KAGRA

DGS & AEL report for KAGRA domestic collaboration meeting

2015/10/8(Thrs)

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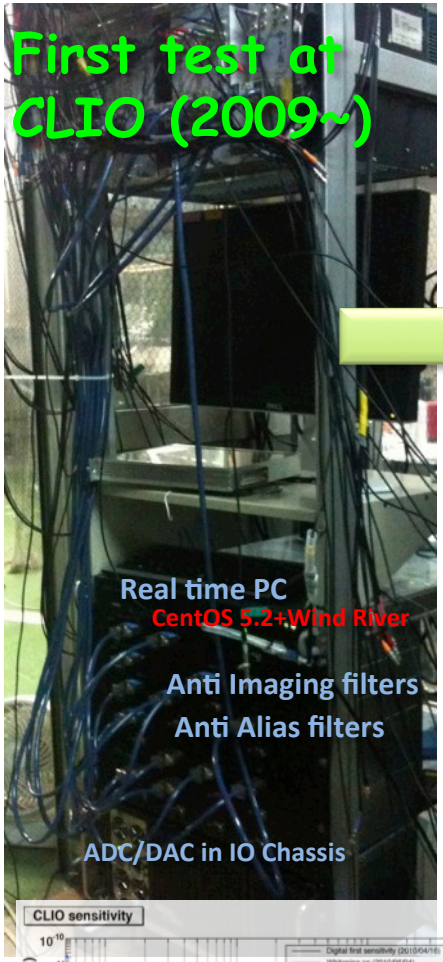
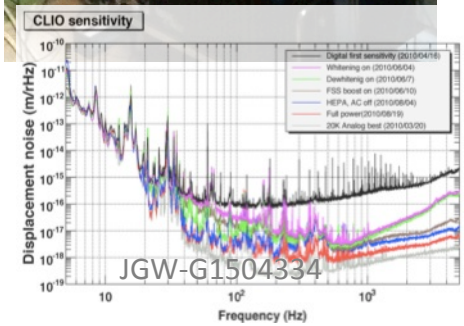
Objectives of digital control for KAGRA

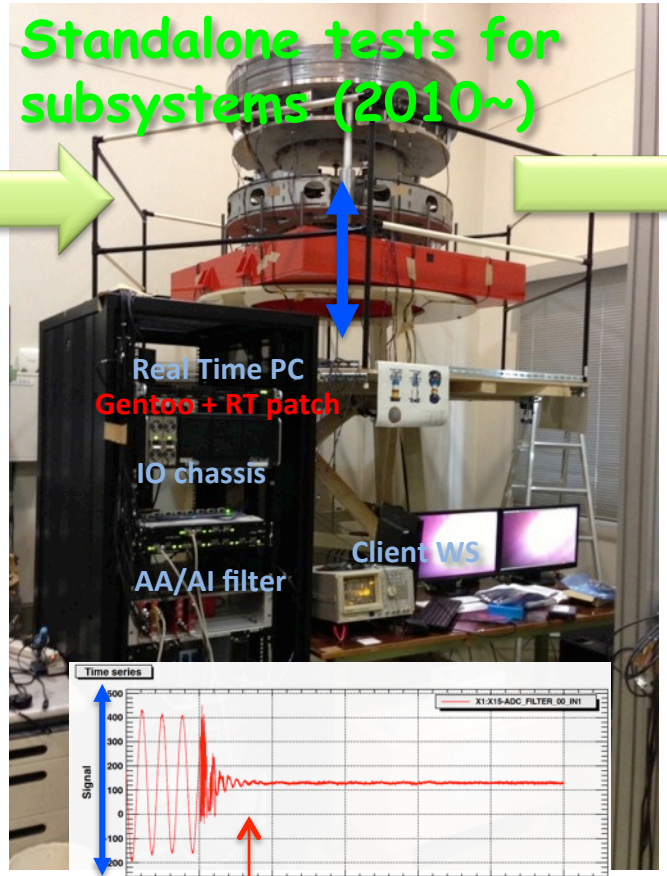
1. Real time control
   - Complicated multiple D.O.F.s
   - Low noise control
2. Data AcQuisition (DAQ) for gravitational waves
   - Controls signal = gravitational wave data
3. Data monitoring system
   - Many environment channels
4. Interferometer tuning system
   - Reduction of commissioning time
5. Operation system
   - Stable observation

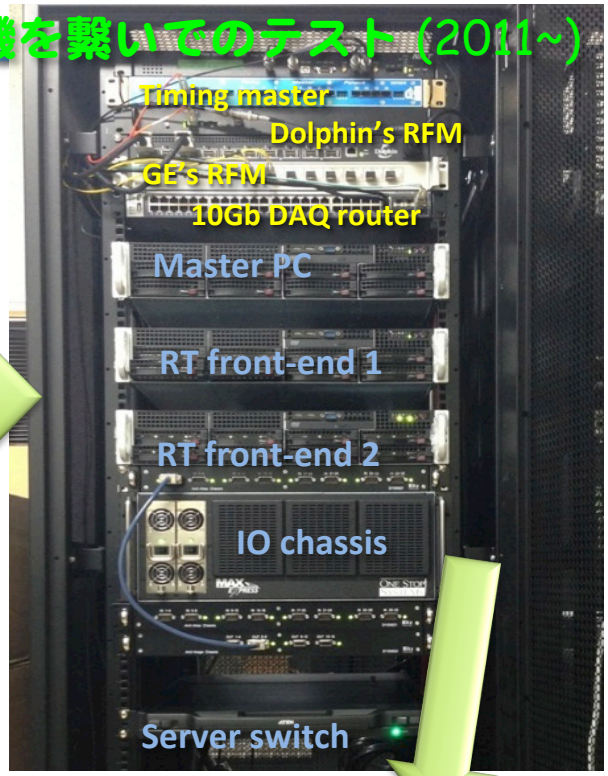
Development of control system for KAGRA

複数台の計算機を繋いでのテスト(2011~)









Movement of Digital controls system to KAGRA mine (Jan. 2015)

XMASS

Kamland

Super Kamiokande

CLIC

KAGRA

3km

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Data Japan Hydrographic Association

Google earth

Installation to KAGRA mine

Specifications:

Input/ Output	• ADC: diff.32ch/card • DAC: diff.16ch/card • DIO: 16ch out, 64+64ch in,out/card	• 16kHz sampling
Control	• Gentoo Linux + real time patch • Max 15 of ADC/DAC cards on PCIe extension chassis connected by optical fiber cable • Real time control by multiple PCs using Reflective memory network	• Design and build on Matlab, Simlink • Digital filter and composer (foton). • Very low latency network by Reflective Memory
DAQ	• Low latency data transfer with 10MB/ sec amount • Writing frame data • Saving data to HDD	• Low latency data transfer by Myrinet • Data Concentrator, NDS, Frame Writer
Monitors	• Many signals: ~100000ch	• Signal database by EPICS • Channel list produced automatically.
Tuning	• Human interface by GUI • Applications for control, tuning, diagnostic	• GUI by MEDM • Dataviewer (Oscilloscope), DTT（FFT）
Operation	• Automatic interferometer control by scripts	• Epics control by command from shell • Gurdian

