DAQ at SCRIT

RIBF DAQ workshop
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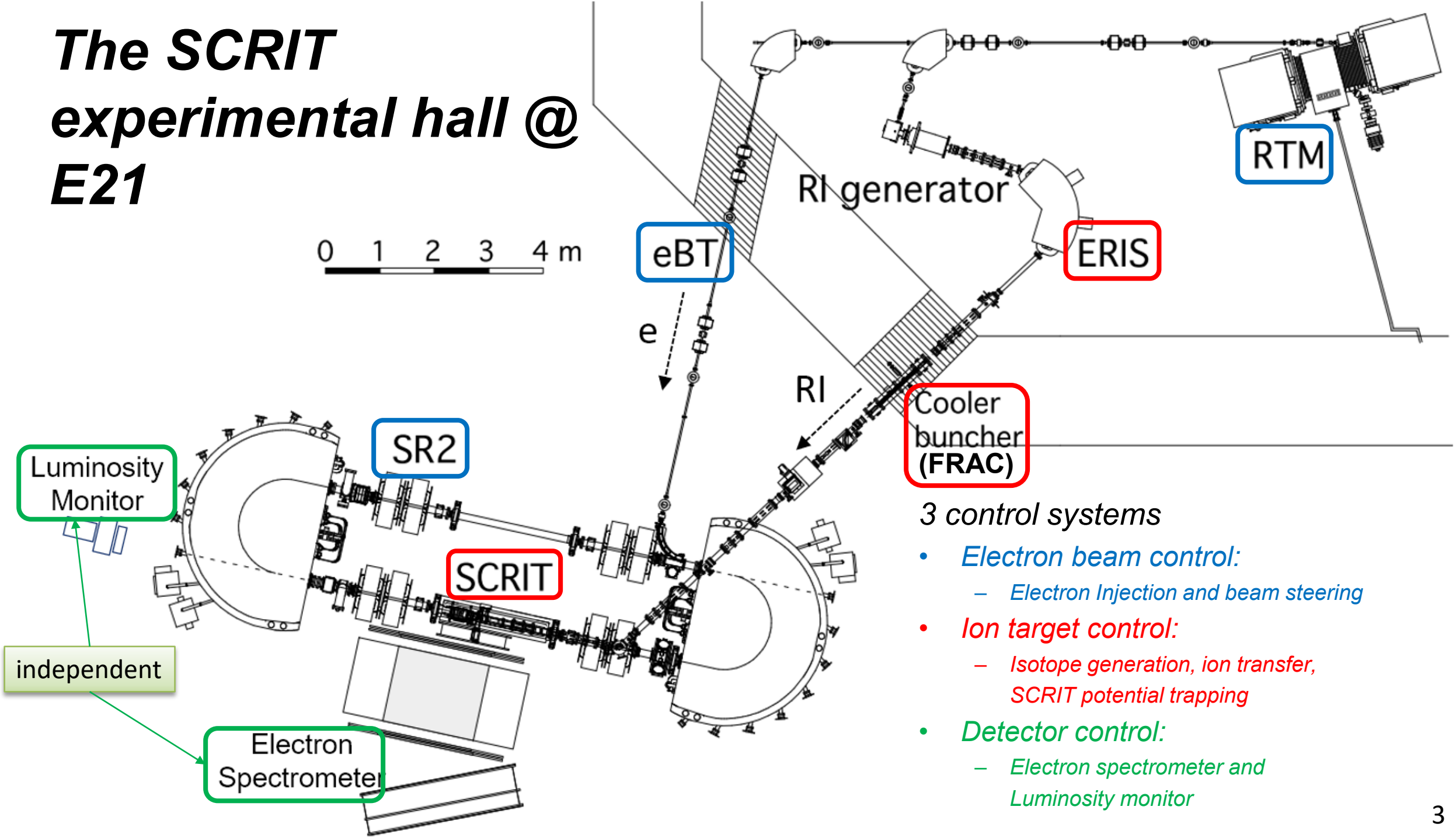
Introduction of SCRIT DAQ

- SCRIT DAQ system is very simple (in other words, it is not so sophisticated) because
  - SCRIT is a standalone experiment
  - measuring only scattered electrons (one electron per event, and no PID necessary)
  - with low rate (~a hundred Hz at most).
    - The luminosity monitor needs higher rate acquisition.

- No special dedicated electronics is designed/developed.

