Study of alignment procedure for OPERA emulsion brick

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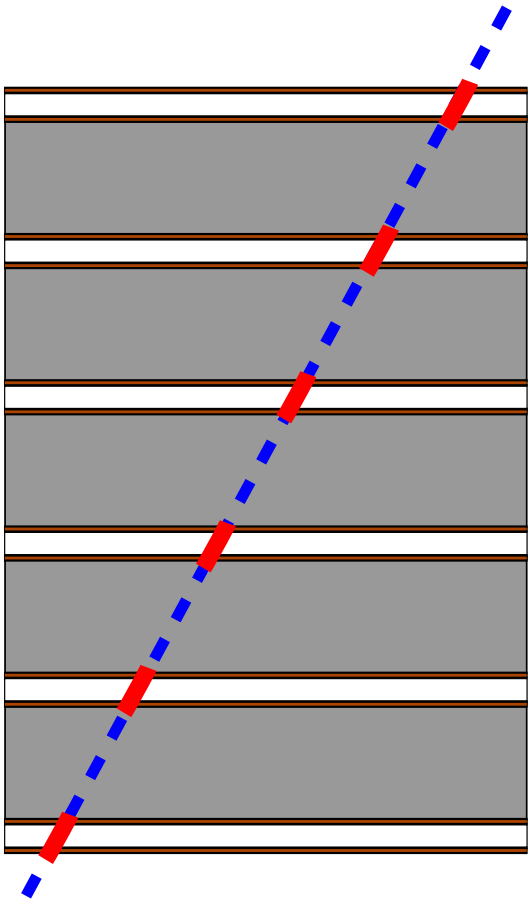
Outline

OPERA Brick

Emulsion Cloud Chamber

- $(DX) \times (DY) = 128 \times 103\ \mathrm{mm}^2$
- Length $(DZ) = 81\ \mathrm{mm}$
- 56 Pb plates $d = 1\ \mathrm{mm}$
- 57 Emulsion plates
  $d = (44 + 205 + 44)\mu\mathrm{m}$

Geometrical defects



- Plates misalignment

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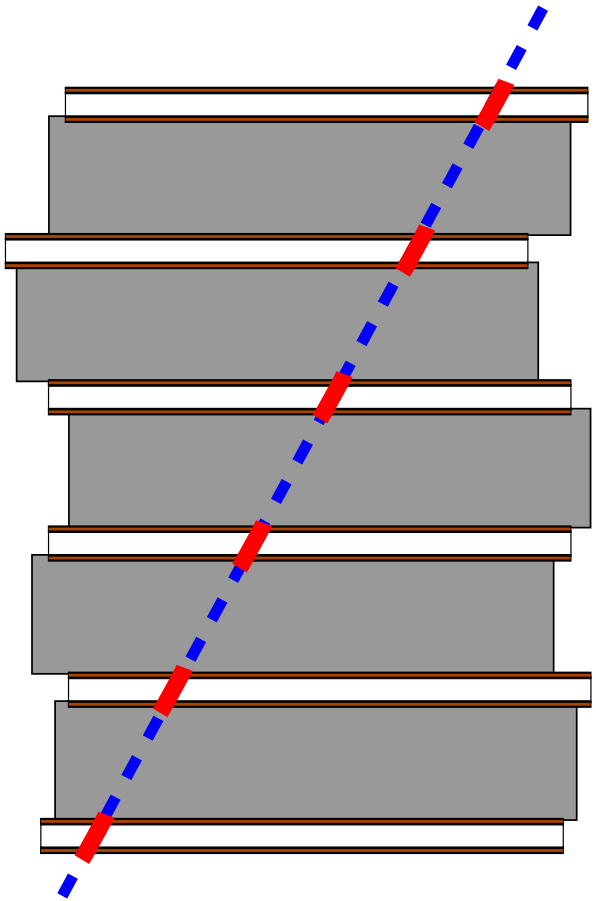

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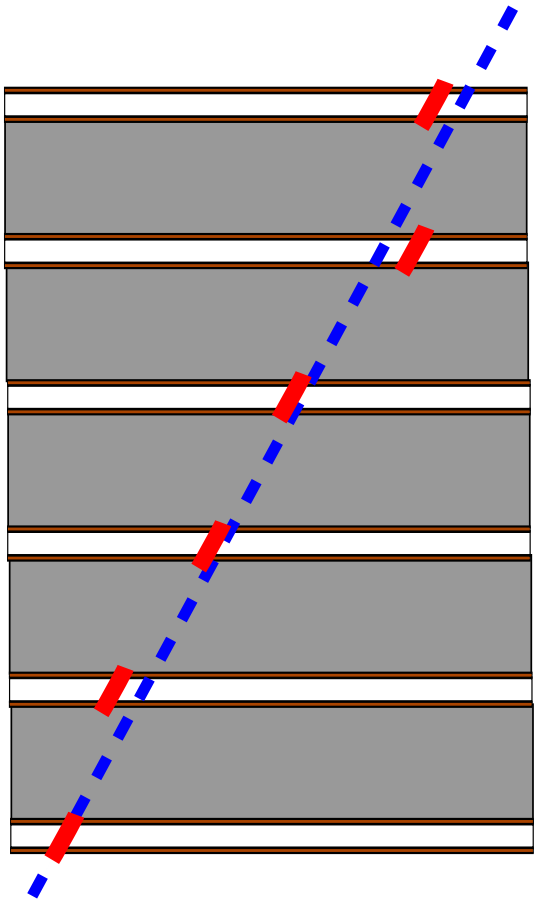