KAGRA DAQ/CTRL network design

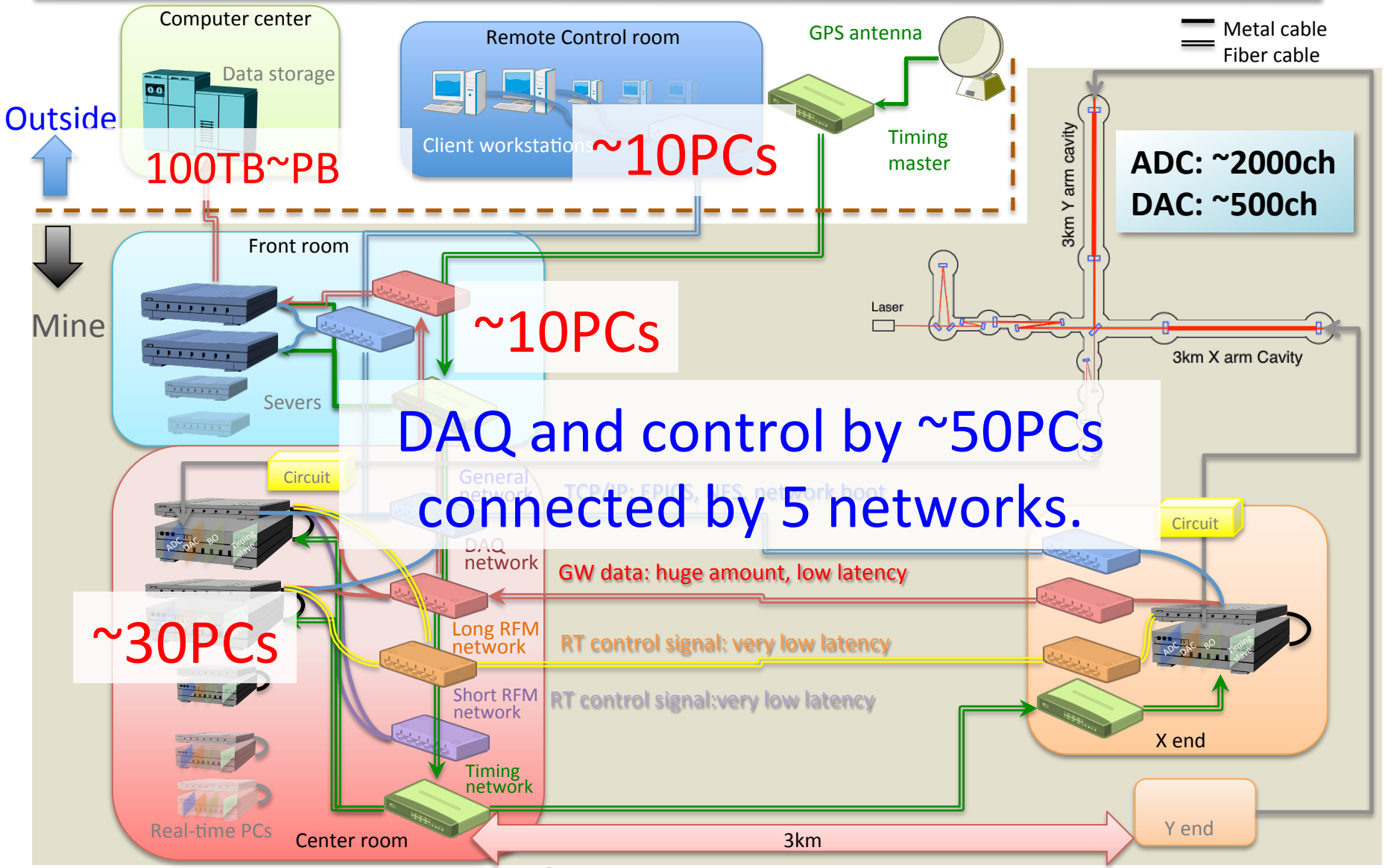


Diagram of KAGRA controls system