  - *So, I'm not sure if this talk is useful information to other groups…*

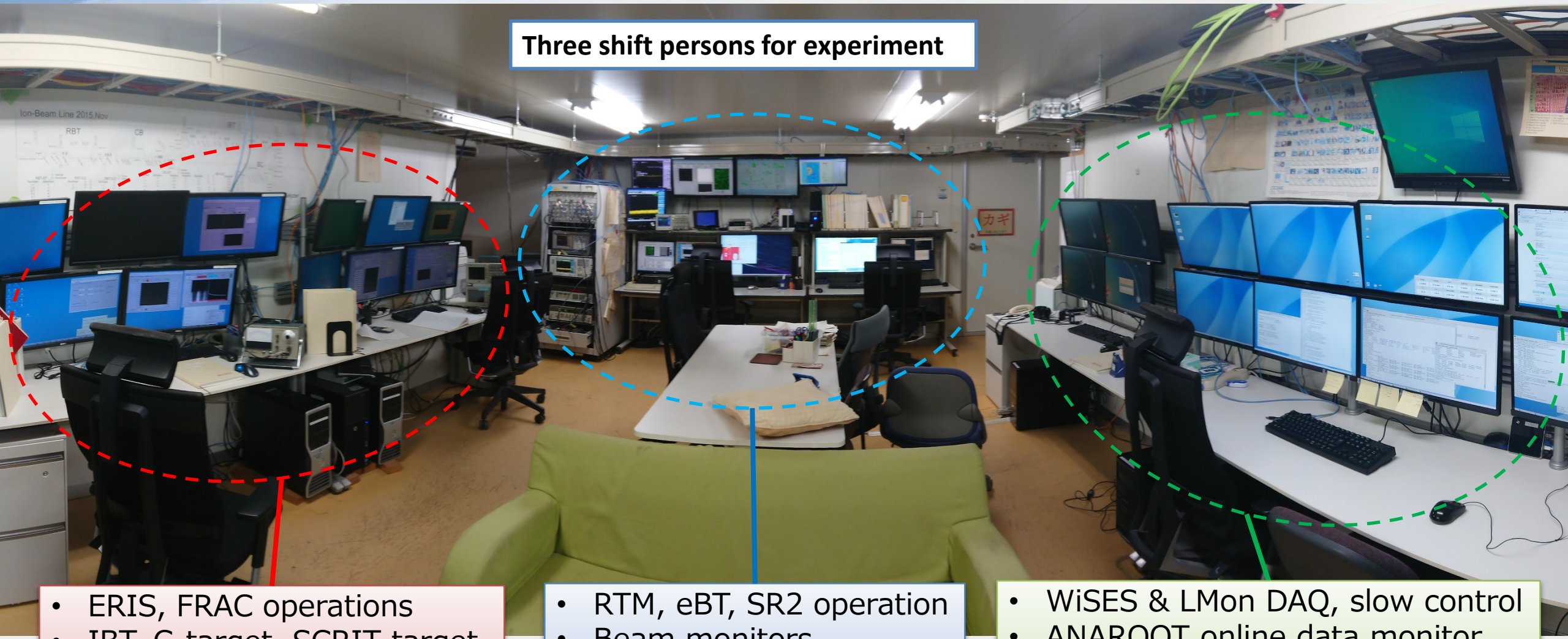
The SCRIT experimental hall @ E21



3 control systems

- *Electron beam control:*
  - *Electron Injection and beam steering*
- *Ion target control:*
  - *Isotope generation, ion transfer, SCRIT potential trapping*
- *Detector control:*
  - *Electron spectrometer and Luminosity monitor*

