



Status report from digital system subgroup

2011/8/4(Thu) LCGT f2f meeting

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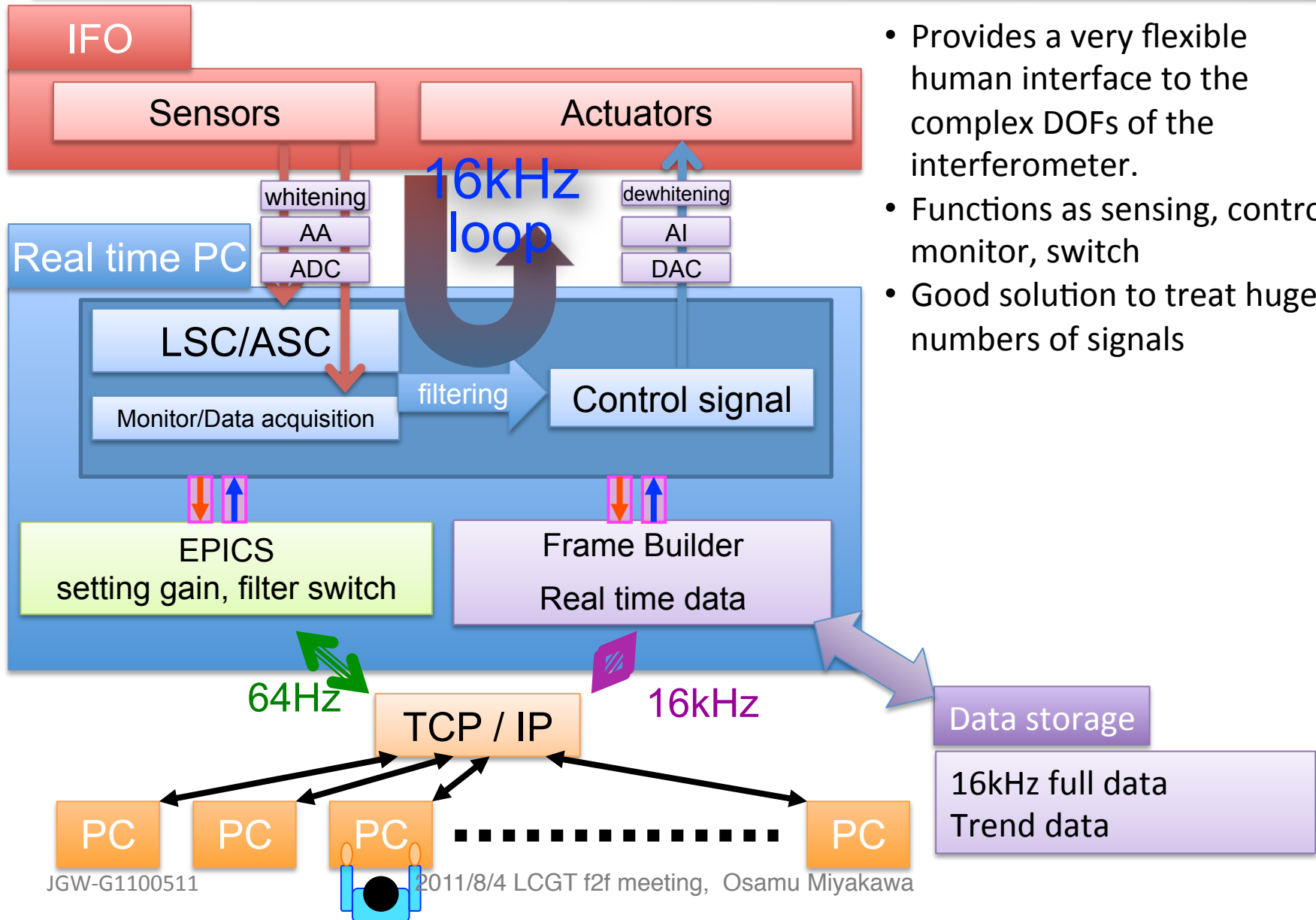


Summary of work from last f2f

- 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



- Provides a very flexible human interface to the complex DOFs of the interferometer.
- Functions as sensing, control, monitor, switch
- Good solution to treat huge numbers of signals



