Report on US420 Activities

Contents

Report on US420 Meeting held July 28th 2005 at Fermilab

Possible US Contributions to FP 420

US420 Meeting July 28th 2005:

US420 revised

Date/Time: Thursday 28 July 2005 from 10:00 to 11:00
Location: Fermilab
Chairperson: Mike Albrow

[last update: Wednesday 27 July 2005]

Thursday 28 July 2005

10:00	Introduction: status (05')	Mike Albrow (FNAL)
10:05	US420 and ATLAS status (10')	Michael Rijssenbeek (Stony Brook)
10:15	3D Si status (15')	Chris Kenney (SLAC)
10:30	Fast Timing Counters (10')	Mike Albrow (FNAL)
10:40	Missing Mass in Exclusive WW and ZZ events (10')	Mike Albrow (FNAL)
10:50	Discussion - What can we do? (15')	All

My Introduction:

FP420 → LHCC, names, institutions, Brian + Albert + Cinzia (TC)
LHCC response (ref: Mario Martinez, saw him Friday)
Announced this meeting and Manchester Dec 12+13
Brief report from Monika Grothe on simulations transmitted

Radiation Levels – calculations:

Igor Rahkno was to do this, ~ 2 man months.
He transferred to another group --- can educate/consult but not do it.
A **NUMI MARS** expert could *help* someone from FP420
Interesting project for student e.g. → **needs action**

Mechanics (Microstation? Hamburg Pipe? Pivot? Brand X?)

Was on hold until LOI submitted. Still on hold!
We might be able to make a prototype at Fermilab but
it needs someone other than me (at least)
with mechanical expertise and an interest in taking responsibility.
Is there someone among us ... ? (since, Andrew Brandt initiative)

Letter of Interest to US-ATLAS
July 27, 2005

A. Brandt, S. Parker, M. Rijssenbeek

Goals

Make US-ATLAS, and its management, "officially" aware of the DPE @ 420 m interest of the US-ATLAS members of US/FP420

Give advance notice of tasks we would possibly undertake, and the funding costs these might entail

Topics in the LoI:

- Goals, and pointers to the Physics arguments
- Scope of the US/FP420 project
  - detectors at 420 m
  - detectors at 240 m (for ATLAS)
- Possible US-ATLAS contributions to US/FP420
  - in-kind: modified connection cryostats for ATLAS IP
  - 3D edgeless detectors
  - Design/Engineering of detector mechanics

Uses of Various Missing Mass in Central Exclusive WW,ZZ

Mike Albrow (at CMS Week, June)

Summary

→JJ and JJJJ events with 220m … can use xi(220) – J ET,eta correlations in Level 1 trigger.

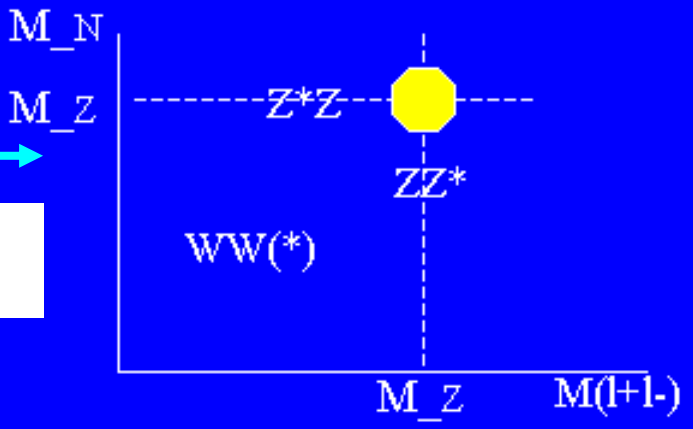
→Several missing mass variables allow almost all decay modes of exclusive WW, ZZ to be used (given central L1 trigger)

$$M_H^2 = (J_1 + J_2)^2 = (p_1 + p_2 - p_3 - p_4)^2$$

$$M_N^2 = (p_1 + p_2 - p_3 - p_4 - p_{l_1} - p_{l_2})^2$$

$$M_N^2 = (p_1 + p_2 - p_3 - p_4 - p_{l_1} - p_{J_1} - p_{J_2})^2 = 0$$

$$M\,M^2 = (p_1 + p_2 - p_3 - p_4 - p_{J_1} - p_{J_2})^2 = M_W^2$$



B(ZZ → l+l- JJ for l = e,mu,tau) = 0.1456

Require 2 jets on l+l- vertex (want to use multiple interactions)

