

Comparison of different detector designs

November 1998

ATLAS Pixel
Sensors meeting
and
Electronics meeting

Mario Aleppo
Francesco Ragusa
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- ❖ Charge collection efficiency
- ❖ Intrinsic resolution

Tested sensor designs

❖ S7O (p spray)

- SSG w30g30
- SSG w37g13
- SXT w37g13-frame
- ST2 13+2*6 (13 implant + 6 gap + 6 n atoll)
- Floating Pixel or Analog 2*(18i+7g)
readout 1 out of 2
- Bricked SSG w37g13
- Bricked ST2

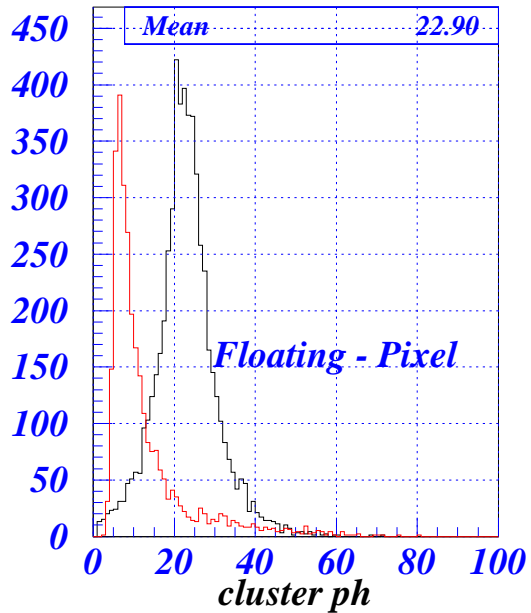
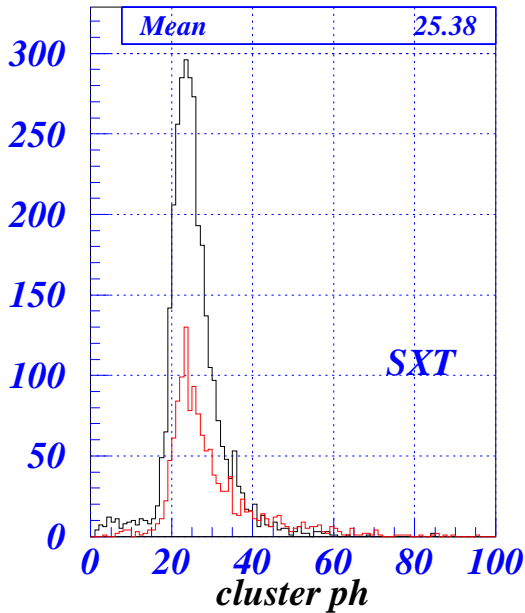
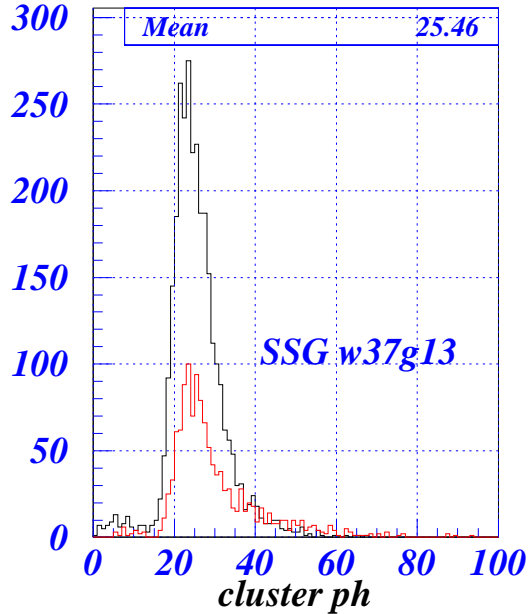
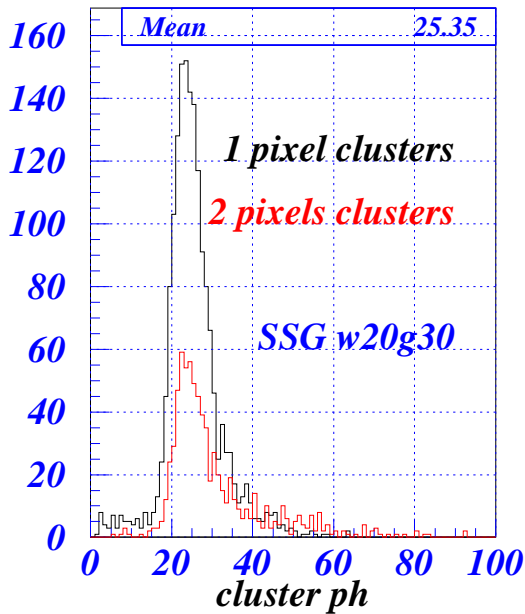
❖ S8O (p stops)

❖ ST1

❖ SCP

Charge collection

S70 chip - Cluster charge

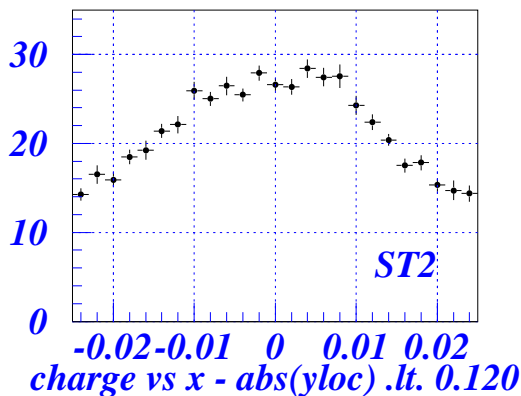
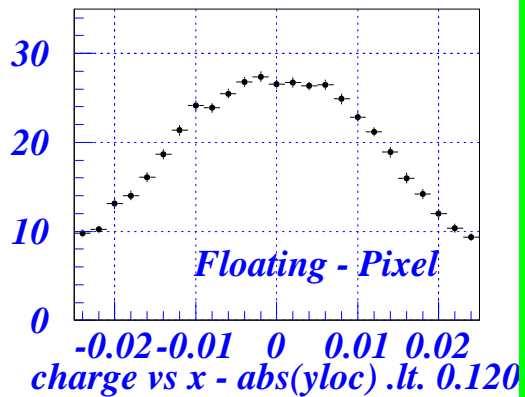
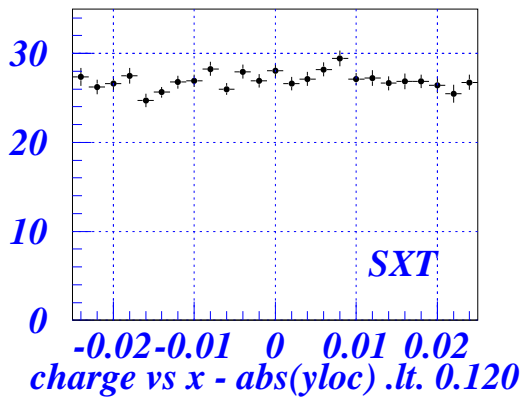
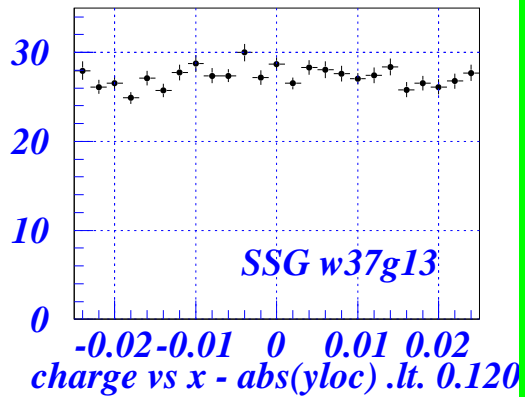
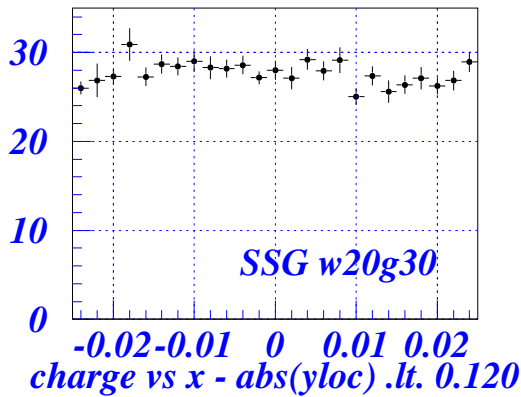


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Charge collection

S70 chip - Cluster charge

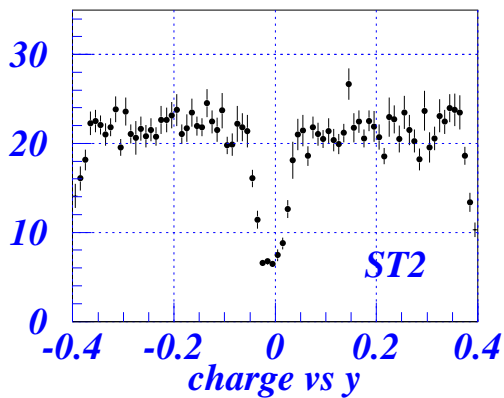
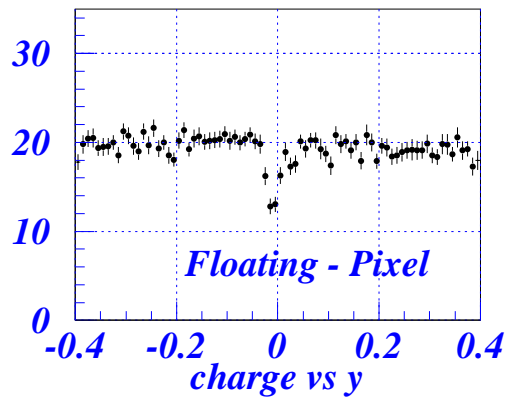
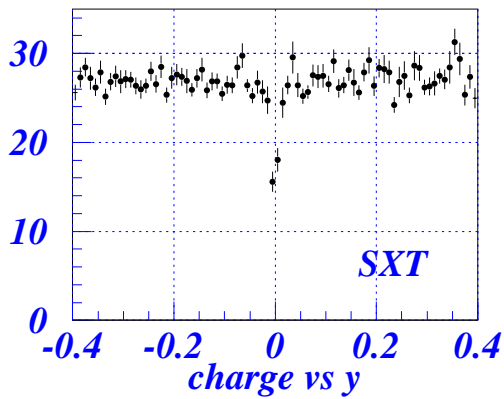
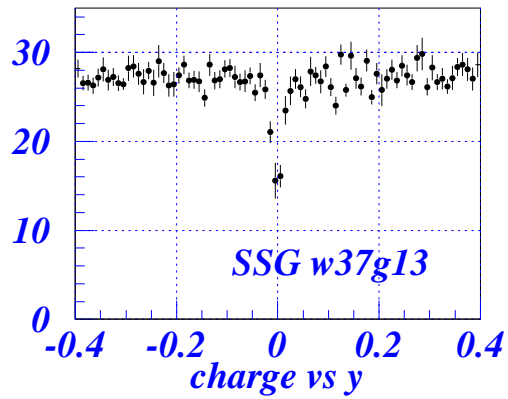
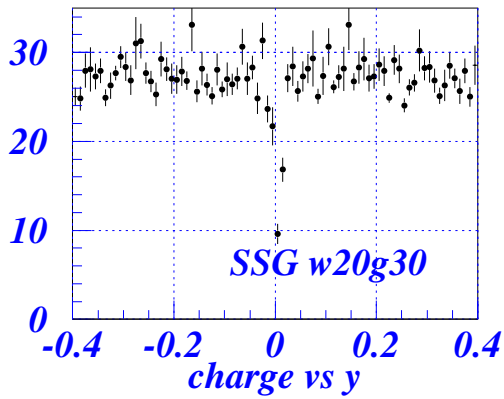


