

Electron-Muon Ranger (EMR)

Status of the EMR Project

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On Behalf of the EMR Group

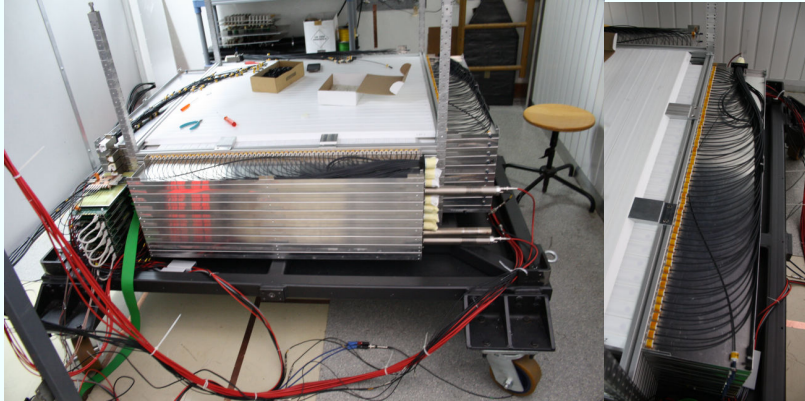
36th MICE Collaboration Meeting
June 17-19, 2013

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Construction Status

Full detector: 48 planes, 96 fiber bundles



- half of the detector assembled (24 planes)
- 12 fiber bundles ready to assemble 6 more planes
- 36 fiber bundles to be made within two next months

Schedule

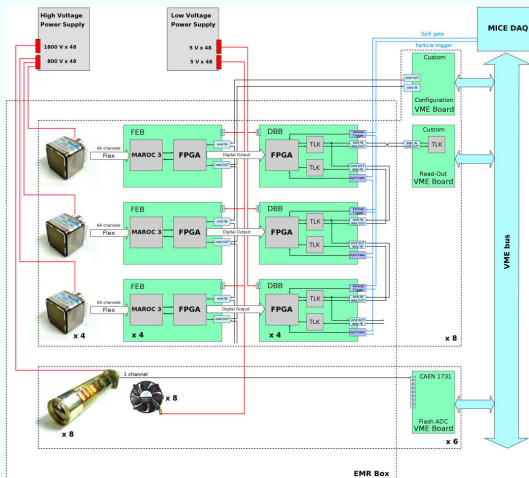
	month	May					June					July					August				September				October			
	week	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44			
fiber bundle assembly																												
plane assembly																												
packing																												
shipment																												
installation and commissioning																												
cosmic tests																												
DAQ debugging																												
physics runs																												

- it was decided to move EMR run to September/October
- this allows us to complete the detector in Geneva
- to estimate rates at EMR, beamline was simulated with actual geometry
- **see EMR Run Plan talk for more details about a schedule and physics program**

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Electronics



The full electronics readout is functional and being tested in cosmic bench

- **Front-End-Board (FEB):**

- ⇒ 64-ch. PMT readout
- ⇒ 60 boards built (12 spares)
- ⇒ firmware ready (old)
- ⇒ **implemented in DATE**

- **VME Configuration Board (VCB):**

- ⇒ FEB configuration and readout
- ⇒ 6 boards built
- ⇒ firmware ready (old)
- ⇒ also performs analog readout
- ⇒ **implemented in DATE**

- **Digitizer Buffer Board (DBB):**

- ⇒ time-over-threshold measurement
- ⇒ data storage during 1 spill
- ⇒ 60 boards built (12 spares)
- ⇒ firmware ready (new)
- ⇒ **implemented in DATE**

- **VME Readout Board (VRB):**

- ⇒ readout of 8 DBBs
- ⇒ 8 boards built (2 spares)
- ⇒ firmware ready (revised)
- ⇒ **implemented in DATE**

- **Flash ADC Board (V1731):**

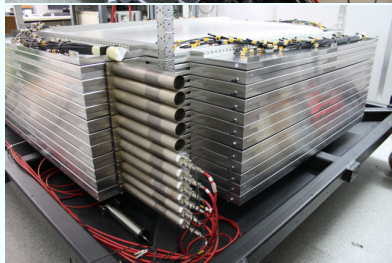
- ⇒ 1-ch. PMT readout
- ⇒ 9 boards purchased (1 spare)
- ⇒ **implemented in DATE**

Cosmics Test Bench

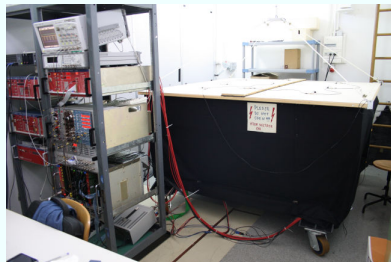


64-ch. PMTs

FEB+DBB



1 ch. PMTs



Light-tight cover

EMR rack (VRB, VCB, fADC)

- full readout of 6 planes
- 384 (energy per bar) + 6 (total energy deposition per plane) channels
- trigger created by coincidence of additional top and bottom planes (not in readout)
- trigger rate 80 hz
- no calibration of PMTs
- there are tens of parameters on MAROC ASIC which affect performance, no optimization so far
- first results are impressive!