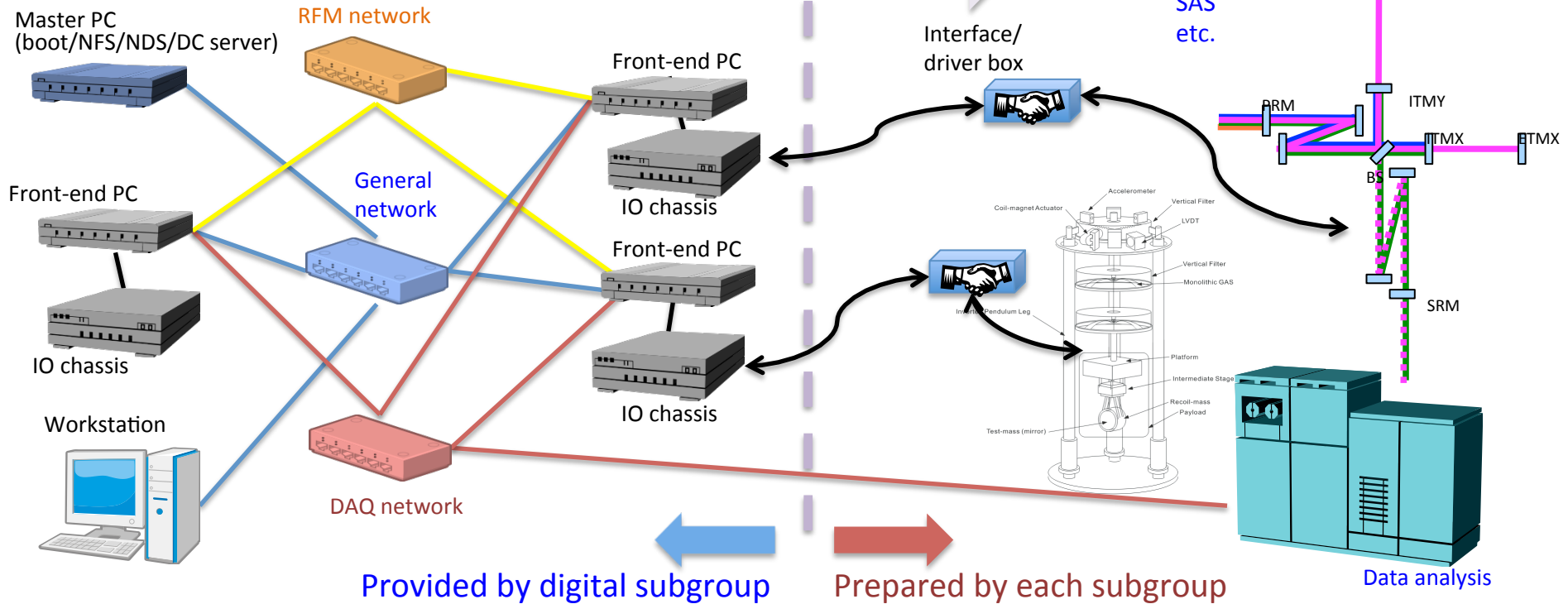
Overview of digital system

Building a whole digital system with various network

Providing a platform for signal input/output

Application

Interferometer SAS etc.



- 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



Schedule

Before LCGT funded

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

After LCGT funded

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

Small **Test bench of network** of digital systems

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

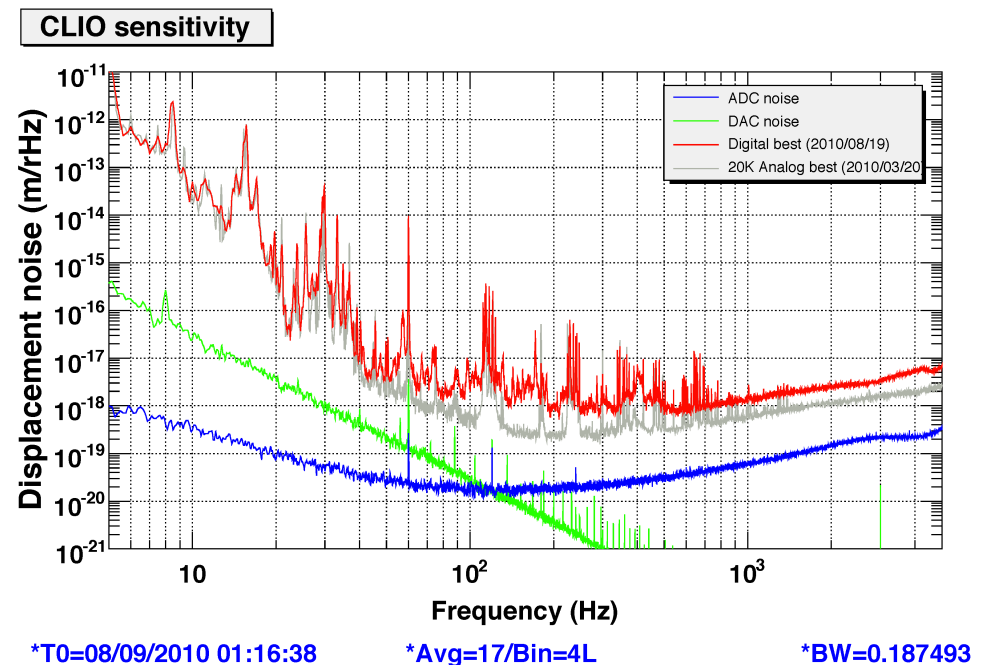
FY2013~: Installation of full digital system into mine