for Real Time Front-End

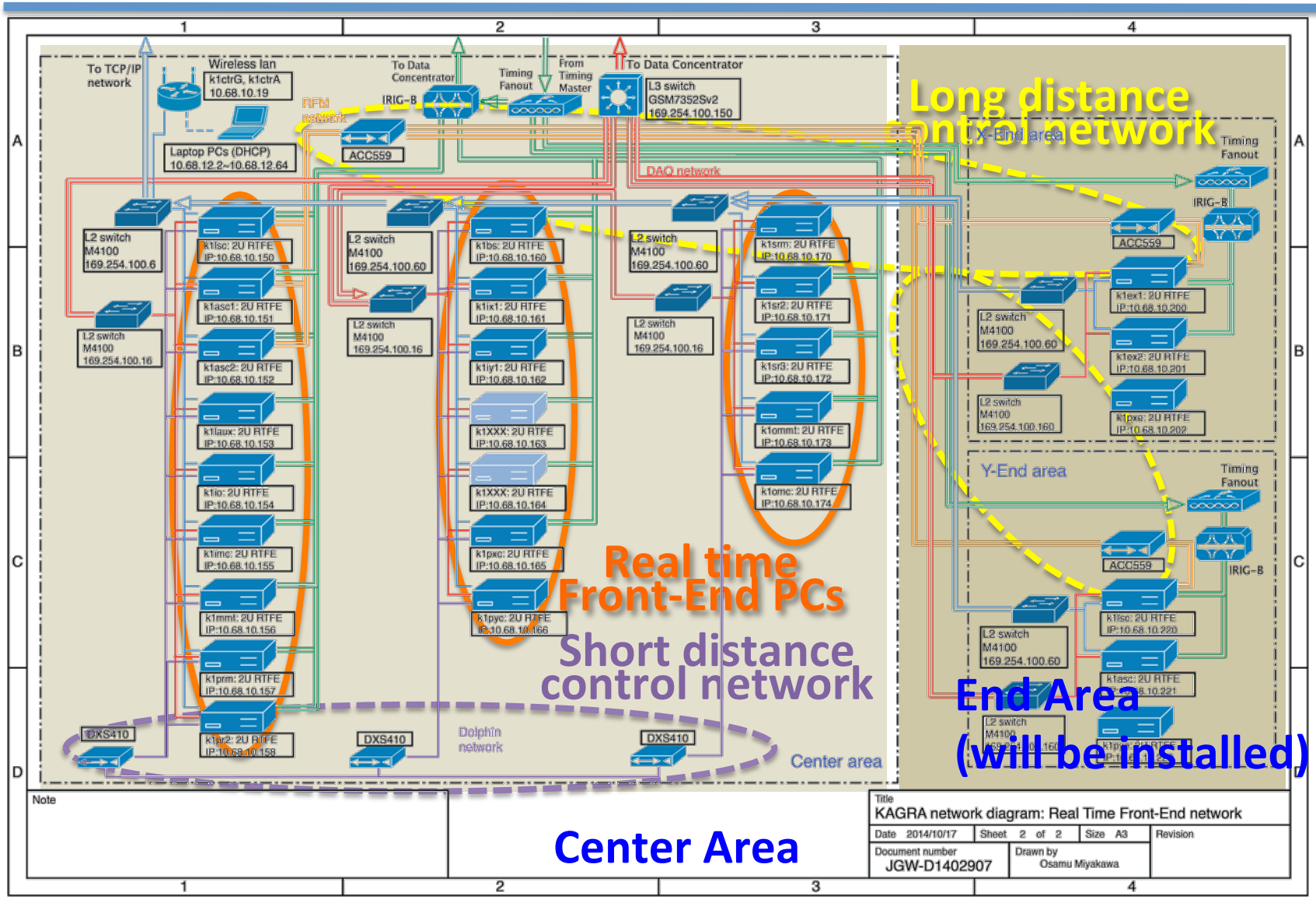
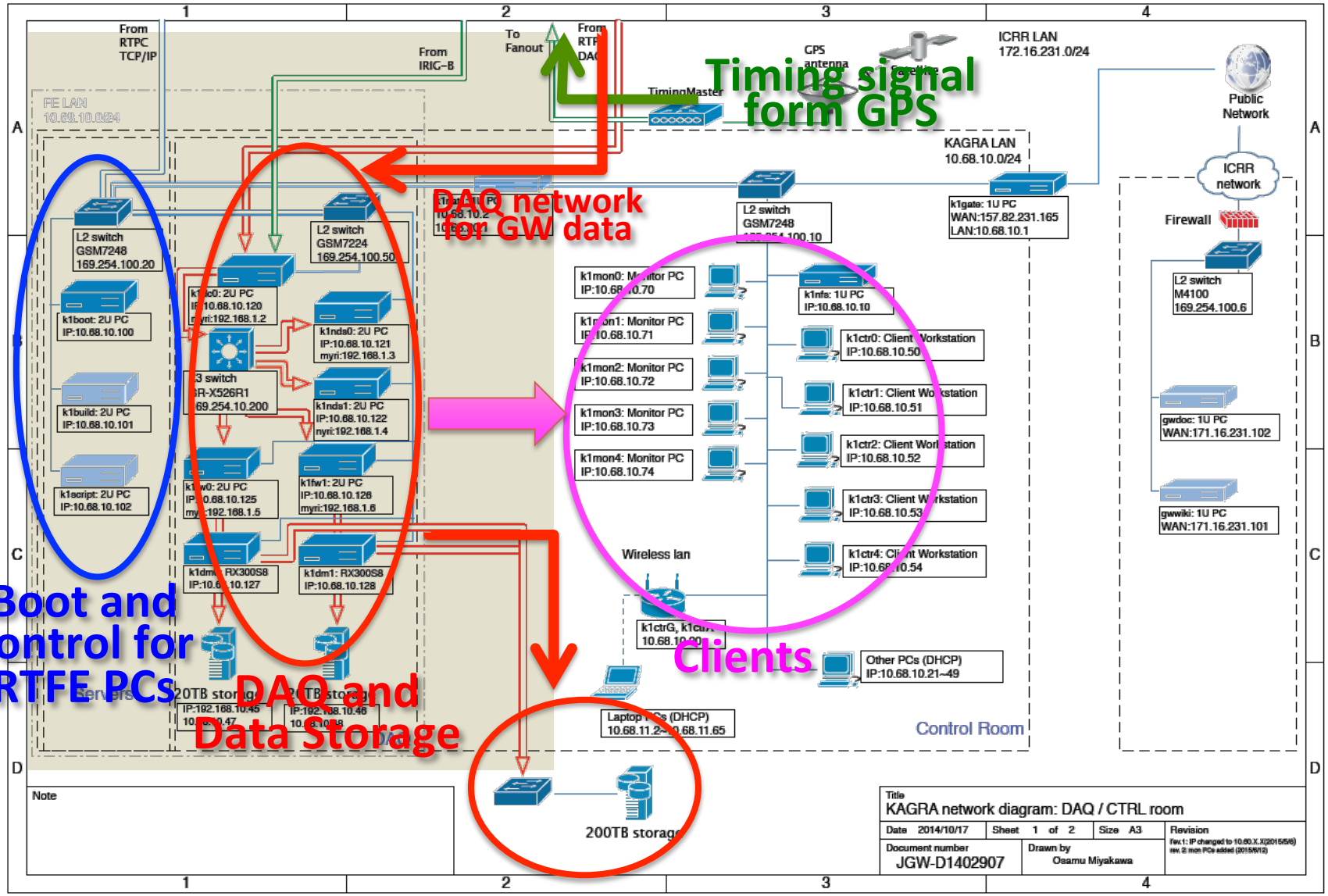


