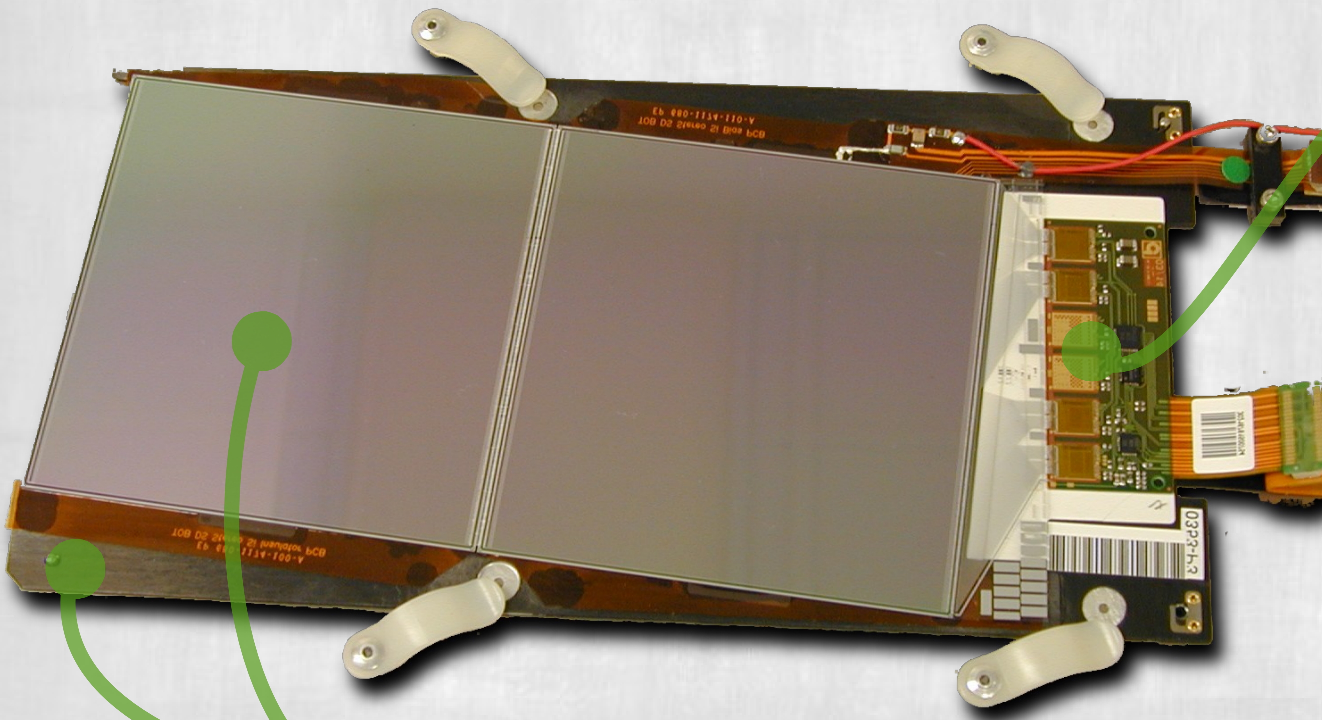
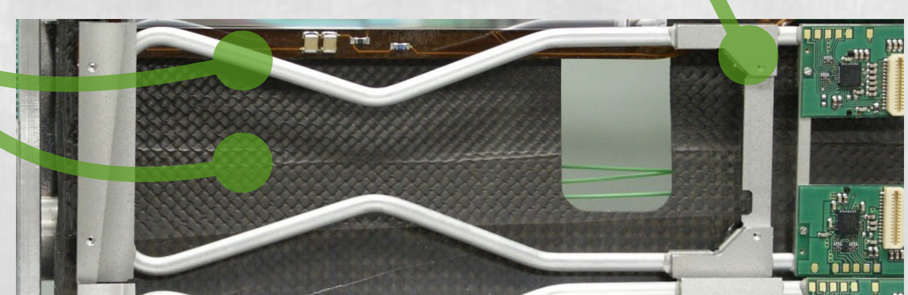
TKLAYOUT

MATERIAL

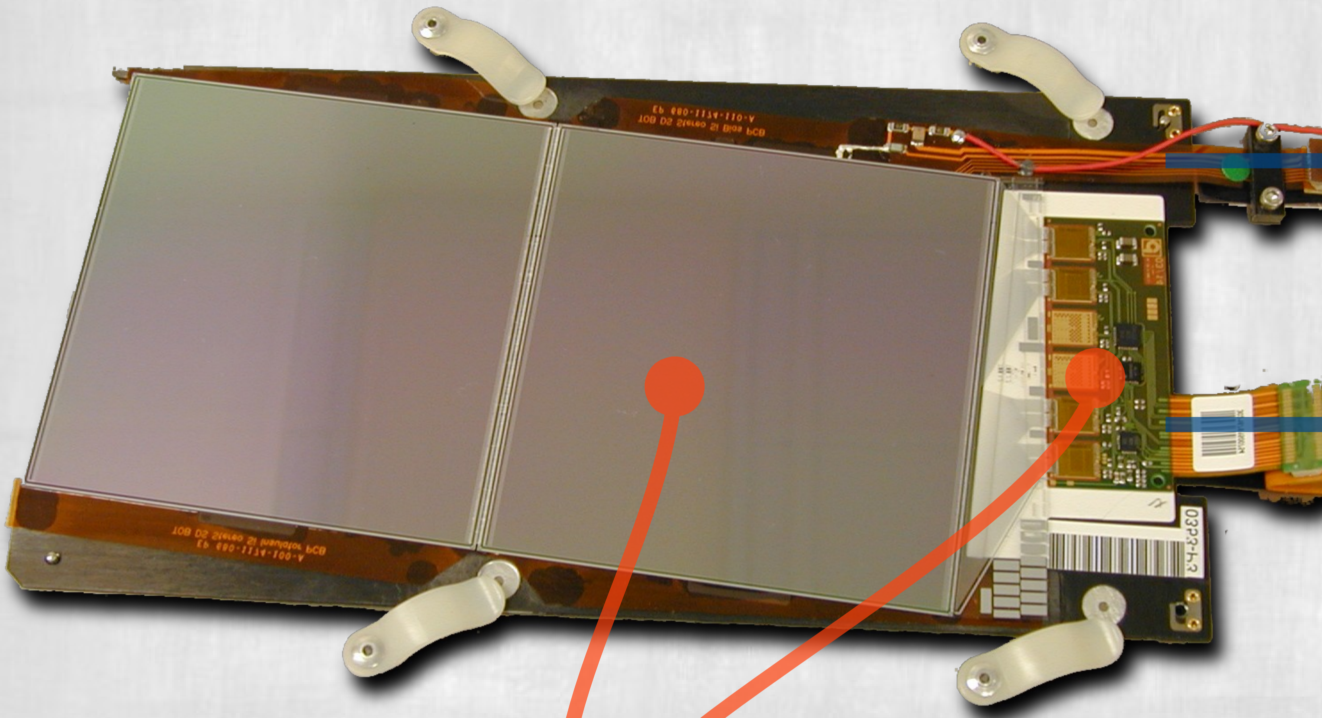


per strip
front-ends
hybrid
cooling block
optical fibres

fixed
sensor
cooling pipes
CF structure



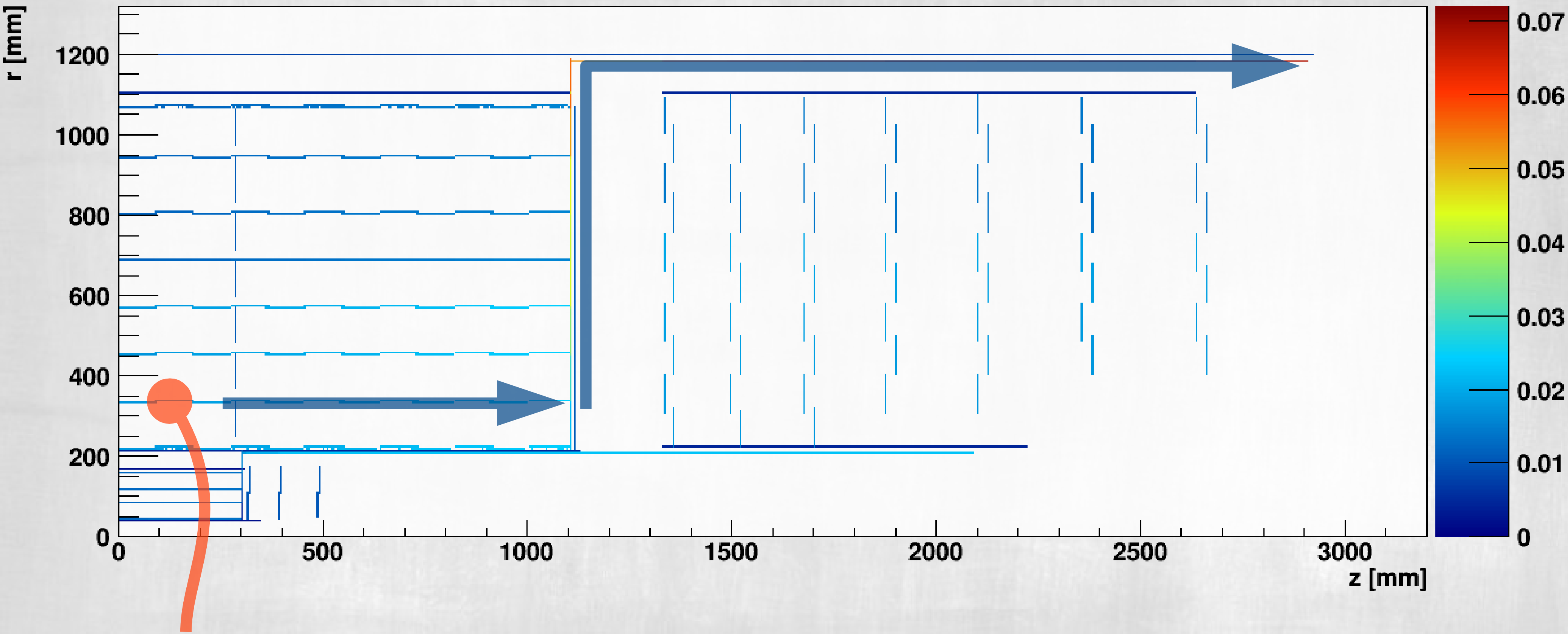
MATERIAL



services
cooling pipes
optical fibres
twisted pairs

on the module

MATERIAL



Material on active elements + Material for services automatically routed

WARNING

Material is accurate for **PS**, **2S** modules

Service material for **pixel** is not... ahem... really accurate (too optimistic)

RESOLUTION ESTIMATE

- Error estimation, following
  - Baseline: Karimäki [1]
  - Multiple scattering introduced by G. Hall [2]
  - With variable geometry [3]
- **A priori error estimation**
  - **No Monte Carlo**
  - **No fit actually done**

[1] V. Karimäki – CMS Note 1997/064 [NIM A410 (1998) 284]
NIM A305 (1991) 187

[2] G. Hall – Calculating parameters for the Pixel and Tracker upgrade performance studies (Tracker Week) http://bit.ly/eXvi8L

