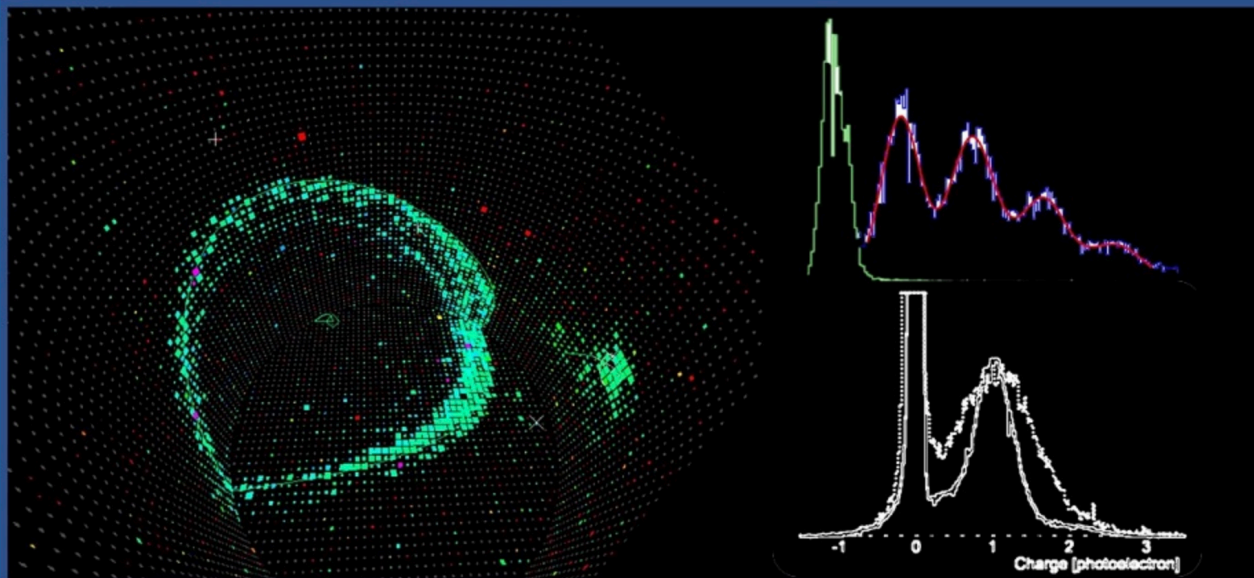


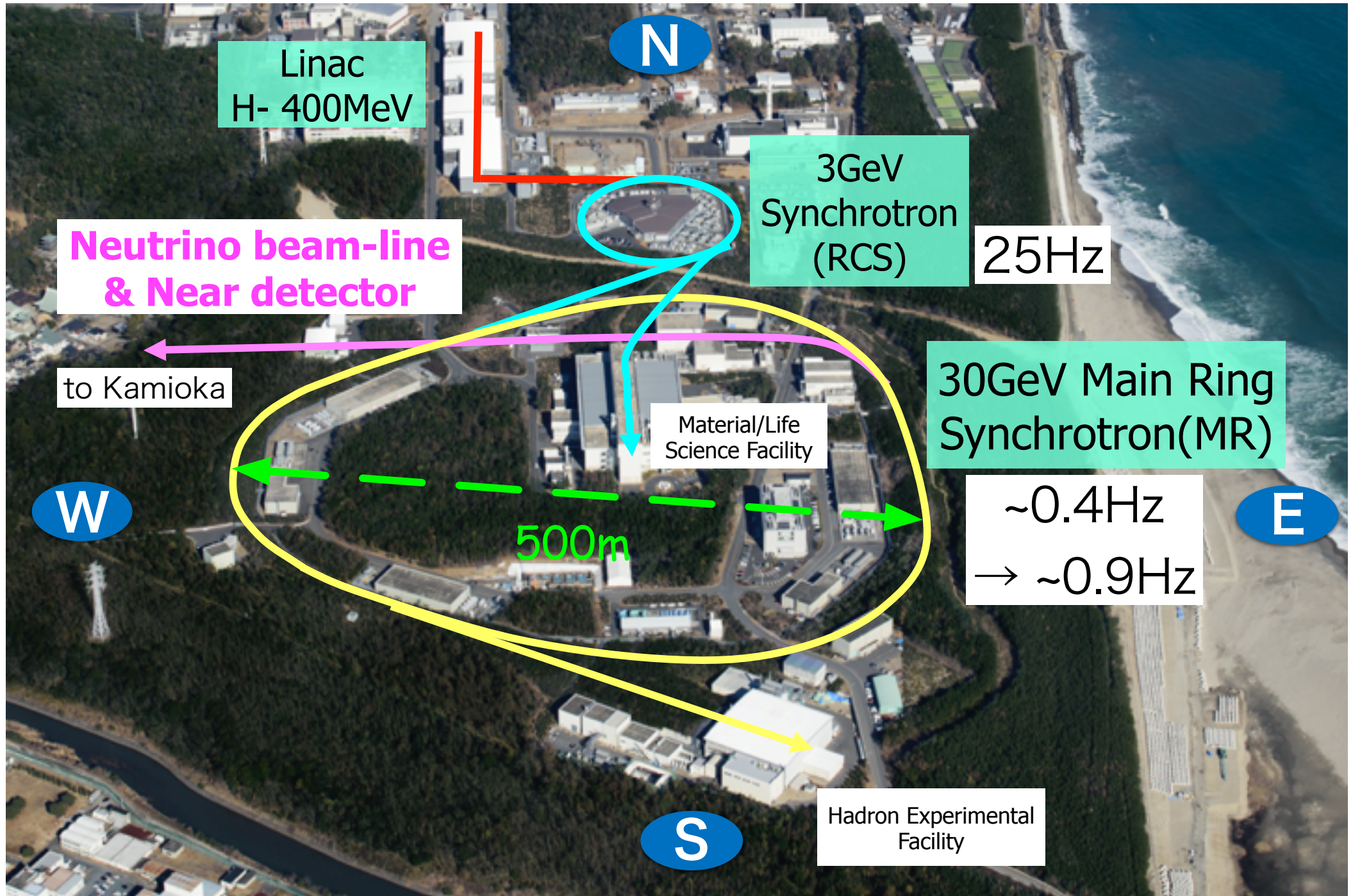
Timing/clock distribution at J-PARC neutrino beamline