Diagram of KAGRA controls system



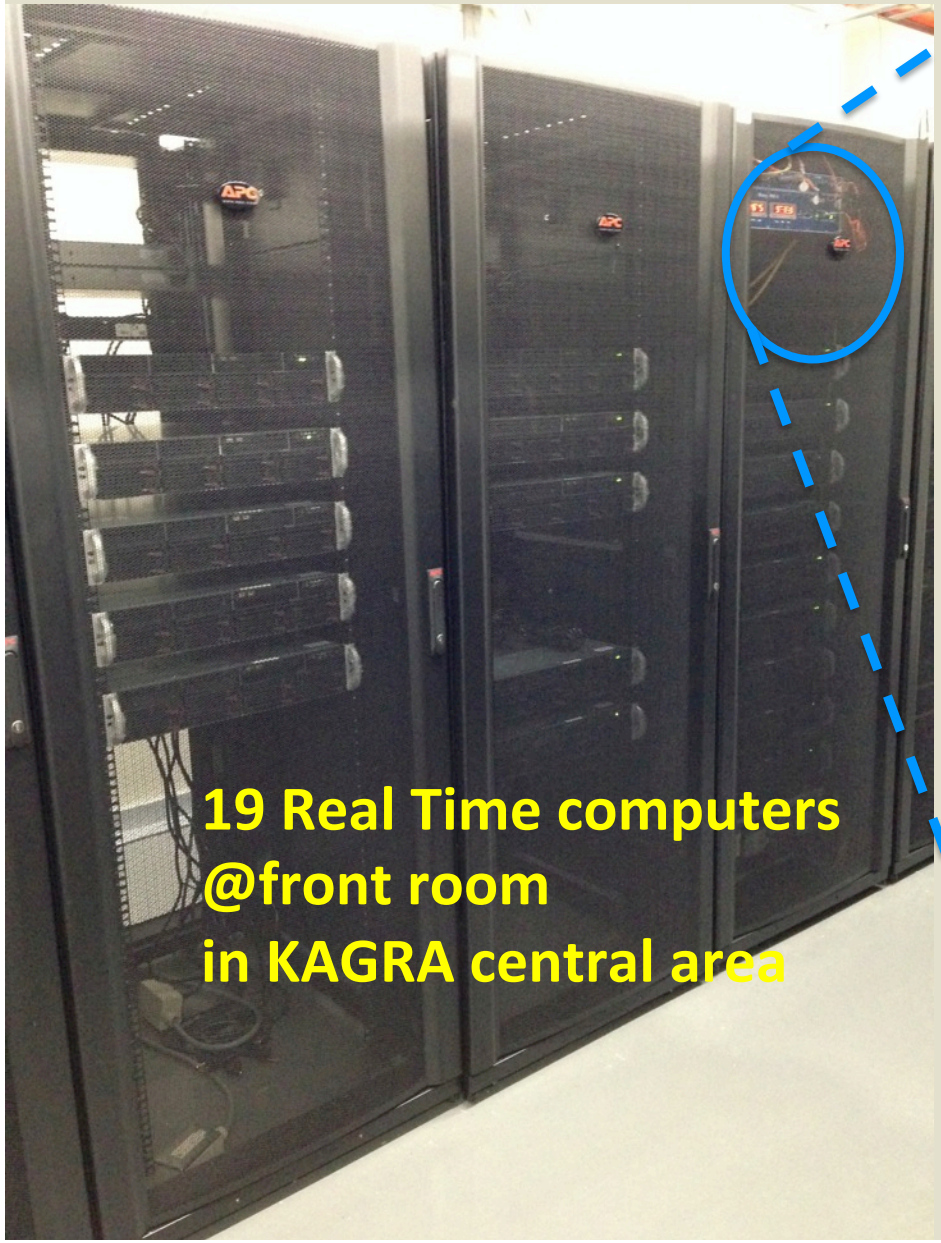
Other specifications

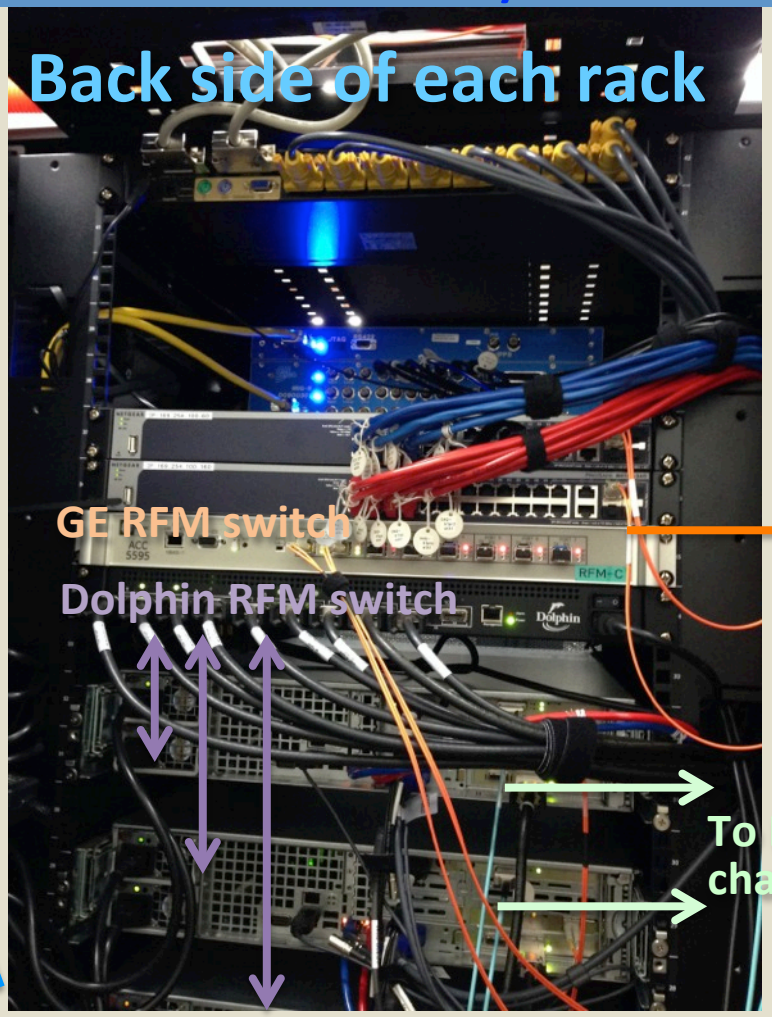
- NAT: Entrance of KAGRA control network
- Control of all KAGRA from an outside remote control room
- Wireless LAN at center room in KAGRA mine

- Boot server: Booting RT PCs through network without HDD
- Network file system (NFS): Data area for users
- Server for building RT modules
- Double path for DAQ route for redundancy
- 20TB data storage in the mine and 200TB data storage at outside building
- Synchronizing all ADC/DAC to 1PPS signal from GPS antenna and synchronizing all RT PC and data concentrator to IRIG-B signal
- Redundancy for power failure using UPS

- IO chassis remotely connected to RT PC by optical fiber cable
- ADC/DAC, Binary switch on IO chassis
- Remote control for electronic circuits through binary switch (gain, offset, switch etc.)

Control signal network test for Real Time Front-end using ReFlective Memory technology



