



Status report from digital system subgroup

2011/8/4(Thu) LCGT f2f meeting

Osamu Miyakawa, ICRR

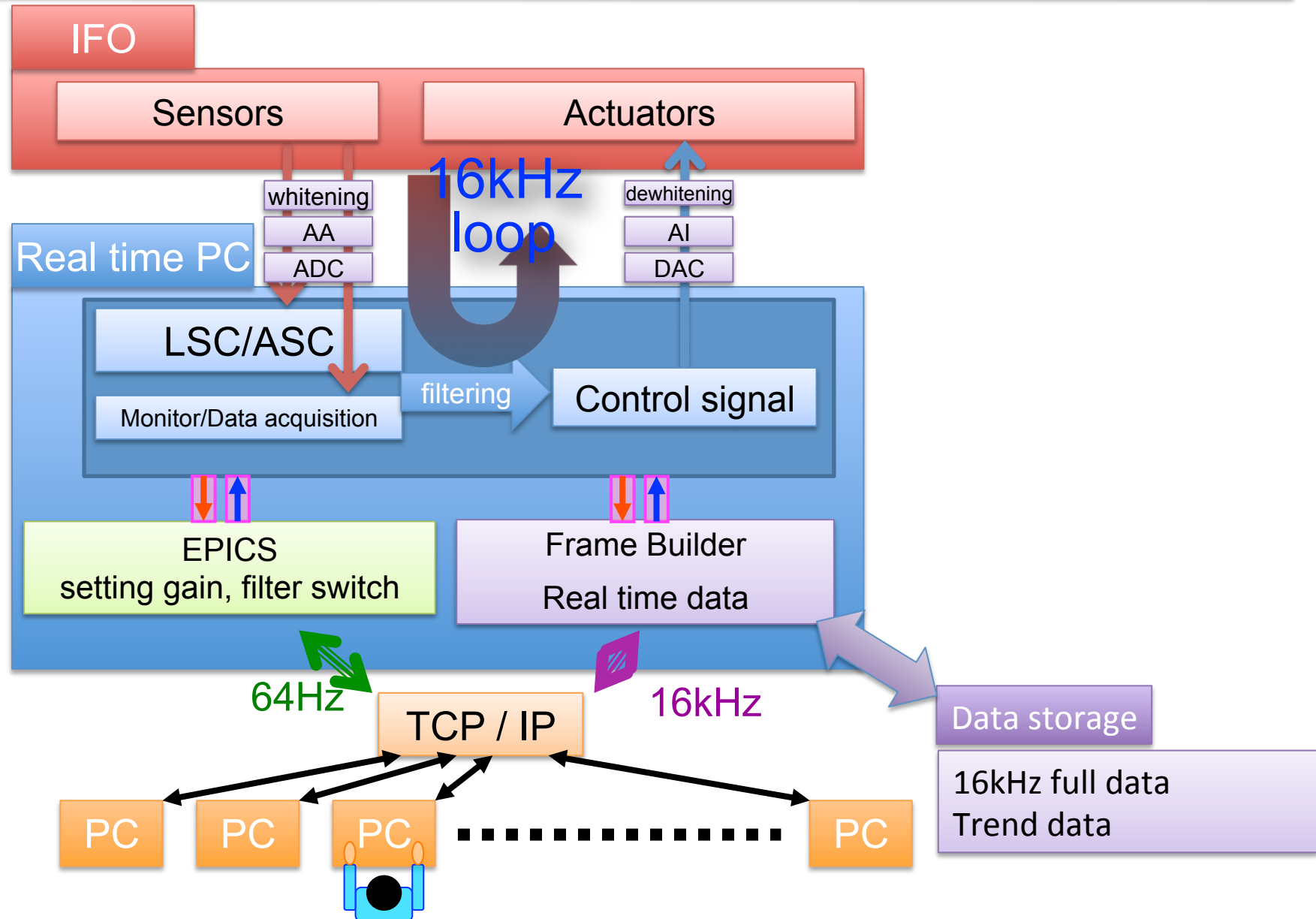


Summary of work from last f2f

- As of the last f2f meeting, visited to Caltech and constructed a stand alone system, and looked at a CDS test bench for aLIGO at LHO
1. Re-construction of **2-3 standalone systems** using Gentoo Linux distribution with RT patch based on vanilla Linux kernel and Ubuntu **workstation benches**
 - Currently working on circuits for distribution
 2. Construction of a **small network test bench** consisting of a master PC and two slave RT PCs, connected by two types of **Reflective memory network** and **DAQ network** using open-mx technology
 3. **Timing system** using GPS synchronizing multiple PCs with 1PPS signal.



