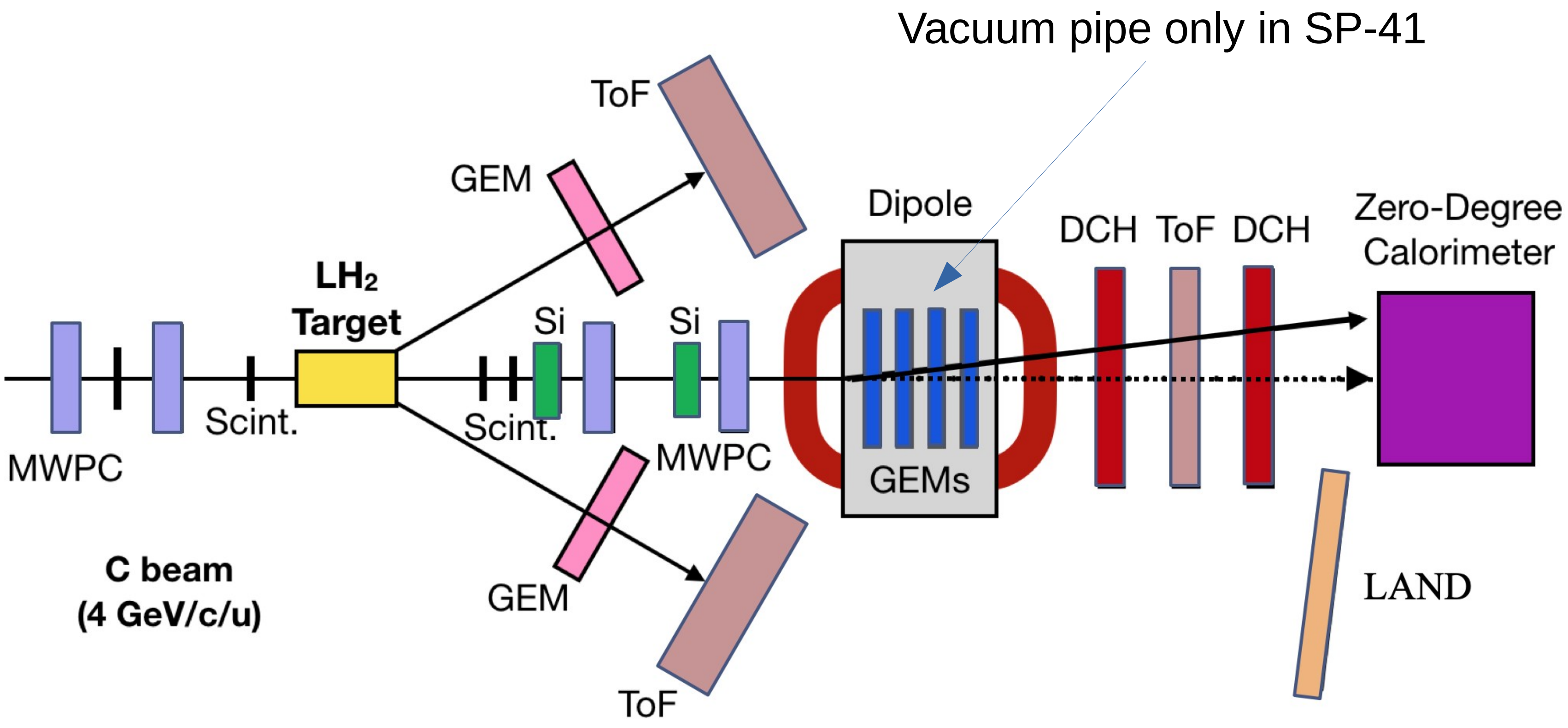
SRC setup for the next run

Same beam 12C with momentum of 4 GeV/c/nucleon
Intensity 10^5 ions/s

Detector meeting JINR Dec 12, 2019

Maria Patsyuk for the SRC team

Same setup as in Run 7



With improvements: more/better beam counters, p/pi separation, laser system

New LH target

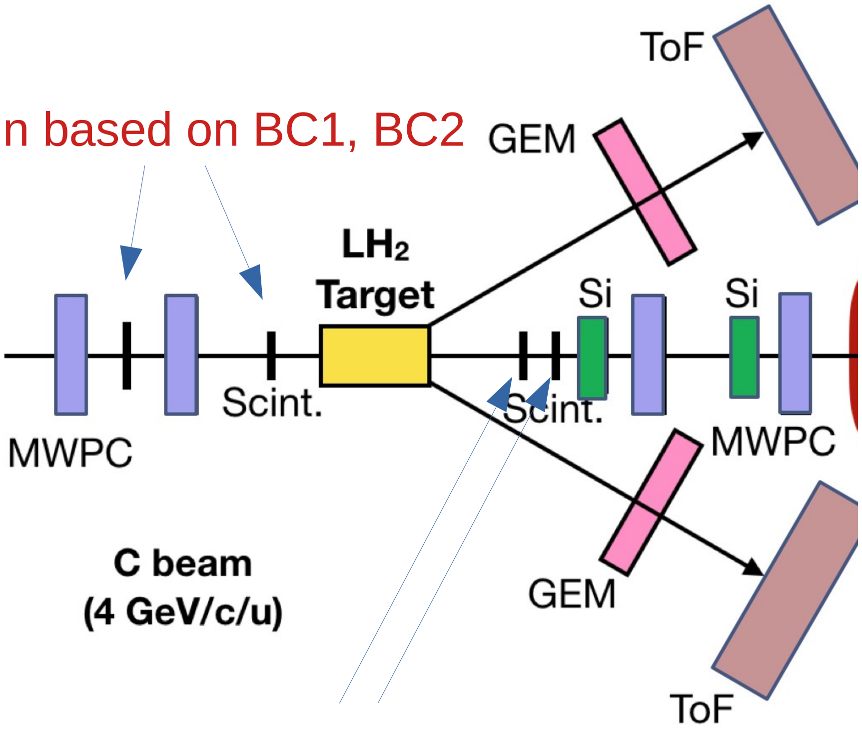
According to the info from the target group – they are developing a new LH target with the same parameters (D = 6 cm, length = 30 cm) for the next run

If possible the target should be insertable into the SP-57 magnet opening to gain acceptance for the arms

