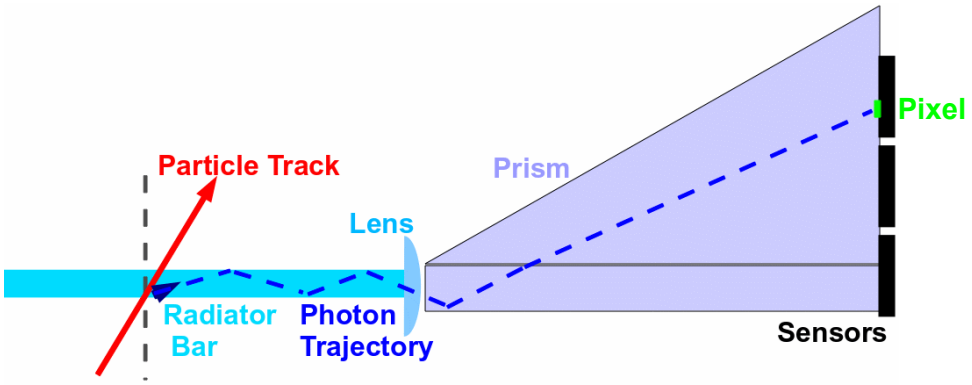
Activities @ GSI

- Test beam data / simulation
- Maximum Likelihood approach for PID
- DIRC resolution requirements
- Bar squareness measurements
- Bars from Zygo LOT

Data Analysis Cherenkov angle reconstruction method



Method similar to BaBar-DIRC:

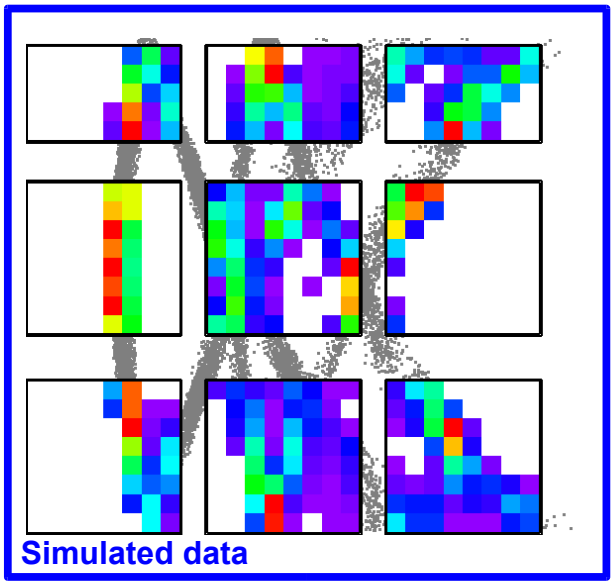
Pixel position + bar location define photon direction at bar end, stored in "Look-up table", combined with particle track to calculate Θ_C.

Single photon Cherenkov angle resolution:

- Effective bar size $\sigma_{bar} \approx$ **15.0 mrad**
- Effective pixel size $\sigma_{pixel} \approx$ **5.9 mrad**
- Chromatic effect $\sigma_{\lambda} \approx$ **5.0 mrad**

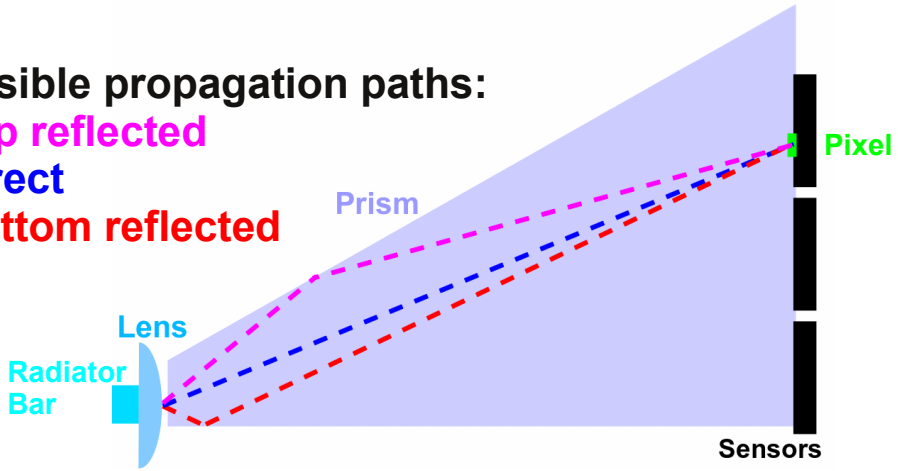
Combined resolution $\sigma_{\Theta c} \approx$ **16.8 mrad**

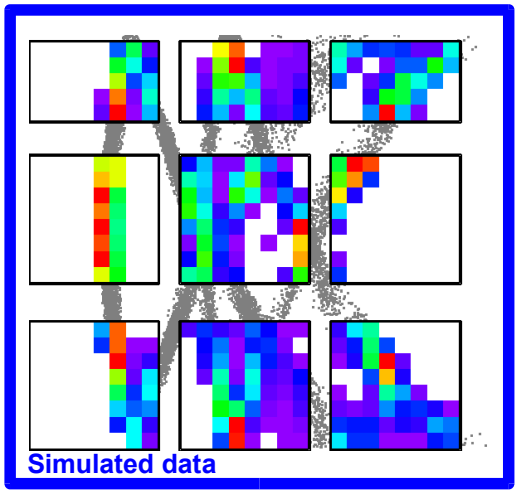
With focusing $\sigma_{\Theta c} \approx$ **9.1 mrad**



Data Analysis Single photon Cherenkov angle reconstruction

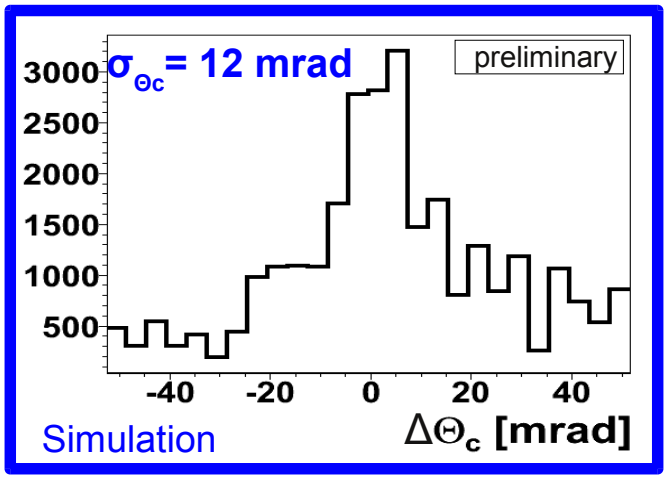
Possible propagation paths:
- **Top reflected**
- **Direct**
- **Bottom reflected**



