Baby MIND
Log book June-July 2017 beam test

7th June to 12th July 2017

Interventions in the T9 beam zone

For any hardware interventions where some component is installed, ensure that two people are present!

If it is simply switching OFF a power supply, or resetting some USB connection, one person is sufficient.

Procedure for swapping bbMIND magnet polarity

- Beam stoppers IN
- Access….
- Get toolbox!! (with the right tools!! Wrenches 11mm and 17mm)
- Switch power supplies OFF (front of rack)
    - ON/OFF button
    - Switch 1 to 0 PS1 & PS2
- Open rack door at rear of rack
- Remove plastic cover at rear of rack
- Loosen bolts
- Swap leads according to diagram
- When done:
- All above in reverse order
- Switch PS back ON!

BEAM configurations

Reference beam configurations for Baby MIND (focus = parallel) can be found at:

\\cern.ch\dfs\Experiments\BabyMIND\\Run-Plan\May2017\Reference_beam_settings

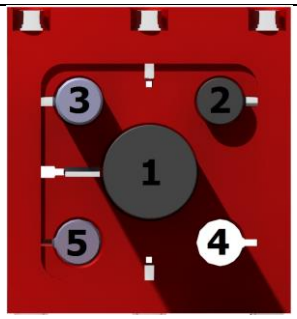
	Muon beam	**Hadron beam**
Collimator values [mm]	+/- 30 mm	+/- 5 mm
Collimator settings on console	65.5	52.5
Stopper STP1	IN	OUT
Stopper STP2	OUT	OUT
Manual beam request	Must do! Set ON	Auto ON

Note on targets

Details on targets used for production of the secondary particles transmitted down to T9 can be found at:

http://sba.web.cern.ch/sba/targets/TargetNorth.html

The target is controlled by the CCC operator on request by the SBA beam line physicist.



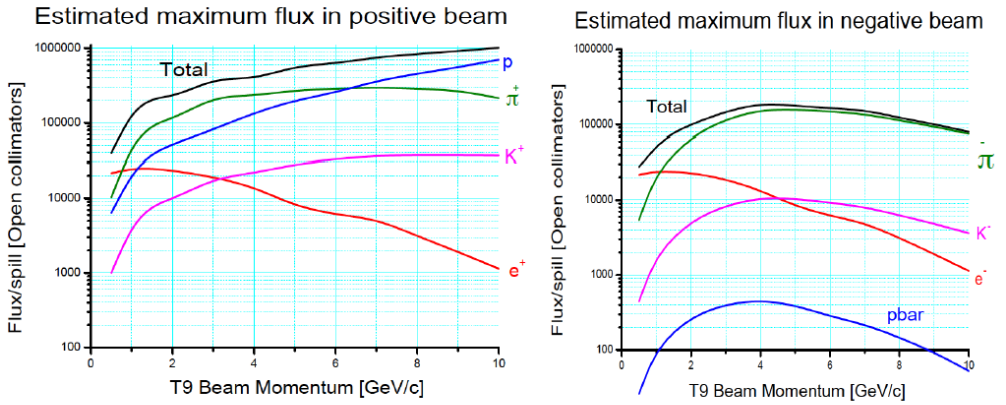
EAST AREA: North Target with 5 target heads.

Target Head nr.	Material and length	Diameter	Comments
1	200 mm BE + 3 mm W	10 mm	Electron target
2	100 mm AL + 3 mm W	10 mm	Electron target
3	**200 mm AL**	**10 mm**	**Hadron target**
4	0 mm	-	Empty target
5	20 mm AL	10 mm	Thin target

We are interested in the hadron target, nr.3, which produces far fewer electrons.

Beam fluxes

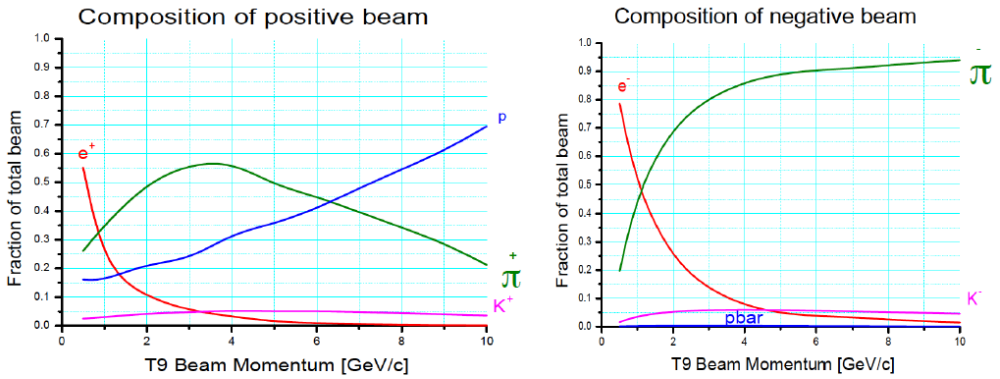
T9 Maximum Beam rates



For wide open collimators, i.e. $\Delta p/p \approx \pm 7.5\%$

Lau Gatignon, 10 March 2014 *The T9 beam line* *1*

T9 Beam Composition



With electron enriched target (otherwise $e^{\pm}$ strongly reduced)

Lau Gatignon, 10 March 2014 *The T9 beam line* *2*

Note on collimator settings

The controls are located upstairs

Collimator settings must be changed **everytime** we change from muon to hadron beams. This is because in muon beam mode, the rate would simply be too low, so the collimators have to be open wide, and in hadron beam mode we lose momentum resolution if the collimators are too wide, so they must be closed.

… also one on the two beam stoppers has to be taken OUT of the beam.

Note on beam request:

A manual beam request cannot be made IF both stoppers are OUT: the system goes automatically to beam request ON.
… so the manual beam request is only needed when one stopper is IN and the other OUT
…. OR when both stoppers are OUT (so we don't need beam at T9) and T10 is also not receiving beam, and beam to IRRAD is required.

Note, for extended periods of time, please keep beam request ON, otherwise, if T10 does not have its beam request ON either, then there is no beam on target, and IRRAD does not take beam.

… then load the correct beam profile for the desired momentum.

Obtaining low momenta by placing absorbers in the beam

By placing a block of iron (40cm, 80cm) in the beam (positioned on the DESY table for example), it is possible to reduce the beam momentum, the scattering also leads to a wider beam (useful to test more channels of the Baby MIND). Studies were conducted by Lau Gatignon and Johannes Berhard last summer 2016 in the context of the beamlines for schools, and are detailed here for completeness on this chapter on beam configurations.

Based on measurements on 12th of June by J.Bernhard and L. Gatignon (with and for the Beamlines for Schools team). Count rate with scintillator 1 and also with a 13x15 cm2 scintillator coincidence. The North target head was number 1. Both collimators were at ±30 mm opening. Stop hadrons with one of the beam stoppers. Checked at various energies that the muon flux is about 1.5 times higher with STP1 in than with STP2 in. E.g. at 3 GeV/c beam settings the rates were 2300 per spill wi9th STP1 in, 1500 with only STP2 and just below 300 with both stoppers in. Scanning BHZ1 (upstream of the stoppers) does not really improve the muon rate in either case.

The muon rate was measured either at the entrance to the zone or after one or two iron blocks of 80 cm each. It was calculated by BLFS that each block reduces the muon energy by 1.1 to 1.2 GeV due to dE/dx. Please note that Scint 1 was always upstream of both iron blocks, whereas the BLFS counters were moved from in between the two blocks to downstream of the second block. The first blocked could be moved in or out on a DESY-table.

p_{beam}	**counts**	**BLFS coincidence rate**			**Estimated muon energy (GeV)**		
(GeV/c)	**Scint1**	**0 blocks**	**1 block**	**2 blocks**	**0 blocks**	**1 block**	**2 blocks**
0.5	150				0.5		
1	600		300	25	1		
1.5	1000		500	80	1.5	0.4	

2	1500		550	60	2	0.9	
2.5	2000		700	250	2.5	1.4	0.4
3	2500		2000	670	3	1.9	0.9

22nd June day shift

Taking dark noise on MCR 0,1,2,3. Found some bad cable channels.