Concept of the digital system



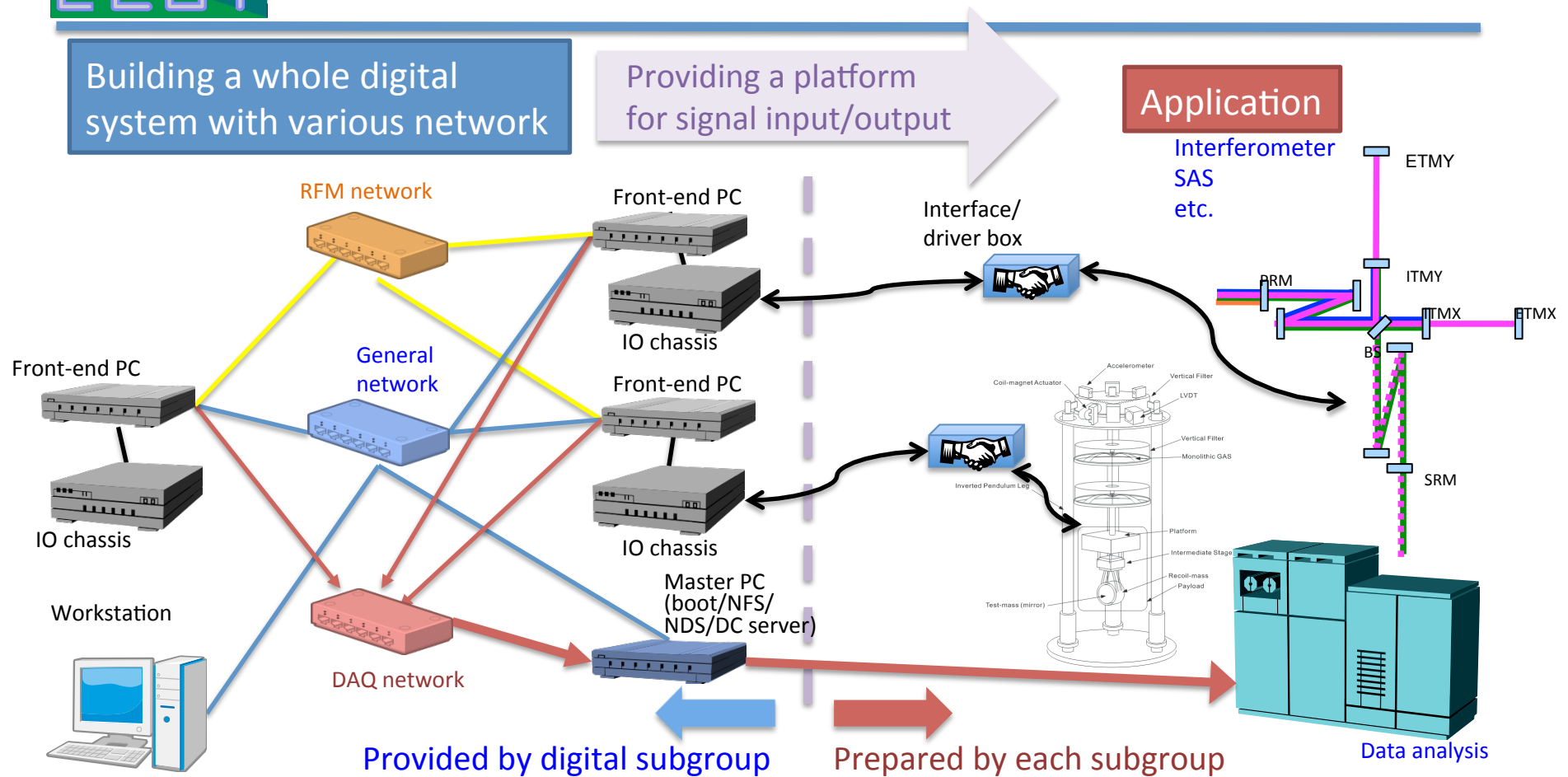


Digital system will be a **Critical technology** for commissioning/noise hunting

- Provides a **very flexible human interface** for a very complicated DOFs of the interferometer.
- Good solution to treat **huge numbers of signals** in Large scale interferometer
- Provides many useful functions as **sensing, filtering, Matrices, controls, monitoring, switching** etc.
- **Multiple people** can work at a time



Overview of digital system



- Real Time Front-end PC
- Workstation, Diagnosis software
- ADC/DAC/BO in IO chassis, AA/AI
- DAQ/RFM/timing network

- Control, monitor, switch
- Auto lock, auto alignment
- Commissioning, noise hunting
- Diagnosis, tuning, calibration
- Operation, observation



~FY2010: Development of **prototype system** at/using CLIO

FY2011: Delivering **stand alone system** to subgroups

FY2012: Test operation system as **whole network** at Kamioka building

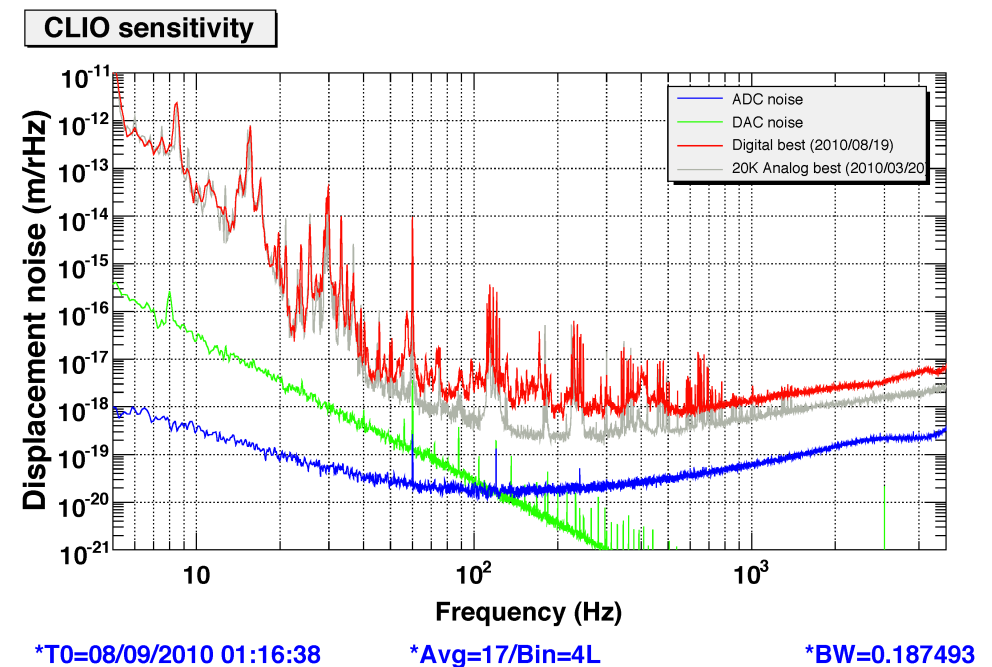
FY2013~: Installation of full digital system into mine

[illegible]



Prototype 1: test in CLIO ~2010

- To establish the first test of aLIGO type digital system
 - Obtaining equipment in Japan like ADC/DAC/BO, IO chassis...
 - Related analog circuits like AA/AI, WF/DWF
- Lock acquisition
 - linearizing error signal
 - normalizing power
- Calibration process on DTT
 - sensitivity monitor
- Noise performance
 - Switching WF/DWF by BO
- Auto alignment
- Application for other R&D experiment



1 day Engineering run is planned using CLIO in this fall
for development online analysis software



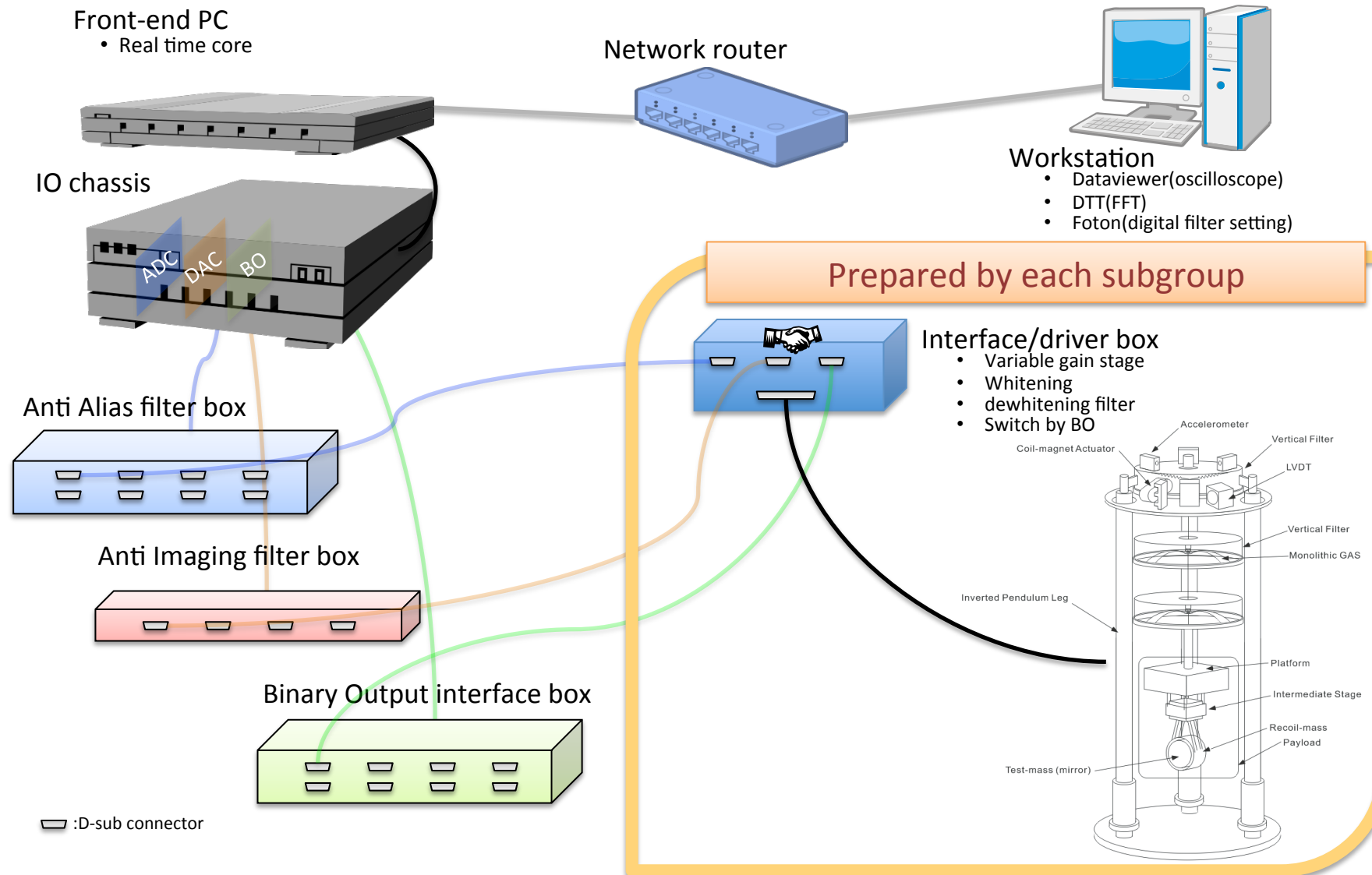
Prototype 2: Standalone system for subsystems

