

Detectores de tempo de voo RPC em HADES. Performance em Au+Au @ 1.25 AGeV

A. Blanco
On behalf of HADES RPC Group



Fundaçāo para a Ciéncia e a Tecnologia
MINISTÉRIO DA CIÉNCIA, TECNOLOGIA E ENSINO SUPERIOR



Ciéncia, Inovação
2010
Programa Operacional Ciéncia e Inovação 2010
MINISTÉRIO DA CIÉNCIA, TECNOLOGIA E ENSINO SUPERIOR



União Europeia
Fundo Europeu de
Desenvolvimento Regional

Sixth
framework
programme

HADES RPC Group

GSI

- D. Gonzalez
- W. Koenig

LIP

- A. Blanco
- N. Carolino
- O. Cunha
- P. Fonte
- L. Lopes
- A. Mangiarotti
- A. Pereira
- C. Silva
- C.C. Sousa
- C. Franco
- L. Silva

USC

- D. Belver
- P. Cabanelas
- E. Castro
- J.A. Garzón
- G. Kornakov
- M. Zapata

IFIC-Valencia

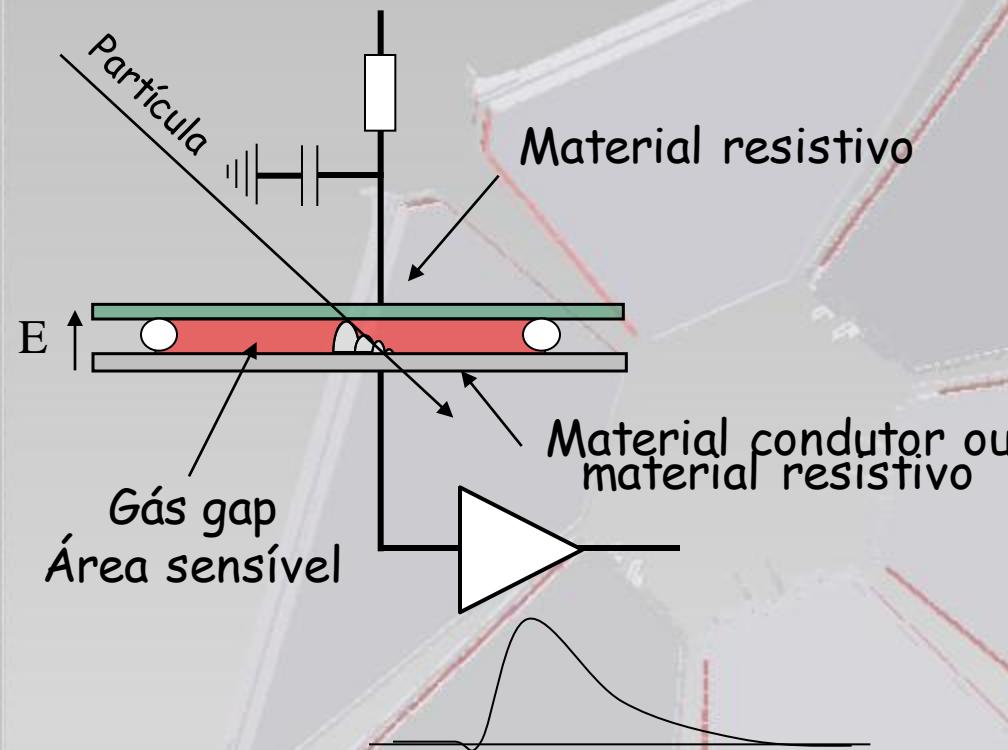
- J. Diaz
- A. Gil

Current and former members

Outlook

- O que é uma câmara de placas resistivas (RPC).
- A experiência HADES.
- O detector de tempo de voo (TOF) baseado em RPCs para a experiência HADES.
- Performance intrínseca. Resolução em tempo e posição.
- Resolução de sistema. Eficiência e resolução em tempo.

Câmaras de placas resistivas (RPCs)



R&D em RPCs

Medida de tempo: [NIMA 449 2000]

[IEEE 48 2001]

Grande área: [NIMA 485 2002]

Medida de tempo e posição:

[NIMA 508 2003]

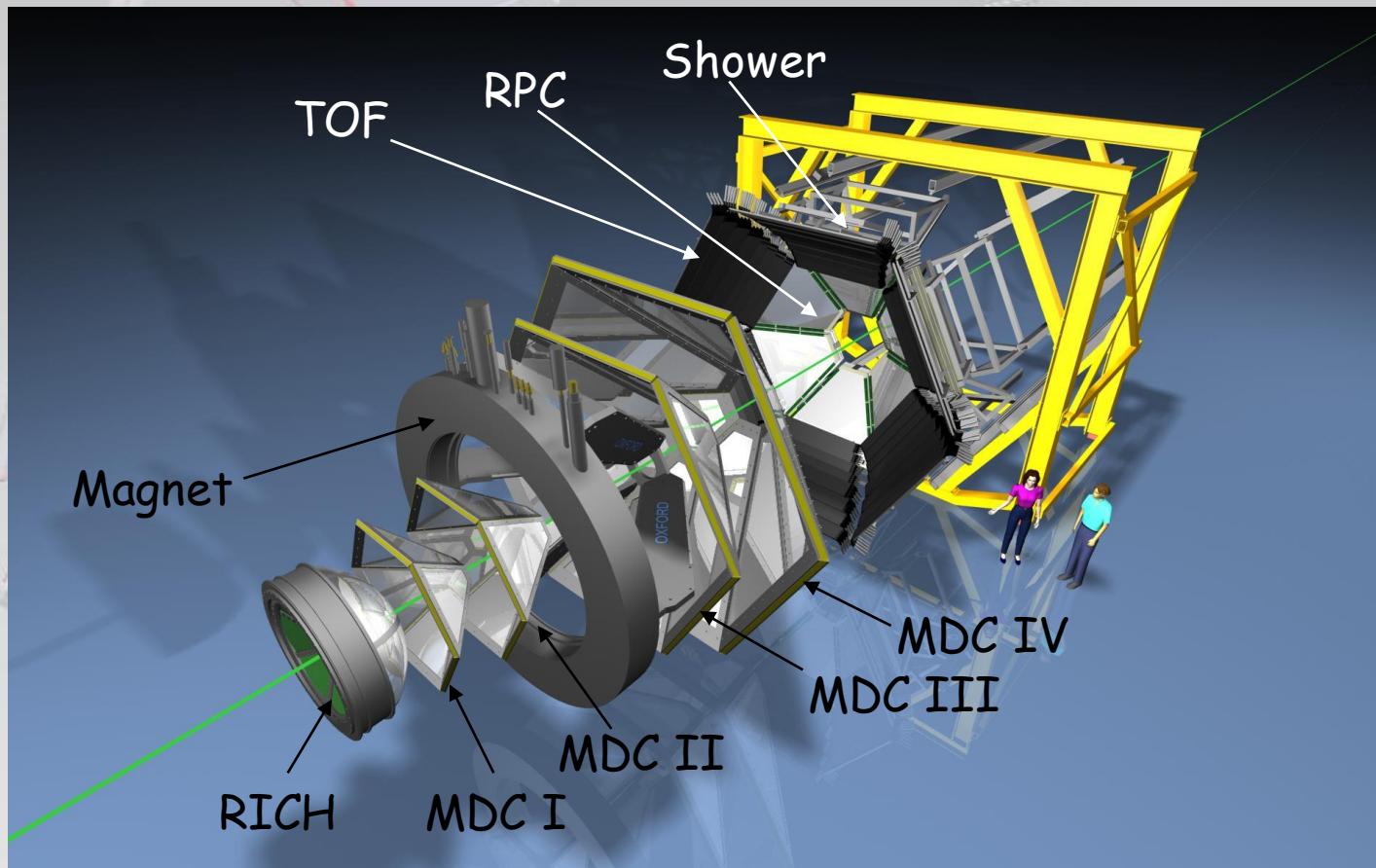
Características principais

- Eficiência 75% (0.3mm) > 99% (4 gaps).
- Resolução temporal 50 ps σ .
- Não têm resolução em energia.
- Possibilidade de medir a posição.

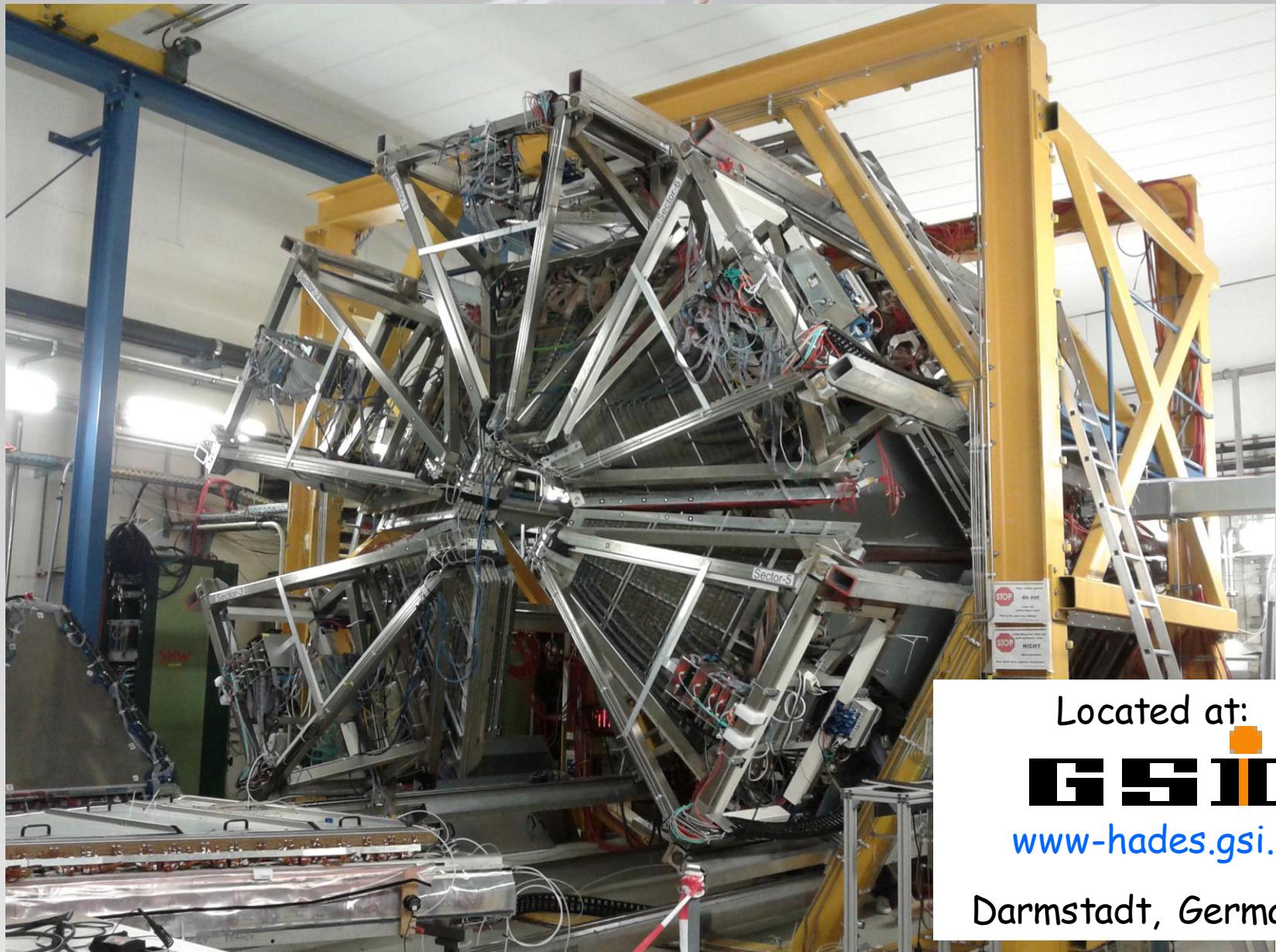
Espectrómetro HADES

A investigação das propriedades dos hadroes dentro do núcleo a densidades e temperaturas altas é uma das principais objectivos da física nuclear actual. Nestas condições, modificações significativas de propriedades básicas dos hadroes (massa, largura de decaimento, etc) são esperadas.

HADES => Alta aceitação, precisão e capacidade de contagem.



Espectrómetro HADES



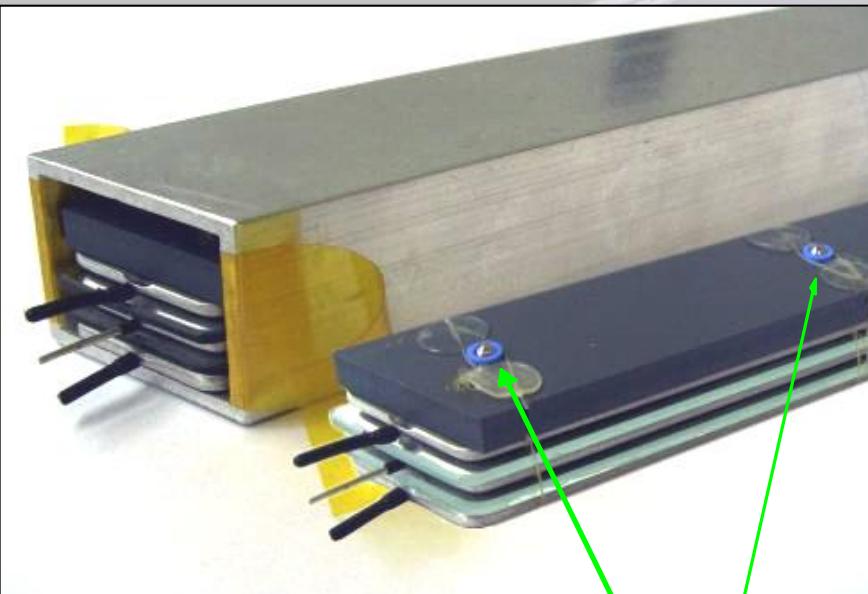
Located at:



www-hades.gsi.de

Darmstadt, Germany.