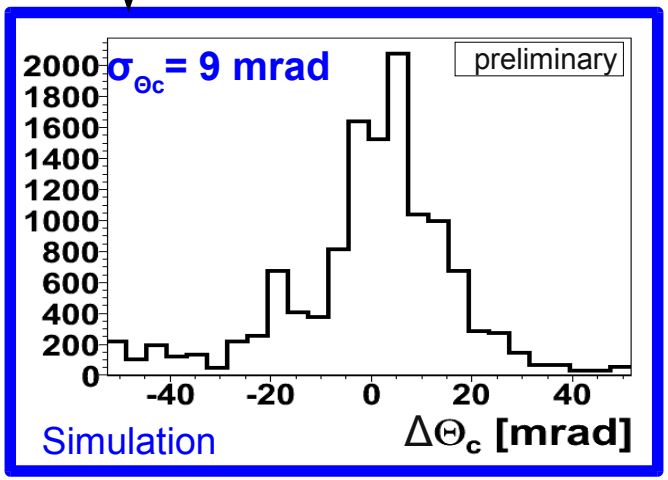


- **Path pixel – bar not unique**
  combinatorial background in Θ_C not easy to handle even in Monte Carlo data.
- **Time cut**
  ($t_{measured} - t_{expected}$) improves resolution in simulation. Timing resolution in test beam data not sufficiently good.

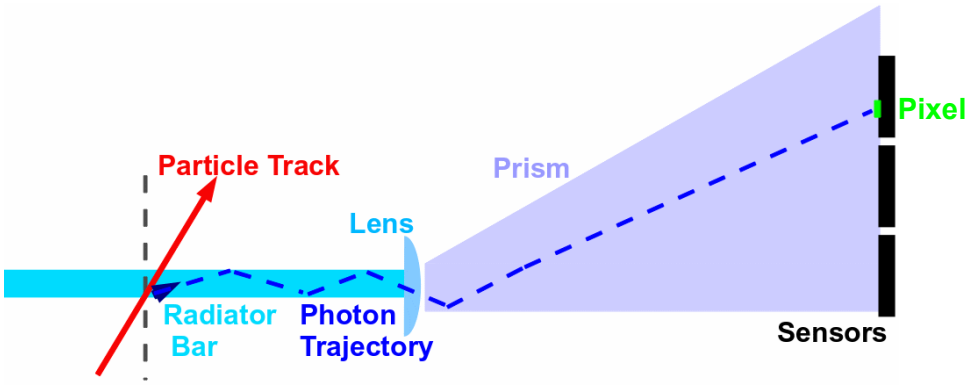
$\Delta\Theta_C$ (measured – expected) :



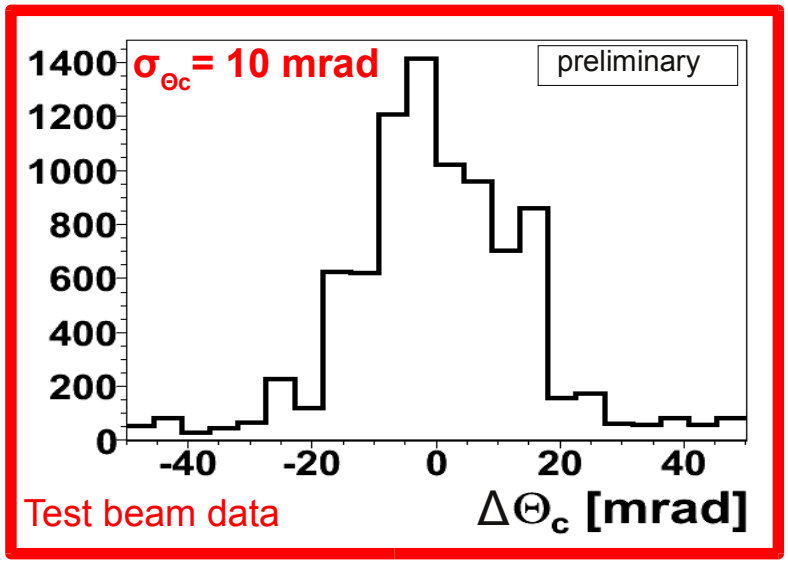
Time cut

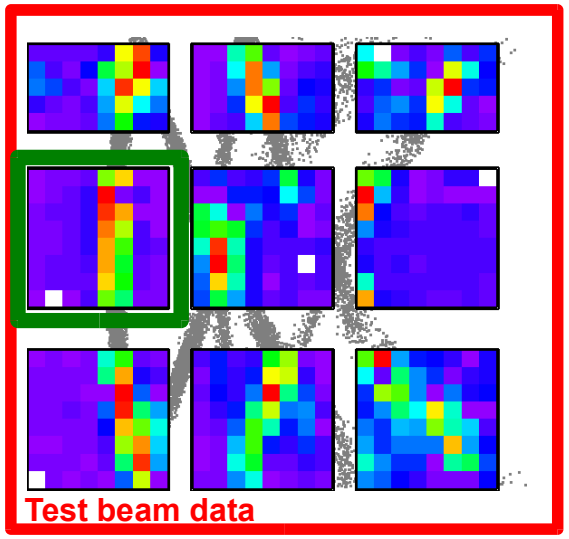


Data Analysis Single photon Cherenkov angle reconstruction



- **Using combined runs from fine angular scan study** (122.4º – 124.4º particle track).
- **First look at test beam data single photon Cherenkov angle resolution.**
  Just one MCP to avoid background from overlapping ring segments.
- **Study to include all MCPs in analysis in progress.**



