GRINCH Layout

Weldment

Scintillating paddle triggers (logic formed at weldment), ~30m

200m total ribbon cables

510 channels readout by VETROC TDC

LVDS to ECL translators

digital output

32 NINO cards (16 channels each)

GRINCH front-end

510 PMTs
GRINCH Layout

Weldment

Scintillating paddle triggers (logic formed at weldment), ~30m

GRINCH front-end

200m total ribbon cables
510 channels readout by VETROC TDC
200m 100m BNC cables
64 channels readout by v792 QDC

LVDS to ECL translators
digital output

32 NINO cards (16 channels each)
64 ADC channels (from 4 floating NINOs)

analog output

510 PMTs
Tuning HV and NINO Thresholds

• To promote PMT longevity, the voltages powering them should be set as low as possible (before gain matching)

• The measured NINO thresholds were first reduced from ~1.87V (near maximum) to 1.30V ± 0.02V
  – 1.25V is the absolute min., but accepts too much noise

• All HV’s powering the PMTs were reduced by 16%
  – Found to be the highest reduction, while still allowing for a signal
GRINCH front end

LVDS to ECL translator for front-end signal viewing
Tuning HV and NINO Thresholds

Before

NINO analog

NINO digital

After
ADC – ToT Correlation

"bottom right corner" PMT

ADC[21] (goes with TDC 501)

ADC[21] vs. TDC_501’s ‘Time over Threshold’

- Entries: 5911
- Mean: 217.6
- RMS: 72.4
- y' / off: 354.3 / 367
- Prob: 0.6739
- pedestal_constant: 33.79 ± 2.47
- pedestal_mean: 118.9 ± 0.2
- pedestal_sigma: 3.959 ± 0.173
- Landau_constant: 2312.2 ± 5.2
- Landau_MPDF: 192.2 ± 5.6
- Landau_sigma: 19.211 ± 0.35
2 different types of PMT hits? Vertical cosmics passing through more glass?
PMT Trigger

- Analog NINO output can be used to create a trigger signal from PMT rows at the front-end.
- This signal can then be sent to the weldment, to be included in trigger logic (same timing).
- In principle, these triggers can be placed anywhere within the GRINCH geometry (so portable).
- In particular, 2 PMT rows surrounding the region wherever the ADC is being output.
Cosmic tracks in the GRINCH

PMT rows forming trigger (noisy cables)

Selecting only the TDC peak
“3 Trigger” configuration

- The entire GRINCH is now active, but a top + bottom trigger is slow (~1 event / min)
- To help look for tracks, a PMT row trigger was included in the middle of the GRINCH
- An event is readout if any two of these 3 triggers make a signal
- A cosmic then only needs to pass vertically through ½ of the GRINCH instead of its entirety (from different events)
PMT Rate Counter

“Corner paddle”

‘and’ logic

“3 trigger”

pairwise ‘and’

Noisy channels can be easily seen
ADC cable lengths were halved

- The 200m ADC cables (two 100m sections) necessitated a huge delay in the trigger:

- The “patch panel in the middle” was eliminated, and the 100m cables sent directly to weldment
Current Timing Status

Everything now fits nicely within ~450ns
Shortening cables to 50m likely not possible though (TDC must come before TI)
Summary

• The GRINCH is now fully cabled, fully powered, and taking cosmic data
  – Cosmic tracks have been identified, using several trigger configurations
  – Persistently noisy channels should be checked, NINOs maybe replaced

• ADC – ToT correlation has been established, and PMTs are ready to be gain matched with it
  – The tools are there, but more streamlined software needs to be developed
  – Better visualization of all PMTs, Automatic fitting, etc.

• More HV connections are still needed for paddles (and larger paddles), but PMT trigger works well enough in the meantime