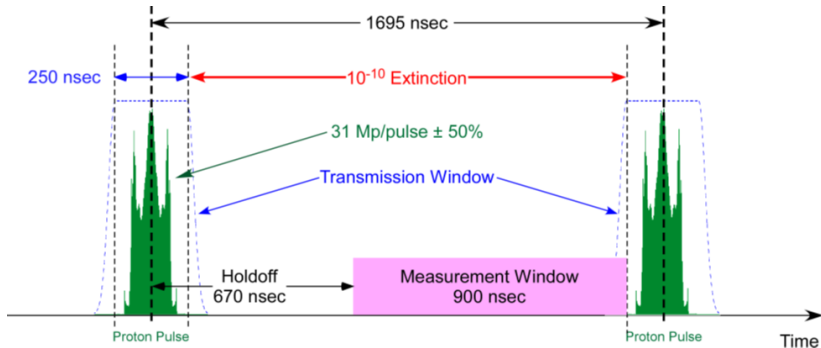


Thoughts on extinction measurement for Mu2e-II

Andrei Gaponenko

Mu2e-II workshop 2018-08-29

Introduction



Extinction: $\varepsilon = \frac{\text{protons between pulses}}{\text{protons in pulse}} < 10^{-10}$ for Mu2e

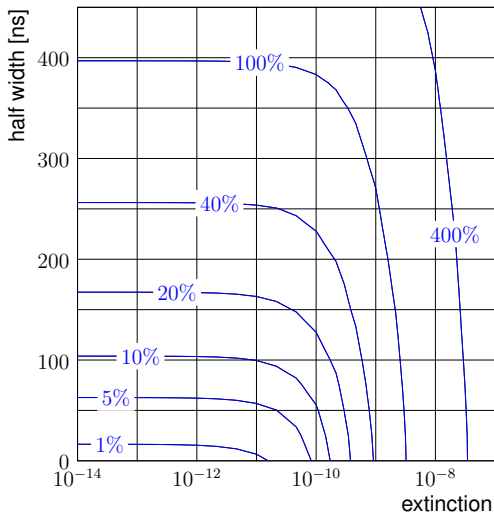
Changes for Mu2e-II

- ▶ pulse width 250 \Rightarrow 100 ns
- ▶ pulse spacing 1695 \Rightarrow 500 to 2000 ns

Extinction: how good is good enough?

Mu2e docdb-4148: Discovery sensitivity degradation w.r.t. ideal beam

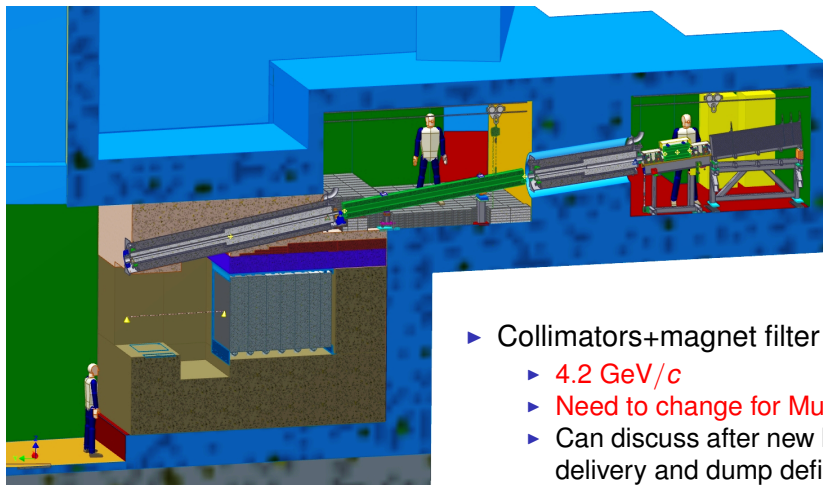
- ▶ Fig on the right is for Mu2e, won't change much for Mu2e-II: extinction competes with pion transport and life time
- ▶ Mu2e-II: for 50 ns beam half width 10^{-11} is a good number



