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Digital oscilloscope-based acquisition for fast and dynamic sampling of photodetector signals

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Two main physical objectives & digital oscilloscope as a solution

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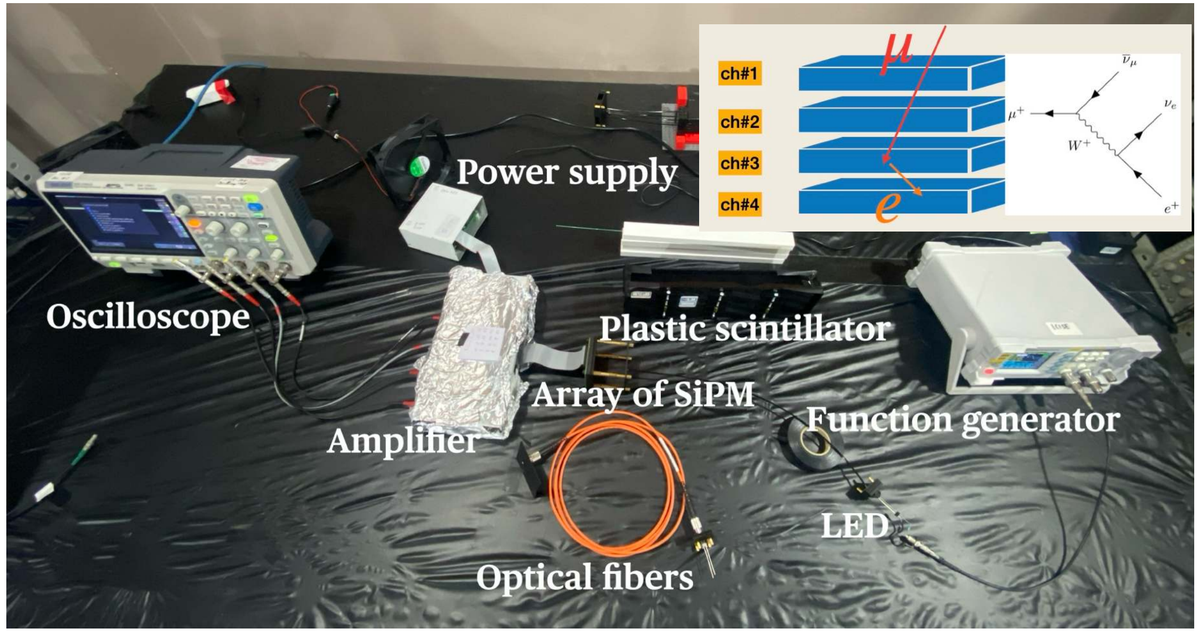
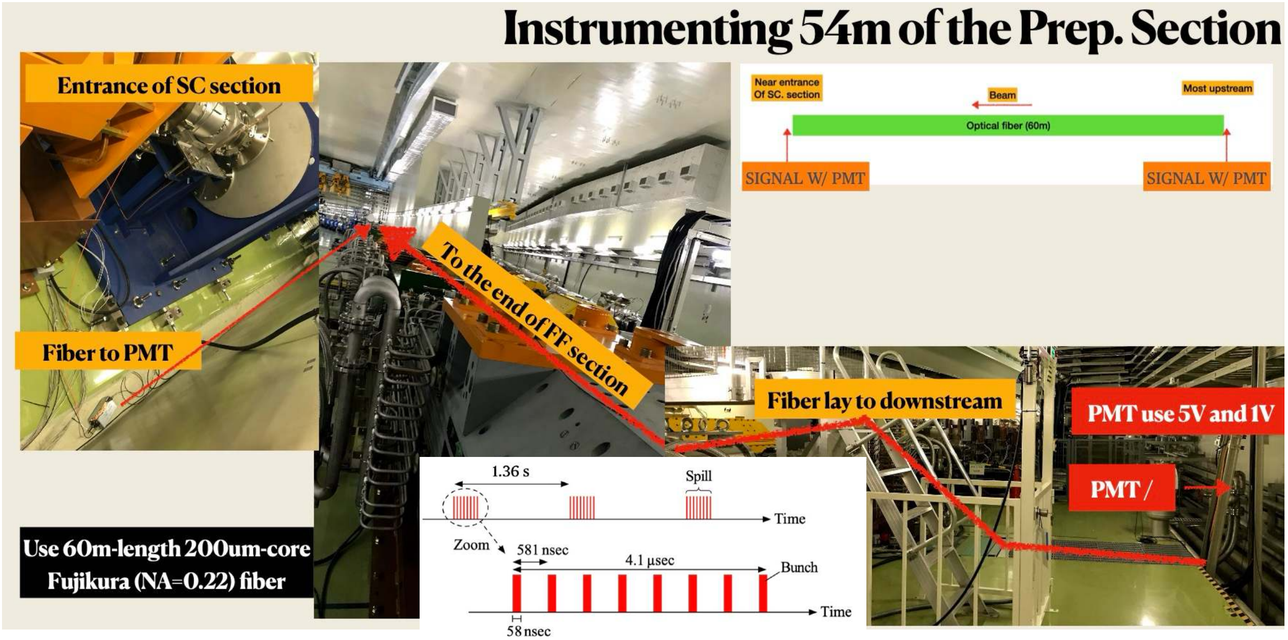


(1)Table-top muon detectors and the like

- Use plastic scintillator and SiPM
- Wo/ amplifier, faint signal with ~ few 10mV pulse height, single p.e < 1mV
- Prompt signal ~ ns - few ns
- Delay signal ~ few us to few 10s of us
- Unknown timing trigger
- Rate (depending on detector size), but mostly ~ Hz; some coincidence needed