[3] S. Mersi – Progress on layout tools (TUPO) http://tinyurl.com/2u7dbbv

CORRELATION MATRIX

- Use measurement errors to estimate the errors in track fit parameters
- **Multiple scattering** treated as (correlated) a measurement error

deviation from the ideal (straight) path

CORRELATION MATRIX

- Use measurement errors to estimate the errors in track fit parameters
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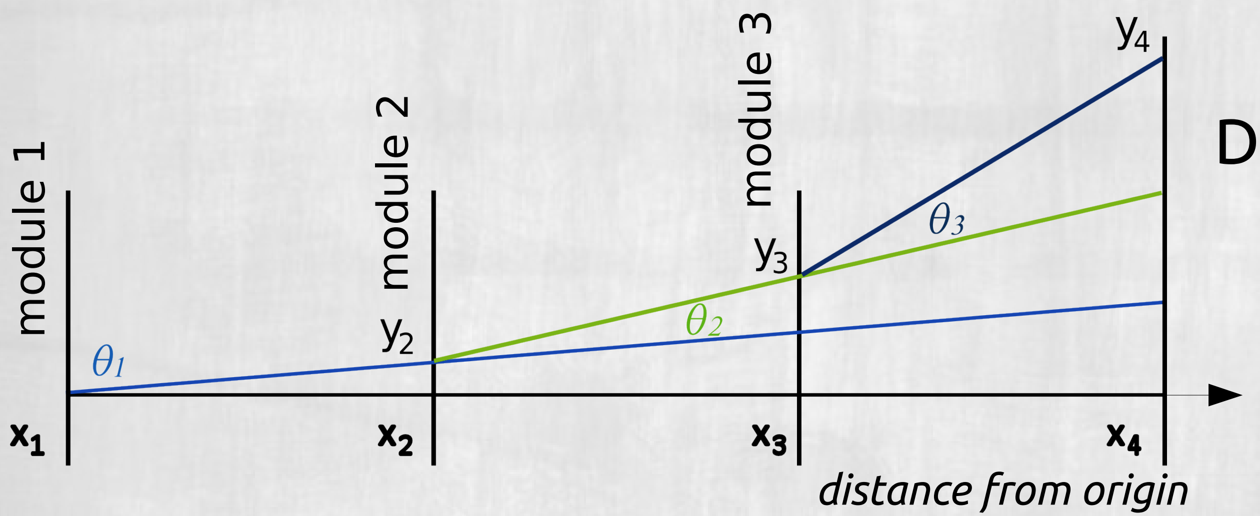


Deviation due to scattering:

$$y_n = \sum_{i=1}^{n-1} (x_n - x_i)\,\theta_i$$

Error correlation matrix:

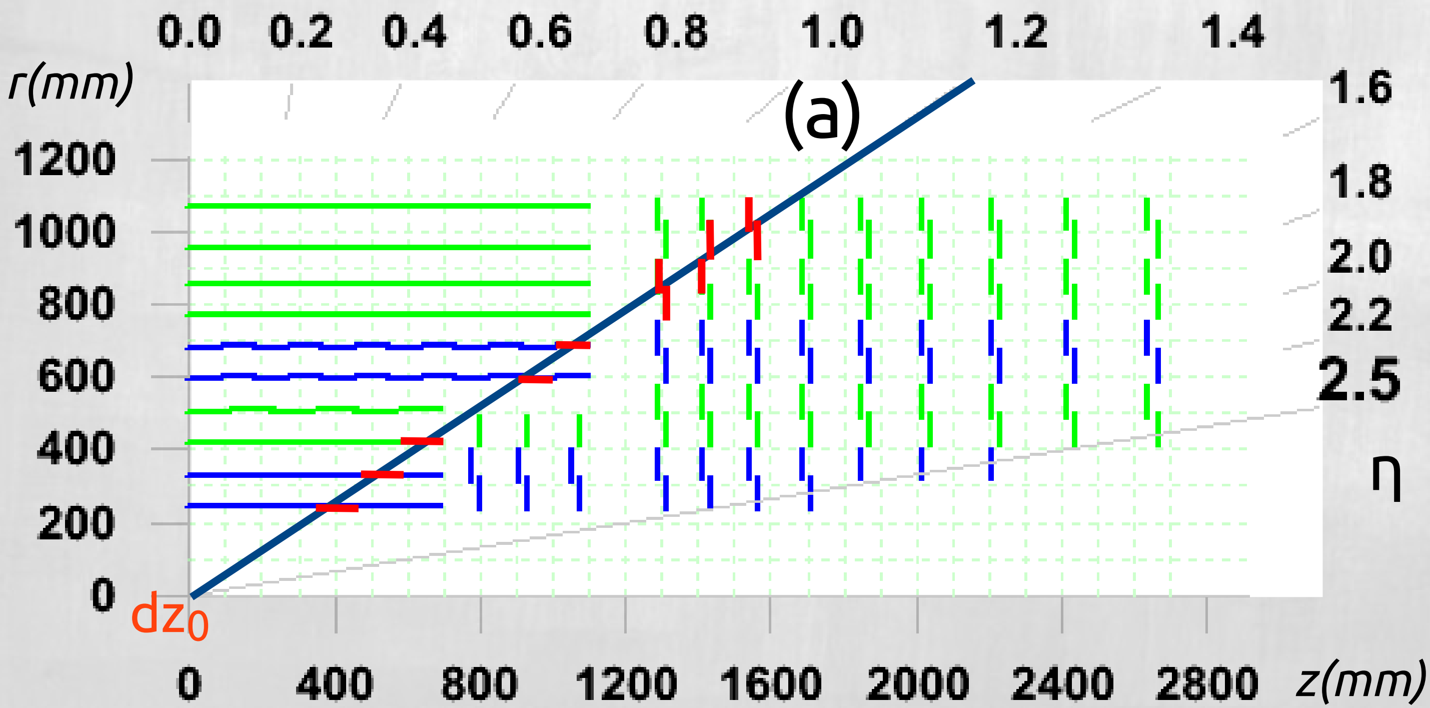
$$\sigma_{n,m} = \langle y_n y_m \rangle = \sum_{i=1}^{n-1} (x_m - x_i)(x_n - x_i)\langle \theta_i^2 \rangle$$

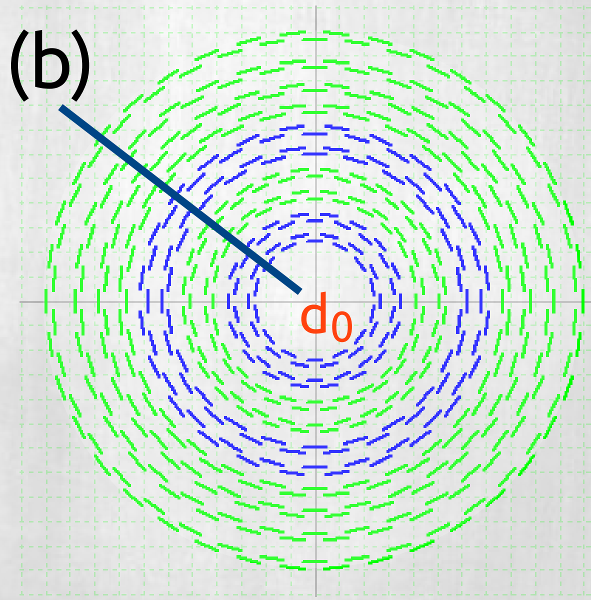
$$\sigma_n^2 = \frac{p^2}{12}$$

ERROR ESTIMATION

- For each η value:
  Find volumes met **by straight lines**
  Compute average **multiple scattering**
- Error correlation matrix
- **Expected error** in track fitting

Two independent fits evaluated
5 parameters
(a) r,z plane: straight ctg(θ), dz_0
(b) rφ plane: circle d_0, φ, p_T





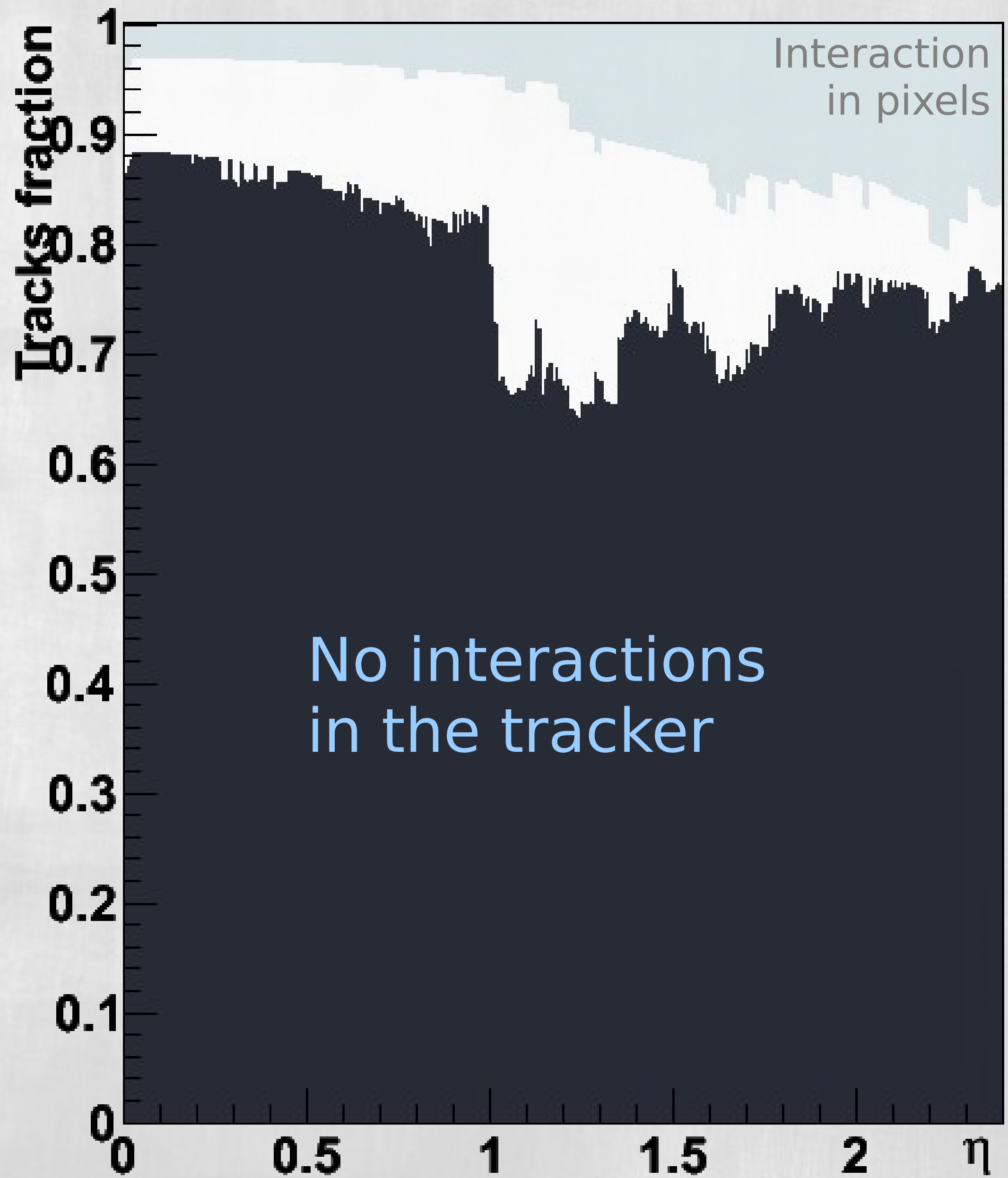
PARTICLE INTERACTIONS

- Nuclear interaction length

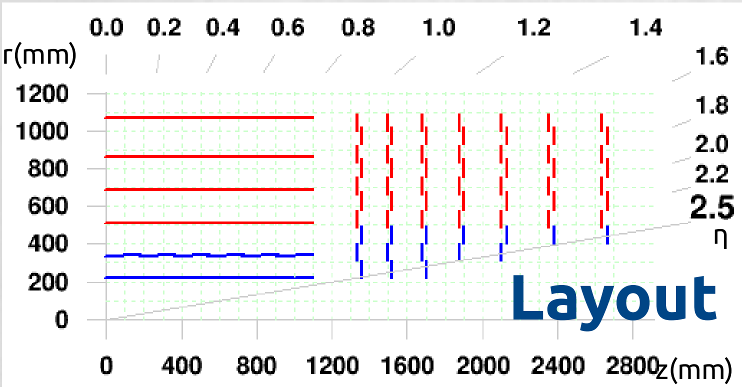
$$p_n = \exp\left[-\sum_{i=1}^{n-1} \frac{l_i}{\lambda_i}\right]$$

