Recent Activity in the Test Beam

Erik Ramberg

AEM

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- Quick overview of facility
- Preliminary results from experiments that have taken beam so far this year
- New experiments likely to take beam this year
- Updates to beamline
The Facility
2 beam enclosures, but cannot be operated independently.
6 user stations, with a 7th downstream of the beam dump. An experiment can take up more than one station.
2 climate stabilized huts with air conditioning.
2 separate control rooms.
Outside gas shed + inside gas delivery system brings 2 generic gas lines, 1 nitrogen line and 2 exhaust lines to each of the user areas.
Lockable work area with 3 offices for small scale staging or repairs, plus 2 open work areas.
# Measured rates in the MTBF beamline

<table>
<thead>
<tr>
<th>Tune (GeV)</th>
<th>Rate in MT6/spill*</th>
<th>e⁻ fraction</th>
<th>Resolution in ECAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>800,000</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>66</td>
<td>90,000</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>33</td>
<td>40,000</td>
<td>0.7 %</td>
<td>1.0 %</td>
</tr>
<tr>
<td>16</td>
<td>14,000</td>
<td>10 %</td>
<td>1.2 %</td>
</tr>
<tr>
<td>8</td>
<td>5,000</td>
<td>30 %</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>500</td>
<td>60 %</td>
<td>2.4 %</td>
</tr>
</tbody>
</table>

* (Rates are normalized to 2.4E12 protons in Main Injector)

Spill is 4 seconds long, every 2 minutes
Current Experiments
List of MTBF Memoranda of Understanding (MOU):

- **T926: RICE** Experiment completed
- **T927: BTeV Pixel** Experiment completed
- **T930: BTeV Straw** Experiment completed
- **T931: BTeV Muon** Experiment completed
- **T932: Diamond Detector** Signed
- **T933: BTeV ECAL** Experiment completed
- **T935: BTeV RICH** Experiment completed
- **T936: US/CMS Forward Pixel** Taking data
- **T941: UIowa PPAC Test** Experiment completed
- **T943: U. Hawaii Monolithic Active Pixel Detector** Experiment completed
- **T950: Kaon Vacuum Straw Tracker** Analyzing data
- **T951: ALICE EMCAL Prototype Test** Analyzing data
- **T953: U. Iowa Cerenkov Light Tests** Analyzing data
- **T955: RPC Detector Tests (Argonne)** Taking data
- **T956: ILC Muon Detector Tests (Indiana)** Taking data
- **T957: ILC Tail Catcher (NIU)** Taking data
T927/936: The CMS pixel setup (INFN)

- Telescope of 6 pixel detectors
  - (50 μm × 400 μm)
    - 2 Y-measurement planes
    - 4 X-measurement planes
- CMS pixel detector in the center
  - (100 μm × 150 μm)
- Triggers to CMS detector are provided by two upstream scintillators
Pulse Height across cells

Note that the edges of the irradiated cells show the expected charge loss due to charge sharing with adjacent cells.
Conclusions

- The first analysis of data collected at the January test-beam indicates that
  - The plaquettes irradiated @ $3 \times 10^{13}$ work well and show no significant signs of damage
  - They provide a detection efficiency very close to 100% @ 150V.

- Additional near-term irradiations and beam tests are planned. Next scheduled tests are in July.
T953: CMS Calorimeter Upgrade (Iowa)

- Although we have only 6 layers, we got data at different depths (up to 70 cm of iron).
- We developed our own DAQ with NIM, CAMAC and LabView. At M-Test we had opportunity to test it.
Results from Test Beam @ Fermilab M-Test

- With limited number of layers we observed a shower profile at 120 GeV.
- The 66 GeV has very low statistics

- We compared the quartz plates with scintillators at different shower depths.
- We showed that the Cerenkov light collection is comparable with scintillation light.
- Plan to bring full calorimeter (20 layers) to MTest in Fall, 2006.
• Taken data with 120 GeV proton and 16 GeV pion, at beam intensity 60 – 5k Hz/cm²
• Tested 3 RPCs, this talk will cover the results from the first 2 chambers
AIR9: efficiency and hit multiplicity

- **Efficiency measurement**
  - ~92%, consistent with cosmic ray tests
  - All method agrees for HV>6kV
  - Prob. Calculation over estimate at low HV (as expected from method)

- **Hit multiplicity m~1.2**
  - Should be treated as an upper limit
  - Consistent with cosmic ray tests m~1.1
‘High’ rate measurement

- **AIR5**
  - Efficient up to 100Hz/cm²
  - If operated at 7.4 kV, better rate capability expected
- **AIR9**
  - Match data: only provide first two data points
  - Match data II: tells how efficiency changes with rate, but significantly underestimate absolute value
  - Should be efficient for 100-200Hz/cm²
T956: ILC Muon Detector Test (Indiana/FNAL)
Preliminary Result – ADC Spectrum, 5000 events