As células de HADES



Alumínio
Vidro
Molas &
suporte mecânico



HV & leitura
do sinal

- 0.27 mm x 4 gaps

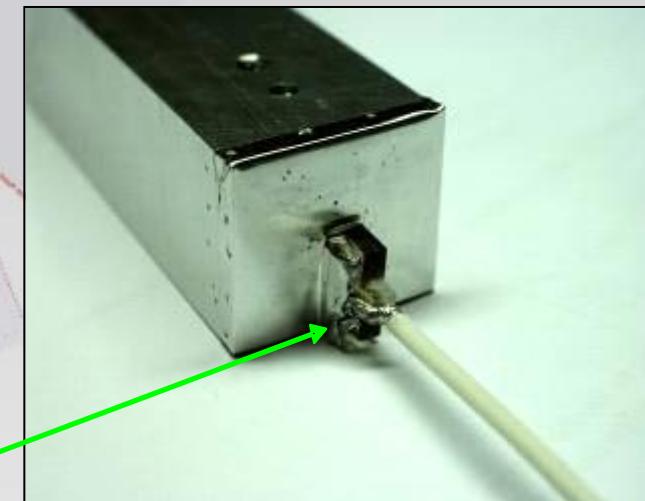
Mínimo para uma boa eficiência

- Eléctrodos de alumínio e vidro (2 mm)

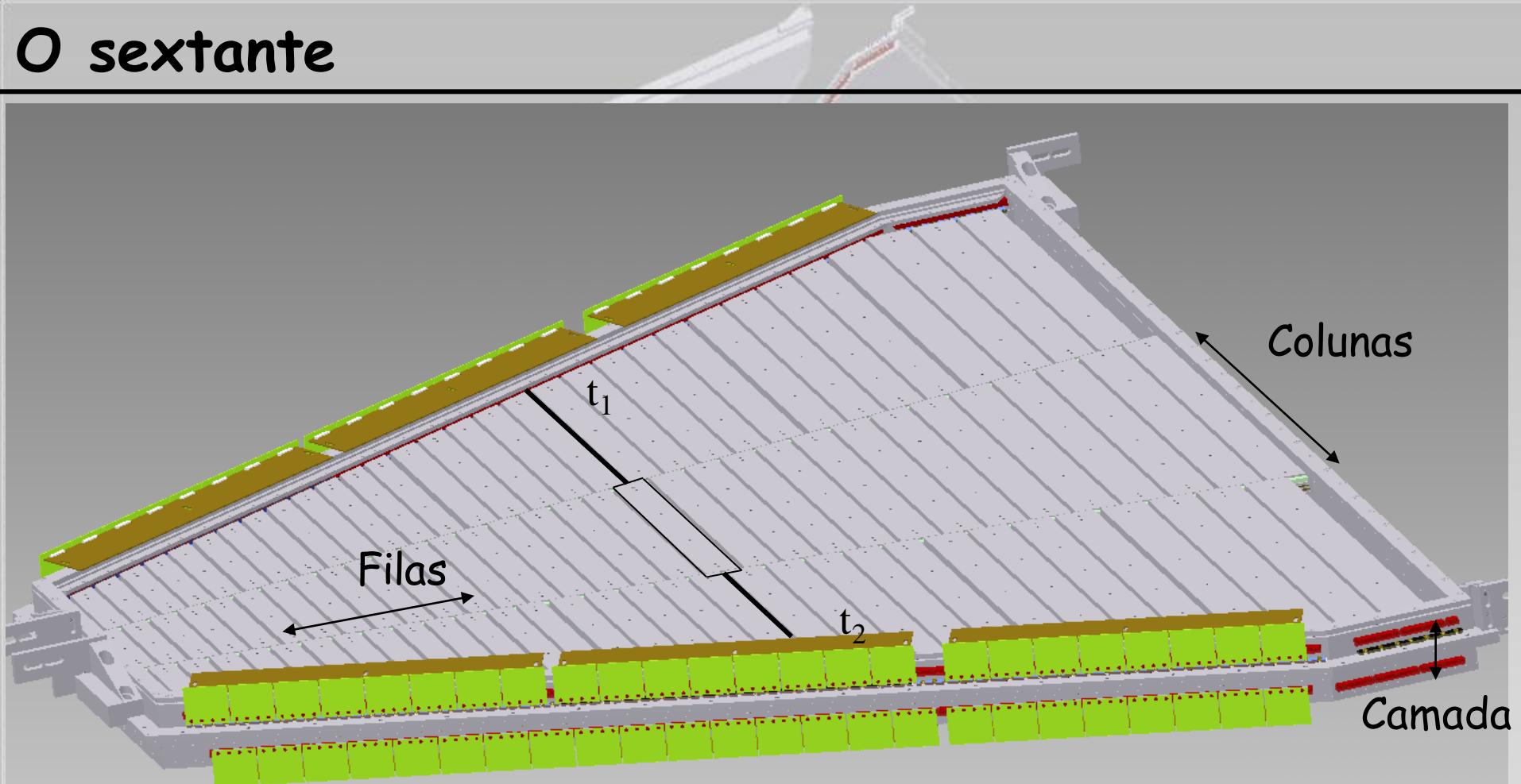
Minimizar a quantidade de vidro=>
Maximiza a capacidade de contagem

- Materiais tolerantes ao aquecimento

**Electricamente isolado
na totalidade**



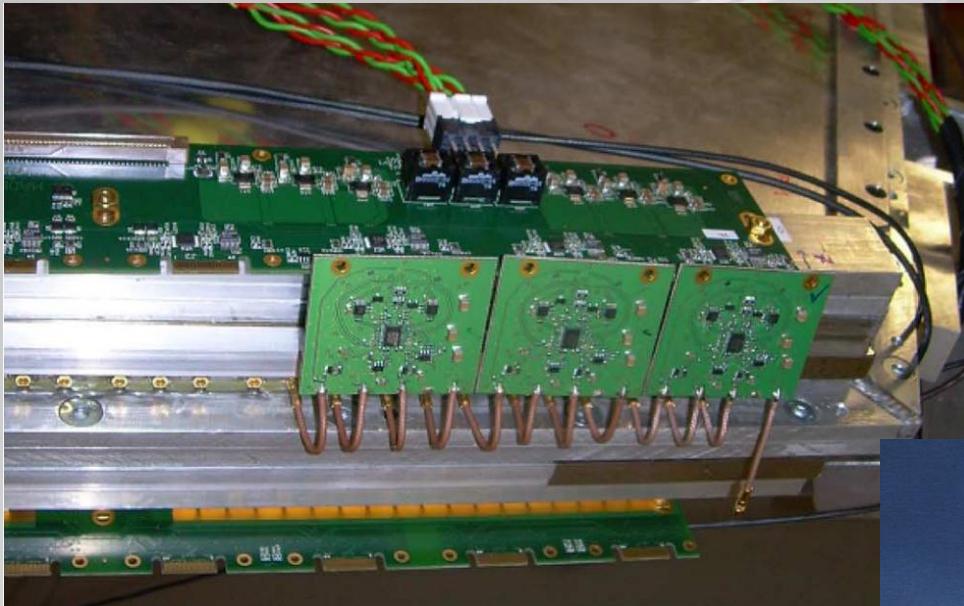
O sextante



- 187 células/sextante distribuídas em 32 filas, 6 colunas e 2 camadas
- 1116 células no total
- 124 tipos diferentes de células (comprimento, largura, forma)
- Leitura feita nos dois extremos

$$T = (t_1 + t_2)/2 \quad X = t_1 - t_2$$

FEE and DAQ



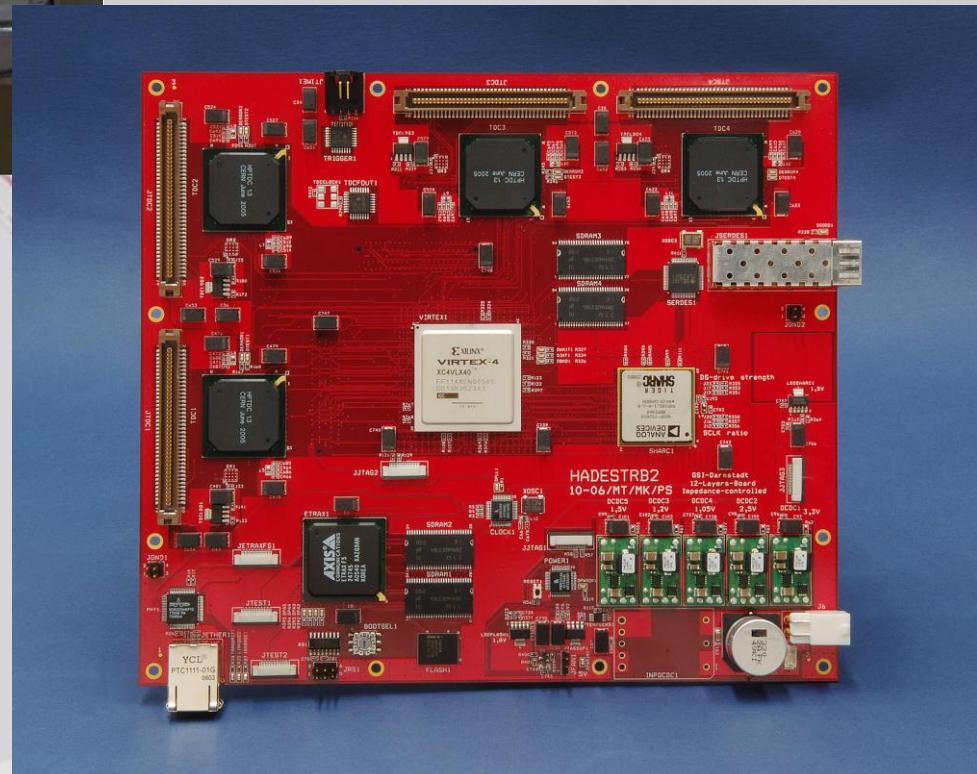
FEE based on Philips BGM1013

$G = 35.5 \text{ dB}$, $\text{BW} = 2 \text{ GHz}$, $\text{NF} = 4.5 \text{ dB}$

[TNS 57 vol 5 2010, 2848]

DAQ based on a 128 ch
multihit TDC

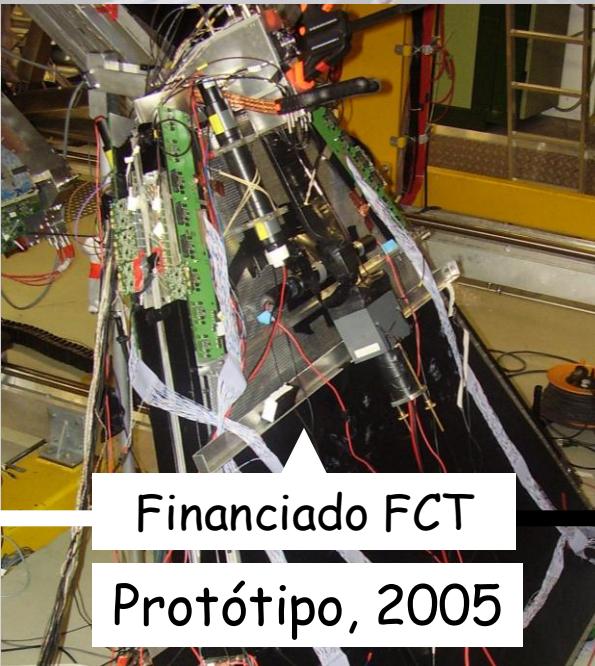
[TNS 58 vol 4 2011, 1745]