The vertical cables with the old screw were all disconnected from the detector.

7 new vertical cables were connected.

Fixing the cables.

22nd June night shift

23nd June day shift

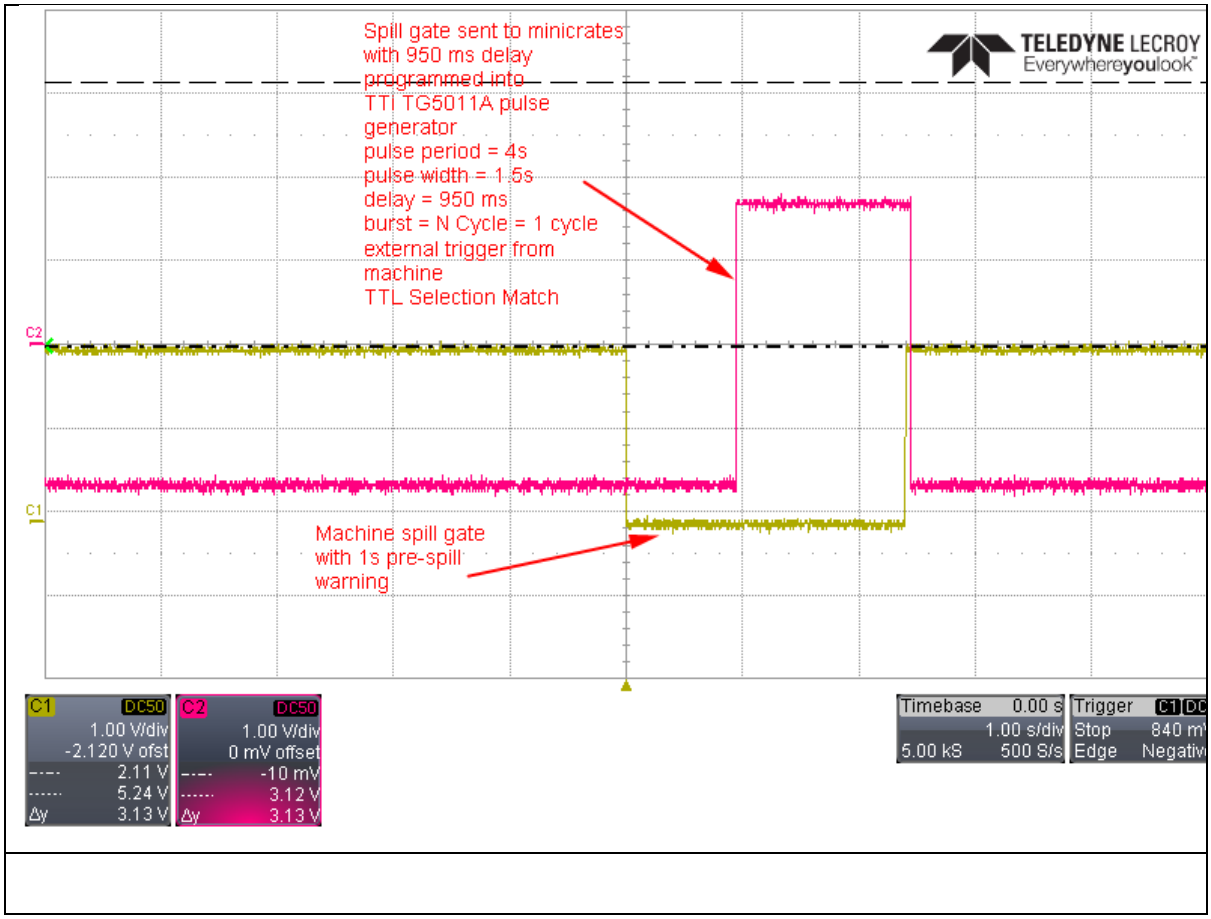
Taking dark noise data on the MCR 4 and 5 and checking the fingerplots.

Fixing the cables continues.

23nd June night shift

Spill gate for minicrates setup:

The pulse generator is now in the control room so we can set it up either to take the spill gate from the PS machine for beam data taking, or a more regular pulse for dark noise data taking.



Beam at last! Took beam with MCR0 and MCR1, in full bandwidth mode, both with their FEBs being read out.

We setup configuration files to acquire in full bandwidth mode with a high threshold which cuts off quite a bit of the dark noise, from:

MCR0_slot1

MCR1_slot1

MCR3_slot3

The files can be found on BabyMIND03 PC, under
D:\Data\t9_trials\Full_bandwidth\beam_with_spill\

The scripts can be found in C:\FEB_Software\MonoDev\Scripts\gigabit\Full-Bandwidth-script\MCR2

They are labelled “high threshold.

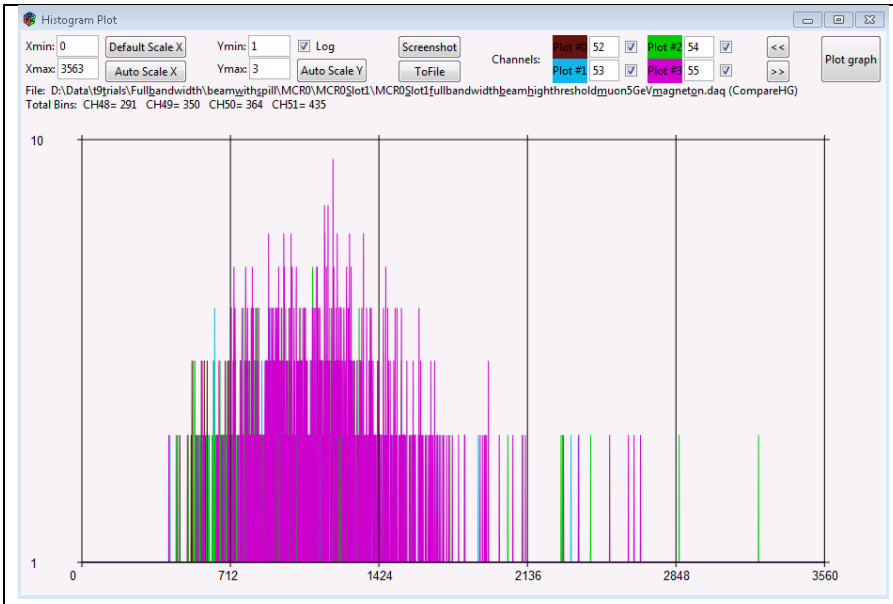
24th June day shift

To do:

- Check magnet power supply. It’s been on since 10am on the 23rd.
- Convert to csv daq files obtained during night shift and have a look in excel.
- Take beam data at 5 GeV muons with the scripts mentioned earlier.
- Work on calibration/optimization software (e.g. how to run root from a script).

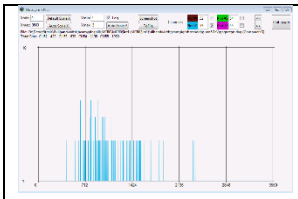
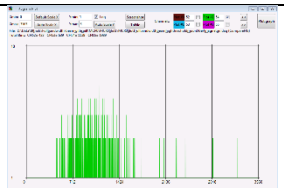
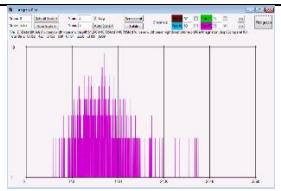
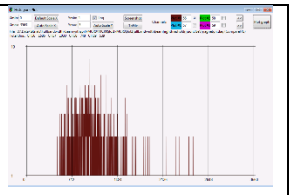
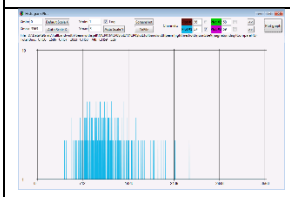
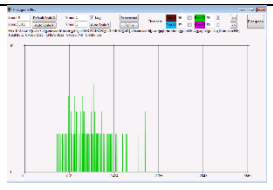
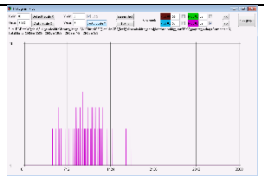
- Cabling if possible.