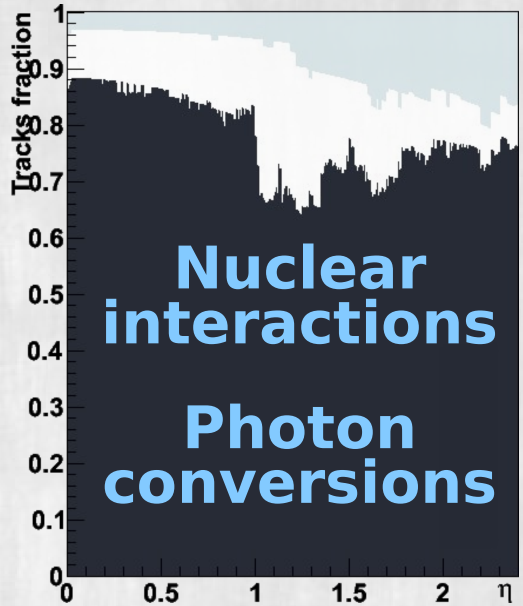
an indicator of how many "good" pion tracks we should expect

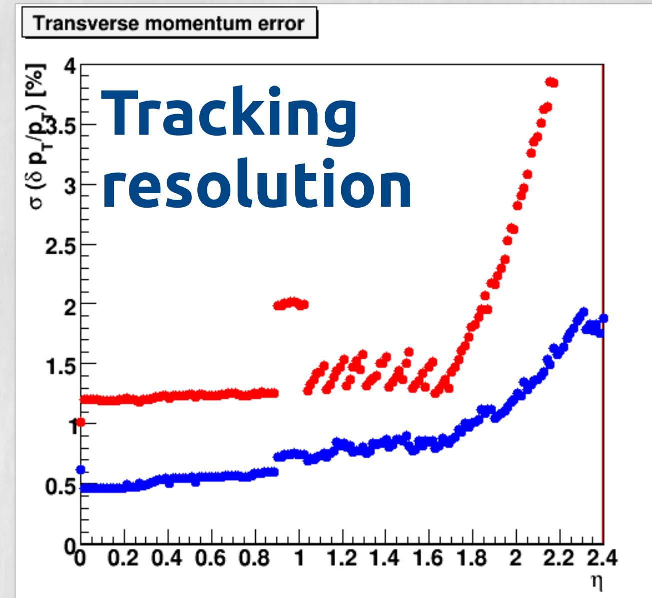
- Photon conversion rate is computed likewise



MANY SUMMARIES

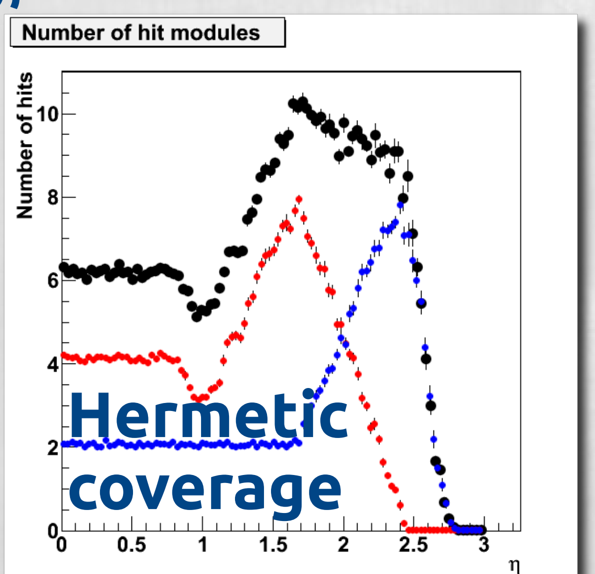


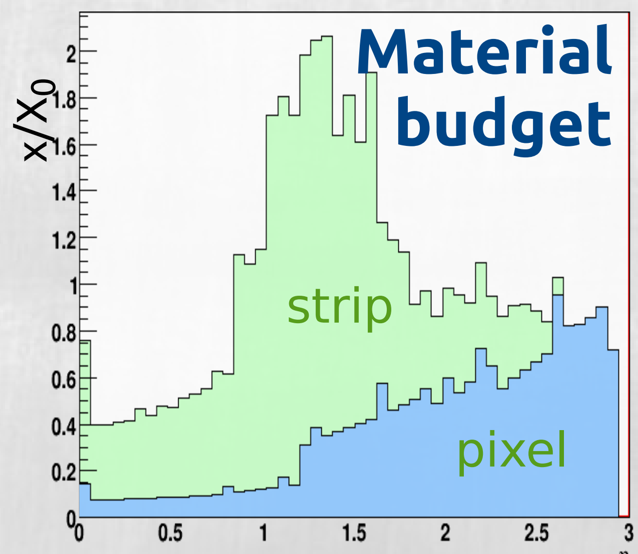


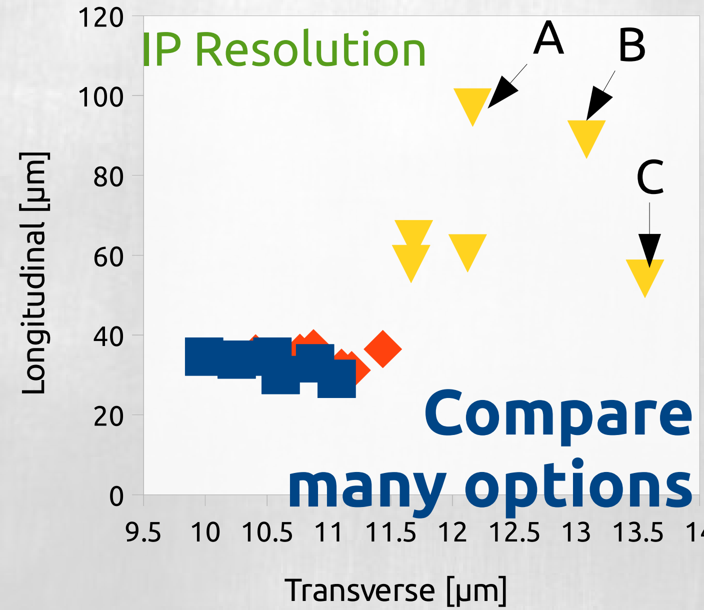


Summaries

- Weight
- Channels, Surface
- Power
- Bandwidth







OUTPUT TO A MINI-SITE

Firefox | 2st_4Pt - Geometry

http://mersi.web.cern.ch/mersi/layouts/2st_4Pt/

2st_4pt
layouts

geometry | band width | material (outer) | material (pixel) | weights (outer) | resolution | resolution (trigger) | info | log page

layers and disks

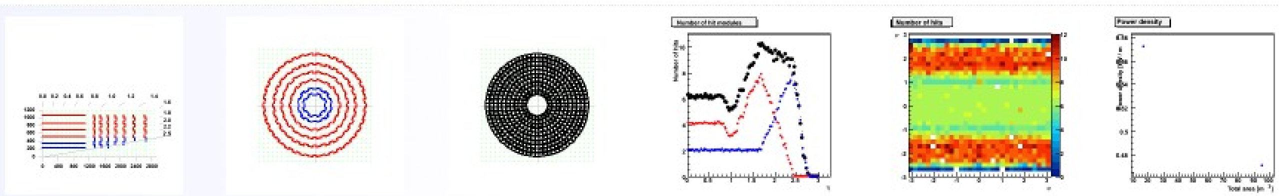
Layer	L1	L2	L3	L4	L5	L6
r	230	348	524	699	874	1080

Disk	D1	D2	D3	D4	D5	D6	D7
z	1346	1507	1687	1889	2114	2367	2650

Ring	1	2	3	4	5	6	7	8	9	10
r_{min}	222	308	404	486	583	661	759	833	932	1003
r_{max}	315	401	497	578	675	753	851	926	1025	1095

