Beam Profile Monitor

For Slowly Extracted Beams @CERN

Karolina Kmiec, Inaki Ortega
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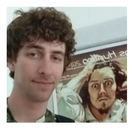
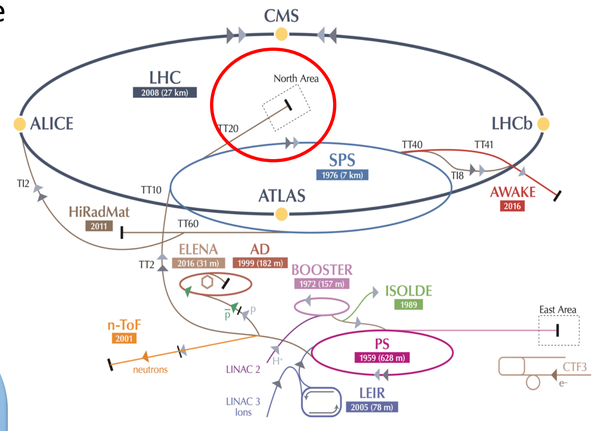
Expectations vs. *Reality*



Beam profile monitors are needed to inspect the beam in real time to ensure the required quality. The beams delivered to the North Area are extracted slowly ($4.8\ or\ 9.8\ s$), are un-bunched and very intense ($10^{13}\ part/s$). Currently there is no satisfying instrumentation.

We investigate the feasibility of a Cherenkov Fiber Detector, which would fulfil all those requirements.



North Area @CERN

Perfect Beam Profile Monitor is:

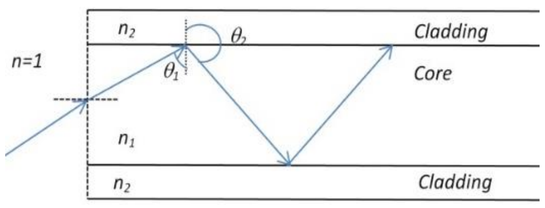
- Zero energy loss
- Zero beam perturbation
- Radiation hard
- Fast
- Precise
- Cheap

Cherenkov Light Detector Based on SiO_2 Optic Fibers

- ✓ $\frac{x}{x_0} = 44.47\ \mathrm{cm}$
- ✓ Radiation Hardness $\geq$ MGy
- ✓ Time resolution ~ns
- ✓ Spatial resolution < 1mm
- ✓ Low cost

Physical phenomena in SiO_2

Total Internal Reflection

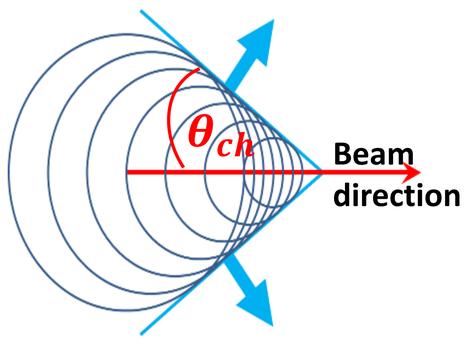


http://bwtek.com/spectrometer-part-6-choosing-a-fiber-optic/

$n_2 = 1.37$
$n_1 = 1.46$
$\theta_{TIR} = 69°$

$$sin\theta_1 = \frac{n_2}{n_1}$$

Cherenkov light emission in cone defined by angle:



$$cos\theta_{ch} = \frac{1}{n\beta}$$

Predicted Cherenkov angle:

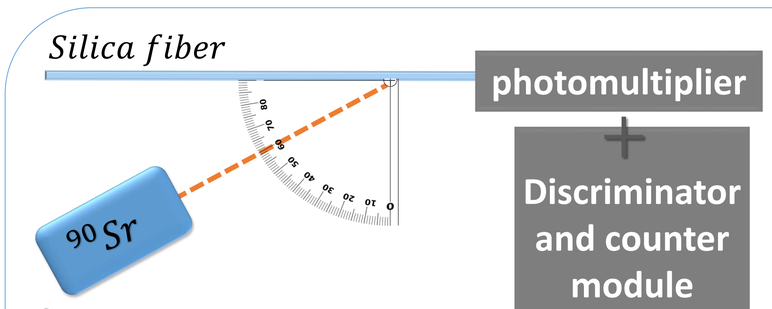
beam	E	β	θ_{cher}
p	$450\ GeV$	1	47°
e	$1\ MeV$	0.86	38°

