

Backward Calorimeter Update

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Outline

- Prototype preparations
- New MPPC with excellent radiation hardness properties
- Particle Identification



Prototype Preparations

- I applied for a grant of 210k NOK (~35k USD)
- About 12k USD should be used to pay a master student to help with with stacking and testing of the prototype
- The rest is meant for purchasing high precision power supplies and other small items and travel for 3-4 persons for 2 test beam periods
- Gigi told me yesterday that he has 50 m of Y11 fiber left and will send it after the meeting
- This is not enough, so I need to get some samples somewhere else

Pb Plates

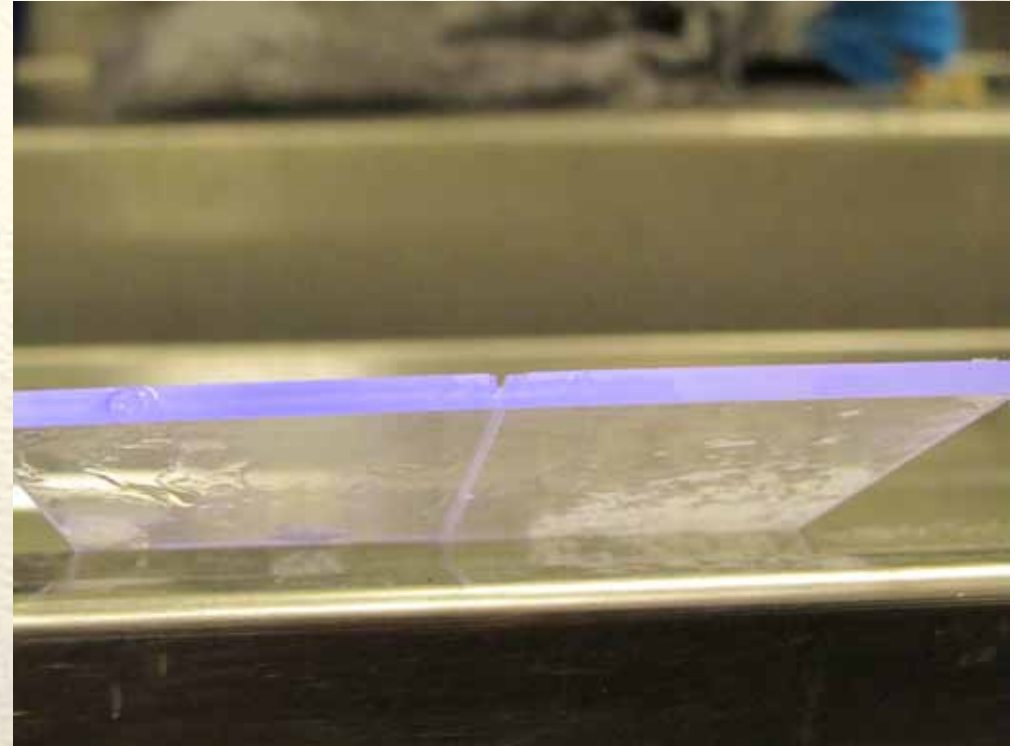
- The 24 Pb plates machined to the right shape are in Bergen
- The packing from the company to CERN was terrible
- Plates have a lot of dents and scratches



- The packing from CERN to Bergen was not good either
- Plates were in a box but could move around in the box

First Strip

- First radial strip milled with old machine
- The groove for the MPPC is visible
- There is some nasty residual glue we try to wash off



Computer-controlled Milling Machine

- The machine shop in Bergen has a computer-controlled milling machine
- Dominik Fehlker, our electronics engineer has programmed 48 left-handed spirals and 48 right-handed spirals in Pro Engineer
- Dominik is transferring one spiral from Pro Engineer to the milling machine