5 sets of stand alone digital system will be delivered to subgroups in FY2011

1. Real time control computer as front-end
 2. Client workstation PC with software setup
 3. PCIe I/O chassis for ADC/DAC/BO modules
 4. Timing slave board
 5. ADC, DAC, Binary Output
 6. Anti Alias/Anti imaging filters
- good chance for subgroups to use a digital system before the commissioning of LCGT
 - Network diagram: JGW-D1100404
 - Additional distribution:
 - Tsubono group (HDD only)
 - NAO for data analysis



Connecting subsystems into digital system





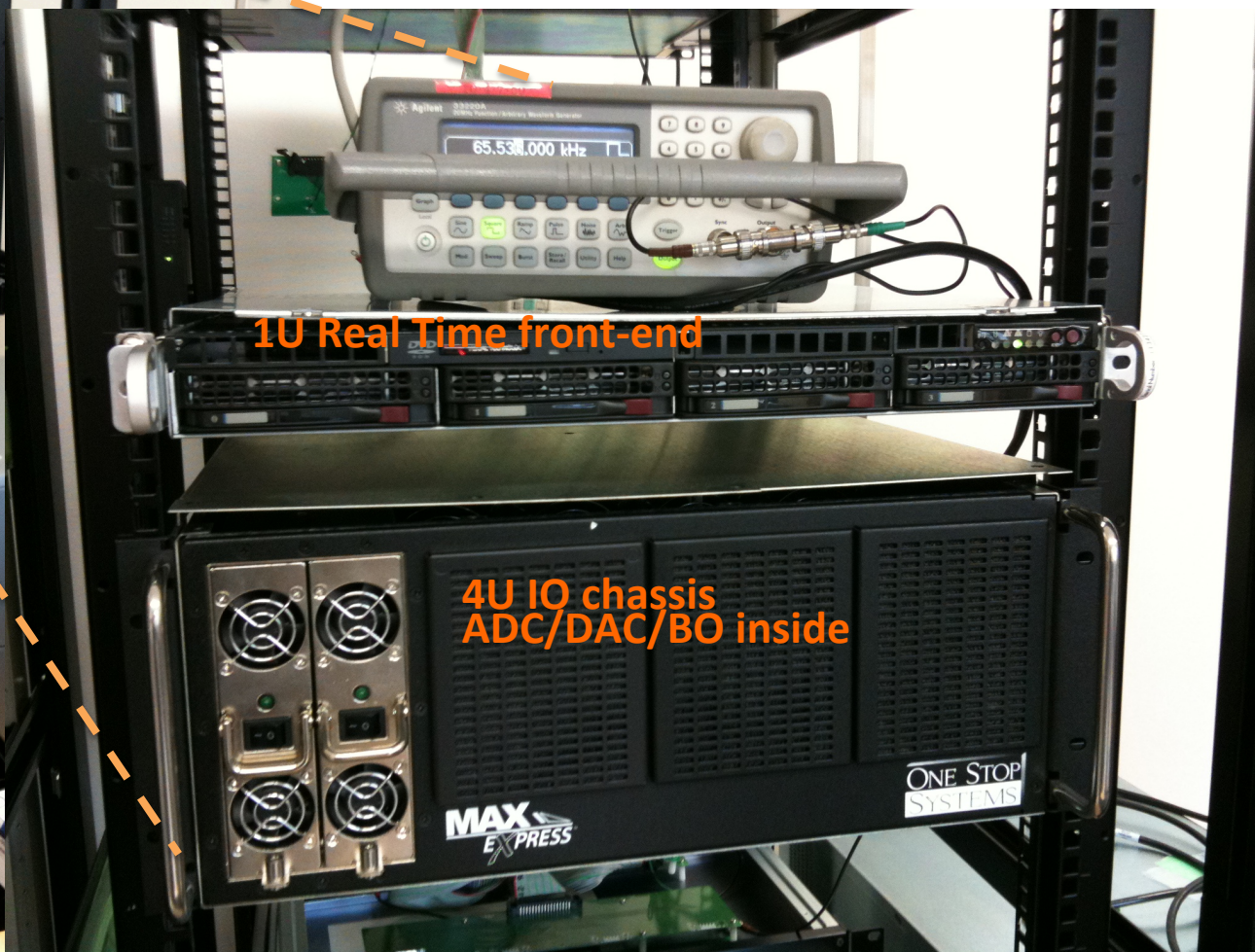
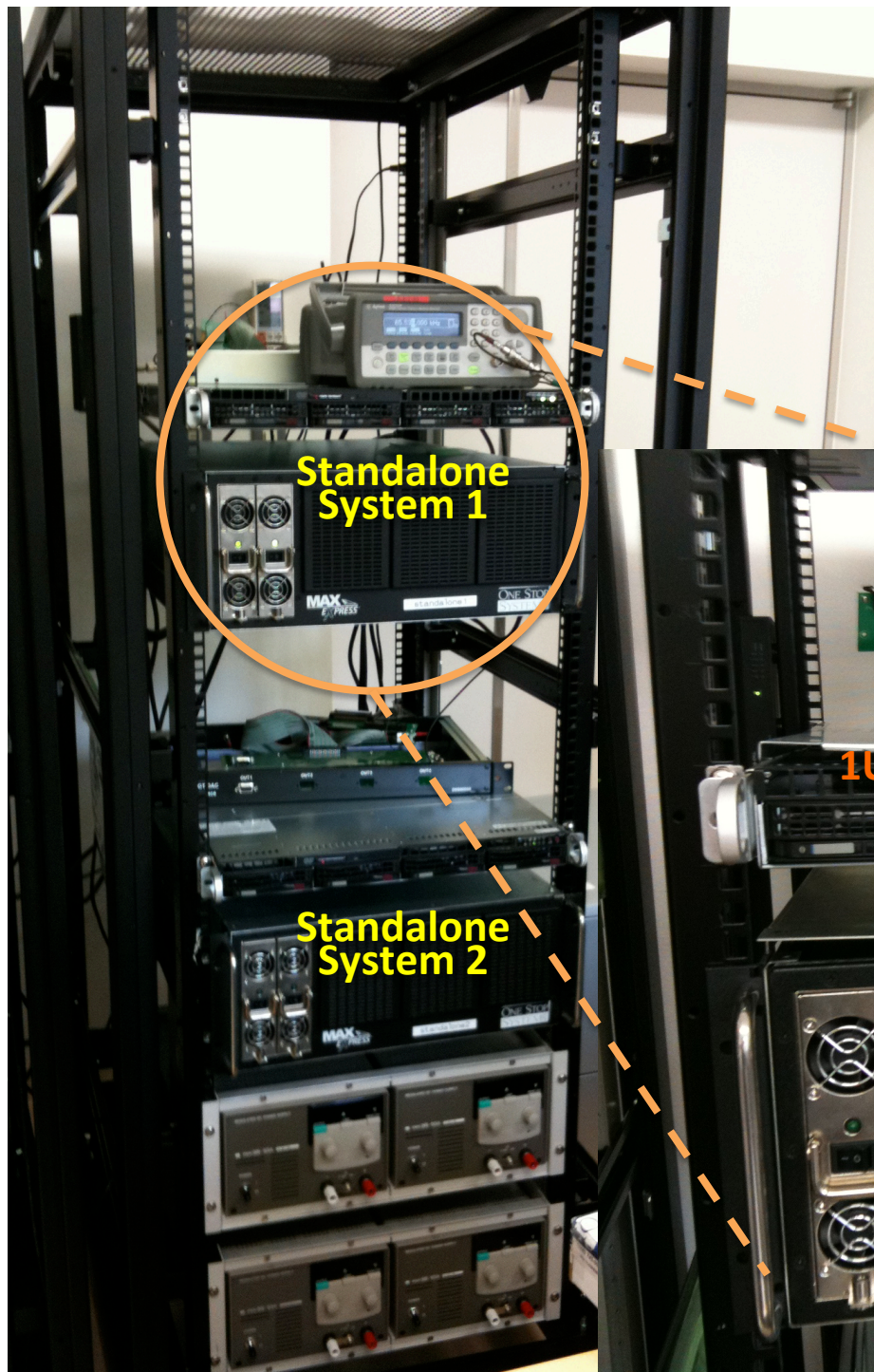
Troubles in Standalone system