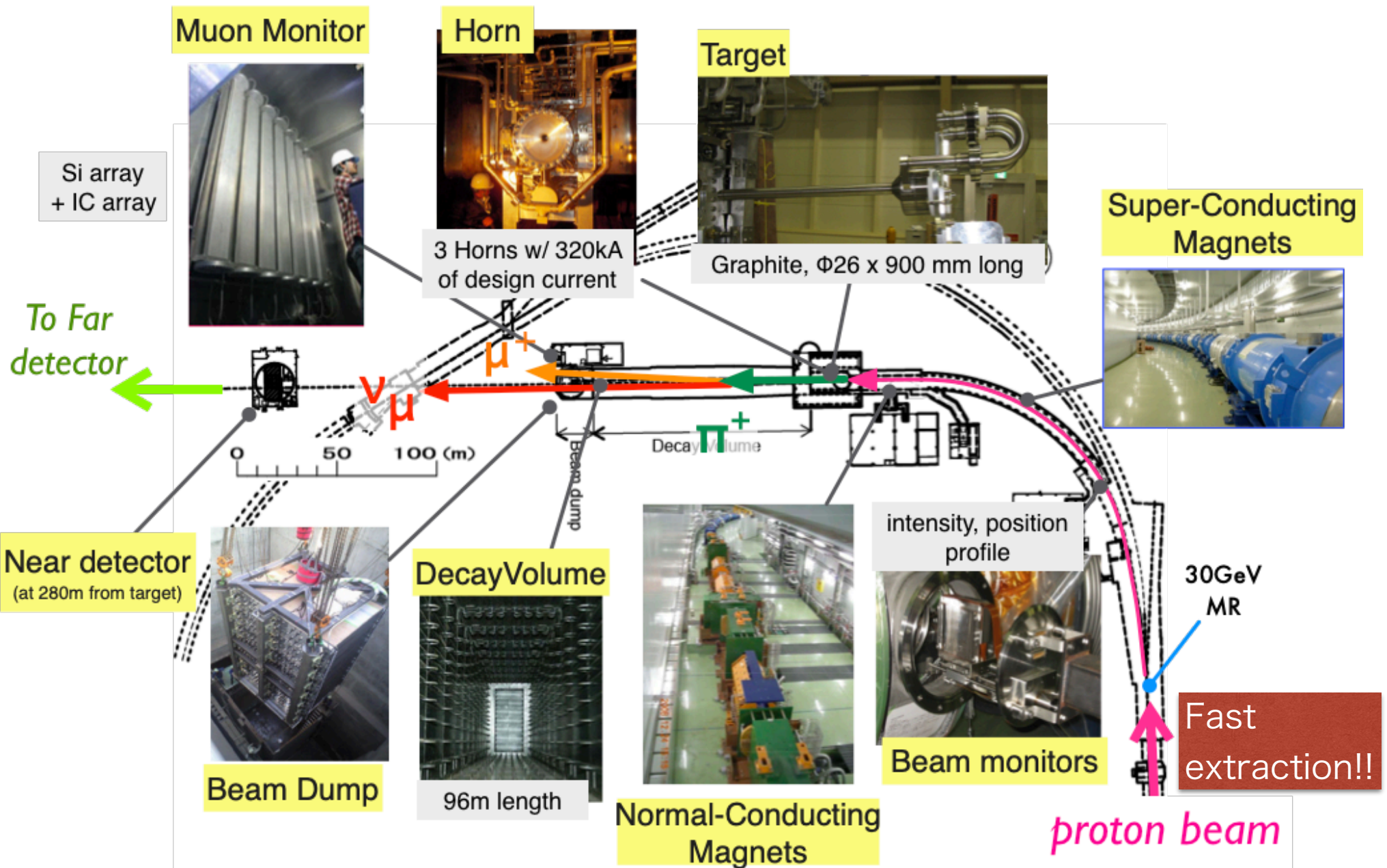
Contents

- ❖ Introduction
- ❖ Timing distribution from accelerator
- ❖ GPS system at J-PARC neutrino beamline
- ❖ Timing distribution to detectors
- ❖ Summary