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Charge collection

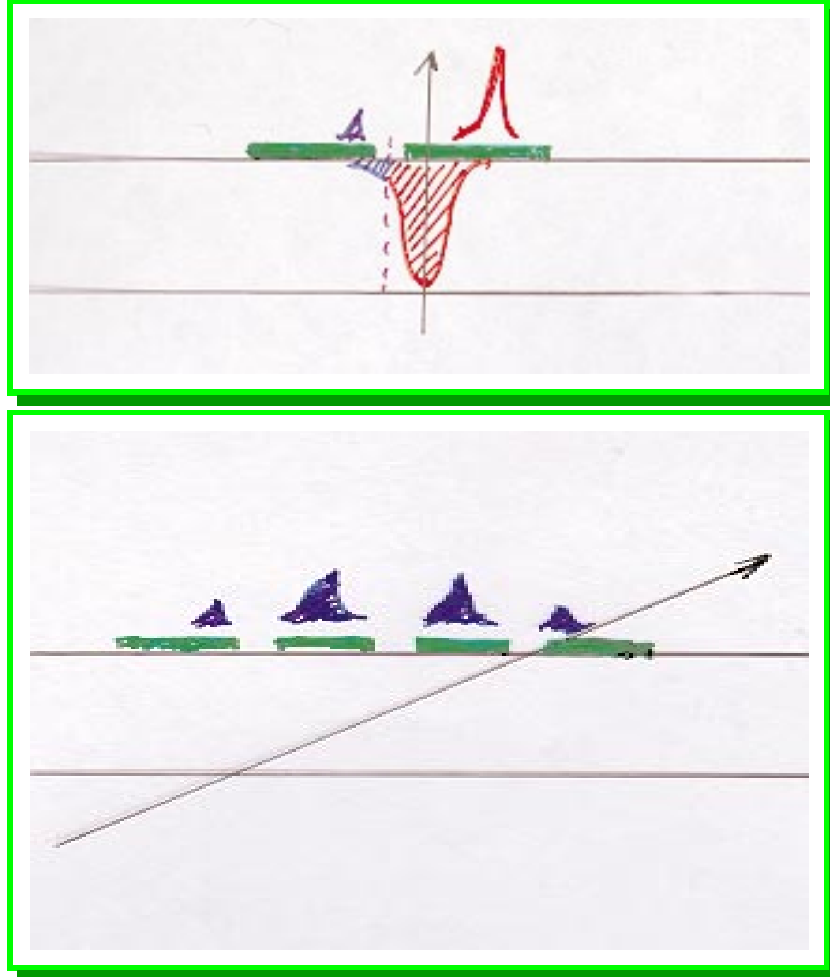
S70 chip - Cluster charge



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Analog algorithm



$$\eta = \frac{PH_R}{PH_L + PH_R}$$

linear interpolation

$$\hookrightarrow x = x + pitch * \eta$$

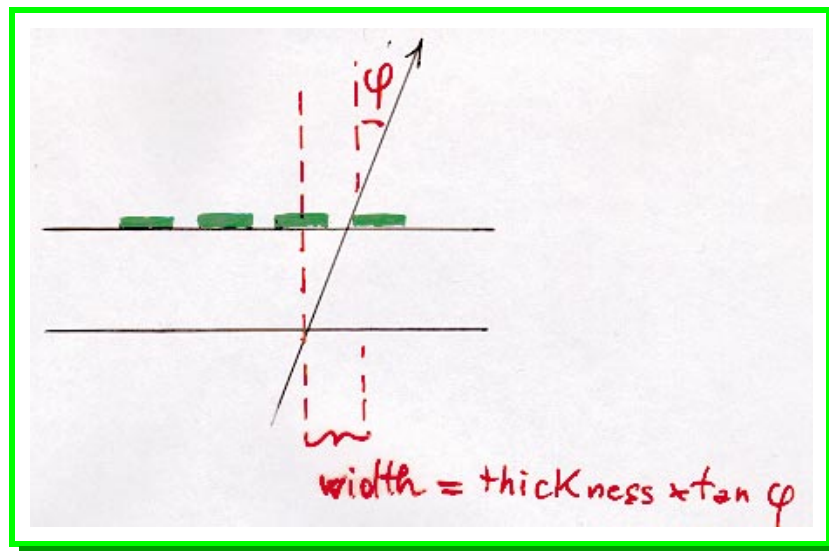
not linear interpolation

$$\hookrightarrow x = x + pitch * \int \frac{dN}{d\eta} d\eta$$

Analog algorithm

Effective Pitch (μm)

	0°	5°	10°	15°	20°	30°
ST2	10	20	36	44	30	28
SSG	16	24	48	24	40	40



Important:

$$\Delta(PH) \implies \sigma_x$$

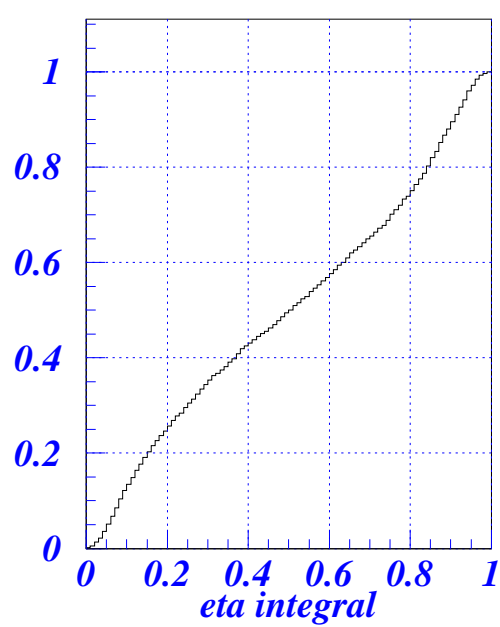
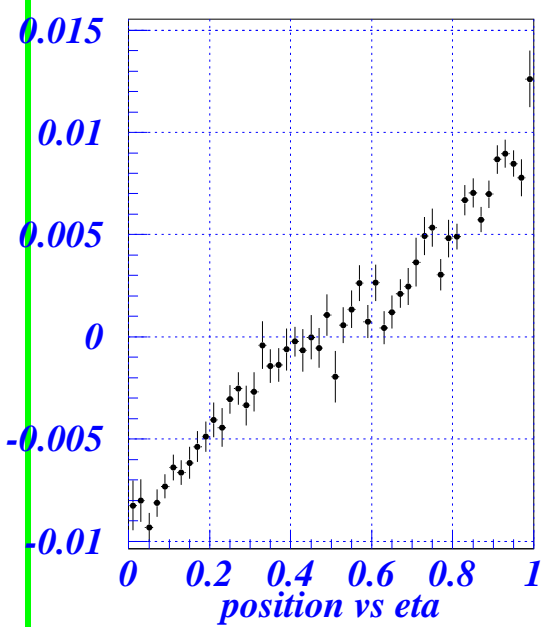
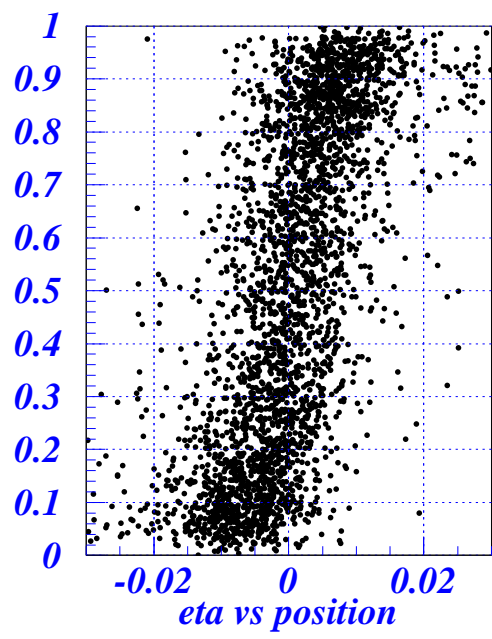
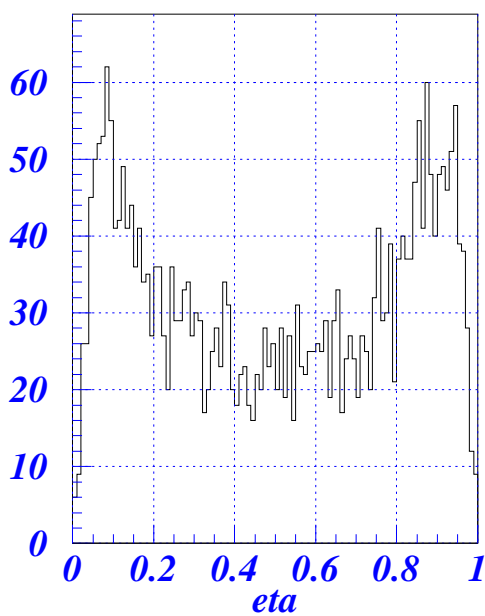
Test beam: TOT dynamic range $\approx 6 - 7$ bits

LHC : worse (4 bits ?)