1. DAC trouble

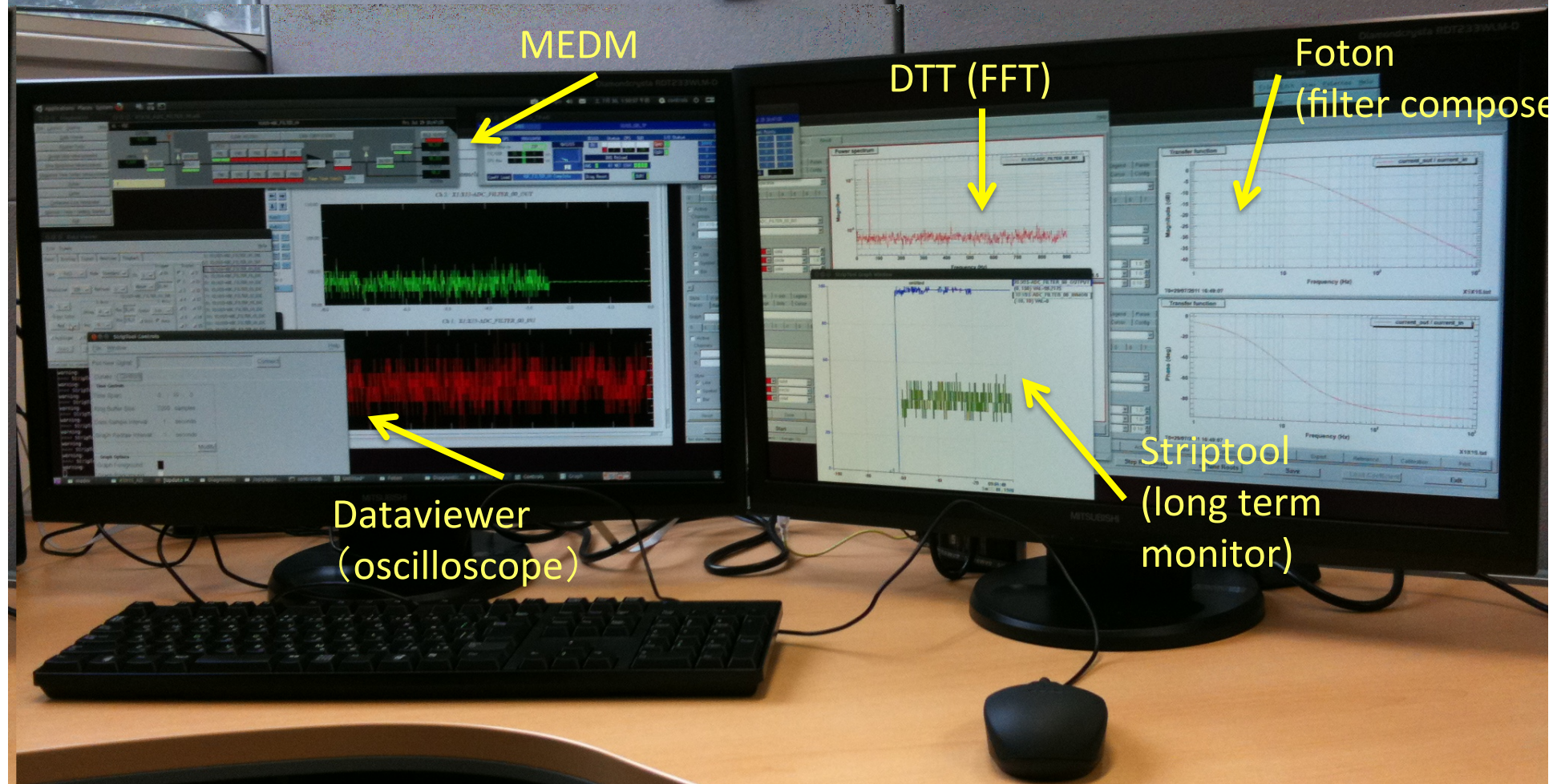
- Could not produce output signal
- Fixed by making multiple models in one PC which have a relationship of master and slave

2. Unstable connection with IO chassis using HIB

- GEN1 (HIB2) or GEN2 (HIB25)?
 - LIGO fixed using GEN1 card, but not for ours
- Cable length?
- Not fixed yet