R&D, validação de protótipos, construção e teste



Validação, 2003



Financiado FCT

Protótipo, 2005

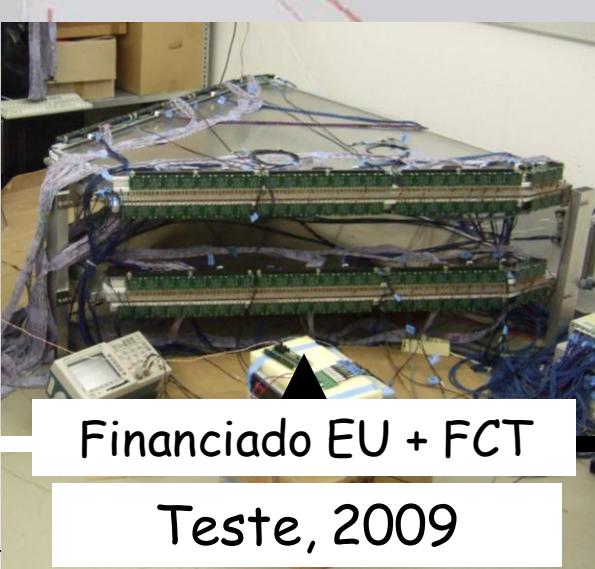


Sextante

completo, 2007



Construção, 2008-09



Financiado EU + FCT

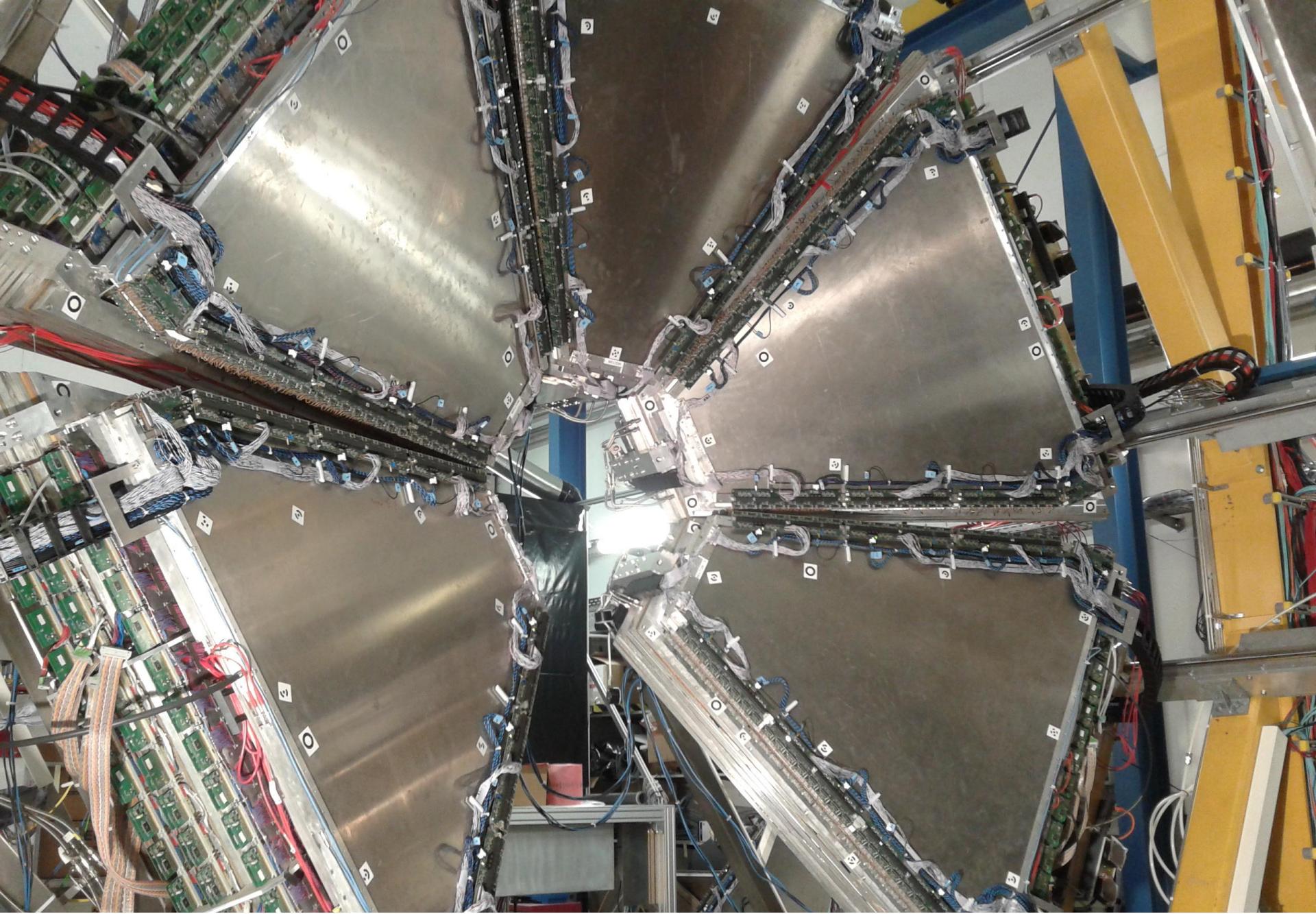
Teste, 2009



Instalação, 2010

A. Blanco

Jornadas LIP 2012, Lisboa

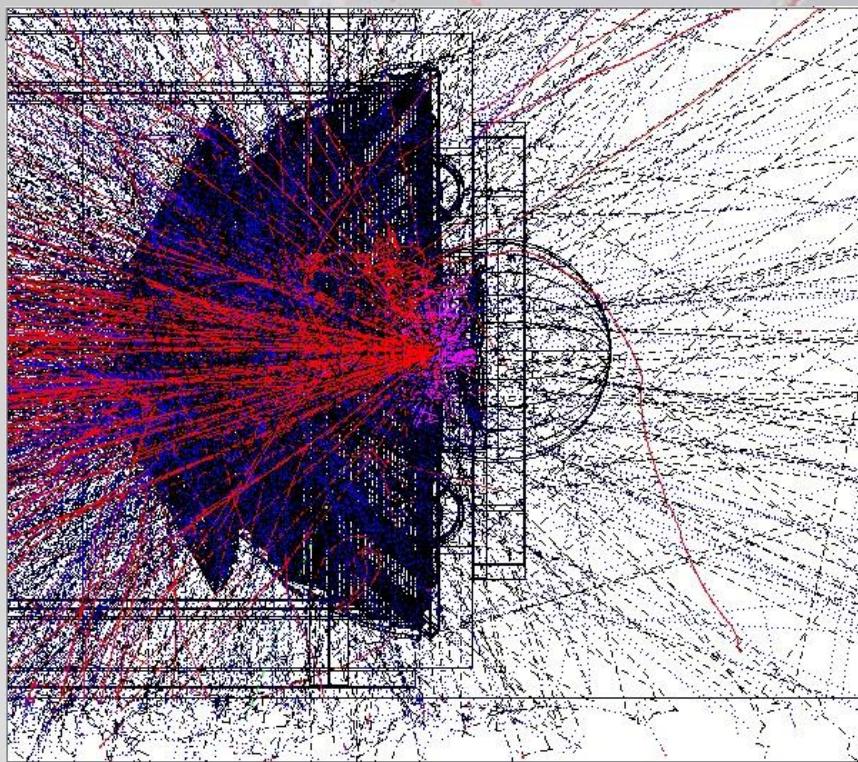


Instalado e integrado no espectrómetro

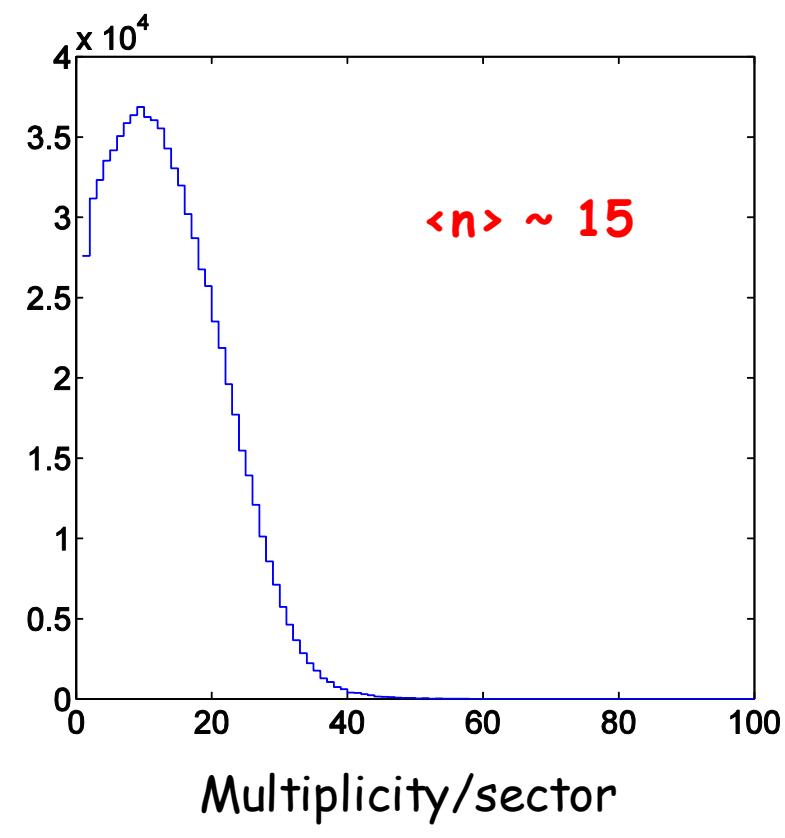
Intrinsic RPC performance. Au + Au @ 1.25 AGeV

First Au + Au test run in HADES (Aug 2011)

