Expected Environment and Performance of LUMI
Neutrals on the TAN

From Baseline and Requirements for a Luminosity Monitoring at the LHC.

• Crossing Angle – 300 µrad
• Luminosity – $10^{34}$ cm$^{-2}$s$^{-1}$
• Mars Calculation

Figure 2: Neutron flux at the TAN surface.

Figure 3: Photon flux at the TAN surface.
Table 3: Average number of particles $\langle N \rangle$, particle energy $\langle E \rangle$ and total energy $\langle N \rangle \times \langle E \rangle$ per ppi incident on the IP5 TAN absorbers [12]. The total particle flux $\phi_{\text{tot}}$ at $8 \cdot 10^8$ ppi/s is also shown.

<table>
<thead>
<tr>
<th>particle</th>
<th>$\langle N \rangle$</th>
<th>$\langle E \rangle$ [GeV]</th>
<th>$\langle N \rangle \times \langle E \rangle$ [GeV]</th>
<th>$\phi_{\text{tot}}$ [cm$^{-2}$s$^{-1}$]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n$</td>
<td>0.479</td>
<td>1516</td>
<td>726</td>
<td>$1.2 \cdot 10^6$</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>301</td>
<td>2.20</td>
<td>662</td>
<td>$6.8 \cdot 10^8$</td>
</tr>
<tr>
<td>$p$</td>
<td>0.109</td>
<td>938</td>
<td>102</td>
<td>$2.5 \cdot 10^5$</td>
</tr>
<tr>
<td>$\pi^\pm K^\pm$</td>
<td>0.875</td>
<td>64.8</td>
<td>56.8</td>
<td>$1.8 \cdot 10^6$</td>
</tr>
<tr>
<td>$e^\pm$</td>
<td>24.5</td>
<td>0.294</td>
<td>7.2</td>
<td>$5.3 \cdot 10^7$</td>
</tr>
<tr>
<td>$\mu^\pm$</td>
<td>0.006</td>
<td>4.87</td>
<td>0.031</td>
<td>$1.4 \cdot 10^4$</td>
</tr>
</tbody>
</table>
TAN power deposition (W/kgm)

- Peak power density 1-10 W/kg \times m (location of ionization chamber)
- Located in high radiation area (100 Gy/oper yr)
Parameters of the Test

- 350 GeV protons
- Final prototype analog electronics
- Method
  - Trigger on incoming proton
  - Study BRAN response
Measured average pulse height with a scope
- Units are mV
- Used different thickness of copper absorber
- Keep beam steady
- Move chamber
- Study shower sharing
- Scan of one quadrant
- Mid point band approximately 2 cm × 2 cm
- Size of quadrant
2D Projection

- Two sides where receives shower from neighboring quadrants
- Edge effect
- Two sides where no neighbors
Simulations
Simulations

- FLUKA and MARS running on our computer
- Want to do detailed shower calculations in BRAN
- Intend to pursue a collaborative approach to model TAN detectors
- Summer students working on MARS and FLUKA simulations
  - Cory Fantasia - Northeastern (2007)
  - Johannes Stiller - Heidleburg (2008)
Detailed Simulation
Geometry Setup

Fluka Simulations by Johannes Stiller
Detailed Simulation
Geometry Setup

Fluka Simulations by Johannes Stiller
Detailed Simulation
Geometry Setup

Stainless Steel Housing

Fluka Simulations by Johannes Stiller

CAD

FLUKA
Detailed Simulation Geometry Setup

Ceramic Cover

Stainless Steel Housing

Fluka Simulations by Johannes Stiller
Detailed Simulation Geometry Setup

Ceramic Cover

Stainless Steel Housing

Copper

Fluka Simulations by Johannes Stiller

CAD

FLUKA
Detaile Simulation
Geometry Setup

Ceramic Cover

Stainless Steel Housing

Copper

6 Gaps

Fluka Simulations by Johannes Stiller

CAD

FLUKA
Compare to Models

Absorber Scan at the SPS - 2008

Fluka

SPS Data
Vadim Talanov generated a set of particles from p-p events for IR5

- 7 TeV
- Crossing angle 285 µrad
- 450 Gev

Used by experimenters with detectors in the TAN

Cross check results

File limitation
- Not decayed to final states
- No interactions in upstream material
- No model of beam background
- Need them at all CERN energies
Future Simulations