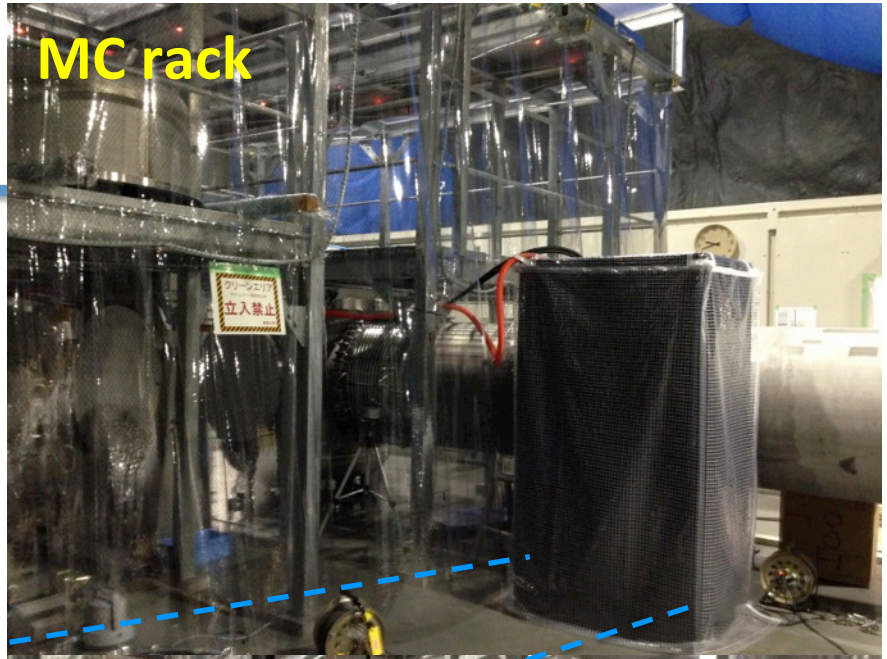


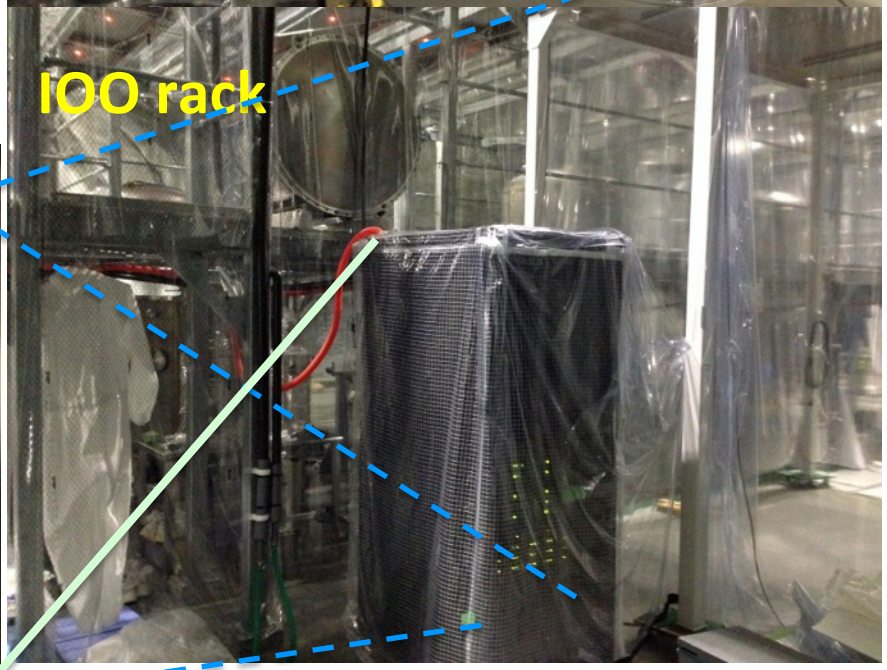
Dolphin RFM:
Short distance real time signal ~100m

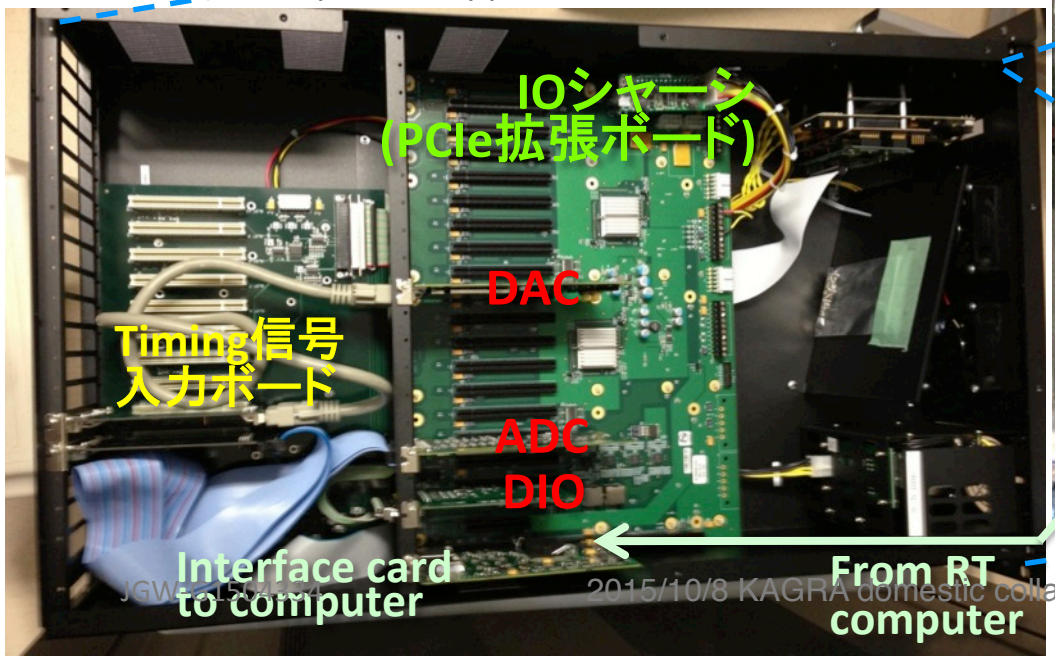
GE RFM:
long distance real time signal ~3km

IO chassis in Field rack

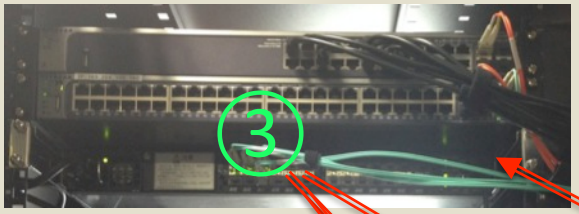
- Field racks are located in the laboratory area with a plastic cover to avoid humidity by heating of electronics
  - inside temp. : 25~30℃ (cf. out: 14℃)
  - inside humidity: 35~45% (cf.out: 70~90%)
- A Field rack includes
  - IO chassis with ADC/DAC
  - AA/AI filter chassis
  - whintieng filter chassis
  - electronic circuit chassis, like coil drivers
  - No Real time PCs
  - No DC power supplies