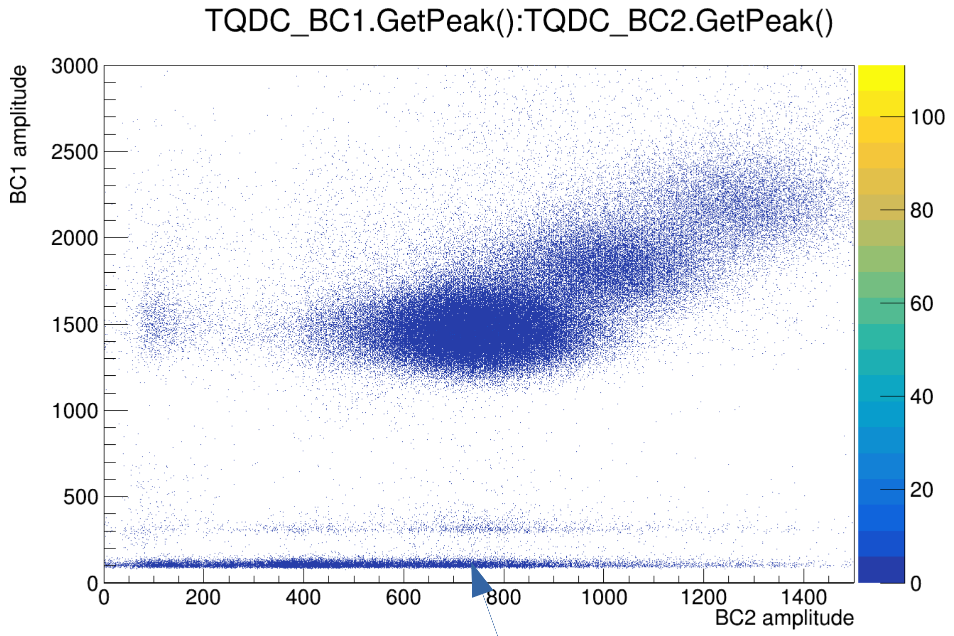
If this target is not ready, we'd like to use the one from the last run.

BC counters provide charge

Z2in based on BC1, BC2



Z2out based on BC3, BC4

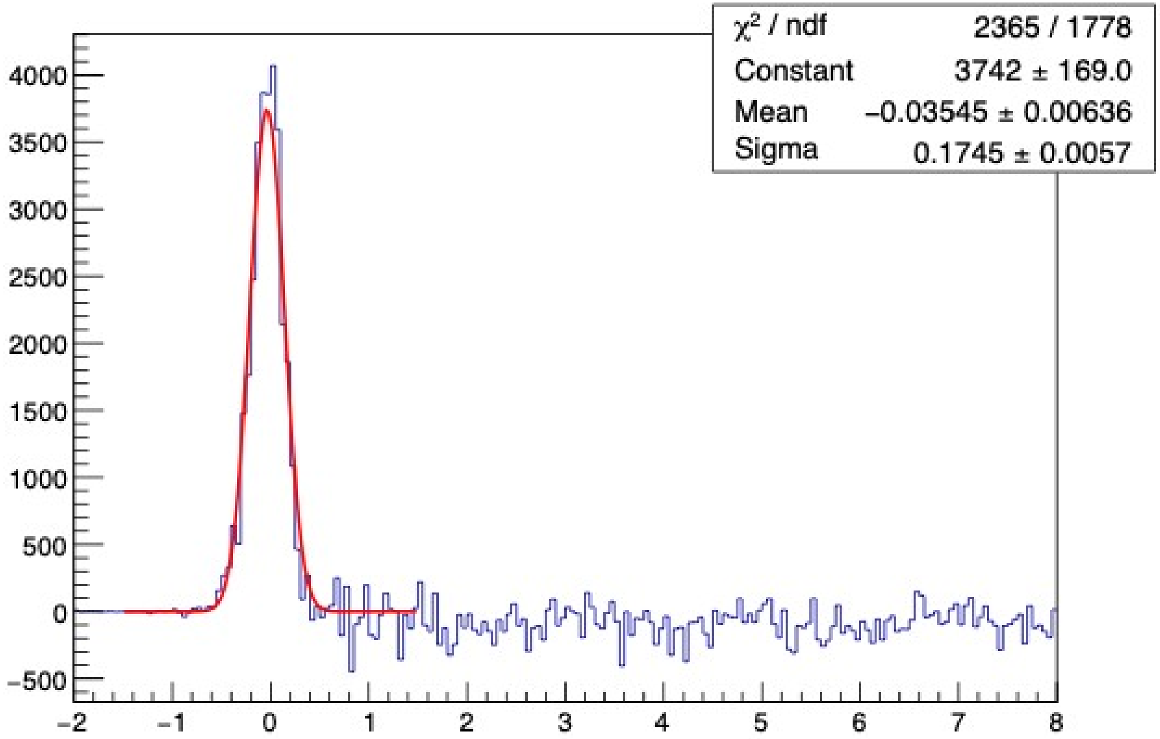


A lot of triggers with low amplitude

T0 did not provide design timing resolution

$$\sigma_{\text{ToF-T0}} = \sqrt{\sigma^2_{\text{measured}} - \sigma^2_{\text{strip-position}}} - \delta = \sqrt{\sigma^2_{\text{T0}} + \sigma^2_{\text{ToF}}}$$

