Prototype of a DIRC-barrel for the $\bar{\text{P}}$ANDA Experiment

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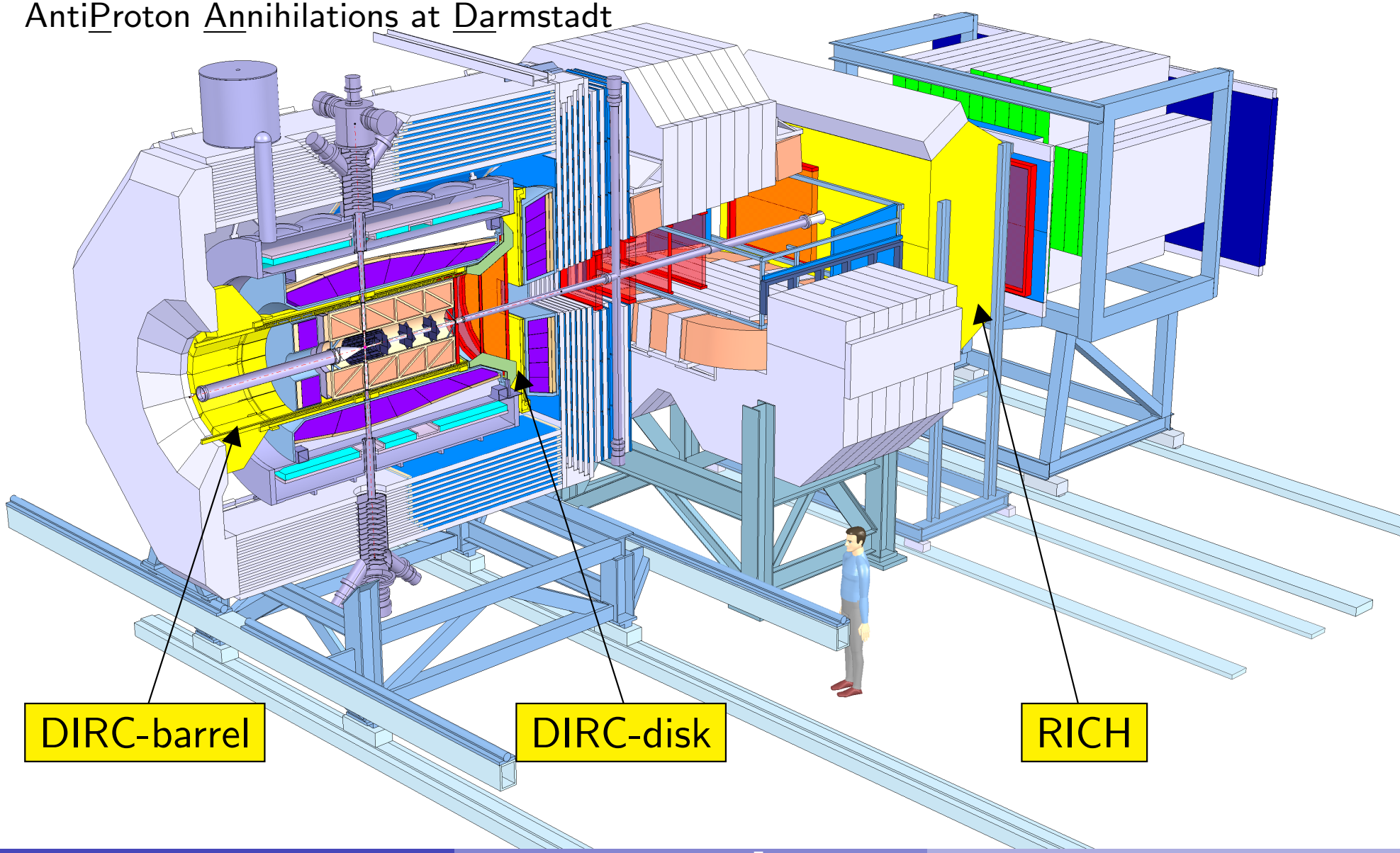
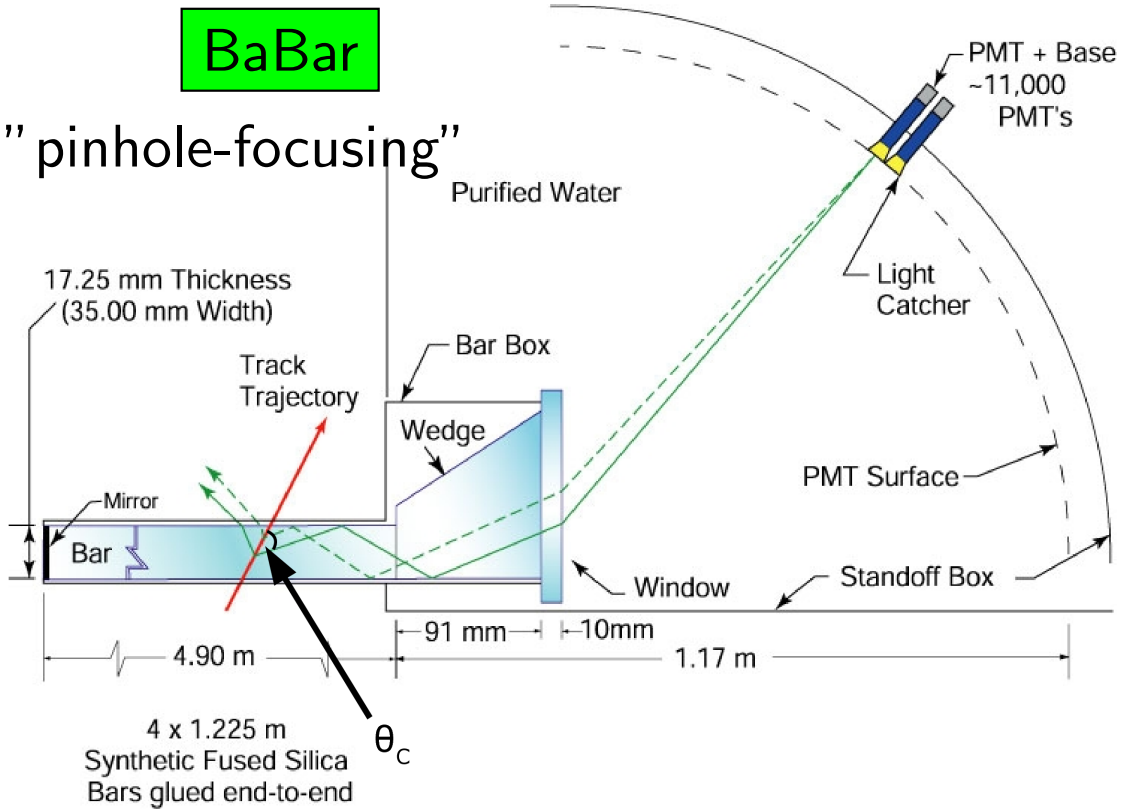
PANDA detector: Cherenkov