J-PARC accelerators at Tokai

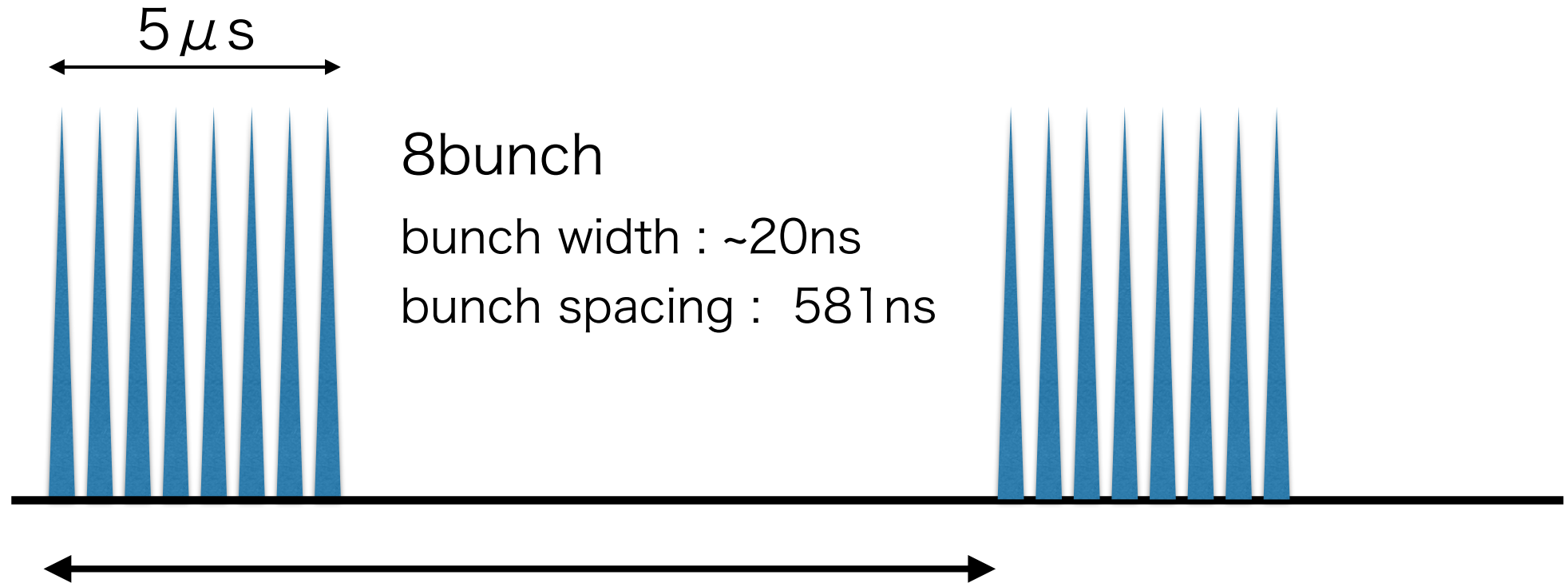


J-PARC neutrino beamline



J-PARC MR beam structure

500kW → 1300kW



T_{rep.} : 2.48 [s] → 1.32 [s] → 1.16s [s]

of protons :

2.6 x 10¹⁴ [p/pulse] → 3.2 x 10¹⁴ [p/pulse]

Timing/clock distribution system at neutrino beamline

[purpose]

Determine neutrino beam production timing and distribute its to ND and SK

[functions]

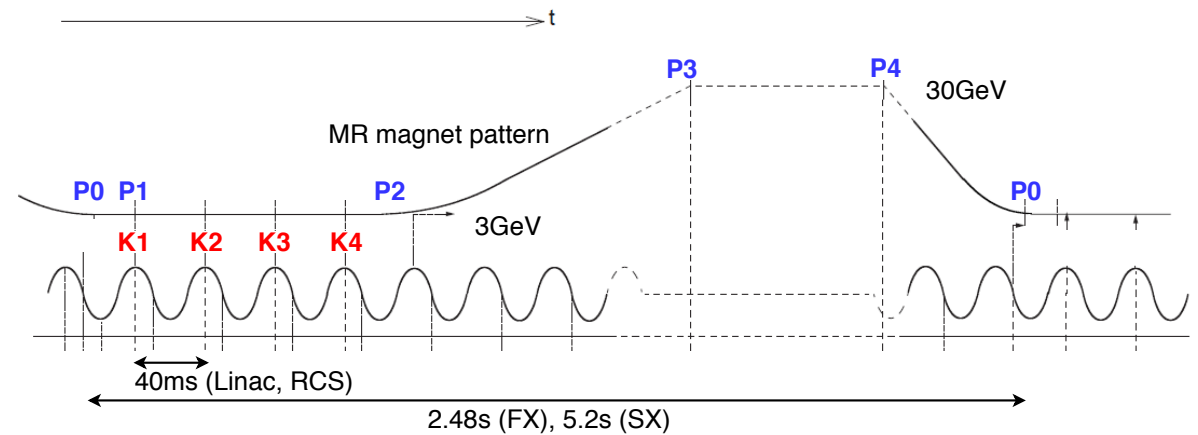
- ▶ Receive beam timing from accelerator
- ▶ Record time stamp of beam extraction timing using GPS
- ▶ Distribute the extraction timing and its time stamp to detectors

Beam timing from accelerator

Two kinds of timing are defined:

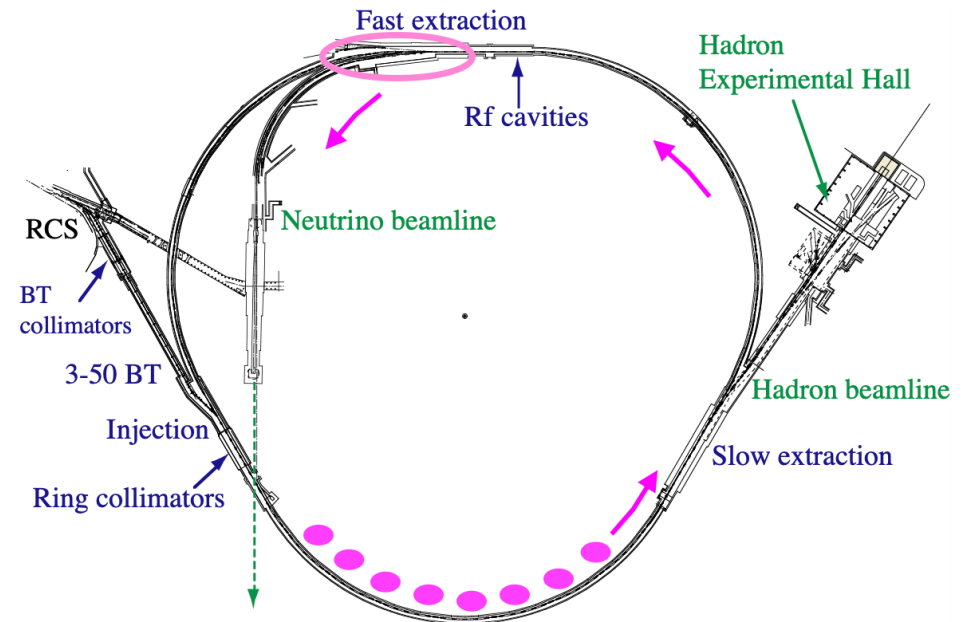
(1) Scheduled timing

- based on 25Hz clock (master clock is 12MHz)
- to generate magnet excitation pattern etc.