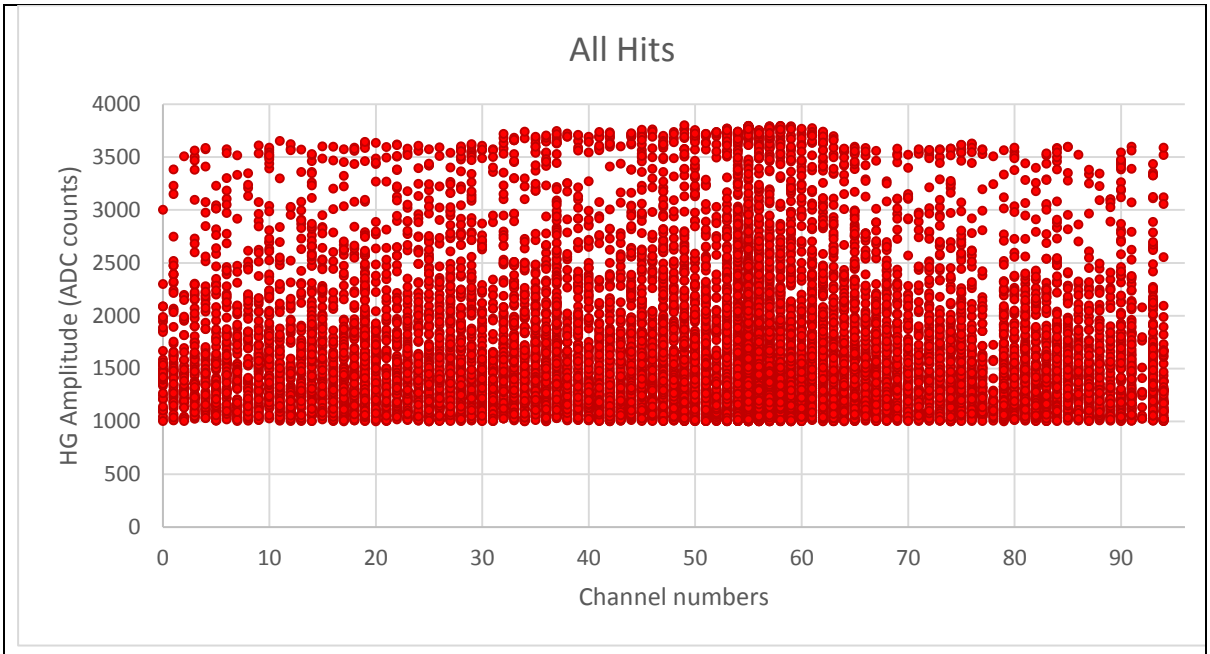
Looking at the data file acquired during the night shift. The center of beam is located between channels 54 and 59.



MCR0_Slot1_beam_Muon_5GeV

Locating the height of the center of beam. Data from horizontal bars.

			
Ch 53	Ch54	Ch55 **(Center of Beam)**	Ch56
			
Ch57	Ch58	Ch59	



This is a plot of all the hits with amplitude higher than 1000 ADC counts. There is no coincidence cut applied. So is a combination of MPPC s firing and cosmic events and beam events.

ATTENTION:

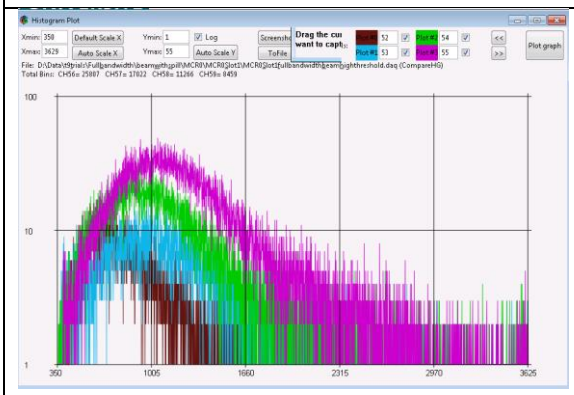
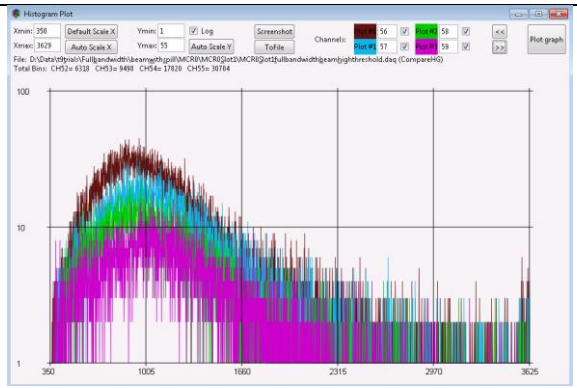
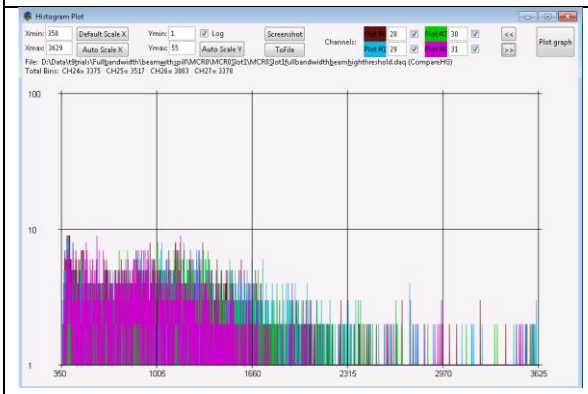
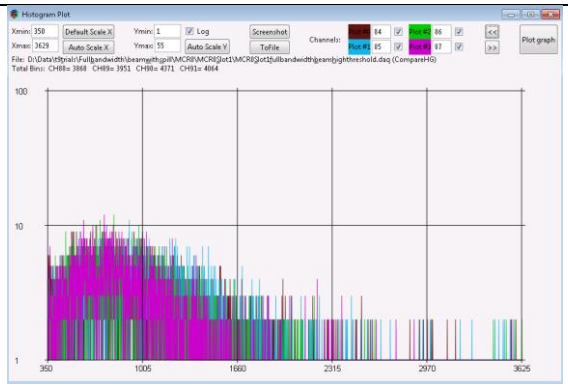
In order to prevent the **data acquisition freezing** **after one spill**:

In the config files under USB parameters, **AutoResetOnTimeout** should be **OFF**

BEAM data: 5GeV Muons

Large data files ~ 100MB

Data MCR0_Slot1 (Mod 1, Hor Left)

Mod 1	
	
Ch52-55 BEAM	**Ch56-59 BEAM**
	
Other channels not center	**Other channels not center**

The center of beam on Horizontal bars in between ch 54 and ch 57.

