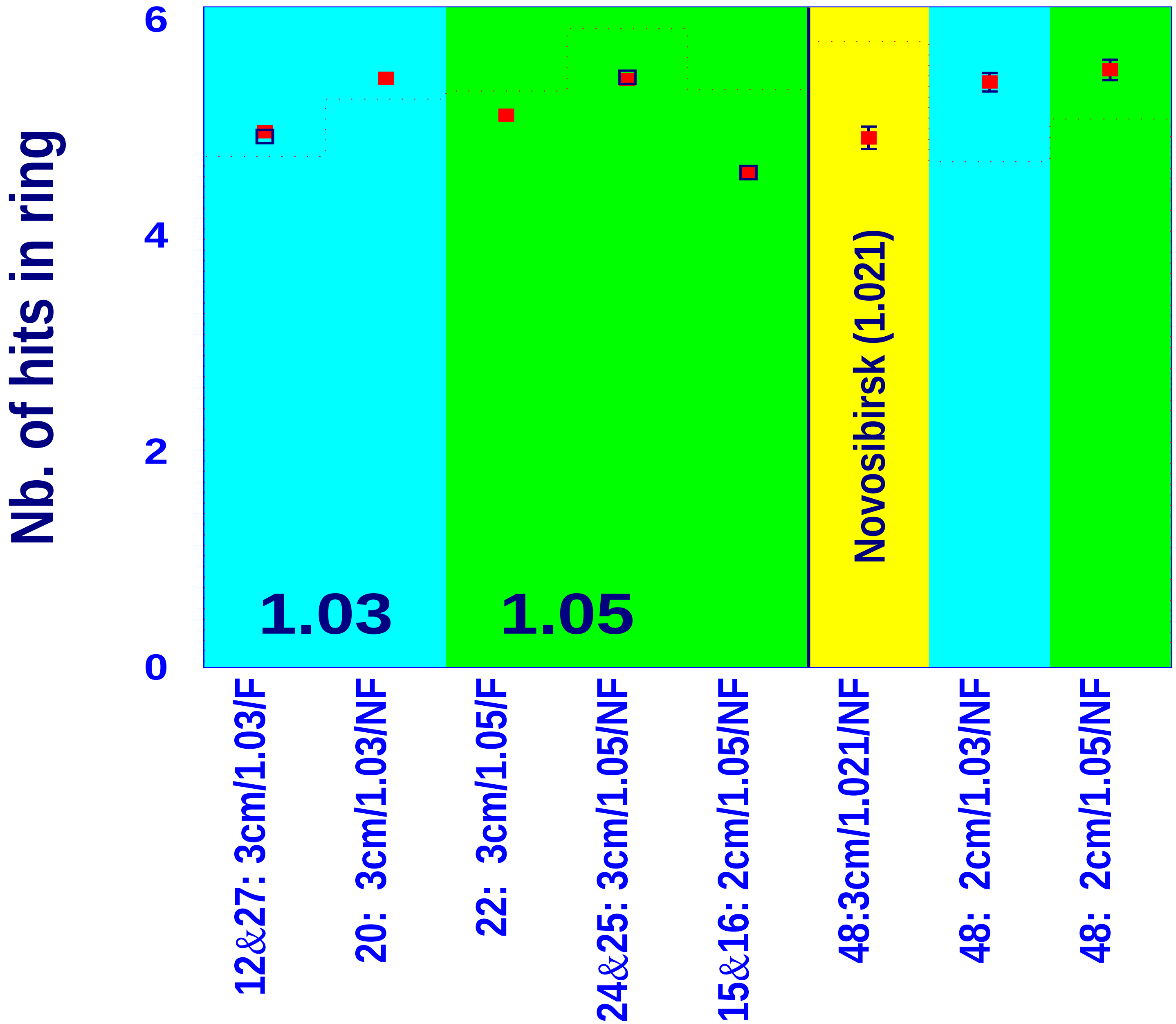
$$\sigma(\beta)_{hit} = \lim_{N_{used} \to \infty} \sqrt{\frac{N_{used}}{N_{used} - 1}} \sigma(\beta_{hit} - \beta_{event})$$

- We use the common reference N_{exp} for data and MC to find systematic deviations:
  The ratio in the number of hits between data and MC is computed as