SCRIT control/counting room @ RIBF K3



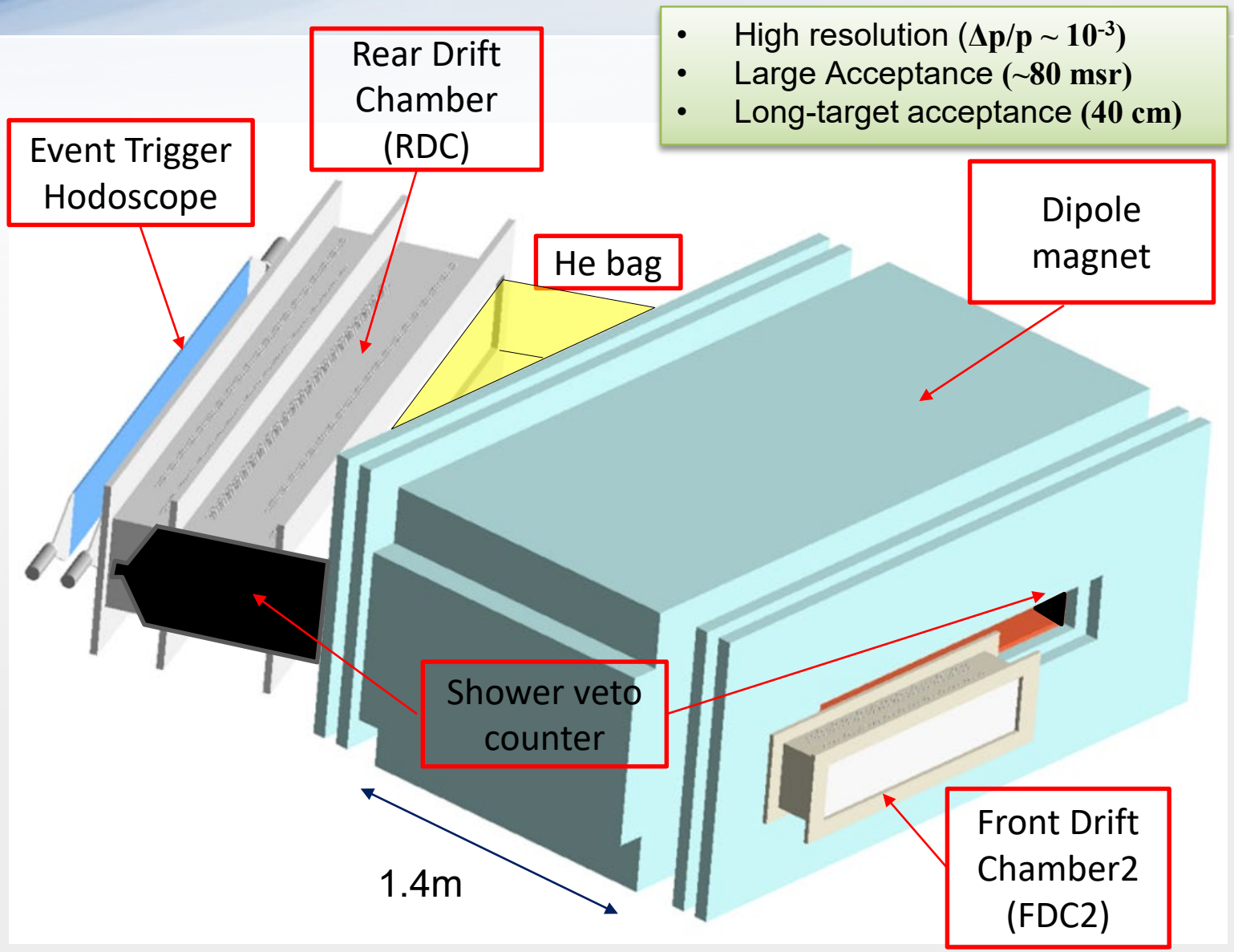
Three shift persons for experiment

- ERIS, FRAC operations
- IBT, C-target, SCRIT target controls
- Mostly Windows

- RTM, eBT, SR2 operation
- Beam monitors
- E21 interlock system
- Linux + Windows

- WiSES & LMon DAQ, slow control
- ANAROOT online data monitor
- Offline data analysis
- Mostly Linux