Resolution

S70 chip - Resolution

floating_pixel - $\phi=0^\circ$



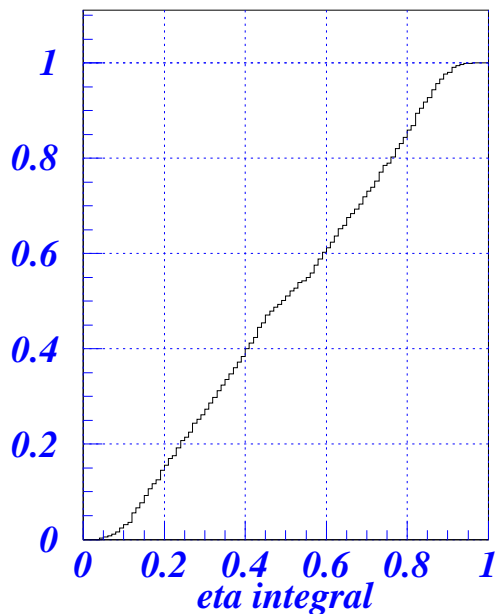
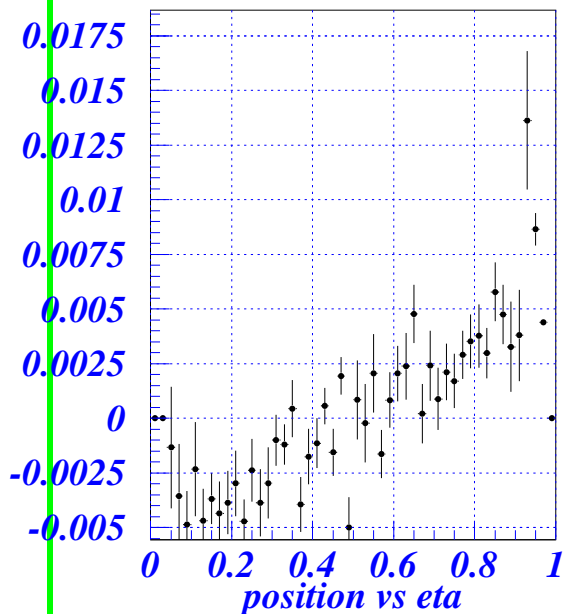
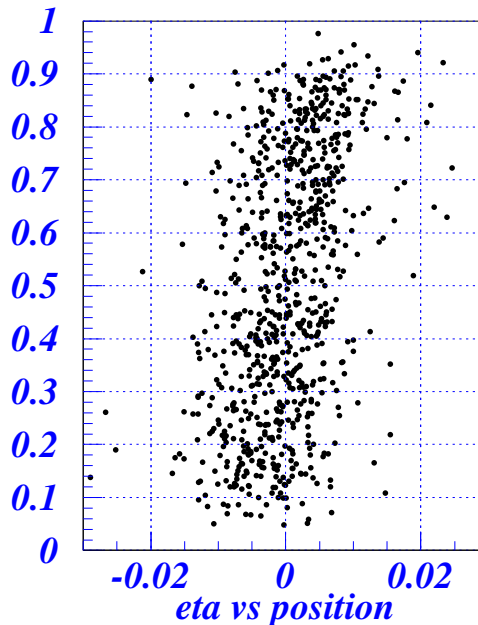
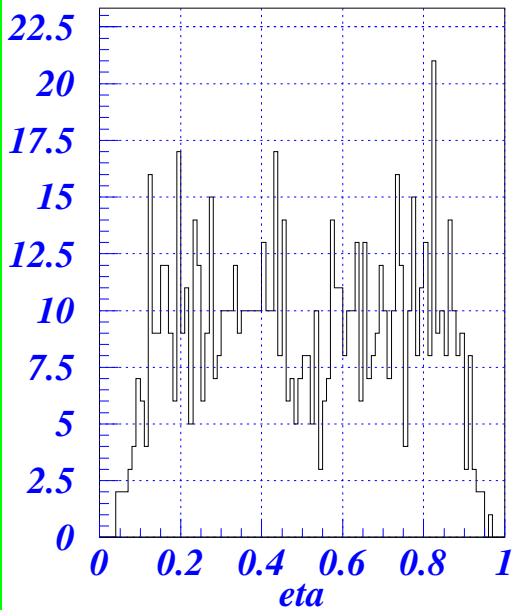
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Resolution

S70 chip - Resolution

ST2 - $\phi=0^\circ$



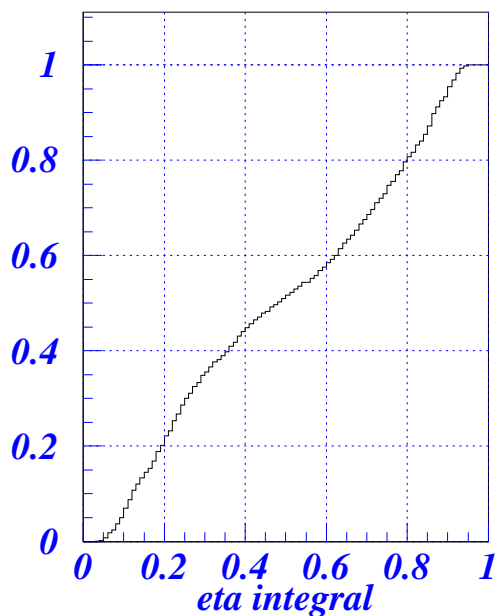
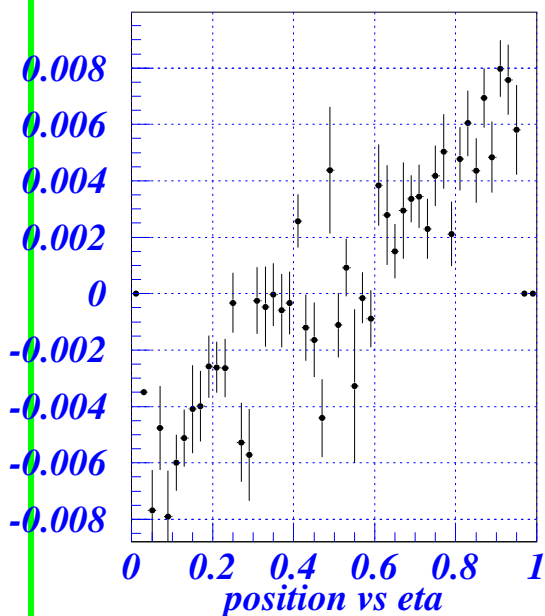
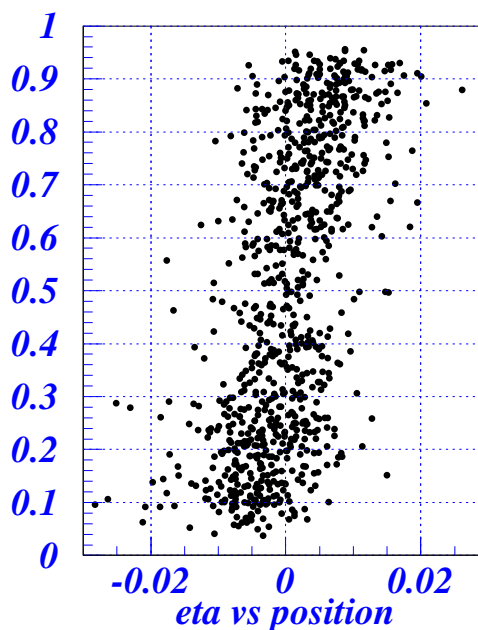
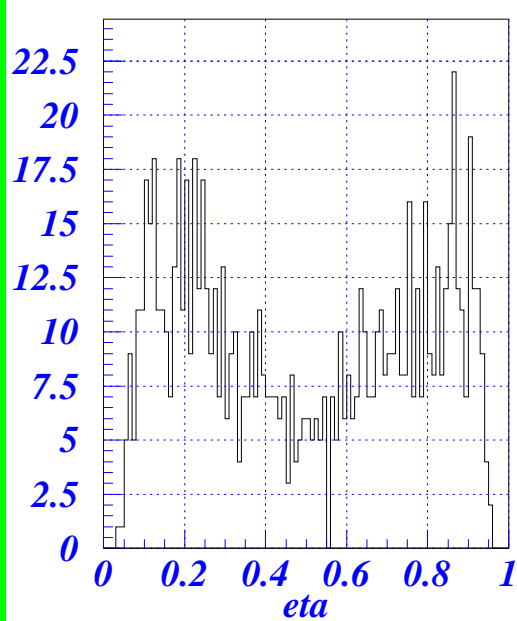
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Resolution

