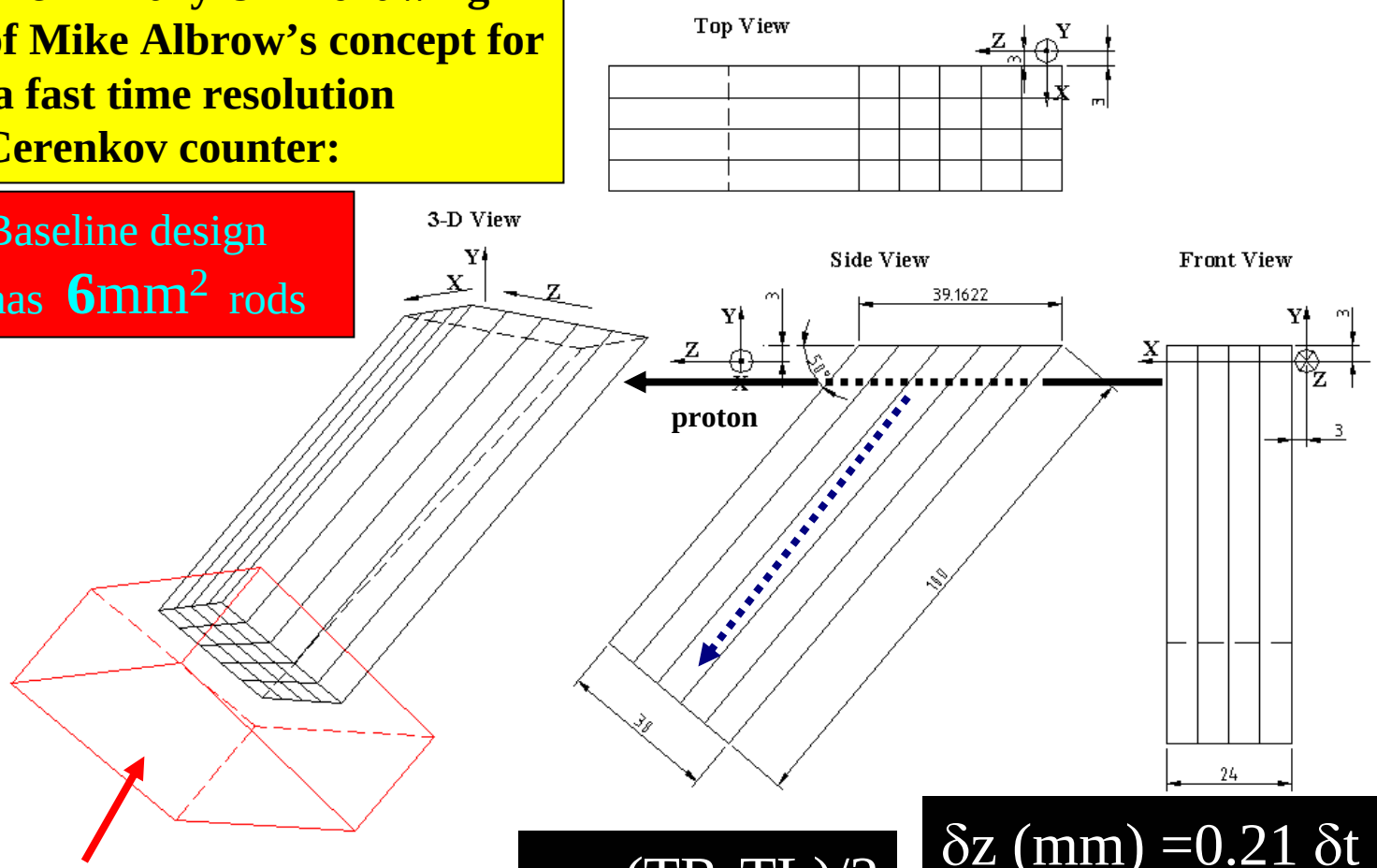
QUARTIC Update

Andrew Brandt (UT-Arlington), Mike Albrow (FNAL), Jim Pinfold (Alberta)