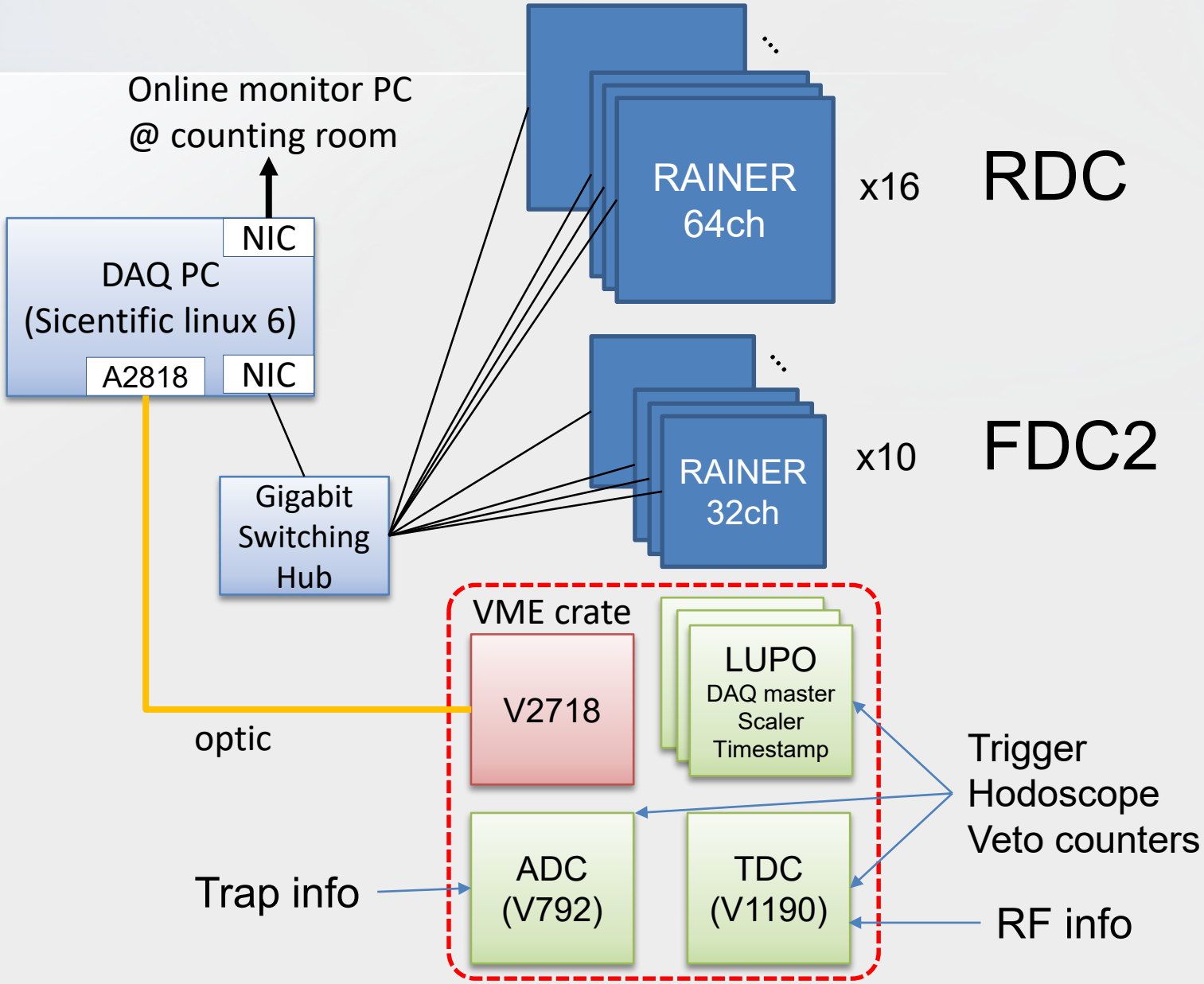
Electron Spectrometer (WiSES)



- **FDC2 (Front Drift Chamber 2)**
  - YY'XX'YY'XX' (Cell size: 10 mm)
  - 306 channels in total
  - Upgrade from FDC
    - XX'XX' 128 channels (Cell size: 18mm)
- **RDC (Rear Drift Chamber)**
  - UU'VV'XX'UU'VV' (Cell size: 10 mm)
  - 1002 channels in total
- **Trigger Hodoscope**
  - Two scintillation counters for event trigger, plus two for the cosmic veto and two more for the beam shower veto.