- Plates misalignment — 2D affine tranforms:

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} + \begin{pmatrix} b1 \\ b2 \end{pmatrix}$$

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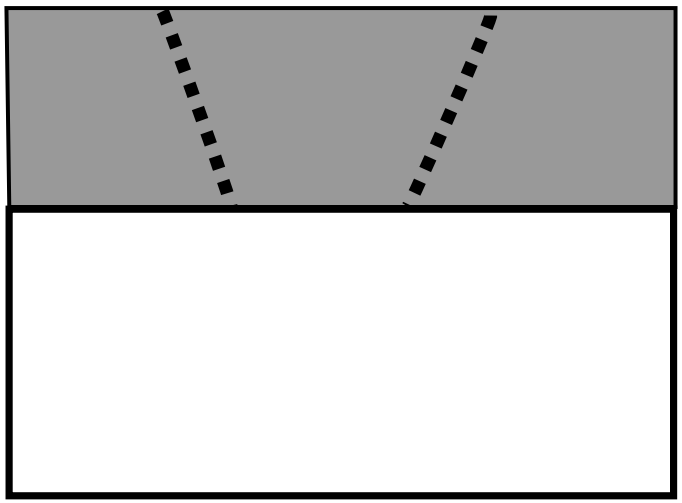

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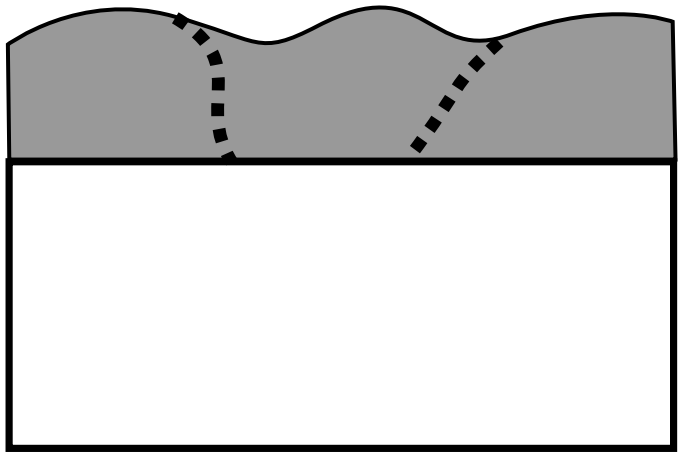

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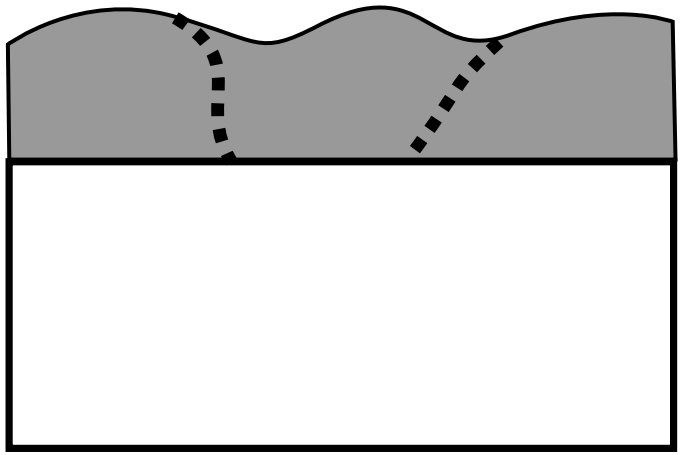

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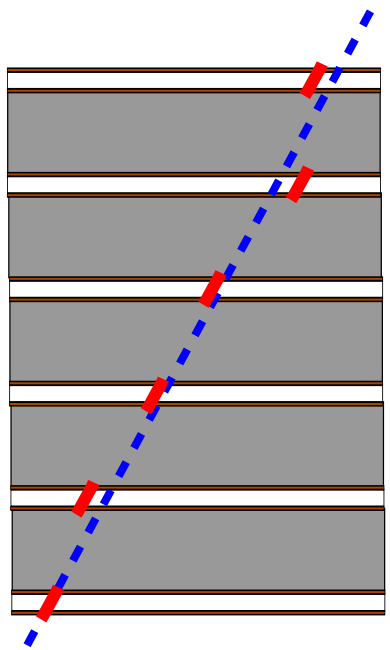