- Transfer simulation work from Johannes to Ryoichi Miyamoto (Visit to LBNL next week)
- Need to obtain or generate CERN data files at different energies
- Understand CERN modes of operation other than 7 TeV
Commissioning LUMI
A working system at IP1 and IP5
Determine Bunch by Bunch relative luminosity
A tool that CERN operators use
# Stages to Maximum LHC Luminosity

**CERN EDMS 347396**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Bunches</th>
<th>Bunch Spacing</th>
<th>Luminosity [cm⁻² s⁻¹]</th>
<th>Interactions/ Xsing</th>
<th>Mean pulse height/ occupied bunch Xsing - mV</th>
</tr>
</thead>
<tbody>
<tr>
<td>A–Collision studies with single pilot bunch beam - no crossing angle</td>
<td>1</td>
<td>N/A</td>
<td>2.5×10²⁶ - 3.7×10²⁷</td>
<td>0.0006-0.092</td>
<td>0.04-0.53</td>
</tr>
<tr>
<td>B–Collision studies with single higher intensity bunch - no crossing angle</td>
<td>1</td>
<td>N/A</td>
<td>1.1×10²⁹ - 4.3×10³⁰</td>
<td>0.27-10.71</td>
<td>16-611</td>
</tr>
<tr>
<td>C–Early p-p luminosity</td>
<td>43</td>
<td>2.025 µs</td>
<td>4.8×10³⁰ - 8.4×10³¹</td>
<td>0.28-4.86</td>
<td>15-277</td>
</tr>
<tr>
<td></td>
<td>2808</td>
<td>25 ns</td>
<td>6.5×10³²</td>
<td>0.58</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>936</td>
<td>75 ns</td>
<td>1.8×10³³</td>
<td>4.79</td>
<td>273</td>
</tr>
<tr>
<td>D–Nominal p-p luminosity</td>
<td>2808</td>
<td>25 ns</td>
<td>1.0×10³⁴</td>
<td>8.87</td>
<td>506</td>
</tr>
<tr>
<td>E–Ultimate p-p luminosity</td>
<td>2808</td>
<td>25 ns</td>
<td>2.3×10³⁴</td>
<td>20.39</td>
<td>1163</td>
</tr>
</tbody>
</table>

Pressure = 8 atm – (57 mV for each 7 TeV collision)

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BRAN Instrument
Commissioning Plan

A–Collision studies with single pilot bunch beam - no crossing angle
- Collision rate too low to use as a luminosity monitor
- Minimize noise
- Get baseline software and hardware ready
- Study beam background (beam-gas, neutron ...)

B–Collision studies with single higher intensity bunch - no crossing angle
- Start in pulse counting mode
- Transition to pulse height mode
- Need sustained presence at CERN

C–Early p-p luminosity
- Develop deconvolution algorithms
- May need deconvolution for this phase
- Implement and test crossing angle algorithms
- Can do pulse counting for most of this period
- Develop pulse height mode algorithms

D–Nominal p-p luminosity
- Pulse height mode
- Deconvolute

E–Ultimate p-p luminosity
- Might need to lower pressure to reduce voltage
Specific Plan
**Mode A + B-Circulating Beam**

- Measure noise rates and compare to expected
- Measure interactions
  - beam halo with beam pipe
  - beam gas
  - collimator
- Synchronize DAQ

- Measure for occupied and unoccupied bunches
  - pulse height
  - pulse shape
- Compare to simulations
Mode C – Collisions

- Synchronize DAQ and LHC clock
- Measure counting rates as a function of measured voltage
- Determine threshold for pulse counting
- Verify bunch pattern
- Compare luminosity measurement with other detectors
- Analyze beam background
- Develop and test deconvolution algorithms
- Compare to simulations
Mode D – Nominal luminosity

- Transition to pulse height counting mode
  - Compare to counting mode
  - Cross correlate with other luminosity detectors
  - Compare with simulation and expected fill pattern
FY10

- Commission detector with beam
- Cross correlate with PMT luminosity system
- Integrate DAQ into LHC control system
- Compare with models
Detector works with beam

Commissioning will continue with each change in LHC operating conditions

We will commission in FY10

Need simulations to understand data at the energies that LHC will use

Commissioning dependent on luminosity and fill pattern

Need presence of personnel at CERN

Will take effort to make BRAN part of LHC beam instrumentation