Preliminary UTA drawing of Mike Albrow's concept for a fast time resolution Cerenkov counter:

Baseline design has **6mm^2** rods

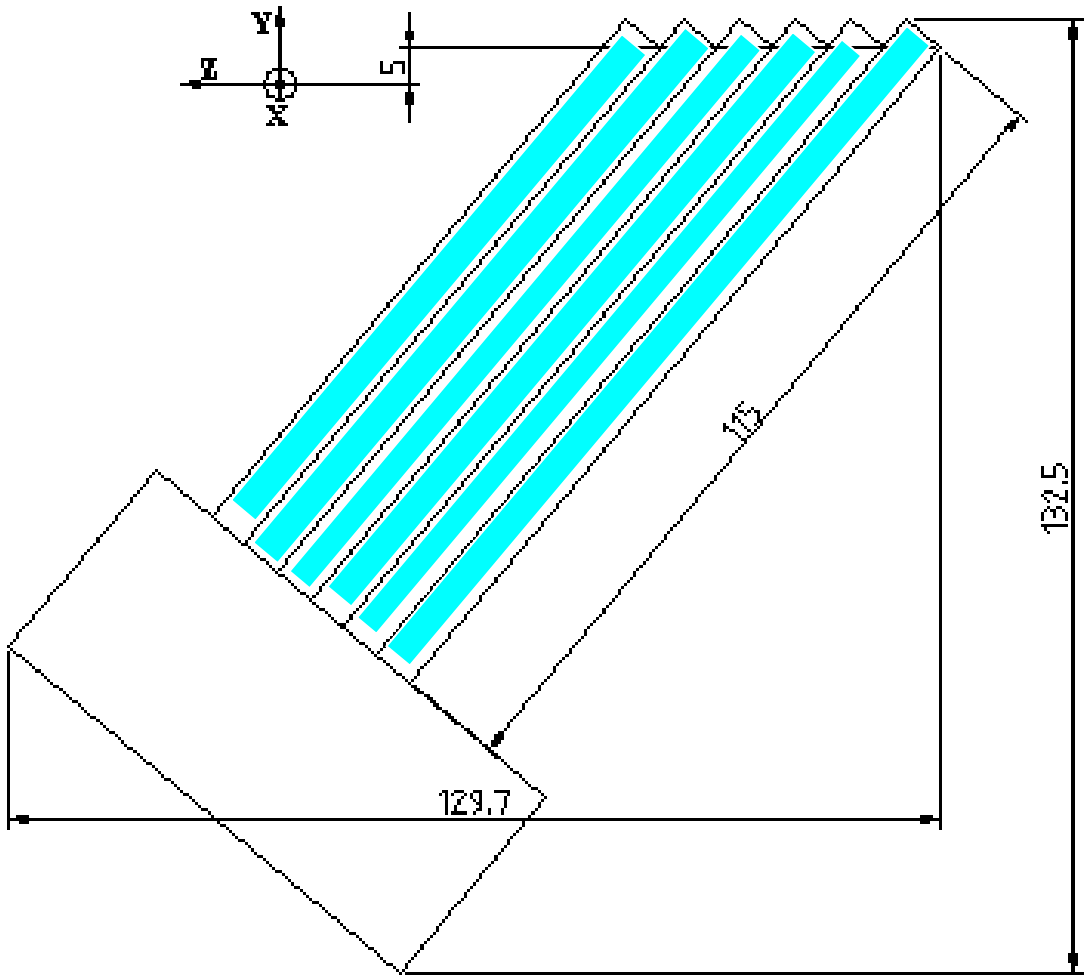


Microchannel plate PMT

$z=c(TR-TL)/2$

δz (mm) $=0.21\ \delta t$ (psec)
(2.1 mm for $\delta t=10$ psec)

New Drawing



- Sawtooth easier to fabricate
- 6 rods in z
- New drawing to evaluate dimensions (min z in baseline design is 130 mm).