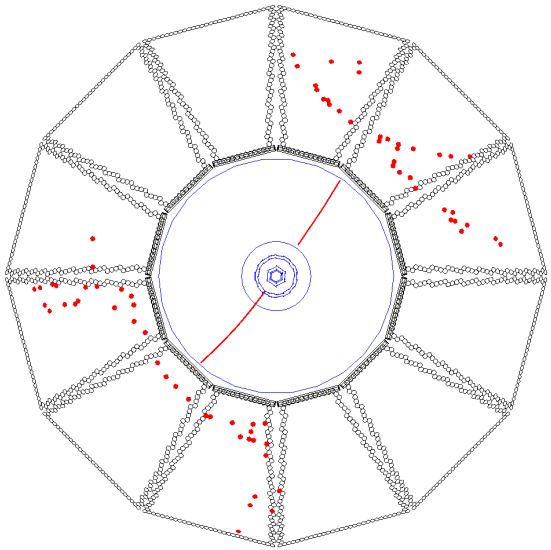
AntiProton Annihilations at Darmstadt



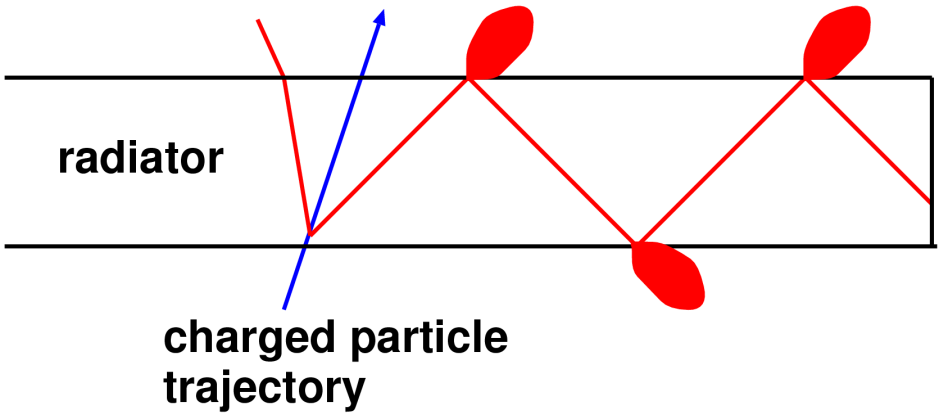
DIRC concept

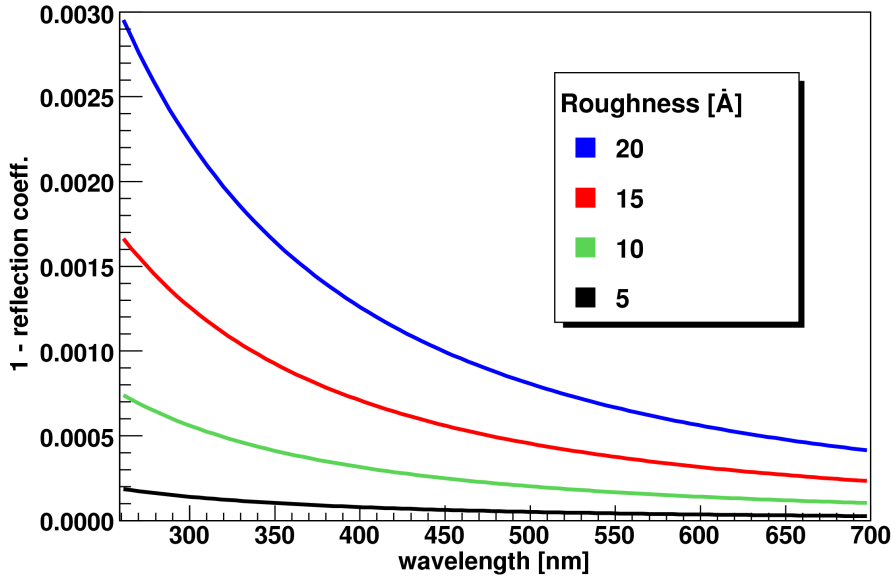
Detection of Internally Reflected Cherenkov light





Motivation for the radiator quality test