~130ps ~175ps ~60ps ~35ps ~120ps ~60ps

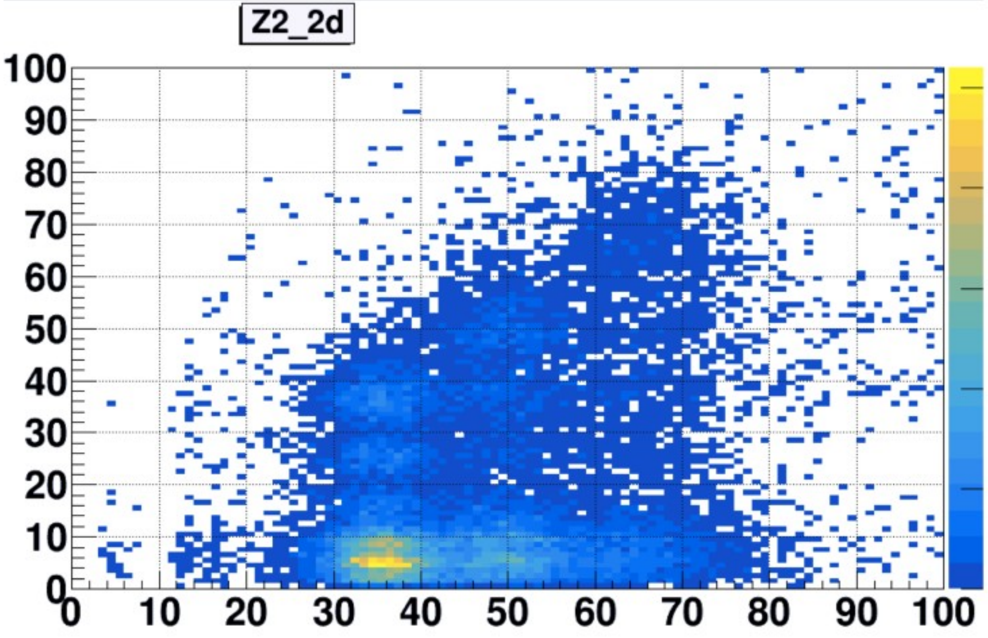


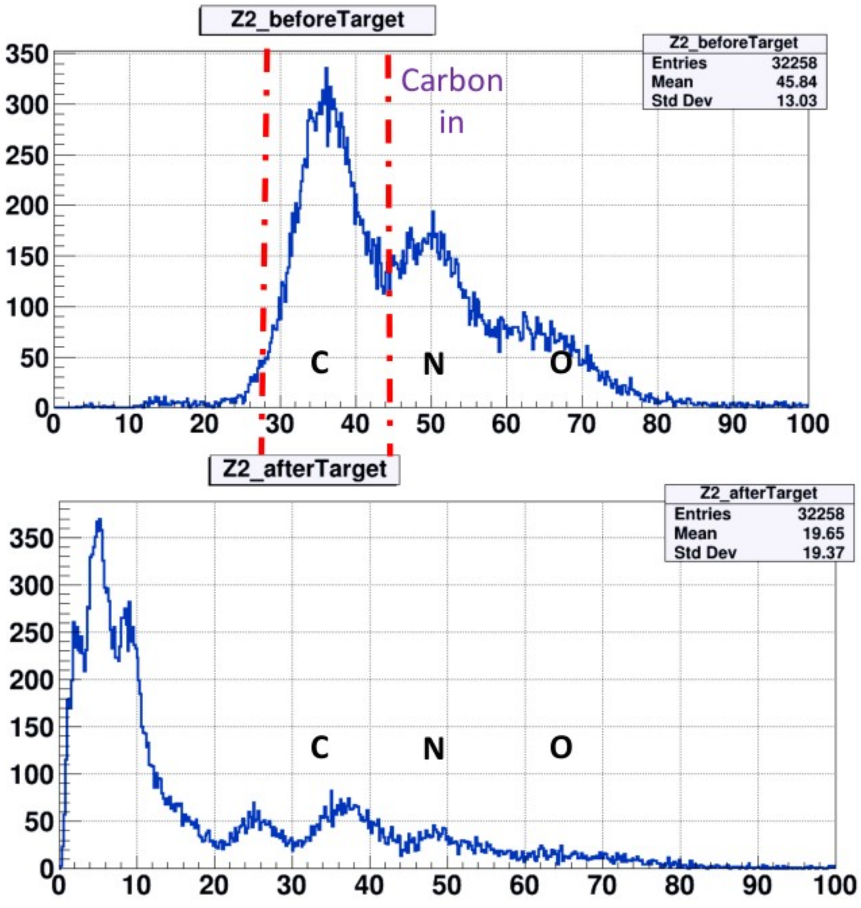
Timing resolution based on the lead wall data: integrated over strips on the same TOF400 module