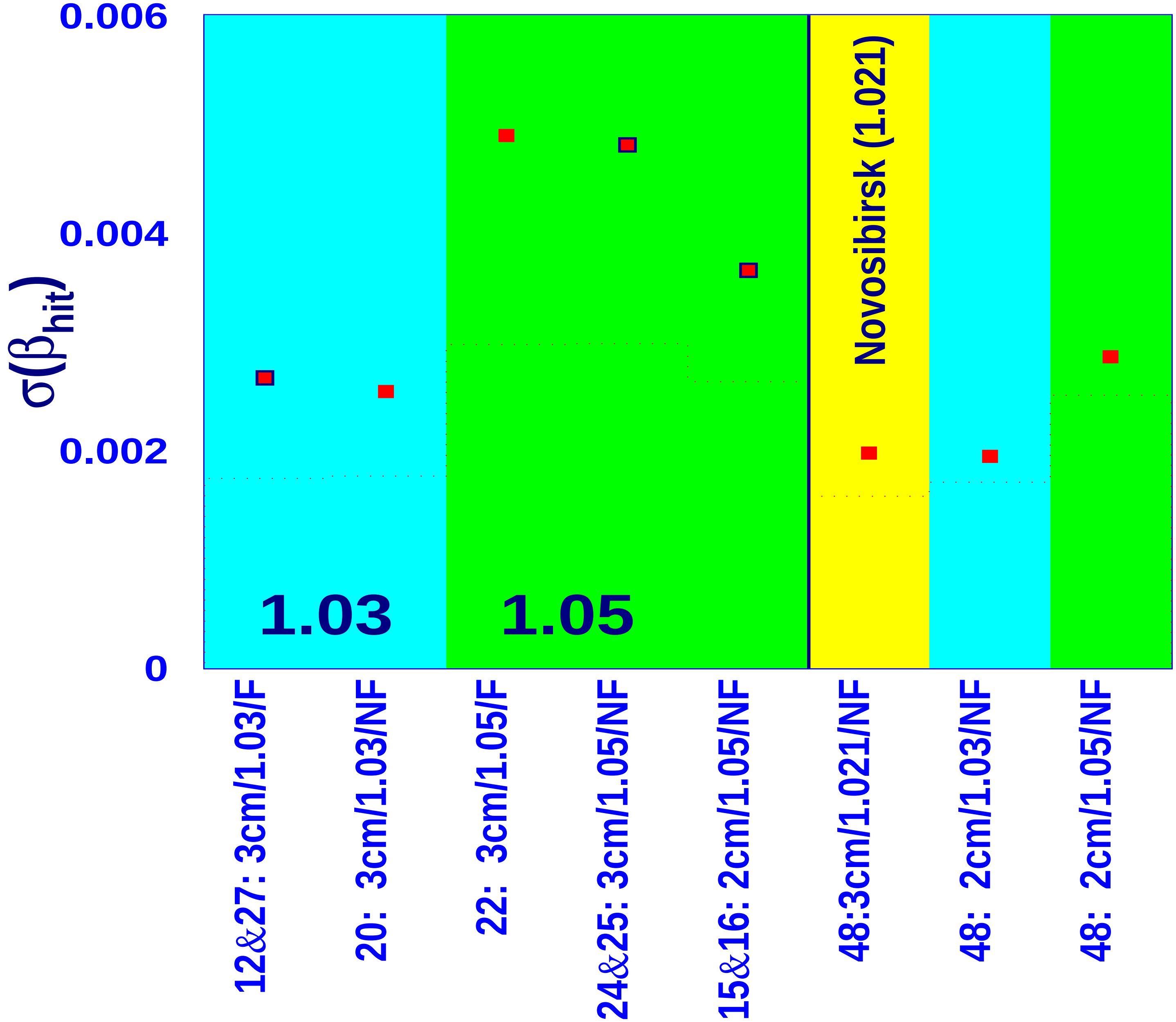
$$R = \frac{\langle \frac{N_{used}}{N_{exp}} \rangle_{data}}{\langle \frac{N_{used}}{N_{exp}} \rangle_{MC}}$$

  And the number of hits is estimated in a consistent way.