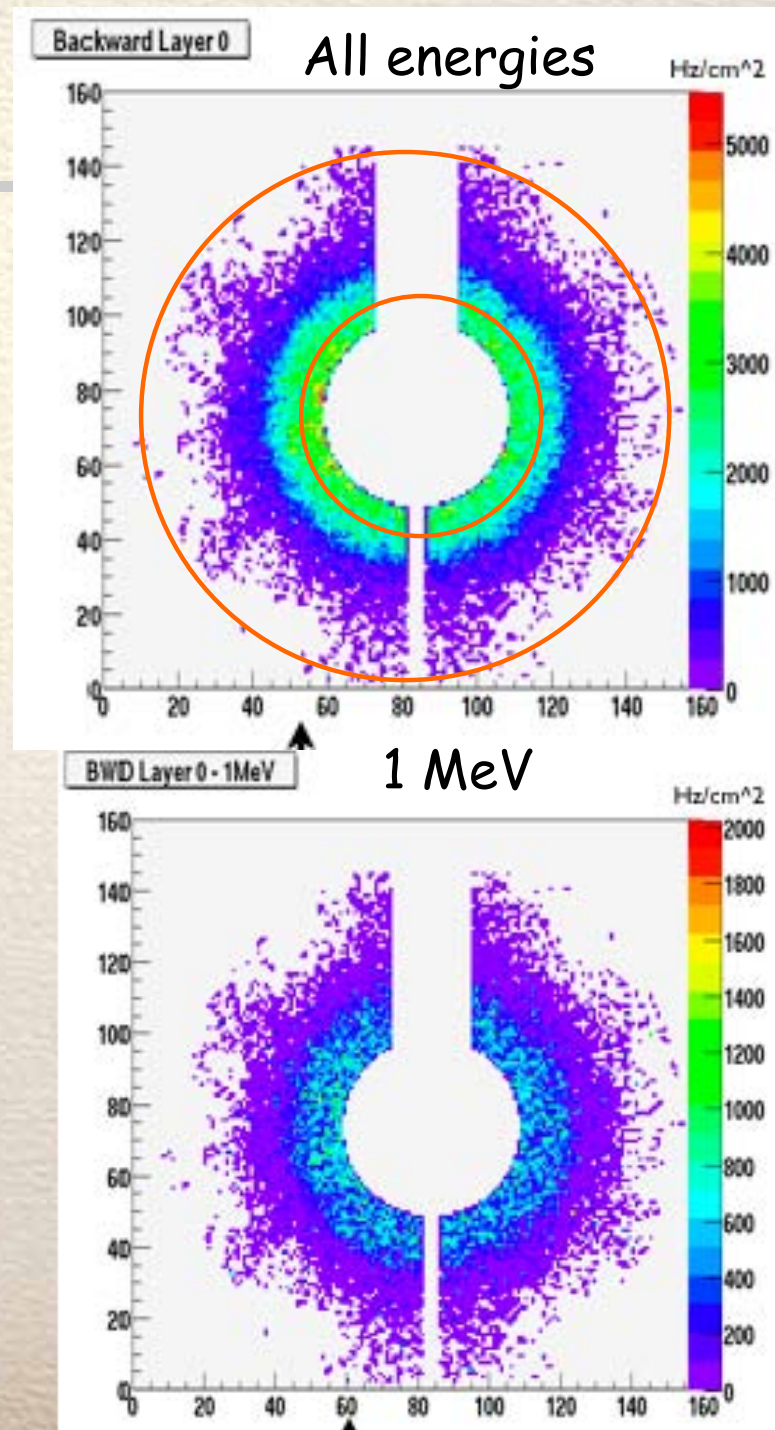
Properties of New MPPC's

- Hamamatsu has produced two new photo sensors with 2500 pixels and 4489 pixels
- These have larger dynamic range but smaller gain

MPPC type	# cells 1/mm ²	C, pF	R _{cell} , kOhm	C _{cell} , fF	$\tau=R_c \times C_c$, ns	V _B , V T=23 C	V _{op} , V T=23 C	Gain(at V _{op}), X10 ⁵
15 μ m pitch	4489	30	1690	6.75	11.4	72.75	76.4	2.0
20 μ m pitch	2500	31	305	12.4	3.8	73.05	75.0	2.0
25 μ m pitch	1600	32	301	20	6.0	72.95	74.75	2.75
50 μ m pitch	400	36	141	90	12.7	69.6	70.75	7.5