S70 chip - Resolution

SSG - w37g13 - $\phi=0^\circ$



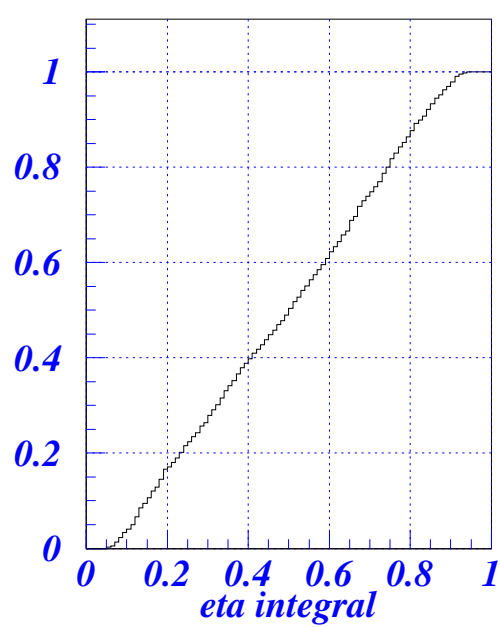
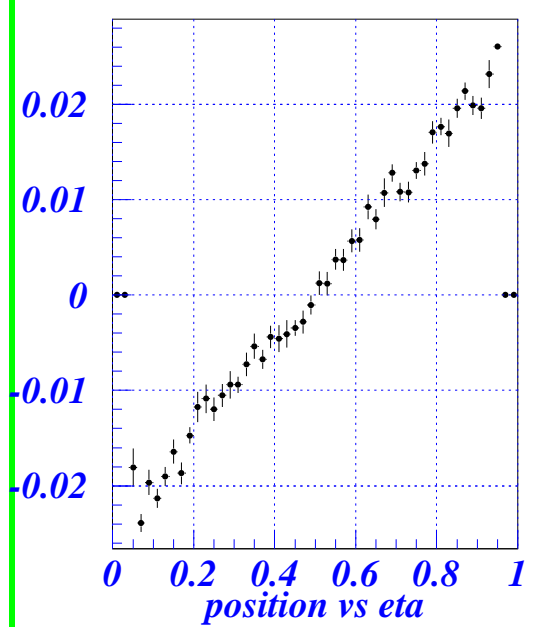
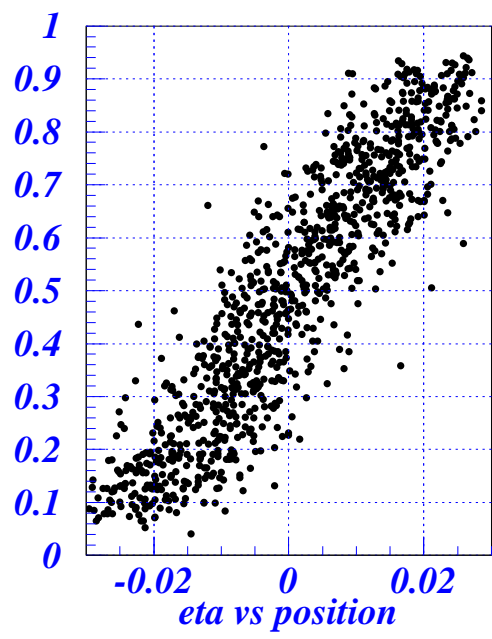
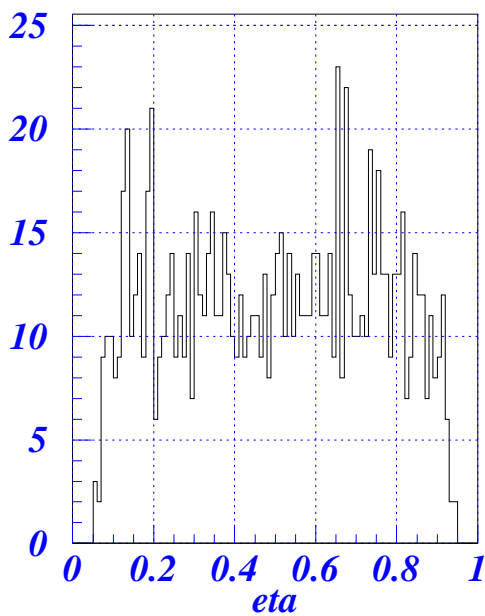
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Resolution

S70 chip - Resolution

S5G - w37g13 - $\phi=10^\circ$



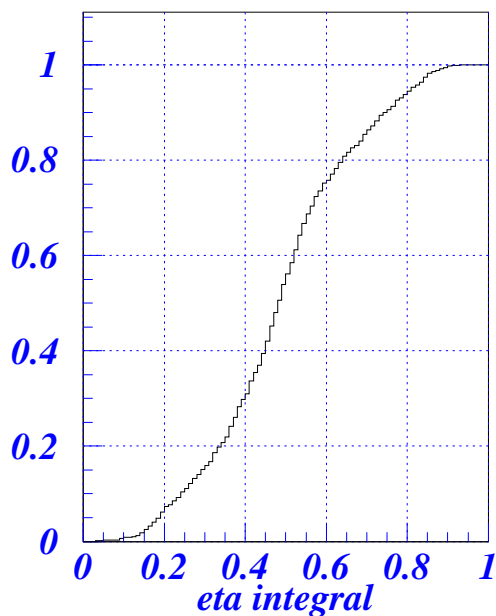
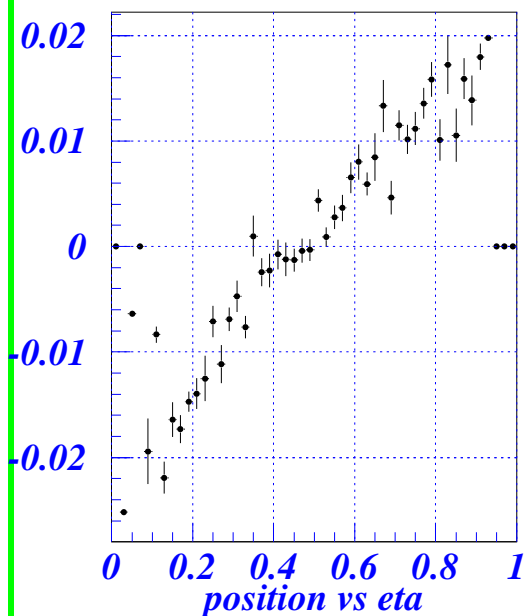
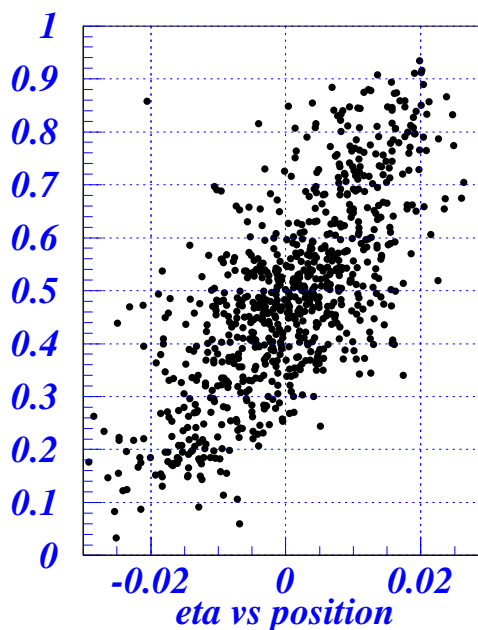
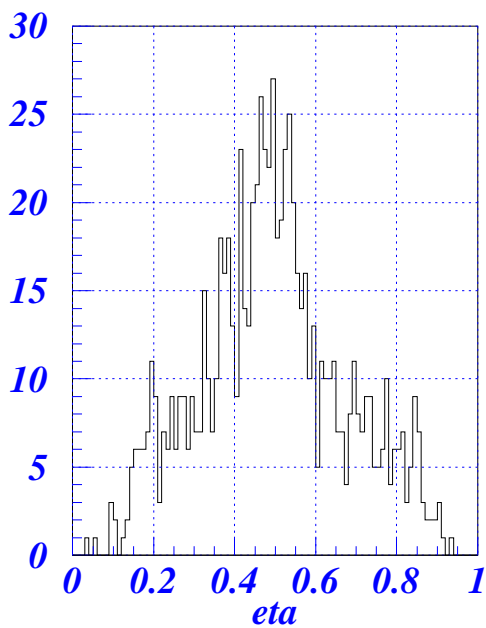
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Resolution

S70 chip - Resolution

*S*S*G* - w37g13 - $\phi=20^\circ$



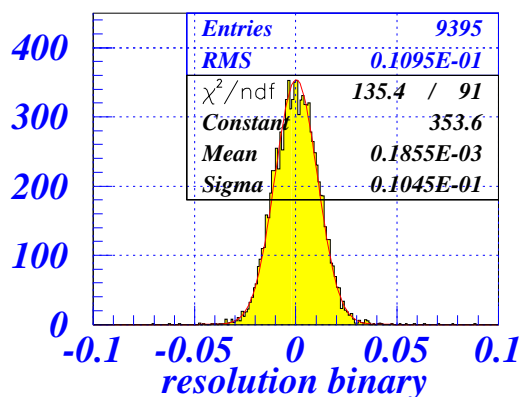
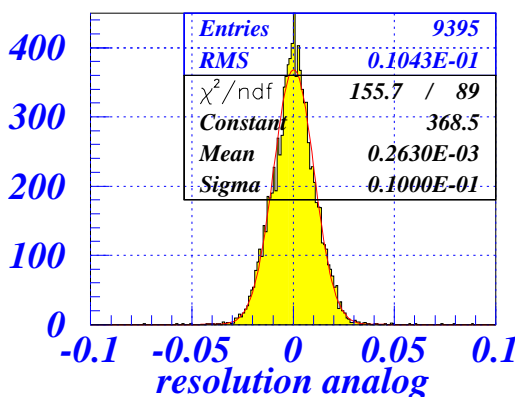
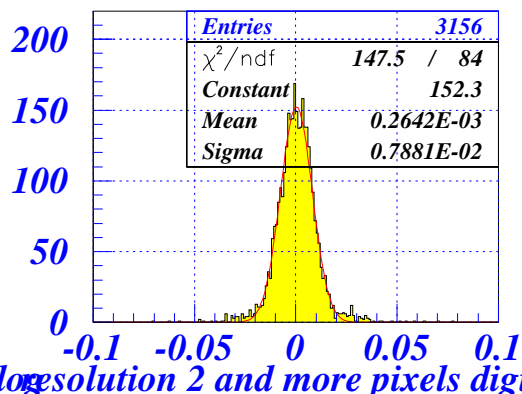
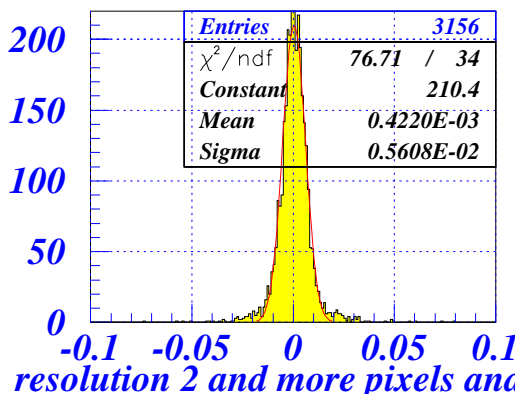
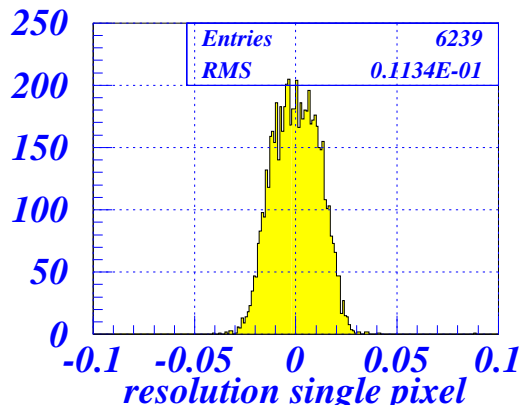
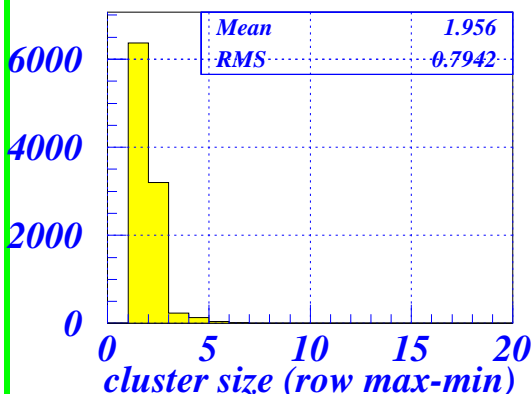
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Resolution