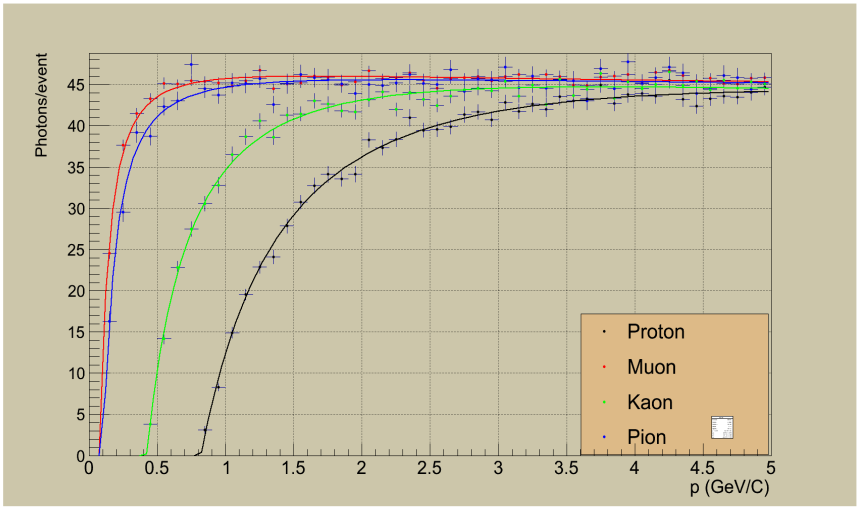


Maximum Likelihood approach for PID

$$L_N = \frac{1}{\sqrt{2\pi\sigma_N^2}} \exp\left(-\frac{(N - N_{est})^2}{2\sigma_N^2}\right)$$

$$L_\theta = \frac{1}{\sqrt{2\pi\sigma_\theta^2}} \exp\left(-\frac{(\theta - \theta_{est})^2}{2\sigma_\theta^2}\right)$$

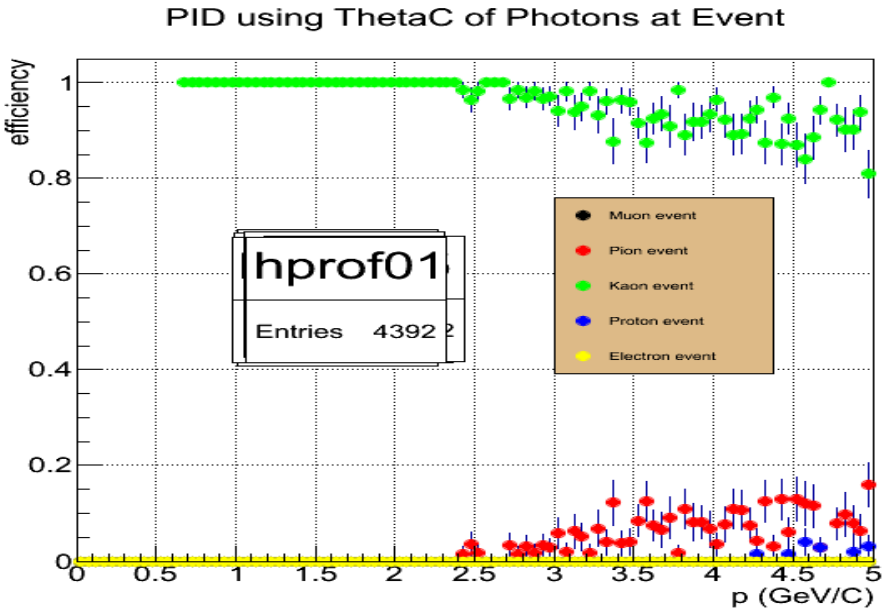
$$L = L_\theta x L_N$$



- **First approach**

Decision about the PID is just maximum of the normalized likelihood values without considering the background.

- **Second Approach**
  - **Extended maximum likelihood method which incorporates the background and the photons in the same function**
  - **Decision of the PID is based on relative number of photons in the maximum likelihood bin.**
  - **This work is in progress!!!!!!**



Study of the required DIRC resolution

No focussing

Based on the PID TAG report

Toy MC simulation (no particle tracking, all the detector responses are parametrized) using macros from Klaus G.

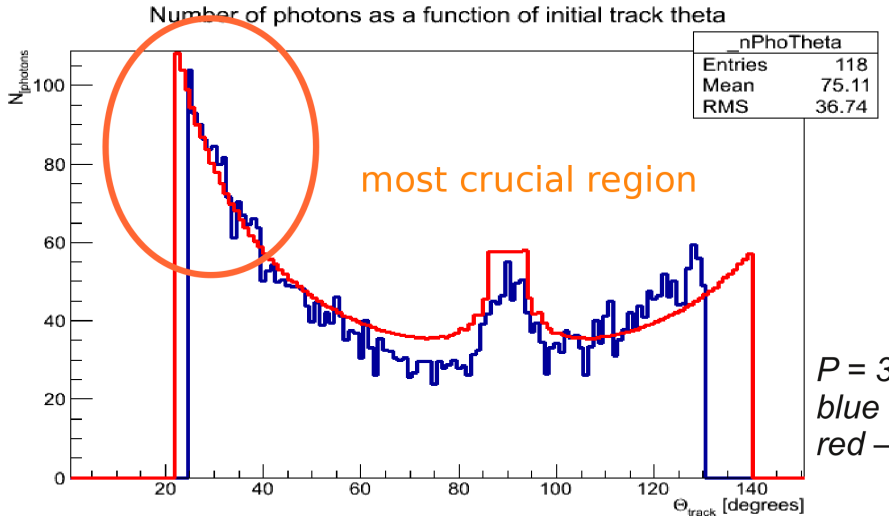
Basic DIRC parameters (assuming the simple geometry):

SPR = 18 mrad (10 – in PID TAG report)

Photodetector efficiency = 8.8 % (7.5%)

Tracking resolution = 1 mrad (0 mrad)

N photons is parametrized (λ1 = 290nm, λ2 = 580nm):



P = 3 GeV/c,
blue line – PandaRoot
red – parametrization

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Barrel DIRC parametrized signal