modules

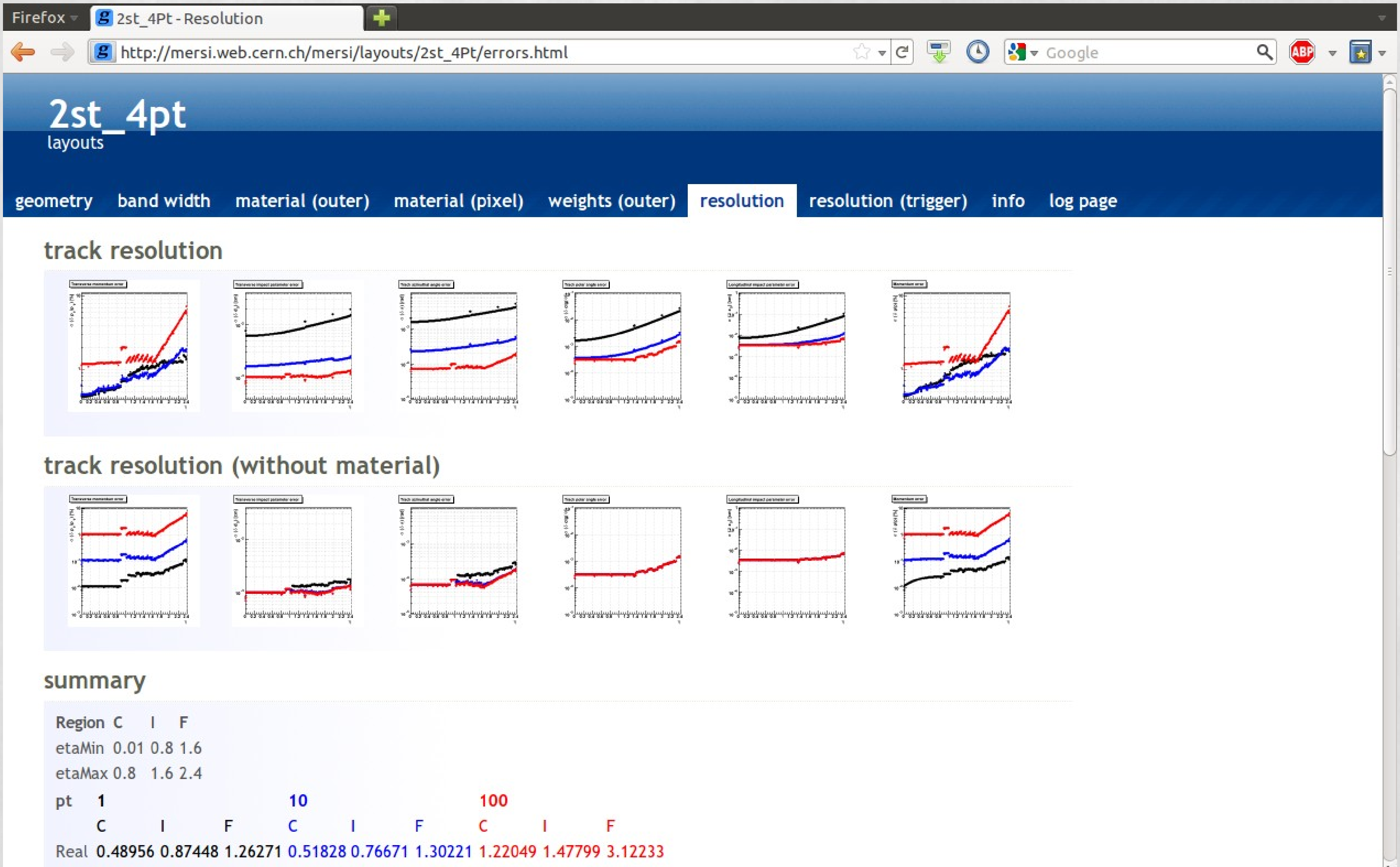
plots



Page created on Tue Apr 5 09:49:56 2011 GMT
by tkGeometry revision 517M

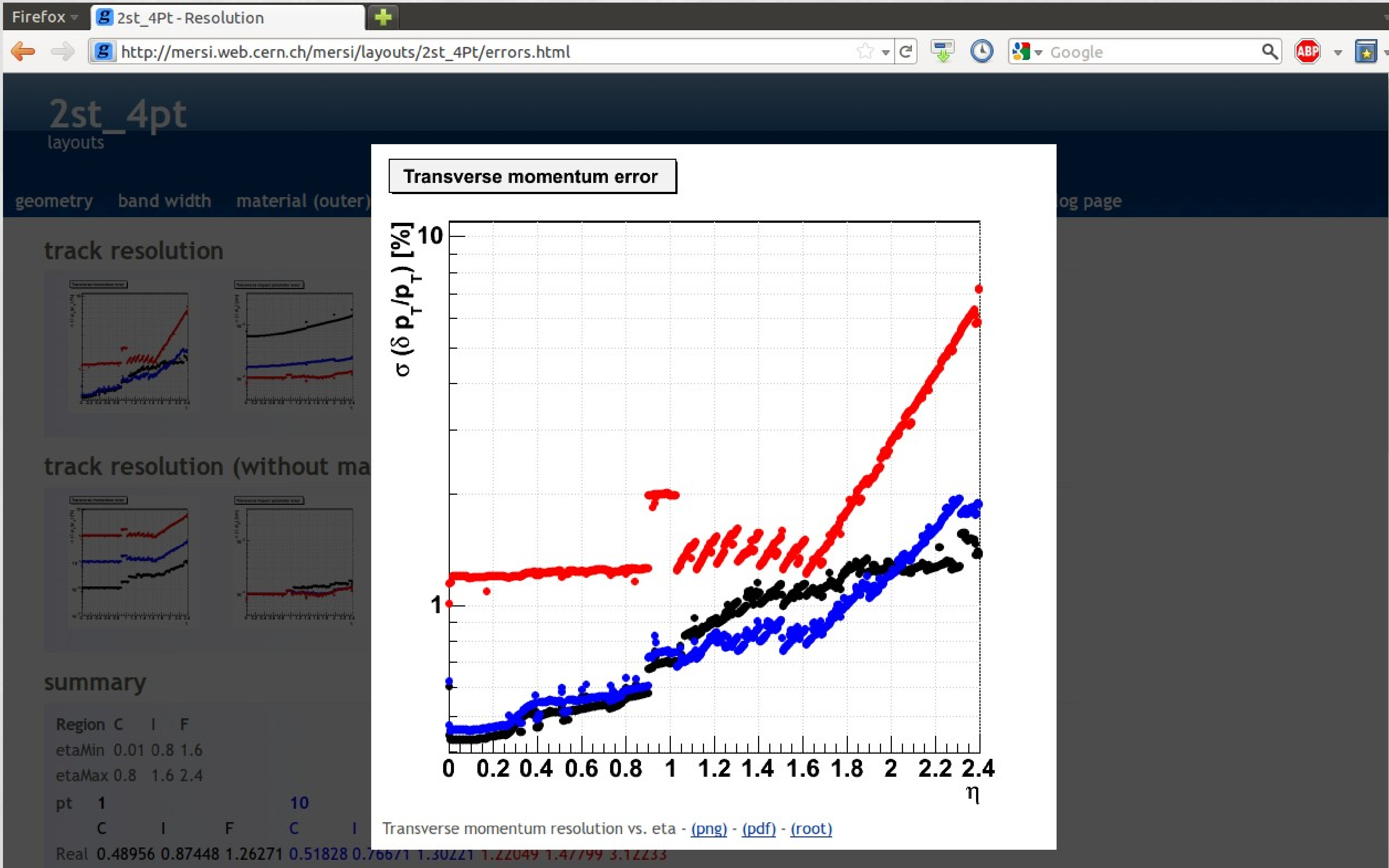
http://cern.ch/mersi/layouts

OUTPUT TO A MINI-SITE



http://cern.ch/mersi/layouts

OUTPUT TO A MINI-SITE



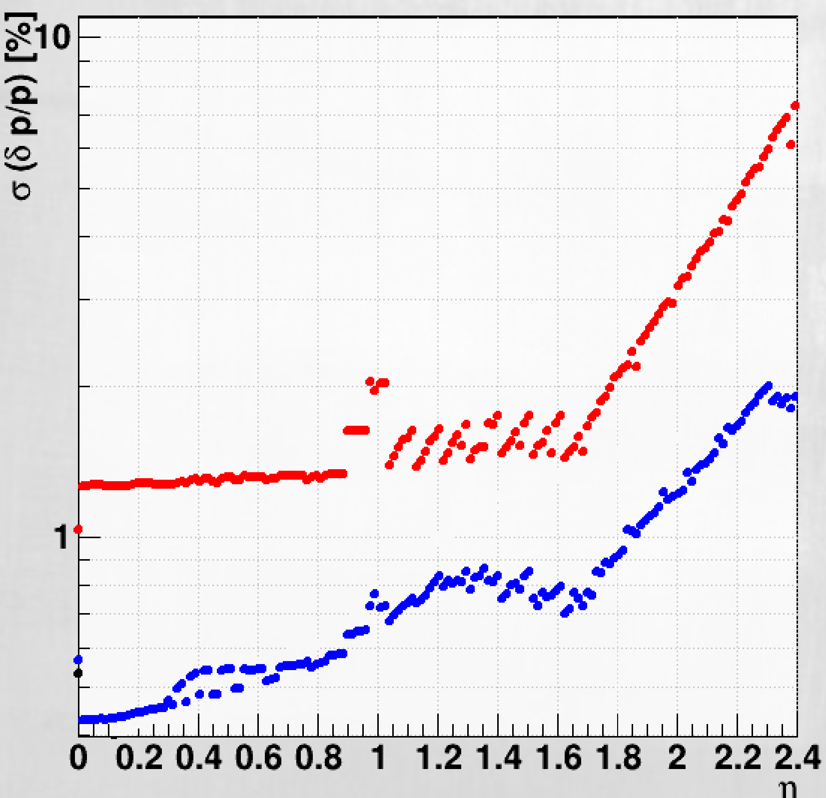
http://cern.ch/mersi/layouts

MOMENTUM RESOLUTION

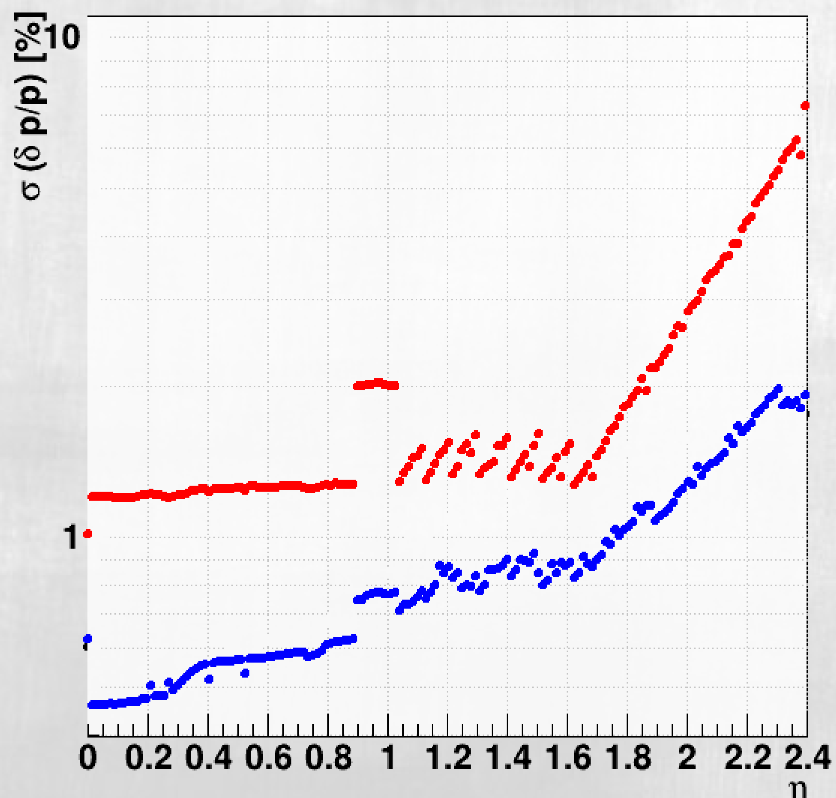
100 GeV μ

10 GeV μ

Tracking only



Trigger



MOMENTUM RESOLUTION

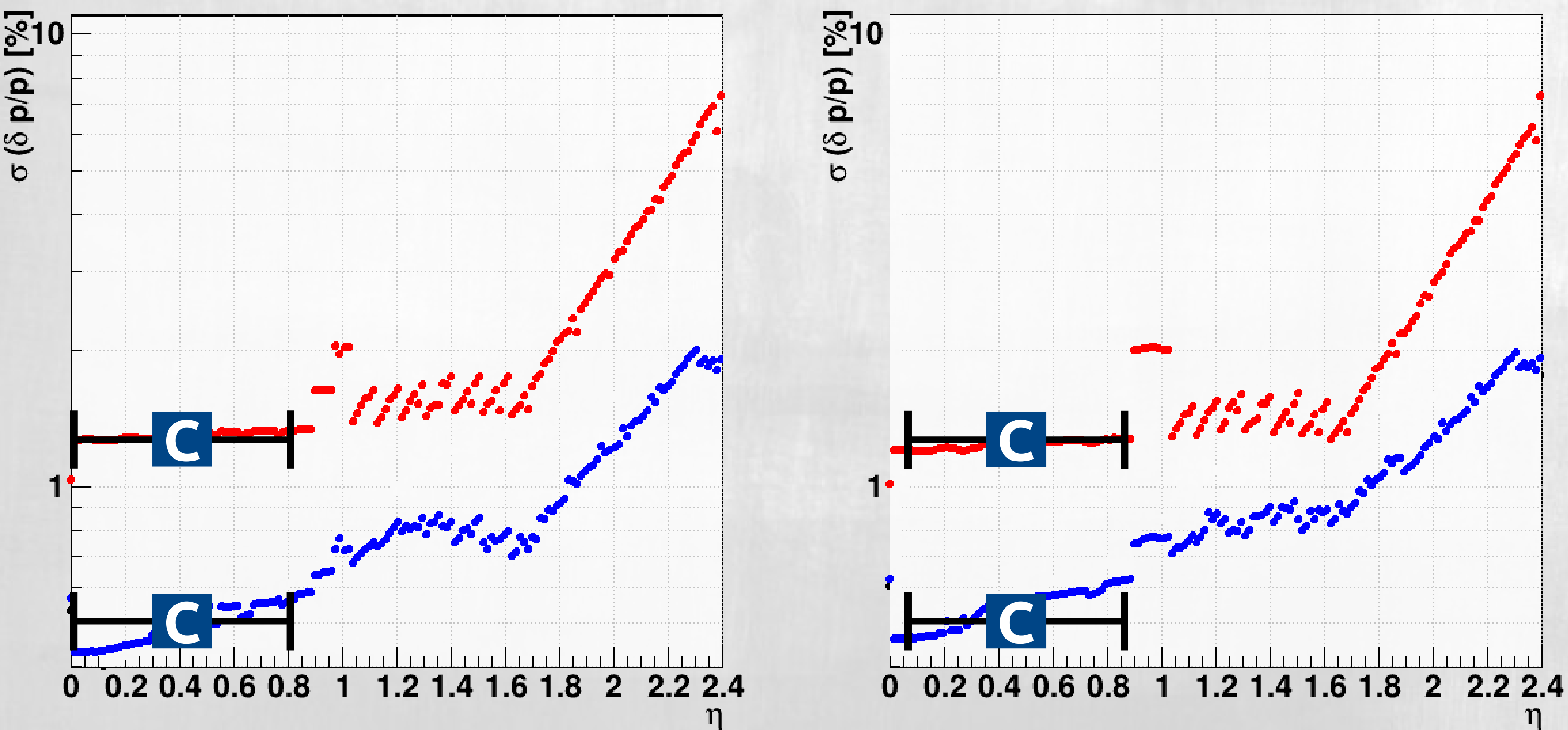
η

C $0 \rightarrow 0.8$

100 GeV μ
10 GeV μ

Tracking only

Trigger



MOMENTUM RESOLUTION

η