(2) Synchronization timing

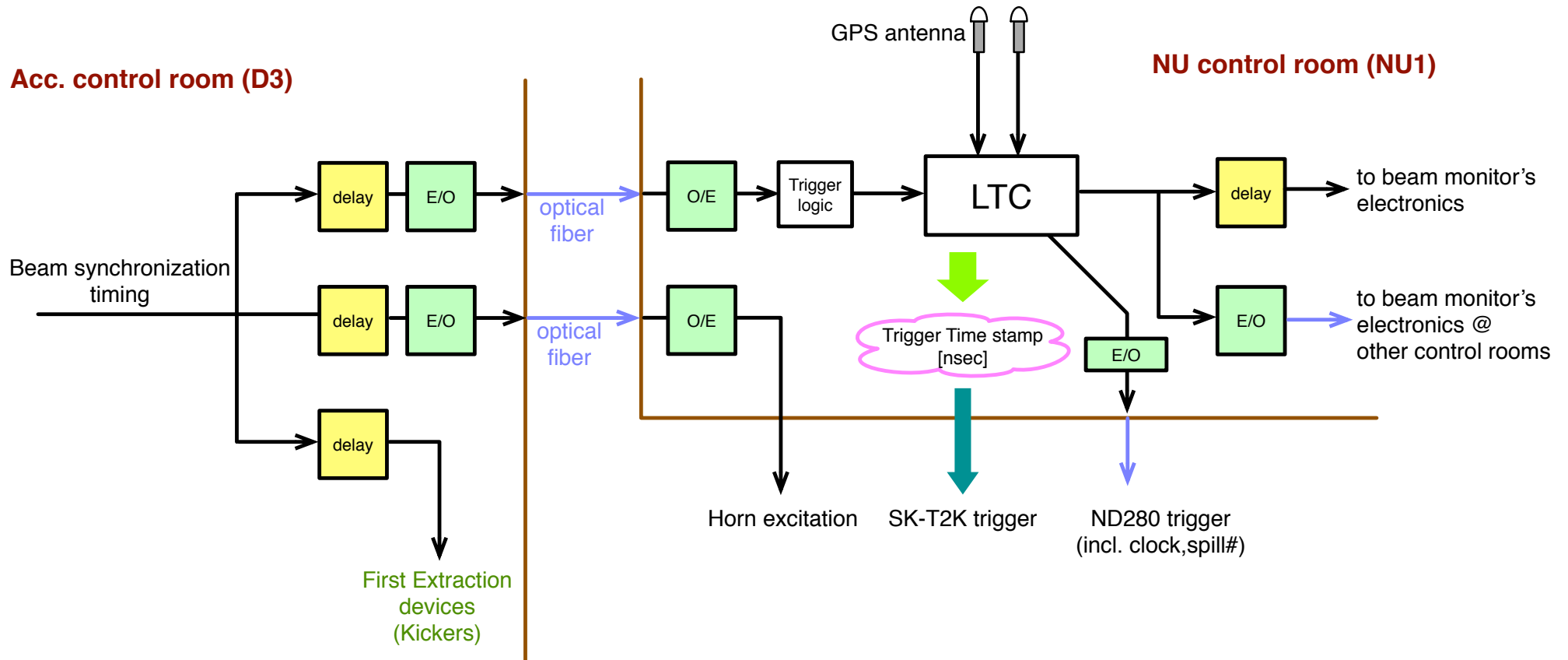
- based on RF clock (1.671-1.721MHz for 3-30GeV)
- to generate Injection & Extraction devices excitation



Both timing signals are sent to neutrino beamline

RF captured beam
→ synchronized with RF clock signal

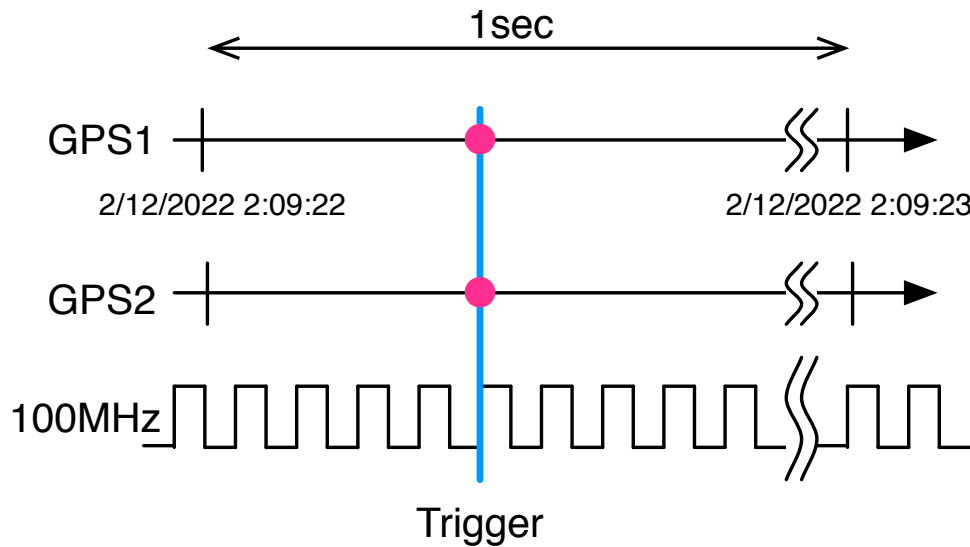
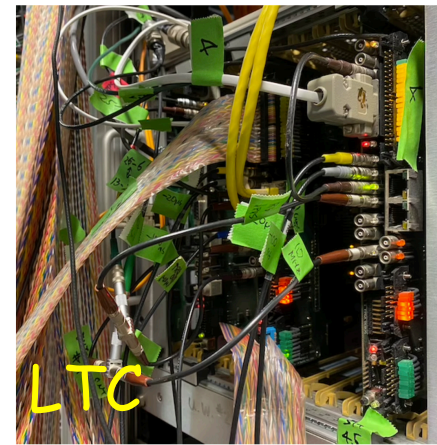
Timing distribution and time-stamp recording at neutrino beamline control room



- Time-stamp of the beam extraction timing is recorded using GPS system (Local-Time-Counter: LTC module)
- Spill# (counter of # of beam trigger) and the beam extraction timing signal (NIM-level pulse) is then distributed to beam monitors, ND detectors through E/O, O/E modules

GPS system (T2K)

- Two independent GPS receivers (identical set at both Tokai and Kamioka)
- Rb clock as a master clock of LTC → generate 100MHz
- In LTC, time-stamp of beam extraction trigger is recorded

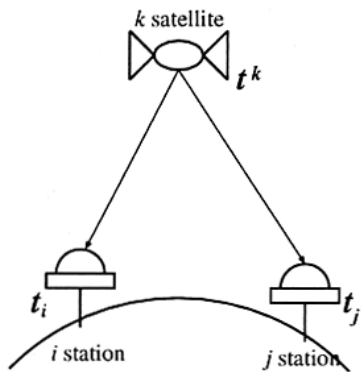


New participation for HK era is highly welcome !!