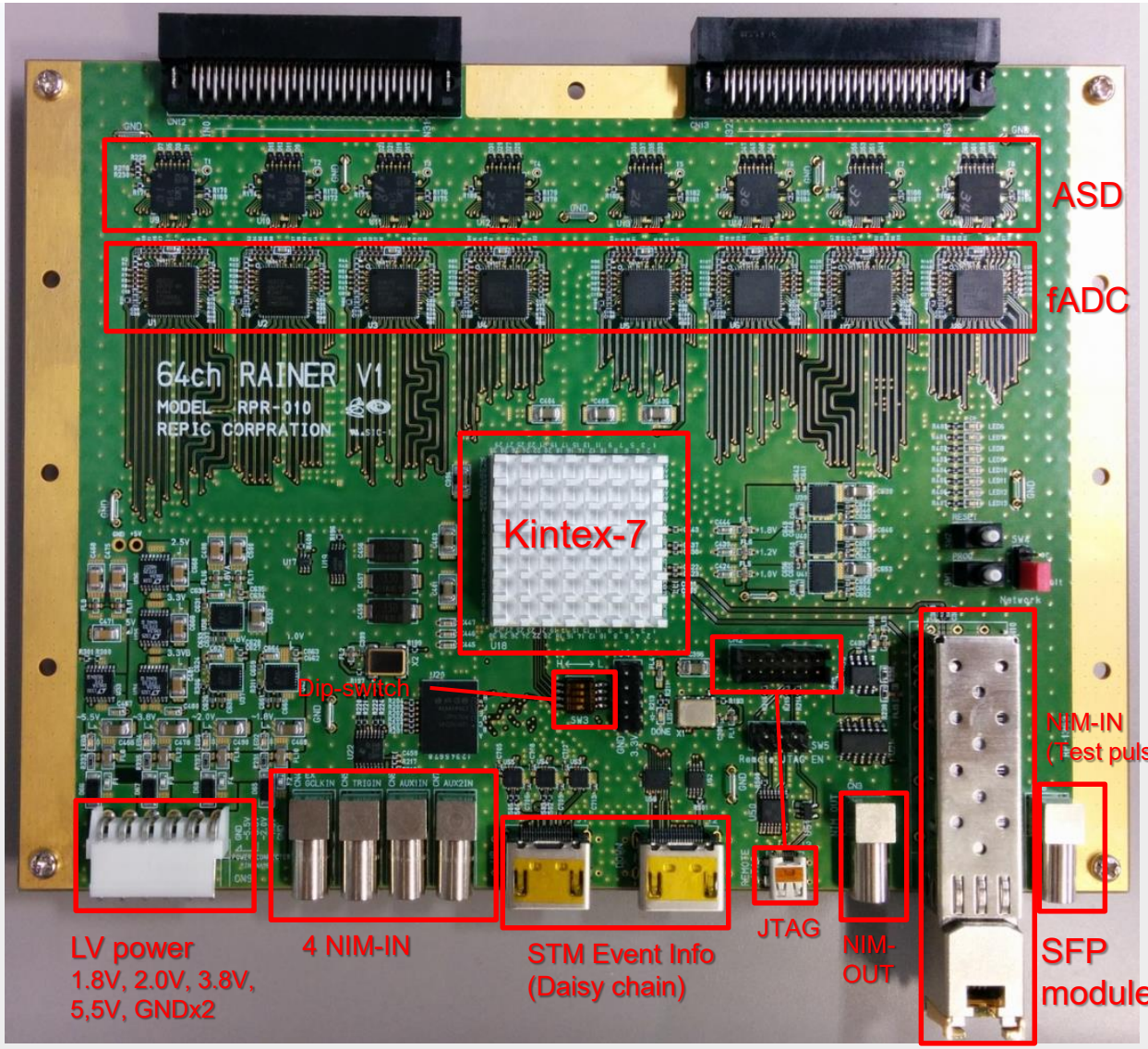
WiSES DAQ system

- WiSES has only one DAQ PC.
  - Running babirl event builder.
  - All data is written on the PC, copied to SCRIT data server, sometimes backup to RIBF data cluster. (200GB so far.)
  - one more PC for online monitor running ANAROOT.
- RDC and FDC2 utilize SiTCP based RAINER cards
  - Running 26 babies (+1 for VME)
- VME modules handle the other information including trigger hodoscope times, trap state, RF timing etc…
  - 3 LUPOs are used as an interrupter and scalers.
- ~1 kbyte per event in average with zero-suppression mode.



RAINER (64ch TDC and fADC)

Produced by REPIC (originally developed for Belle-II CDC)



Specifications:

- Size: 20 cm x 15 cm
- Custom KEK-ASD chips

Parameter	Specification
Gain@Analog output	-1.1V/pC
Gain@Comparator input	-15V/pC
Peaking time	8nsec
Max drive current	8mA
Noise	4000e@20pF
Digital output	CMOS(3.3V)
Time walk	<700psec
Digital-Analog cross talk	<<0.5%
Power consumption	34mW/ch
Process	BiCMOS 0.8um
Chip size Package size	4.1mm × 4.1mm 8.0mm × 8.0mm
Number of ch	8

- 1nsec TDC resolution (FPGA)
- 10bit 40MHz flash ADC
- 1GbE Ethernet or optic transceiver in magnetic field.
- 7us ring buffer, 15 triggers on FPGA
- Open FPGA source code
- Price: ~800k /board as of 2015

Sub Trigger Module (STM) for RAINER

- Selection of master or slave.
- Spill and event number information is sent to RAINER through 4 HDMI outputs）
- Daisy chain can be used for more RAINER modules.
  - Tested up to 4 RAINERs.
- Serial transfer clock 125MHz
  - DDR14bit: Event# 12bit(info)+2bit(flag) + Spill# 8bit(info)+2bit(flag)+4bit(N/A)
  - Transfer rate 125MHz/7clk/2word ~ 8.9MHz
- Still not used for SCRIT, but maybe in the future.