Mu2e approach

- ▶ Monitor extinction for beam **on target**, not elsewhere
- ▶ Shift the 10^{10} dynamic range down
 - ▶ Instead of looking at every proton, detect a small fraction of particles scattered from production target (dozens per bunch)
 - ▶ Accumulate statistics for $\mathcal{O}(10^9)$ pulses (hours) **while maintaining zero background**

Mu2e extinction monitor



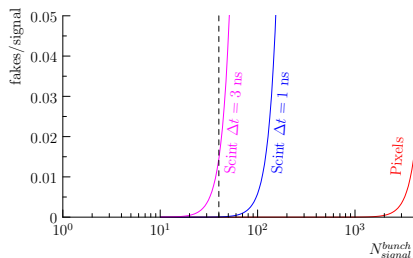
- ▶ Collimators+magnet filter
 - ▶ 4.2 GeV/c
 - ▶ Need to change for Mu2e-II
 - ▶ Can discuss after new beam delivery and dump defined
- ▶ Pixel detector. Reuse?

Mu2e ExtMon

Why pixels

- ▶ Low noise
- ▶ **Granularity** \implies large margin on particle flux/combinatorial background

Mu2e docdb-1845: Analytic estimate of intrinsic detector performance



Mu2e ExtMon performance

Background $< 0.015 \pm 0.004$ (dominated by cosmic) per 1 signal out of time track for $\epsilon = 10^{-10}$ *Mu2e docdb-2481*

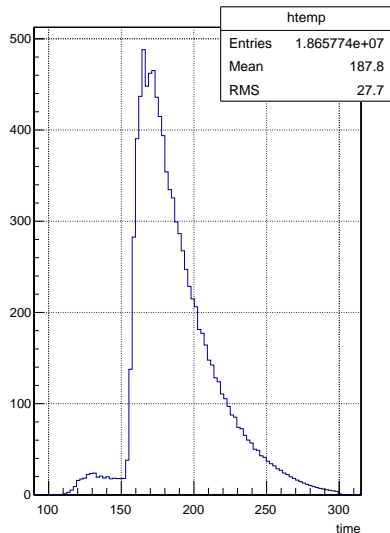
- ▶ **OK for 10^{-11} !** (Can also add timing and momentum cuts.)
- ▶ Can handle larger flux to avoid measurement time $\times 10$

Time resolution?

- ▶ Current ExtMon: 25 ns pixel clock tick
 $\Rightarrow \sigma_t > 25/\sqrt{12} \approx 7$ ns
- ▶ Too coarse for 100 ns pulses?
 - ▶ Sharpness of “end of pulse” time
- ▶ Physics impact: **competes with pion transport, ≈ 20 ns smearing**
- ▶ Do not **need** to do much better than that

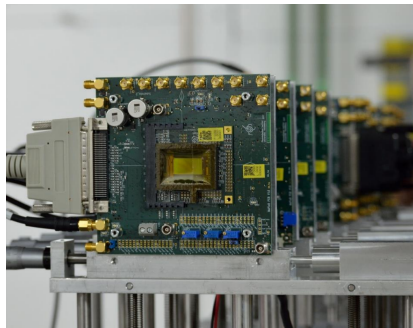
cd3-pions-nts3.v563_v563_v563

time {{(time<300)*exp(-tauNormalized)}}



If we want a new detector. . .

- ▶ **Mu3e HV-MAPS** pixel R&D looks promising.
- ▶ $81 \times 80 \mu\text{m}^2$ pixels:
about $\times 2$ **granularity**
(current: $50 \times 250 \mu\text{m}^2$)
- ▶ **125 MHz** sampling
(current: 40 MHz)
and < 1 **ns charge collection**
- ▶ See **Dirk Wiedner talk at LPC on 2018-07-17**



Your thoughts?