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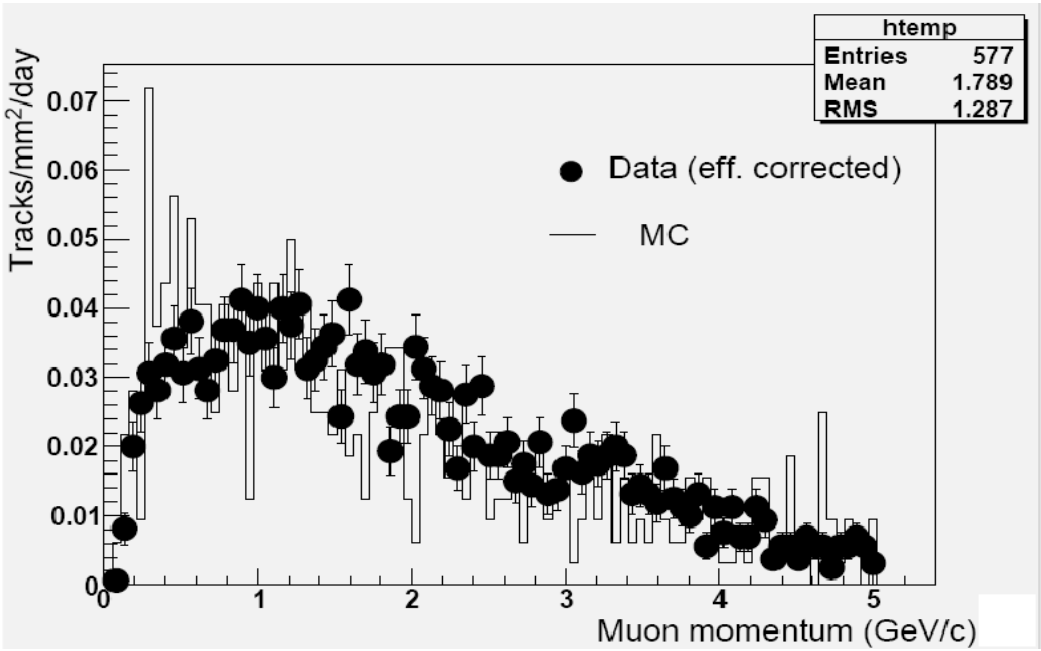
- CR exposure (Gran Sasso)