FY		2010				2011				2012				2013				2014				2015				2016			
Quarter		1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Main Phase		Design				Tunnel								Vacuum				FPMI				RSE				Cryo			
Prototype test	CLIO operation	█	█	█	█																								
	Data analysis test							█	█	█	█	█	█																
Standalone system for subsystems	Hard/software setup					█																							
	Circuit					█	█	█																					
	Delivery								█																				
Article test	Small network test							█	█																				
	Large network test									█	█	█	█																
Full system installation	TOS→full system													█	█														
	Software setup													█	█	█													
	Circuits													█	█	█	█												
	Network													█	█	█	█												
Upgrade	RSE																												
	Cryo																									█	█		



Prototype 1: test in CLIO

- 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



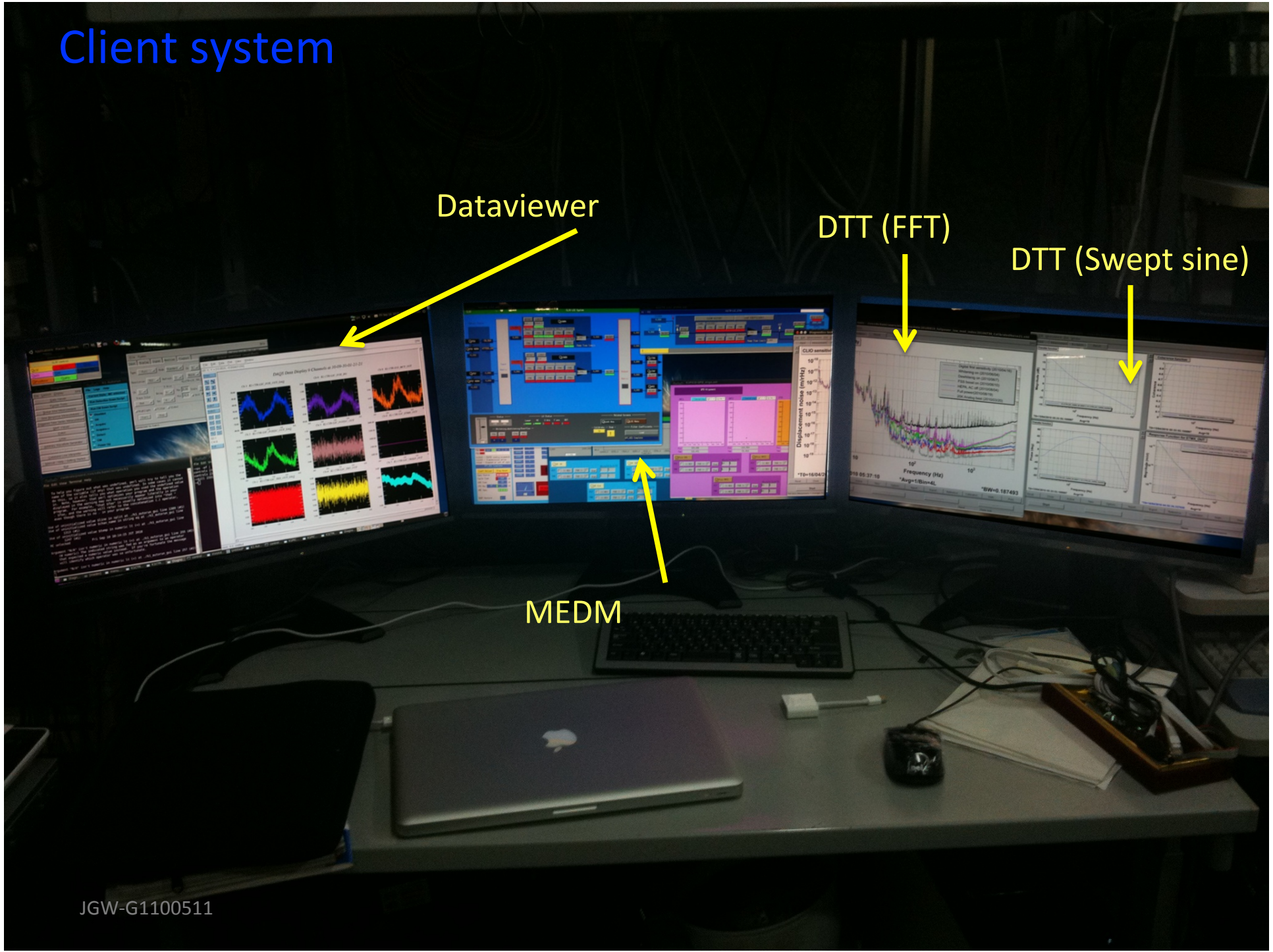
Client system

Dataviewer

DTT (FFT)

DTT (Swept sine)

MEDM





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 be accustomed with a digital system before the commissioning of LCGT
 - Additional distribution:
 - Tsubono group (HDD only)
 - NAO for data analysis