S70 chip - Resolution

Floating - Pixel - $\phi = 0^\circ$



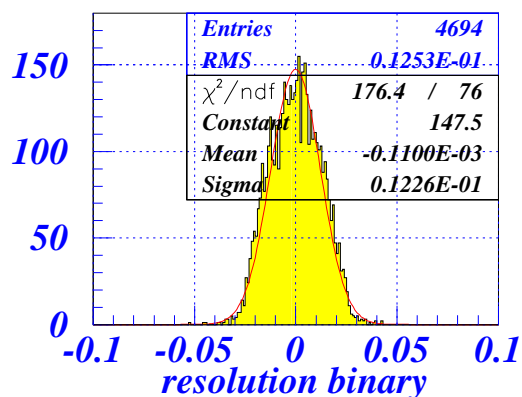
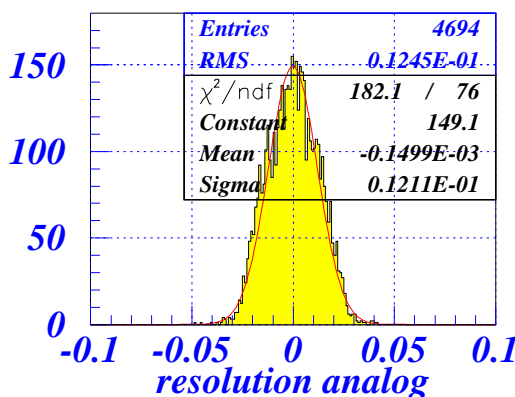
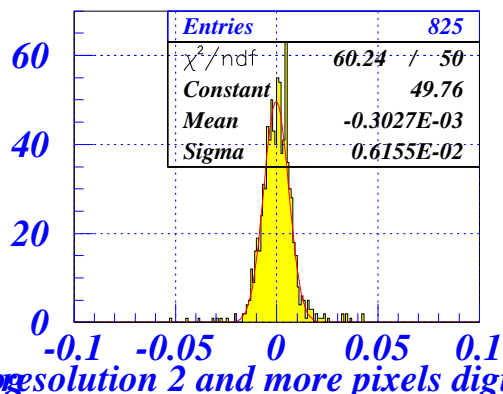
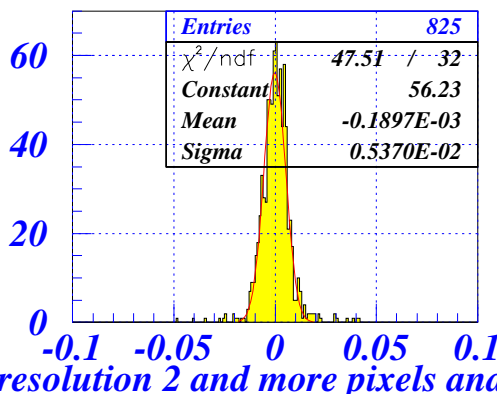
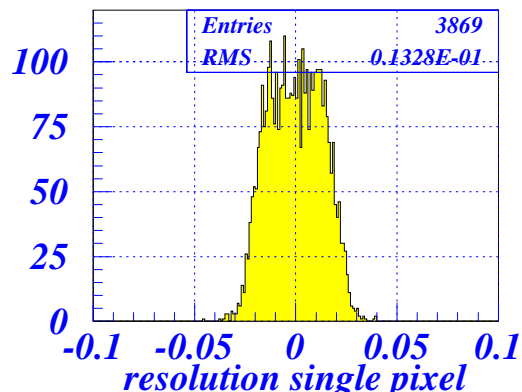
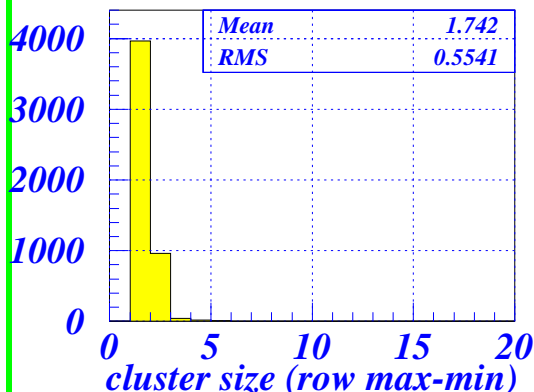
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Resolution

S70 chip - Resolution

ST2 - $\phi = 0^\circ$



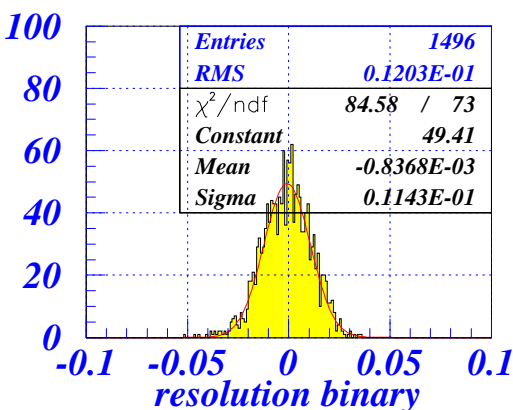
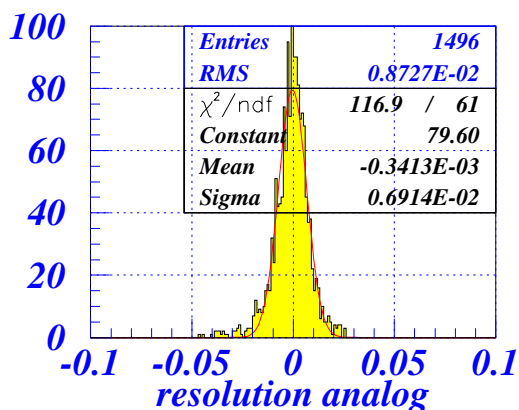
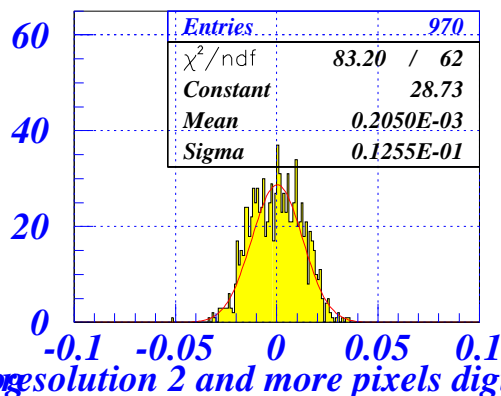
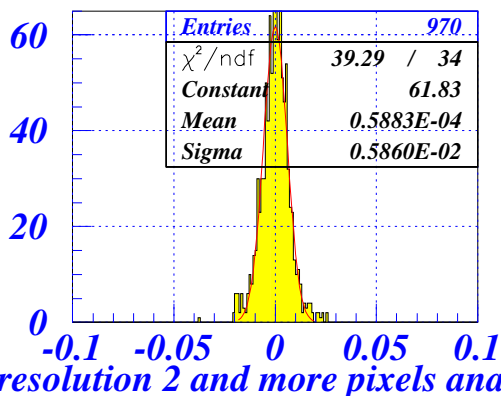
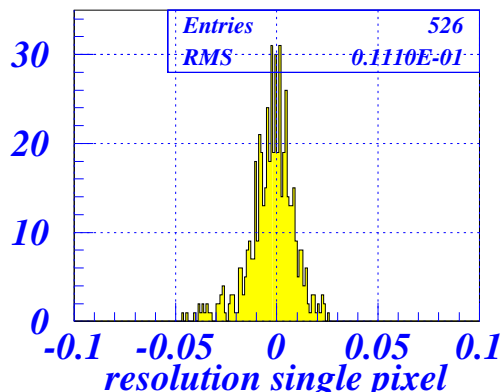
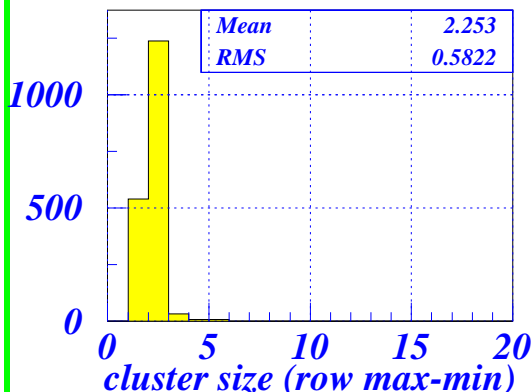
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Resolution