UTA News

- Formed group with 2 undergrads and grad student
- Contacted quartz vendors
- Calculated background rejection as f(resolution)
- Calculated light output
- Calculated time distribution
- Poster session at UTA leads to EE contacts
- Pico-sec workshop in November (short but valuable)
- Established contacts with Burle
- Submitted internal pre-proposal for Texas ARP;
  11/30/05 approved for ARP submission (12/79!)
  2/14/05 full proposal; 4/20/05 decision; 5/15/05 funds (?)
  $100k/2 years
  mechanics+pulser+students

- Submitted DOE ADR 12/15/05
  $100k/2 years May/June notification Q only, elec+students

Burle Collaboration

BURLE INDUSTRIES, INC. | 1000 New Holland Ave. | Lancaster, Pennsylvania 17601-5688 | U.S.A. | Telephone (717) 295-6000

BURLE

1 December 2005

Dr. Andrew Brandt
Associate Professor of Physics
University of Texas, Arlington
PO Box 19059
Arlington, TX 76019

Dear Dr. Brandt,

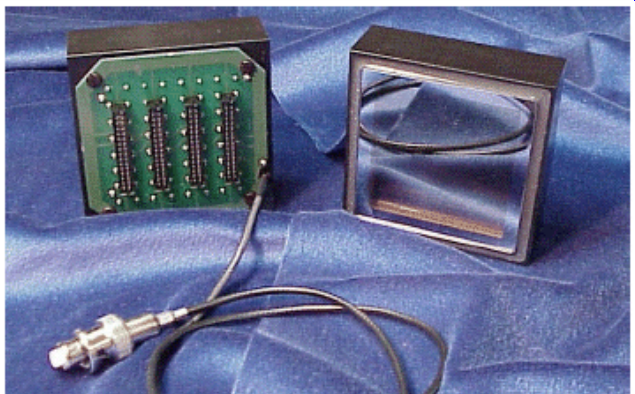
As you know, BURLE INDUSTRIES, INC. is a leading manufacturer of photomultiplier tubes for the medical, biomedical and research communities. As an advanced device company we recognize the necessity to maintain a strong effort in the development of new technology. We recently developed a unique 50mm square MCP-PMT with excellent timing performance known as the PLANACON. In addition, these devices utilize construction technique that allows flexible configuration of the anode readout pattern and are insensitive to magnetic fields. All of these features make the PLANACON ideally suited to your Ultra-fast TOF detector.

As part of your proposed Advanced Detector Research Program, BURLE agrees to fabricate a series of prototype test devices based on our 50mm PLANACON. Our current technology utilizes a 25 micron pore MCP for electron multiplication and a standard flat faceplate. To further characterize and improve the timing properties of these devices we will provide you with the following: 2 PLANACONs having 25 micron pore MCPs and a standard faceplate, 2 PLANACONs having 10 micron pore MCPs and a standard faceplate, and 2 PLANACONs having 10 micron pore MCPs and a stepped faceplate which reduces the photocathode-to-MCP gap. This will allow you to characterize the effect of MCP pore size and cathode-to-MCP gap on the timing performance of the PLANACON. Further, we will try to equip at least one of these devices with MCPs having increased current capacity.

I would like to wish you success on your U.S. Department of Energy Advanced Detector Research Program (DE-FG01-05ER05-27) proposal "Development of an Ultra-fast Time of Flight Counter." BURLE is excited about partnering with you to realize this important advance in Time of Flight Instrumentation.