Photon yield

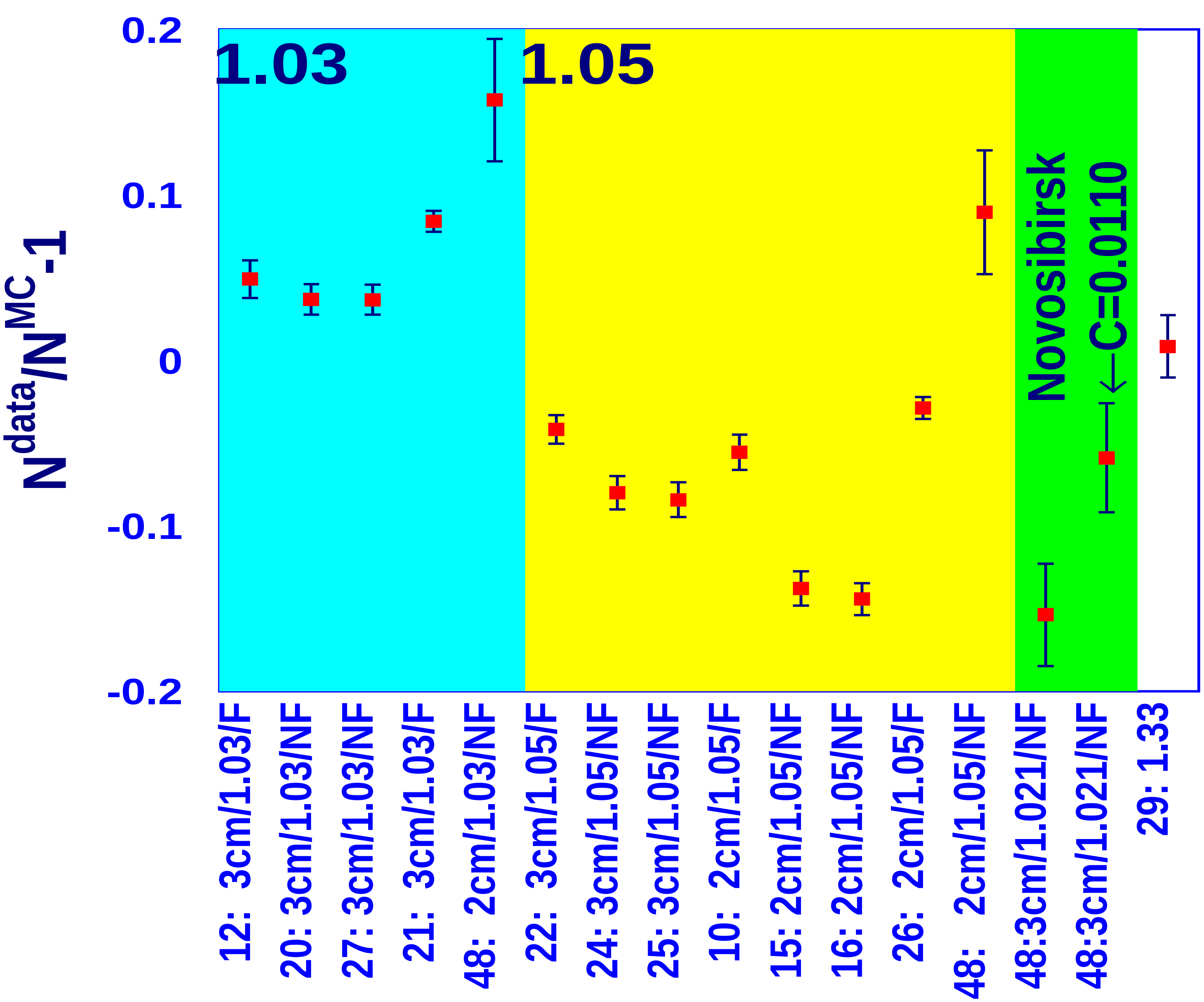


Resolution

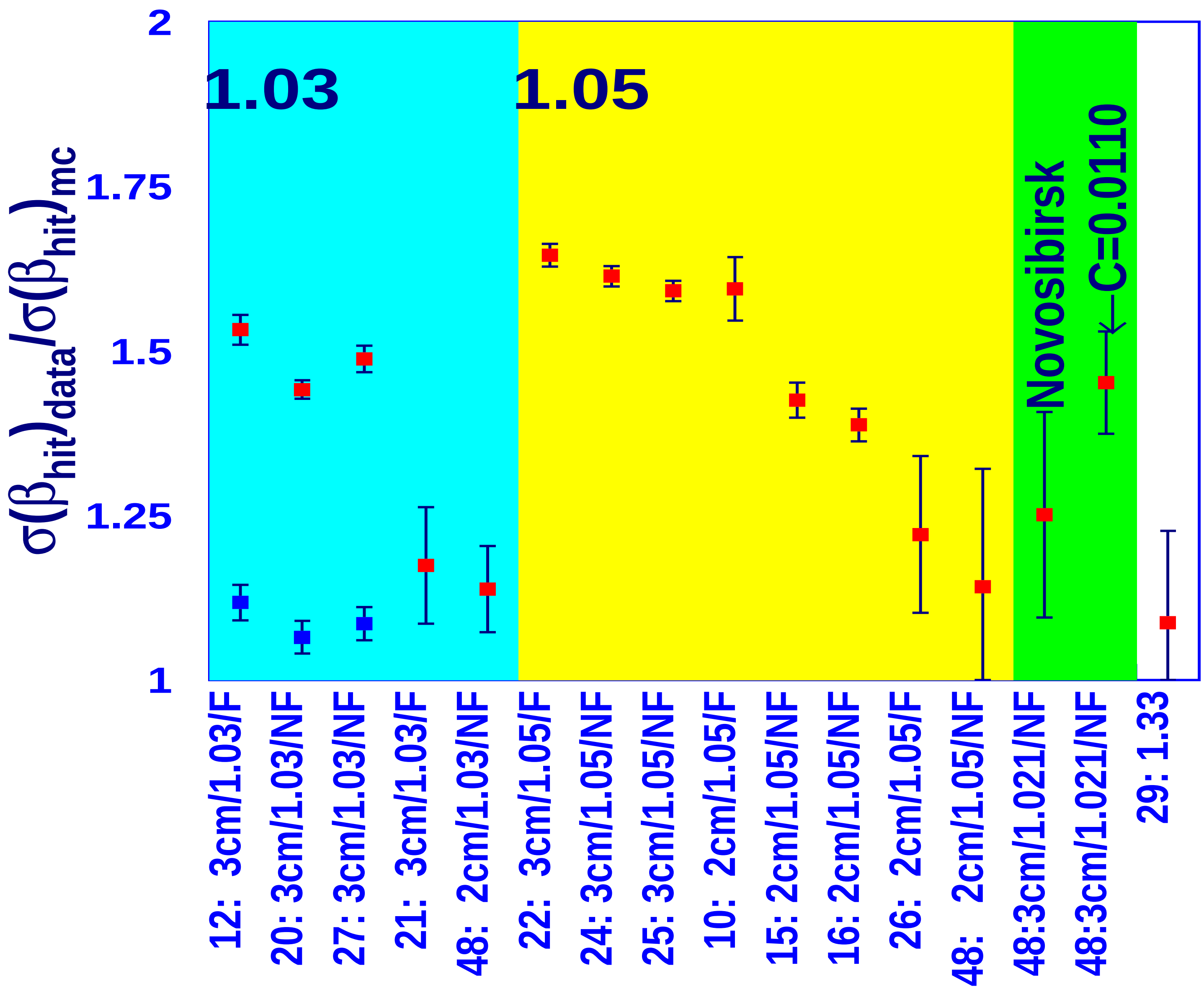


0.006
0.004
0.002
0
$\sigma(\beta_{hit})$
Novosibirsk (1.021)
1.03
1.05
12&27: 3cm/1.03/F
20: 3cm/1.03/NF
22: 3cm/1.05/F
24&25: 3cm/1.05/NF
15&16: 2cm/1.05/NF
48:3cm/1.021/NF
48: 2cm/1.03/NF
48: 2cm/1.05/NF