Not only M(JJ) = M(Z) but also:

$$MM^2 = (p_1 + p_2 - p_3 - p_4 - p_{J_1} - p_{J_2})^2 = M_Z^2$$

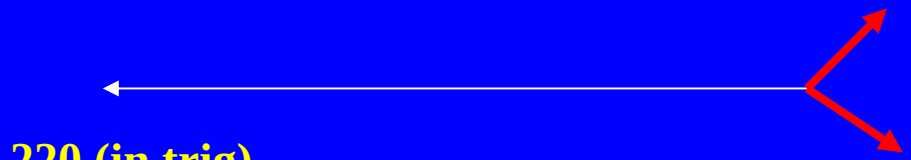
This equation works also for leptonic Z → nu-nu!
B(ZZ→JJ nu-nu) = 0.2796. That's a giant leap!
0.0045 + 0.0045 + 0.0269 + 0.1456 + 0.2796 = 0.46 (100x)

ee&μμ also ττ also $\nu\bar{\nu}$ also llJJ also $\nu\bar{\nu}$JJ

The remaining ~ 50% of both WW and ZZ are JJJJ
(and 4-tau & 4-nu (only 4%))

JJJJ Hard but maybe not impossible IFF we can trigger well.

Exclusiveness brings rewards



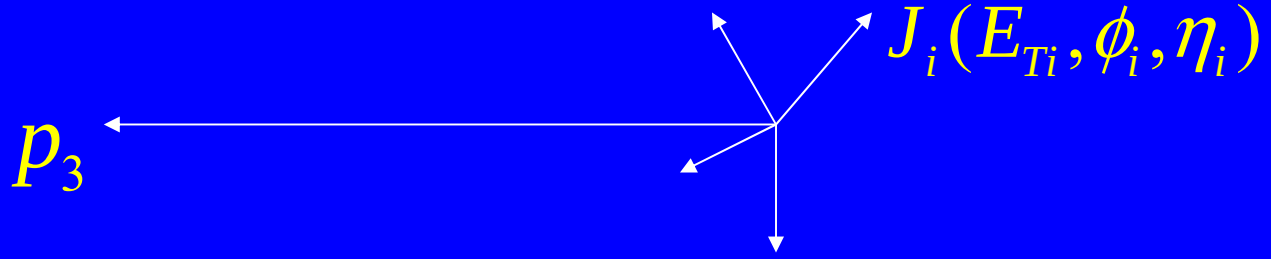
220 (in trig)

420 (at L2)

Two jets' E_T are the same to ~ 1 GeV, $\Delta\varphi=180^0$
and, knowing that and η_1,η_2 and(??) $\xi_1(220)$
in L1 trigger (fast look-up) can use correlation
to reduce L1 trigger rate.

$$\xi_{1(2)} = \frac{1}{\sqrt{s}} \sum_{\text{jets}} E_{Ti} e^{+(-)\eta_i}$$

Triggering on WW/ZZ → JJJJ + one (220m) forward proton, L1



$$\xi(p_{3(4)}) = \frac{1}{\sqrt{s}}\left[\sum_{i=1,4} E_{Ti} e^{-(+)\eta_i}\right]$$

So, it is very important to push RP(220) xi resolution hard, and get a xi value into L1 trigger, as well as ET, eta of all jets.
Same as for JJ case, but then had ET1 = ET2 and dphi = 180.