RDC and 64ch-RAINER cards

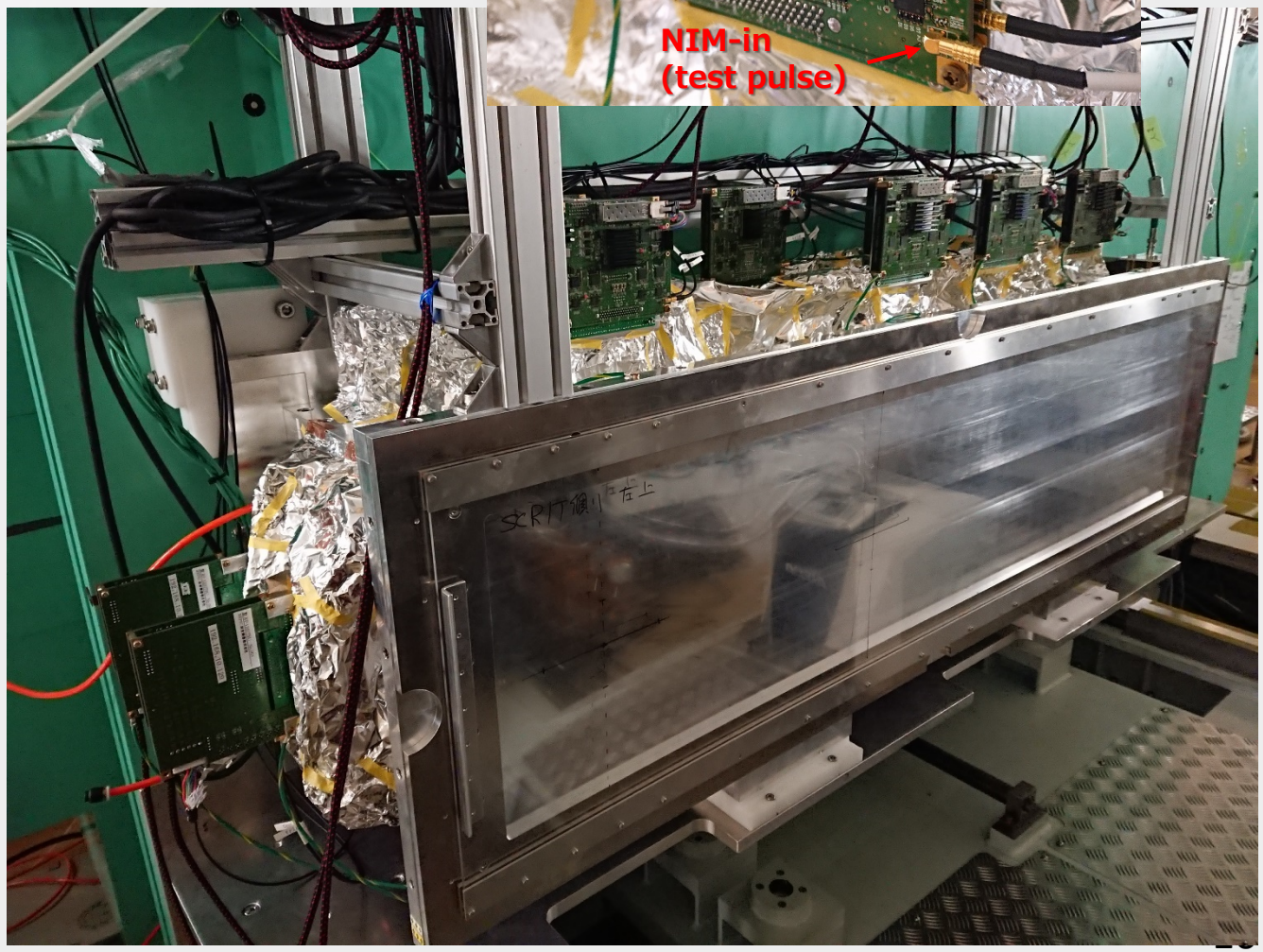
- 16 64ch-RAINER cards are installed directly on RDC through the interface board.
  - We don't need fast DAQ at all, but want to make the analog path as short as possible.