Data On MCR3_Slot3 (Vertical bars Mod 1,2,3)

Beam location: Module 1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

Beam location: Module 2

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

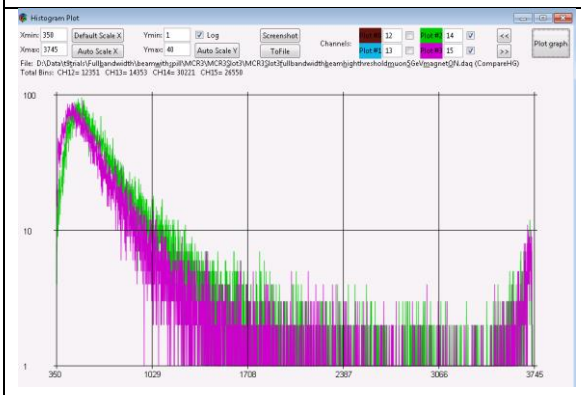
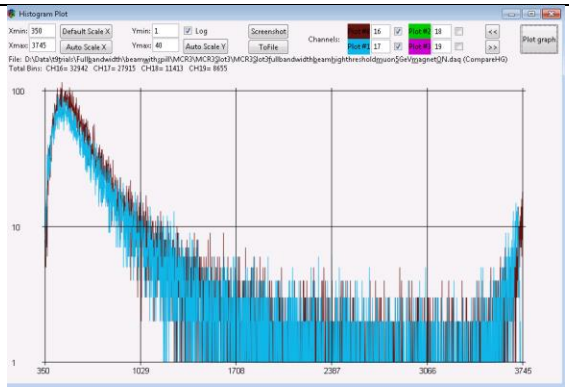
Pcb1 Pcb2 Pcb3 Pcb4

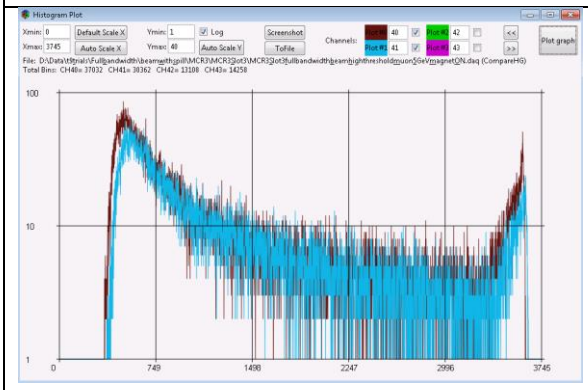
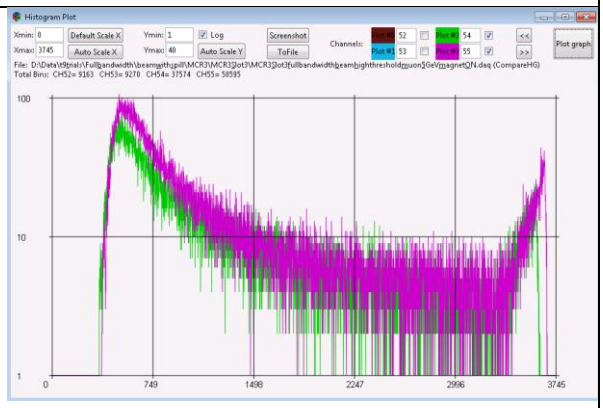
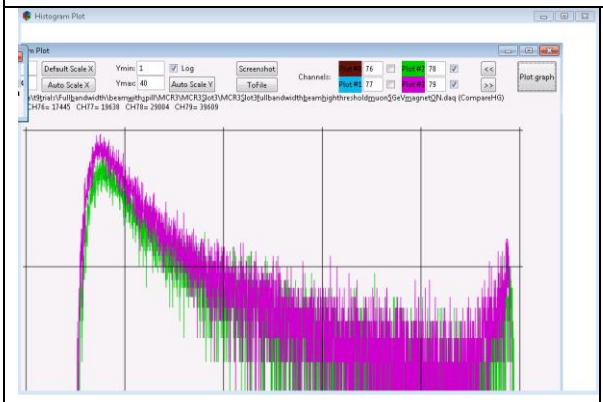
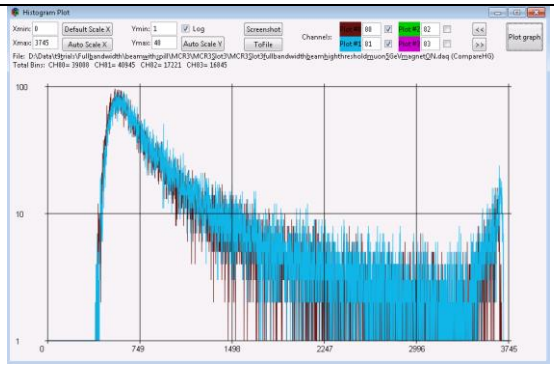
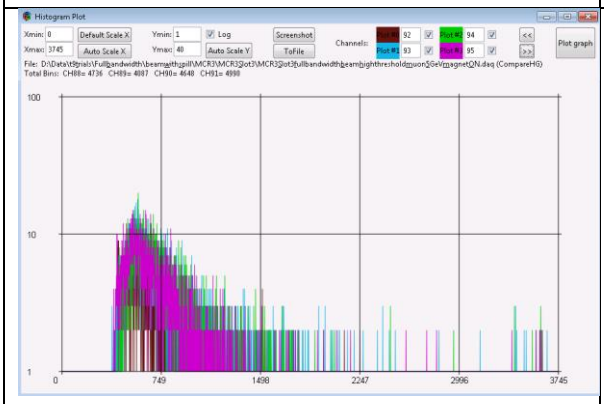
Most probably the Mid cable PCB 2 and 3 are connected inversely.

Beam location: Module 3

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

The amplitude plots of the channels with beam data are shown below:

Module 1	
	
Ch 14,15	**Ch 16.17**

Module 2	
	
Ch 40,41 (8,9)	**Ch 54,55 (22,23)**
Module 3	
	
Ch 78,79 (14,15)	**Ch 80,81 (16,17)**
	
Other channels not center	

	BEAM Data 5GeV Muons Full Bandwidth Mode					
Mini crate #	Slot #	Data	File size	date	Convert to CSV (HG)	Magnet
MCR 0	1	Ok	72 MB	24-june	Ok	ON
	2	Ok	60 MB	24-june	Ok	ON
	3	Ok	64 MB	24-june	Ok	ON
	4	Ok	100 MB	24-june	Ok	ON
	5	Ok	100 MB	24-june	Ok	ON
MCR 1	1	Ok	116 MB	24-june	Ok	ON
	2	Ok	104 MB	25-june	Ok	OFF
	3	Ok	98 MB	25-june	Ok	OFF
	4	Ok	126 MB	25-june	Ok	OFF
	5	No Gtrig sync !!! No data				
MCR 2	0					
	1					
	2					
	3	Ok	100 MB	24-june	Ok	ON
	4					
	5	No cable				
MCR 3	0	OK	101 MB	25-june	Ok	OFF
	1	Ok	98 MB	25-june	Ok	OFF
	2	Ok	73 MB	25-june		OFF
	3	Ok	102 MB	24-june	Ok	ON
	4	No cable				
	5	No cable				

The script files for MCR1 and MCR3 are created.

The night shift can continue taking data and fill this chart.

24th June night shift

Magnet is OFF from 1AM.

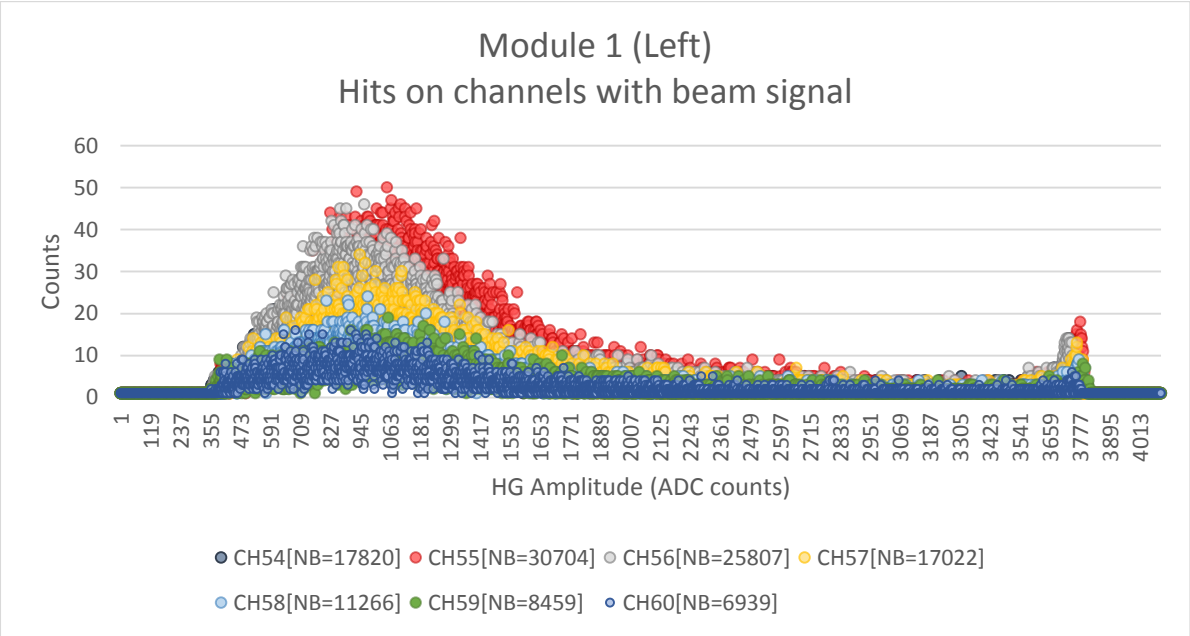
TDM unpacking → pretty done;