S70 chip - Resolution

ST2 - $\phi = 10^\circ$

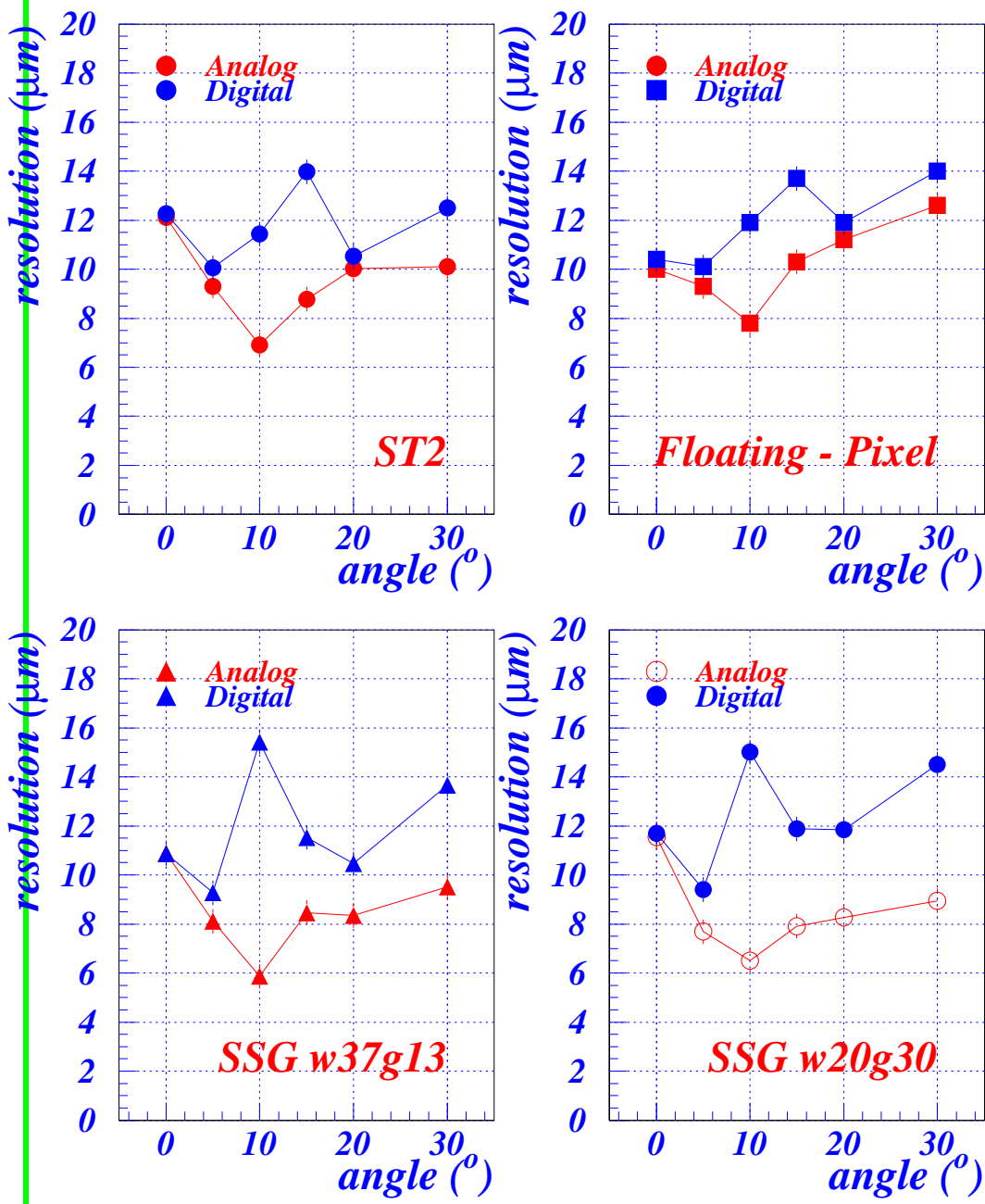


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Resolution

Resolution vs. azimuthal angle ϕ



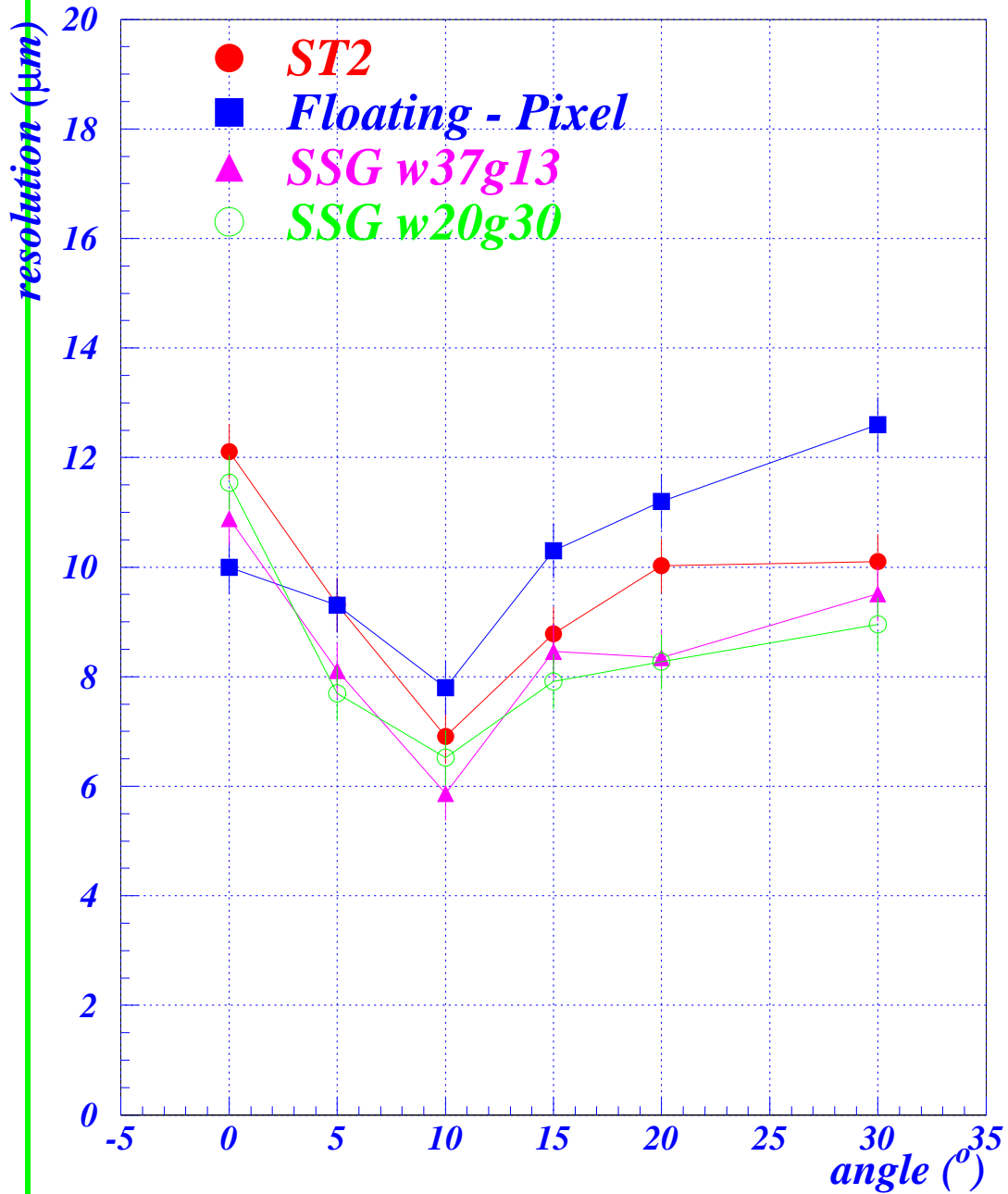
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Resolution

Resolution vs. azimuthal angle ϕ

Analog Algorithm



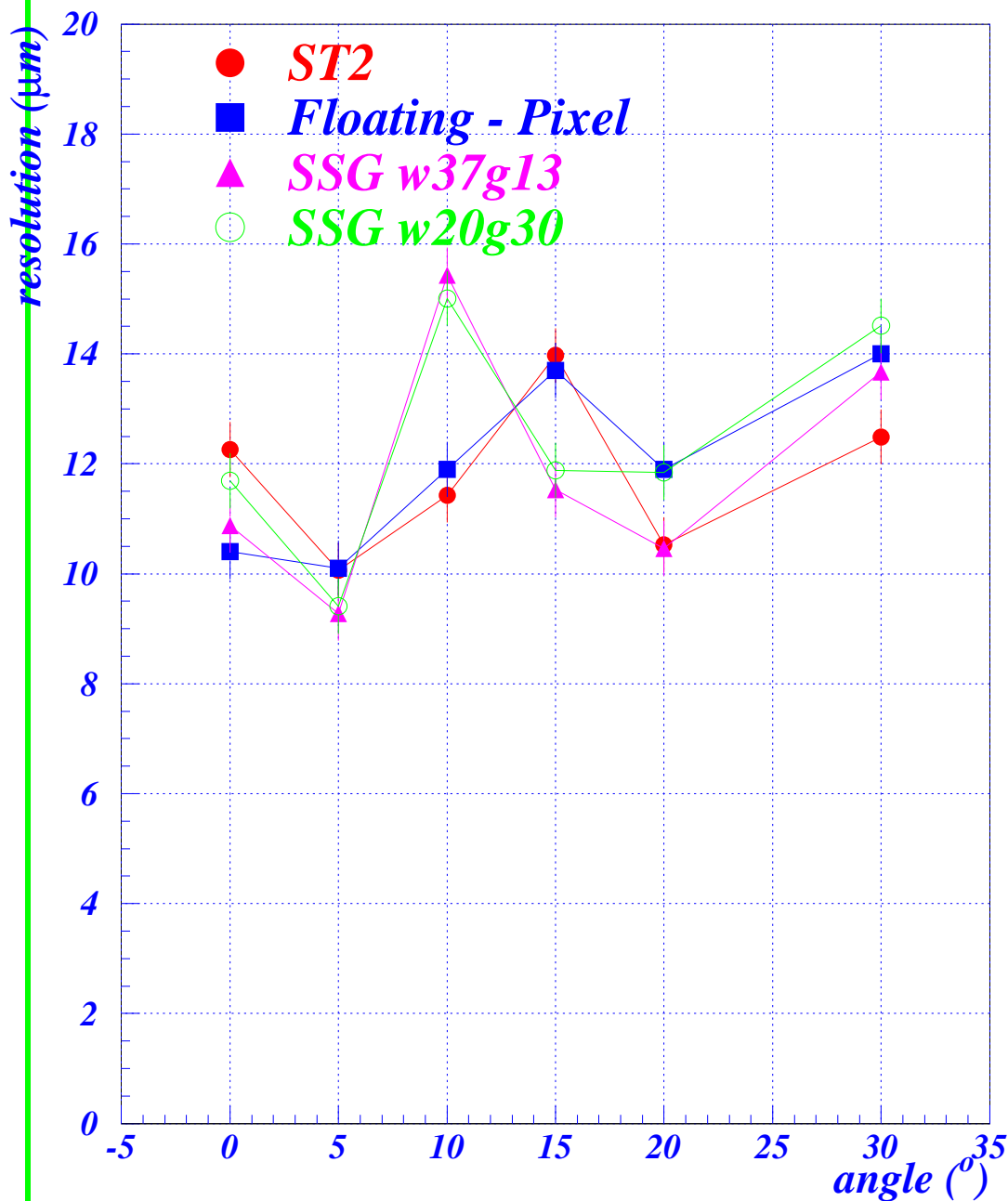
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Resolution