Cosmic Rays at Gran Sasso



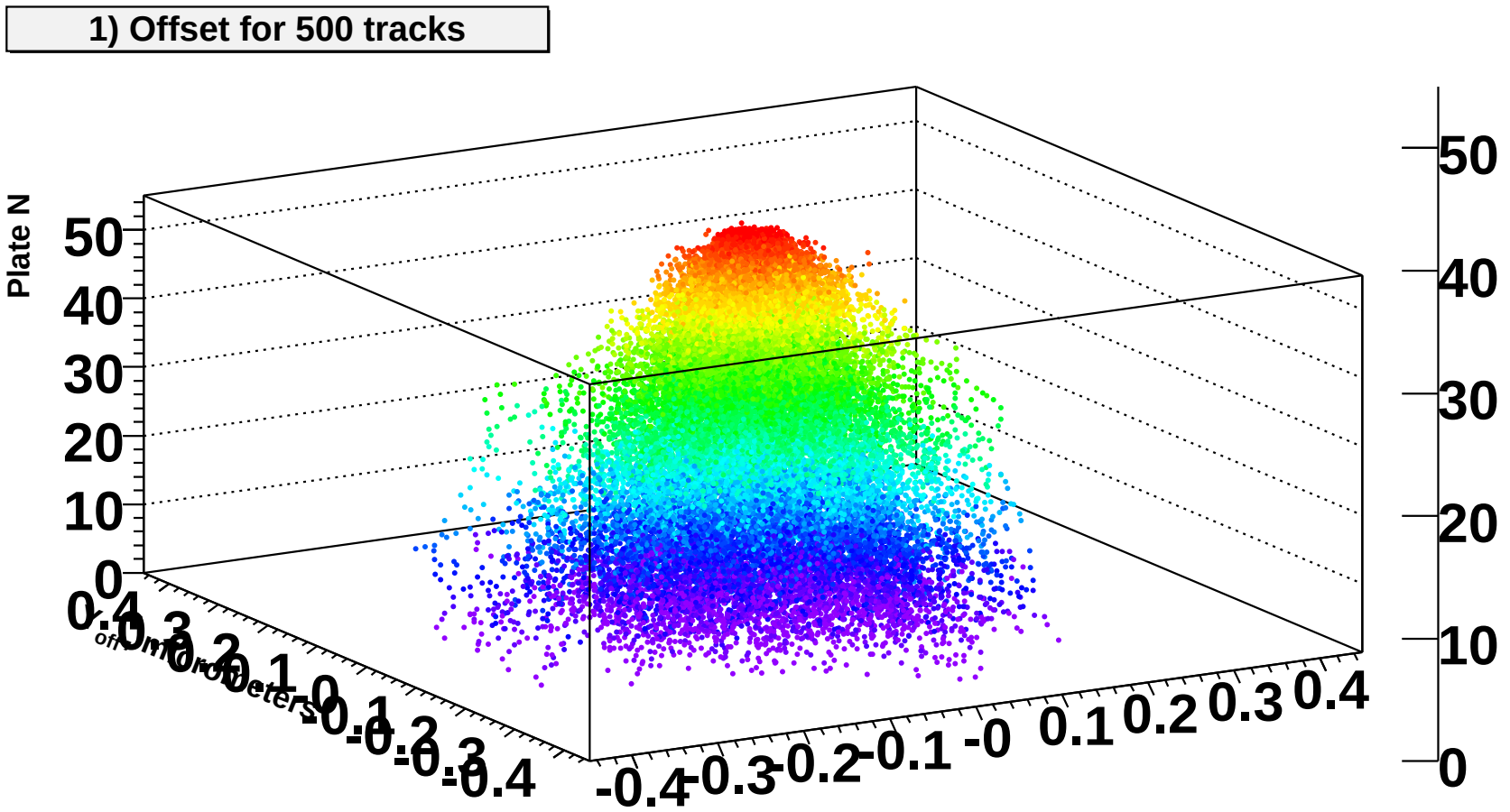
CR exposure

- flux is about $2 tracks/\mathrm{mm}^2/400 mrad$ per day of exposure
- about 70% with $E > 1$ GeV
- about $< 10\%$ are e^- (the rest are all μ^-)

Analisys scheme

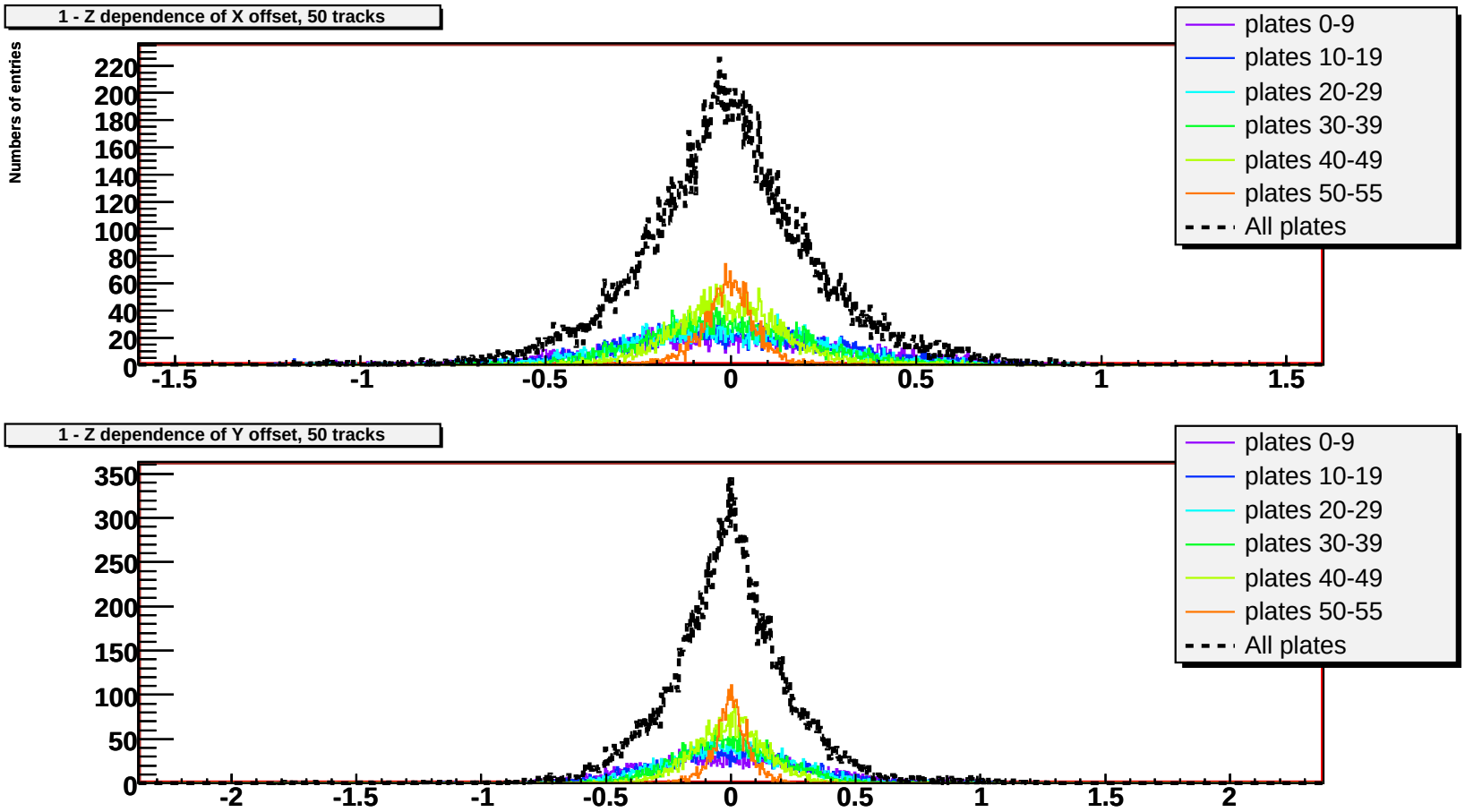
- Simulation of CR μ^- tracks in unshifted ECC brick — FedraVMC
- Alignment procedure (shifts only) — FEDRA
- Results of alignment $\{X_{off}, Y_{off}\} \Rightarrow \{\sigma_x, \sigma_y\}$
- Obtain dependences: $\sigma = \sigma(N_{tracks}, E_\mu, \theta_{max})$