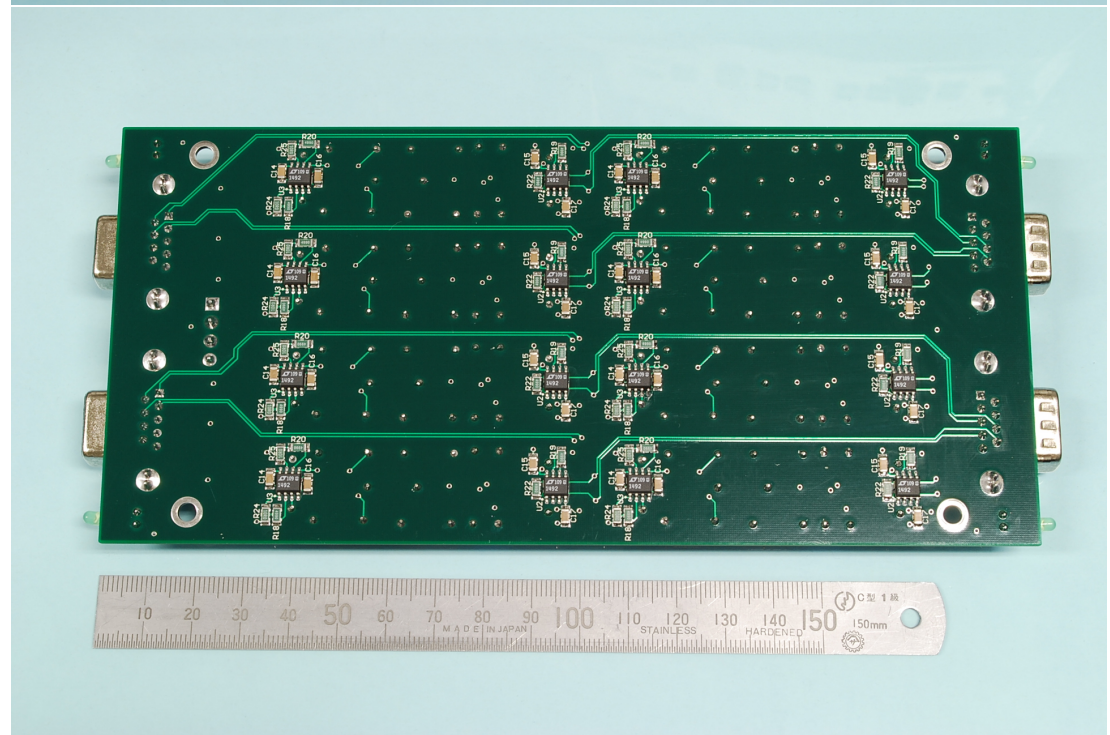
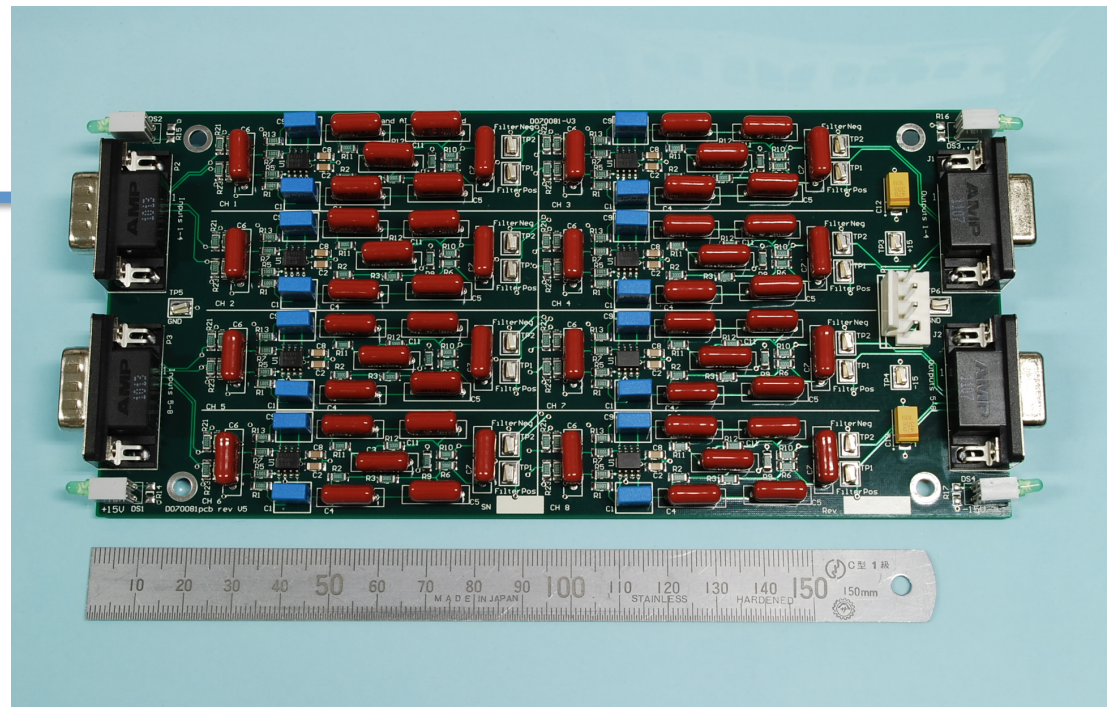
Client system





AA/AI board

- Manufactured by P-ban through Analog circuit group, thanks Moriwaki-san!
- 10 LIGO designed AA/AI boards ordered
 - 6 layers circuit board
 - auto mounted
 - Soldered
- Needs:
 - power supply board
 - Interface boards
 - 1U box





Standalone system to network system

- Standalone digital system is not so difficult:
 - No time loss in local memory
 - GW data locally stored
 - No timing required
- Real time control using **multiple PCs will be much more difficult** for the **speed of network** with bandwidth and delay
 1. **Control signal**: small amount of data, but only minimum delay acceptable for real time control
 - > Reflective memory
 2. **GW data**: not so strict for speed as control signal but only tiny delay acceptable for time stamp, and very wide bandwidth for Huge amount from many RT PCs
 - > Myrinet or Open Myrinet
 3. **Synchronization** for all ADC/DAC and all PCs
 - > Master/Slave style timing system



First Article test

1. Small network test in FY2011

- Network among 1 master and 2 slaves
- GE RFM, Dolphin RFM, DAQ, timing network

2. Full network test in FY2012

- ~8 network PCs
 - 1 boot/nfs server
 - 1 data concentrator server
 - 2 nds servers for redundancy
 - 2 frame writers for redundancy
 - 2 gateways for redundancy
- 2 data storage devices for redundancy
- ~7 RT front-end PCs
- ~5 Workstations
- Multiple RFM/Dolphin/DAQ/general network hubs
- Redundancy test