Assuming gaussian signals, the DIRC output: Θ_c and σ for each particle type, momentum, polar angle,

$\sigma^2 = (SPR/sqrt(N_\gamma)) + \sigma_{corr}^2$

Θ_c (p, type, $n_{average}$)

Approaches:

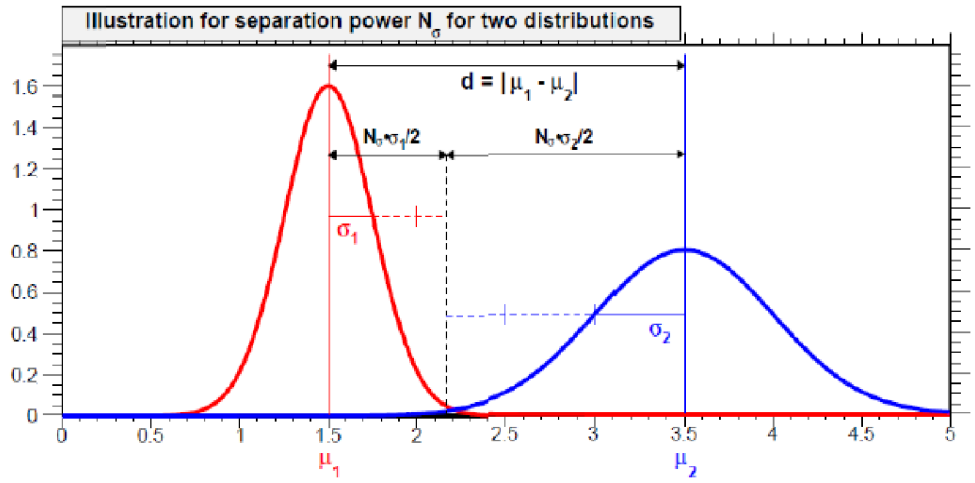
1. cut is defined by the separation power (as in PID TAG report)

2. the efficiency of K id is fixed to 95%, thus the cut is defined

Separation Power

- Measure for distance between probability distributions relative to their widths
- With Gaussian PDFs, separation power was defined as

$$N_\sigma = \frac{|\mu_1 - \mu_2|}{\sigma_{avg}} = \frac{|\mu_1 - \mu_2|}{(\sigma_1/2 + \sigma_2/2)}$$



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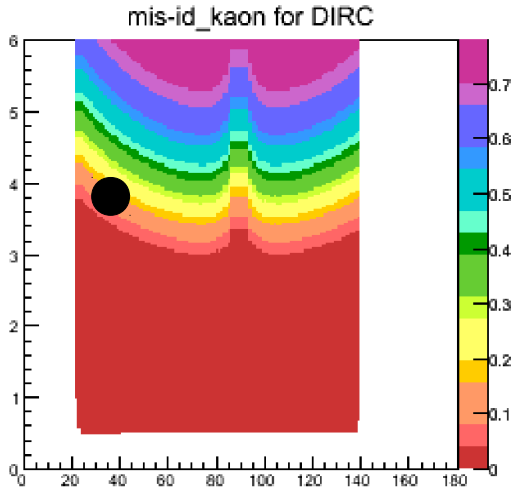
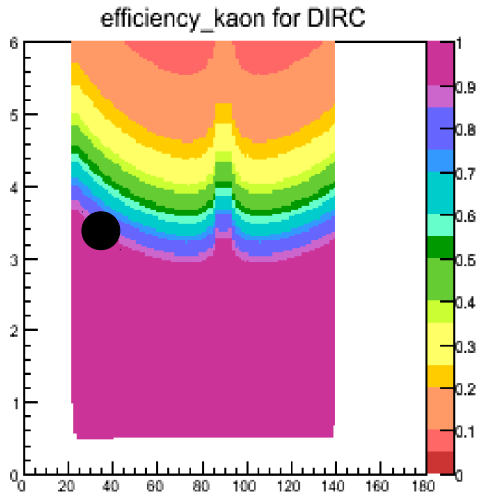
Hard cuts