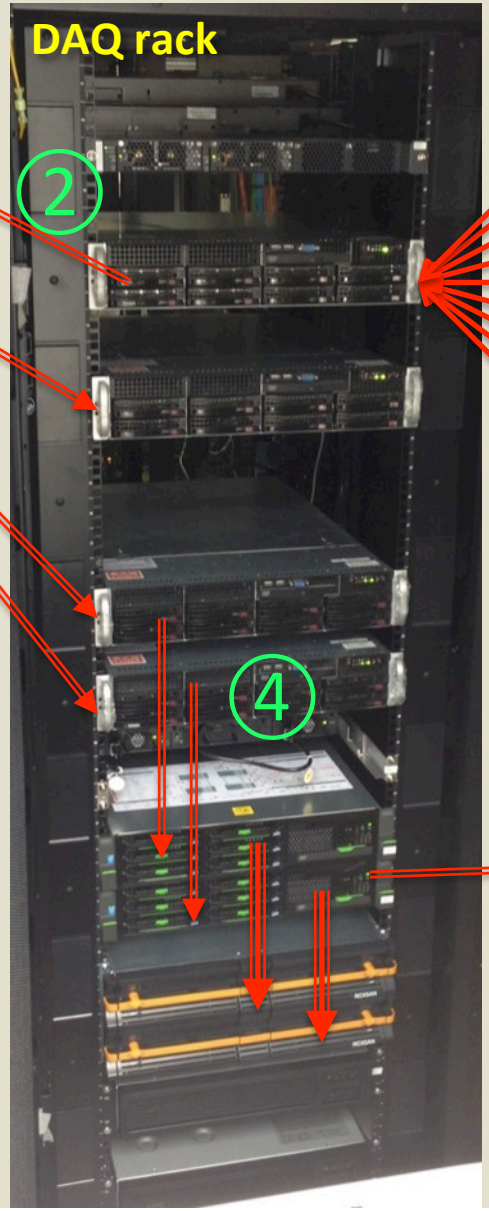


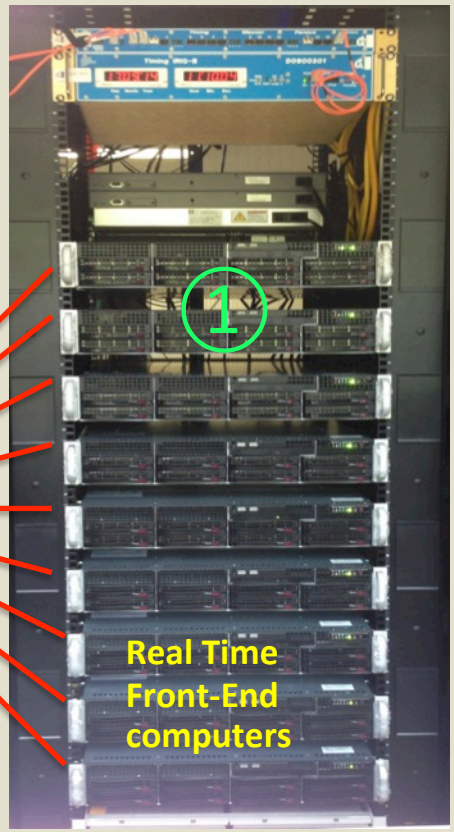


Control/DAQ network



Fujitsu: SR-X526R1
10GB low latency
switch





k1dc0

k1nds0

k1fw0

k1fw1

k1dm0
k1dm1

20TB storage
20TB storage

UPS

- **k1dc0**: data concentrator from all RTFE
- **k1nds0/k1nds1**: network data system as response server for realtime/past data request from users
- **k1fw0/k1fw1**: frame writer
- **k1dm0/k1dm1**: frame data manager for local 20TB storages and remote 200TB storage