Small network test at Kashiwa campus

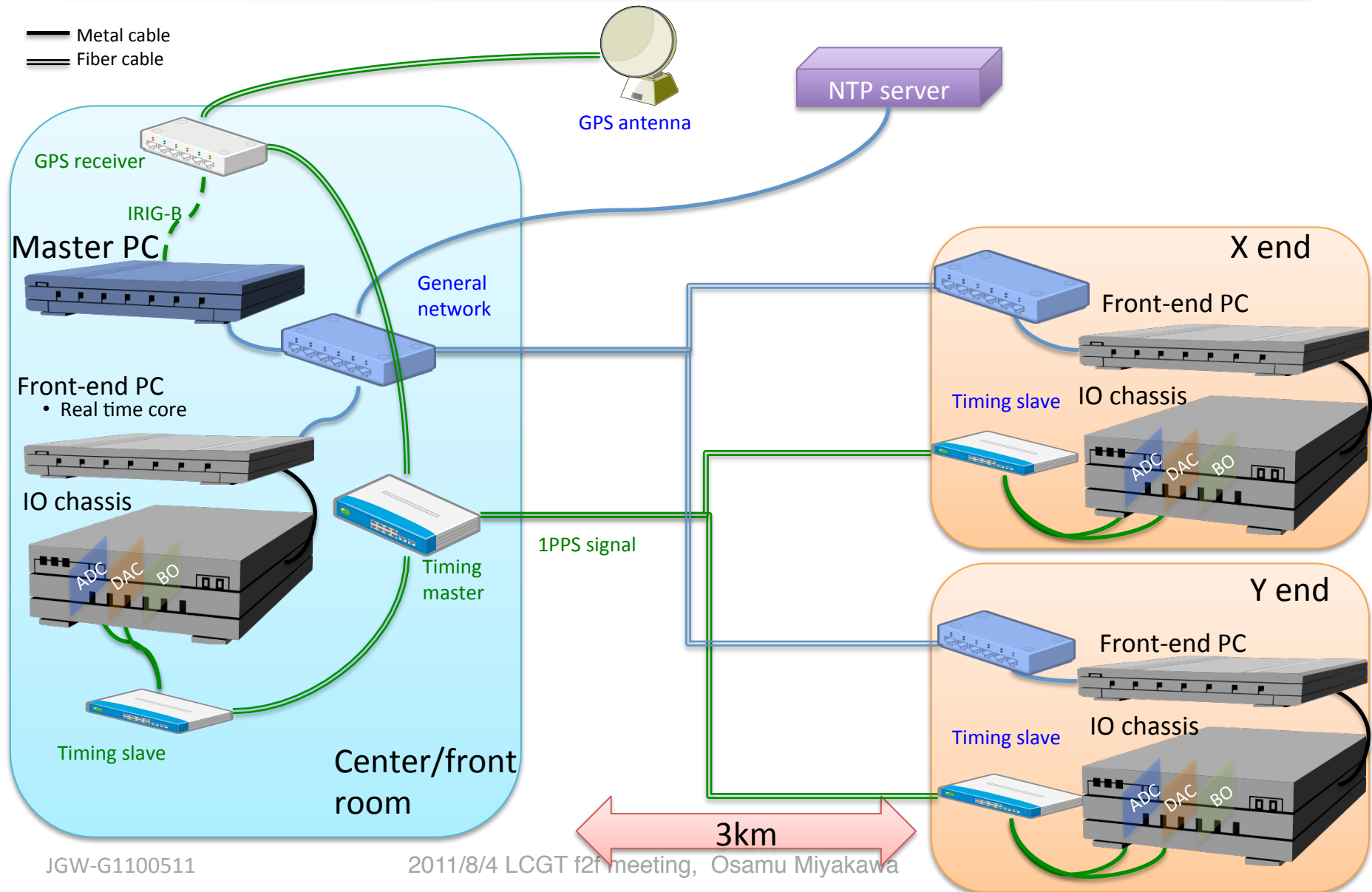
- Man power: Joseph Betswiezer (Caltech post-doc, 40m's main CDSer) and Osamu Miyakawa
 - Lecture for students of Tsubono group for standalone system

What we did:

1. 1 master PC as a boot server, and PXE booted 2 slave PCs
2. Timing system
 - GPS antenna and receiver
 - LIGO Master/slave timing system
 - 1PPS synchronization into each ADC card on 2 slaves
 - IRIG-B signal is necessary for master synchronization for future
3. GE Reflective memory hub using fiber cable connection between 2 slaves
4. Dolphin reflective memory hub using metal cable connection between 2 slaves
5. DAQ network with open-mx protocol
 - Myrinet card is necessary for data concentrator in future