Sincerely,

Paul L. Hink, Ph.D.
VP & General Manager, Phot



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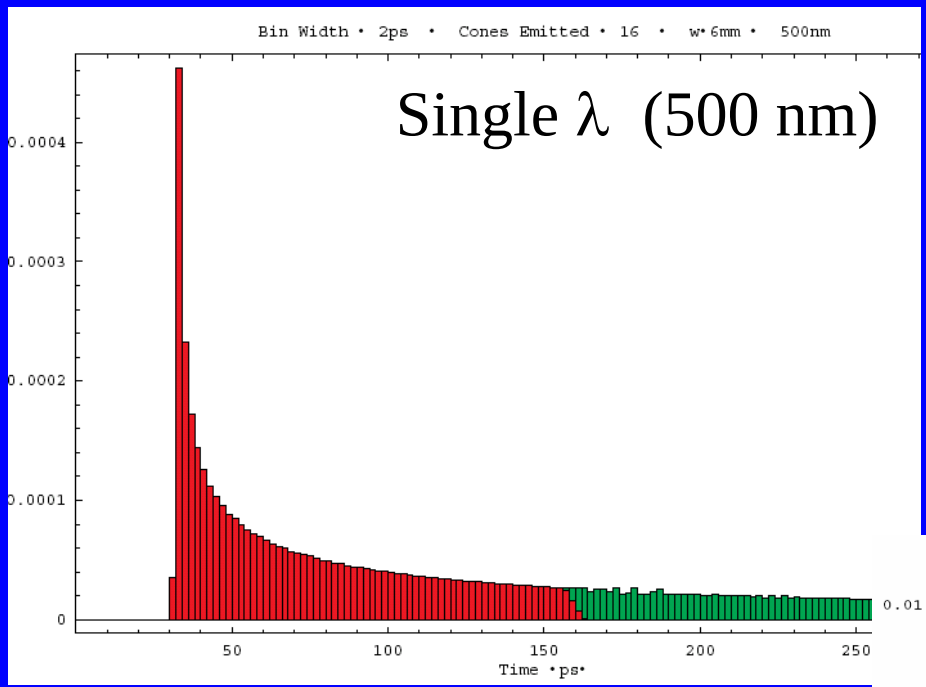
10 Psec Workshop April 28 at UTA

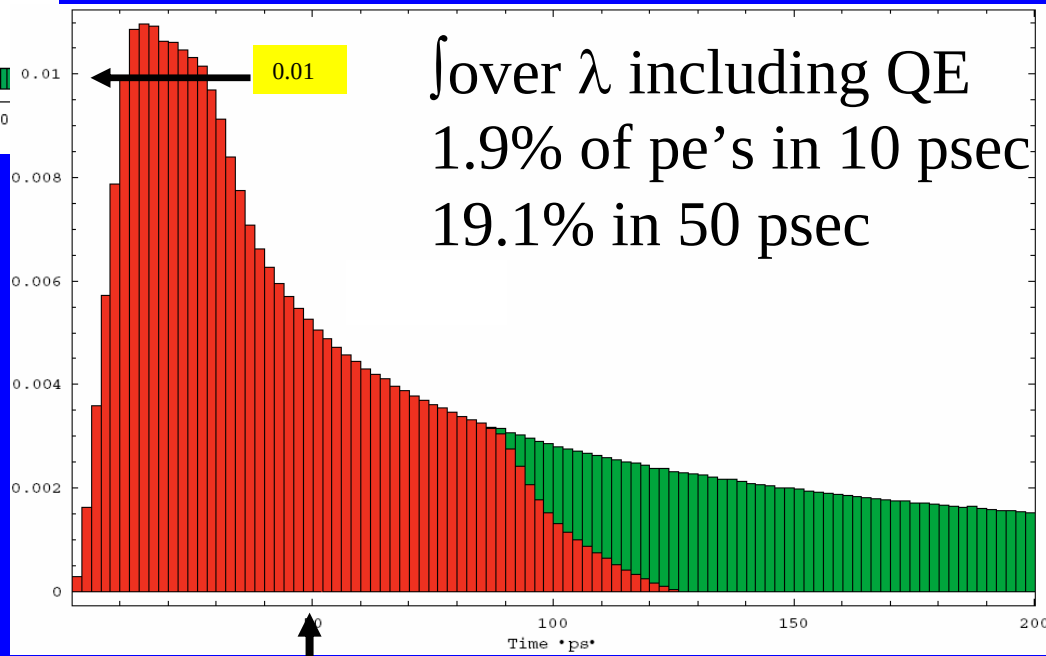
Very useful trip to SLAC Mar. 2 to meet with Jerry Va'vra (Babar), discuss Burle MCP-PMTs, fast-timing issues, leads to April 28 UTA 10 psec workshop with Va'vra, QUARTIC principles, +Louvain engineer,+Hink (Burle), +Frisch+engineer (Chicago)