(almost)All runs summary: photon yield



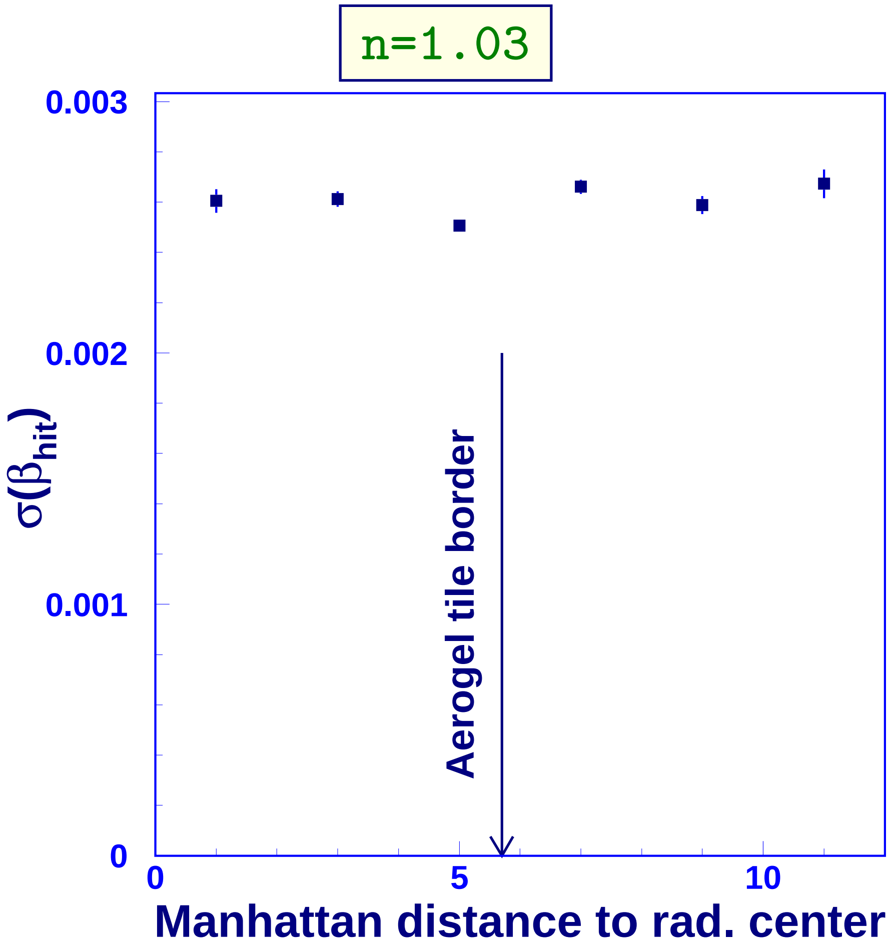
(almost)All runs summary: resolution

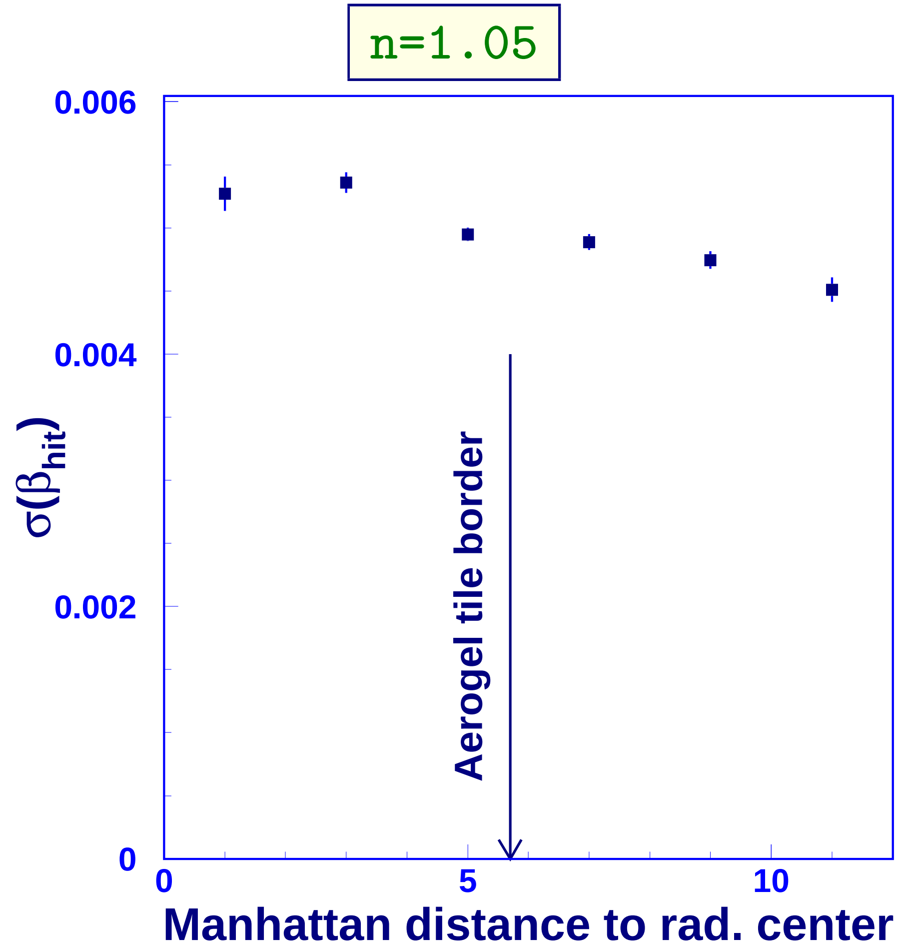


Blue dots: MC with extra scattering in the surface between two tiles according to CIEMAT measurements.