Multihit environment



One Au + Au collision from HGéant
simulation package



Intrinsic RPC performance. Analysis

Overlapped cells



Time difference

$$\Delta T = (t_1 + t_2)/2 - (t'_1 + t'_2)/2$$

Time resolution

$$\sigma_T = \sigma(\Delta T)/\sqrt{2}$$

Position difference

$$\Delta X =$$

$$V_{\text{prop}}/2 [(t_1 - t_2)/2 - (t'_1 - t'_2)/2] =$$

$$V_{\text{prop}}/2 [X_1 - X_2]$$

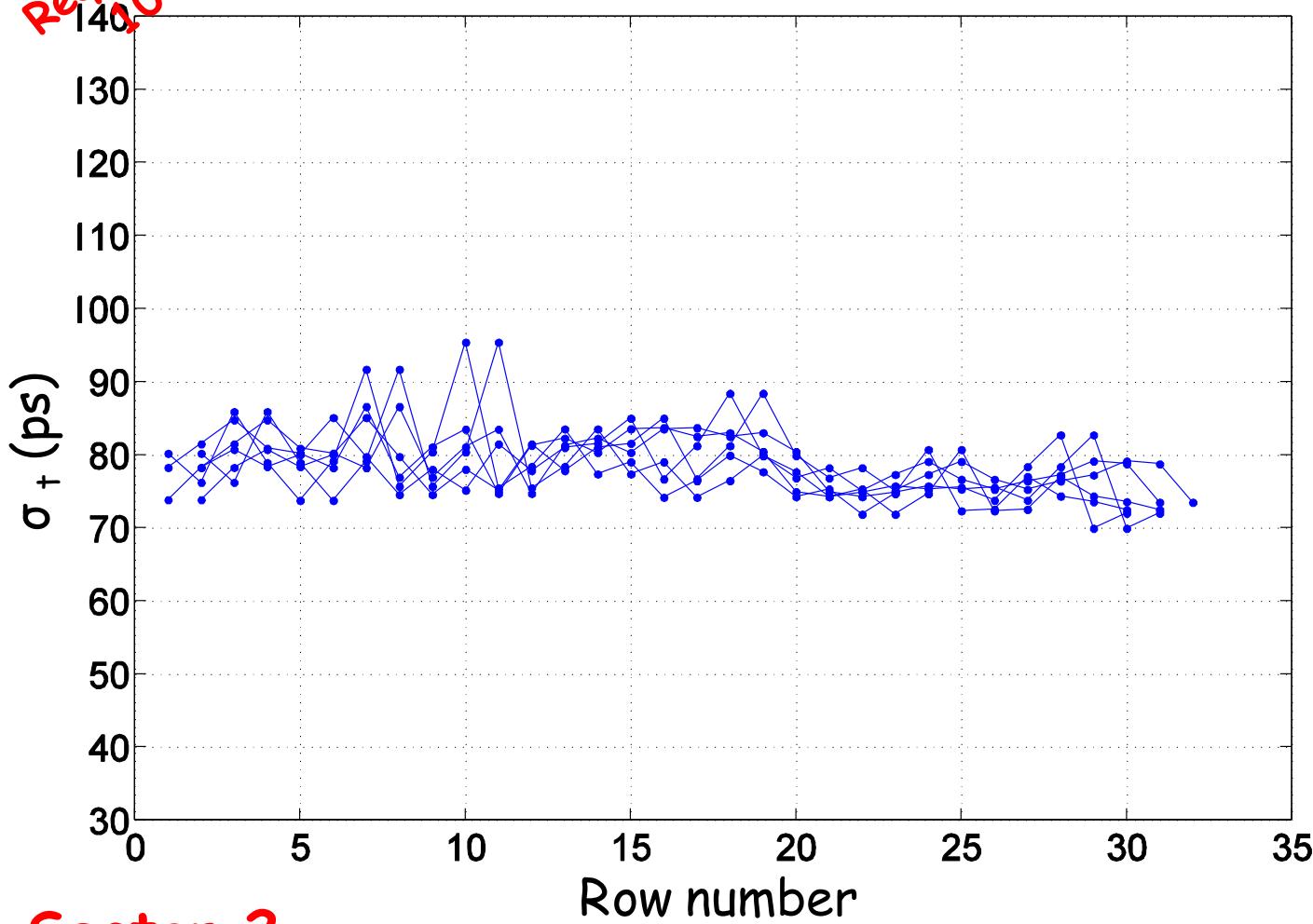
Longitudinal position resolution

$$\sigma_x = \sigma(\Delta X)/\sqrt{2}$$

Intrinsic RPC performance. Time resolution

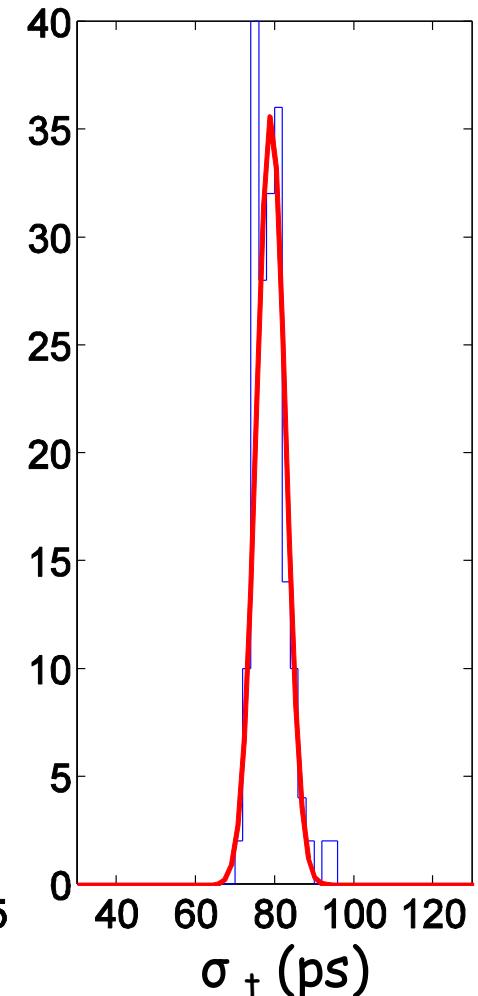
Requirement
10000ops

Homogeneous time resolution < 100 ps

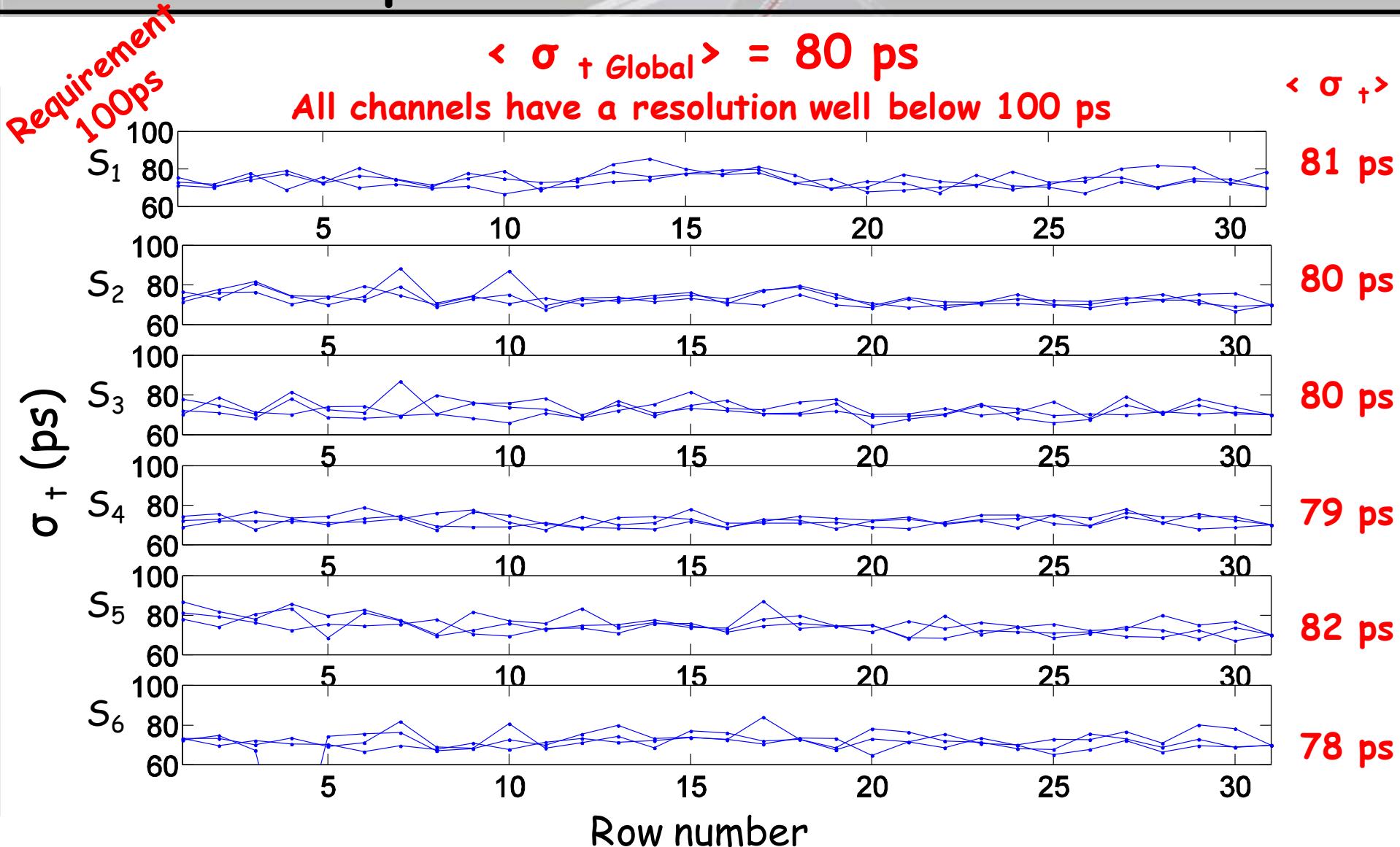


Sector 2

$\langle \sigma_t \rangle = 80$ ps

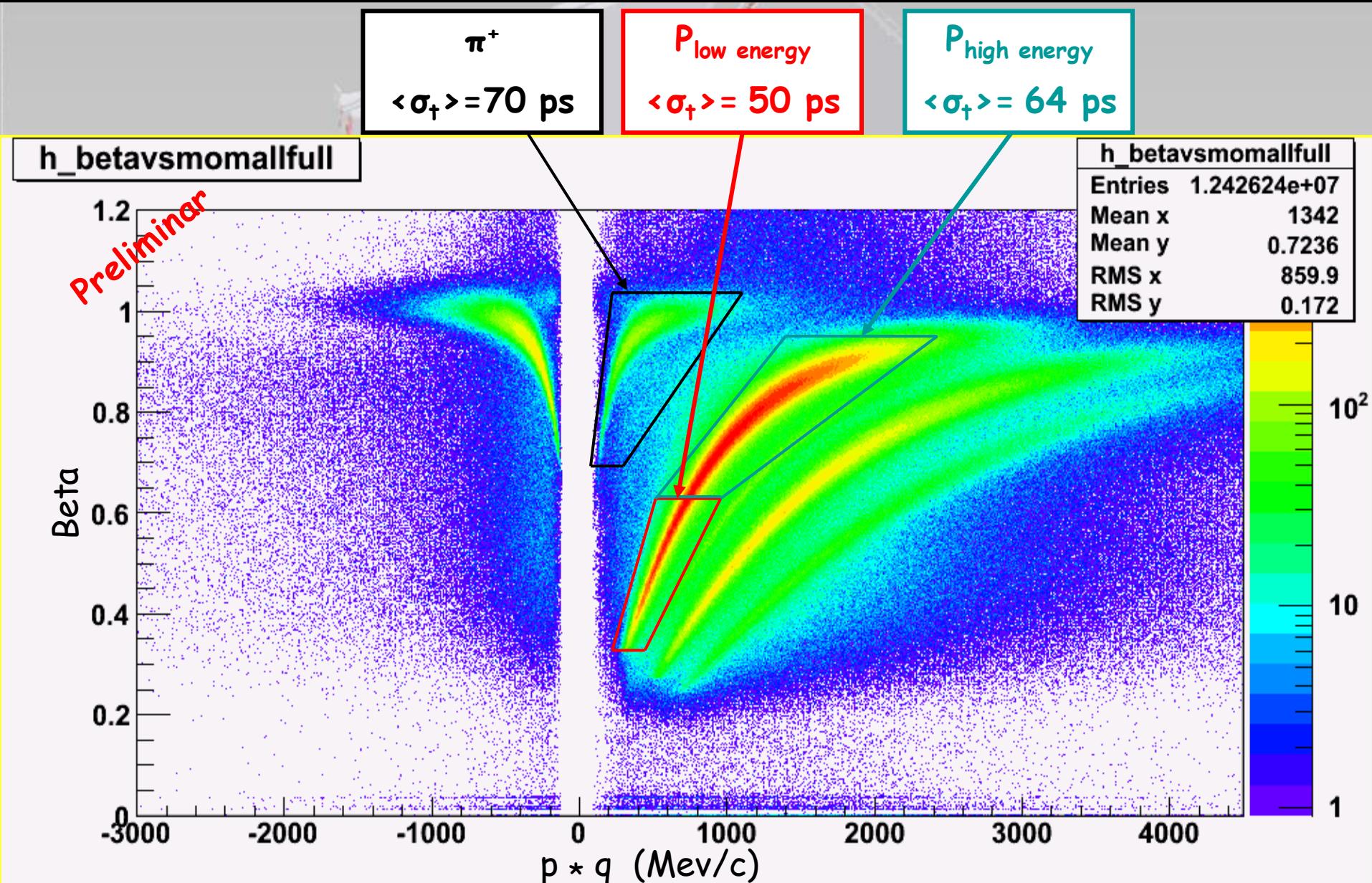


Intrinsic RPC performance. Time resolution



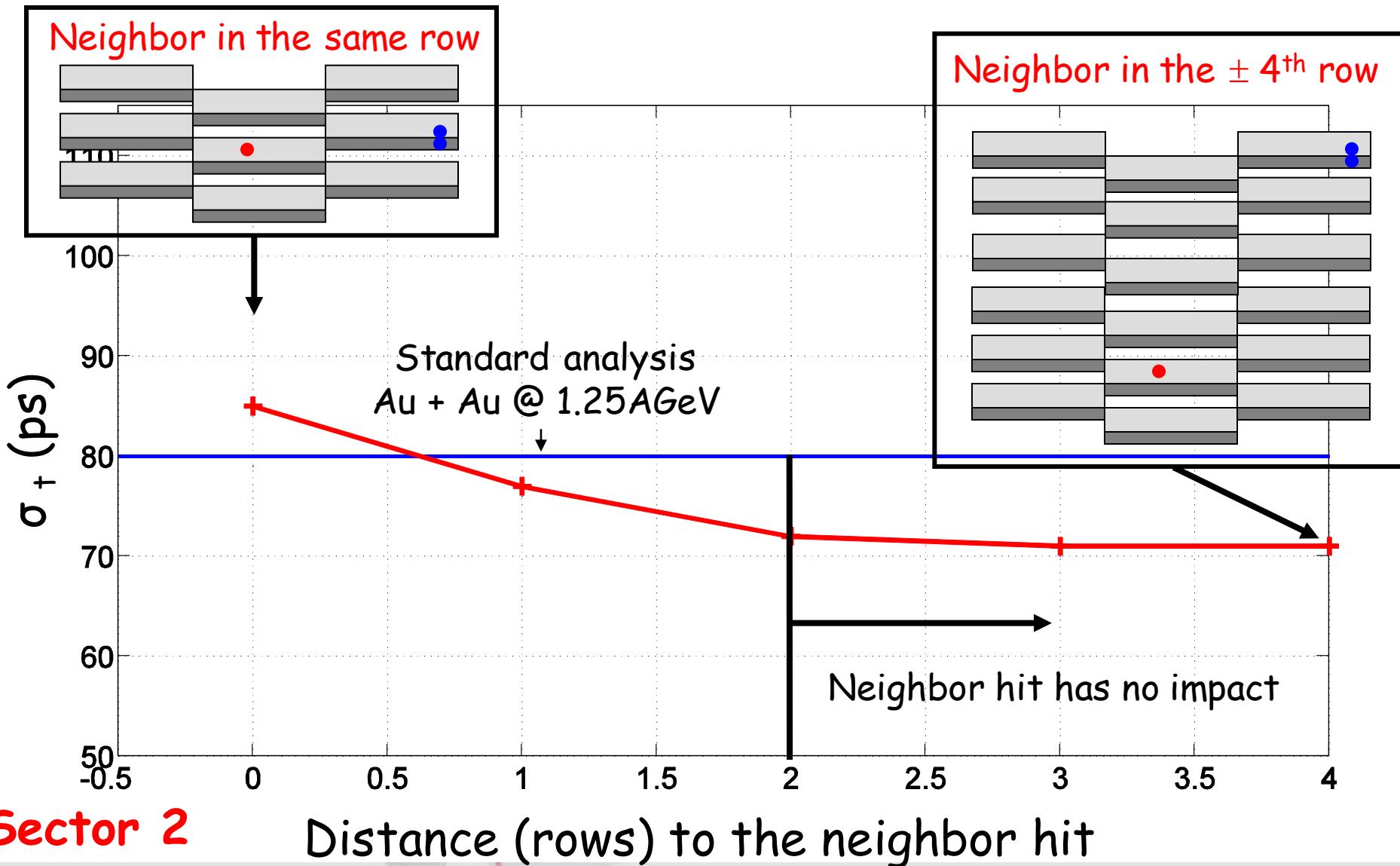
Out of a total of 1116 cell, 1112 are operative along with 2232 FEE

