Calibration Light Injector for HF Optical Calibration

Marc Baarmand
Igor Vodopianov

HF ROBOX PRR – CERN
April 3 - 4, 2003
HF Optical Calibration Components:

- 1x4 Splitter
  - LV1 UV laser light splitter
- Calibration Box (CBOX)
  - LV2 1x9 laser and LED light splitter
- Calibration Light Injector (CLI)
  - LV3 1x24 splitter
  - Injecting light into 24 PMTs of ROBOX
  - CLI sits in empty PMT tube in ROBOX
HF Optical Calibration Layout

Counting Room

N₂ Laser
200 µJ
337 nm

300 µm QQ 65m

1 × 4

HF –

HF +

9 ROBOXs / Quad
24 PMT / ROBOX
216 PMTs / Quad
864 PMTs / End
1728 PMTs Total

9 ROBOX

Top Rack

600 µm QP

9 ROBOX

Bottom Rack

CBOX

9 ROBOX

Top Rack

600 µm QP

Bottom Rack

CBOX

9 ROBOX

CBOX

CBOX
CLI in ROBOX

ROBOX

- Empty PMT TUBE
- Calibration Light Injector (CLI)
- PMT

Shielding

- Light Guide
  - Non-reflective coating
- 40 cm
- 120 fibers
- 5 cm
Collimator produces uniform beam of light
Measured non-uniformity ≈5%
Prototype CLI Layout

Holographic 60° diffuser (polycarbonate)
Radiation hard?!

This CLI was used in 2002 beam test
Measured efficiency = $1 \times 10^{-4}$ per PMT
CLI in ROBOX

CLI
Beam test 2002
2002 Beam Test Results

PMT 157

- **2.3% laser input**
  - Ped.Mean=208
  - 1PE Mean=319
  - 2PE Mean=436

- **100% laser input**
  - Mean=7657
  - RMS = 893

**Single PE Response:**

- Plot#1: 111 or 117 ADC counts
- Plot#2: 106 ADC counts
- Plot#3: 104 ADC counts

**Similar results with LED**
100% laser input
Mean = 73.7
RMS = 15.3
Rel. Resolution = 21%

32% laser input
Mean = 25.4
RMS = 5.0
Rel. Resolution = 20%

PMT 154
8-10 fibers!!!
Production Schedule

- **Need 72 CLIs + 8 spares \( \Rightarrow \) 80 in total**
  - 36 HF wedges \( \Rightarrow \) 72 ROBOXs \( \Rightarrow \) 72 CLIs
- **Produce / test 40 for 2003 beam tests**
  - Deliver to TTU (N. Akchurin) by May 31, 2003
- **Remaining 40 will be done in ~ Fall 03**
  - Deliver to TTU or CERN?!
- **Team:**
  - Marc Baarmand
  - Igor Vodopianov (research associate)
  - John Lee (machinist)
  - Talal Qureshi (graduate student)
  - Leandro Almeida, Brian Dudley (undergrad students)
- **Materials at hand, ready to start production**
Additional Slides
Summer Beam Tests

- Test 18 HF wedges ⇒ 36 ROBOXs
- HF optical calibration needs:
  - 1x4 Splitter – 1 unit
  - CBOX – 2 units
    - Need 2 LED drivers - HB pulser card!
    - Need 2 QIE cards - standard HF QIE
  - CLI – 36 units + 4 spares
  - Various optical fiber cables
- Calibration system/QIE readout test
- Do single PE with both LED and laser
1×4 Splitter

Cross section ratio \( \approx 7 \) (14%)

Expected efficiency \( \approx 5\% \)

**Old splitter:** 1000µ QQ on 4 × 300µQP

- Cross section 9%
- Lab, red/blue 4.5%
- Test beam, UV 2.5%
New CBOX Design

- Changes to improve light yield by ~10x
  - Smaller polystyrene mixer: 4x8x25 mm³
- Placing CBOX in HF crate
  - Total of 5 slots: 4 for CBOX, 1 for QIE
- Integrate LED driver card and CBOX
  - Minimize LED leads length by mounting card on CBOX side
  - Air cooled
- Keep QIE card as separate module
  - No need to open CBOX (fragile optics) if QIE malfunctions
  - Other 3 QIE channels readily accessible
  - Standard air-cooled QIE card

PTP clock: slots 4-9 and 14-21

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<tr>
<th>Calib</th>
<th>QIE</th>
<th>CCM</th>
<th>QIE</th>
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<td>5 slots</td>
<td>4 slots</td>
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CBOX Layout 1

Standard 3U VME

4 slots wide
CBOX Layout 2

Non standard depth

195 mm
Better fiber-scintillator connection

CBOX would stick out of crate by 35 mm !!!

Marc Baarmand
HF ROBOX PRR – April 03
Expected PMT signal size

- **UV laser (FSU, 175µJ)**
  - Measured PIN3 signal (full laser power, 75m QQ fiber) = 44 pC
    - X 0.05 (1x4 splitter efficiency)
    - X 10 (expected CBOX efficiency improvement)
    - X 10^{-4} (CLI+LG+CalibFiber efficiency)
    - X 0.25/0.80 (PIN/PMT QE ratio)
    - X 5x10^4 (PMT gain)
  - Expected PMT signal = 34.4 pC

- Maximum HF QIE charge = 27 pC
- PMT gain varies by factor of 2 within same ROBOX!

UV laser provides sufficient dynamic range...