The design timing resolution is 50-60 ps

Single BC does not separate ions

Run 3339: B 1800A, target H2

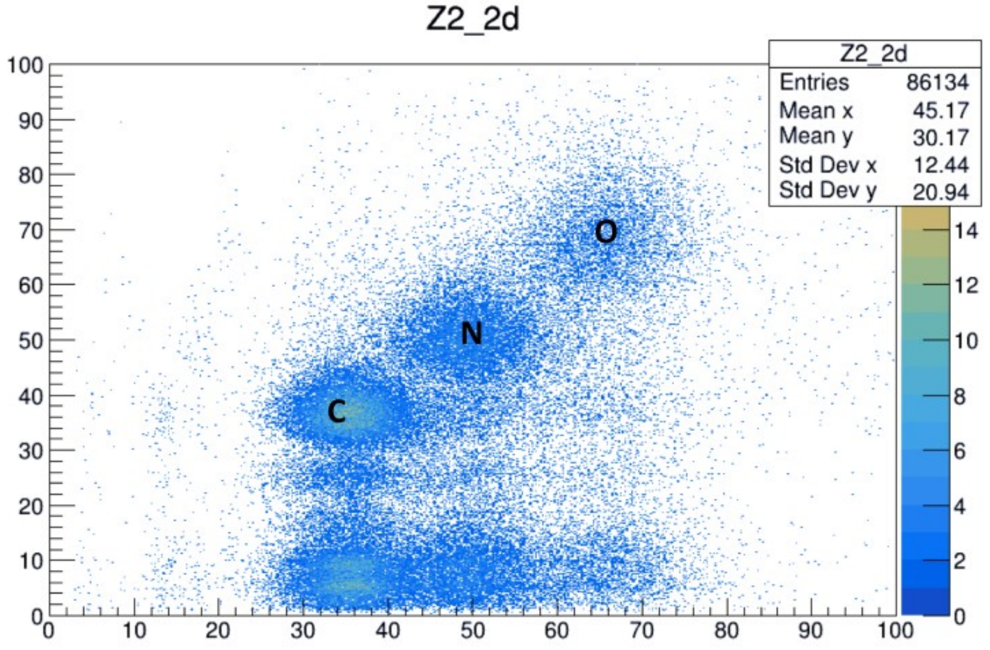


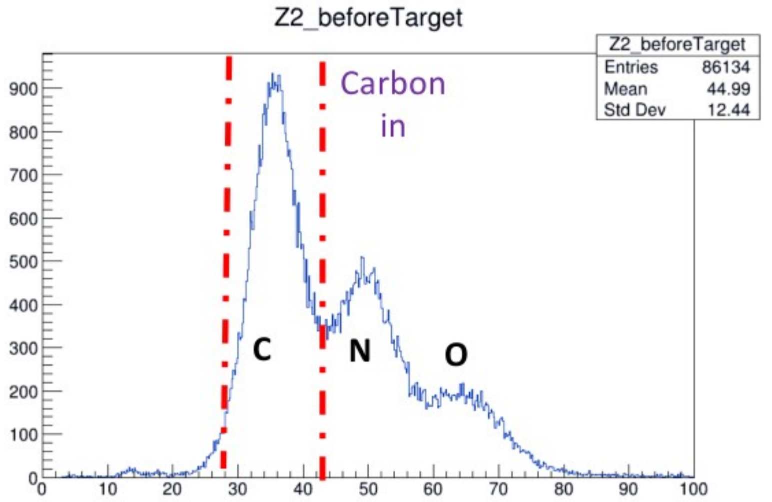


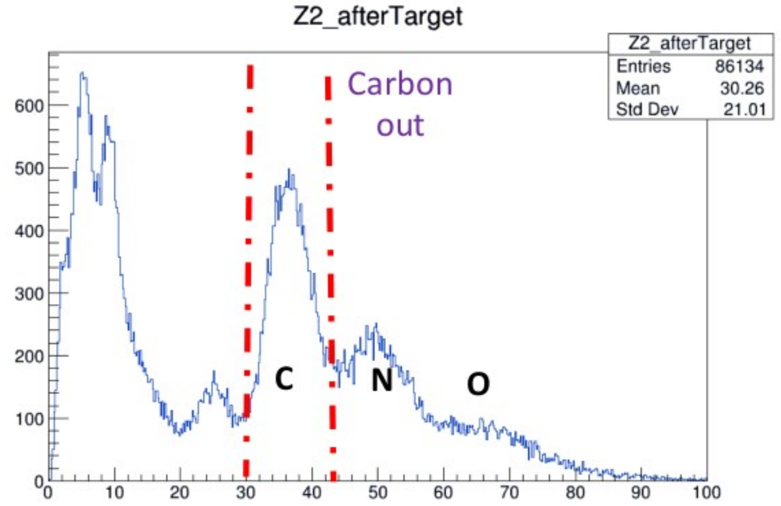
Single BC does not separate ions

Trigger cuts

Run 3338: B 1800A, target H2



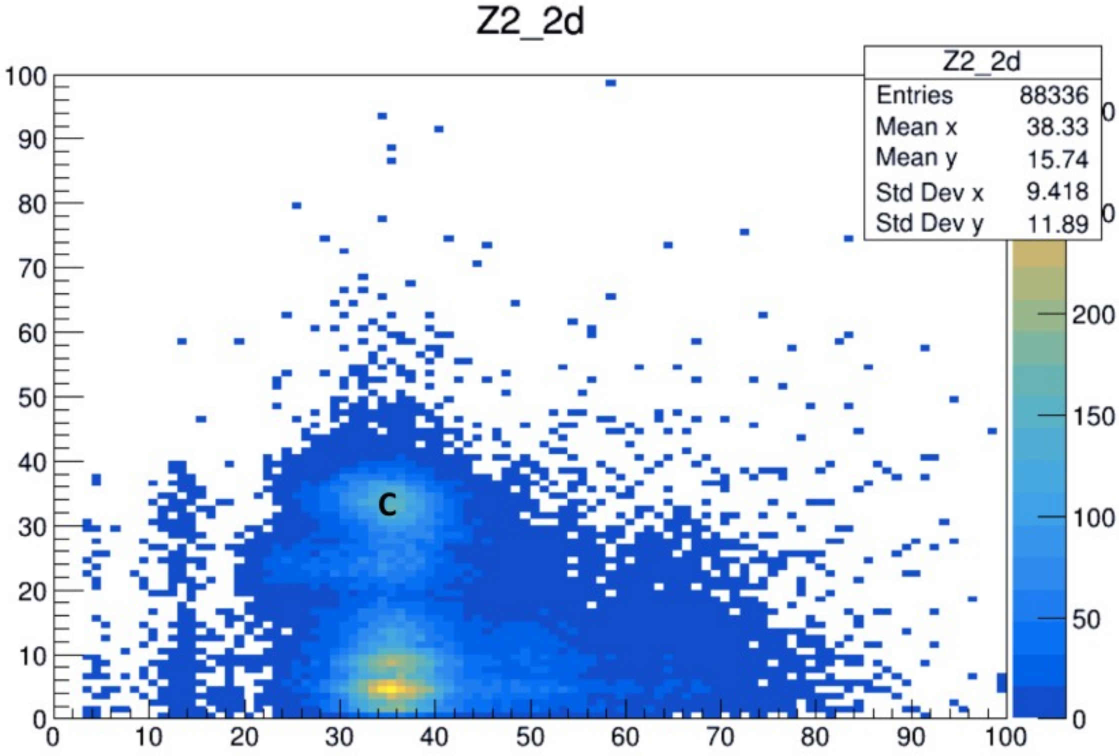


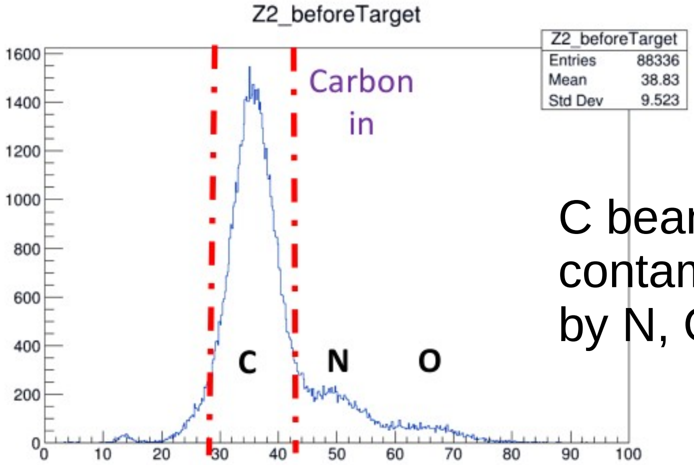


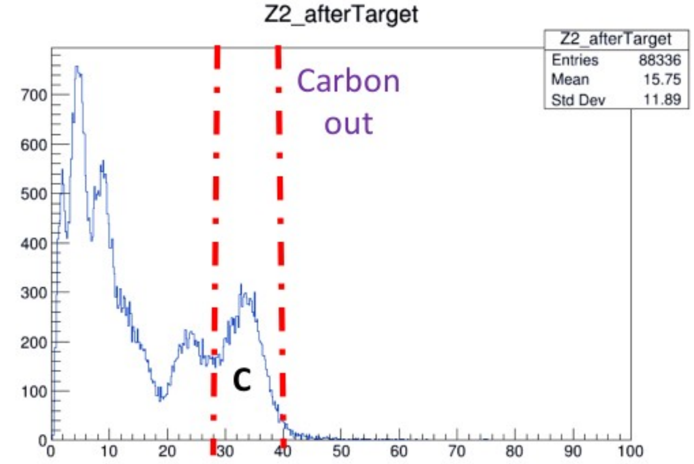
Single BC does not separate ions

Trigger cuts

Run 3531: B 1800A, Pb(9mm)