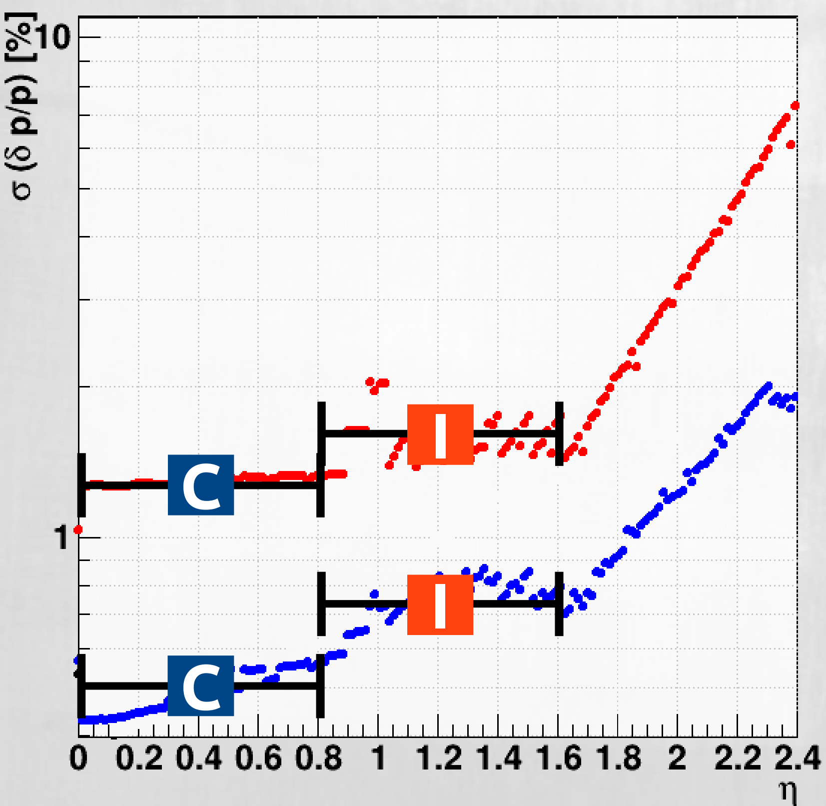
C 0 → 0.8

I 0.8 → 1.6

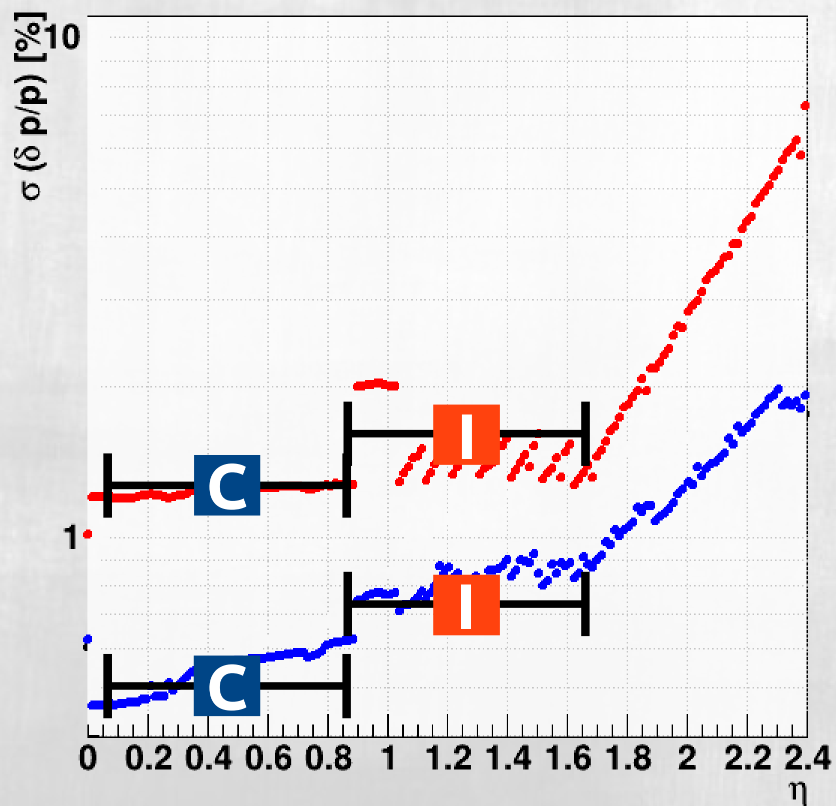
100 GeV μ

10 GeV μ

Tracking only



Trigger



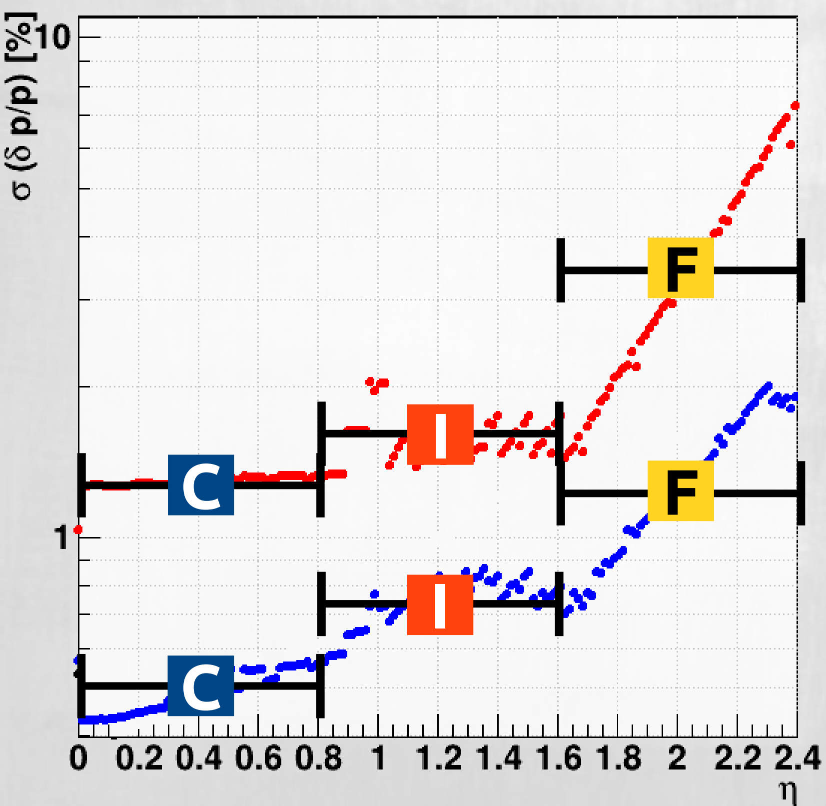
MOMENTUM RESOLUTION

	η
C	0 → 0.8
I	0.8 → 1.6
F	1.6 → 2.4

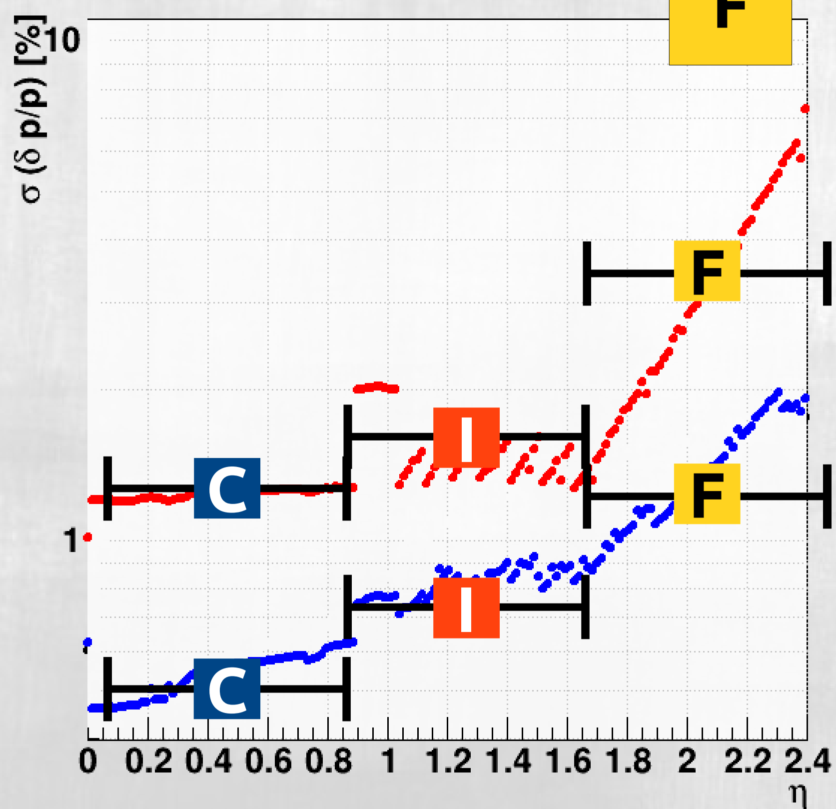
100 GeV μ

10 GeV μ

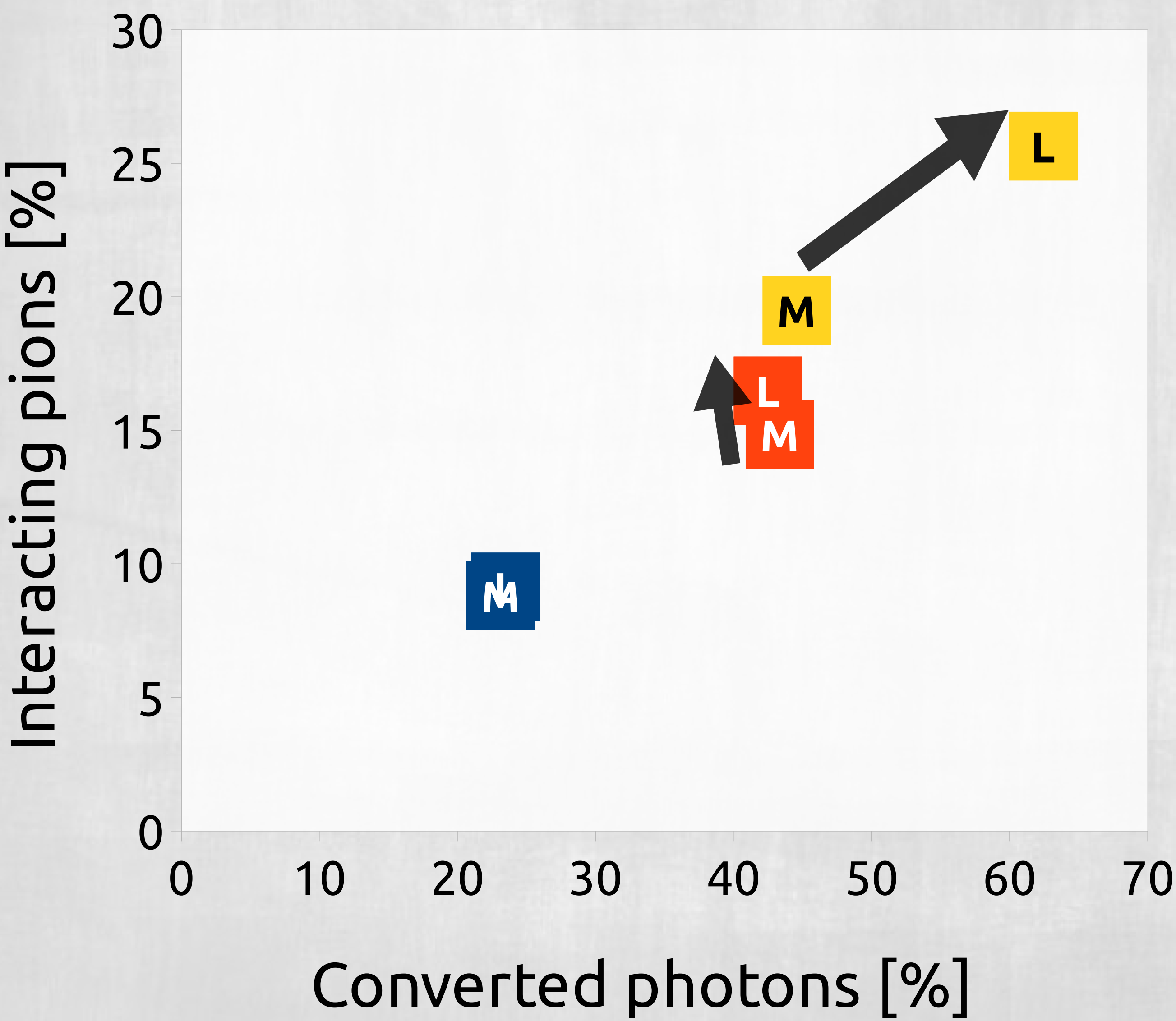
Tracking only



Trigger



PARTICLE INTERACTIONS



η

C	0 → 0.8
I	0.8 → 1.6
F	1.6 → 2.4

More interactions in the forward

M Mixed

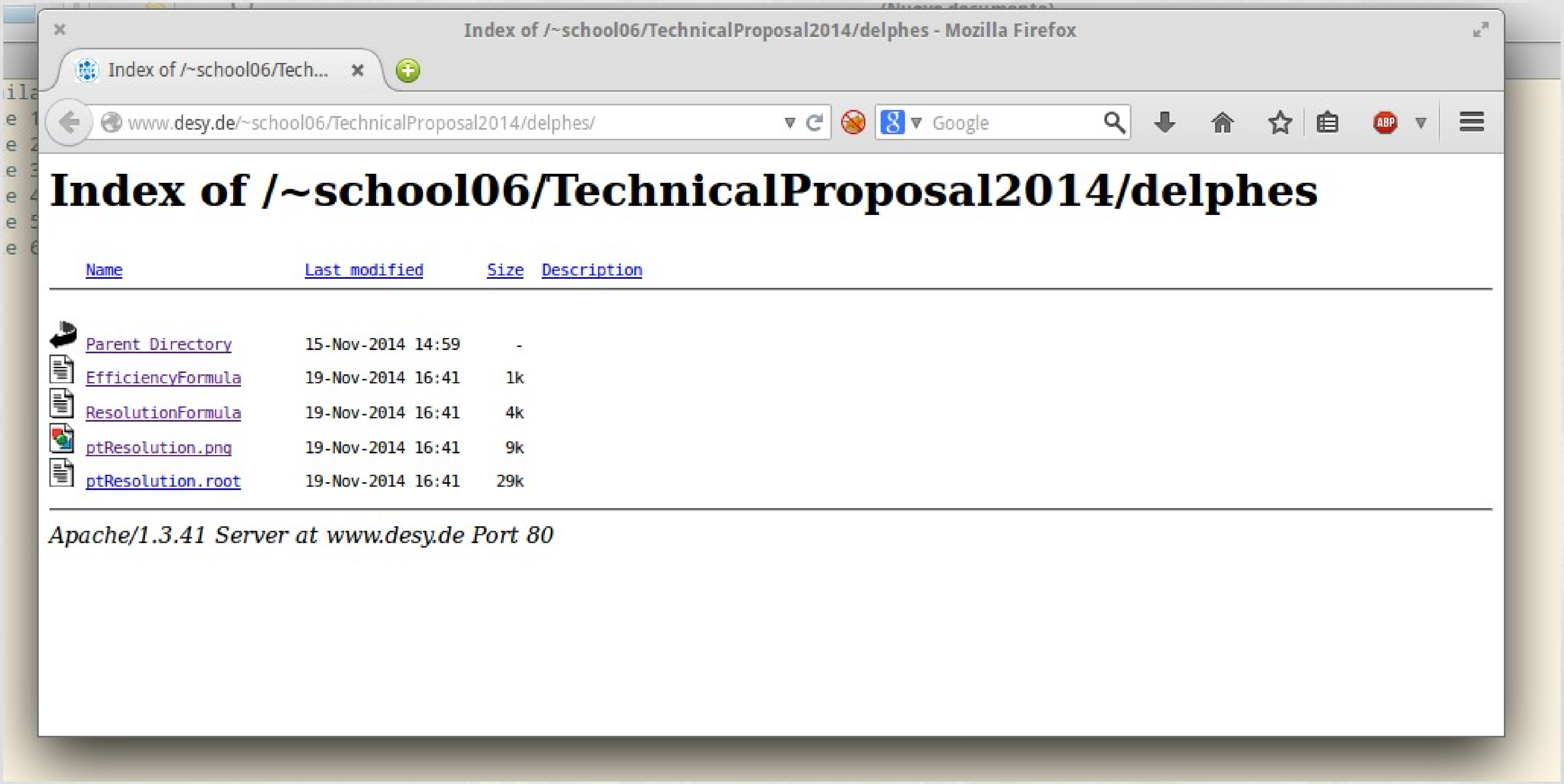
L Long Barrel

DELPHIZE!

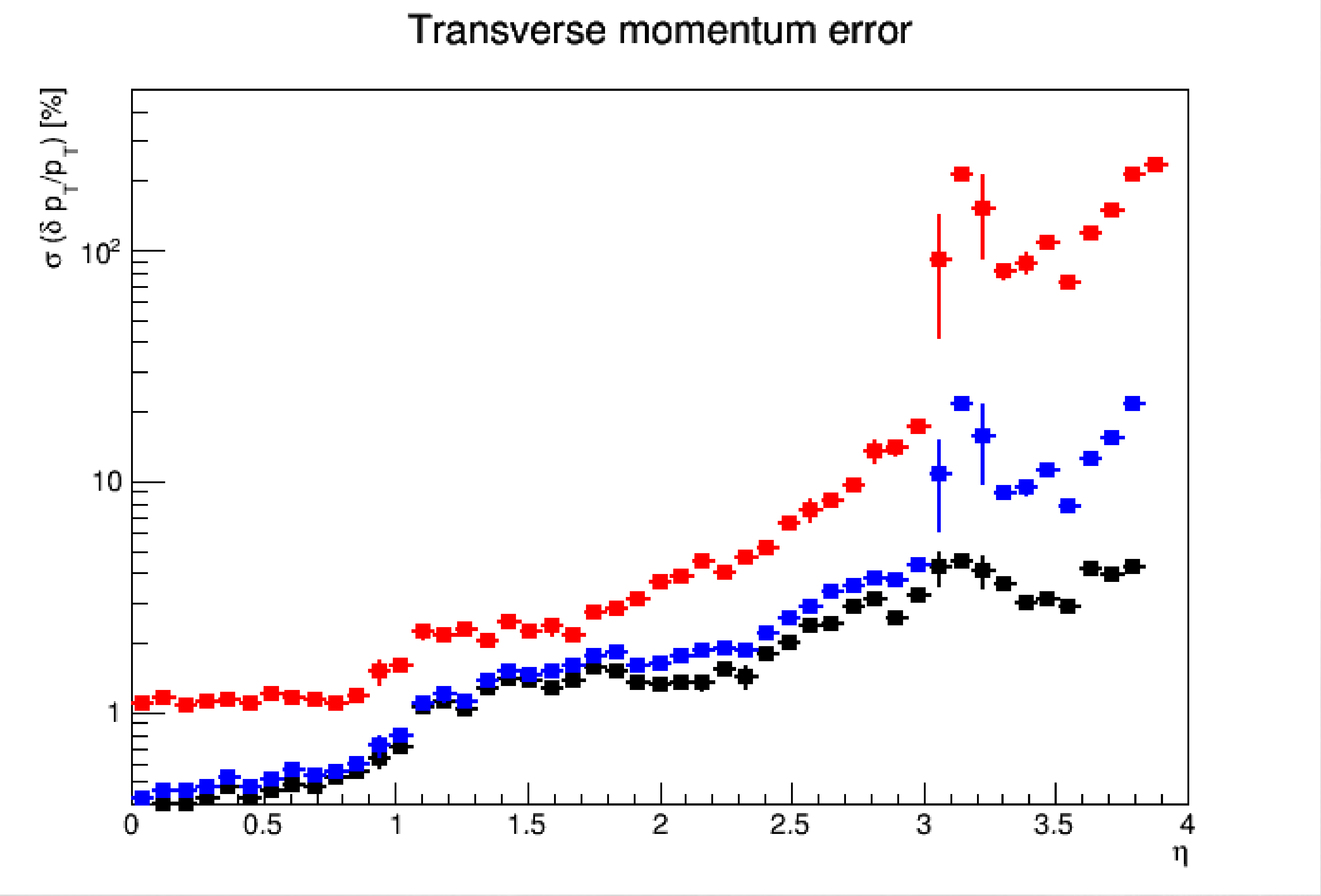
```
> source ~/tklayout.env
> delphize
Available resolution files:
File 1 = 3xPS_3x2S_5disks_baseline_pixelV0/linptres_pixel_MS000.root
File 2 = 3xPS_3x2S_5disks_baseline_pixelV0/linptres_tracker_MS000.roo
File 3 = 3xPS_3x2S_5disks_baseline_pixelV0/linptres_trigger_MS000.roo
File 4 = TechnicalProposal2014/linptres_pixel_MS000.root
File 5 = TechnicalProposal2014/linptres_tracker_MS000.root
File 6 = TechnicalProposal2014/linptres_trigger_MS000.root

Select the desired resolution: 11
Newly generated configuration files and corresponding plots
should be available here:
http://www.desy.de/~school06/TechnicalProposal2014/delphes
max eta=3.85
```