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Software Status

Simulation

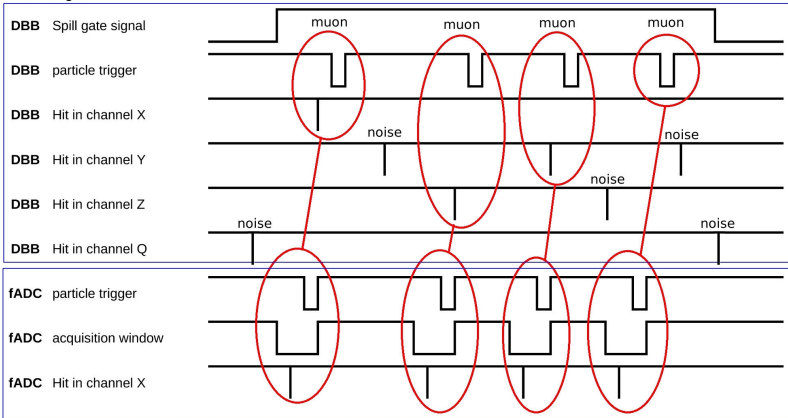
- EMR simulation has been implemented and currently available in MAUS (not in trunk yet)
- Monte Carlo analysis is mainly concentrated on study of discriminating variables and their momentum dependence

Cosmic Data Analysis

- DAQ software compatible with DATE
- data is compatible with MAUS structure
- first step of reconstruction is implemented
- simple event display visualizes muon track

Timing of Hits

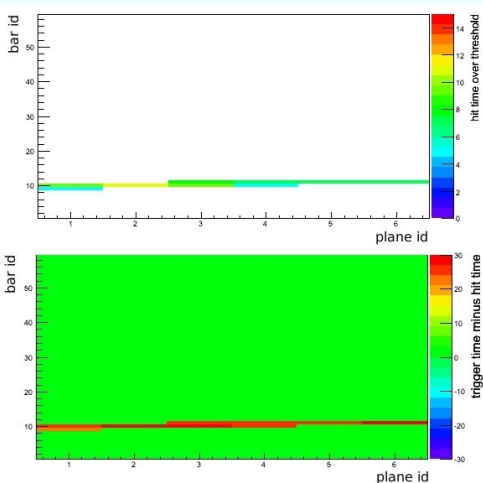
board Signal



- DBB hits must be associated with triggers and fADC hits
- all other hits are due to noise

Cosmics: Muon Track

- 6 planes • 59 bars each • particles come from the right
- **no calibration, no optimization of MAROC ASIC parameters**



- **Time-Over-Threshold measurement**

- ⇒ 1-2 bars in every plane per track
- ⇒ 6-12 sampling clocks per hit
- ⇒ 2ns/clock

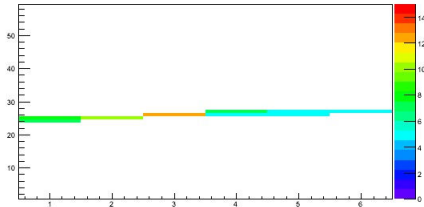
- **Trigger time minus hit time**

- ⇒ 30 ns delay between hit
- ⇒ delay in cables
- ⇒ delay in trigger and FPGA logic

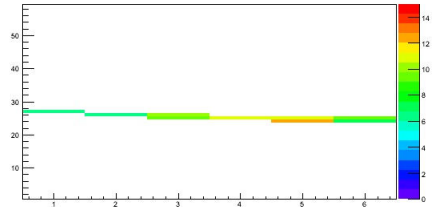
Muons

Two Events

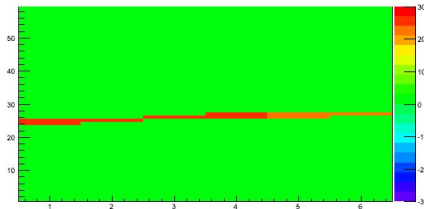
hit time over threshold



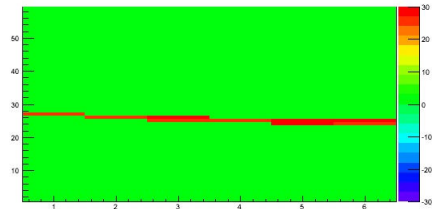
hit time over threshold



trigger time minus hit time



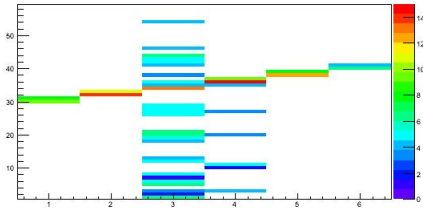
trigger time minus hit time



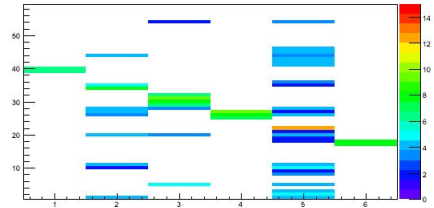
Noise!