Estimation:

Assumption: 100 reflections, photons in UV-range and

single reflection loss of ≈ 0.002

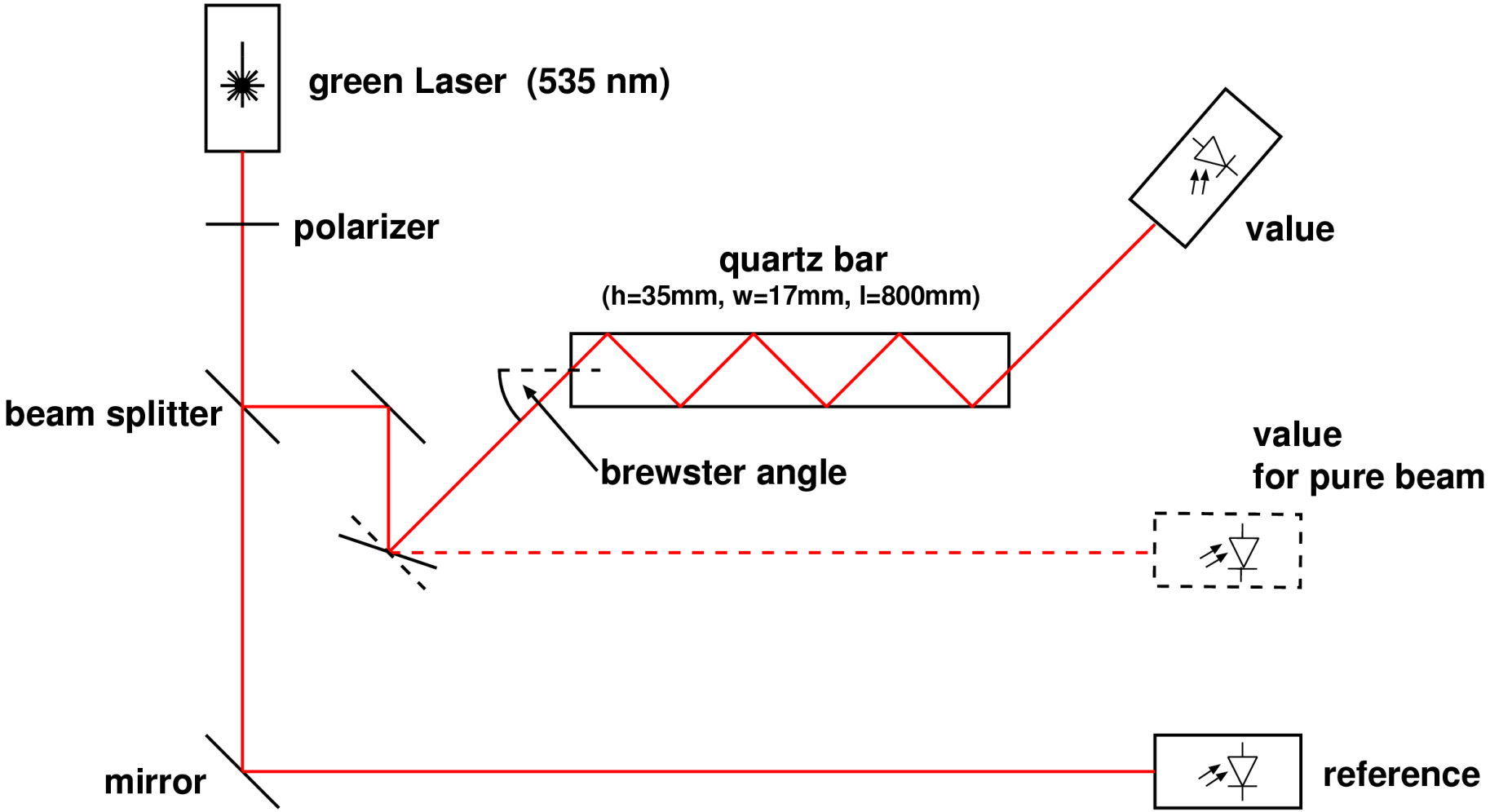
$\Rightarrow$ transmission of $0.998^{100} \Rightarrow 81.9\%$ (roughness: $\sigma \approx 22\,\text{Å}$)