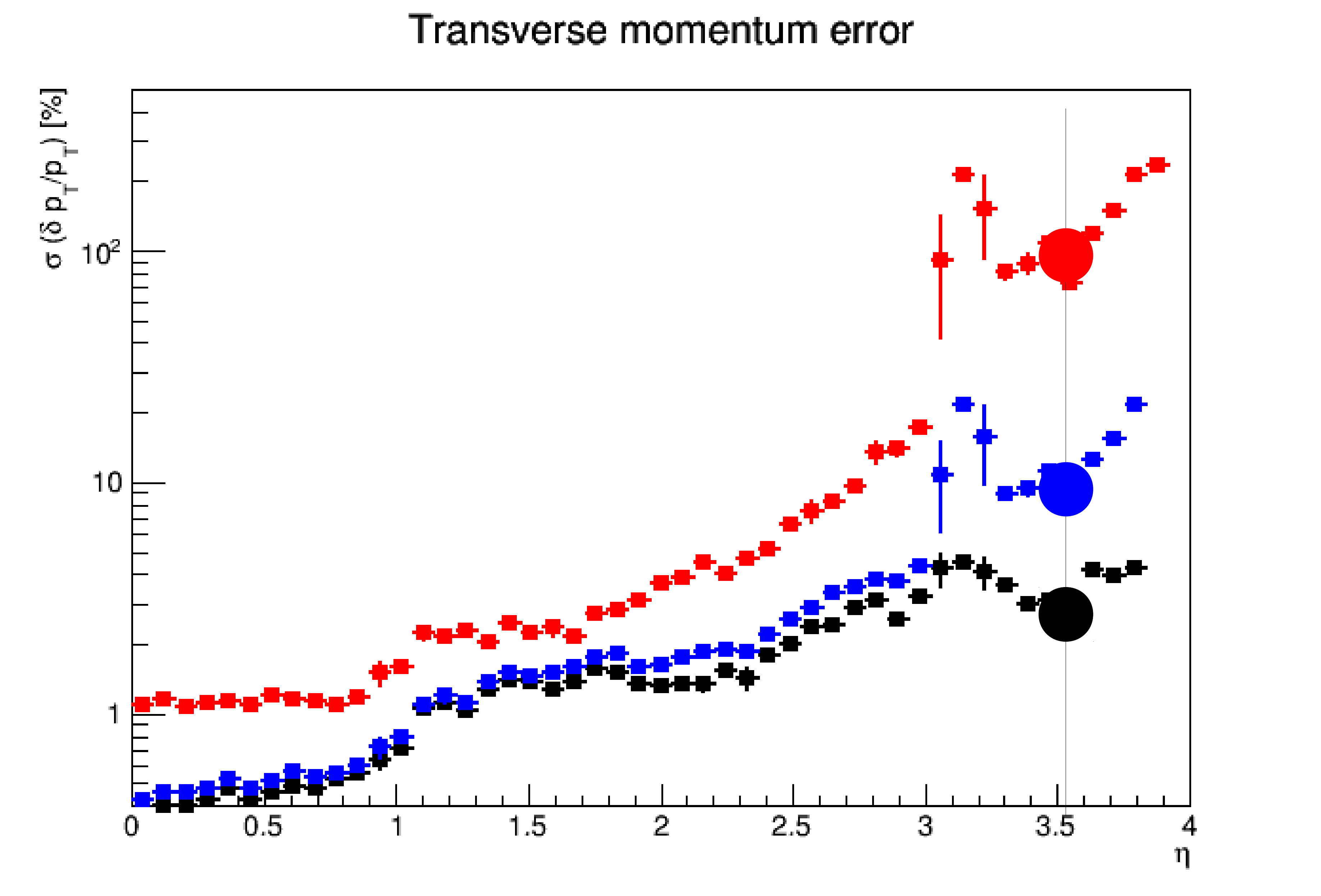
DELPHIZE!


Index of /~school06/TechnicalProposal2014/delphes - Mozilla Firefox
Index of /~school06/Tech...
www.desy.de/~school06/TechnicalProposal2014/delphes/
Google
Index of /~school06/TechnicalProposal2014/delphes
Name Last modified Size Description
Parent Directory 15-Nov-2014 14:59 -
EfficiencyFormula 19-Nov-2014 16:41 1k
ResolutionFormula 19-Nov-2014 16:41 4k
ptResolution.png 19-Nov-2014 16:41 9k
ptResolution.root 19-Nov-2014 16:41 29k
Apache/1.3.41 Server at www.desy.de Port 80

DELPHIZE!

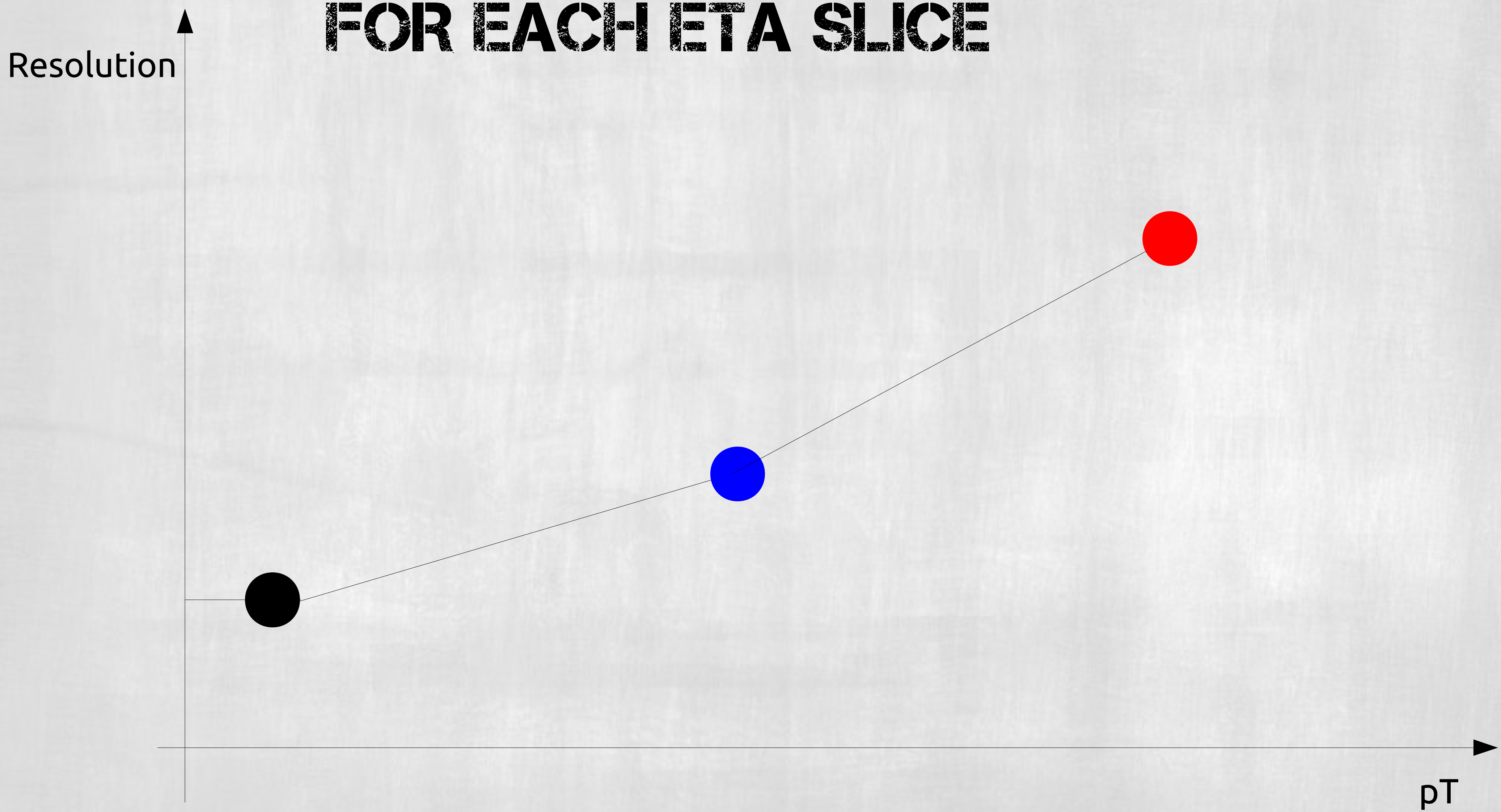


DELPHIZE!



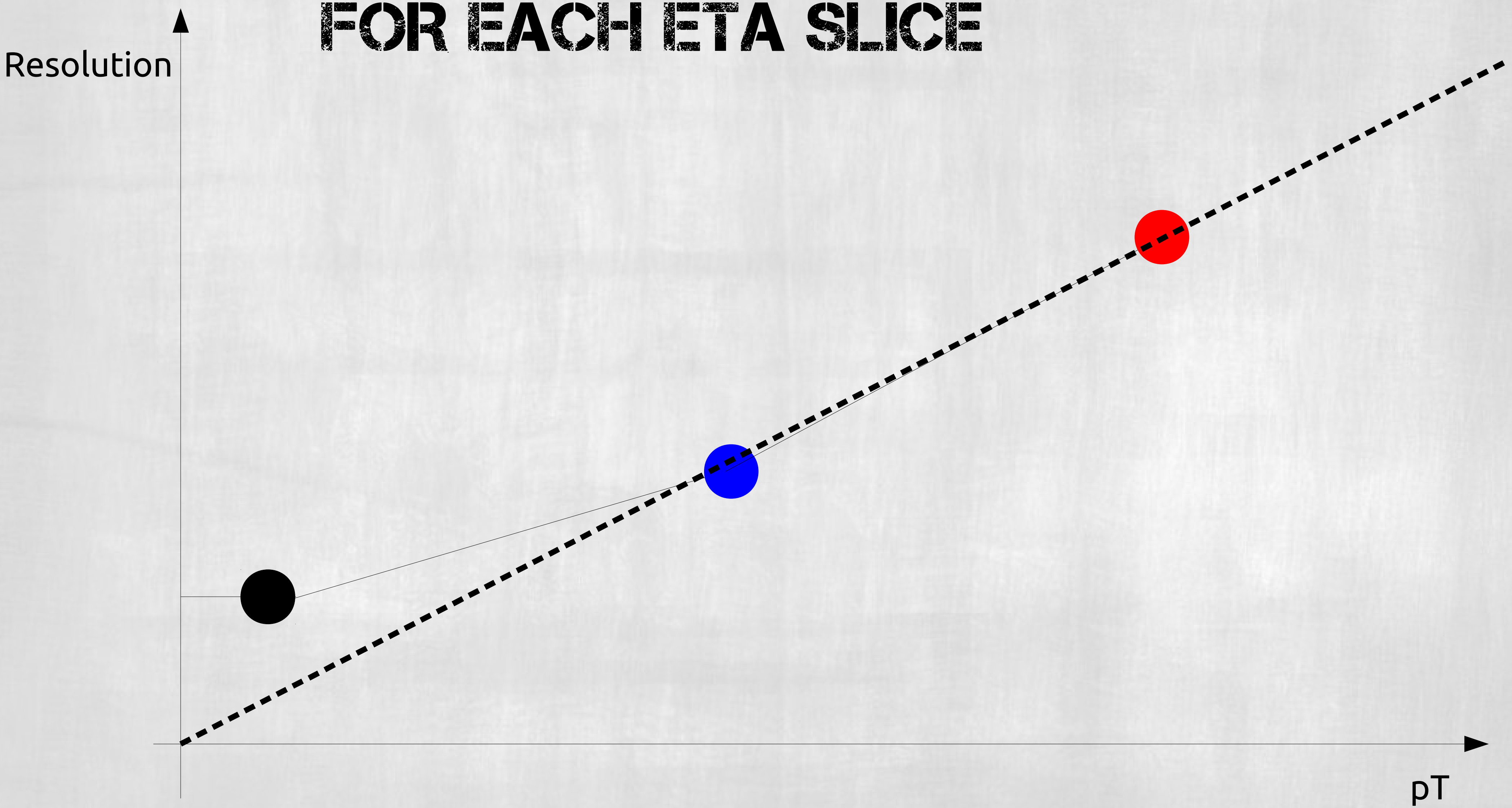
DELPHIZE!