Fast Timing Counters

Mike A + Jim Pinfold + others interested

Counters with ~ 10 ps timing resolution behind tracking

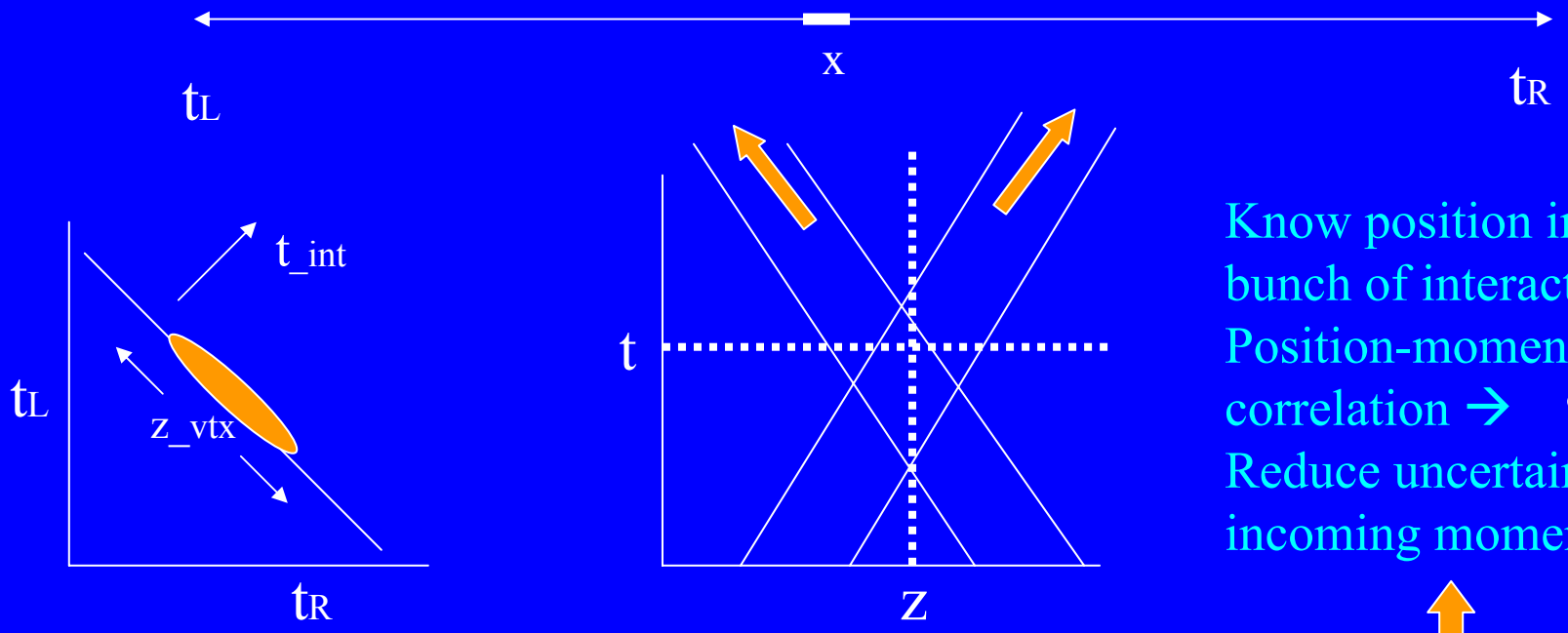
10 ps = 3 mm

1) Check both p's from same collision (reduce background)
2) Get z(vertex) to match with central track vertex
3) Tell what part of bunches interacting protons were (F-M-B)

Likely solution:
Solid Cerenkov block or fibers (quartz?)
MCP-PMT (Micro-Channel Plate PMT) ... or APD?

Put at back of 420m (220m?) tracking high precision timing counters.
Suggested in Tevatron LOI: Quartz Cerenkov + ~ Microchannel PMT
Then said 30 ps(?). Now tested (Japanese Gp) → **10 ps**

Check that p's came from same interaction vertex (& as central tracks)



Know position in each bunch of interacting p's. Position-momentum correlation →
Reduce uncertainty in incoming momenta.

Potentially valuable e.g. MSSM triplet (Higher cross section & close states)

Available online at www.sciencedirect.com
SCIENCE DIRECT®
Nuclear Instruments and Methods in Physics Research A 528 (2004) 763–775
NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A
www.elsevier.com/locate/nima

MCP-PMT timing property for single photons

M. Akatsu, Y. Enari, K. Hayasaka, T. Hokuue, T. Iijima, K. Inami*, K. Itoh, Y. Kawakami, N. Kishimoto, T. Kubota, M. Kojima, Y. Kozakai, Y. Kuriyama, T. Matsuishi, Y. Miyabayashi, T. Ohshima, N. Sato, K. Senyo, A. Sugi, S. Tokuda, M. Tomita, H. Yanase, S. Yoshino

Department of Physics, High Energy Physics Laboratory, Nagoya University, Furo-Cho, Chikusa, Nagoya 464-8602, Japan

Received 8 January 2004; received in revised form 1 April 2004; accepted 2 April 2004

Abstract

We have measured the performance, especially the timing properties, of micro-channel plate photo-multiplier tubes (MCP-PMTs) by irradiating with single photons with/without a magnetic field. A time resolution of $\sigma = 30$–35 ps was obtained for single photons under 1.5 T. With an MCP-PMT, a small time-of-flight counter by means of Cherenkov light radiation instead of scintillation light has been prepared, and a time resolution $\sigma \sim 10$ ps was attained for a high-energy π-beam by multiple photons.

It's been done!