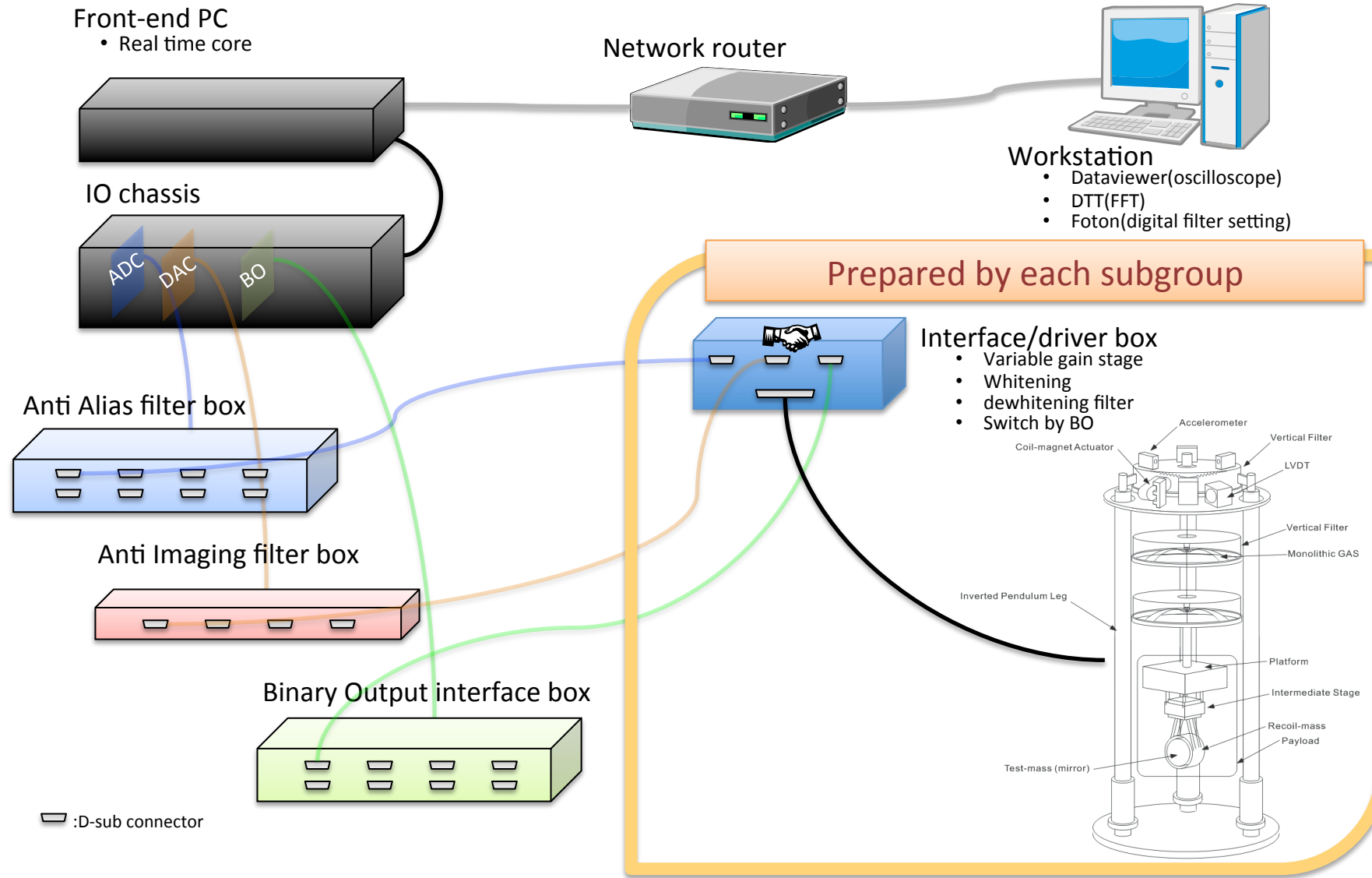