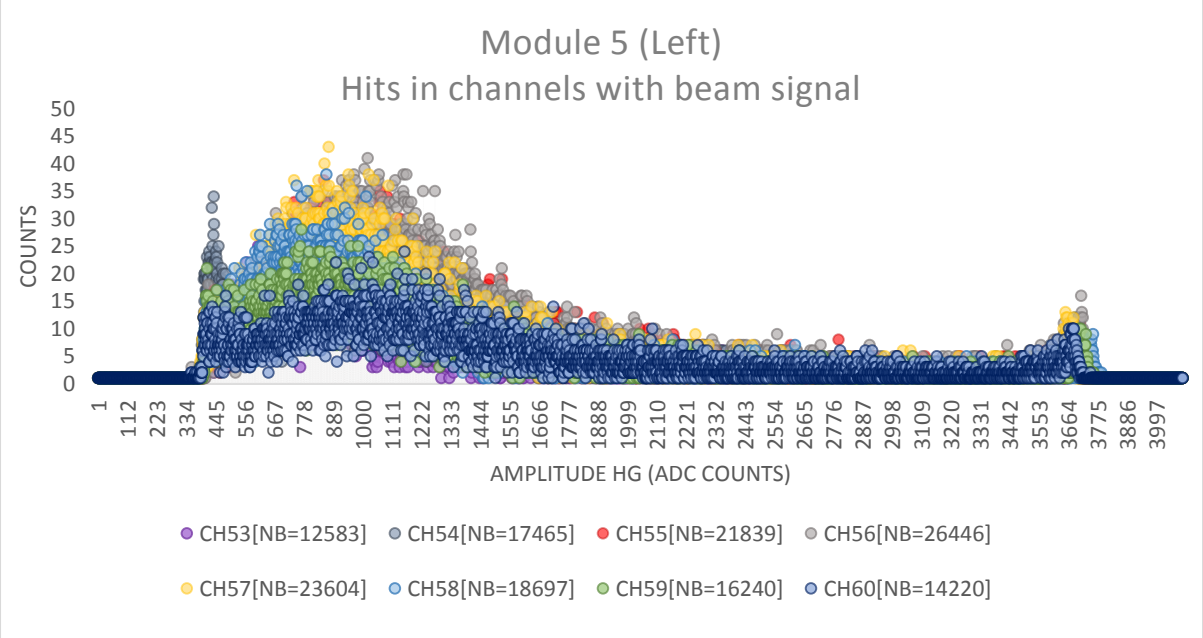
25th June day shift

Looking at the data **5GeV Muons** with Magnet ON.

A visible **shift of beam location** one bar up, after **9cm** steel.

(Click on the plots and use filtering tool to view histograms separately.)





Further studies of daq options

(Click on the plots and use filtering tool to view histograms separately.)

To do:

- Full bandwidth mode:
  - Readout following independently:
    - MCR0, slot1 (Module position 1, horizontal left)
      Check -> OK
    - MCR1, slot1 (Module position 1, horizontal right)
      Check -> OK
    - MCR3, slot3 (Module position 1, vertical ch0-31)
      Check -> OK
  - Readout above MCRs in parallel
    Check 2 in parallel (MCR0,1) -> OK
  - Quick look at data for consistency of position of beam
    RESULT: IT WORKS!
    See next page the histograms in the channels which are in the way of the beam below in the three FEBsa
    We also check there is a hit in the same GTRIG (2091) in
    MCR0-slot1 channel 55 PH=1561
    MCR1-slot1 channel 55 PH=1712
    MCR3-slot3 channel 10 PH=507
    MCR3-slot3 channel 44 PH=747
    MCR3-slot3 channel 45 PH=970
    MCR3-slot3 channel 74 PH=2763
    MCR3-slot3 channel 75 PH=1405
  - Installed another computer (Neutrino13.cern.ch) in the T9 area, controls the clock. Start DAQ from that computer. **Successfully run 4 MCR simultaneously!**

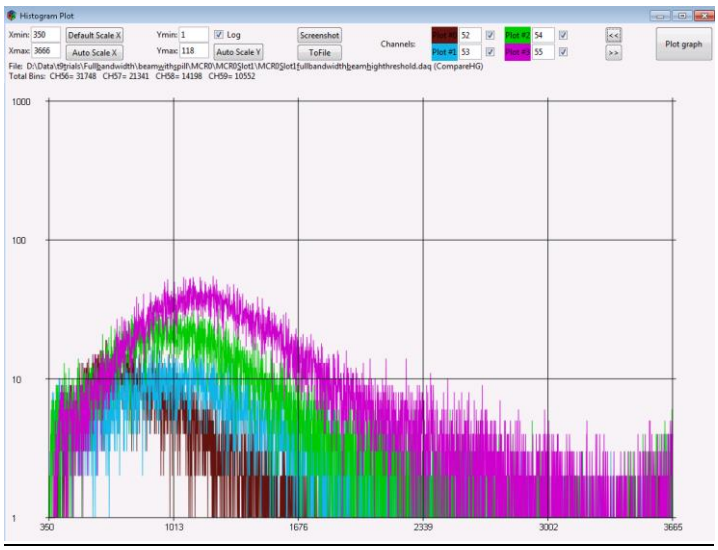


Figure 1 Taken data with three minicrates : here MCR0 slot 1 (first plane left MPPCs)

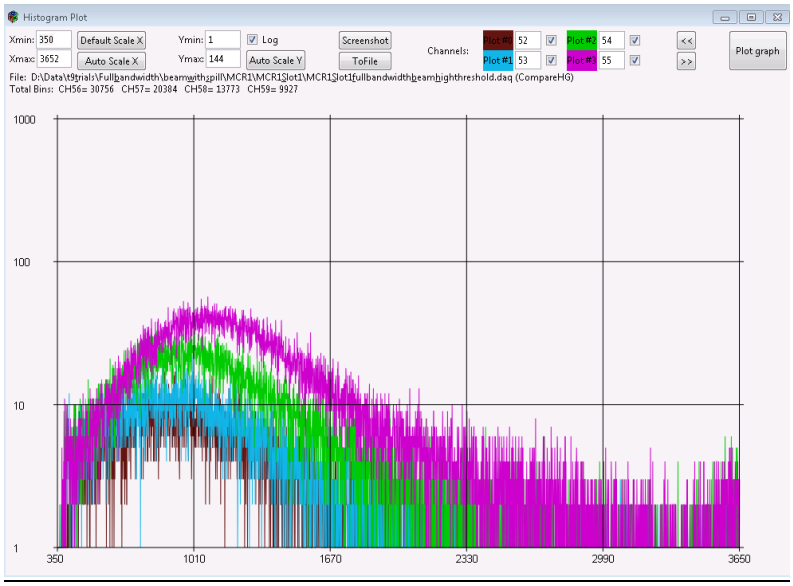


Figure 2 Taken data with three minicrates : here MCR1 slot 1 (first plane right MPPCs)