Resolution vs. azimuthal angle ϕ

Digital Algorithm

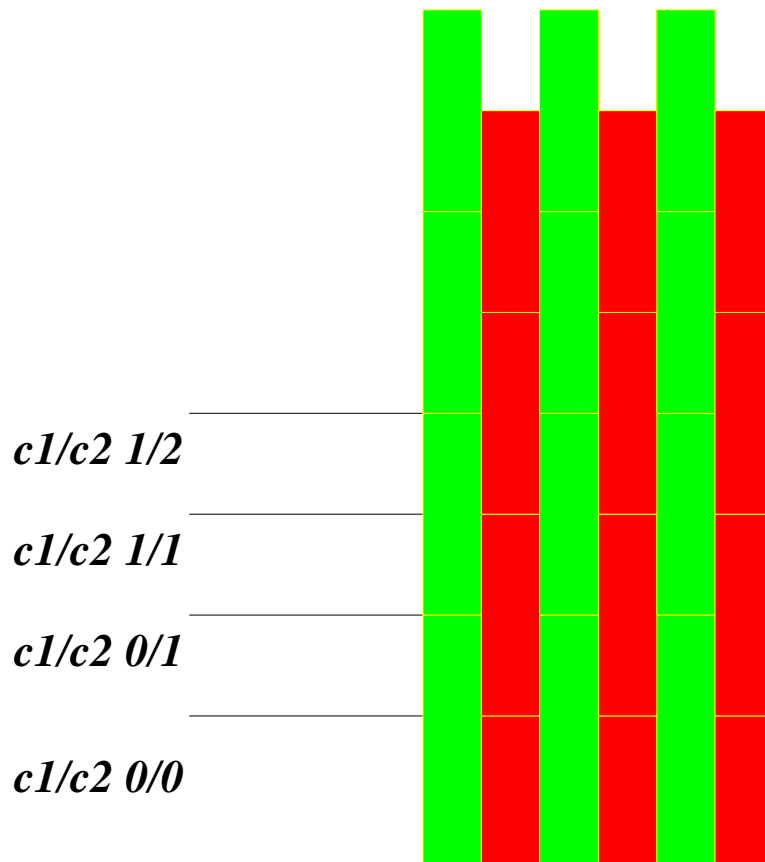


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Bricked design

Bricked Option Layout



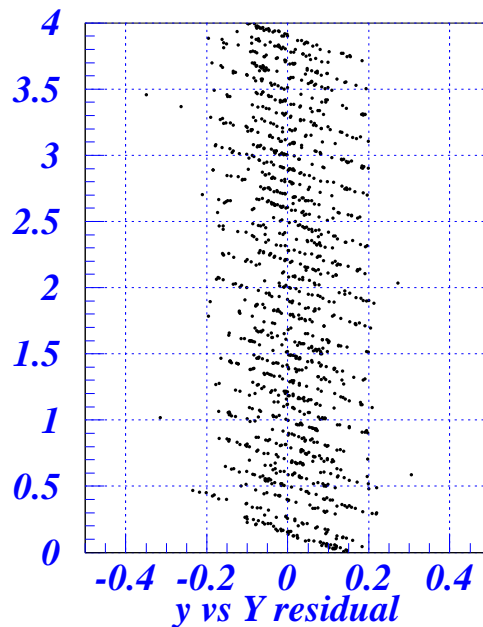
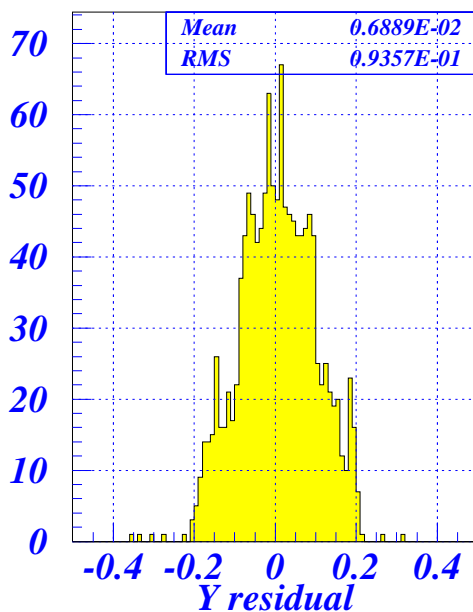
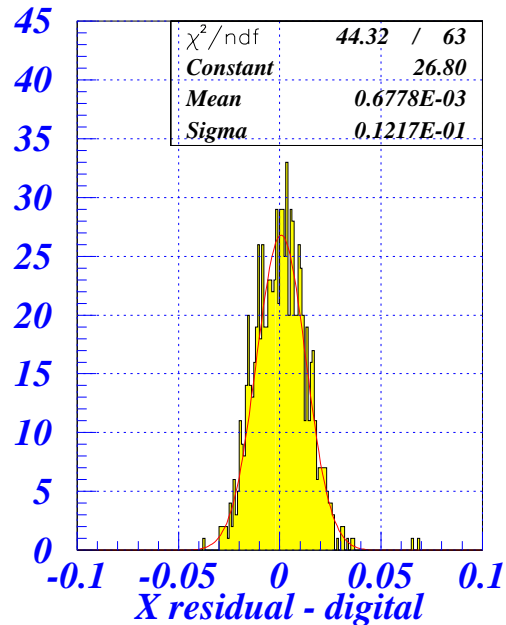
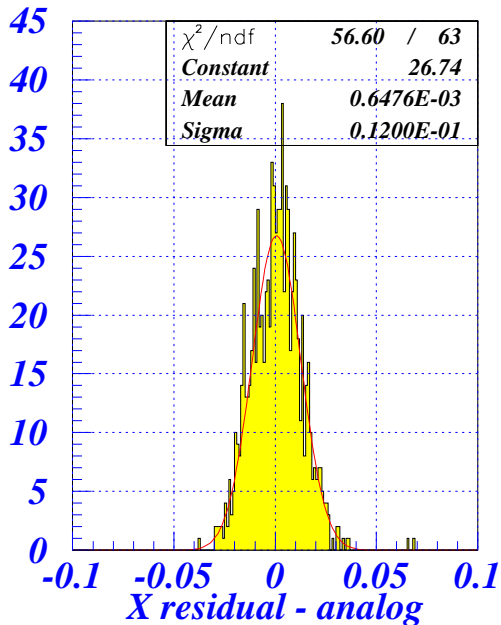
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Bricked design - X and Y Resolution

S70 chip - Resolution

Bricked SSG Design - $\phi = 0^0$



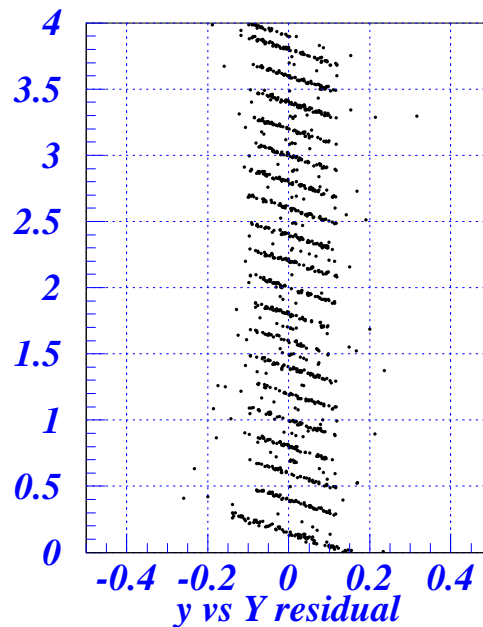
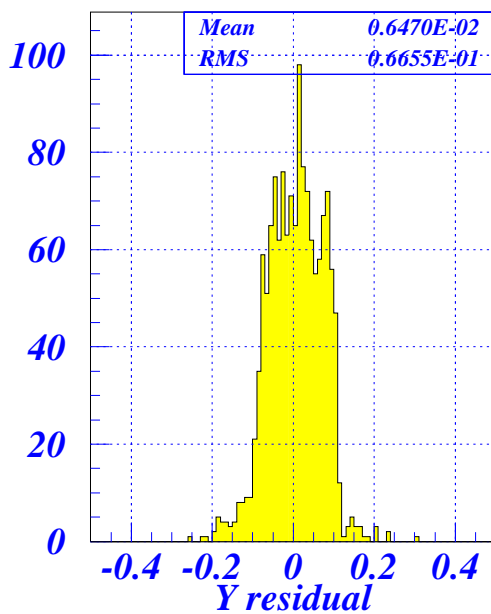
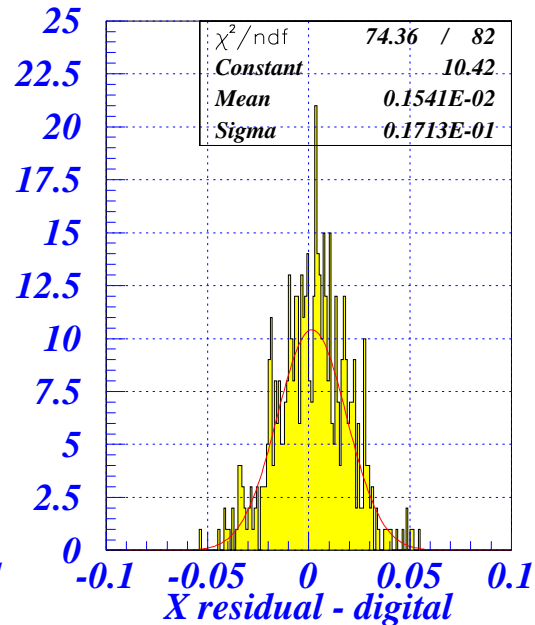
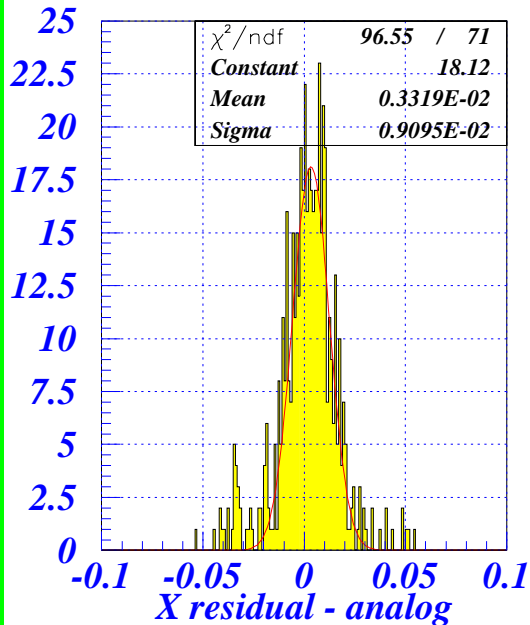
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Bricked design - X and Y Resolution