X_{off} and Y_{off} distributions



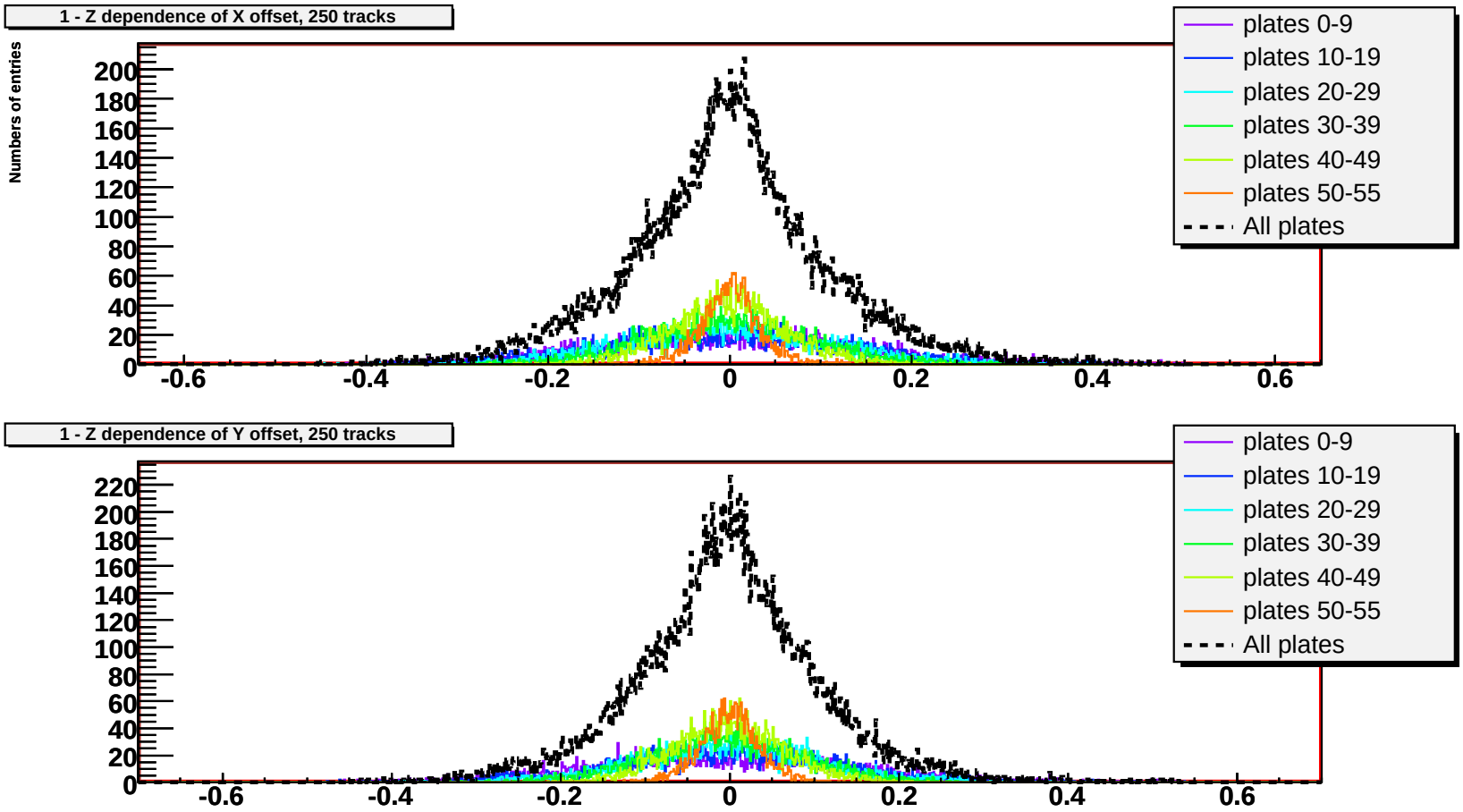
X_{off} and Y_{off} distributions

50 *tracks*



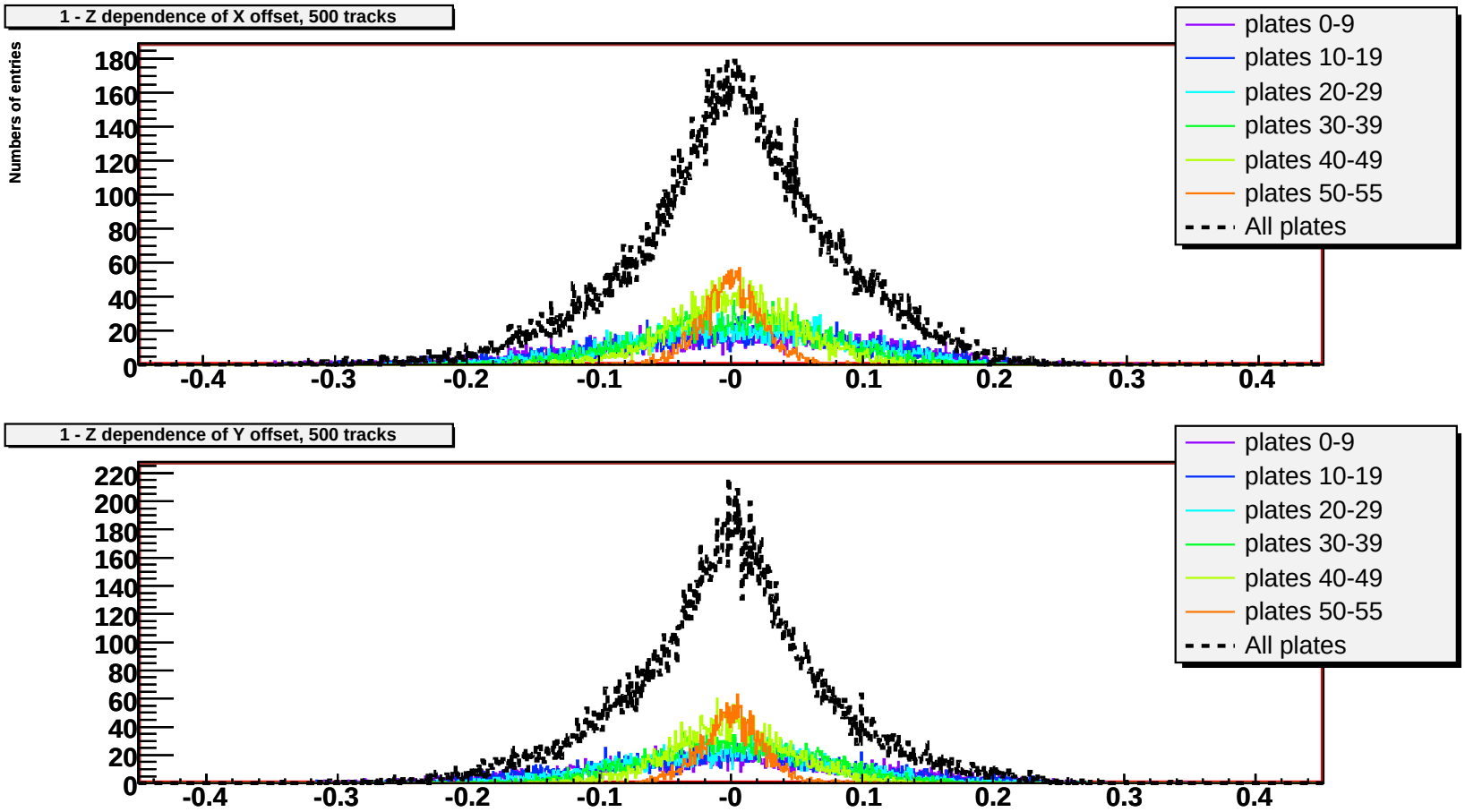
X_{off} and Y_{off} distributions

250 *tracks*



X_{off} and Y_{off} distributions

500 *tracks*



Exposure duration

N_{tracks}	20	30	50	100	500
$\delta\theta$	31%	19%	11%	6%	2%
$\sigma, \mu\mathrm{m}$	0.7	0.61	0.46	0.33	0.15