C beam contaminated by N, O

New BC counters + new trigger module

BC1, VC – same as last time

X1, X2, Y1, Y2 – trigger counters same as last time

BC2 – two new detectors, each read out by two PMTs (last time it was one detector read out by 1 PMT)

BC3, BC4 – new detectors, each read out by 2 PMTs

Additional BC5 – read out by 2 PMTs

T0Module – same module with additional channels and corresponding logic modifications

More BC channels than last time

BC1 – 1 channel + 1 spare channel
VC – 1 channel

T01 (MCP-PMT-based) – 2 channels
T02 – 10 channels

BC3 – 2 channels
BC4 – 2 channels
BC5 – 2 channels

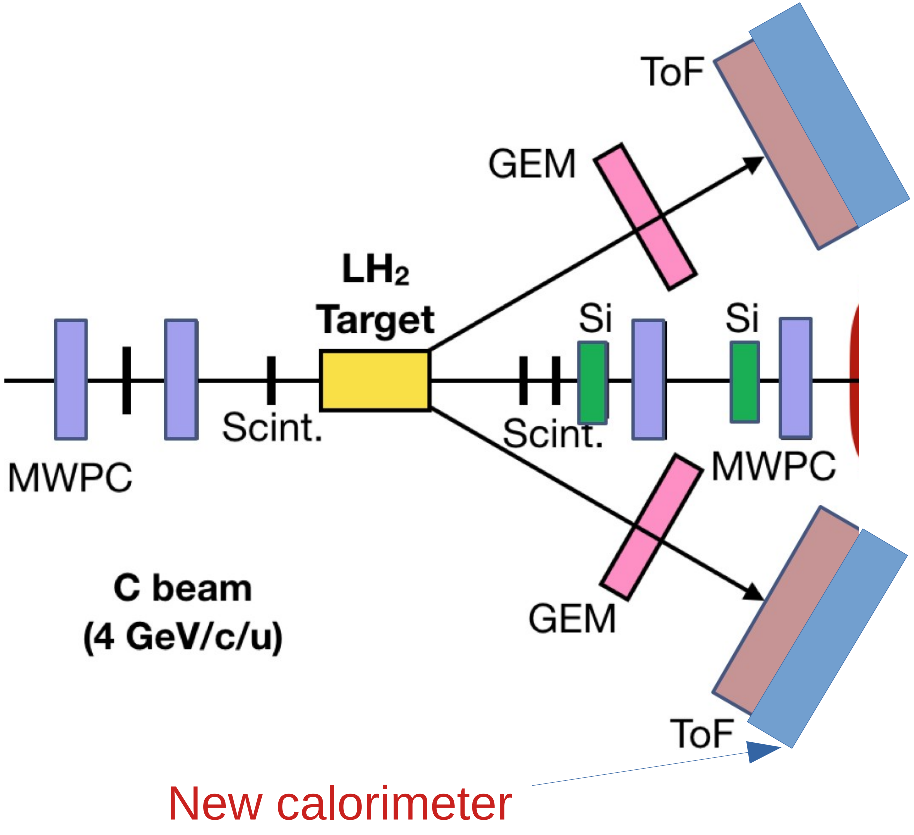
X1, X2 – 4 channels
Y1, Y2 – 4 channels

29 TQDC channels

29 TDC channels

Power supplies will be provided by V. Yurevich

New calorimeter



The MIT-TelAviv group plans to bring a new calorimeter

The calorimeter is planned to be used on the arms additionally to TOF400 (measure time + stop pions → proton identification)

The calorimeter will have around 80 channels and will use standard electronics (TDC + ADC)

Concept: Proton-Arm Calorimeter

Proton-Pion separation:
- stop the pions
- sample energy loss
- sandwich-like structure of plastic-scintillator and iron sheets

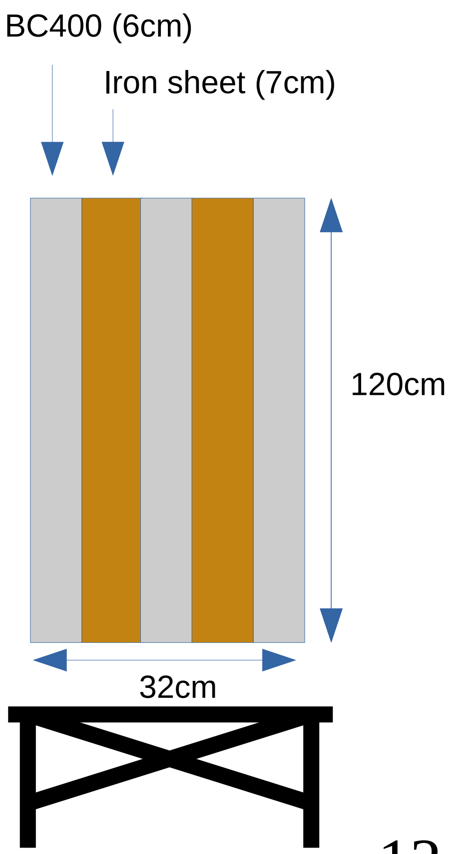
Assume protons at 2GeV/c (=1.275GeV) and a flight path of 5m:
ToF(p) = 18.4ns
Beta = 0.907
Δx ~ 100cm of iron to stop proton

→ need to discriminate pions with similar ToF:
T(pi) = 190MeV with p=300MeV/c (E=330MeV)

Take range R/M ~ 700 g/cm²/GeV and ρ(Fe)=7.874g/cm³
→ **Δx ~ 13cm of iron to stop pion**

(energy loss of protons ~ 210MeV)

Sandwich of ~3x 6cm thick Scintillator (6 bars per layer, readout at each end) and 2 x 7cm thick Iron (120 x 120cm² face size),
Exact design needs optimization
Total mass ~ 1500kg