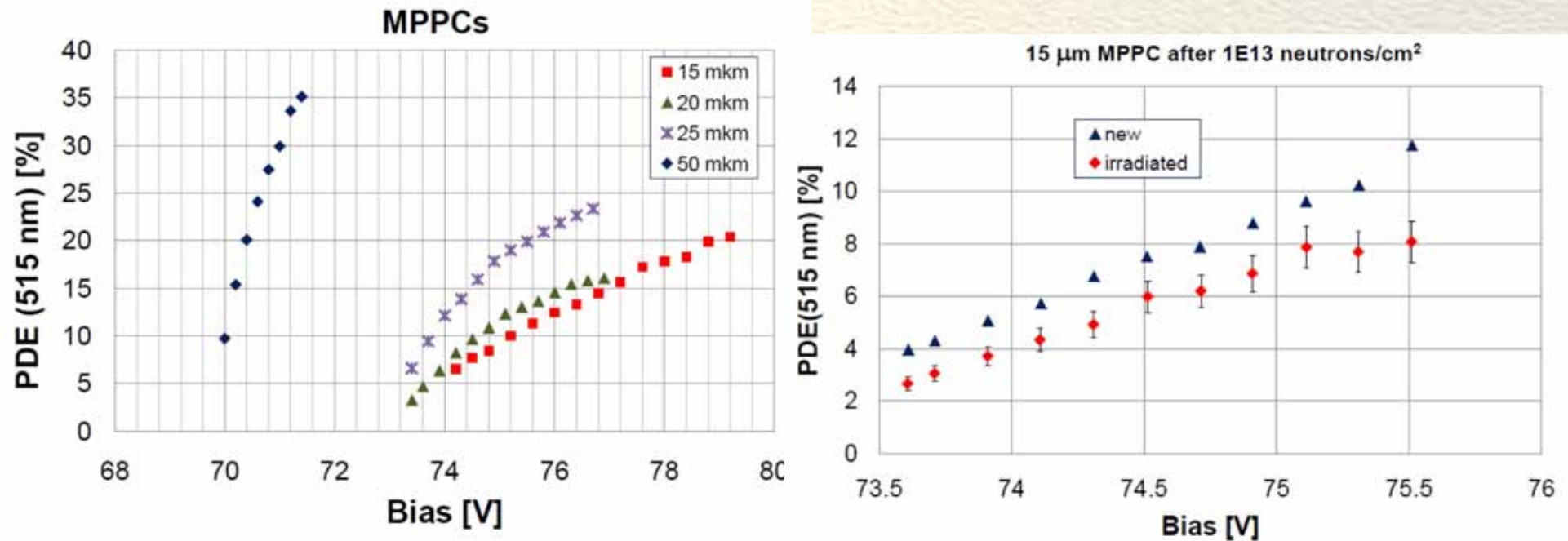
Expected n Flux

- Take values from Eugeneo's values from Annecy talk
- In layer 0 of backward IFR EC, worst rate is 3500 Hz/cm²
→ rate at z=-128 cm should be lower
- In ten years (200 days running) estimate 6.1*10¹¹ n/cm² or 6.1*10⁹ n/mm²
- This high flux is only in the inner region (r=31-41 cm)
- The rate drops by significantly towards outer edge
- If n's come from IP, MPPC is perpendicular to flight path



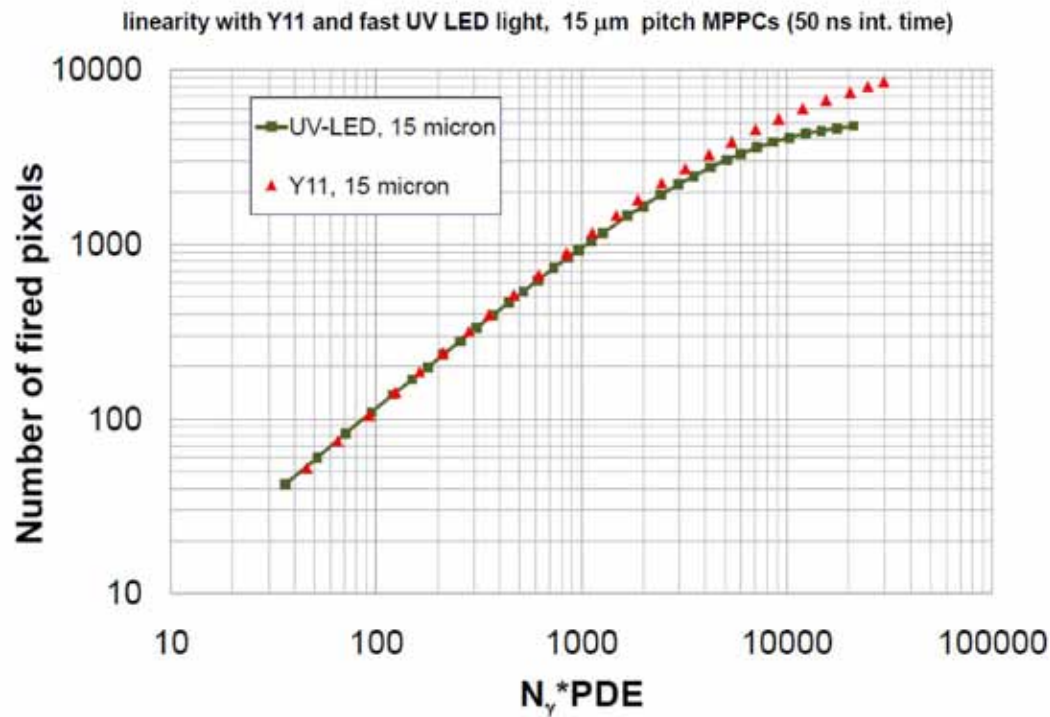
Performance of 15 μm MPPC after 10^{13} n/cm²