$\Rightarrow$ 18.1% loss at low photon statistic

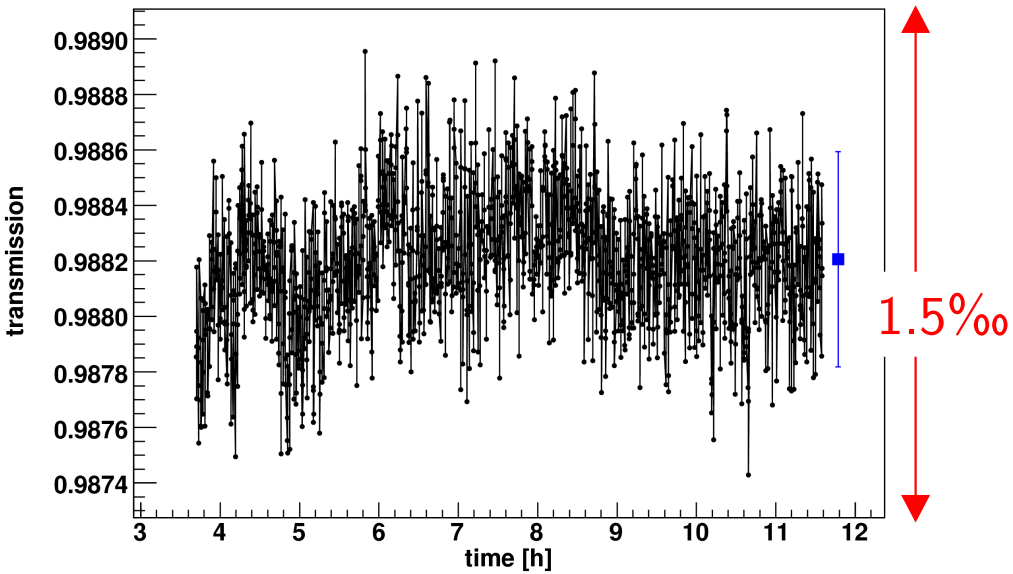
to get transmission of 90% $\Rightarrow$ single reflection loss of ≈ 0.001

$$\sigma \approx 16\,\text{Å} \quad \Rightarrow \quad \Delta\sigma \approx 6\,\text{Å}$$

Internal reflection setup



Roughness determination



$T = 0.9882 \pm 0.0004$

$$T = \mathcal{R}^N \cdot \exp\left(-\frac{L}{\Lambda}\right)$$

observed: 15 reflections inside the quartz bar

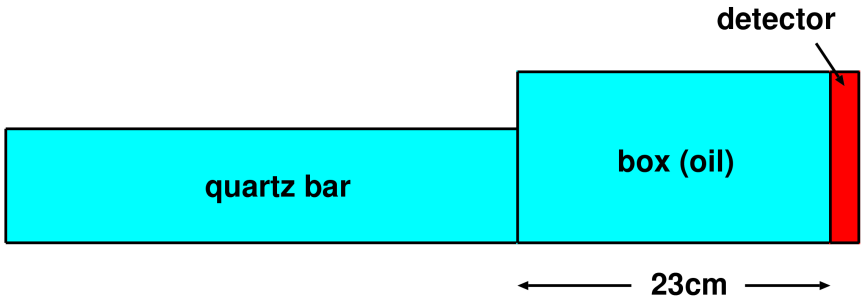
bulk absorption:
$\Lambda = (281 \pm 97)\,\mathrm{m} \quad (535\,\mathrm{nm})$