New laser calibration system

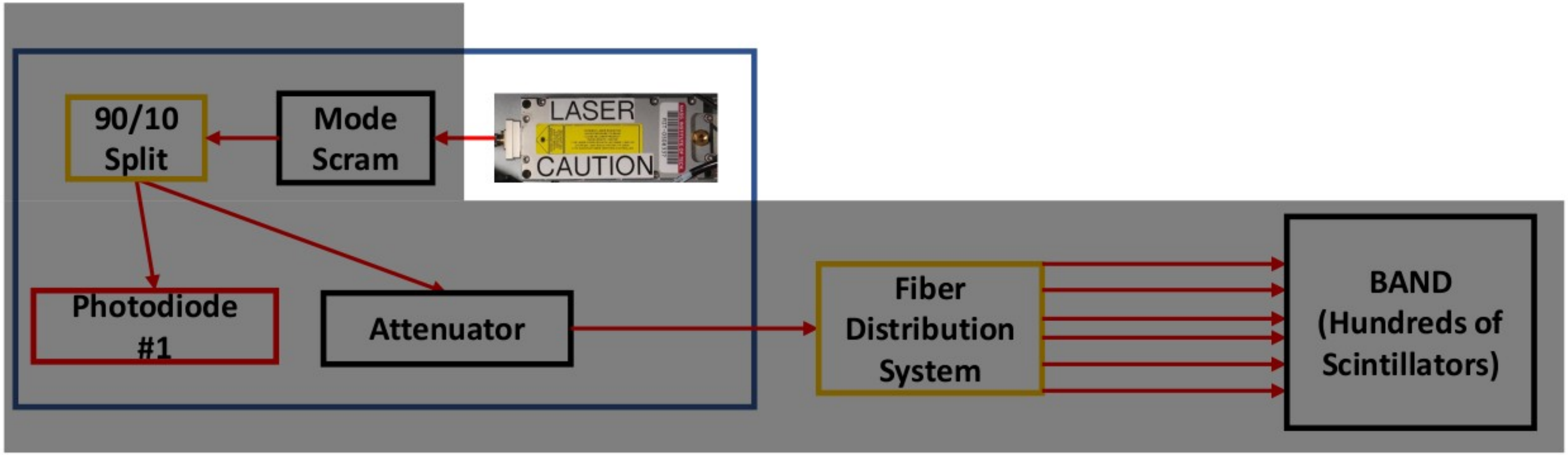
A new laser calibration system will be brought to calibrate all scintillator counters and the calorimeter without the beam

Wavelength is 335 nm or 405 nm, and the fibers are 200 um core diameter

Fiber length will be adjusted to fit the setup

Around 50 fibers

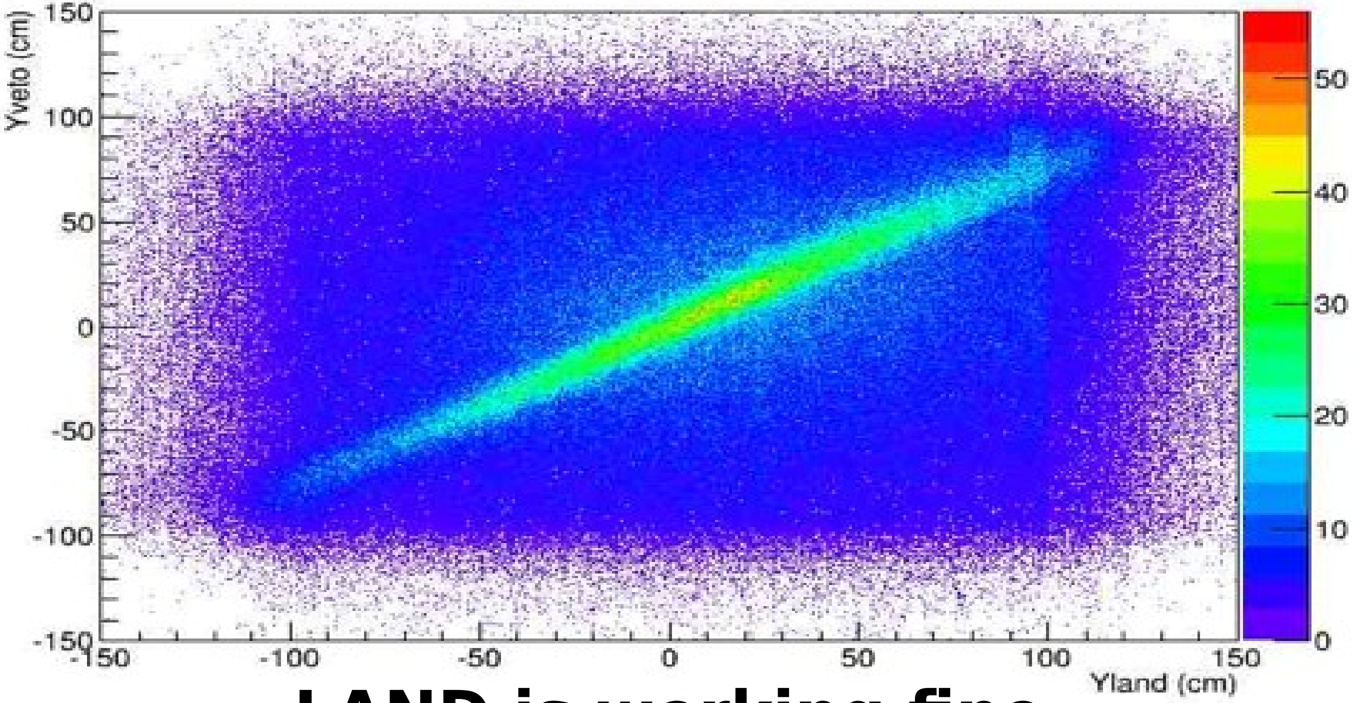
BAND Setup



- Laser
  - 355 nm
  - ~0.3ns pulse width
  - 1kHz pulse frequency
  - Controlled by Raspberry PI

Neutral and charged particles in LAND

DATA from March 2018 in coincident with SRC trigger



LAND is working fine

Readout time
(old electronics)
200 us

Readout time (new electronics)

SRC trigger rate – 1k

LAND does not slow down the DAQ

Absolute time calibration → use the laser system

Fixing last run problems:

T0 did not provide design timing resolution → two T0 devices next time read out by 2 PMTs each

BC counters provided poor charge separation and low efficiency → new design of BC counters