- The new MPPCs have lower efficiency (more boundaries) and need higher bias voltage to compensate for loss

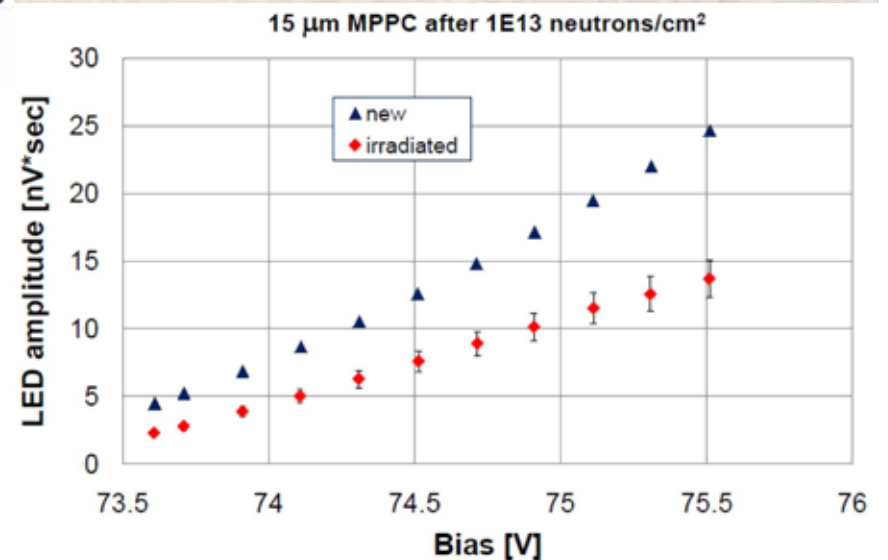


- There is also a new SiPM from China (NDL) that looks good too

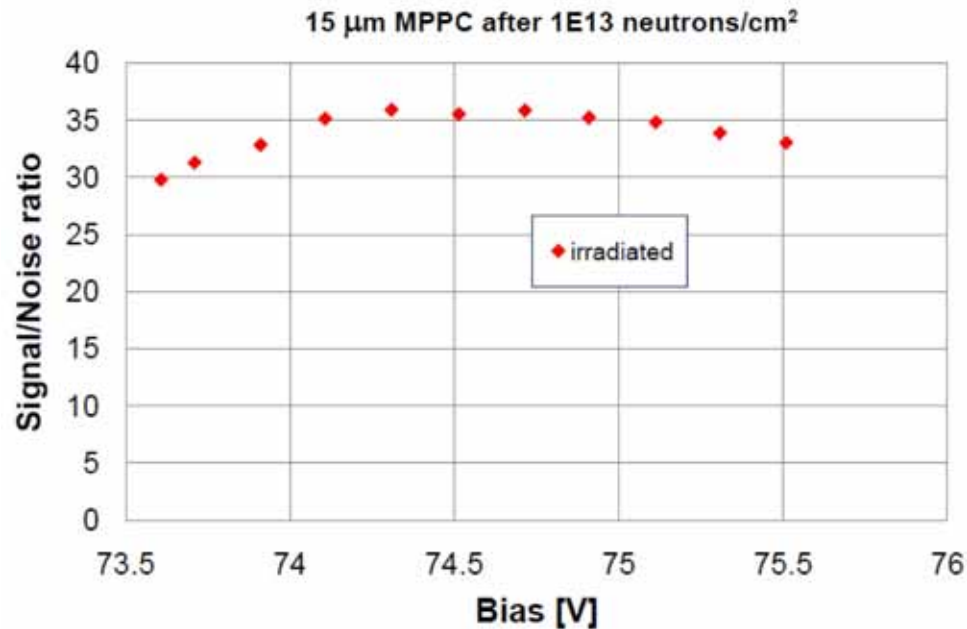
Performance of 15 μm MPPC after 10^{13} n/cm²