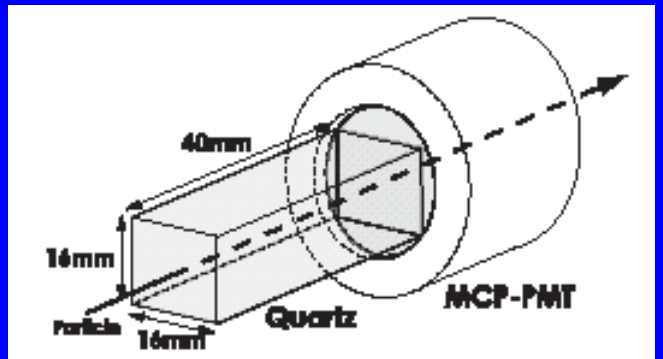


Fig. 12. Schematic drawing of the test TOF counter. HPK10 is used as the MCP-PMT.

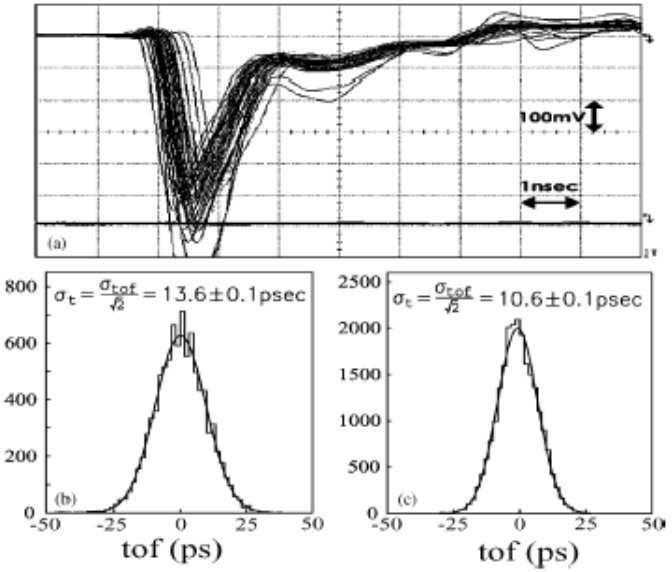
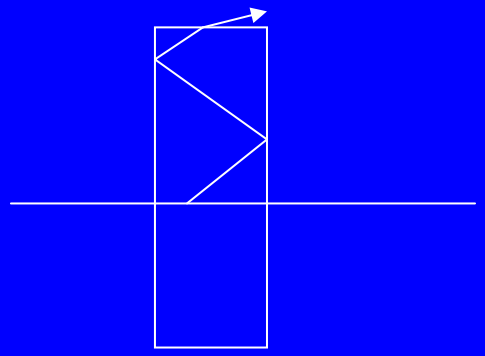


Fig. 13. (a) shows HPK 10s output signal for 3 GeV/c pion beam; (b) and (c) are the distributions of the time difference between two test counters without and with a quartz radiator, respectively. Their resulting time resolutions of the single counter are obtained as $\sigma_t = \sigma_{tof}/\sqrt{2} = 13.6 \pm 0.1$ ps and 10.6 ± 0.1 ps.

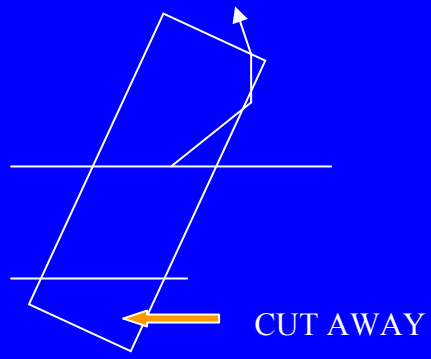
Geometry?

Want max light in delta-function

u/g student at ATA
Yushu Yao (Alberta)



Rectangular Block



Tilted

Plates or Fibers

For quartz $n(\lambda) \sim 1.54$

$$\cos(\theta_{Cerenk}) = \frac{1}{\beta n} = \frac{1}{n} = 0.65;\ \theta_{Cerenk} = 49.5^{o}$$

For TIR $\sin(\theta_i) = \frac{1}{n} = 0.65;\ \theta_i = 40.5^{o}$

Challenging, needs study: (1) 3D ray tracing program, with times
Design a practical compact detector. Beam test.
… great project for interested-in-instrumentation student/postdoc

Possible US+Canada Contributions:

Hardware:

1) 3D Silicon trackers (Hawaii **together with Brunel et al**)
2) Vacuum mechanics (u-stations or derivative) **with Helsinki et al**
3) Timing and trigger counters
4) Liaison with LHC on BPMs

Software:

1) Simulations and tracking (?)
2) Radiation Levels (?)