Intrinsic RPC performance. Time resolution, P_{low} , P_{high} , π^+



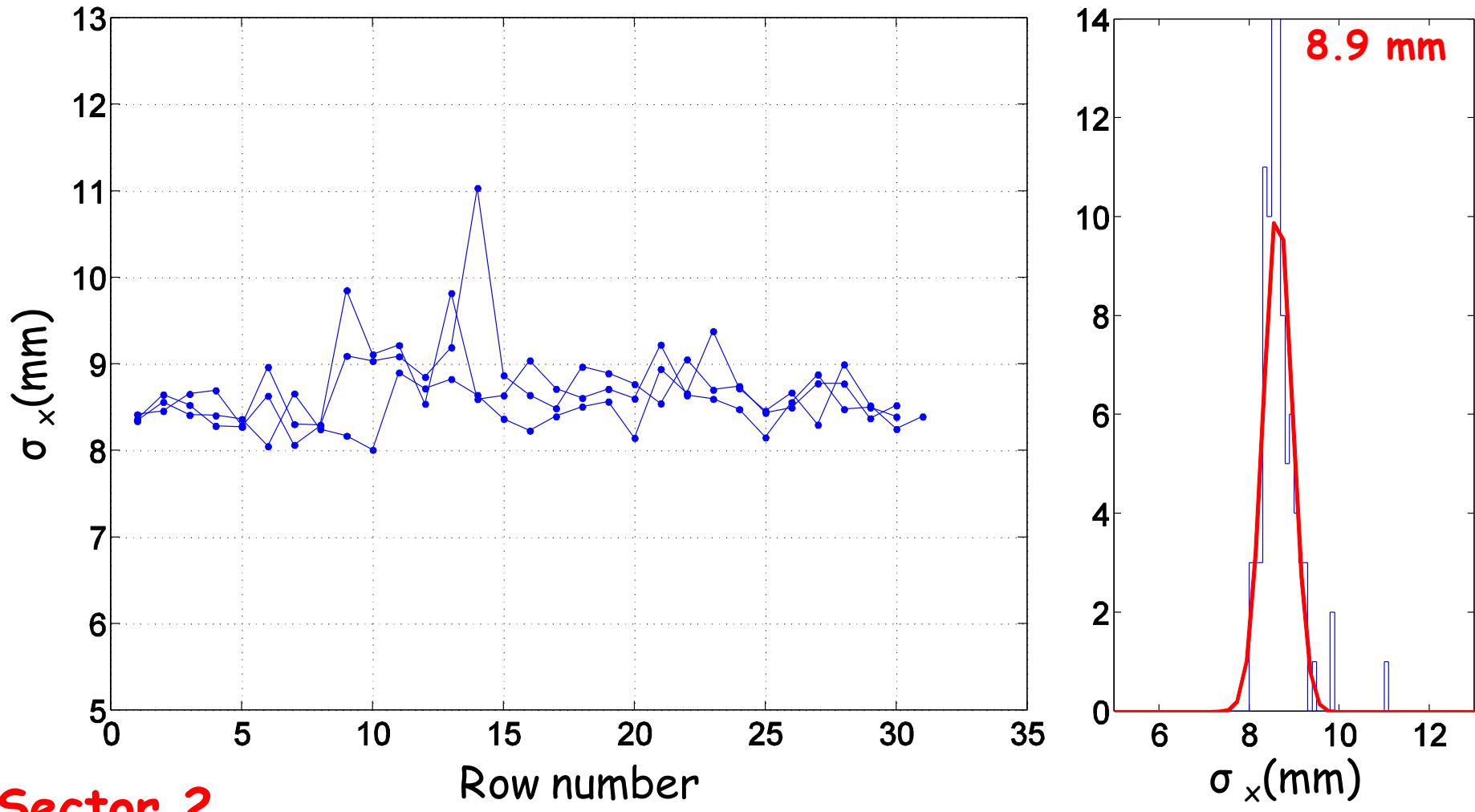
Intrinsic RPC performance. Time resolution, multihit

Multihit time resolution



Intrinsic RPC performance. Spatial resolution

Homogeneous longitudinal position resolution $< 10 \text{ mm } \sigma$

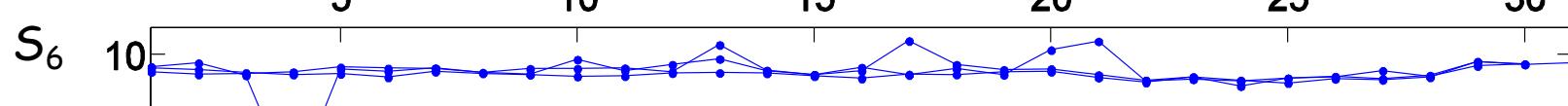
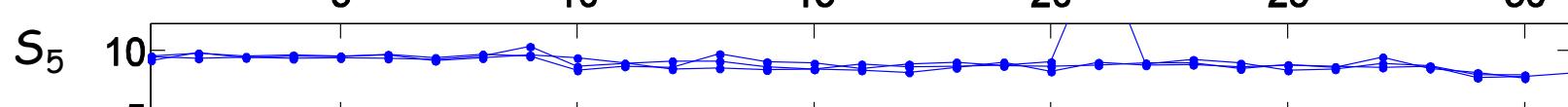
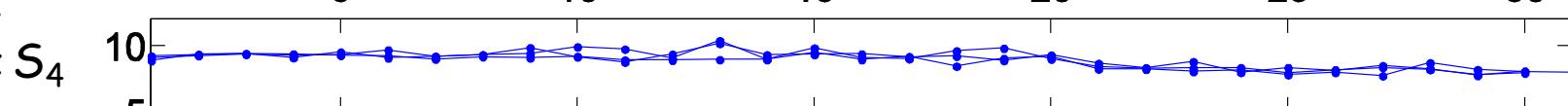
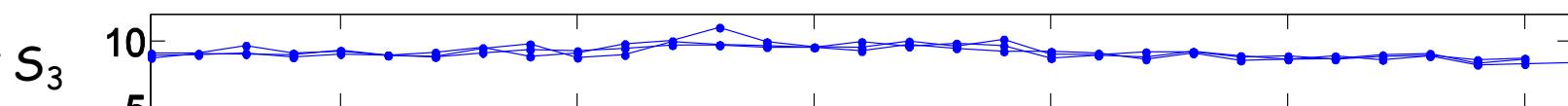
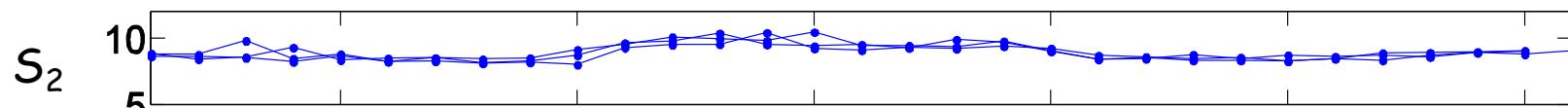
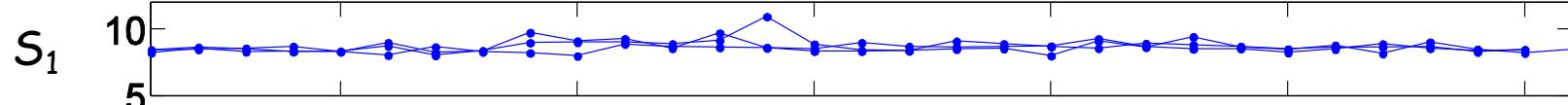