- 15 μm MPPCs still work fine after 10^{13} n/cm² irradiation
- Saturation curve is not effected
- Response decreases by 40%



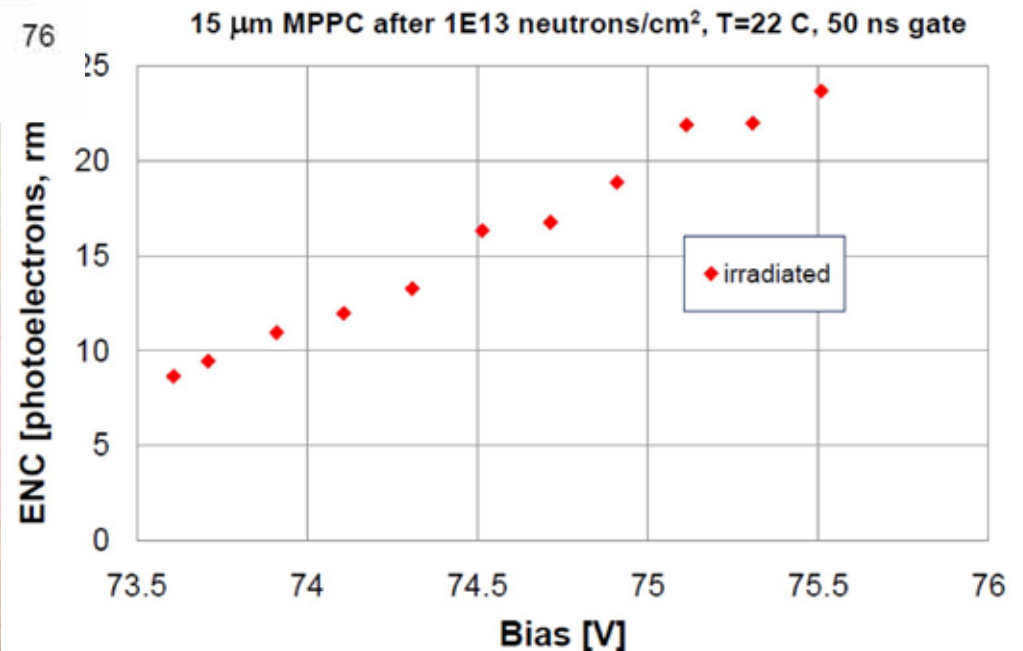
Performance of 15 μm MPPC after 10^{13} n/cm²



● S/N and equivalent noise charge after irradiation looks ok

● According to Eugenio's study backward endcsp EMC will see 10^9 n/mm² after 10 years

- So if the 25 μm pixel MPPC show a problem we switch to 20 μm pixel or 15 μm pixel MPPCs
- here we have a safety margin of at least 10^4