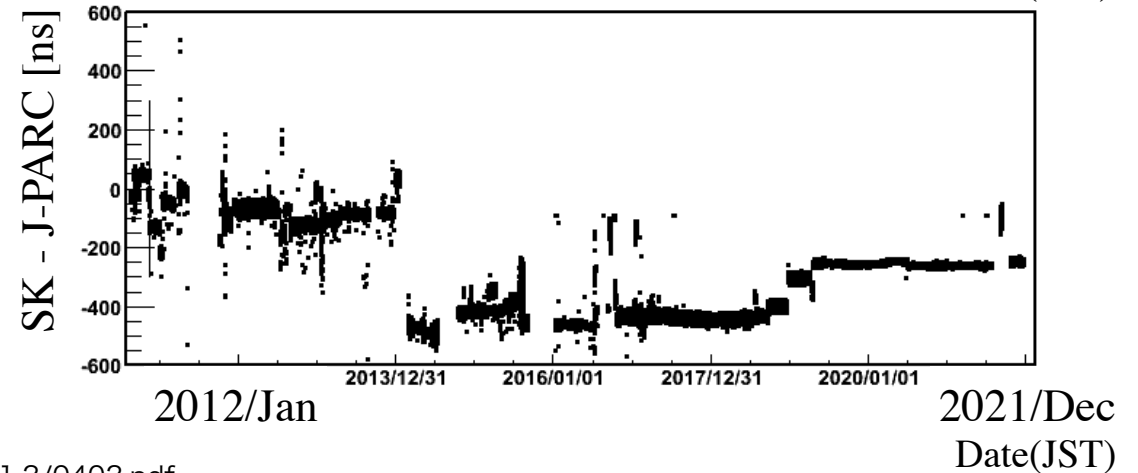
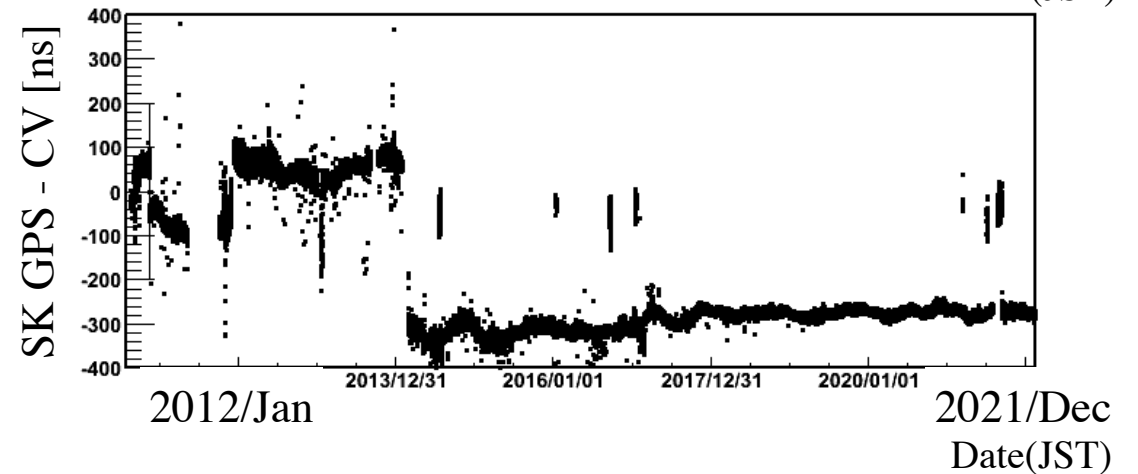
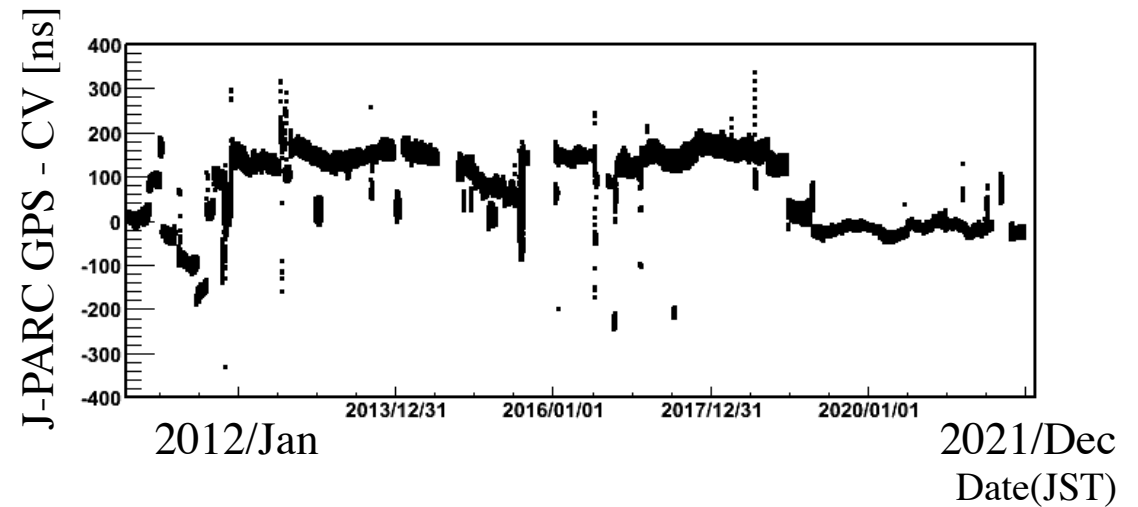
[developed by H.Berns (UC Davis)]

Common view (CV) system

- Since satellites used in Tokai and Kamioka GPS may be different, there are uncertainties on time synchronization between Tokai and Kamioka
- To monitor the Tokai-Kamioka time synchronization, we introduce "common view" system