Goal: Discuss electronics issues to achieve 10-15 psec resolution, status of tube development (timescale for 32 x32 1.5 mm pixel tube + associated readout card), foster collaboration

Preliminary Time Distributions (UTA):



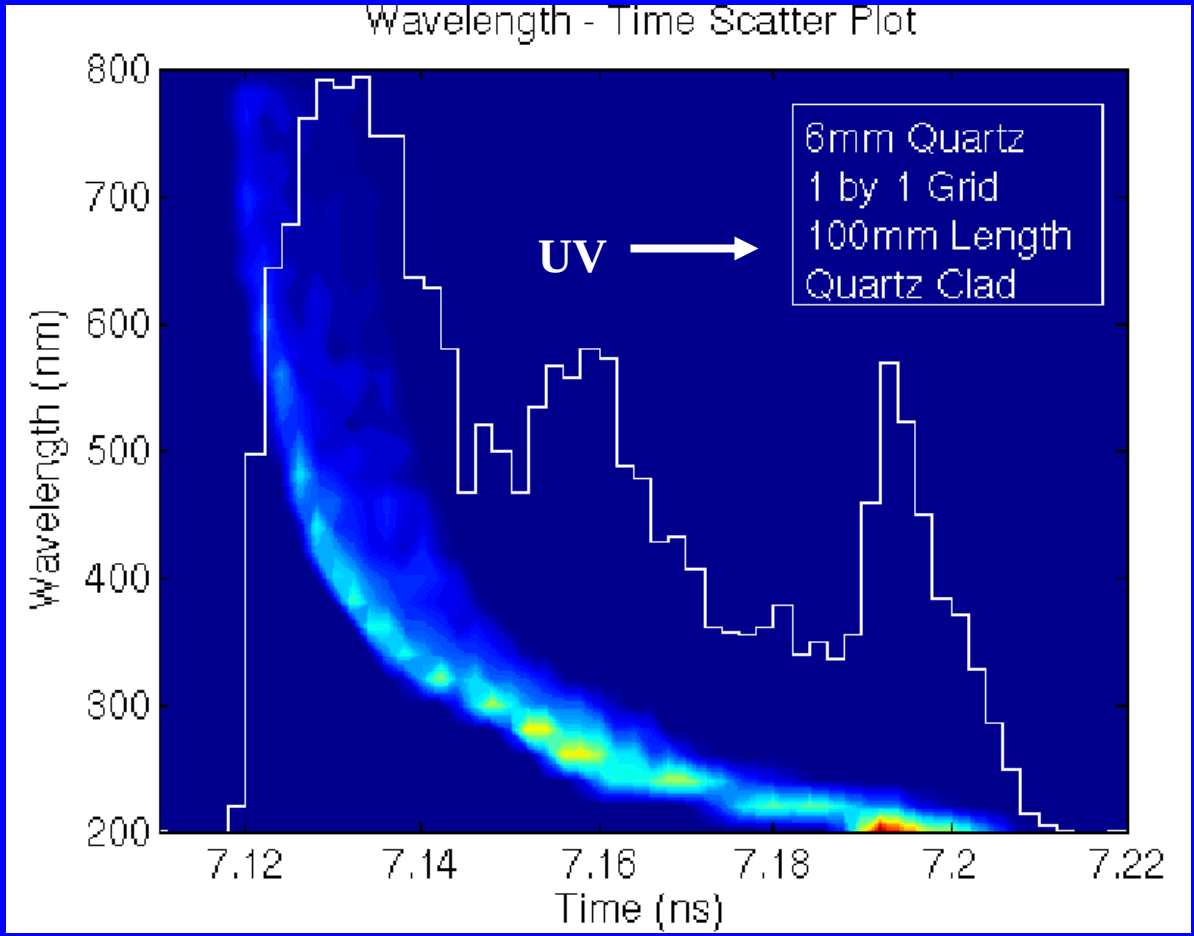
red = totally internally reflected light
green = extra light if aluminized