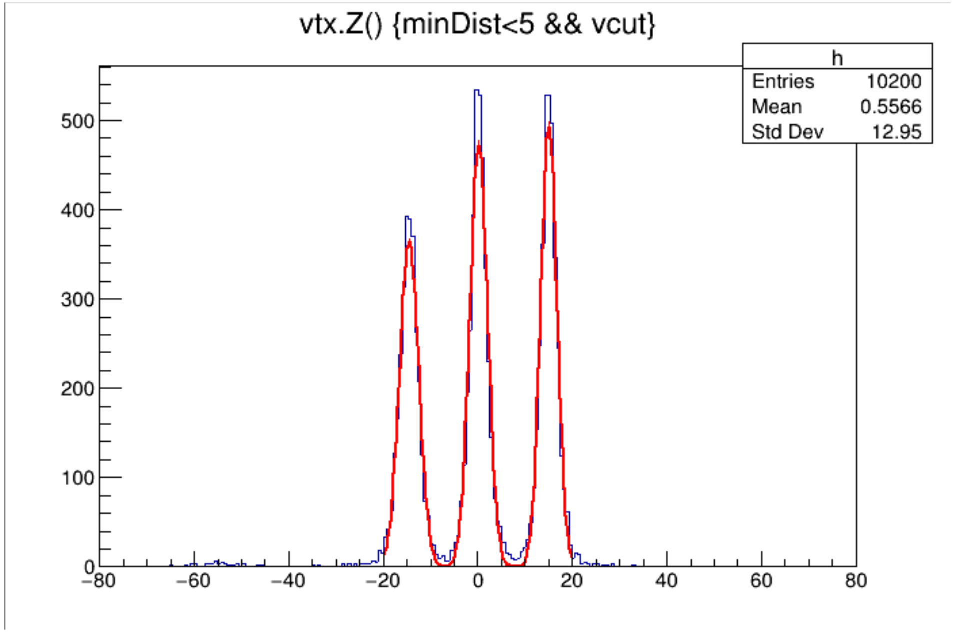
TDC counts were not written out properly to the file → high discriminator threshold?

Gas mixture in the MWPC was not adjusted properly

X’ readout for the Si was poor

Add one more tracking detector to each arm?

Vertex reconstruction using the arms



3 lead targets:

With 2 points on each arm we can reconstruct the target, but additional coordinate detector would be useful

1	p0	3.64580e+02	9.19591e+00
2	p1	-1.45893e+01	3.84713e-02
3	p2	2.03092e+00	3.59187e-02
4	p3	4.71407e+02	1.12282e+01
5	p4	1.48560e-01	3.18350e-02
6	p5	1.88953e+00	3.16257e-02
7	p6	4.92501e+02	1.16778e+01
8	p7	1.49918e+01	3.03773e-02
9	p8	1.73513e+00	2.89649e-02

New electronics for LAND based on TRB3

IPC 21694

TRIXOR1

KINPEX1A

EXPLODER

TAMEX3_IN2

FEBEX_POW1A

TAMEX3_BKP2

TAMEX3_PWR3

TAMEX3_OUT2

TAMEX3A

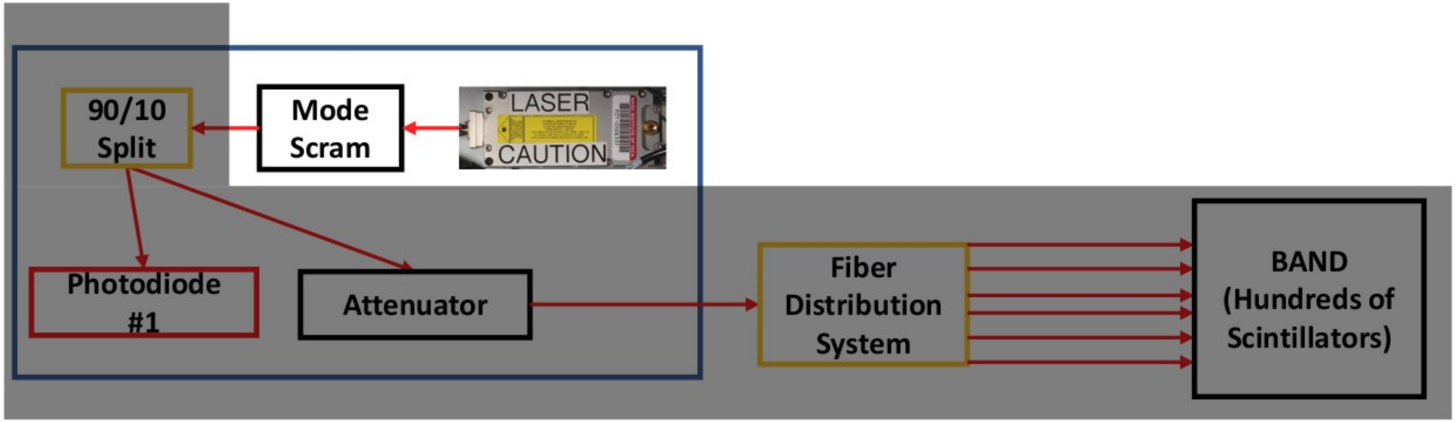
NEULANDFQT1 – QDC

FQTINT1

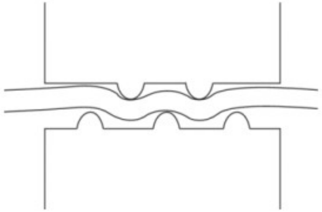
CLK-TRG-DISTR2

This is a new electronics (not the one used last time).