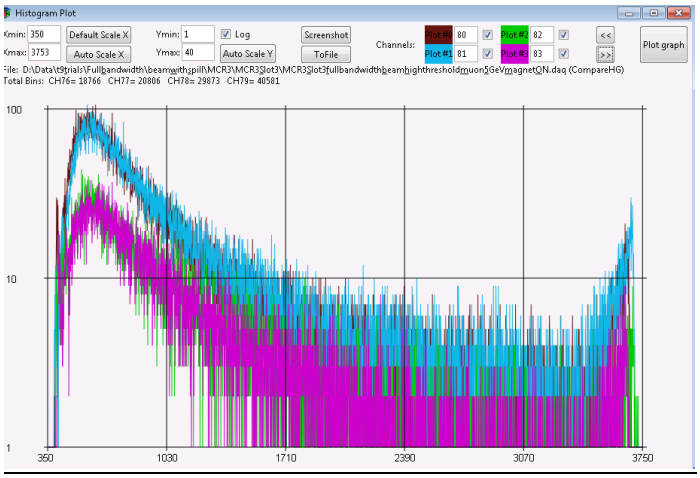


Figure 3 Taken data with three minicrates : here MCR3 slot 3 (3th plane top MPPCs)

- TDM mode (requires testing new scripts):
  - Check MCR0, MCR1, MCR3 independently with following program:
    - MCRx, slot1 (slot3, MCR3)
    - MCRx, slot1,2,3 (slot1,2,3 for MCR3)
    - MCRx, slot(0),1,2,3,4,5
  - Acquire data with MCR0, MCR1, MCR3 in parallel
  - Quick look at data for consistency
  - Store data, use for TDM unpacking code newly release.

To do night shift 25th June

- Check vertical cable module #2
- Correct if necessary
- Check correction if done
- TDM mode acquisition
- TDM mode data processing

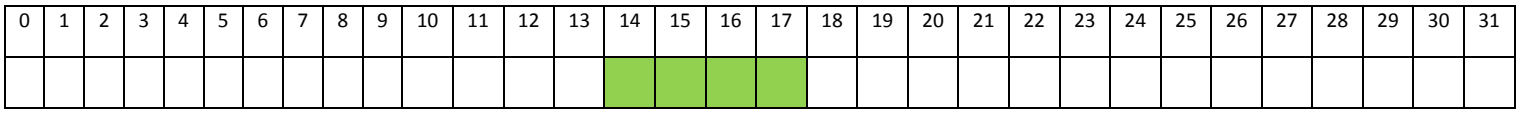
25th June night shift

5m cables connection is changed:

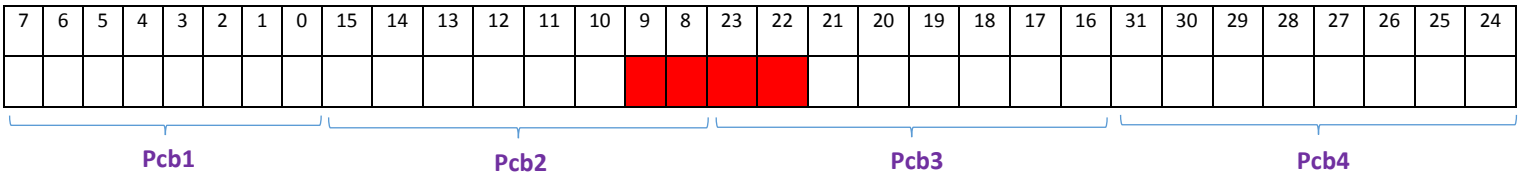
It was :

Data On MCR3_Slot3 (Vertical bars Mod 1,2,3)

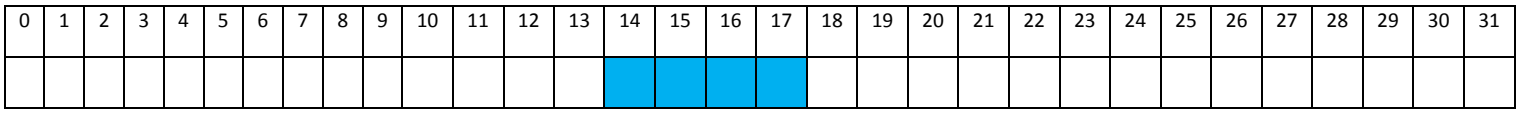
Beam location: Module 3



Beam location: Module 2



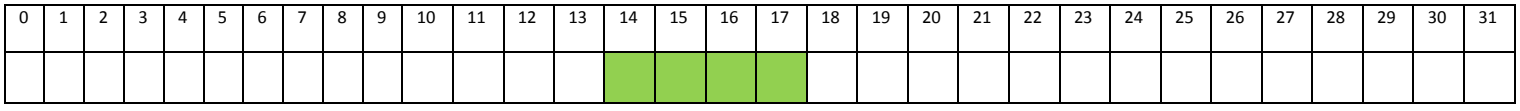
Beam location: Module 1



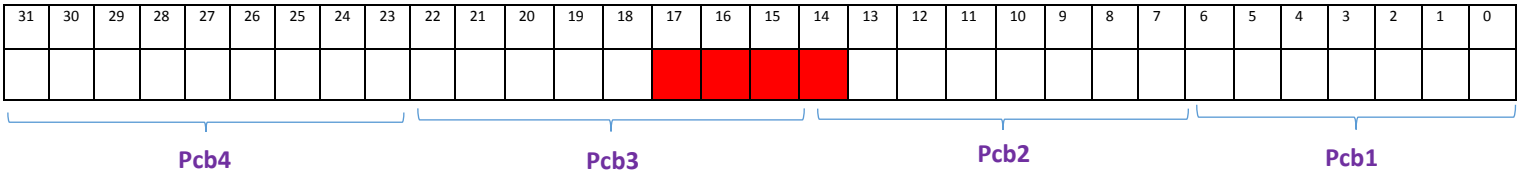
Should be noticed: Module d2, d4, d14, d15, d17 is in inverted orientation, so connection for vertical cables should be inverted (from right to left in beam orientation).

Connection now:

Beam location: Module 3



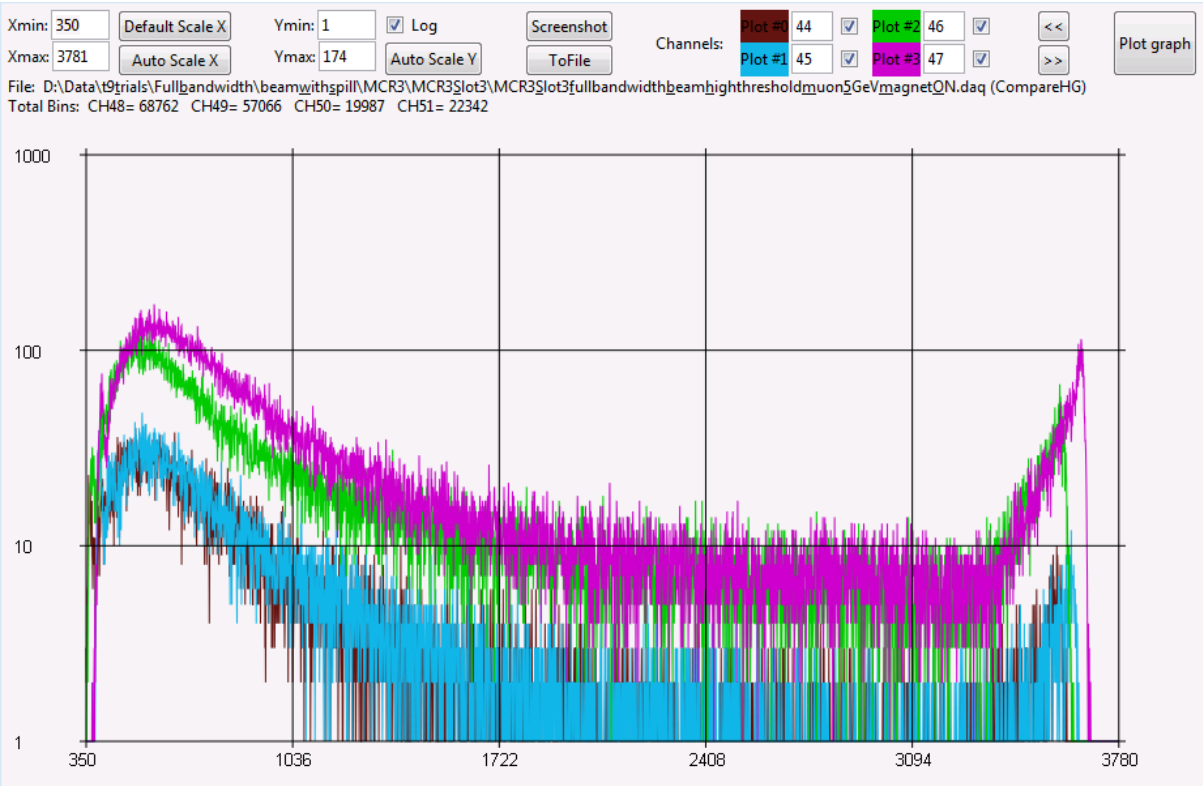
Beam location: Module 2



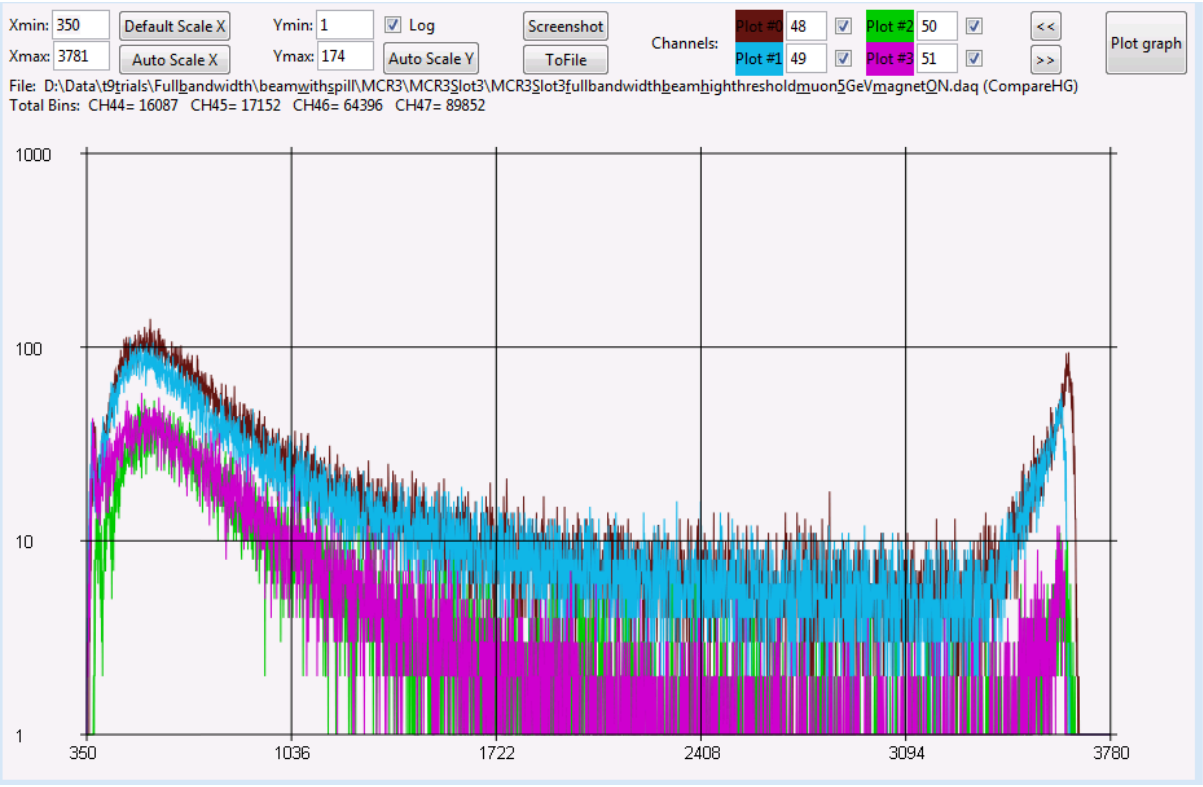
Beam location: Module 1

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

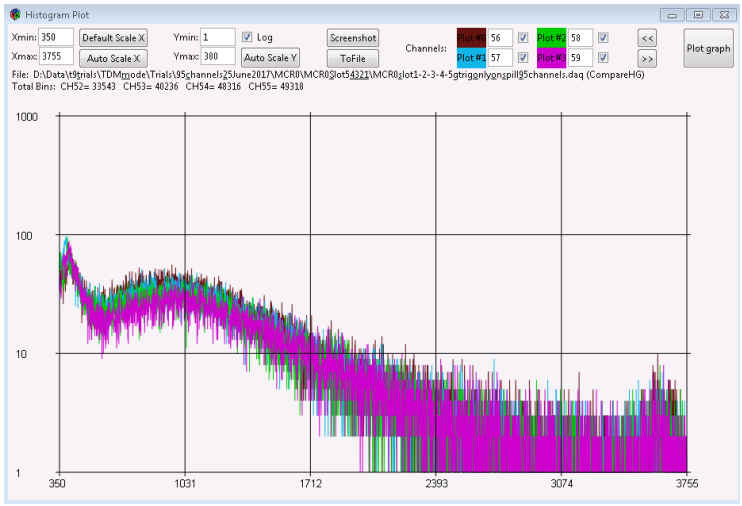
Ch14/15 now:



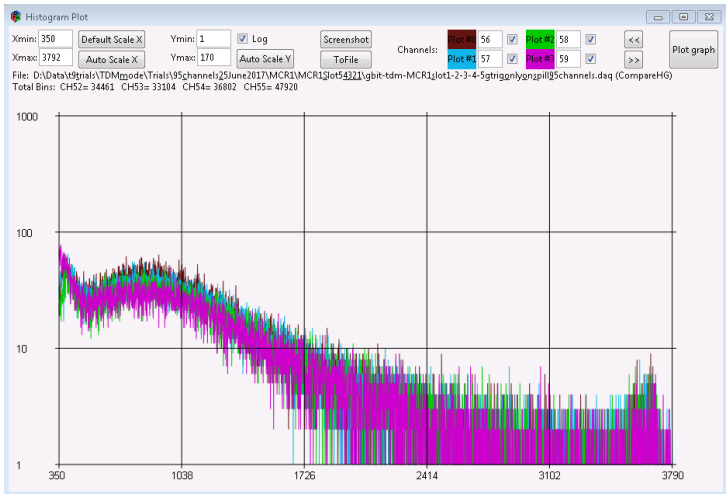
Ch16/17 now:



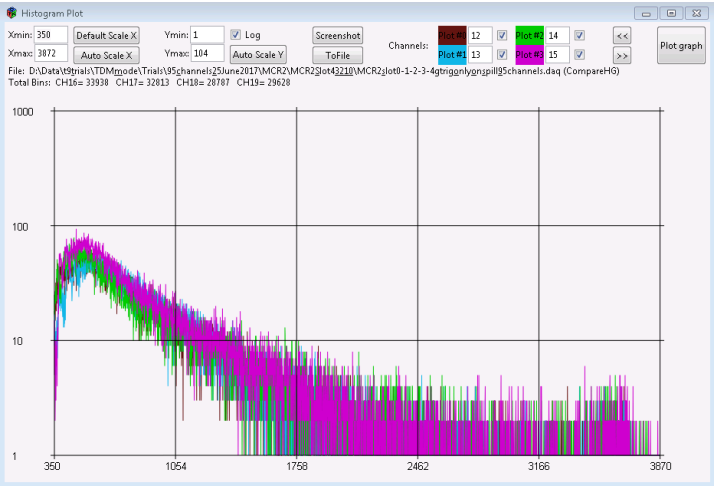
Having spend some time configuring TDM mode scripts, with a few difficulties due to some parameters being configured in previous runs, and remaining when a SetDirectParameters or BoardConfigure are sent, we finally managed to readout 3 MCRs in parallel with a total of 15 FEBs read out, 5 per MCR.