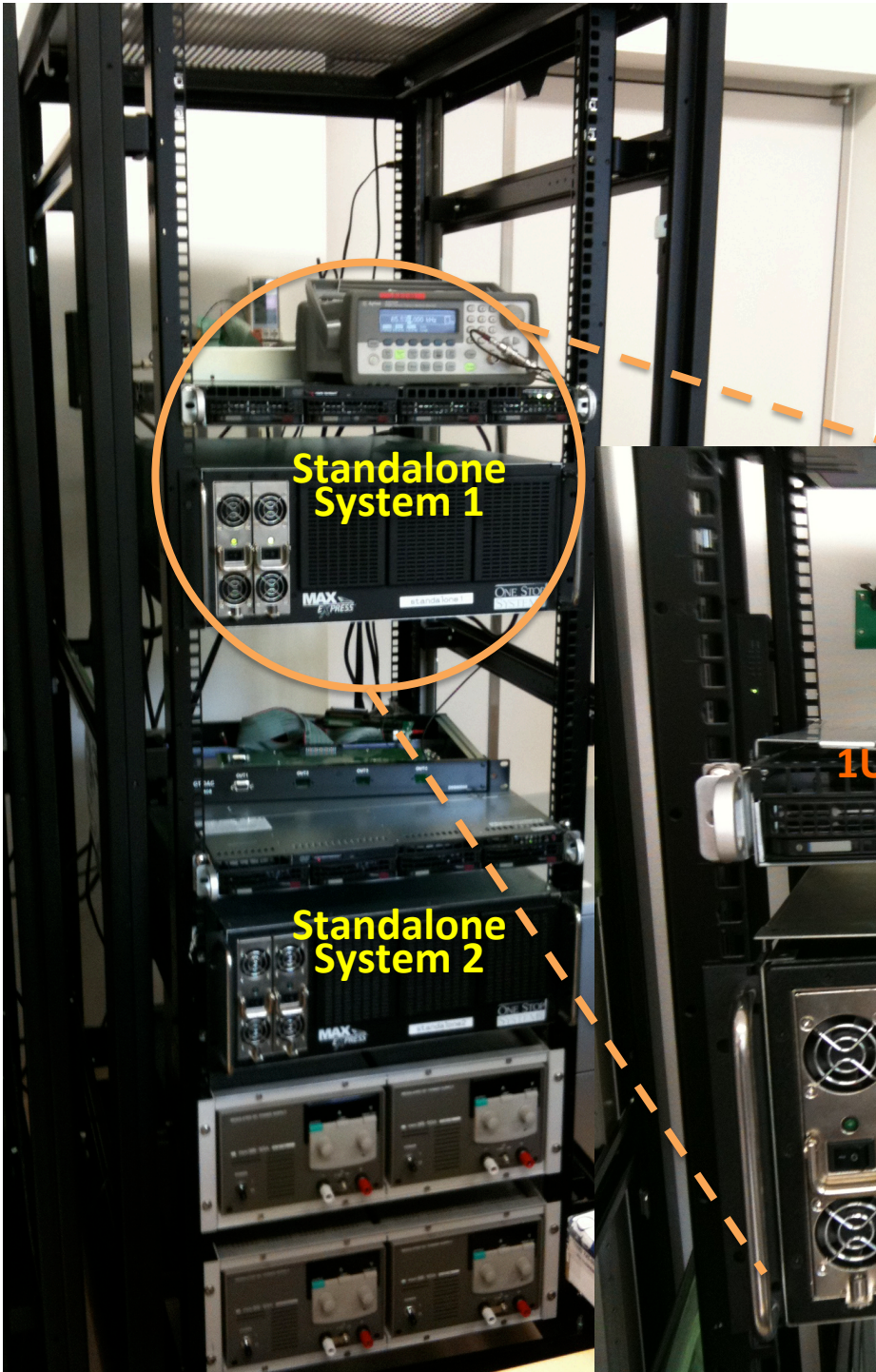
Designing subsystems with digital system