(2) Time-profile of the beam loss from the high-intensity beam delivered for the neutrino experiment

- Optical-fiber -based + Metal-package PMT (also SiPM)
- (*basically*) known timing trigger
- Proton bunch structure: ~ (60ns/bunch width + 600ns bunch gap) x 8 bunches with T = 1.36s cycling
- Wide dynamic range in both pulse height and sampling interval

Cost-effective all-in-one solution

Digital oscilloscope

+ Over ethernet transfer to PC
+ SCPI/VXI11—based protocol
+ Used as intelligent trigger, fast ADC, wide-dynamic TDC, flexible logic unit
+ Real-time and sequence DAQ modes

Key features, and results of applications

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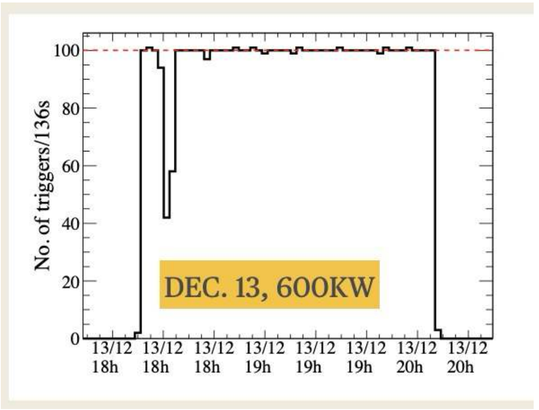
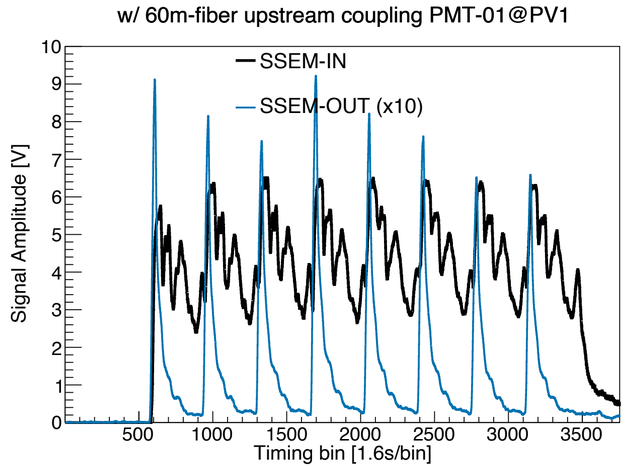
(Strongly depend on the oscilloscope choice, here 500MSa/s, bandwidth 100Mhz) Siglent 1104X-E

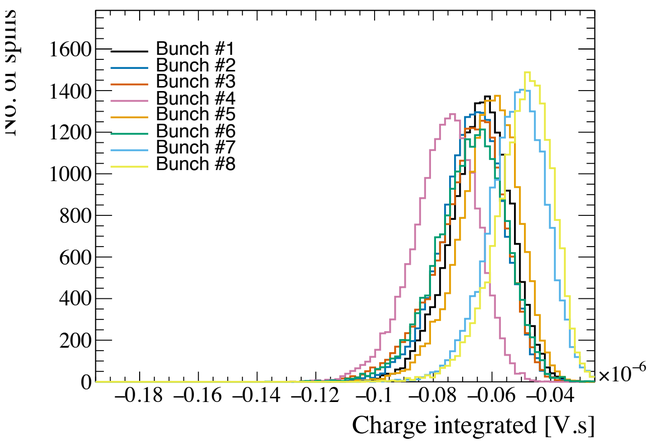
DAQ operation modes

- **Real-time** capture : maximum rate ~100,000 wfms/s -> 3-4 Hz total (trigger, data transfer and reformat) DAQ rate
- **Sequence** capture: maximum rate ~400,000 wfms/s -> sequently recorded ~ 300k frame/s + 0.089s/frame for data transferring and formatting

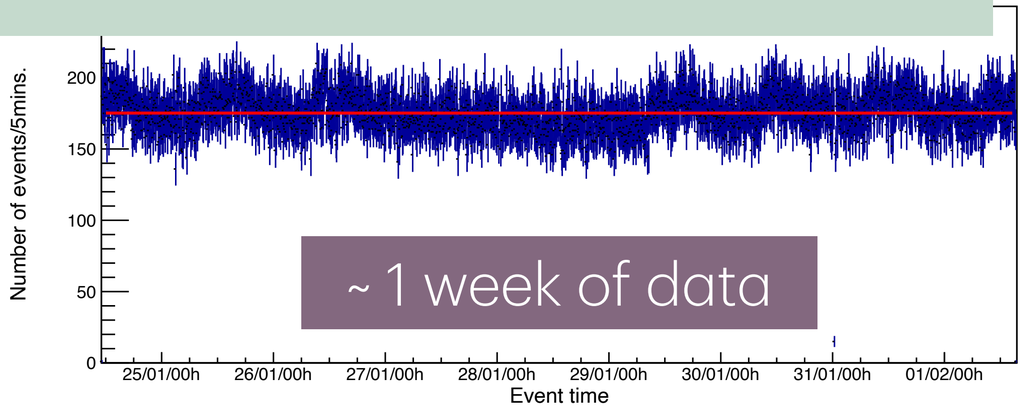
New ways to acquire the beam loss monitor: first bunch-by-bunch structure (used real-time DAQ mode)







Acquiring the cosmic-ray muons with table-top scintillator detector (used both real-time and sequence DAQ mode; oscilloscope also take role of coincidence unit and TDC)



Typical signal