MCR0, data taken in TDM mode in parallel with MCR1 and 2.



MCR1, data taken in TDM mode in parallel with MCR0 and 2.



MCR2, data taken in TDM mode in parallel with MCR1 and 0.

To do 26th June day shift

Run once more TDM mode scripts for MCR0,1,2, they can be easily found, the last ones edited from 3:50am or so on 26th June. Edit a script to run TDM mode for MCR3.

Continue Calibration software.

Note that MCB is now controlled from a different PC, Neutrino13.cern.ch.

26th June Day shift

Prepared the script for MCR3, Run in TDM mode MCR0,1,3.

The **beam was off** from about 11:30 in the morning.

The MCR6 and MCR7 were installed. All the horizontal cables were connected except module18.

The vertical cables are not yet connected.

There is no spill signal connected to MCR6,7 therefore it is not possible to take data and check fingerplots. We need a pulse generator or longer RJ45 cables or we can move the clock setup to the back of detector. To be seen later.

The **beam was back** from 17:15.

26th June Night Shift

To do:

- Working on unpacking
- Working on analysis
- Documentation (FEB spec and single page/sketch updates found on slack -> to dfs)
- First run of 4 FEBs in TDM mode in parallel

Acquisition of 4 MCRs in parallel, for each there is one USB cable connected to FEB on Slot0:

MCR0: 5 FEBs Slot1,2,3,4,5

MCR1: 5 FEBs Slot1,2,3,4,5

MCR2: 5 FEBs Slot0,1,2,3,4

MCR3: 4 FEBs Slot0,1,2,3

Some rough data rates:

During spill: 10 Mbytes/spill/MCR (here measuring the MCR with 4 FEBs). 10 GB per analysis file/run file for raw data for 100 spills recording all 45 FEBs. No need to buy new DAQ PC!!

Between spills: 5 Mbytes in 15s (4 FEBs) -> 5 MB/min/FEB. These are most likely TDM start/stop headers/trailers. In full bandwidth mode, we do not acquire any data outside of the spill gate. For all FEBs ~45 running in parallel, this useless data would represent 13.5 GB/hr. So worth removing.

First beam with Magnet ON (reverse polarity)!!

-1.5 GeV/c muons

4 MCRs read out in parallel

Leaving for the night

Magnet ON

MCR0,1,2,3 ON

Beam ON

27th June Day Shift

To do:

- Setup acquisition with spill for the rear-most 2 minicrates (take spill from extension cable at patch panel (connector #1) situated on wall, right side of detector, front and run extension cable to the rear of the detector, should be straightforward).
- Check fingerplots for all newly connected cable bundles on MCR #6 and #7.
- Run rear MCR4,5,6,7 in TDM mode (requires bringing the Clock MCR to the rear of the detector).

27th June Night Shift

To do:

- De-bug all faulty cables: All faulty cables diagnosed, some were fixed by Georgi.
- Cable vertical modules 11,12,13,14,15.
- Vertical modules 11,12,13,14,15 cabled, tested and all OK.

Cabling/channel functionality status:

- Vertical cable bundles installed for modules 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15
- Horizontal cable bundles installed for modules 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17
- Missing vertical cable bundles for modules 16,17,18 and…
- Missing horizontal cable bundles for module 18.
- 3710 photosensors connected **(93% of detector)** and checked: 1 faulty channel: short circuit channel 9 module 1. (suspected micro-coaxial cabling issue.).
  -> Requires opening up the scintillator module.
  -> most likely will not be fixed before.

28th June Day Shift

To do:

- Check once more channels for vertical slabs 11,12,13 (MCR5) and 14,15 (MCR4).
- Change cable bundle positions for modules 1,2,3 on MCR side from slot 4 to slot 3.
- Re-distribute FEBs from MCR 3 which had to spares, to one each on MCR6 and 7 so the detector as it stands with modules 1-18 can be fully instrumented.
- Configure scripts for TDM mode for rear four MCRs
- Calibration analysis: add two new parameters (number of events in peaks, number of events in troughs for each peak and trough – this will be used in comparing quality of fingerplots).
- Re-write scripts for fingerplots in full bandwidth mode so that one single script handles all MCR and all Slots (i.e by prompting user to input MCR ID and slot number).
  Careful, configuration file for module #1 vertical is different.
- Take calibration data for entire detector with new script, ensuring data cannot be overwritten (i.e. manually change data file name, or find some clever way in script to ensure file name is incremented every time the script is run).
- Check inventory status (CERN and Geneva University) for FEBs
- Check inventory for electronics readout chain currently connected
- Take beam with rear 4 minicrates

Main milestone: cabling of the detector is complete. Just one bad channel (short-circuit to scintillator module mechanics) which has to be silenced out of 3996 channels.

For all other information, see inventory .xls files stored in dfs.

28th June Night Shift

To do:

- Install “trigger” scintillator that tracks beam at entrance to detector

- Take beam with rear of detector in different configuration to be defined during daily meeting
- Analyse beam position using FEB application histogramming function

Note that there is no beam at the PS between Tuesday 4th July 4pm and Thursday 6th July 8pm.

- Install “trigger” scintillator that tracks beam at entrance to detector

Installed on minicrate 1, slot 0 mid. Using cable mod01.

Checked, all OK, excellent fingerplots for the two channels connected to the trigger scintillator module (better light tightness of enclosure?).

@Patrik Found measuring error in the GDML. Need to re-measure detector dimensions. If dayshift feels like it they can follow etams scheme and measure distance between magnet module edges, 33 measurements. Finally have a working event-display like the one which was asked. Need to discuss with Sascha some minor things about the unpacking.

TDM mode scripts written for data taking of rear of detector, MCR4,5,6,7.

Rough beam location for front of detector (takes several scintillator modules at the front of the detector, in TDM mode, with current version of FEB appli we integrate over all FEBs in the TDM data stream for a given channel.).

Run conditions:

Beam: +5 GeV/c muons (Both stoppers were IN, so muon momentum could be slightly lower).

Magnet OFF: (had been reverse polarity until 2 days ago).

The beam deflects very slightly upperwards:

Beam position in first few modules (average of 6 modules at front): ch54,55,56,57.

Beam position in last rear modules (average of 6 modules at rear): ch60,61,62,63.

Note that there is a residual field of up to 1.1 T.

29th June Day Shift

To do:

- Continue with scripting for acquisition of fingerplots
- Acquire data with magnet ON, rear MCRs:4,5,6,7 in TDM mode, i.e. open for Applications and run the scripts that can be found in dfs under: *Data\Data_T9_June2017\t9_trials\TDM_mode\Trials\MultiMCR_beam_position_check_magnet_off_28June2017*

- Acquire data with magnet ON, front MCRs:0,1,2,3.
- Load new FEB firmware on MCR0.

The script for acquisition of fingerplots in Full Bandwidth mode is available on dfs:

BabyMIND:\FEB_software\Scripts\gigabit\Full-Bandwidth-script\gbit-daq-full-automatic-fingerplots.cs

It can be used on both computers and for all MCRs. Inputs are MCR#, Slot# and filename ending (exp: _t1). By changing this filename ending every time, we can assure the files do not get over written.

Conversion to CSV files still has to be done by hand.

New data files and csv files for Calibration can be found on dfs:

BabyMIND:\Data\Data_T9_June2017\Calibration_dark_noise

Beam data:

Trying beam at 1.5 GeV/c mu+