Eff=0.95



0.1

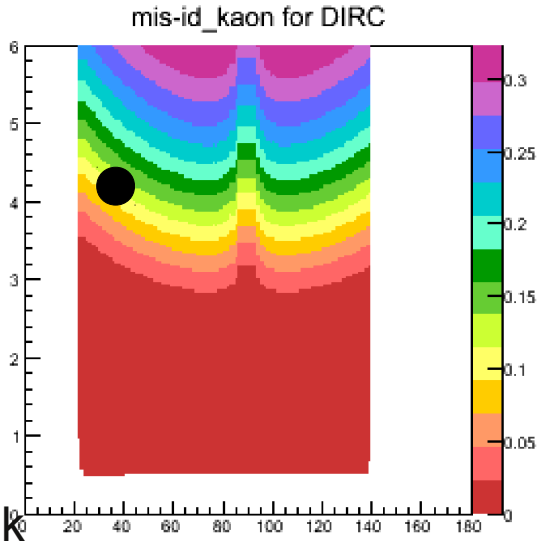
MisId=0.01



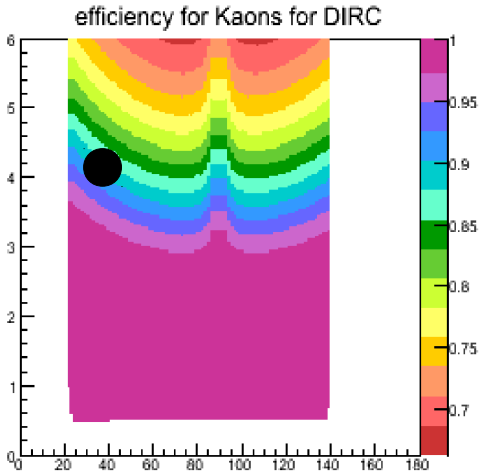
0.9

Pid-Tag cuts

PID-TAG



PID-TAG



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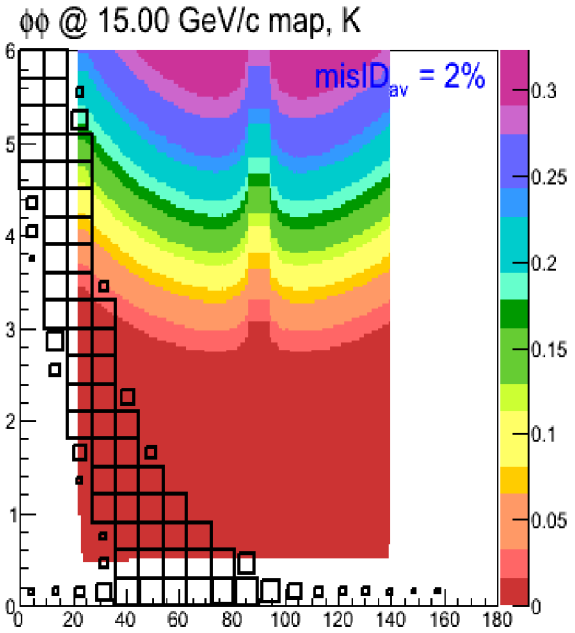
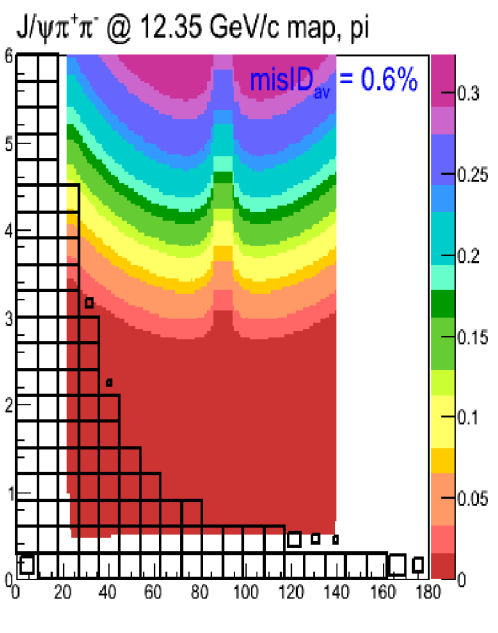
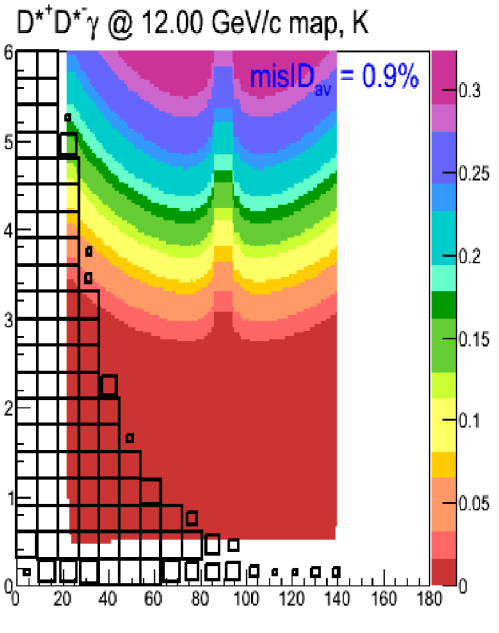
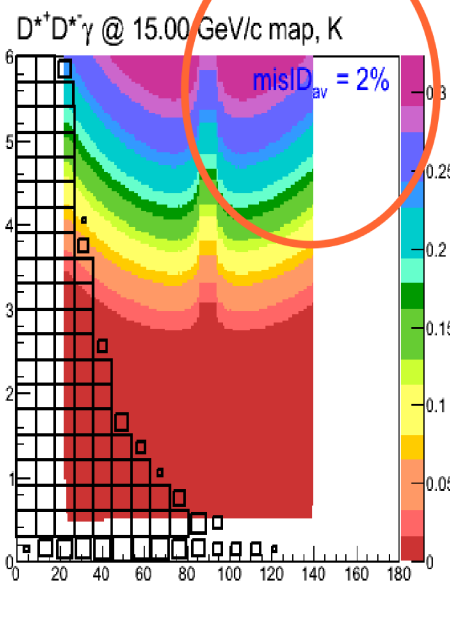
Maximal mis-id

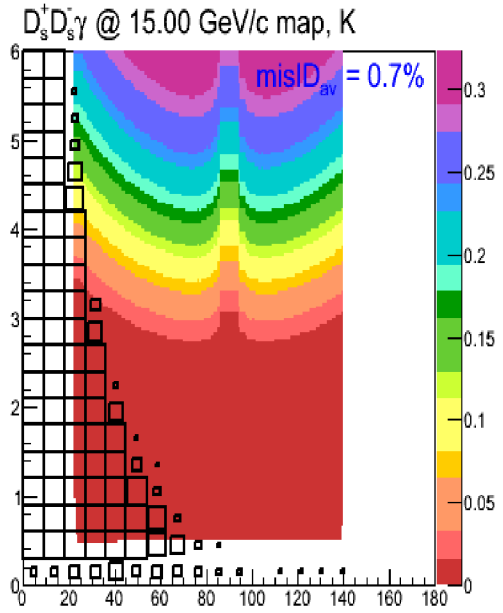
Mis-id for some channels (as in PID TAG report)