FOR EACH ETA SLICE

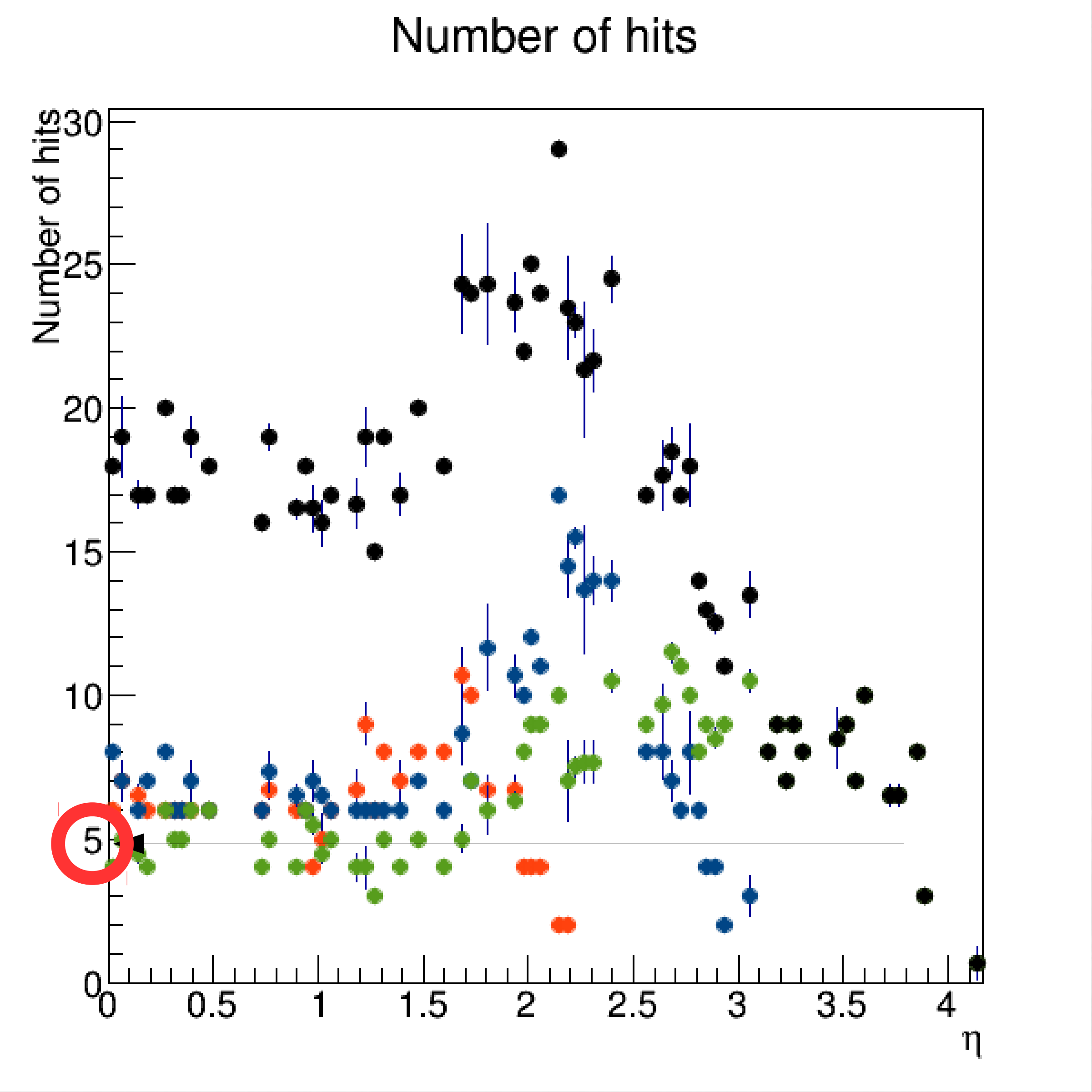


DELPHIZE!

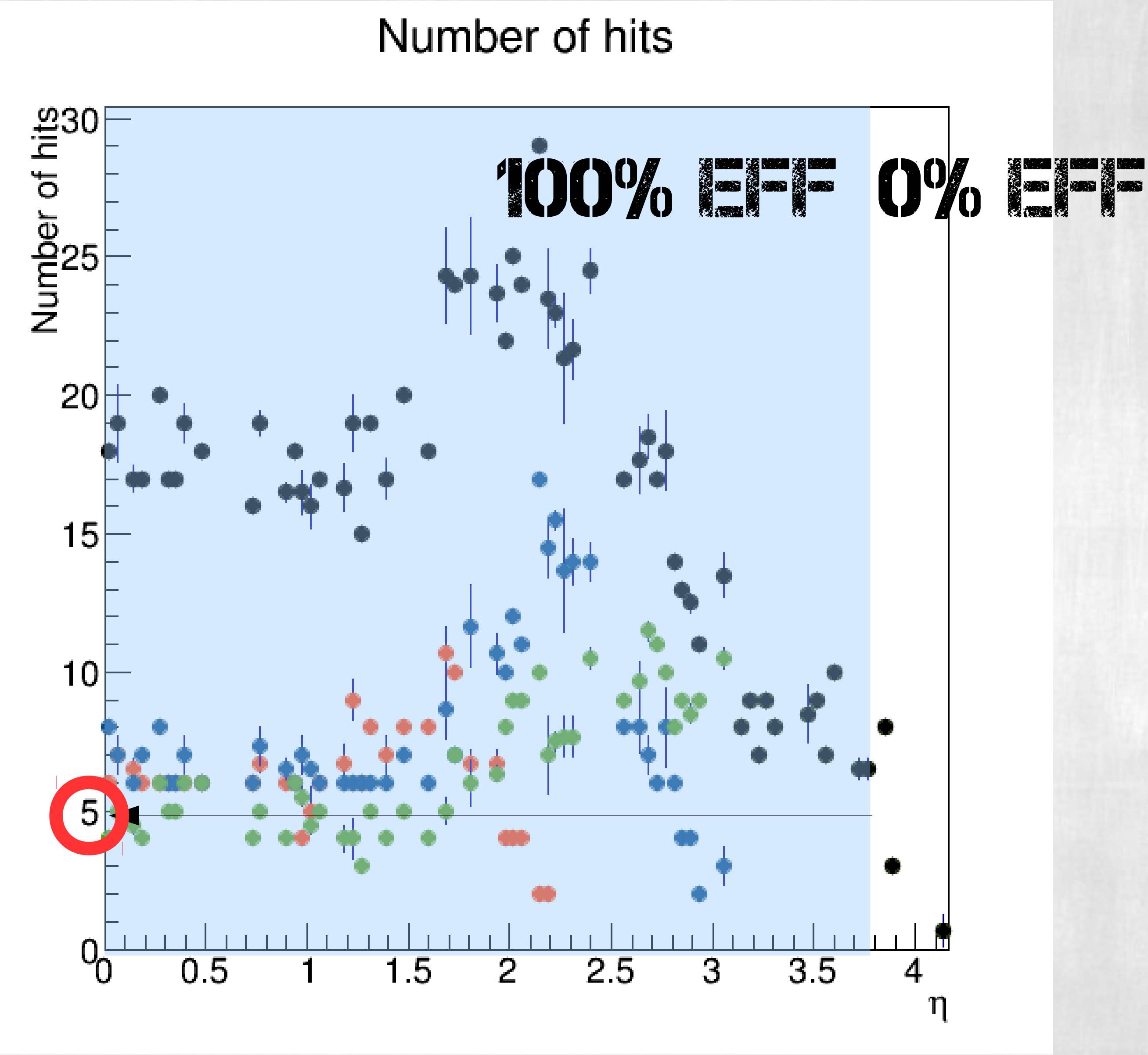
FOR EACH ETA SLICE



COVERAGE: EFFICIENCY



COVERAGE: EFFICIENCY



What can we do?

- In your exercise, please feel free to explore detector configurations
  - (even “funny” ones)
  - (in tkLayout you can even change the resolution of a sensor...)

- Try to understand and comment what would be the **hardware** implications of your choices, that might not be evident from tkLayout (yes, tkLayout is not an oracle)

WHAT CAN WE DO?

UNDERSTAND

HOW A DETECTOR CAN BE DESIGNED/OPTIMIZED

EXPLORE

THE PARAMETER SPACE

HIGHLIGHT

POSSBLE LIMITATIONS, DRAWBACKS,
TECHNOLOGICAL ISSUES

INSTRUCTIONS

www.desy.de/~school06/tkLayout.html

Please run the installer again (tklayout -v should say revision 1038)

I will be available for help during the long exercize

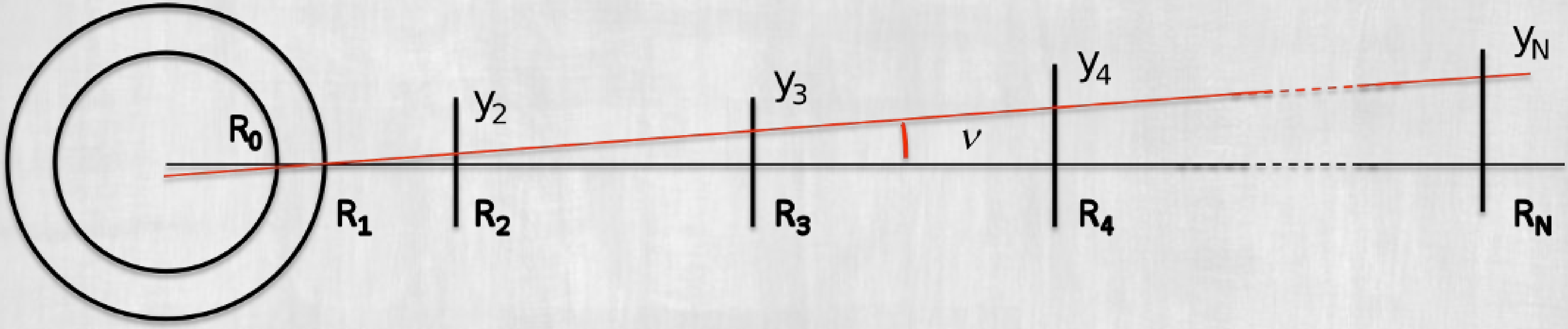
FORBIDDEN ACTIONS

None

Forbidden Actions

None, as long as you point out the R&D (or miracle) that's needed to achieve that :-)

USE OF COORDINATES



- The choice of coordinates was made to be non-degenerate for $p_T \rightarrow \infty$
- For high enough momenta, measurement error is only given by uncertainty on *y*
- The fit procedure will to minimize $\chi^2 = \sum_{i,j} \varepsilon_j C^{-1}_{i,j} \varepsilon_i$

$$\varepsilon_i = \frac{1}{2}\rho r_i^2 - (1+\rho d) r_i \sin(\phi_i - \phi_0) + \frac{1}{2}\rho d^2 + d - y_i$$

C is the error correlation matrix

W is the parameter estimate correlation matrix $W_{k,l} = \sum_{i,j} \frac{\partial \varepsilon_i}{\partial \alpha_k} C^{-1}_{i,j} \frac{\partial \varepsilon_j}{\partial \alpha_l}$

Evaluation of Error

- We do not need to have the hit points and perform the fit to estimate the error

$$W_{k,l} = \sum_{i,j} \frac{\partial \varepsilon_i}{\partial \alpha_k} C^{-1}_{i,j} \frac{\partial \varepsilon_j}{\partial \alpha_l}$$

- We only need

  The partial derivatives

  C

PARTIAL DERIVATIVES

- If the track is straight enough, that's trivial

$$\varepsilon_i = \frac{1}{2}\rho r_i^2 - (1 + \rho d) r_i \sin(\phi_i - \phi_0) + \frac{1}{2}\rho d^2 + d - y_i$$

$$\begin{aligned}
\frac{\partial \varepsilon_i}{\partial \alpha_1} = \frac{\partial \varepsilon_i}{\partial \rho} &= \frac{1}{2} r_i^2 \\
\frac{\partial \varepsilon_i}{\partial \alpha_2} = \frac{\partial \varepsilon_i}{\partial \phi} &= -r_i \\
\frac{\partial \varepsilon_i}{\partial \alpha_3} = \frac{\partial \varepsilon_i}{\partial d} &= 1
\end{aligned}$$

MULTIPLE SCATTERING

- Multiple scattering computed on modules & inactive materials
- 3 momenta used

  1, 10 and 100 GeV/c

$$\sigma_{n,m} = \langle y_n y_m \rangle = \sum_{i=1}^{n-1} (x_m - x_i)(x_n - x_i) \langle \theta_i^2 \rangle$$