Two Events

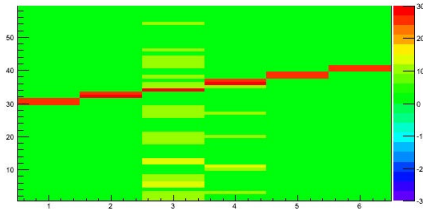
hit time over threshold



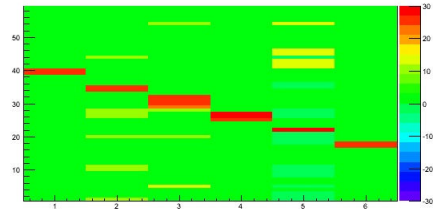
hit time over threshold



trigger time minus hit time



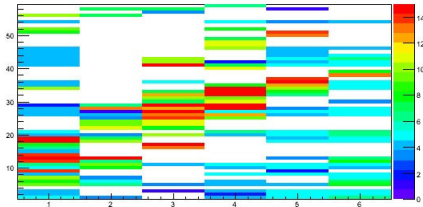
trigger time minus hit time



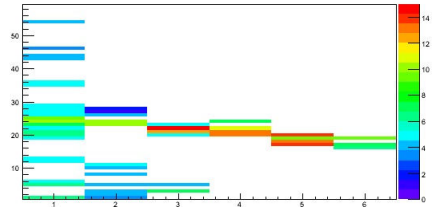
Electrons?

Two Events

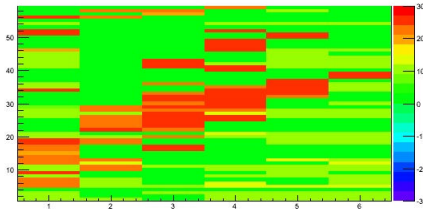
hit time over threshold



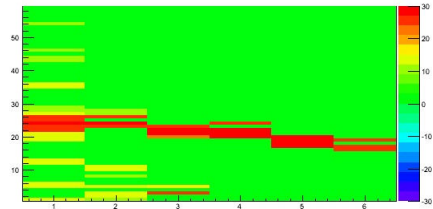
hit time over threshold



trigger time minus hit time



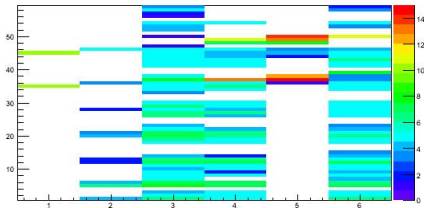
trigger time minus hit time



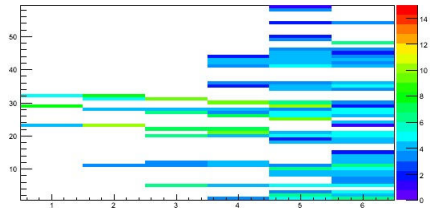
Multiple Tracks

Two Events

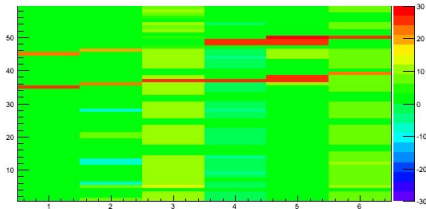
hit time over threshold



hit time over threshold



trigger time minus hit time



trigger time minus hit time

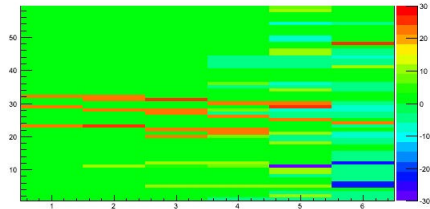


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Summary

- construction is cruising - the harbour is close
- half of the detector built
- full electronics chain is functional and being tested
- even without calibration and tuning of electronics parameters (pedestals, thresholds, gains, etc..) we can see clear muon tracks
- simple event display is implemented

To Do

- build 36 fiber bundles within next two months
- tune DAQ parameters to achieve best possible performance
- test all boards and pmts
- calibrate the detector with cosmics
- further develop analysis software (reconstruction)
- possibly update FEB/VCB firmware
- **the detector promises to be beautiful \Rightarrow anyone interested in jumping on the adventure?**
- one master student will join us this summer