Error bars include systematic estimates.

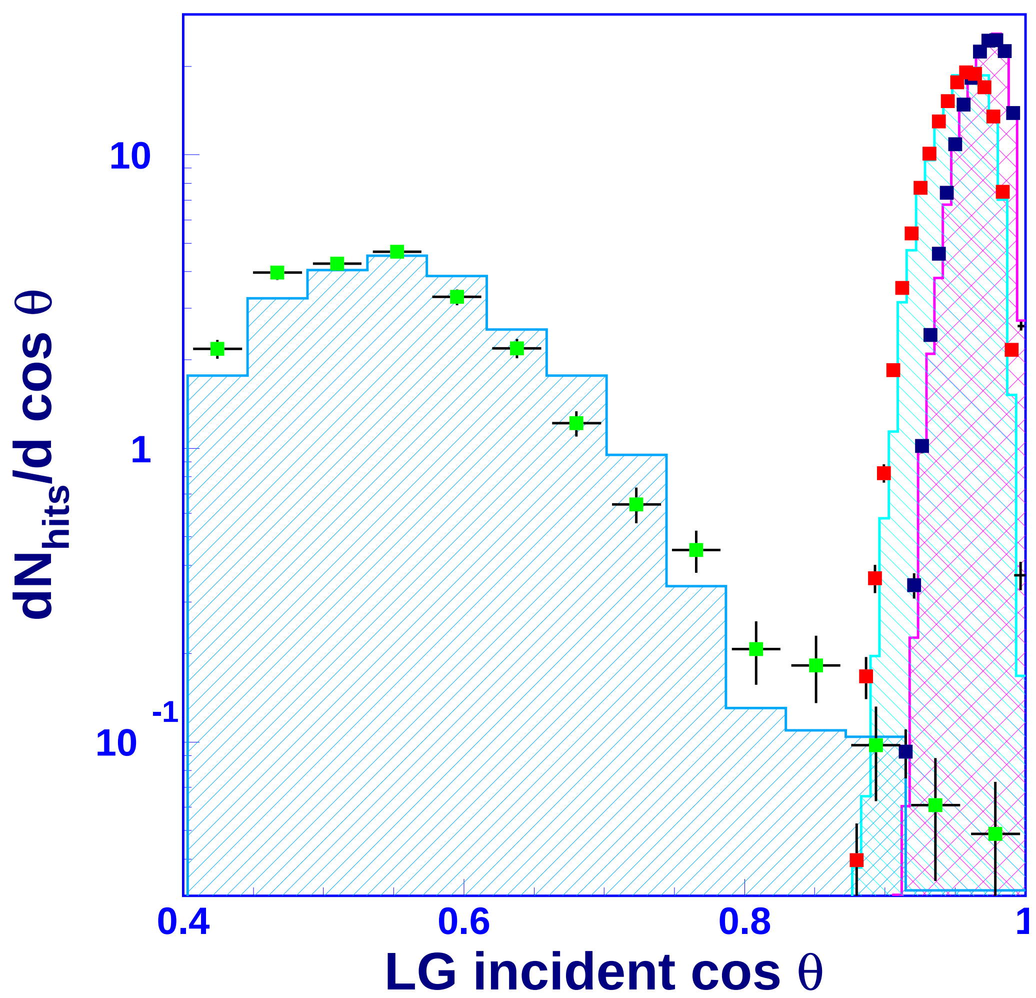
Other results: tile n homogenity





Other results: LG efficiency

- $n = 1.03$, $n = 1.05$ and $n = 1.33$ runs show a good agreement with MC prediction in the shape of the distribution of incident $cos\theta$, covering a large angular range.



Summary and conclusions

- Polyester foil effect is reflected mainly in the photon yield, as expected, and it almost does not affect the resolution per hit.
- The new Matsushita aerogel behaves differently than the old one:
  - Photon yield is larger: 2cm of the new behaves like 3cm of the old for n=1.03. An important improvement is also observed for n=1.05.
  - Resolution per hit: the new one is closer to the MC expectation.
- The Novosibirsk sample behaves well in resolution but not in photon yield
- The angular efficiency for photons is well reproduced in MC in a large range.

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