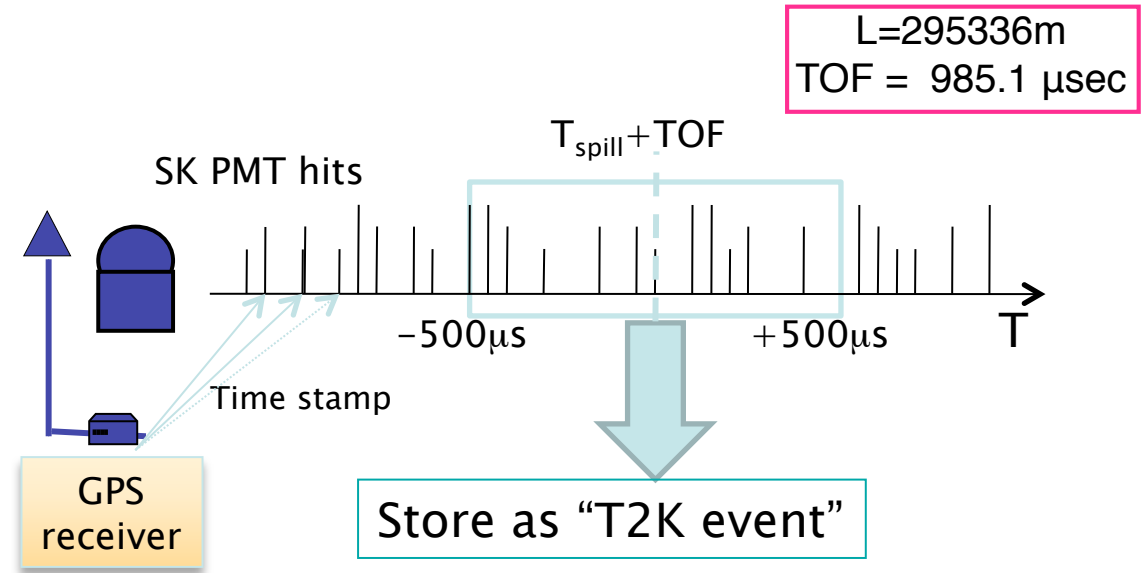


Common view can calculate time for each satellite and JST data from NICT

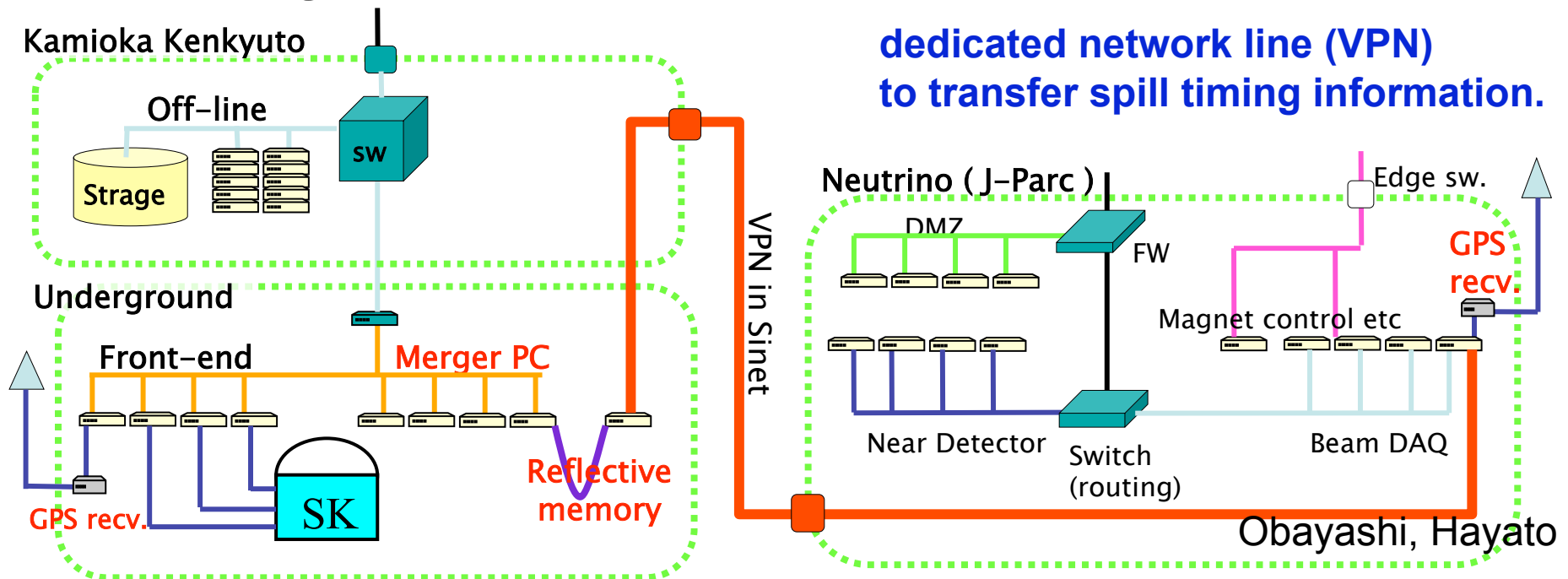


Beam time-stamp information (GPS data) is sent to SK DAQ in realtime

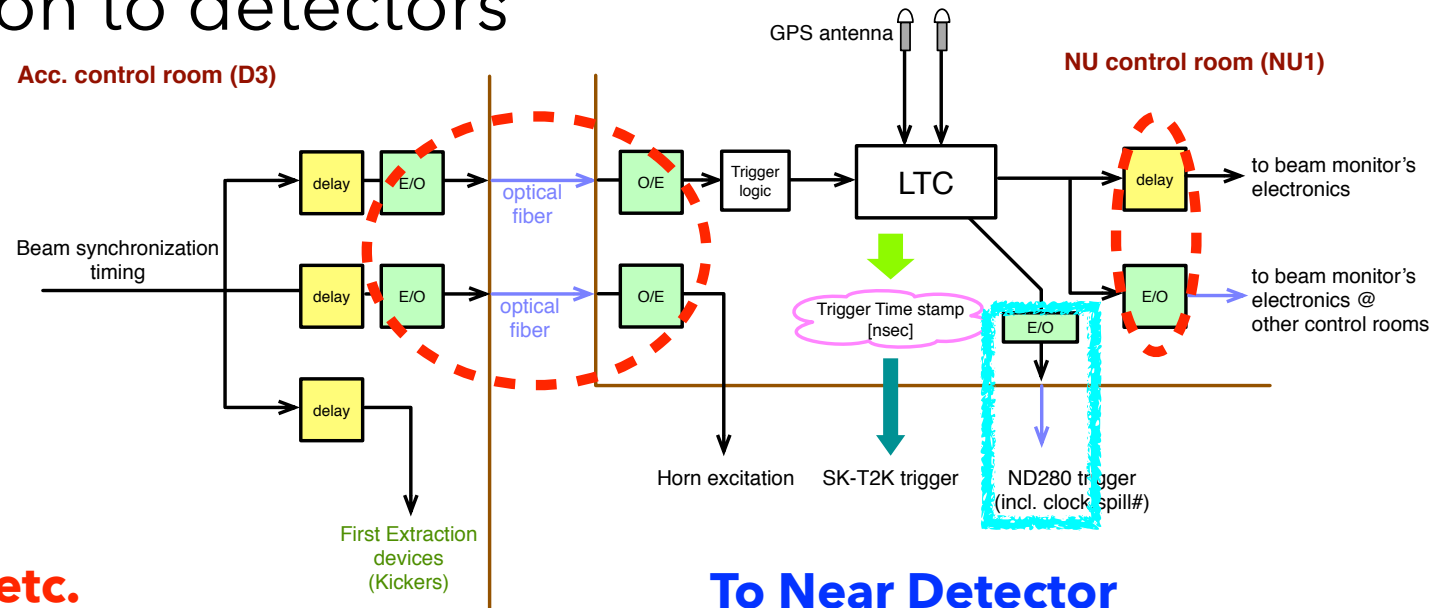
Using the T2K spill timing, all the PMT hits within $\pm 500 \mu\text{s}$ are recorded as the T2K event. (**1st priority** in the software trigger)