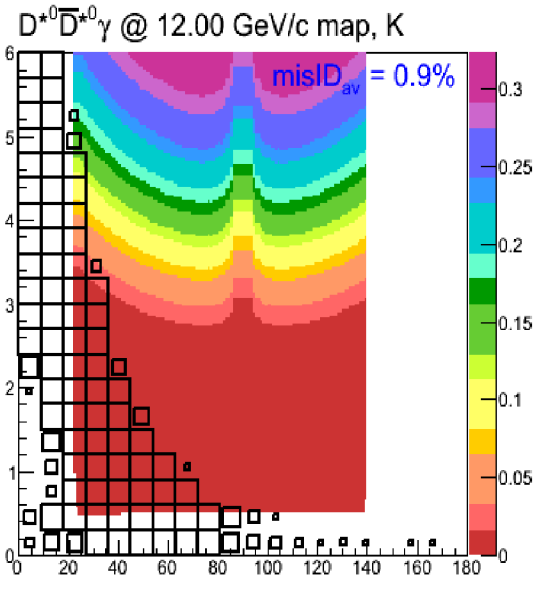


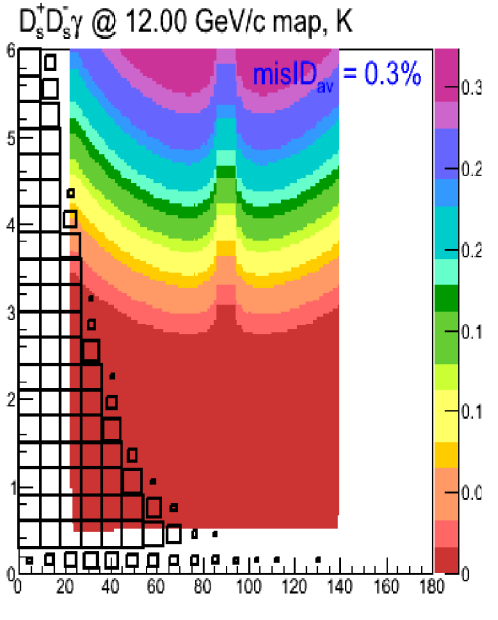


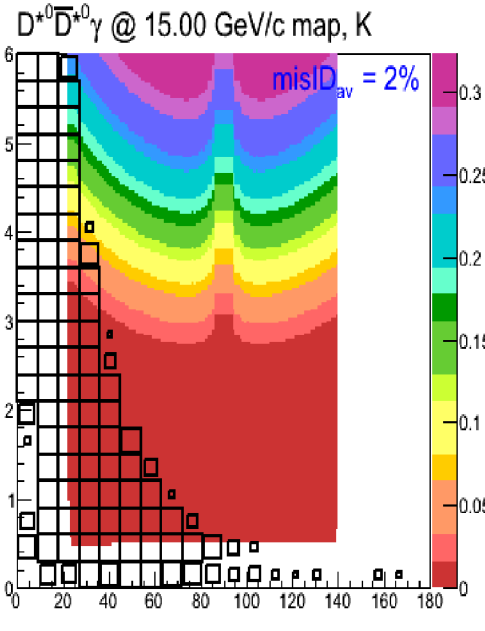








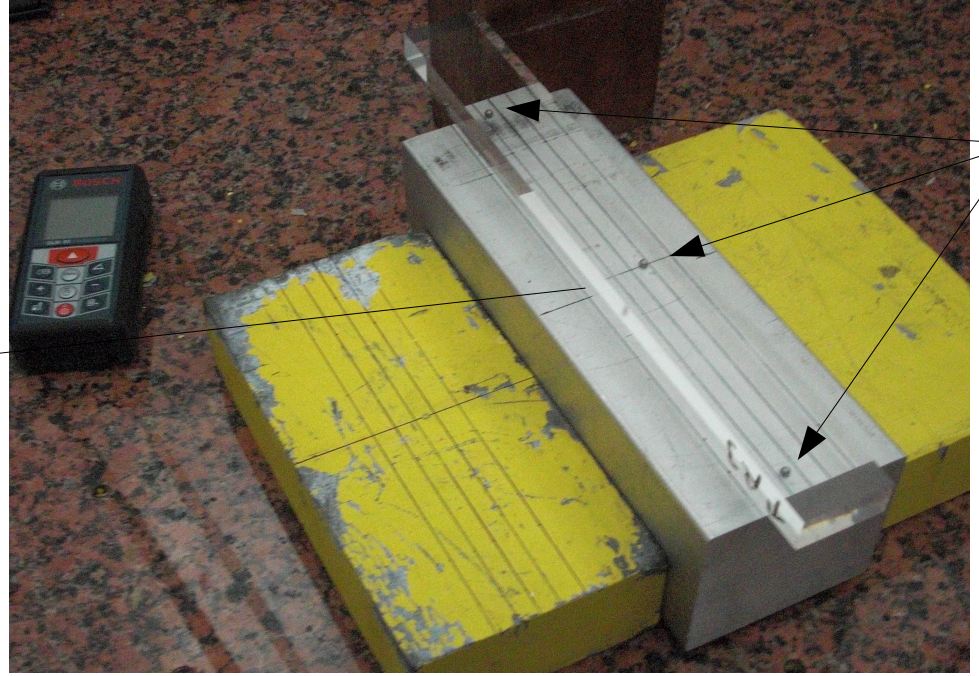


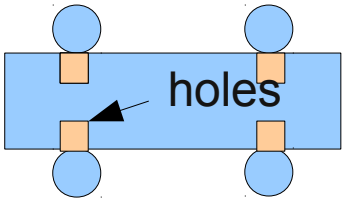


15 channels out of 60 have mis-id>0.5%

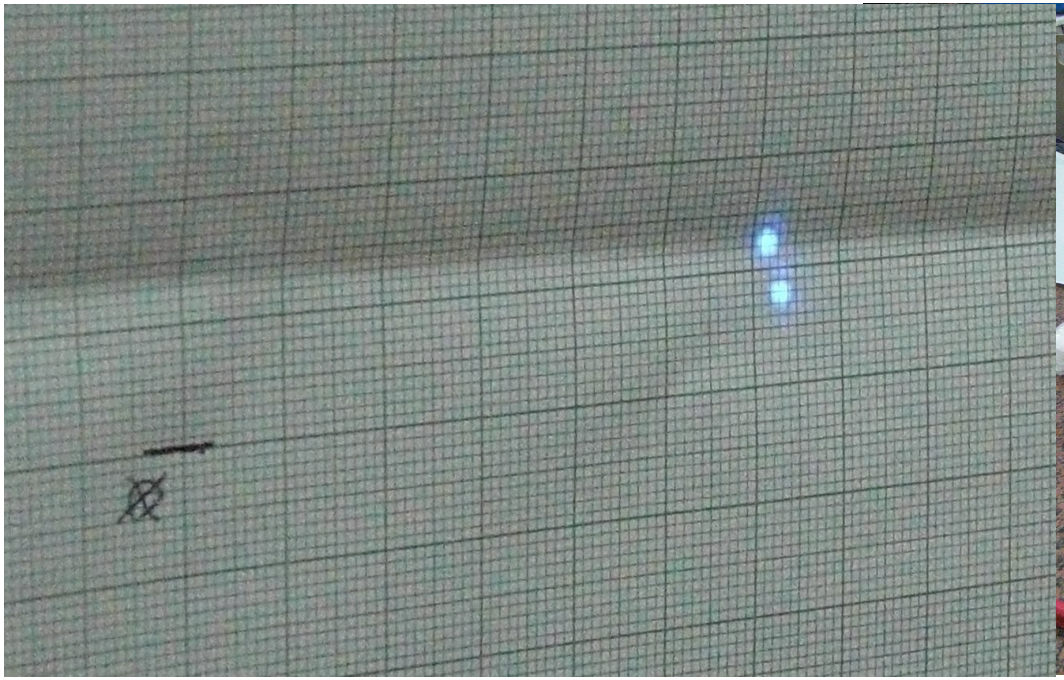
Results without focussing

Bar measurements – Squareness –





And bottom



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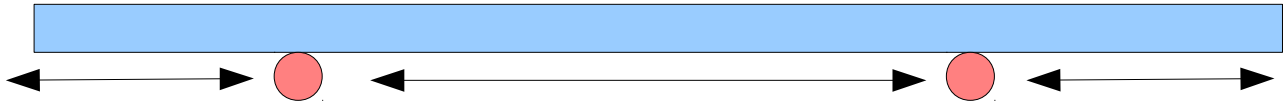