Intrinsic RPC performance. Spatial resolution

$\langle \sigma_x \rangle_{\text{Global}} = 8.9 \text{ mm}$

$\langle \sigma_x \rangle$

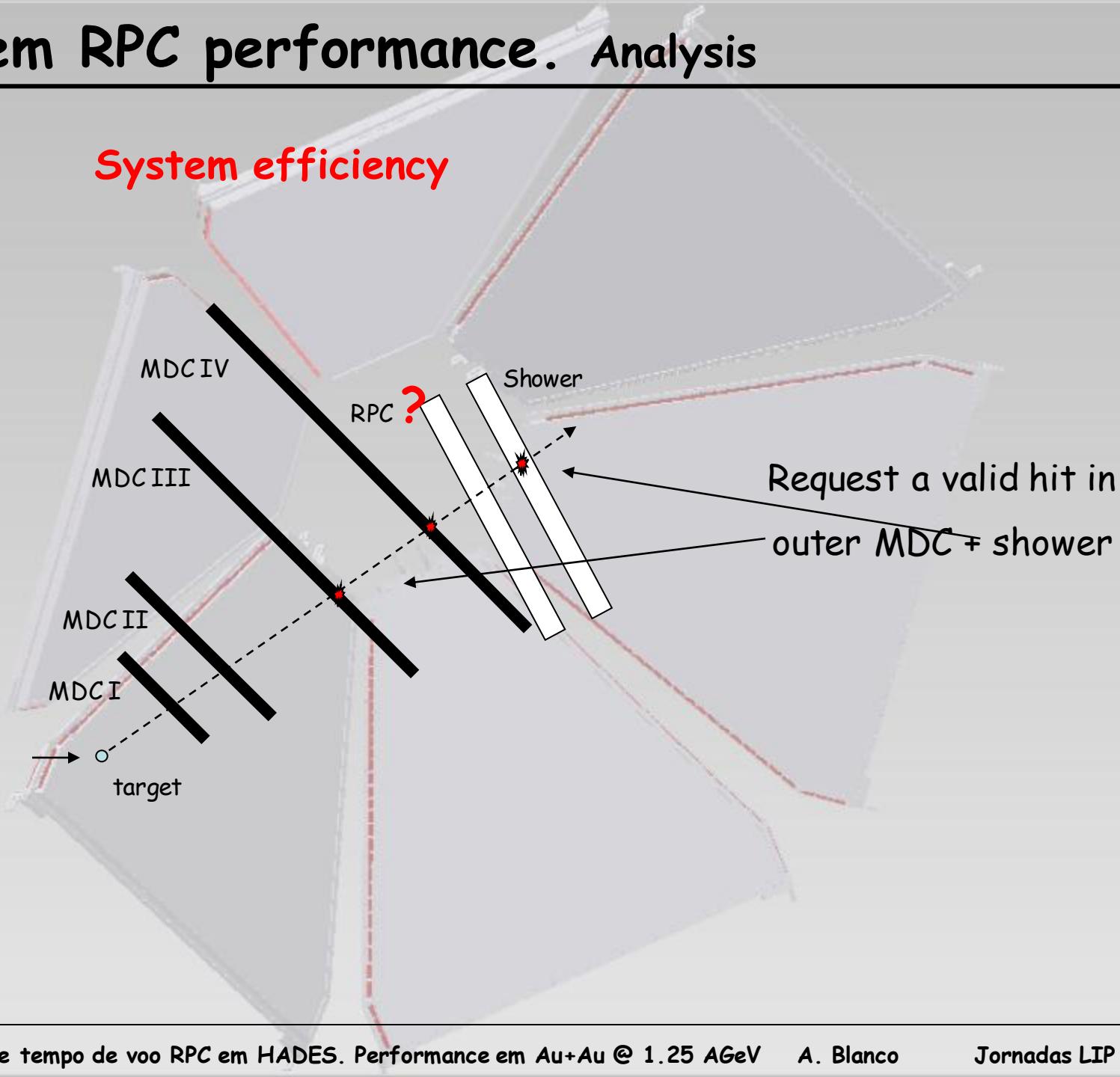
8.7 mm



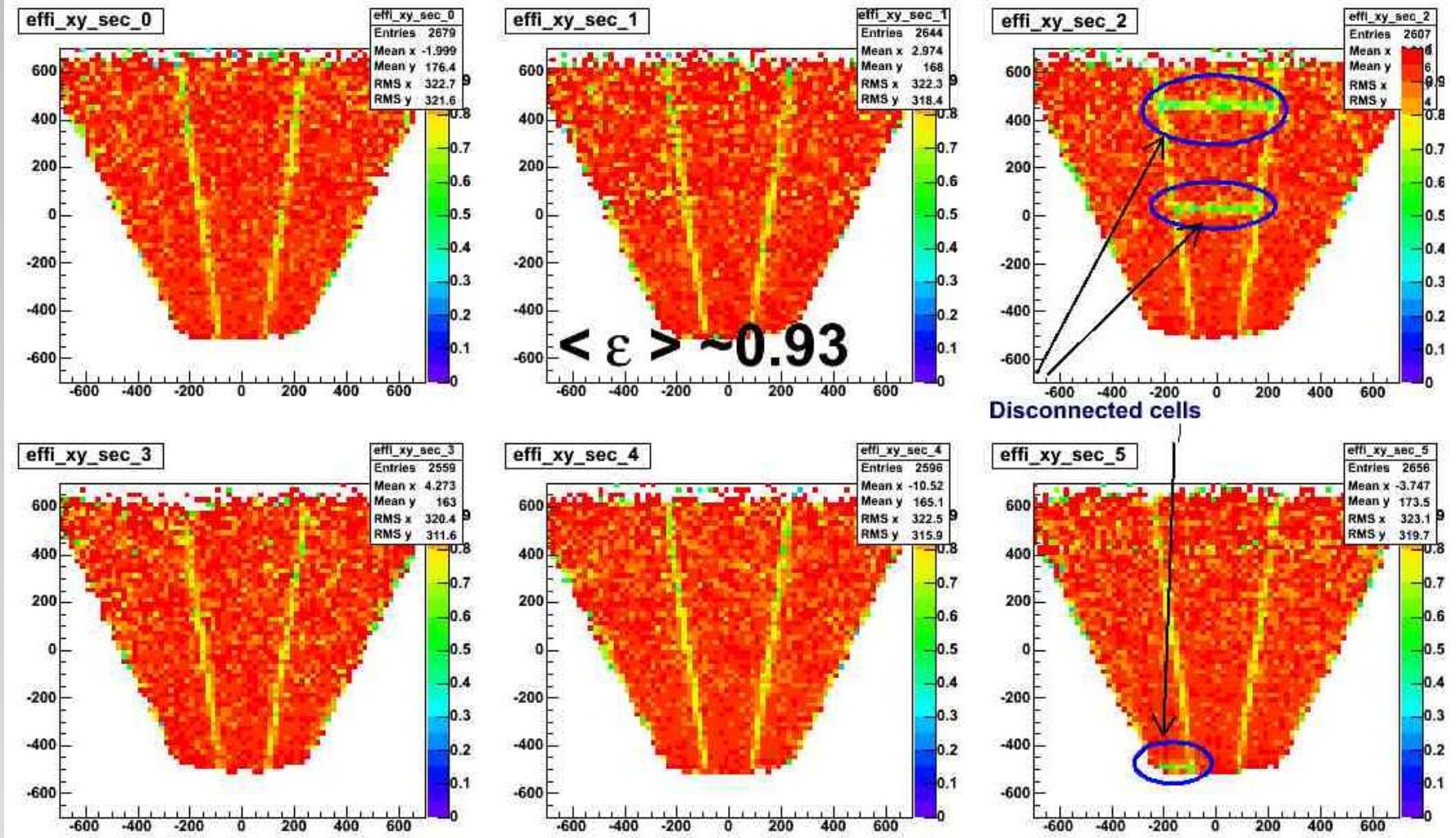
Row number

System RPC performance. Analysis

System efficiency



System RPC performance. Efficiency

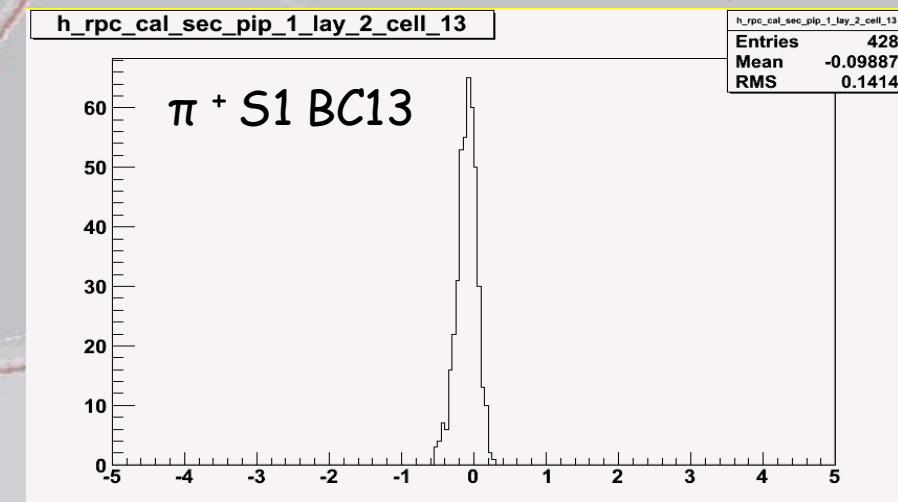
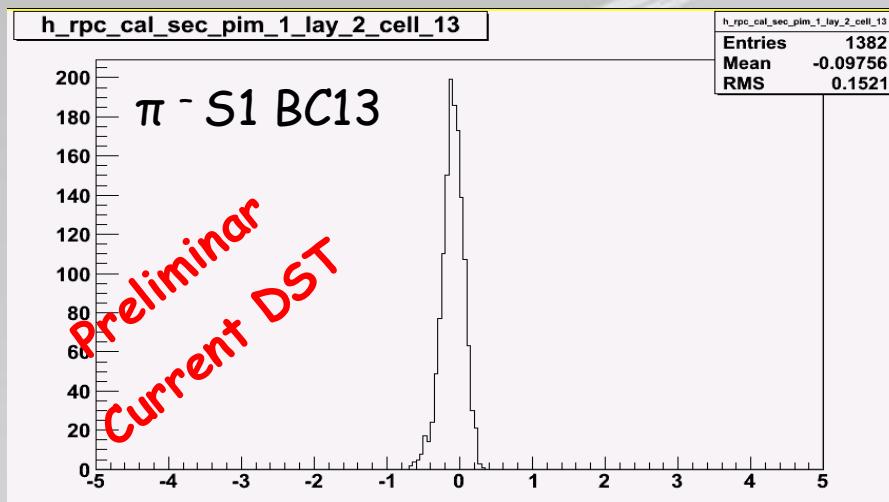


$\langle \epsilon \rangle \sim 0.93$ include inefficiency due to double hits + inter-cell geometry

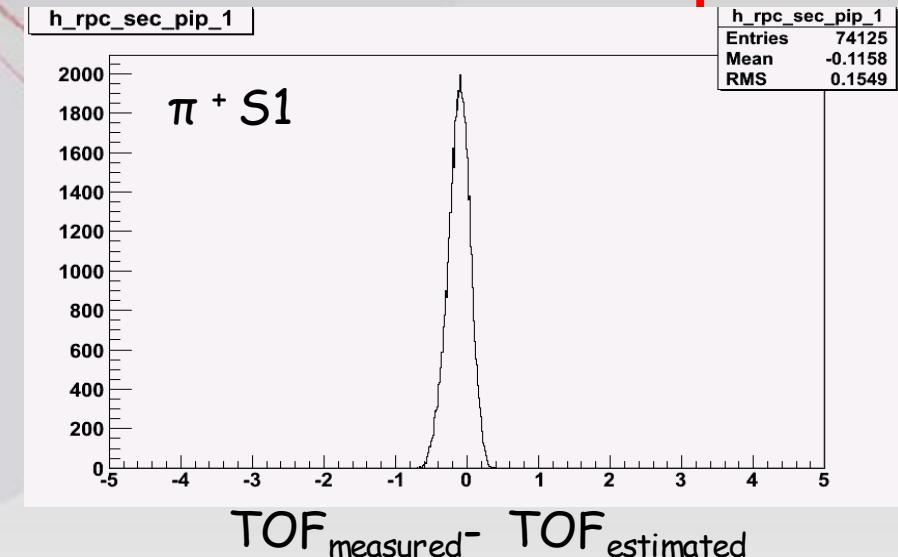
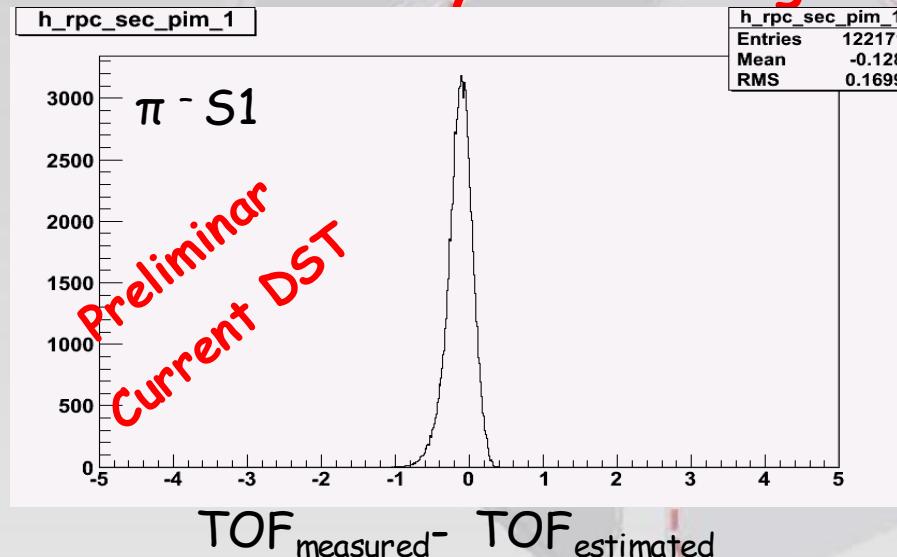
Not include inter-column geometric inefficiency + disconnected cells

System RPC performance. Time calibration

Individual cell system timing resolution at a level of $120 \text{ ps } \sigma$

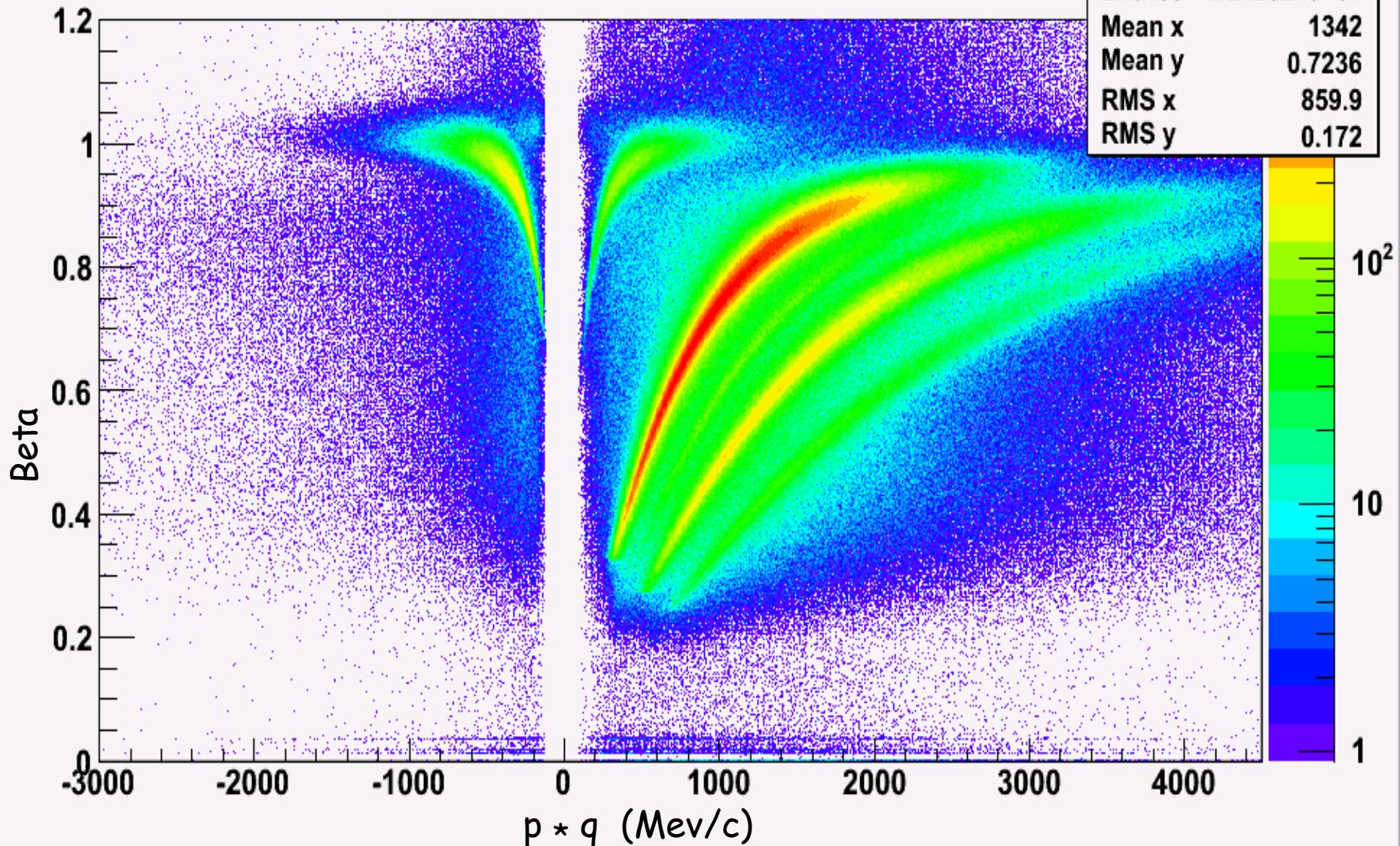


Full sector system timing resolution at a level of $150 \text{ ps } \sigma$

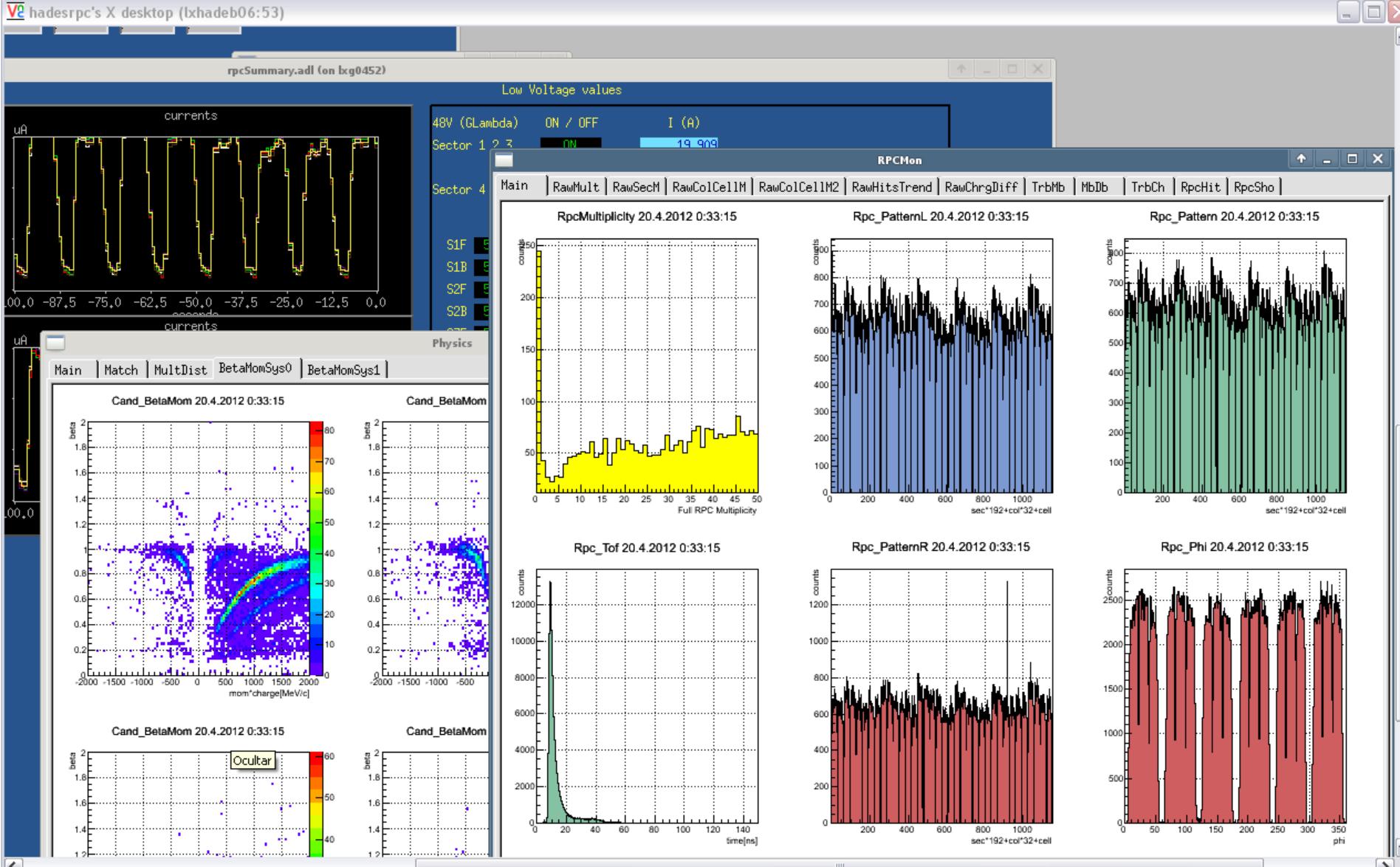


System RPC performance. PID

h_betavsmomallfull



Physics production run now!!