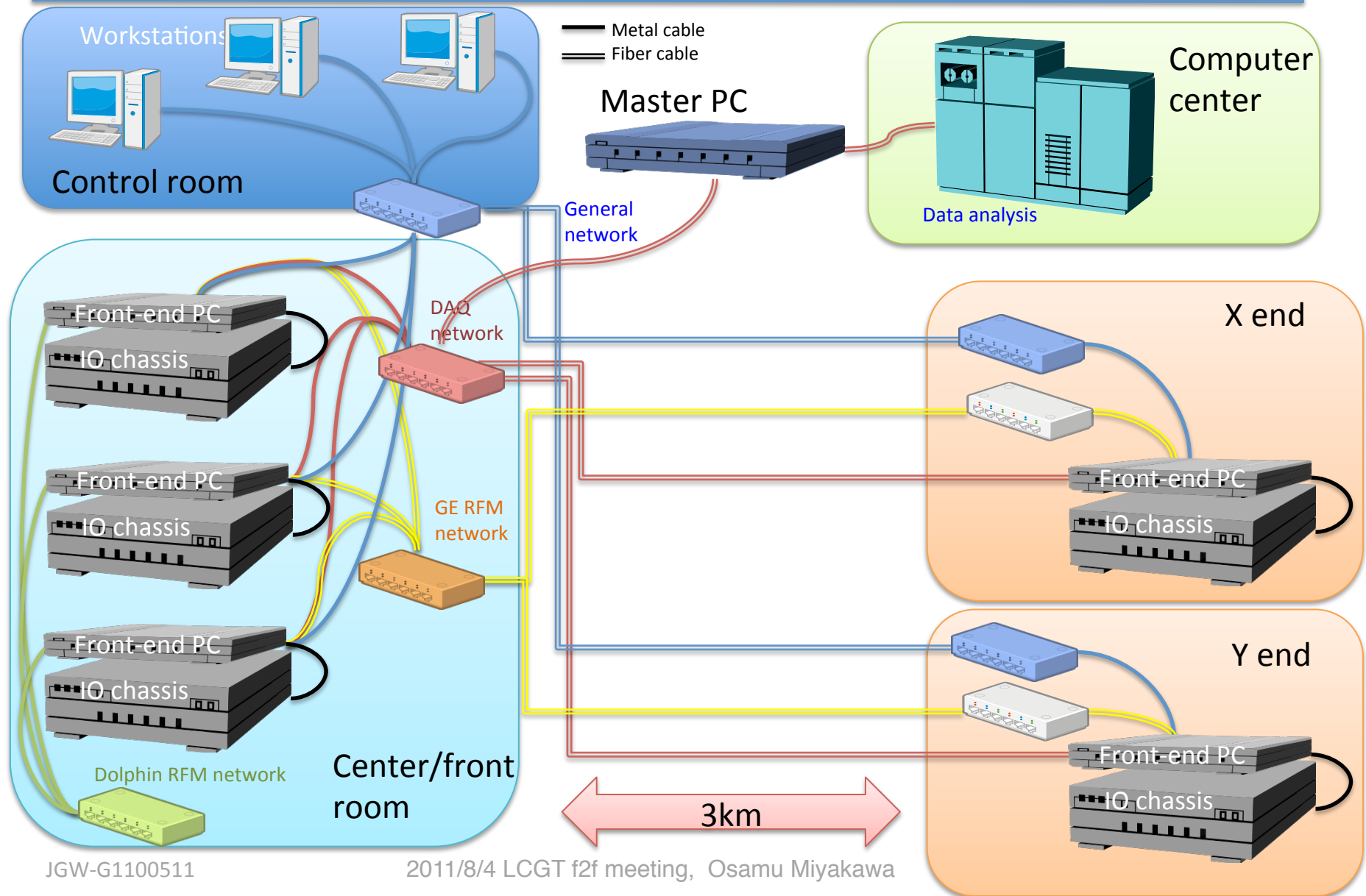


Timing Network



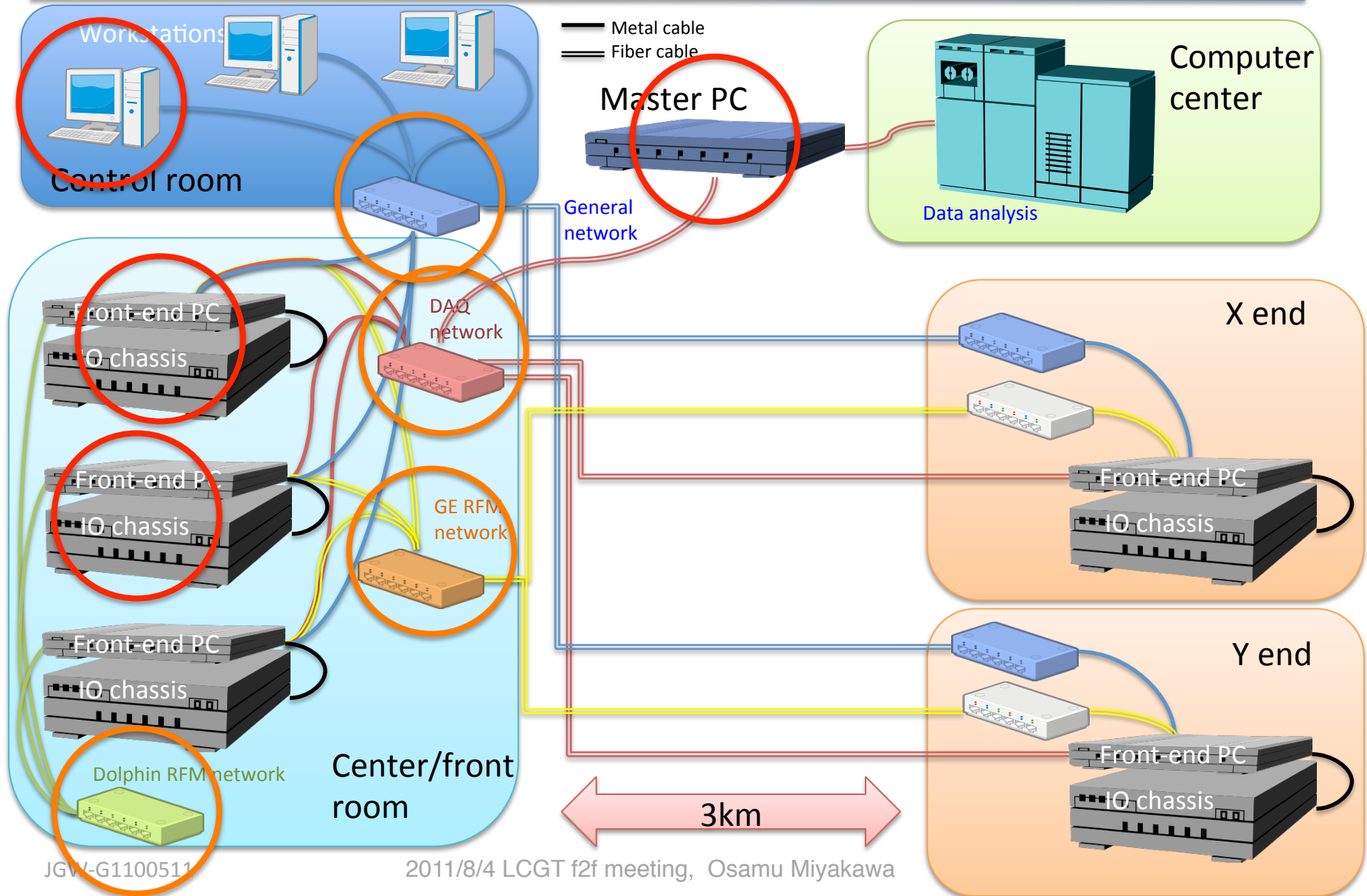


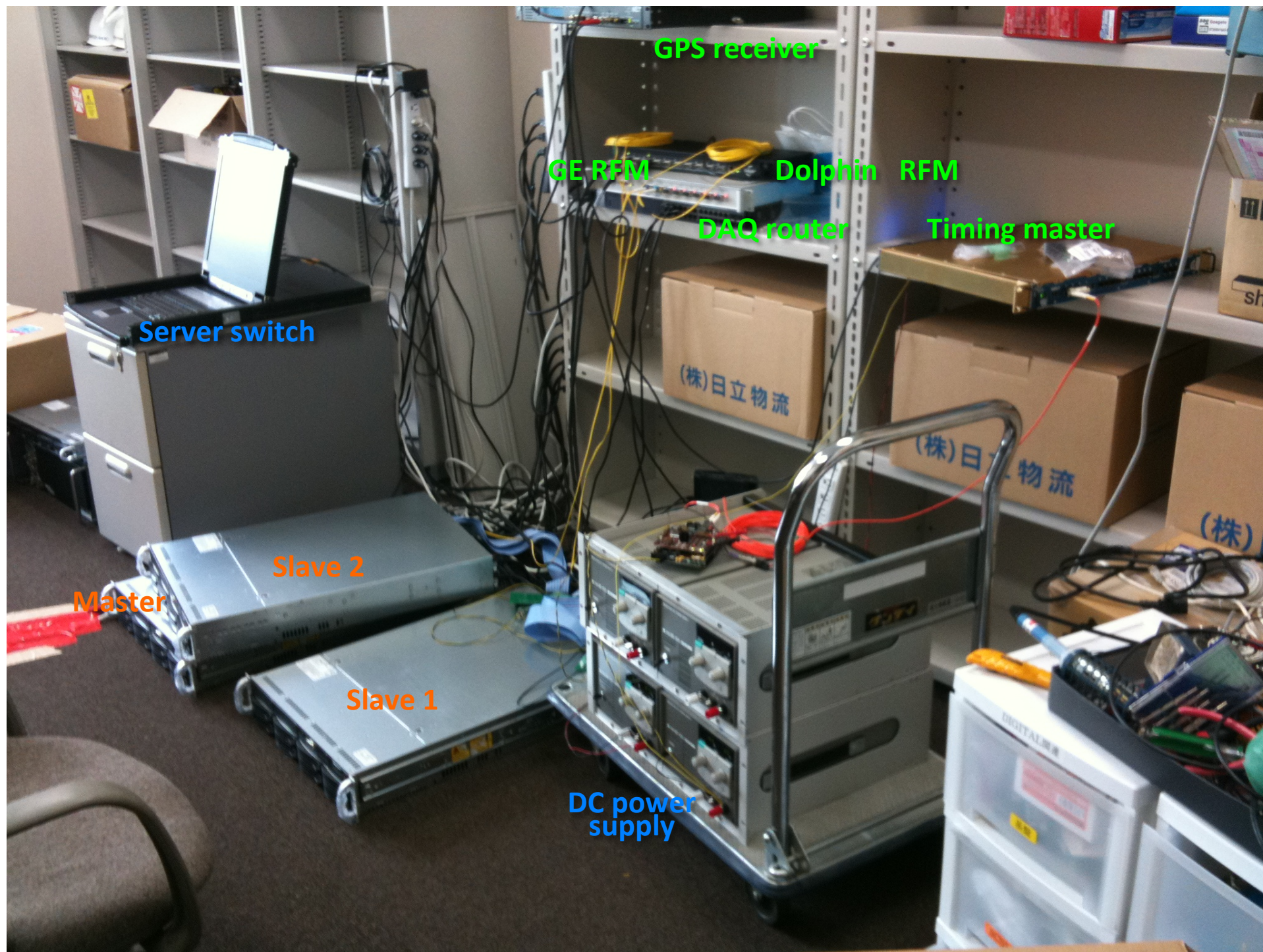
Network design





Network design





GPS receiver

GE RFM

Dolphin RFM

DAQ router

Timing master

Server switch

Slave 2

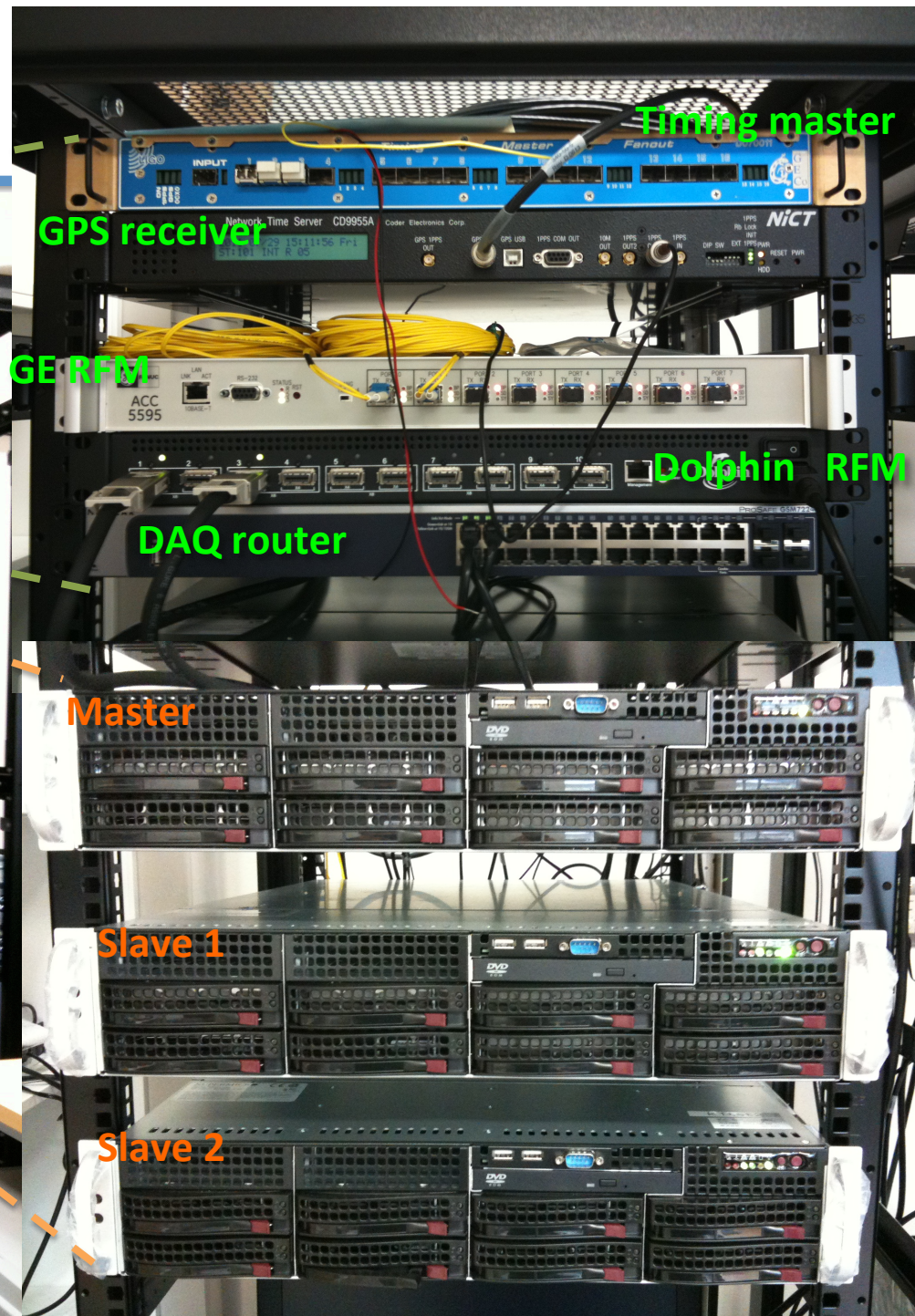
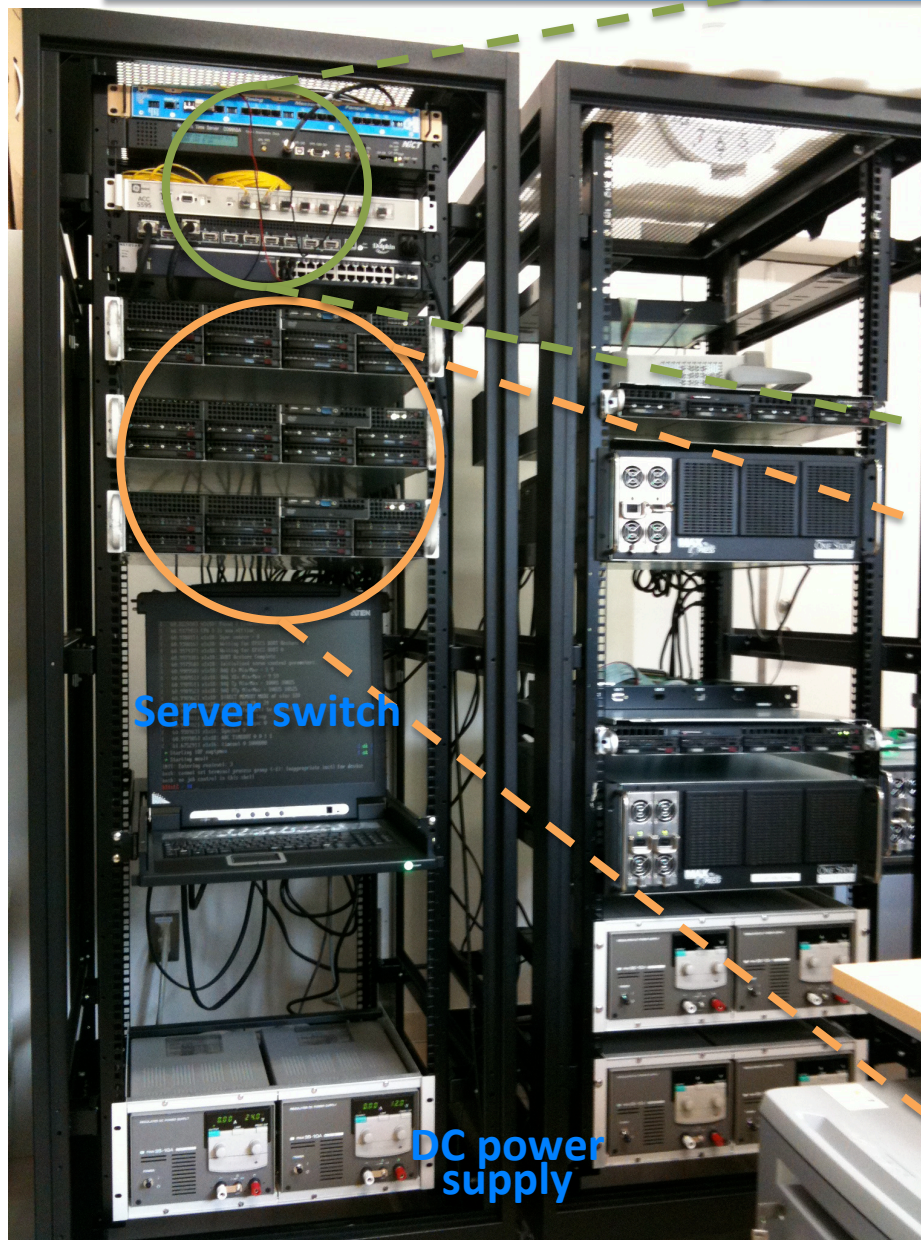
Master

Slave 1

DC power
supply



Re-construction at Kamioka





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Risks

- Cyber security
 - Needs professional level network security system
- Redundancy
- Huge number of channels
 - How do we check huge number of channels for analog and digital to avoid troubles after installed
- It is important to understand whole digital system from inside and it is also important to keep communicating with LIGO CDS group.