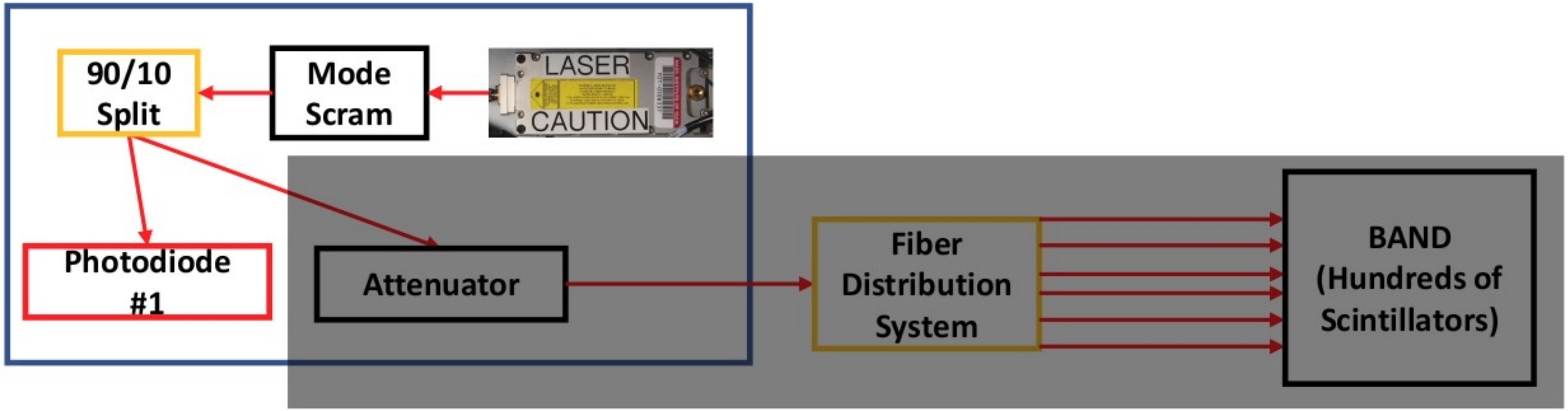
BAND Setup



- Mode Scrambler
  - Single mode laser
  - Multimode splitter

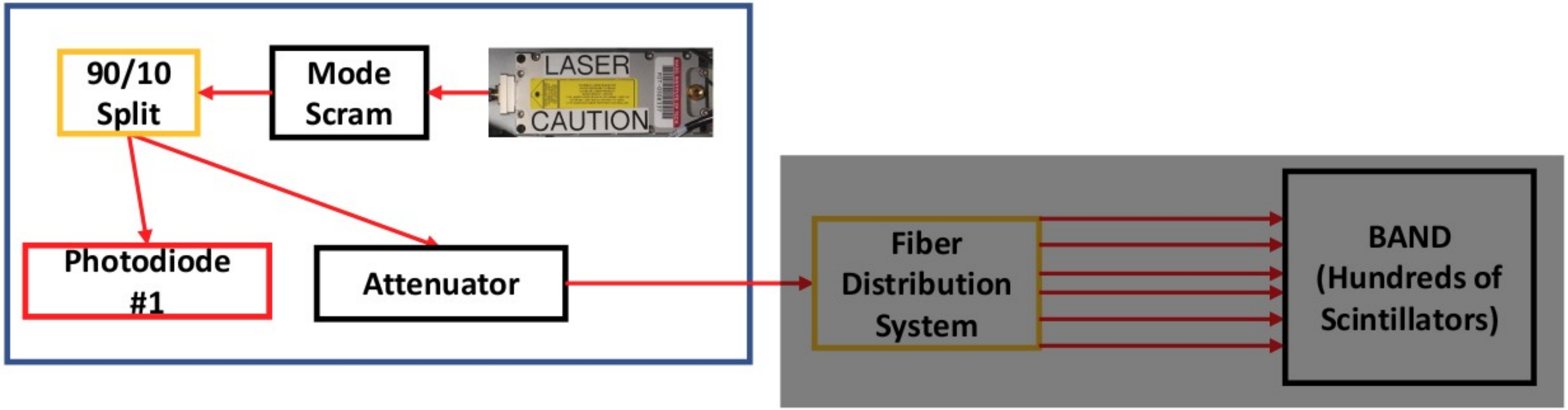


BAND Setup



- Photodiode #1
  - Fast Photodiode
  - Si Biased Detector

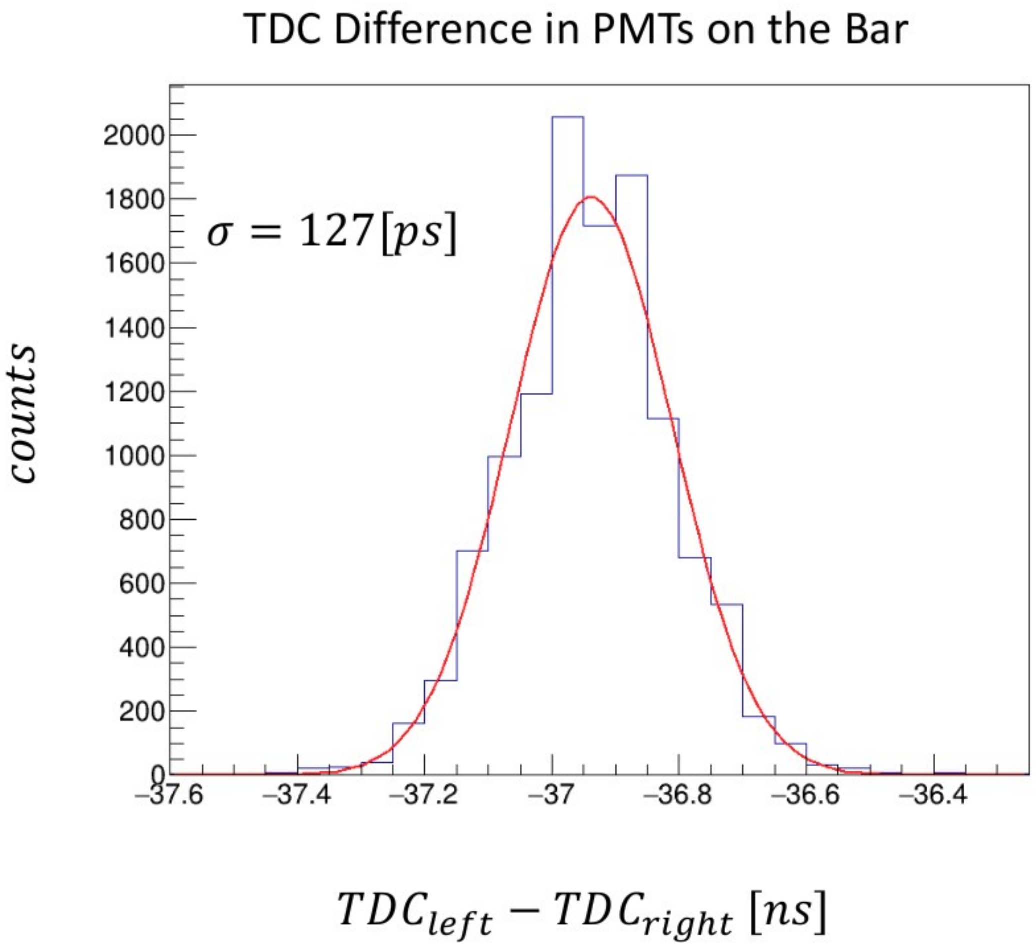
BAND Setup



- Attenuator
  - Variable optic attenuator
  - Range of 5 orders of magnitude

Fiber Distribution System

Great Time Resolution (MIT)



$$\sigma_{diff}^2 = \sigma_{left}^2 + \sigma_{right}^2$$

$$\sigma_{PMT} \approx 90[ps]$$