Conclusões

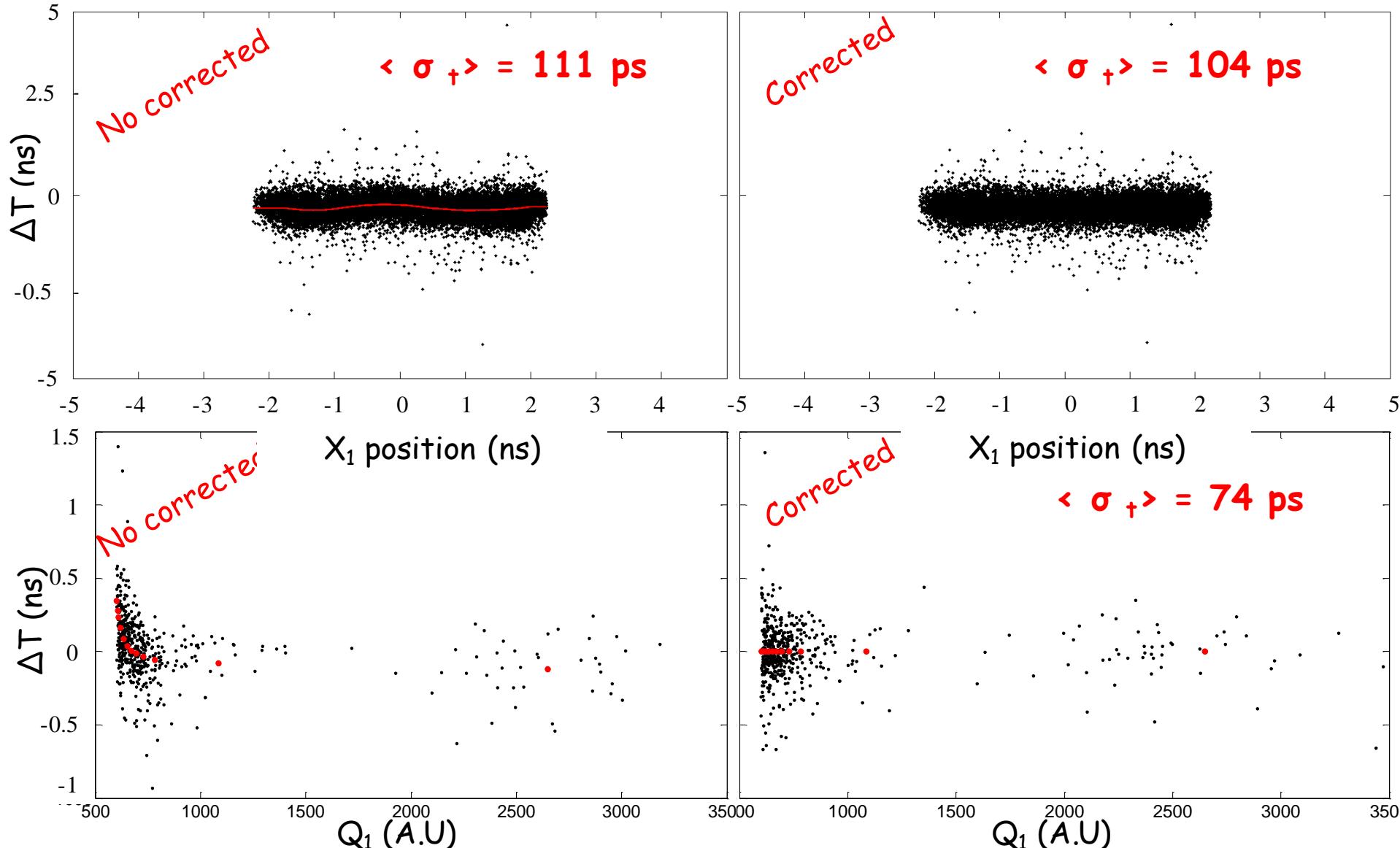
RPC-TOF totalmente integrado no espectrómetro
HADES e testado em feixe de Au + Au

Resolução temporal uniforme $\langle 80 \rangle$ ps σ e eficiencia
media ~93% em Au + Au,
cumprindo os requisitos de desing

Run de produção em andamento!!!

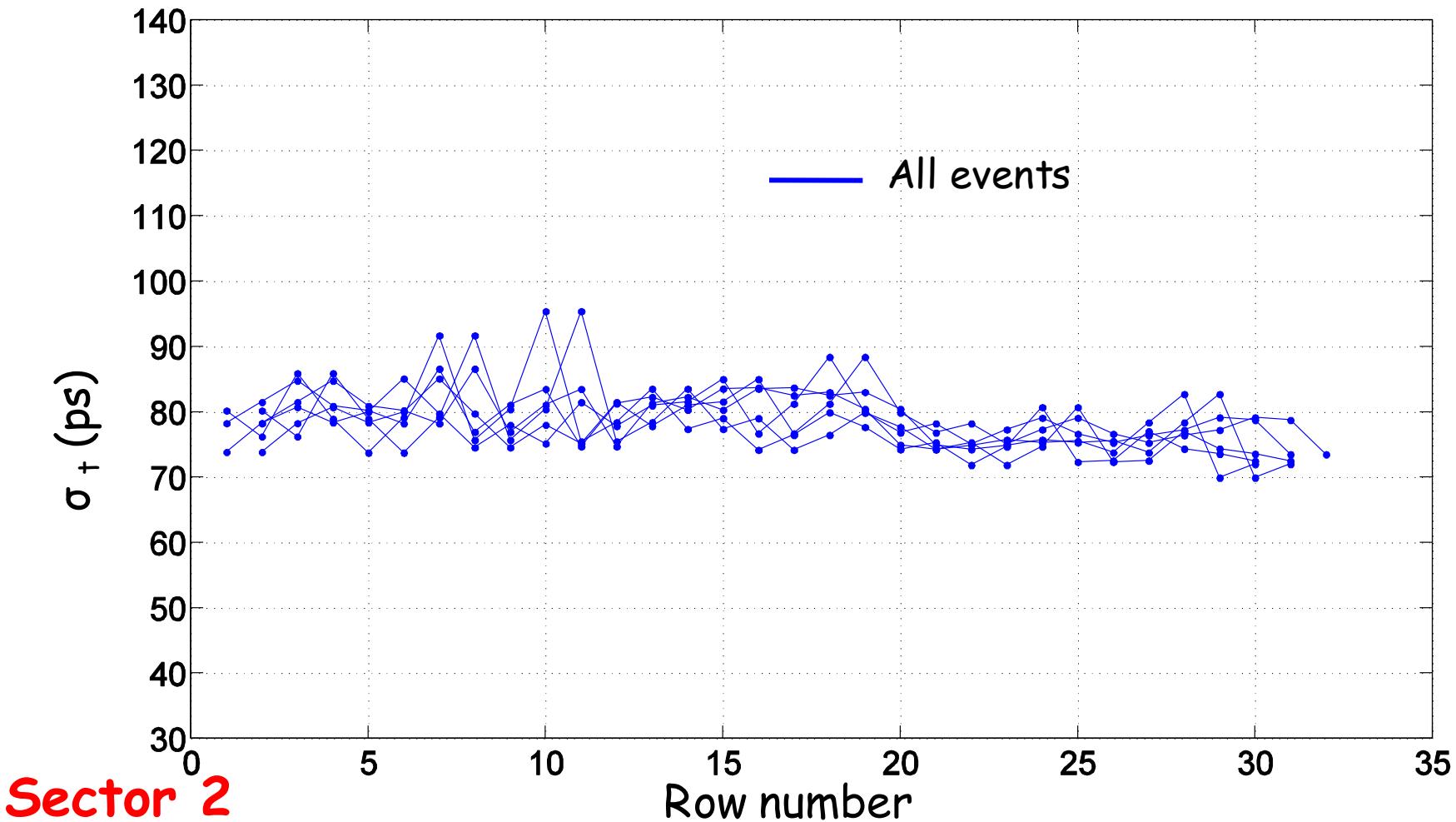
Intrinsic RPC performance. Time resolution, corrections.