S70 chip - Resolution

Bricked SSG Design - $\phi = 10^0$

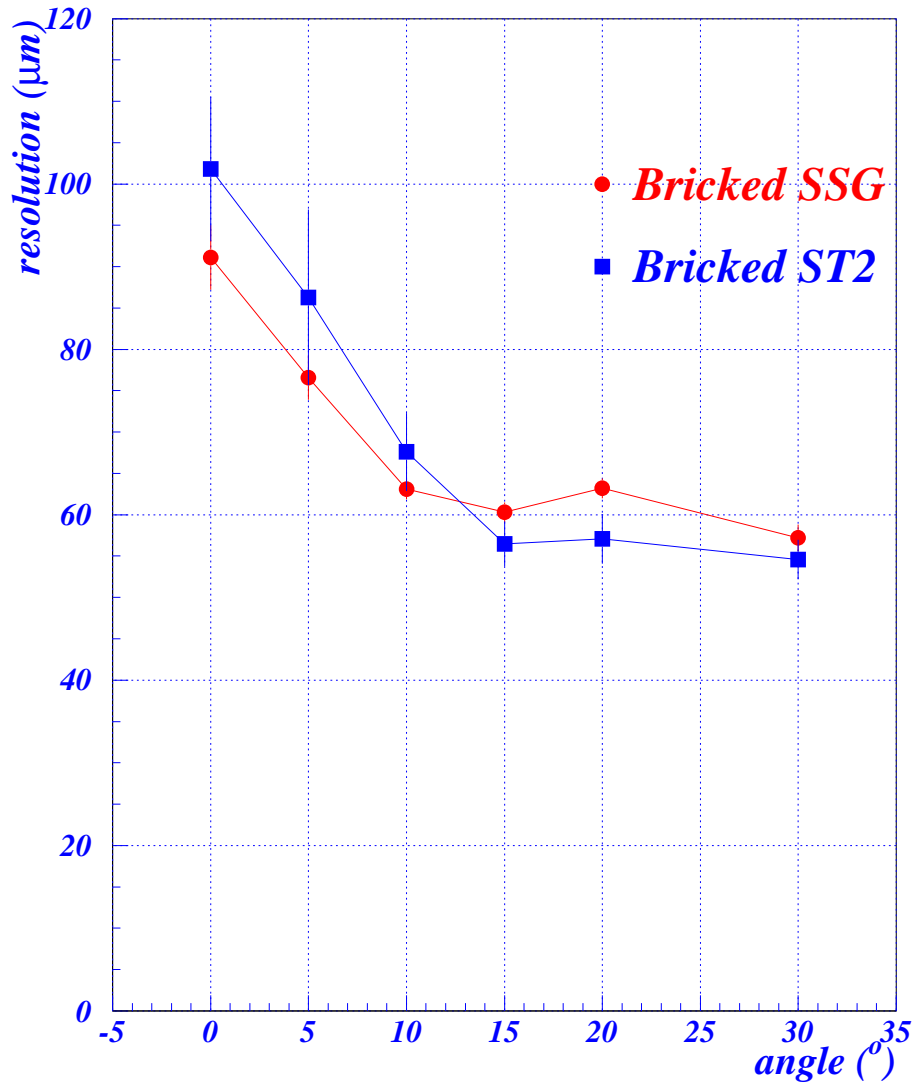


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Bricked design - Y Resolution

Y Resolution - Bricked sensors



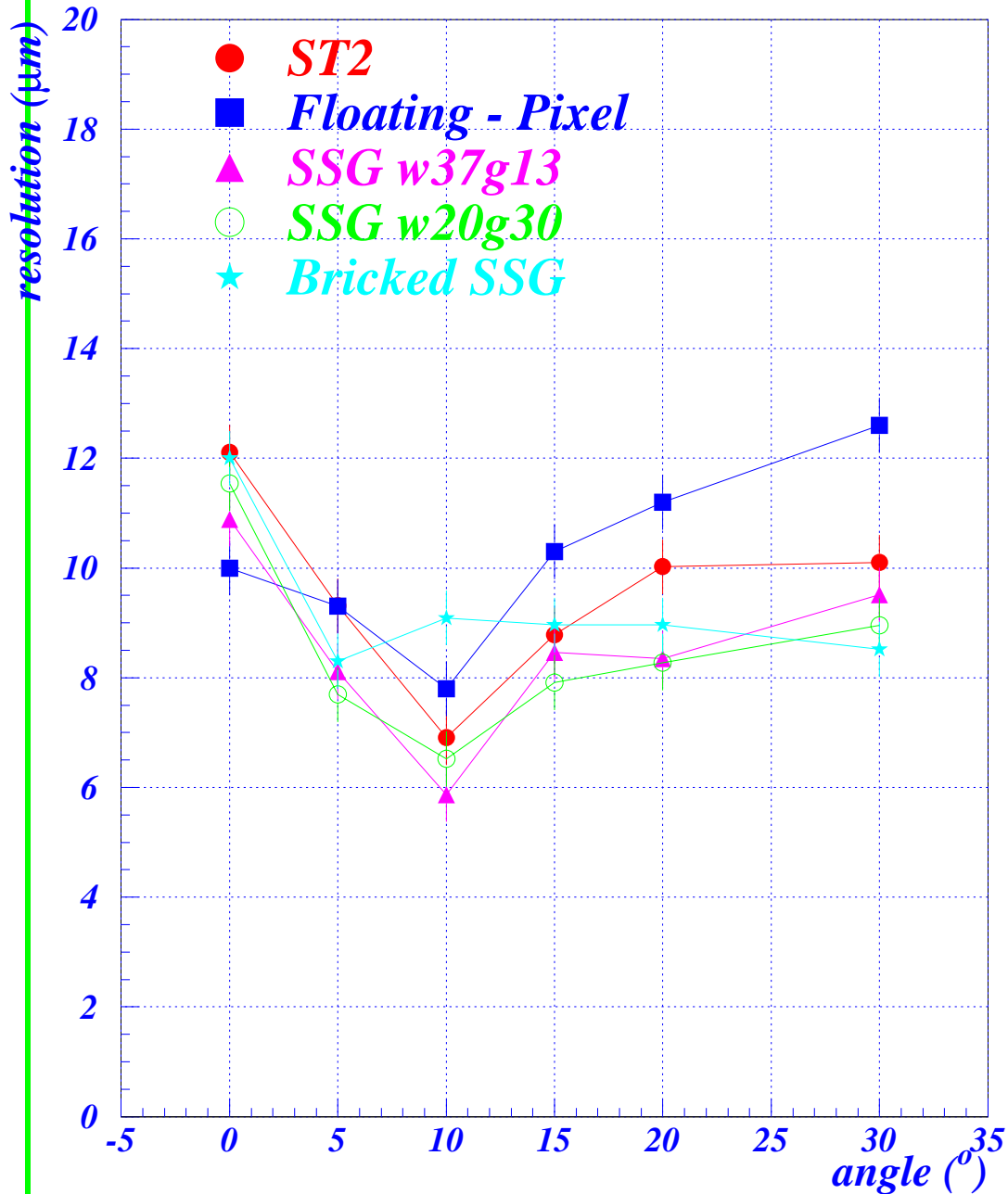
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X Resolution

Resolution vs. azimuthal angle ϕ

Analog Algorithm



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Summary and Conclusions

- ❖ SSG various designs **NO CHARGE LOSS**
FLOATING PIXEL **HAS CHARGE LOSS**
ST2 **confirmed** charge collection behaviour

- ❖ Measured RESOLUTION vs Φ

X	X and Y
SSG w20g30	
SSG w37g13	Bricked SSG
SXT	
ST2	Bricked ST2
Floating Pixel	

- ❖ Resolution determined by

- 1 pixel to **multi** pixels clusters **fraction**
- reconstruction **algorithm**

Summary and Conclusions

- ❖ Analog algorithm for X

EXCELLENT RESOLUTION

(up to 50% improvement w.r.t. digital algorithm)

WE LOVE T.O.T.

- ❖ Bricked design as expected

Y resolution $\approx 60\mu\text{m}$ for $\Phi \geq 10^0$

We can take advantage of it, relaxing the constraints on CELL SIZE

- ❖ Optimize the number of multi pixels clusters

Investigate impact on:

- Occupancy
- End of column buffers
- Mechanical design (optimal angle)