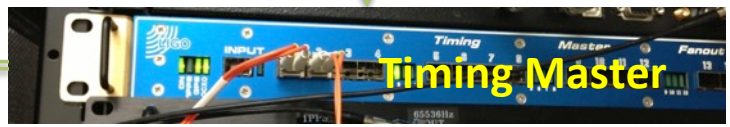
Mine

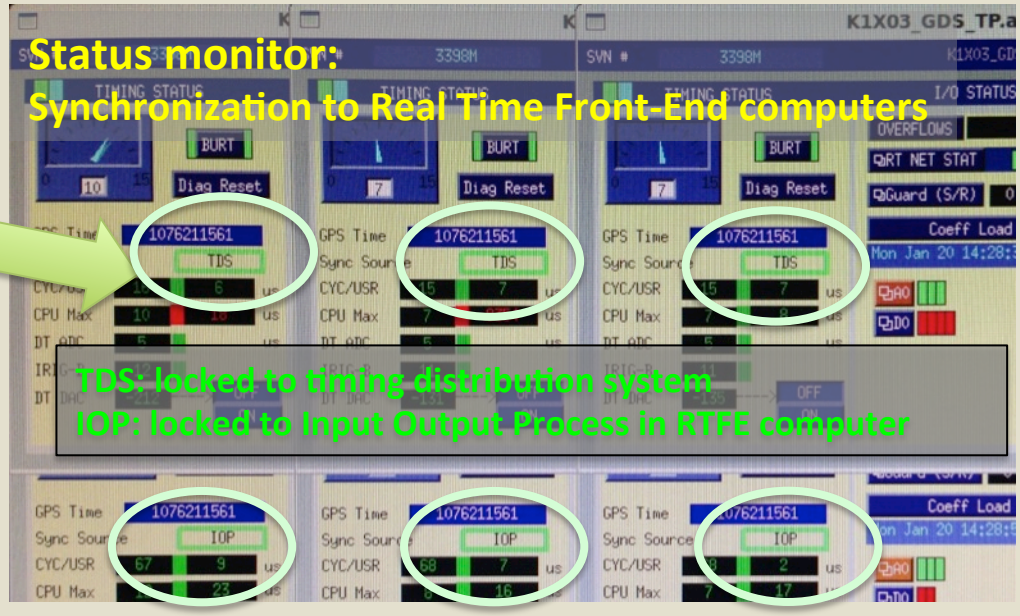
Outside

200TB
storage

How to synchronize ADC/DAC and PC

Mine | Outside

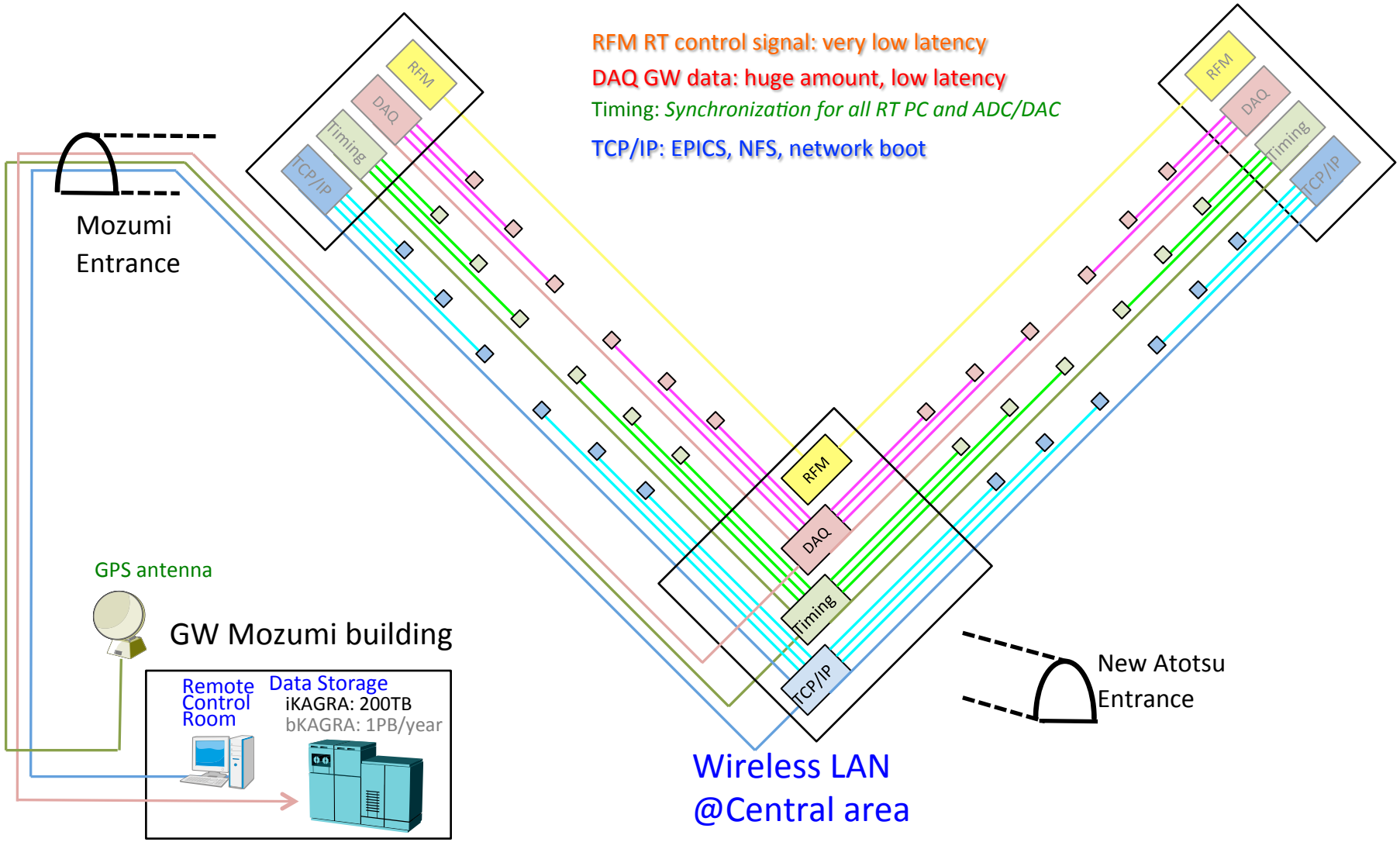




Wireless LAN @ Central area

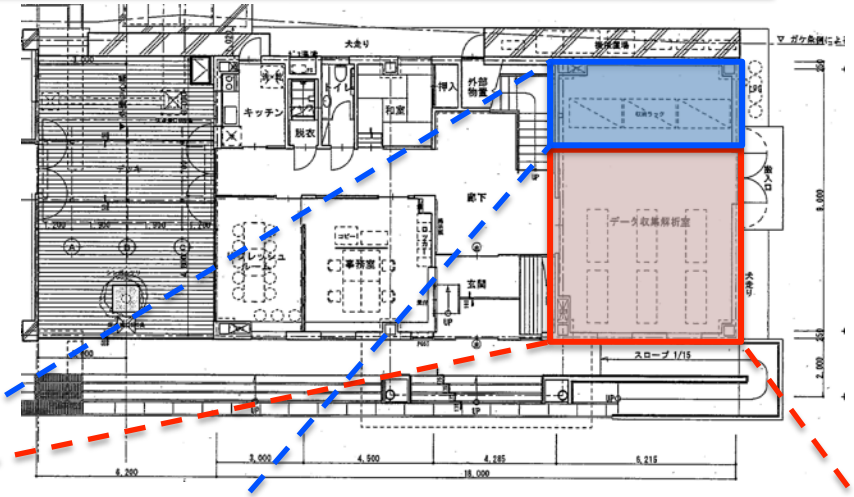
- Covers all central area including 2nd floor.
- 6 PoE access points with no AC power in the laboratory area.
- Placed in a sealed plastic case.
- Connected to control network
- Supports roaming, so you can walk through in the central area during measurement.