Theoretical angle of beam For our ^{90}Sr source of 1MeV electrons:

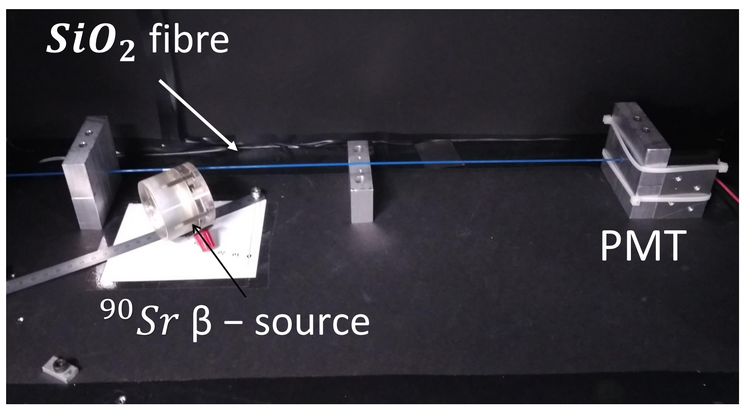
$$17° \leq \theta_{beam} \leq 59°$$

(±16° from non−colimated source)

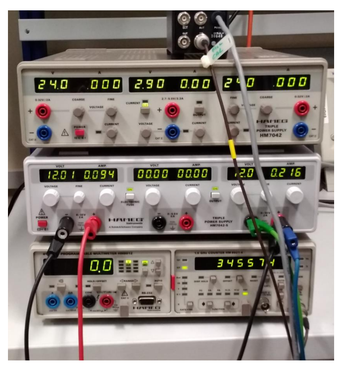
Experimental Setup



Experimental setup scheme

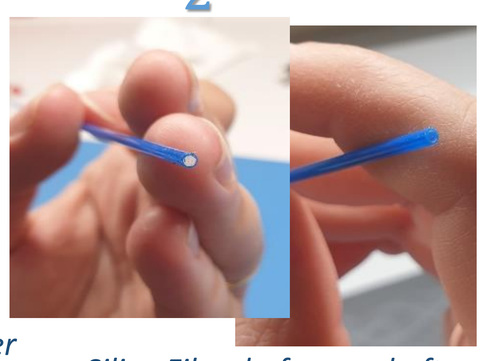


Experimental setup



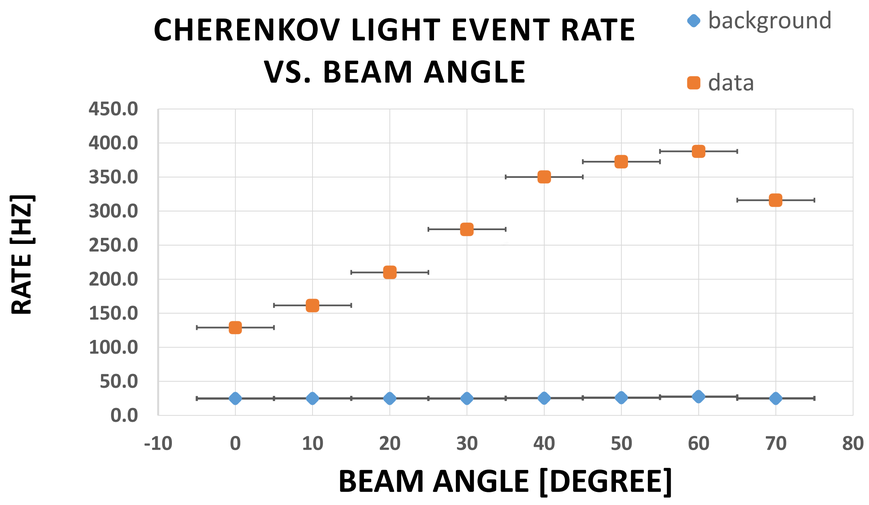
Discriminator and counter module

SiO_2 Fibers



Silica Fiber before and after polishing procedure

First Results



Conclusions and Future investigations

- Signal from $1\ MeV$ electrons is with agreement with theoretical predictions
- GEANT4 simulations are needed to better understand the data
- Next step is a measurement of thinner fibers ($\emptyset\ 1mm, \emptyset\ 0.5mm$)