- Alignment accuracy improves tracking quality
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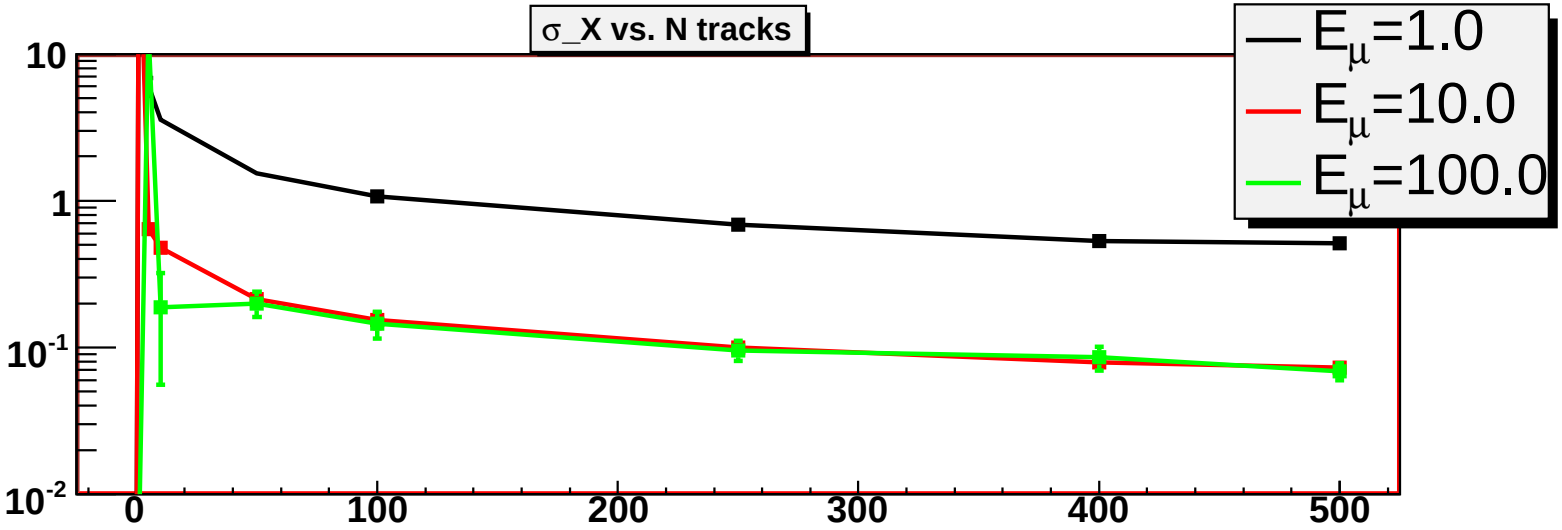
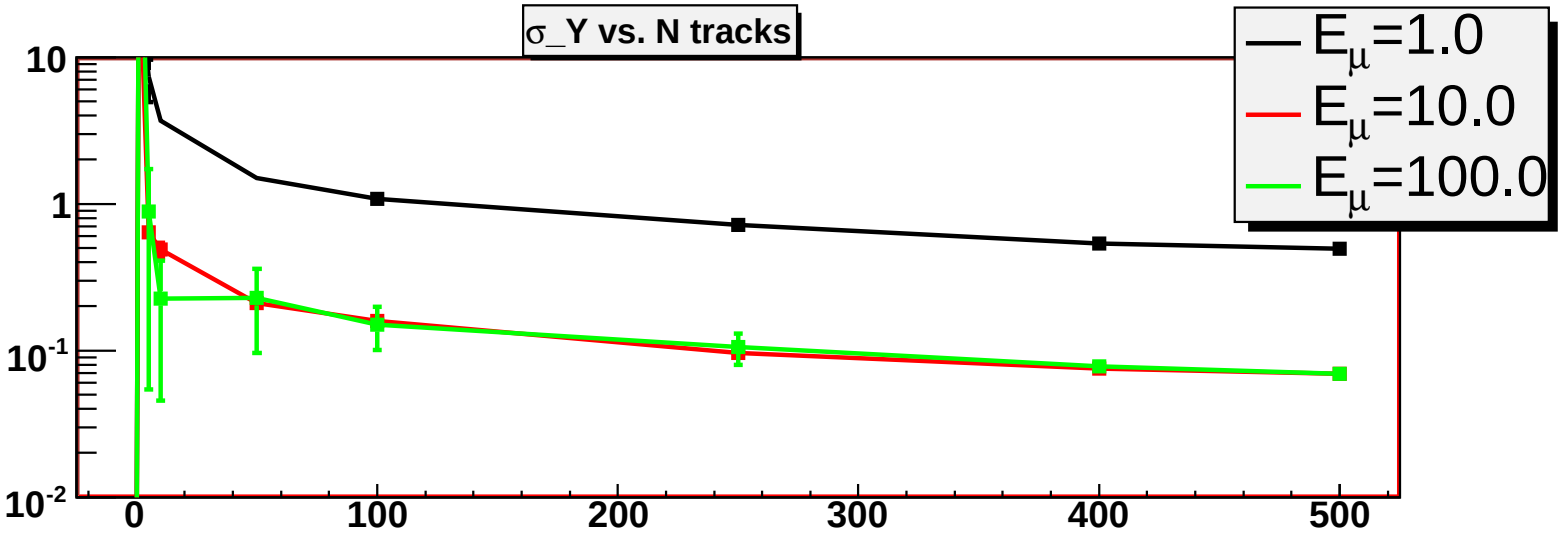
$$\Downarrow$$