- RAINER setup
  - Ethernet cable, NIM(LEMO) x3 (trigger, test pulse, busy out)
  - LV connector (4 lines)
    - 1.8V: 1.47A
    - 2.0V: 2.74A (ADC on)
      → 0.4A (ADC off)
    - 3.8V: 0.67A
    - 5.5V: 0.43A
  - No cooling device (Just a heat-sink on Kintex7)

FDC2 and 32ch-RAINER

- FDC was replaced to FDC2 to improve the momentum resolution.
  - 32ch RAINER is employed to make the analog path as short as possible.
  - The former FDC used GND ASD cards (16ch x 8) + AMSC-TDC for the readout.

- 32ch version RAINER card
  - Smaller footprint size (12cm x 10cm)
  - NIM input/output are connected with mmcx.
  - 4-bit event info can be tagged using 4 NIM (mmcx) inputs
    - GTO will be used if the event tag necessary
  - Price: ~400k as of 2016.

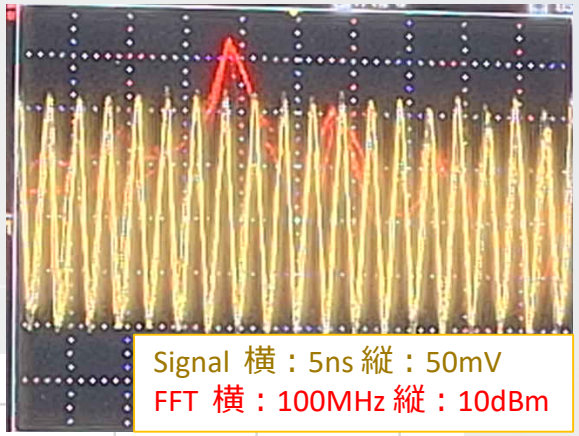


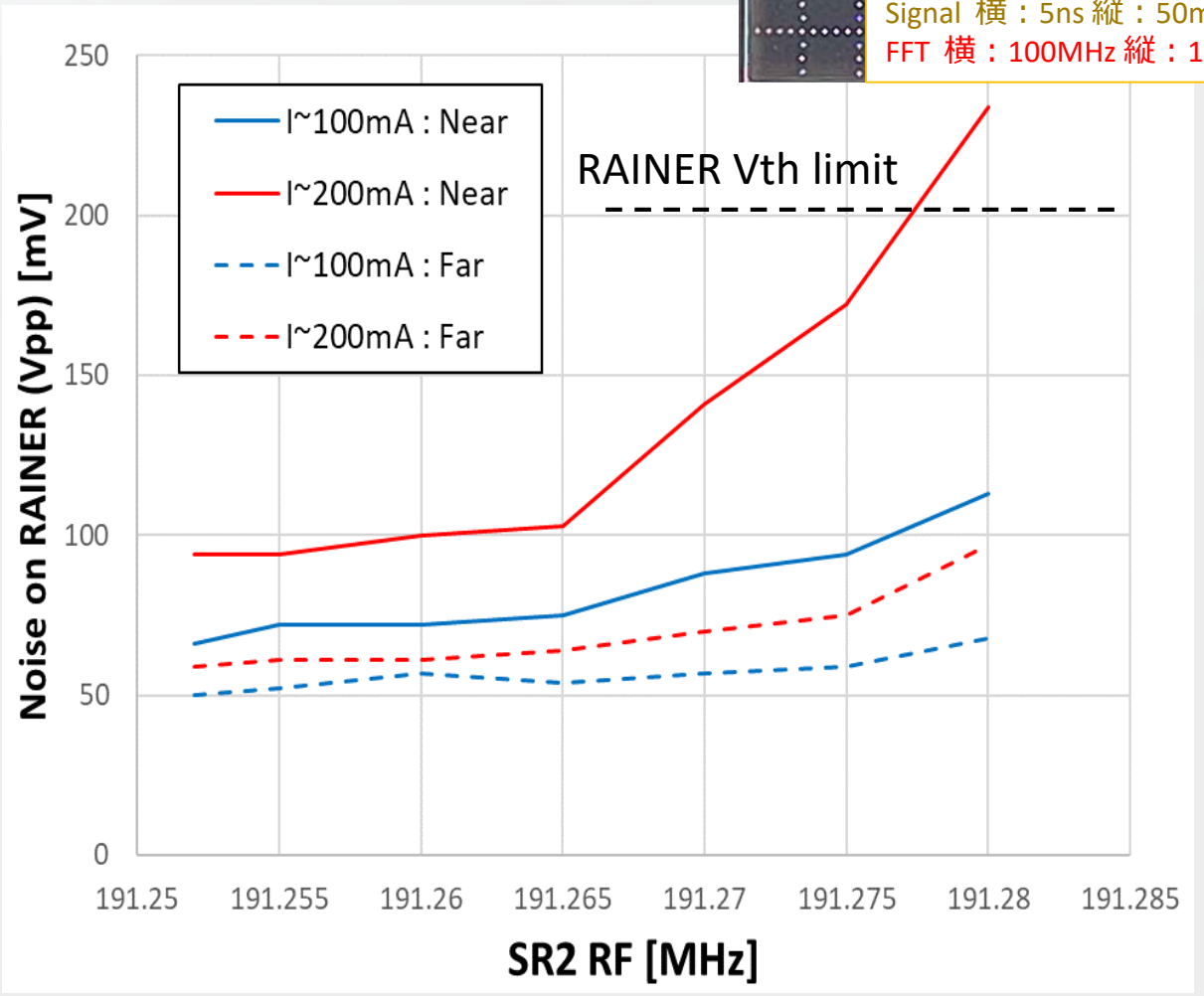
Noise issue on FDC2

- SCRIT needs to tweak the RF of SR2 to optimize the ion trapping.
  - Trapping power is usually maximized ~191.28~191.30 MHz
  - RF noise on FDC2 (check on RAINER output) is exceed the limit of the threshold.

- Need to investigate the sources of the RF noise
  - from the ground line, and
  - over the air.

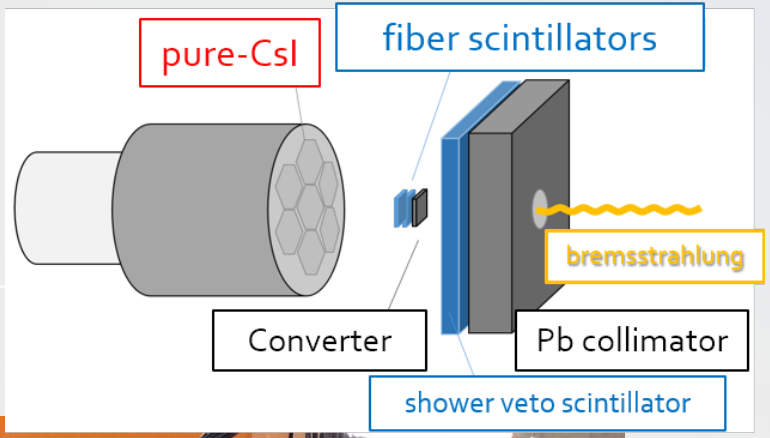
- Also need to pin down the receiver for the over-the-air noise
  - FDC2? (although it's covered by the aluminized mylar window)
  - cable?
  - RAINER card?





No target, No SCRIT potential, No DCH HV condition

Luminosity Monitor (LMon)