$\Rightarrow$ reflection coefficient:
$\mathcal{R} = 0.99944 \pm 0.00009$
$1 - \mathcal{R} = 0.00056$

roughness:
$\Rightarrow \sigma = (17.8 \pm 1.5)\,\text{Å}$

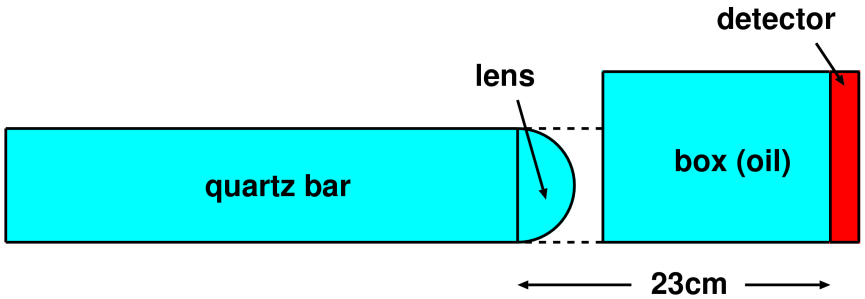
(bar specifications: 20 Å)

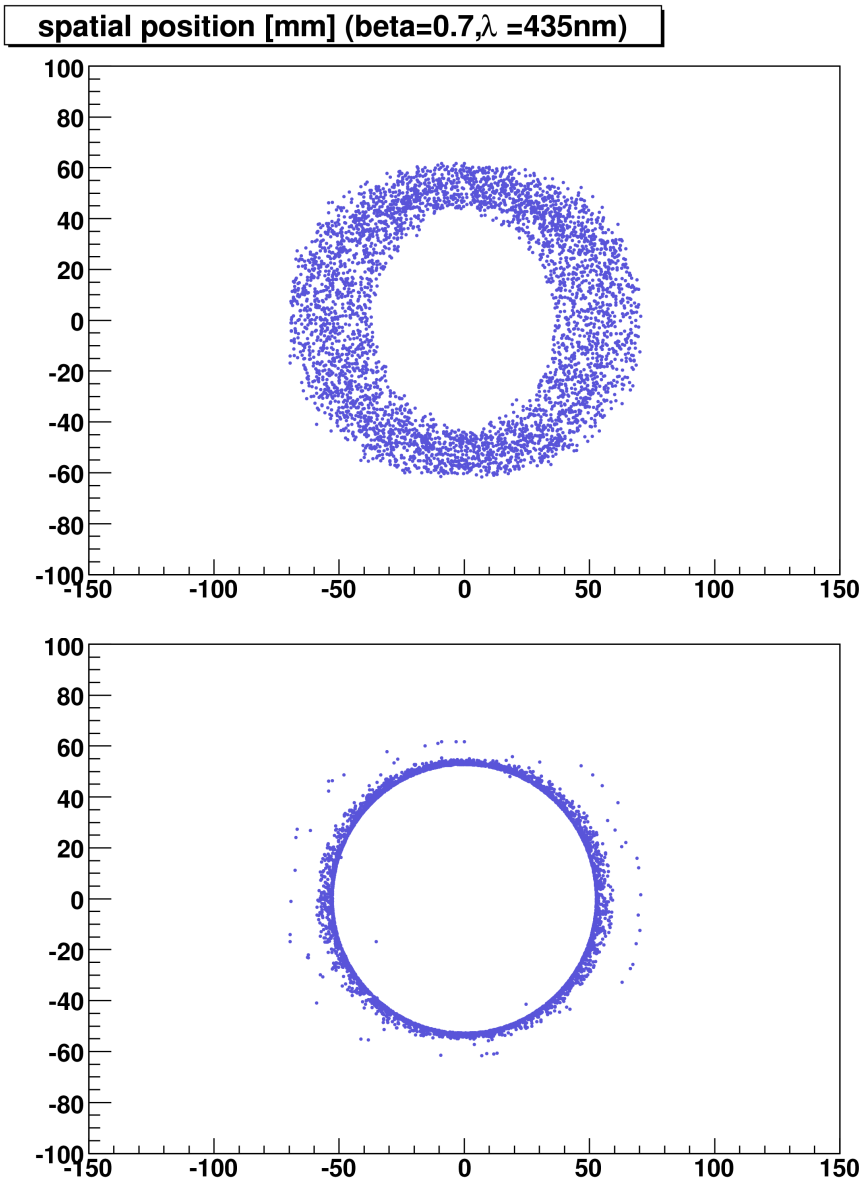
Focusing readout



$$n_{quartz} \approx n_{oil} \approx n_{lens}$$

bar: $h = 17\,\text{mm},\ w = 35\,\text{mm}$





Photon detector

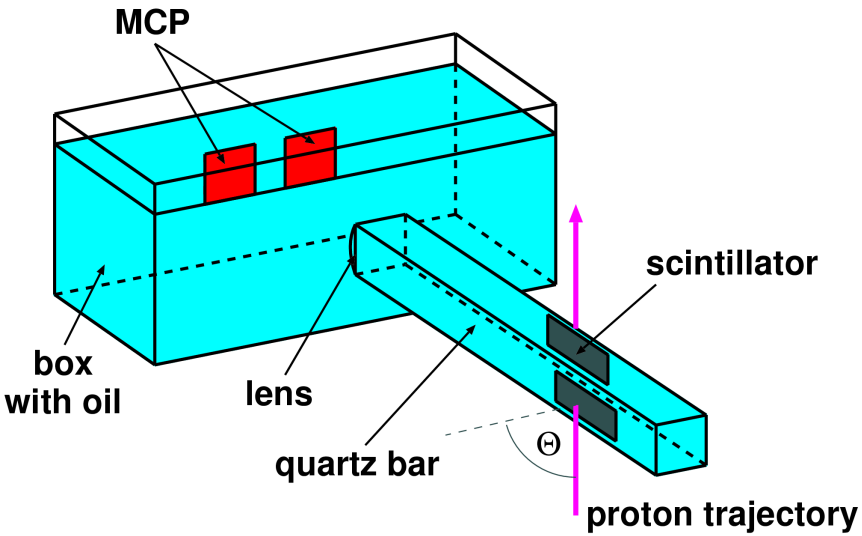
	Vacuum-PMT	MCP-PMT	SiPMT
Gain	$10^6 - 10^8$	$10^5 - 10^7$	$10^5 - 10^6$