Network design

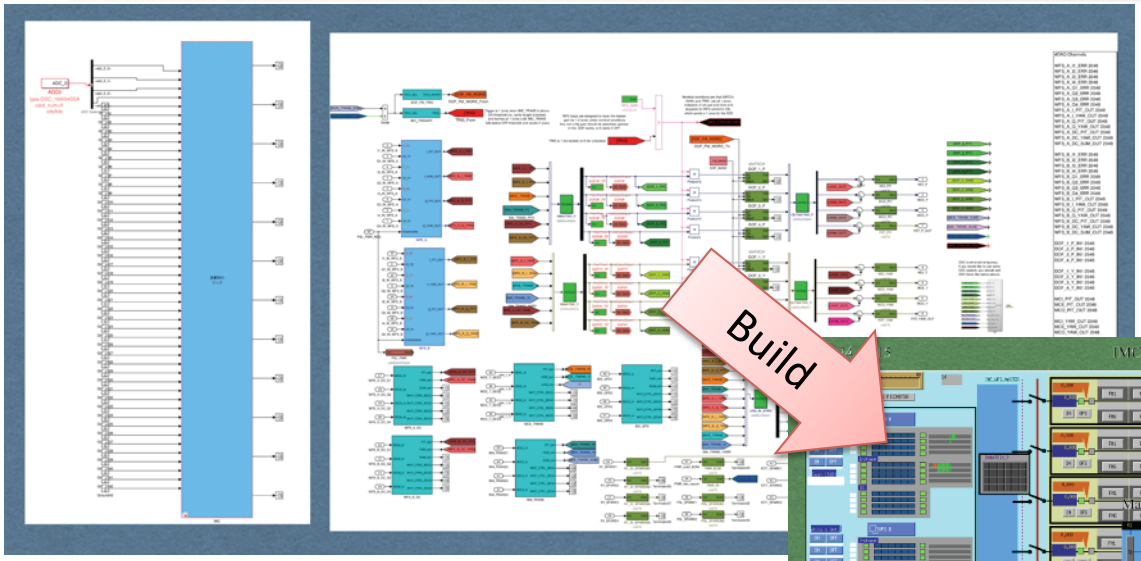


KAGRA Remote control room

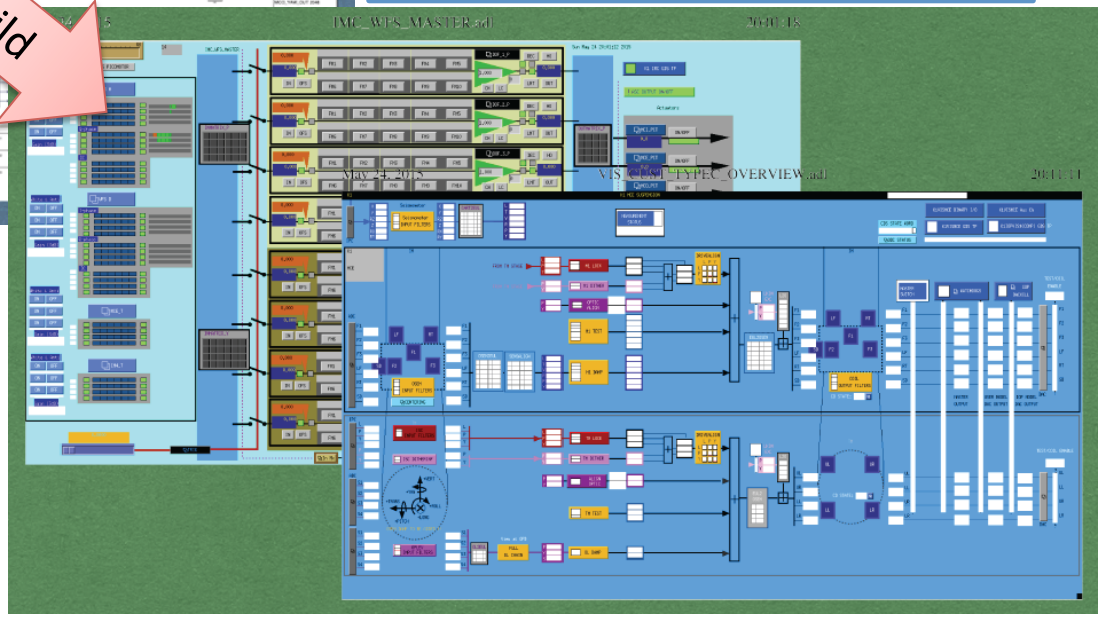
- 1 large desk for discussion etc.
- 5 desks with 3 monitors each for control/analysis
- 7 large monitors for sensitivity etc.
- 3 middle monitors for detailed information.
- 7 small monitors for beam spots.



RT models, MEDM screens



- ADC/DAC channel are assigned here.
- Built on Matlab, Simlink to make a real-time module through c-code.



- Covering by EPICS using MEDM as a graphical human interface

- **Many models have been prepared for initial operation: PSL, MC servo, MC SUS, ASC, LSC, VIS**

Manufactured electronic circuits for control

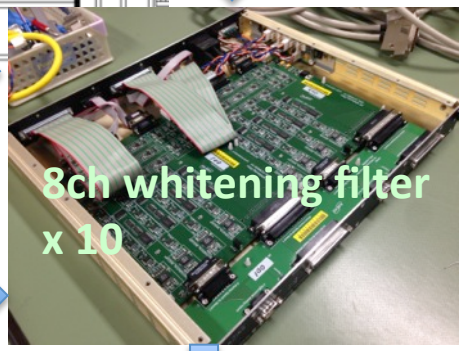
All circuits will be controlled by computer from remote control room.

FSS

PMC

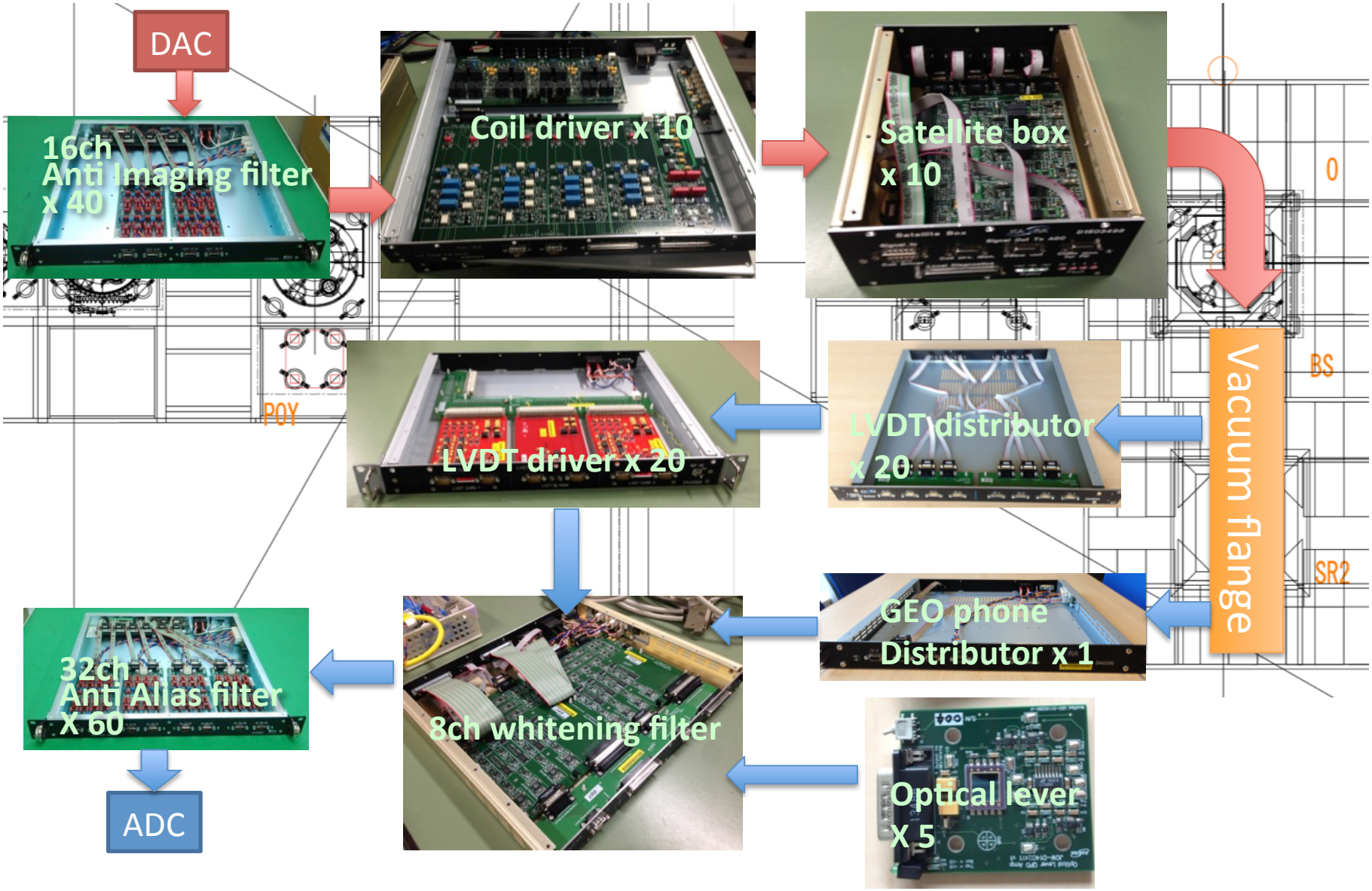
MC

REFL



ADC

Manufactured electronic circuits for suspensions



DC power supply

DC Power distribution

- DC power supplies are located in the front room.
  - KEPCO ATE series: 50 of 36V, 30A, 15 of 25V, 10A
- DC power is distributed by long low loss cables to each field rack.
- D-SUB 3pin power strip is used to distribute power to each circuit.

+-/24V for
IO chassis,
stepping motors

+/-18V
for
circuits

Summary

- Installation of KAGRA control system in the mine completed!
- Preparation of remote control from the control room is done!
- Next task: connection to subsystems in the mine.