Improved mechanical setup

Bar rests on steel balls (3mm dia.)
...plastic balls are no option...

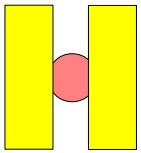


20% 60% 20%

→ minimizes bending of bar

Easy to align (marker)

Improved alignment
of single ball
(before: 0.2 mrad differences)



Rotation of balls caused deviations of
0.05 mrad → fixed with tape

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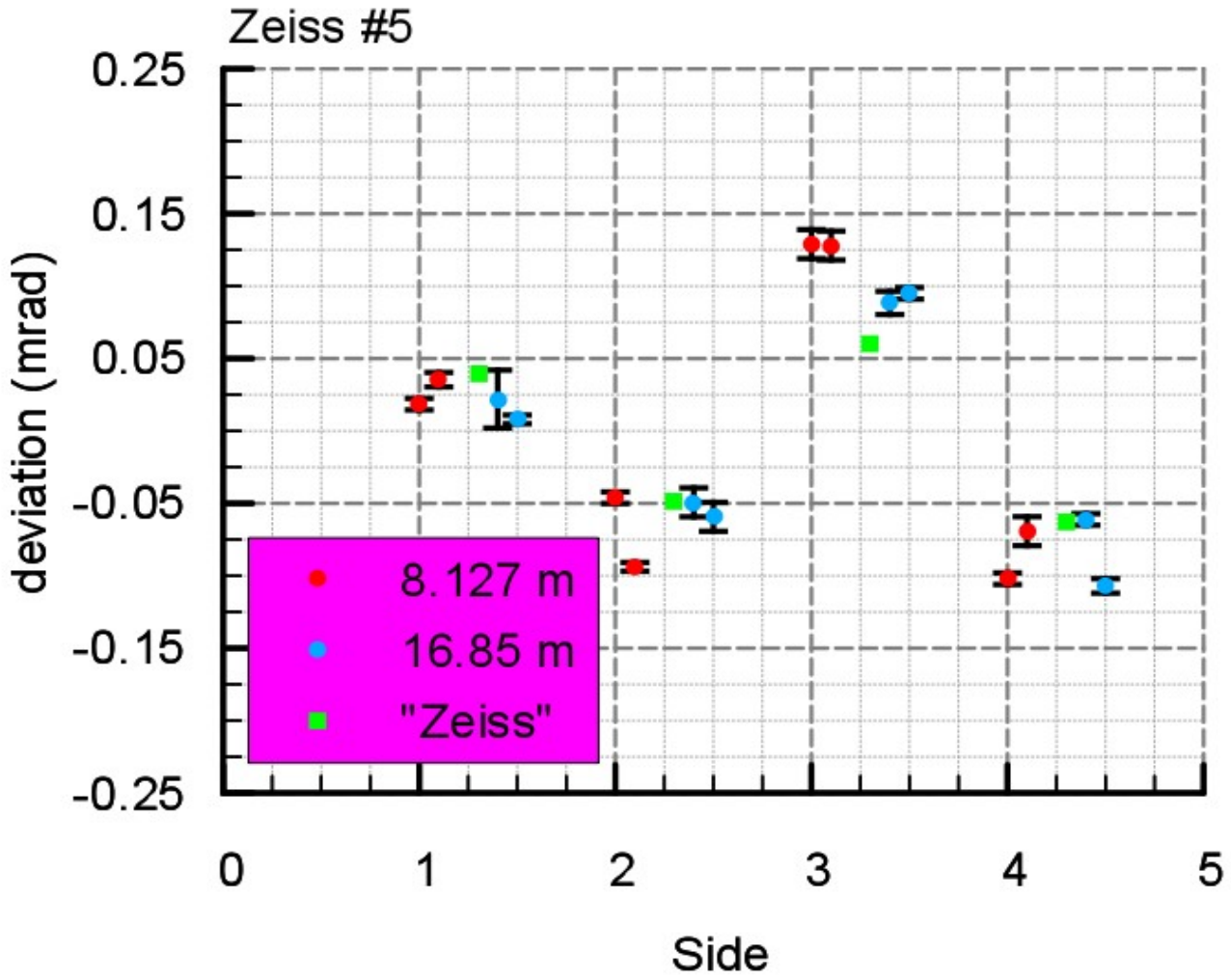

Limits of method are visible (<0.050 msr).