Max. B-field	$< 0.05\,\mathrm{T}$	$2\,\mathrm{T}$	prob. high
Dark count	$< 100\,\mathrm{Hz}$	$10\,\mathrm{kHz}$	$1\,\mathrm{MHz/pixel}$
Max. rate	$10^7\,\mathrm{Hz}$	$10^6 - 10^7\,\mathrm{Hz}$	prob. low
Efficiency	$20\,\%$	$15\,\%$	$\ll 15\,\%$
TTS	$> 350\,\mathrm{ps}$	$< 50\,\mathrm{ps}$	$100\,\mathrm{ps}$
Lifetime	$> 1000\,\mathrm{C/cm^2}$	$< 1\,\mathrm{C/cm^2}$	prob. high

provided by A. Lehmann (University Erlangen)

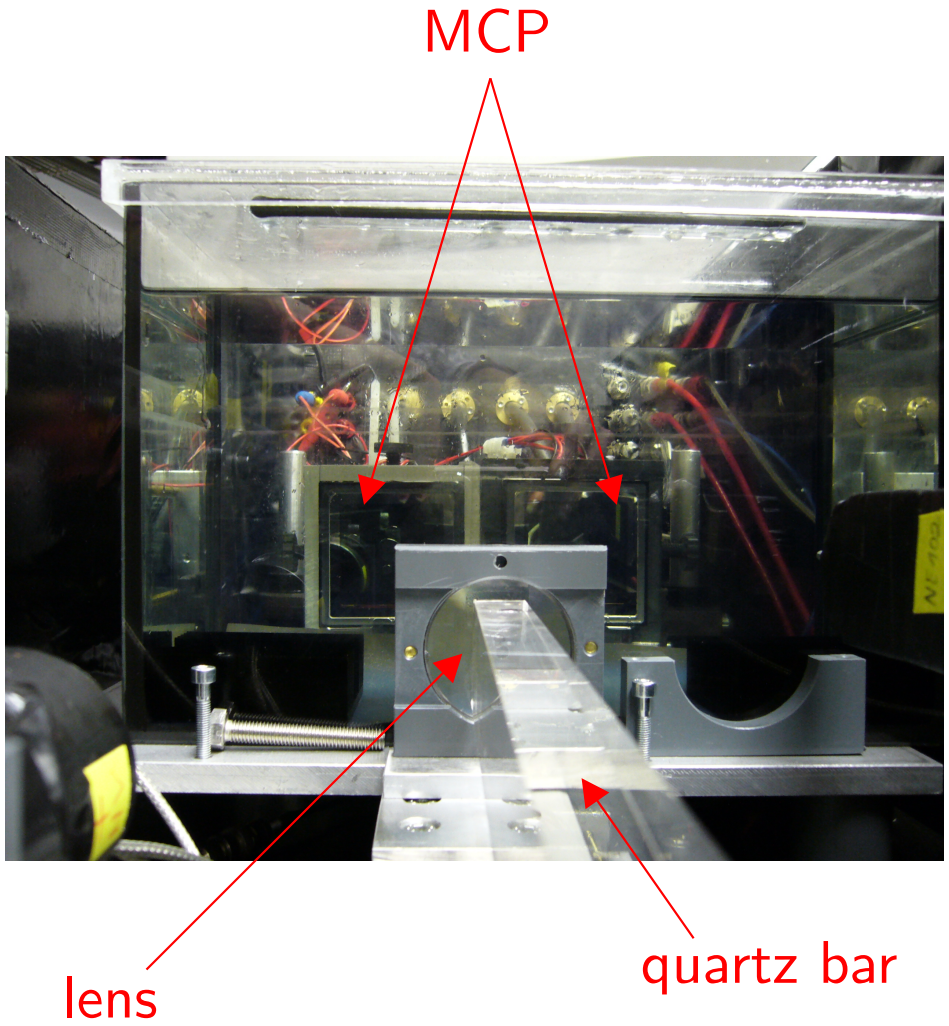
required a high insensitivity to magnetic fields $\Rightarrow$ MCP