UV light is 30-50 psec later than visible {n(λ)}

50 psec

Geant Simulation (Alberta)



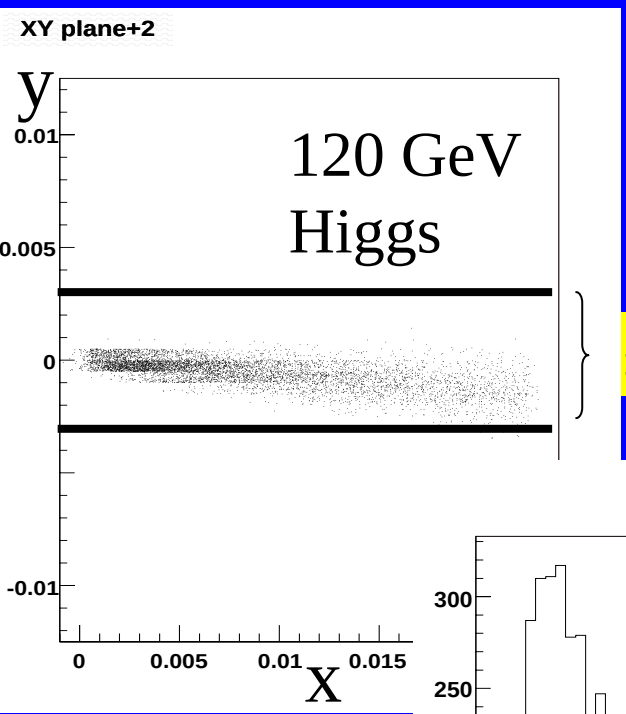
So perhaps fused silica/quartz not optimal: lead glass or other?

(Yushu Yao)

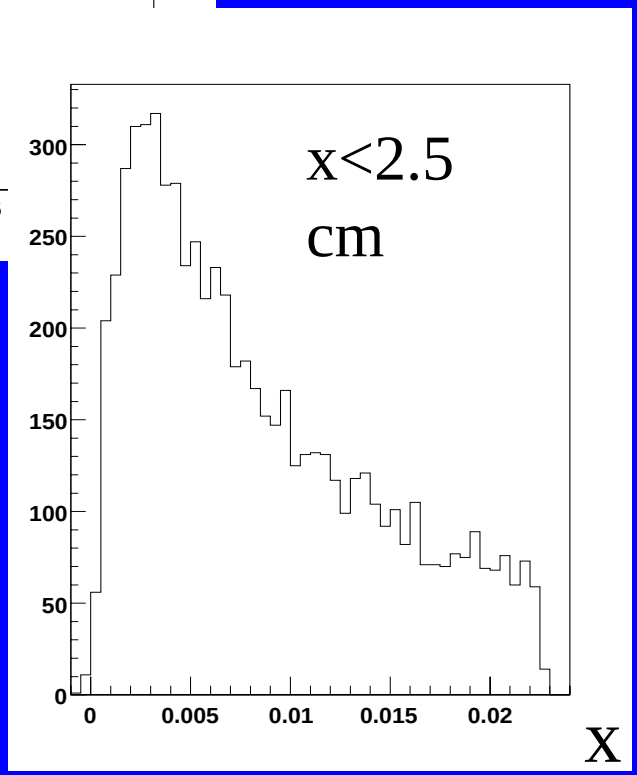
Longer wavelengths arrive first, UV light does not help timing much