Position and charge information used to correct time



Intrinsic RPC performance. Time resolution, multihit

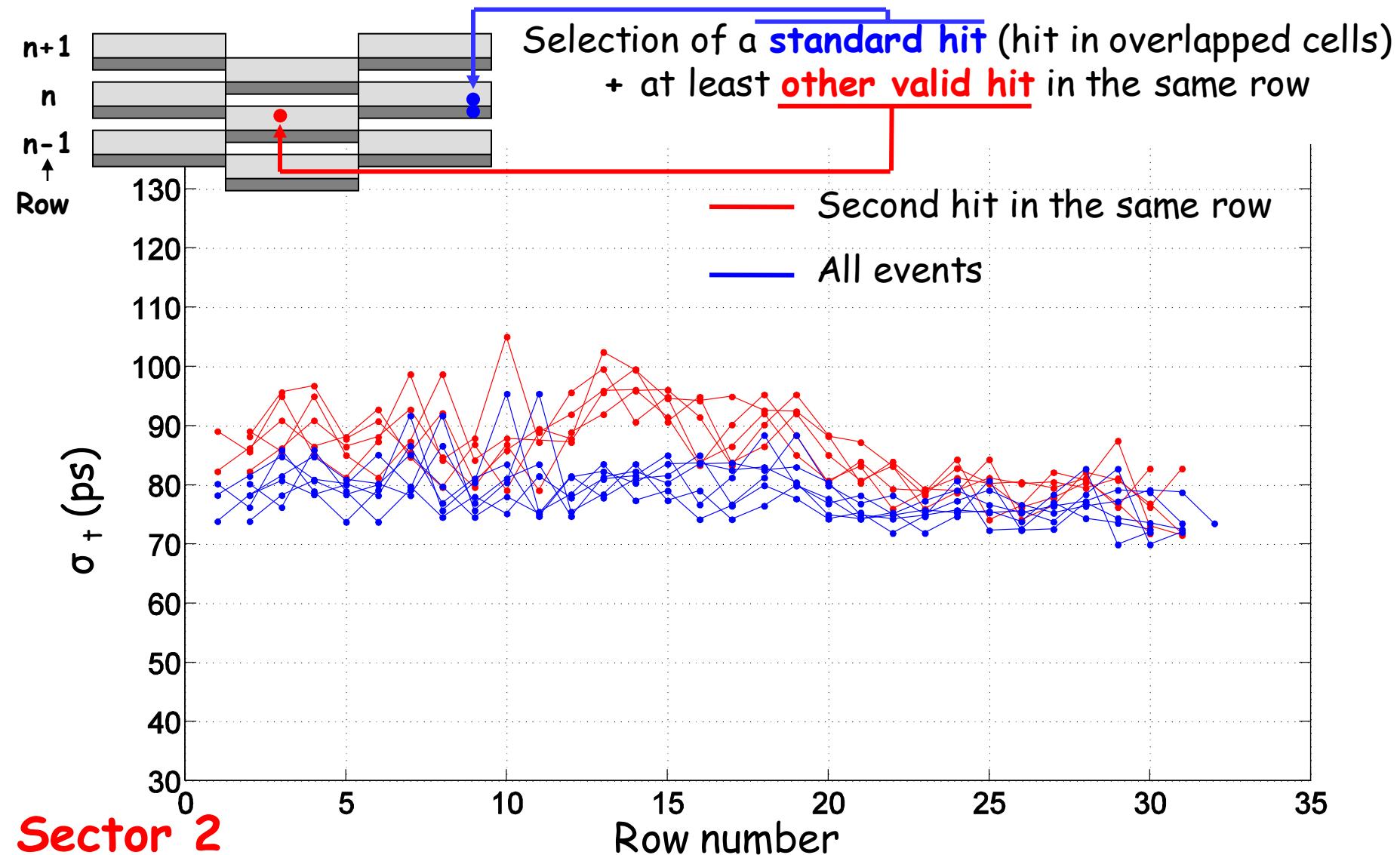
Multihit time resolution



Sector 2

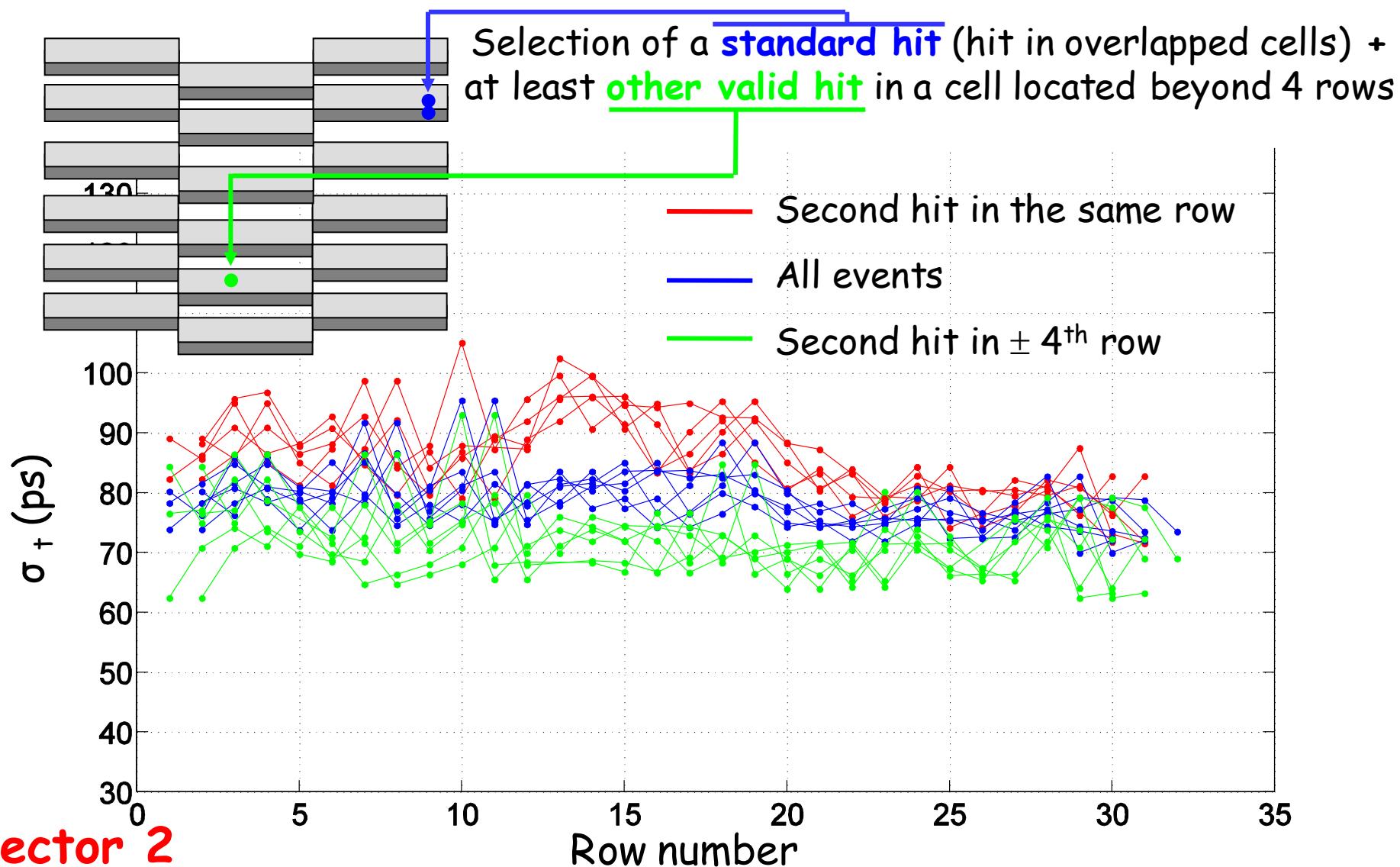
Intrinsic RPC performance. Time resolution, multihit

Multihit time resolution



Intrinsic RPC performance. Time resolution, multihit

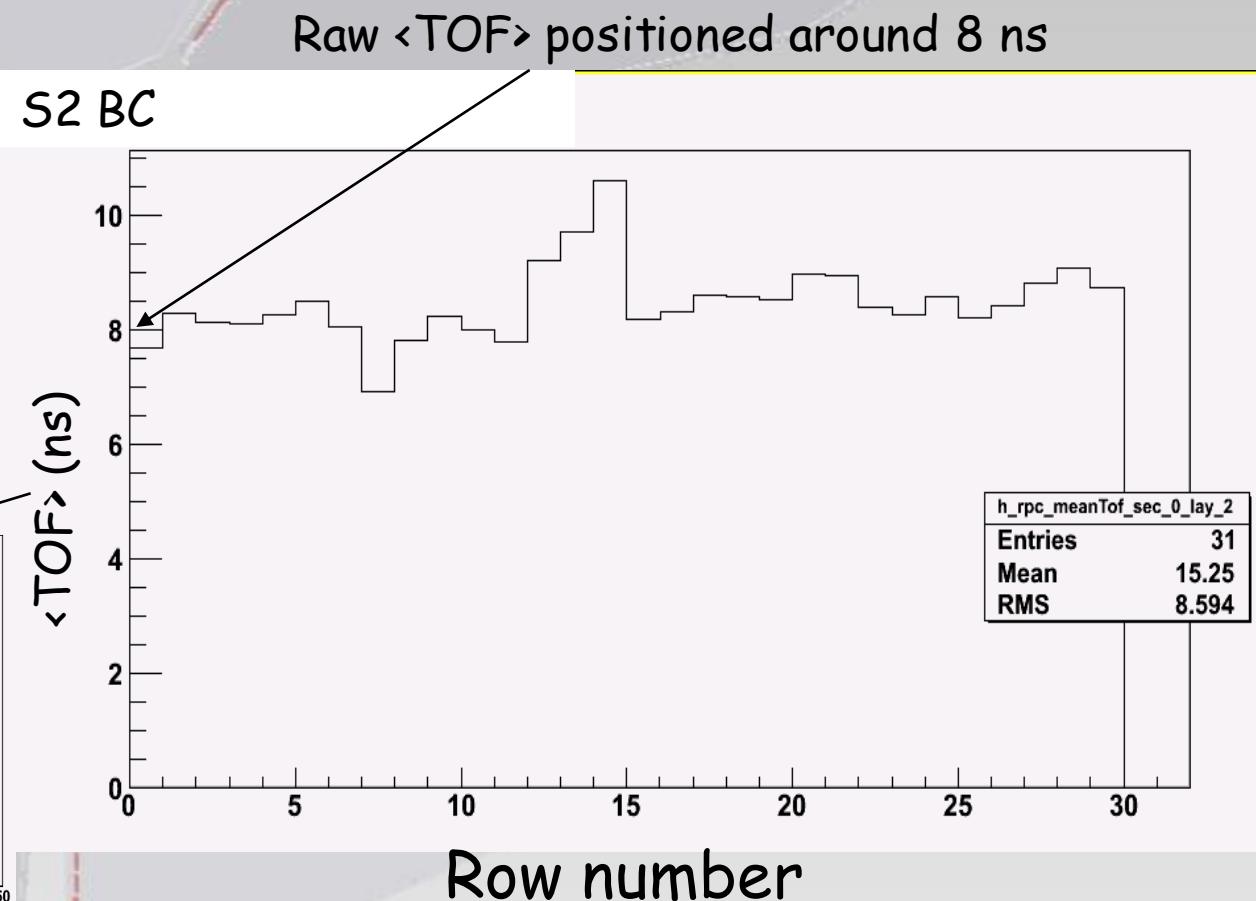
Multihit time resolution



System RPC performance. Time calibration

Different offsets of individual cells **must be corrected to create a isochronous surface**. Protons are used since covers almost all the detector surface with high statistics.

Raw calibrated
TOF from RPC
TOF measured



System RPC performance. Time calibration

Different offsets of individual cells **must be corrected to create a isochronous surface**. Protons are used since covers almost all the detector surface with high statistics.

Raw calibrated
TOF from RPC
TOF_{measured}

Momentum (p) and
path length (L)
from tracking

Momentum
cut at 0.9 GeV
(avoid Mult.Scat)

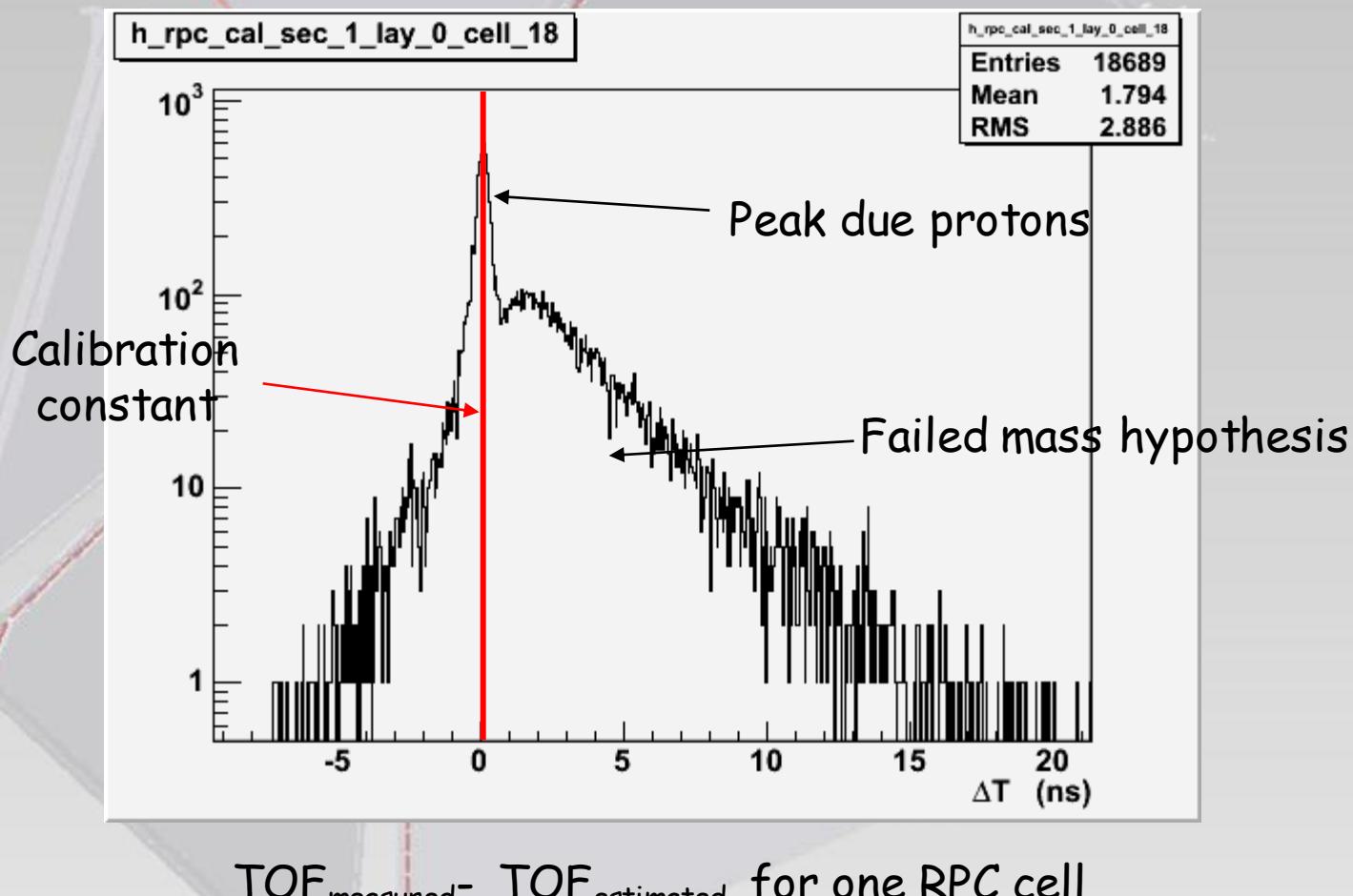
$$\text{TOF}_{\text{estimated}}^* = L/v = \\ = L * m_p / p$$

*assuming all particles protons.

ToF
Calibration
constant

System RPC performance. Time calibration

Different offsets of individual cells **must be corrected to create a isochronous surface**. Protons are used since covers almost all the detector surface with high statistics.



System RPC performance. Time calibration

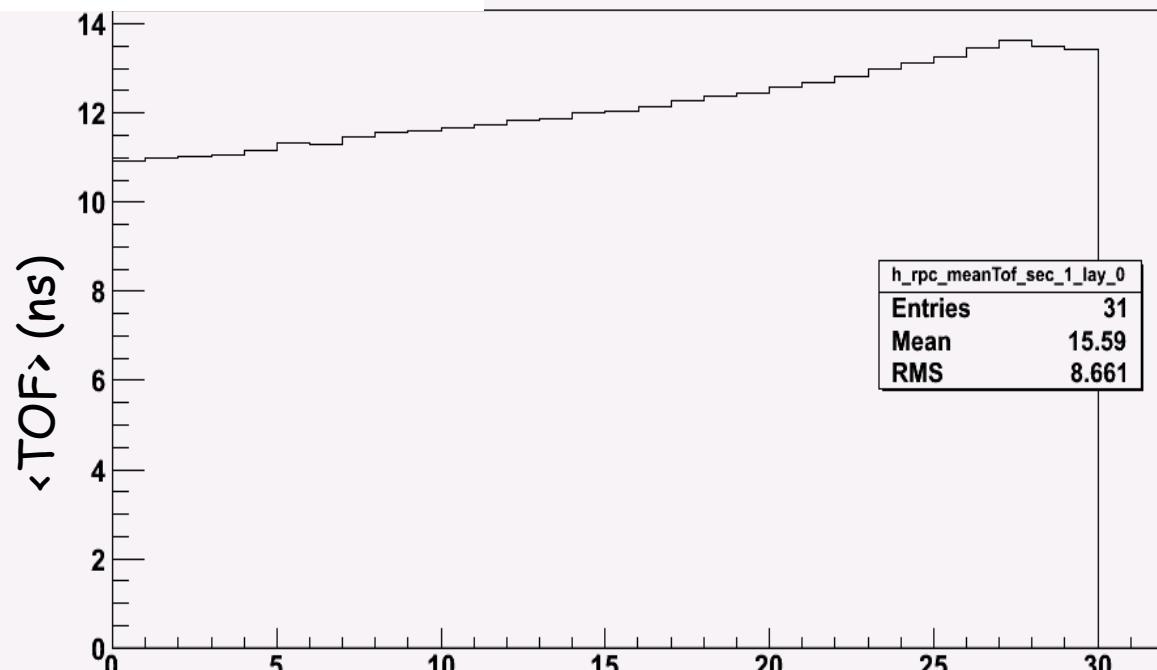
Different offsets of individual cells **must be corrected to create a isochronous surface**. Protons are used since covers almost all the detector surface with high statistics.

Raw calibrated
TOF from RPC
TOF_{measured}

Momentum (p) and
path length (L)
from R-K

$\langle \text{TOF} \rangle$ after calibration

S2 BC



Row number