Burle 85011-501 Microchannel Plate PMT

Beam test setup



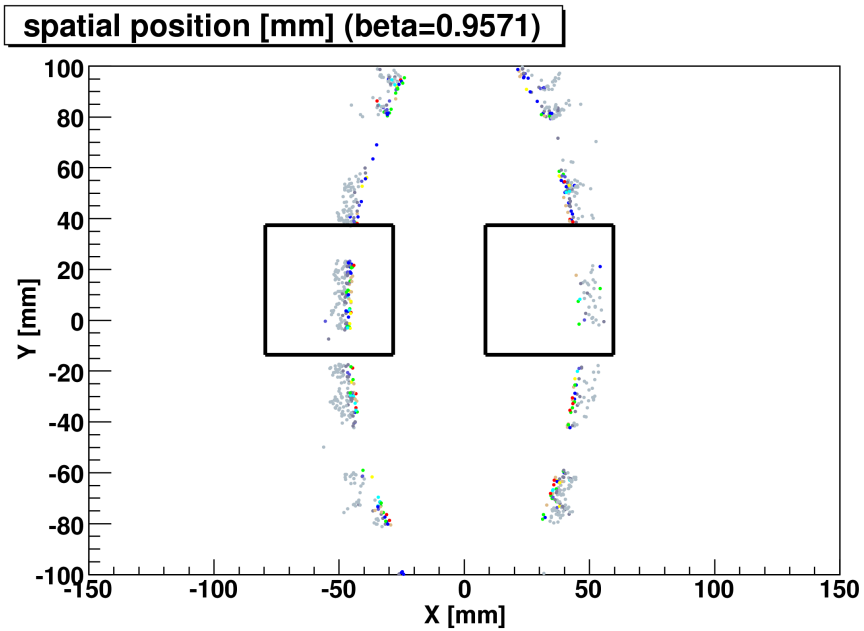
- Proton beam: $T = 2.3\,\text{GeV}$
  $\Rightarrow \beta = 0.9571$
- beam incidence angle: $\Theta = 57°$
- lens focal length: $f = 15\,\text{cm}$
- distance bar - screen: $23\,\text{cm}$
- MCP active area (8×8 pixel):
  $51 \times 51\,\text{mm}^2$



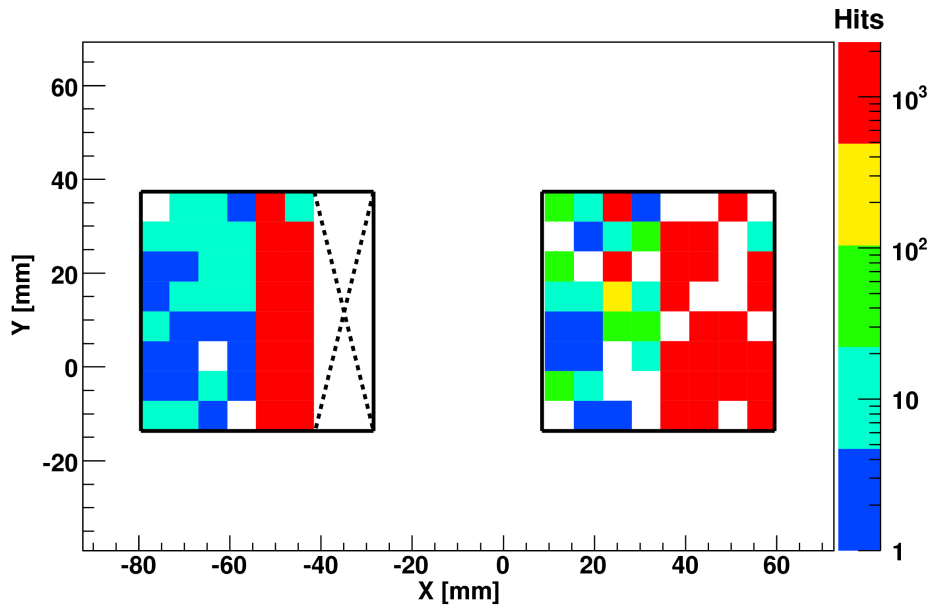
Thanks for the helpful support:
W. König, M. Palka, M. Traxler (GSI)