Need analysis of $\varepsilon_{tr}(N_{tracks})$

Exposing conditions





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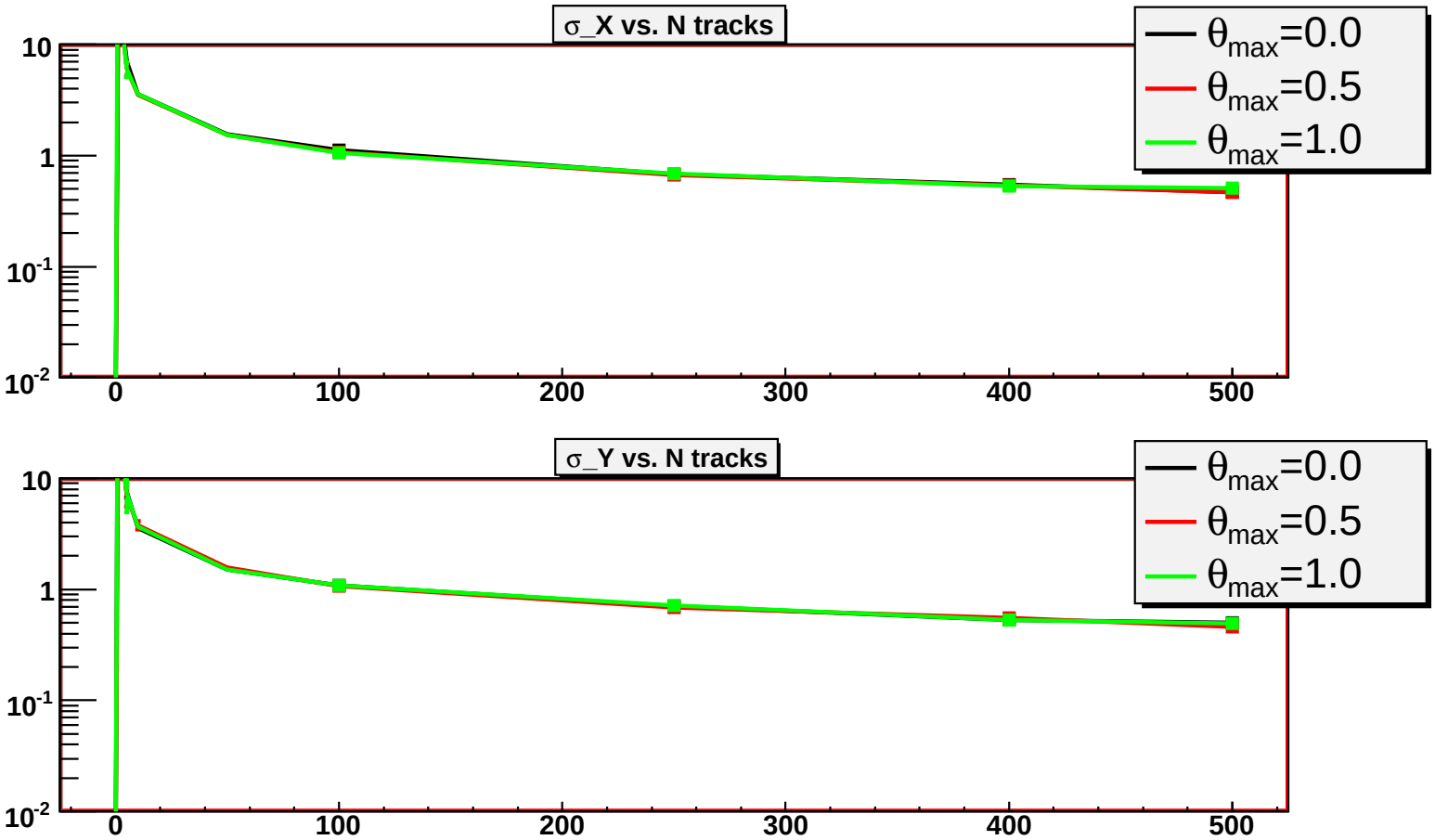

Conclusions

- MC analisys of full brick alignment shows to be useful.
- Resolution of alignment procedure had been calculated.
- There is room for alignment procedure improvements
- Full spectrum of CR μ^- to be simulated
- Tracking quality dependence on N_μ needs to be analised — to determine optimal T_{exp}