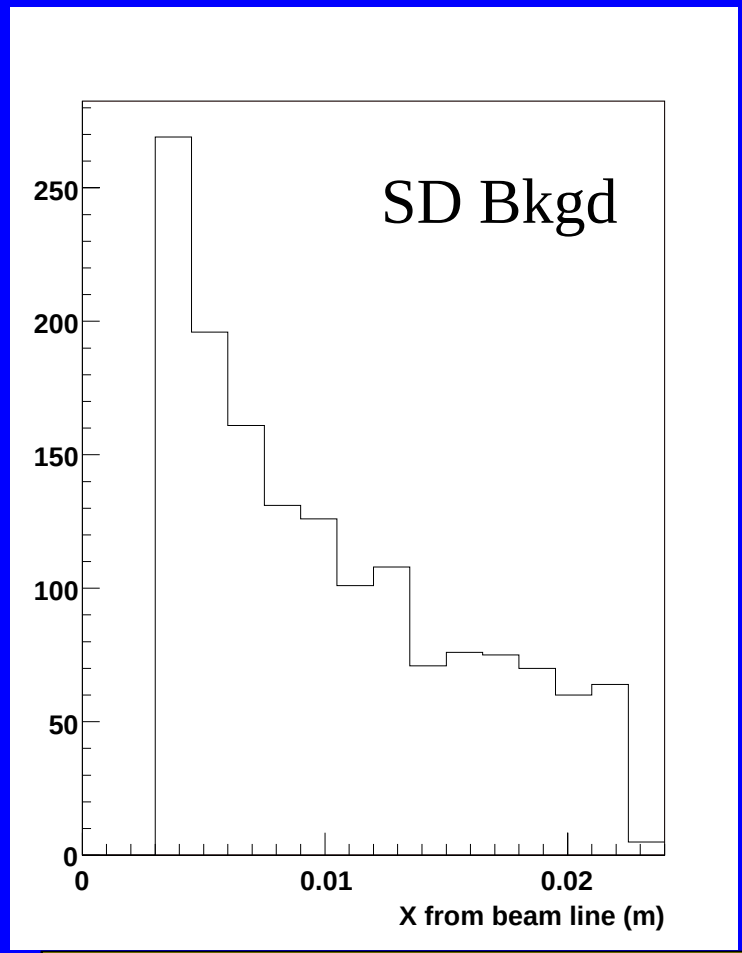
Lumpiness under study—geometric affect?

Where do Protons go at 420m



±3mm

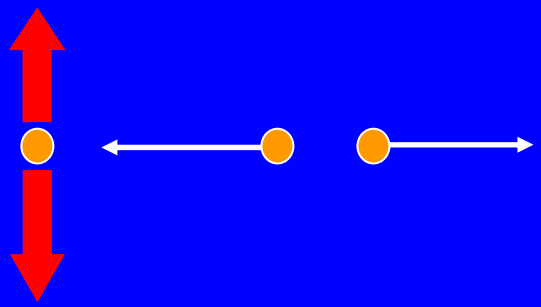




Implies x-segmentation useful for multiple p's in a detector (but this is not the big issue!)