- Pedestal at ~channel 65, with 10X amplifier
- Peaks at ~channels 95, 125, 155, 185, 215, 245, 275, ...
- Correspond to 1, 2, 3, 4, 5, ... photoelectrons
- Mean number of photoelectrons is ~6
- At 0.25 pC/channel, 30 channel separation between peaks yields gain of 4.5 x10^7 (amplified), or 4.5 x10^6 (unamplified)
T957 - CALICE TCMT (NIU)
(“TCMT”=Tail Catcher/Muon Tracker)

Stack designed and being assembled at Fermi

- Designed to test new detector technology (extruded scintillators, Silicon photomultipliers) for the ILC
- Sixteen 1m x 1m ‘cassettes’, each of which has 10 scintillating strips and 20 photosensors, are separated by steel absorber plates
- A single cassette was installed at the FNAL Meson Test Beam Facility in February for initial evaluation in a 120GeV proton beam
• Moved into the facility 3rd week of Feb.
• Took beam in the last week ~ 5 days
• Took 120 GeV/c protons, 16 GeV/c (mostly pions) and some beam dump muon runs
• ~ 1M events collected
• Calice DAQ Electronics chain reproduced and tested
• Results will be compared with 3 GeV/c e- data from DESY
• Will attempt to run at CERN in July, if SiPM chips are available.
• Likely future running at MTest with multiple layers.
Potential New Experiments
Fast Timing (20 ps) Cerenkov Counters

Aim: For eventual upgrade to CMS (and ATLAS), measure very forward protons 420m from intersection.

\[ pp \rightarrow p + H + p, \quad p + W^+W^- + p \]
\[ \sigma \approx 3 - 10 \text{ fb} \quad \sigma \approx 50 \text{ fb} \]

Precise measurements of forward protons gives information on M(H), Spin and CP, Couplings and Width if \( \sigma > \) few GeV.

Detector area only 8 mm x 24 mm, need ~ 10 \( \mu \) tracking and \(< \sim 20 \text{ ps}\) timing to reduce accidentals.

\[ \Delta t \approx 20 \text{ ps} \rightarrow \sigma(z_{\text{vertex}}) \approx 4.5 \text{ mm} \]
\[ cf \sigma_z \text{ (interactions)} \approx 55 \text{ mm} \]
**QUARTIC** = QUARtz TIMing Cerenkov
6mm x 6mm bars mounted at Cerenkov angle 50deg.

**GASTOF:**
Cerenkov angle small → less light, make long (30 cm)
Light arrives within 2 ps.

Plan to test prototypes counters Summer/Fall 2006. High energy protons only. Co-exist with CMS pixel tests.
GEM 30cmx30cm Prototype Chamber (U.T.A.)

- The first 30cmx30cm GEM chamber constructed with 3M foils
- Tested with sources
- Will be used low E electron beam chamber and 3M foil characteristics run in Korea in mid May
- 16 channel will be read out
FNAL Beam Test Plans

• Late July or early August, 2006
• Use two chambers
• Use new PCI based ADC card with 96 channel readout
• Expose to e, π and muons
  – Energies in as wide momentum range as possible
  – Will expose chambers with large bricks in front of the chambers or with some absorber plates between them
  – Will allow us to see chamber behaviors with hadronic and EM showers
  – Verify chamber characteristics measurements in Korea
COUPP bubble chamber nuclear recoil efficiency measurement

• A new bubble chamber is being built by the COUPP collaboration
• Plans are to use it for tests of efficiency and nuclear recoil thresholds.
• One of the best ways to measure recoil energy spectrum of events is to use coherent nuclear scattering, with an incoming low energy (10 GeV) pion beam.
An ILC test beam plan – 34 institutions, ~160 names

- This proposal needs a long term occupation (> 1 year) in MTBF.
- They need a broad range of particle types (e, π, μ, p)
- Requests for high energy electrons (>25 GeV) and low energy pions (1 GeV) can’t be met by current facility.
- Currently at CERN SPS test beam for rest of 2006.
- Have indicated they would like to move to Fermilab test beam in 2007
Upgrading the Test Beam

- Several experiments (ILC, NOVA, MINERVA) would like to see low energy test beams at Fermilab.
- Low energy (1 GeV) pions and electrons are very difficult in the current test beam due to length of beamline and sheer number of windows, scintillators, etc.
- The External Beams Group is working on a design now to install a movable target in the M03 or M04 enclosure and possibly redesign the downstream part of the beamline.
- Low current power supplies and Hall probes will be installed on many of the beamline elements.
- These changes will increase rate of 1 GeV pions by ~50-100.
Meson Detector Building

Current 40 cm Al target

Proposed new target location
Summary

- The Fermilab Meson Test Beam Facility is in full operation and supporting multiple users.
- Several groups ran simultaneously near the end of the last running period and obtained good quality data. Some of these will be running again this summer or fall.
- Additional groups have also expressed serious interest in running this year and can likely be supported.
- A larger scale ILC calorimetry test setup will probably come to Fermilab in 2007. That setup will compromise the flexibility of the MTest facility.
- An augmentation to the MTest beamline is being designed by the External Beams Group. This design would increase the flux of low energy pions in the beamline.