Particle Identification

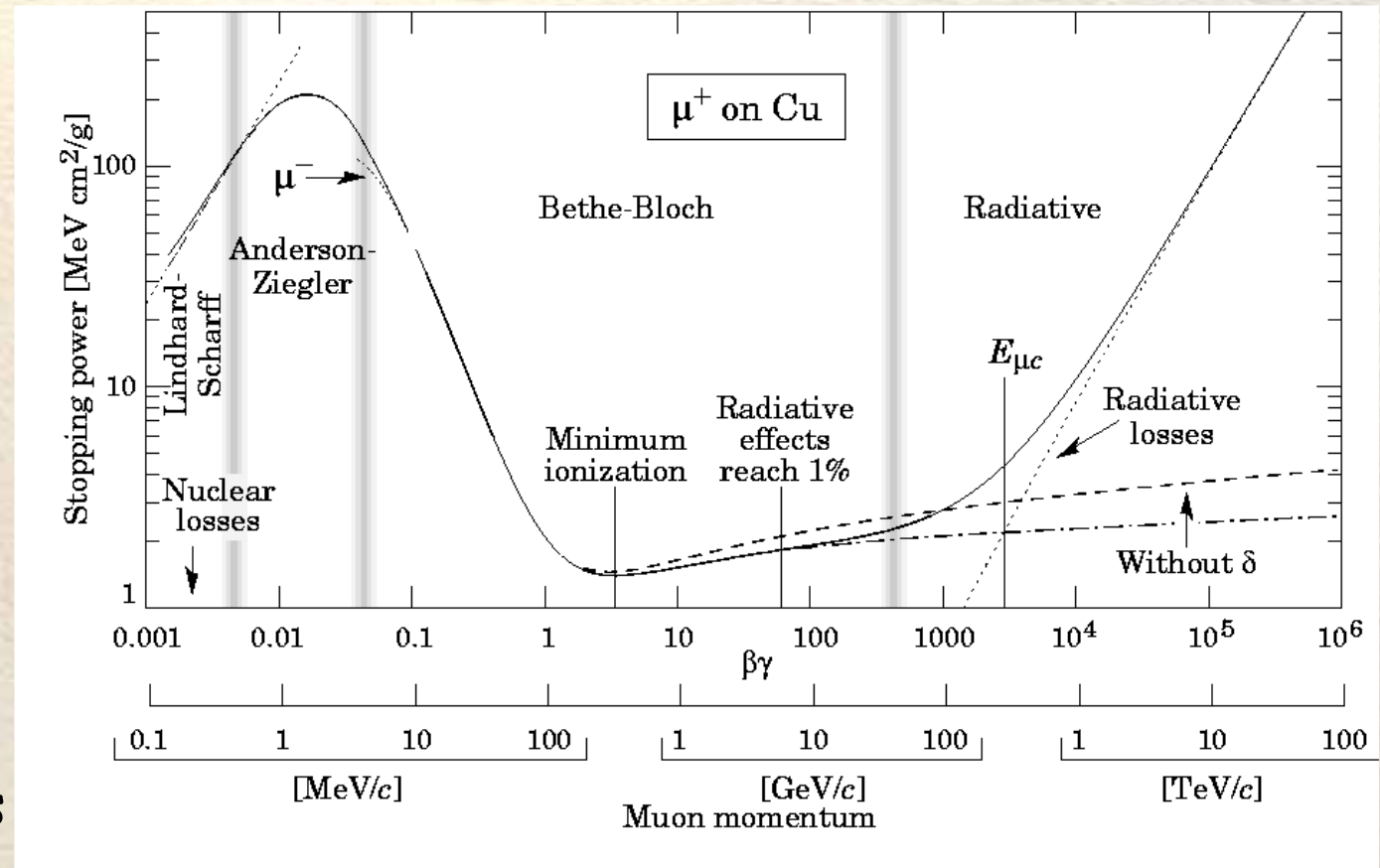
- Do dE/dx pattern recognition for hadrons \rightarrow for MIP-like particles energy losses are ($dE_{pb}=4.3$ MeV, $dE_{scint}=0.6$ MeV)

- A 0.4 GeV π is at the minimum while a 0.4 GeV K is below the minimum

- For MIPs, $\Delta E=100$ MeV in 24 layers

- For particles below minimum dE/dx increases with depth

\rightarrow look at dE/dx pattern and combine it dE/dx information from SVT and DCH \rightarrow improve K/ π separation (3σ) up to 0.6-0.7 GeV



Particle Identification: ToF

- ToF application → 4 time constants
 - Scintillator $\tau_{sc} = 2.2$ ns
 - Y11 fiber $\tau_{fiber} = 2.3$ ns
 - MPPC rise time resolution $\sigma_{MPPC} \sim 0.1$ ns
 - transition time in fiber $t_{fiber} = 2$ ns (56 cm)

● MPPC signal is trigger by arrival of first photon

● We have up to 24 measurements

● Need a measurement for spiral strip

● With TOF measurements K/π separation (3σ) may be improved to >1.2 GeV