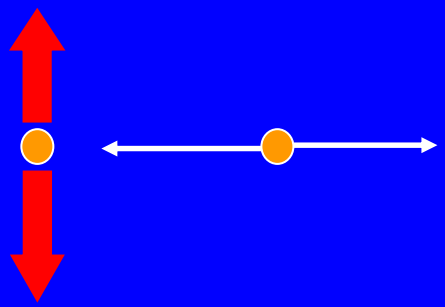
QUARTIC Background Rejection (UTA)

1) 2 single diffractive protons overlayed with a hard scatter (1% of interactions have a proton at 420m)



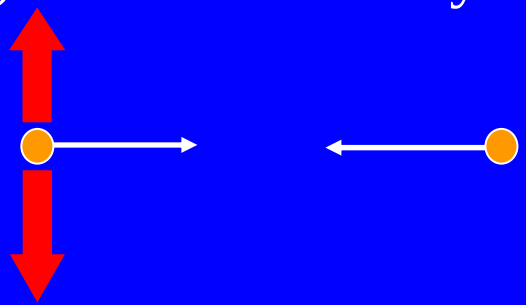
97.4% of events primary vertex and fake vertex from combining proton times more than 2.1mm (1σ) apart ; 94.8% if 20 psec

2) double pomeron overlayed with a hard scatter



97.8% of time vertices more than 2.1mm apart; 95.6% if 20 psec

3) hard SD overlayed with a soft SD



95.5% of time primary vertex and fake vertex more than 2.1mm apart; 91.0% if 20 psec

Background Rejection

- Big issue is fake background, not multiple proton background, we (I) do not know absolute magnitudes
- What I think is needed: generate inclusive SD +DPE (Phojet, other), Hard SD (Pomwig/other), inclusive Higgs (no protons Herwig/Pythia), SD Higgs (Pomwig/other)
- Track protons to 420m
- Apply kinematic constraints, comparison of missing mass to central mass, apply additional constraints from timing and see to what luminosity FP420 is feasible

This could be showstopper, needs concerted effort/task force

QUARTIC Design

Baseline detector: 6x4 6mm square rods of fused silica
in z consider 4x9mm or 3x12 mm
in x consider 16 x 1.5 mm
consider limiting wavelength range
larger n to get more light

Questions awaiting definitive answer from simulations (GEANT) and/or test beam:

1) Radiator: fused silica or if not what? Pb-glass?
2) Surfaces aluminized or spaced/total internal reflection?
3) Length/widths of bars (angle from radiator) ... MCP clearance.
4) Mechanics of housing/integration

Quotes Requested

I) Fused silica n~1.5

lengths for a set are 90,95,100,105,110,115 mm

a) high transmission over range 180-700 nm

i) 4 sets polished on all faces **(baseline detector)**

ii) 2 sets polished except one of the 6mmx6mm sq faces

b) high transmission over range 350-700 nm **(visible detector)**

i) 2 sets polished on all faces

II) Fused silica n~1.5 **(short detector)**

lengths for a set are 45,47.5,50,52.5,55,57.5 mm

a) high transmission over range 180-700 nm

i) 2 sets polished on all faces

III) A high transmission material in the 350-700 nm range with n~1.8 **(high index detector)**

lengths for a set are 83,87,91,95,99,103 mm

a) i) 2 sets polished on all faces

QUARTIC Timeline

1) buy "quartz" (UTA)
slow vendor response, so have got out multiple bids, plan first purchase this week, 4-5 week delivery
2) simple frame, plan to be ready when quartz arrives w/cosmic test stand (UTA) (trigger scint from FNAL)
3) electronics circuit (Alberta) delayed by new building move;
April 28 UTA meeting will be a focal point
given that circuit likely to take 3+ months (1 month design, 2 months fab) and testing, a 2 phase approach seems desirable
i) off shelf nim-type cfd and tdc for early test beam, say July 1
ii) new improved circuit for Aug. 1
4) Test beam preparation (FNAL, UTA, Alberta)
manpower June-August, pedro+? Alberta needs personnel money to send people to FNAL, Louvain?, Helsinki?, Saclay? other?
need to integrate Quartic into test beam readout (Alberta?)

Conclusions

Fast TOF is a critical part of FP420

Background studies are a crucial FP420 issue—potential show stopper

Still plan to test baseline detector in Fermi test beam this summer

Electronics schedule tight

Test beam manpower is an issue

Funding is an issue