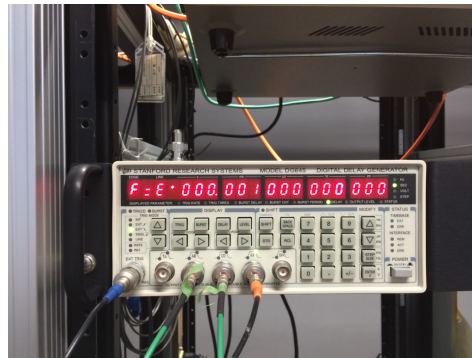
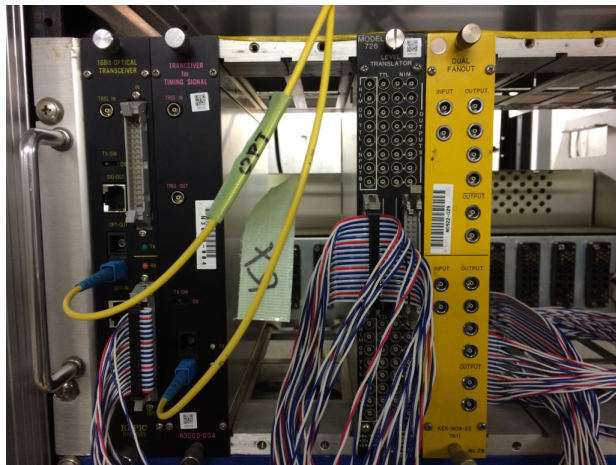
Spill timing transfer from J-PARC to SK



Timing distribution to detectors



To beam monitors, horn etc.



DG645

- ❖ Currently, NIM E/O, O/E modules are utilized to transfer trigger, spill#
- ❖ Plan to develop new timing/clock distribution (FPGA based) system toward HK

To Near Detector

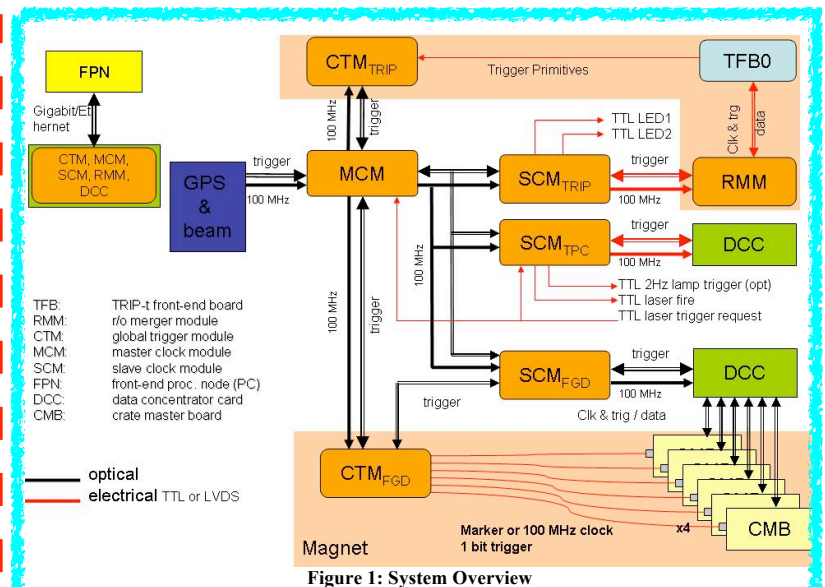
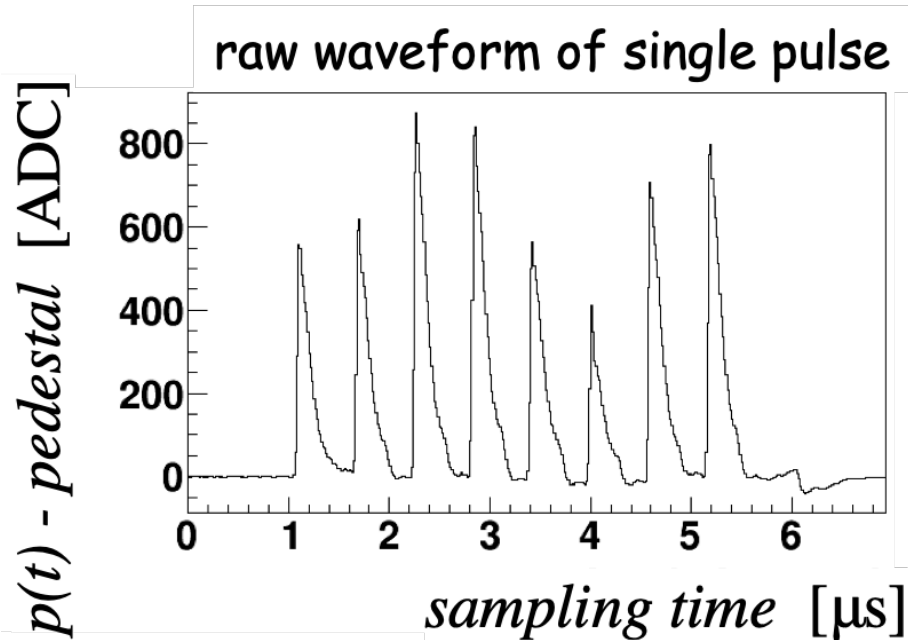