- LMon is measuring bremsstrahlungs to obtain the luminosity of electron-nucleus scattering.
  - Main: 7 pure-CsI calorimeters to count the bremsstrahlungs
  - 32 (16x + 16y) channels fiber scintillators for the beam profile monitor.
    - 3mm resolution

- DAQ
  - BabirI + ANAROOT
  - CAMAC CCNET + ADCs, TDCs, Scalers
    - ~0.4 kbyte per event.
  - ~MHz interaction rate is downscled to a few kHz.
    - CCNET frequently hang up above a few kHz.
  - A GTO is used for trigger logic, downscale, etc.
    - Very useful because the setting can be changed through Ethernet.

Upgrade plan for LMon

- A key to improve the accuracy of the luminosity measurement is to have a better beam profile monitor.
  - The beam condition is very sensitive to the detection efficiency (20~50%)
  - The beam condition is changing time-by-time.

- SSD (borrowed from JParc) is currently setup for the test purpose.
  - 50um pitch, 75mm x 75mm area
  - 3072 (1536-x + 1536-y) channels

- DAQ
  - SBS620 + APVDAQ (x6) + ADC,TDC
  - Babirl (ANAROOT soon…)

Summary

- Since SCRIT is measuring electrons at a few handred Hz, DAQ doesn't require any special high speed device.

- RAINER card is a handy and stable device and working without any big trouble for 5 years.
  - But need to investigate the FDC2 RF noise issue as soon as possible.

- Software, Babirl and ANAROOT are very easy to use and customize for our purpose.
  - Thanks to Baba-san and Isobe-san!