First results (preliminary)

Simulation



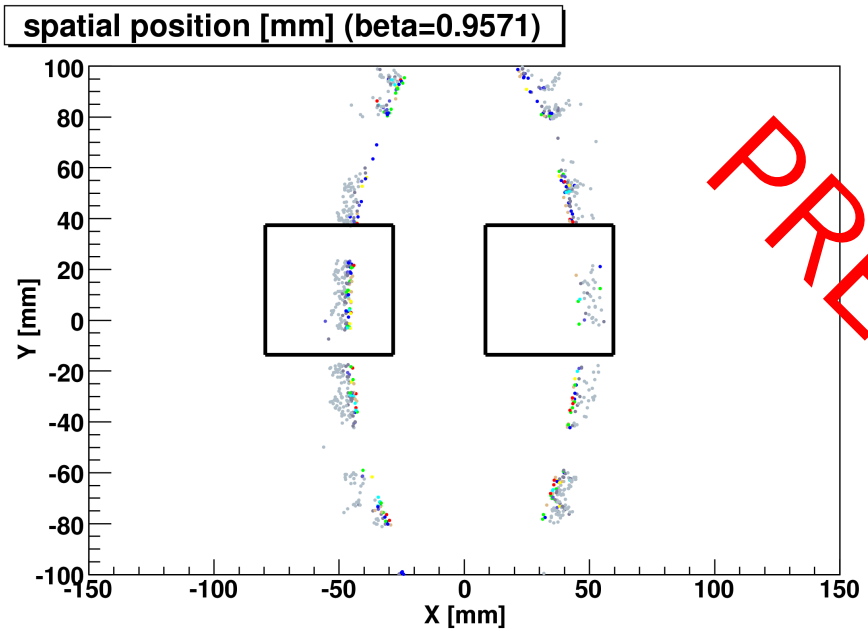
Experimental Results



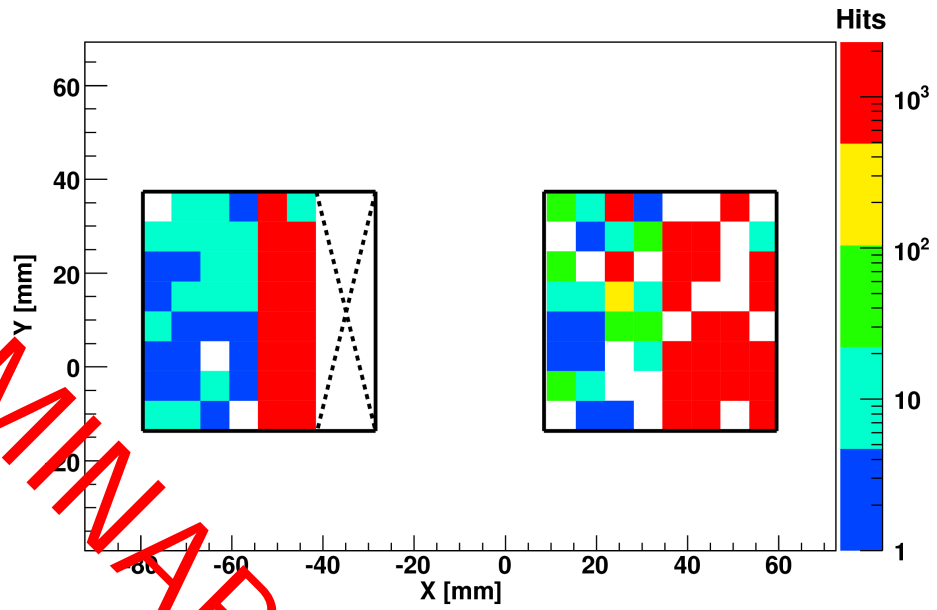
- total beam time: 6h (28 - 30.9.08), used dataset 15min
- successful test run: Cherenkov ring fragments were measured
- results confirm the simulation
- further analyses follow

First results (preliminary)

Simulation



Experimental Results



PRELIMINARY

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Summary & Outlook

- Radiator quality:
  - transmission precision $< 1\,‰$ was achieved
  - able to determine the quartz bar roughness with $\Delta\sigma < 2\,\text{Å}$
- Focusing readout realized by a lens
- MCP as photon detector cause of its insensitivity to a magnetic field
- Beam test:
  - Cherenkov ring fragments were measured
  - simulation and results are in agreement
  - detailed analyses are in progress

- Measure the radiator quality test with other wavelengths
- Next beam time test with 4 MCPs and setup improvements