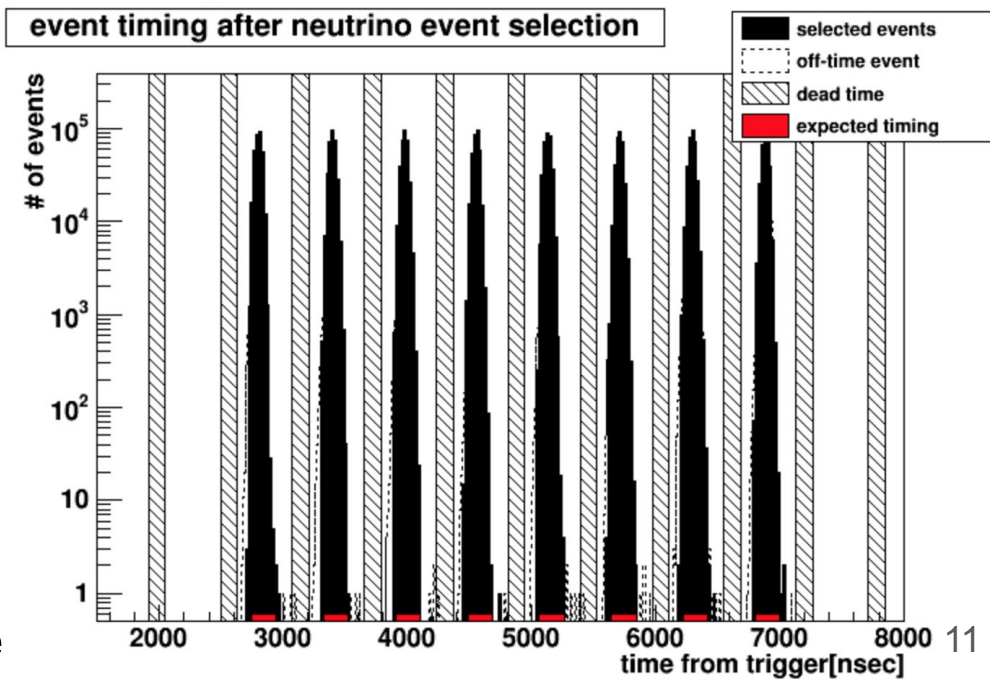
Figure 1: System Overview

- ❖ A dedicated optical module is utilized to transfer trigger, spill#, 100MHz clock

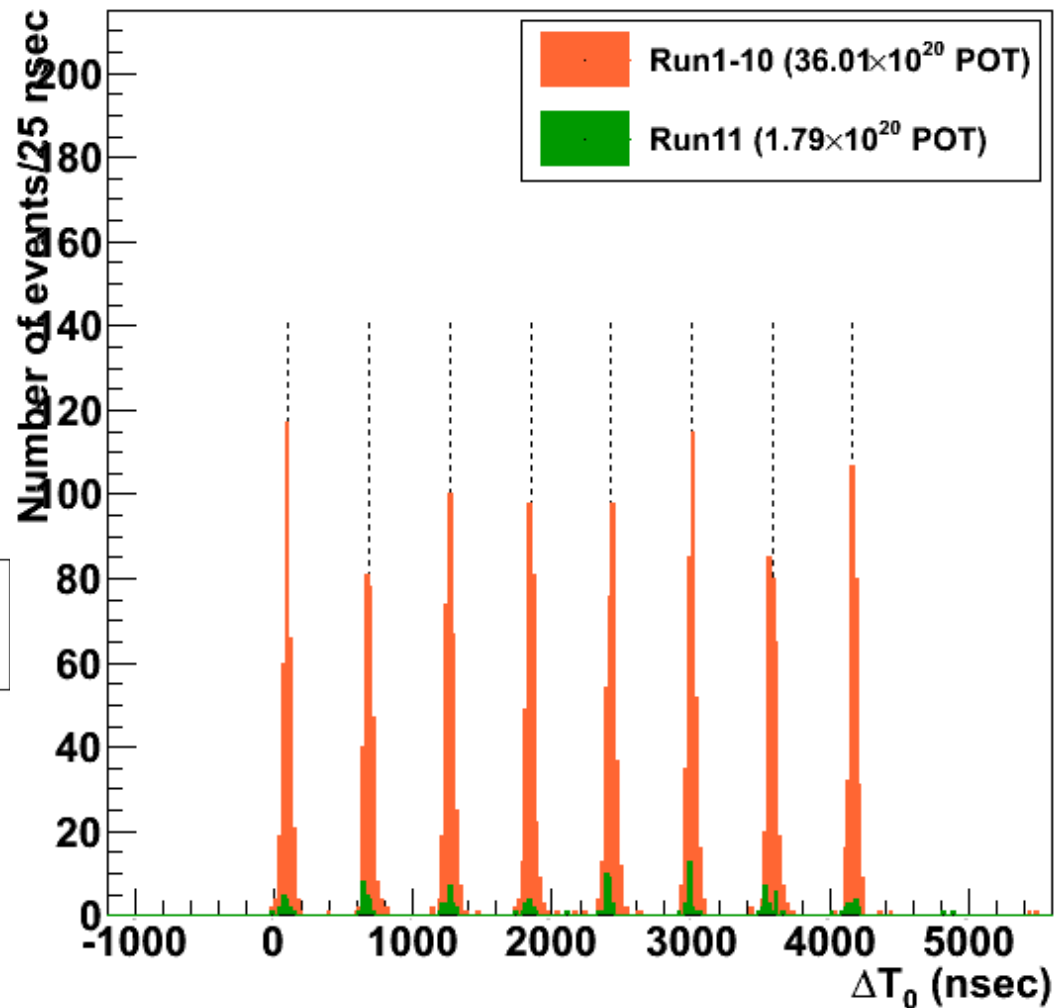
Proton beam signal by SSEM



Event timing dist. (INGRID)



Event timing dist. (SK)



Summary

- ❖ Timing/clock distribution system at J-PARC neutrino beamline is introduced
- ❖ Current system has been working without any troubles but some hardwares are already discontinued
- ❖ Toward HK era, development of some hardwares including GPS system is desired.
New participation is highly welcome !!