- Include following items on your subsystem's design;
 - Analog variable gain stage
 - Analog Whitening/dewhitening filters
 - BO switch for stepping gain stage and switching w/dw filters on/off
 - Do NOT contain slow analog servo, make it digital! We will offer enough number of channels
- Make a **Driver/interface box** between your subsystem and digital system to realize above functions
- Propose 100nV/rHz rule:
 - Do NOT transfer under 100nV/rHz signal, too fragile
 - Amplifier signals until over 100nV/rHz before transfer
 - Use analog variable gain stage and whitening filters in your box which is controlled by digital BO



Connecting subsystems into digital system





Standalone System 1

Standalone System 2



1U Real Time front-end

4U IO chassis
ADC/DAC/BO inside

MAX
EXPRESS

ONE STOP
SYSTEMS



First Article test

1. Small network test in FY2011
 - Network among 1 master and 2 slaves
 - 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 posdoc, 40m's main CDSer), and Osamu Miyakawa
 - Lecture for students of Tsubono group for standalone system

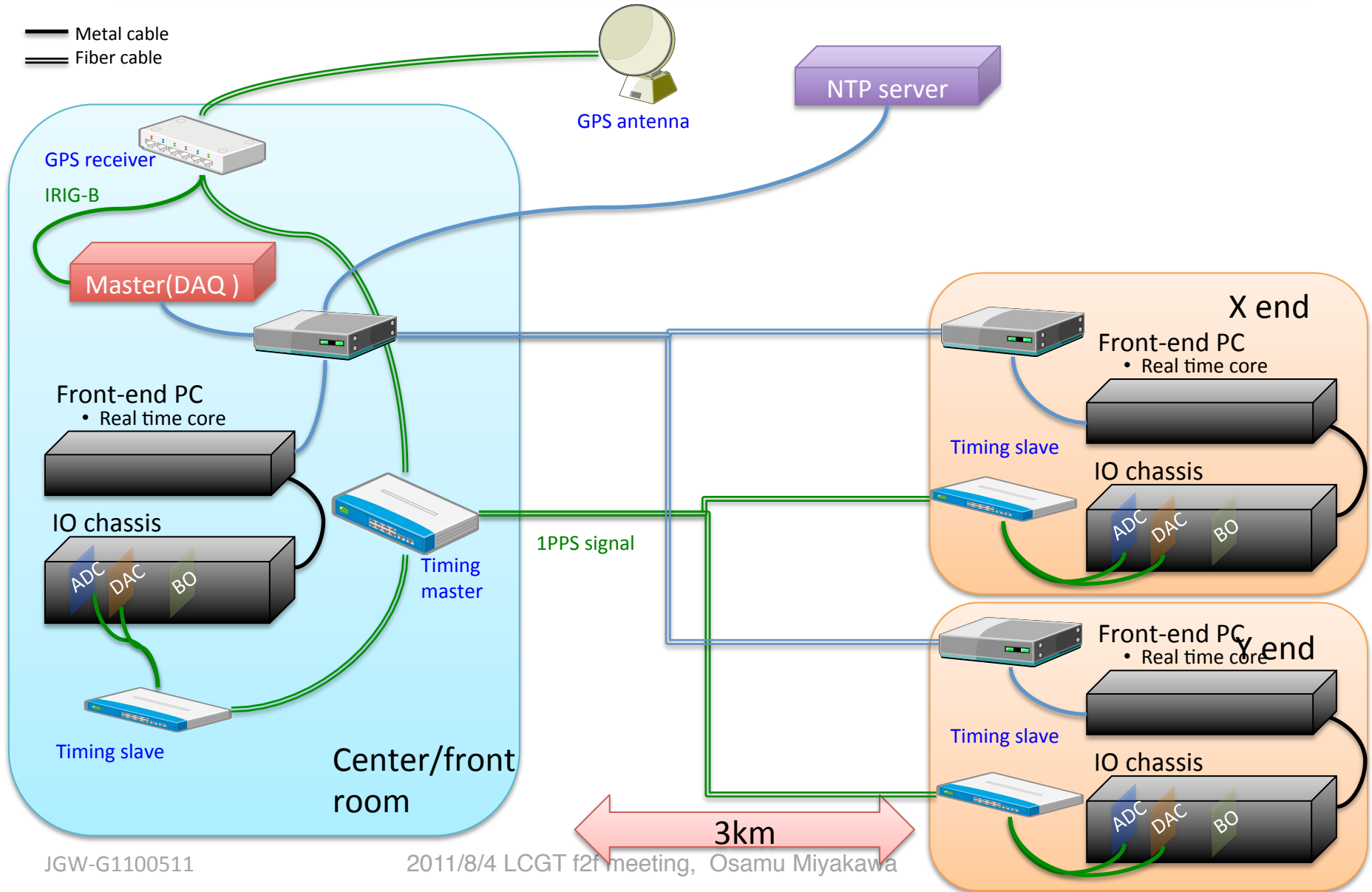
What we did:

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



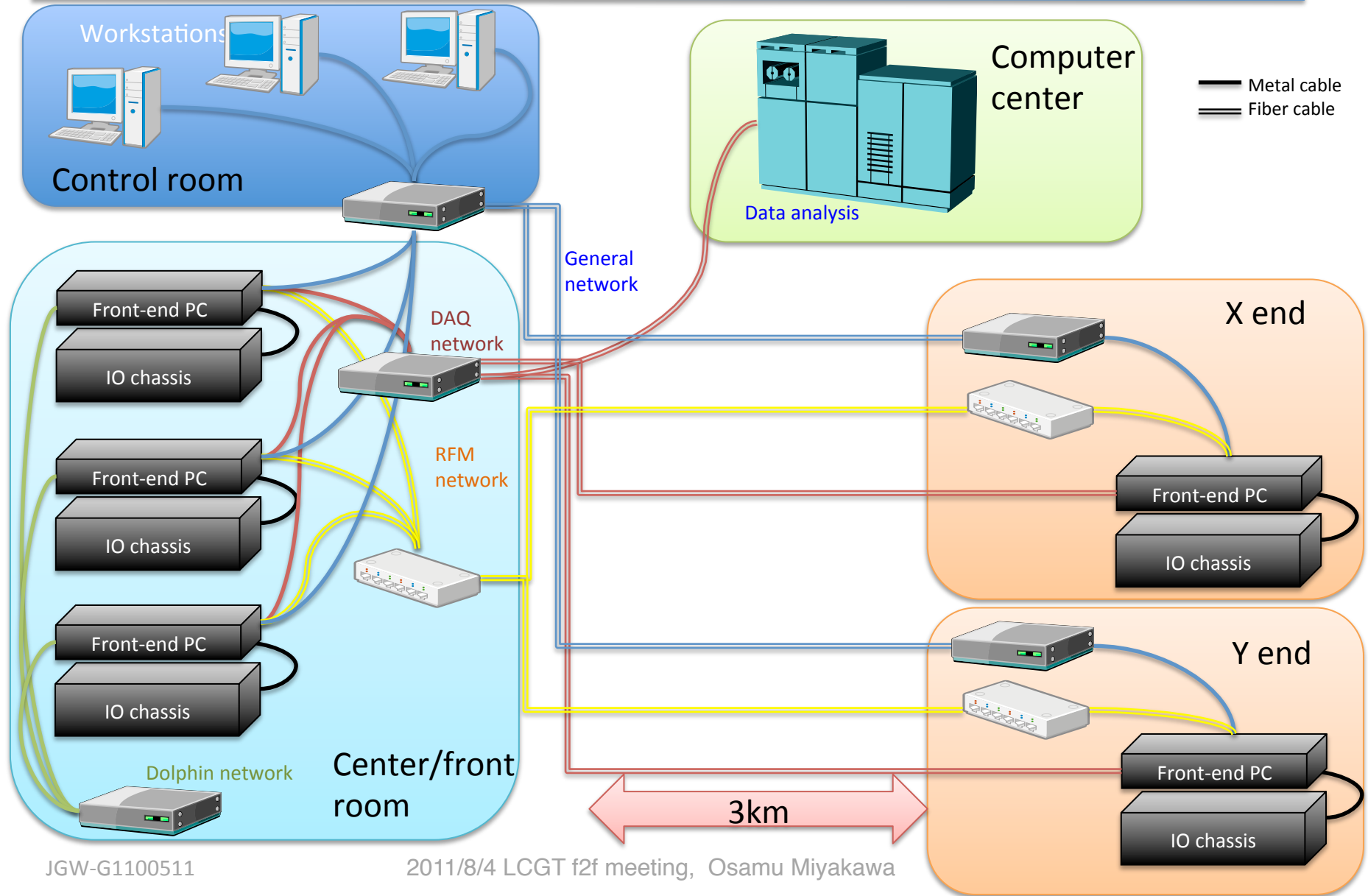
Timing Network

— Metal cable
== Fiber cable





Network design





GPS receiver

GE RFM

Dolphin RFM

DAQ router

Timing master

Server switch

Slave 2

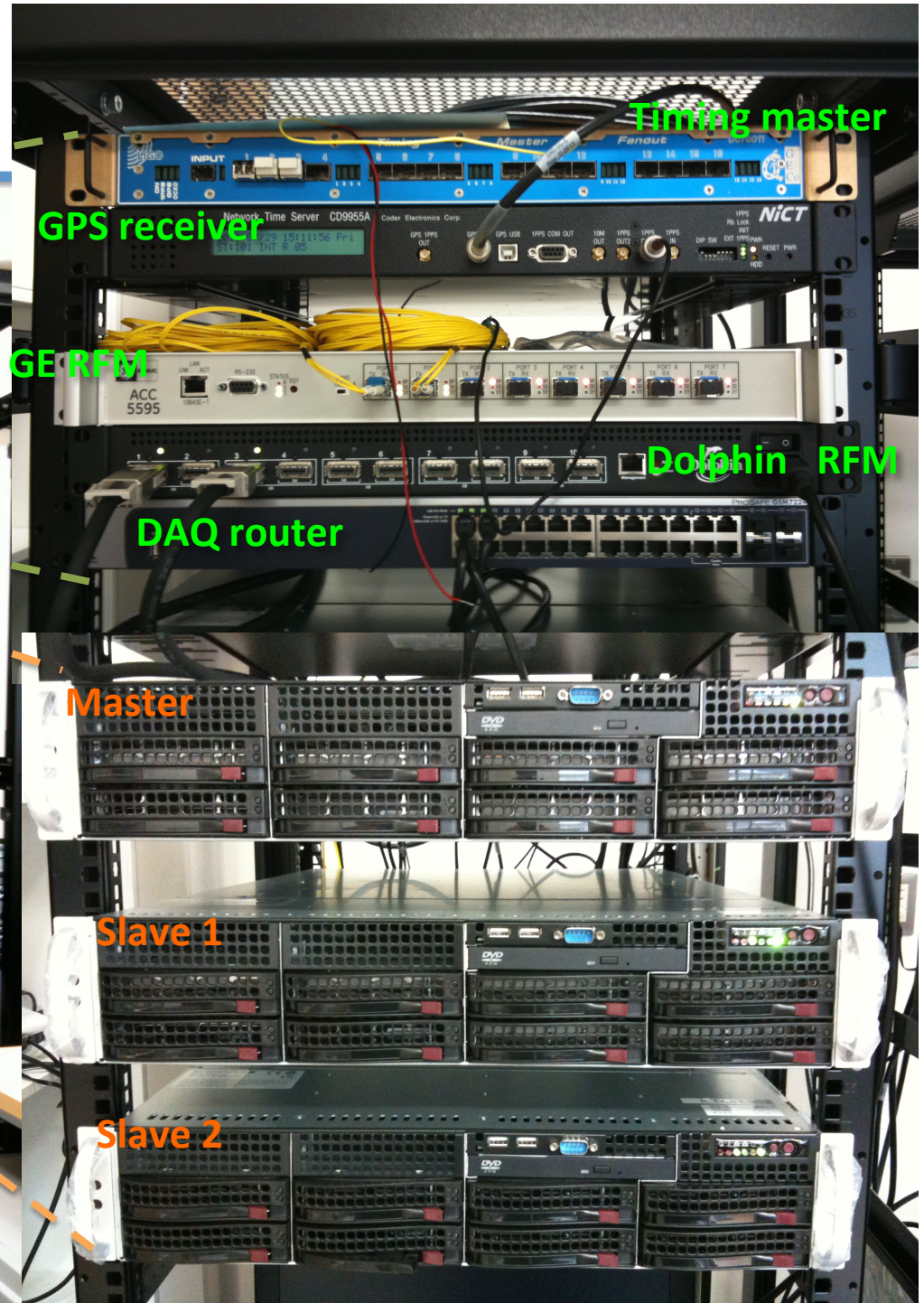
Master

Slave 1

DC power supply



Re-construction at Kamioka





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Main system

- mbuf: memory buffer
- Real time code (64kHz or 16kHz) as a kernel module
- awgtpman: test/excitation point manager
- nds: real time data stream
- daqd: data receiver daemon
- EPICS: providing access channel name for slow (~64Hz) data stream for monitor/control

- Dolphine module: network for control signals in center area, fast but short distance(~100m)
- RFM module: network for controls signals through arms, long distance (~km) but slow
- mx-datastream: data sender service



Tools

- MEDM: epics monitor/controller for gain, offset, filter switch...
- foton: digital filter composer
- dataviewer: multiple channel oscilloscope, but slow
- DTT: FFT, network analyzer, sine response, time trigger
- Striptool
- Script tools as ezca..., tds...
 - read, write, switch, step, servo, demod