Future → Autocollimator

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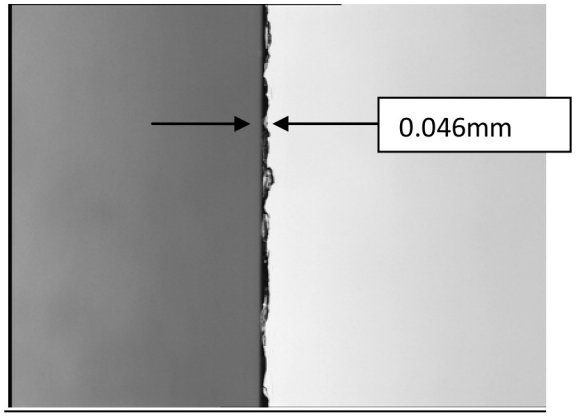
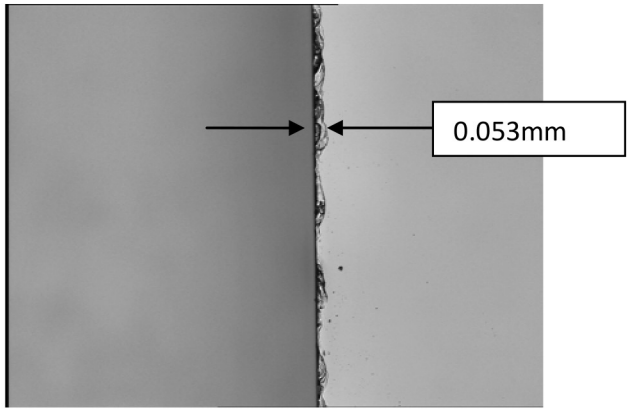
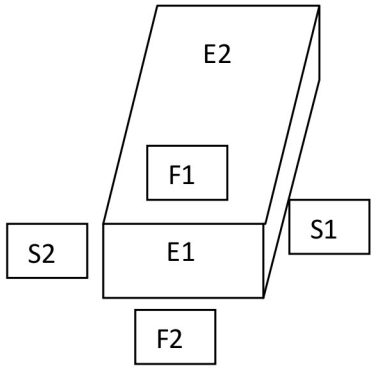
Bar ID # 001



17mm wide edge



35mm wide edge



	Requirement	Measurement
Thickness	17mm +/-1mm	17.870
Width	35mm +/-1mm	35.932
Length	1200mm +/-1mm	1200.737

	Requirement	Measurement
TTV - thickness	25µm	6.84µm
TTV - width	25µm	3.115µm

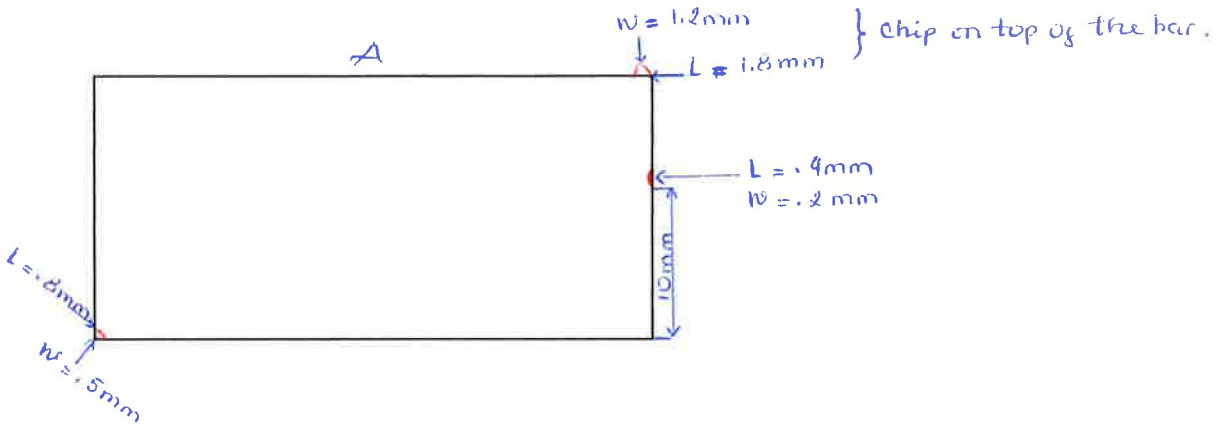
	Requirement	Measurement
Roughness 17mm side	10Å rms	2.78
Roughness 35mm side	10Å rms	2.306
Roughness Ends	25Å rms	16.4
Note typo: requirement is 0.25mrad		
90° Angle	Requirement	Measurement
F1 to E1	25mrad	0.053
F2 to E1	25mrad	0.029
S1 to E1	25mrad	0.029
S2 to E1	25mrad	0.01
F1 to E2	25mrad	0.005
F2 to E2	25mrad	0.05
S1 to E2	25mrad	0.02
S2 to E2	25mrad	0.01

zygo

Zygo Confidential

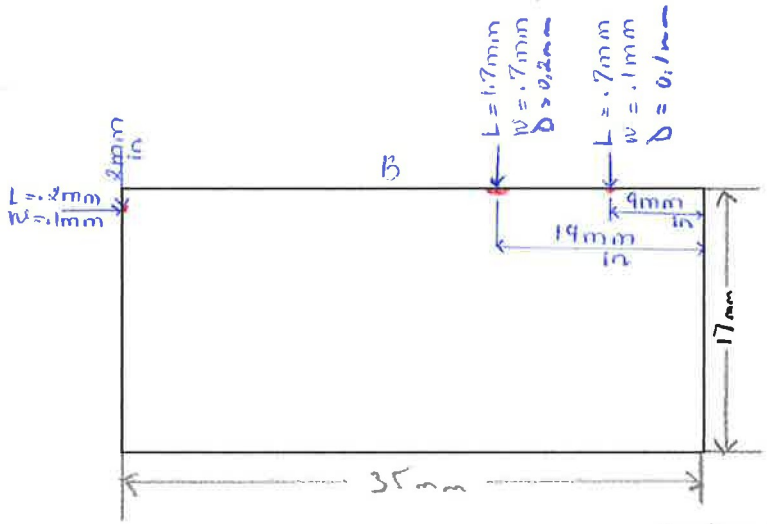
2/8/2013

Jochen Schwiening



Surface Quality: Surface1 A

Serial Number: 1 (W.O.H: 448291) Ends 17 x 35 mm



Surface Quality: Surface2 B

Jochen Schwiening