S1-Global RF Preparation

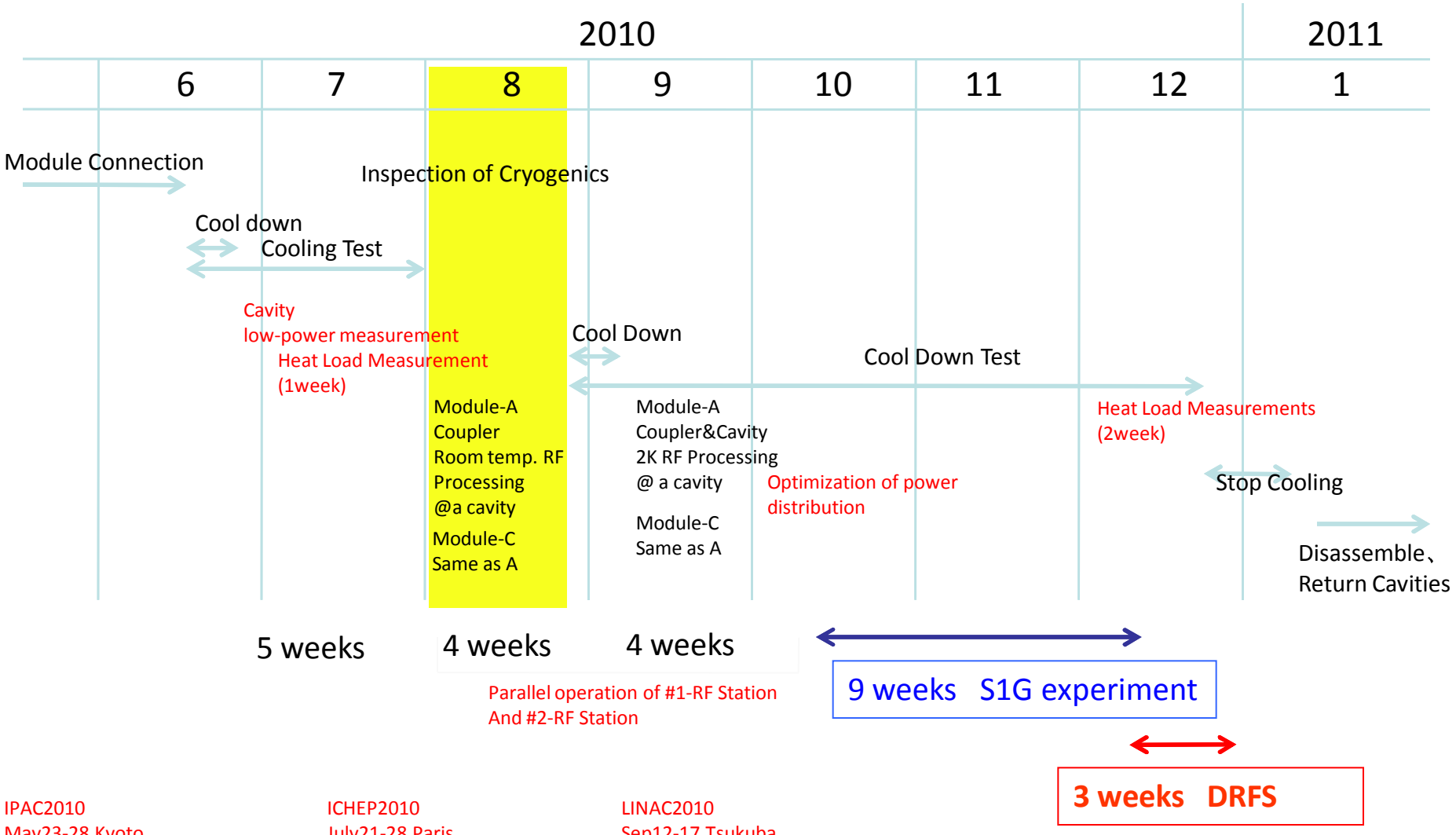
KEK
S. Fukuda

Content

- Time Schedule of S1 Global in KEK
- Achieving Goal of S1-global
- HLRF and LLRF in KEK
- DRFS Test in S1-Global

Time Schedule and Contents of S1 Global (Revised)

Proposed S1 Global Schedule (By Hayano)



IPAC2010
May23-28,Kyoto

ICHEP2010
July21-28,Paris

LINAC2010
Sep12-17,Tsukuba

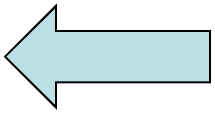
Japan Acc. Meeting
2010

Procedure of Cavity with jacket (By Hayano)

Module C (INFN module)

8 weeks

2009.01~2010.02



Finish / Under Going

Module A (KEK module)

9 weeks

2010.03~2010.04

Connection of Module C (INFN module) and Module A (KEK module) in the Tunnel

6 weeks

2010.05~2010.06

Contents of Test in S1 Global (By Hayano)

First Cooling and Test

1: Low Power Measurement of an individual cavity of 8 cavities

Q-value, Frequency, Coupler adjustment , Tuner adjustment, Response for piezo, Micro phonics, Mechanical vibration and HOM

4 weeks (2010.06-07)

3 Sets of NWA and CT (KEK,DESY,FNAL) ,Computer Control

2. : Thermal Load Measurements (static) 1 week (2010.07)

Second Cooling and Test

1: Lorentz Detuning measurements, comparison, correction survey

Preparation of auto-measurements software by LLRF group 4 weeks (2010.10)

2: Achievement of average maximum accelerating field and investigation of stability and failure rate after long operation. 2 weeks (2010.11)

3 : Thermal Load Measurements (static and dynamic) 2 weeks (2010.12)

4 : Demonstration of DRFS System 3 week(2010.12)

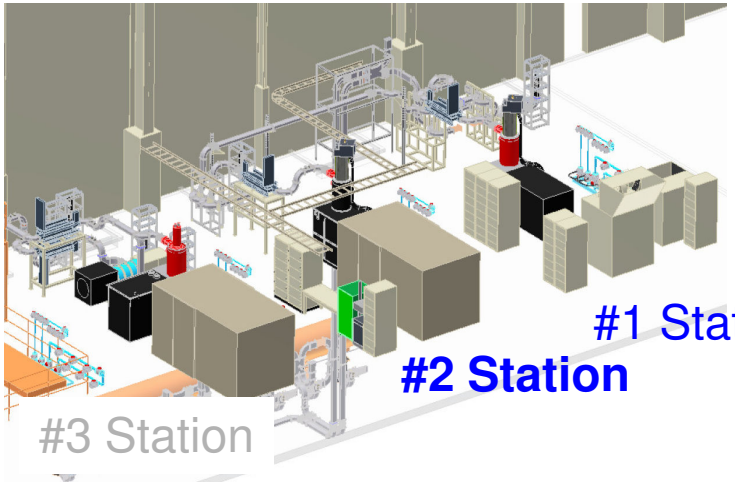
Purpose (Achieving Goal) of S1 Global

- SC Cavity Test under the Internal Collaboration
  - → Cavity Evaluation of 3 Region (US, EU and Japan)
- Achieving the Average Maximum Accelerating Field
  - → Cavity Evaluation of 3 Regions (US, EU and Japan)
  - → HLRF introduces Q adjustment mechanism and power adjustment mechanism to support this purposes.
- Demonstration of DRFS

HLRF &LLRF Configuration

HLRF Status in KEK

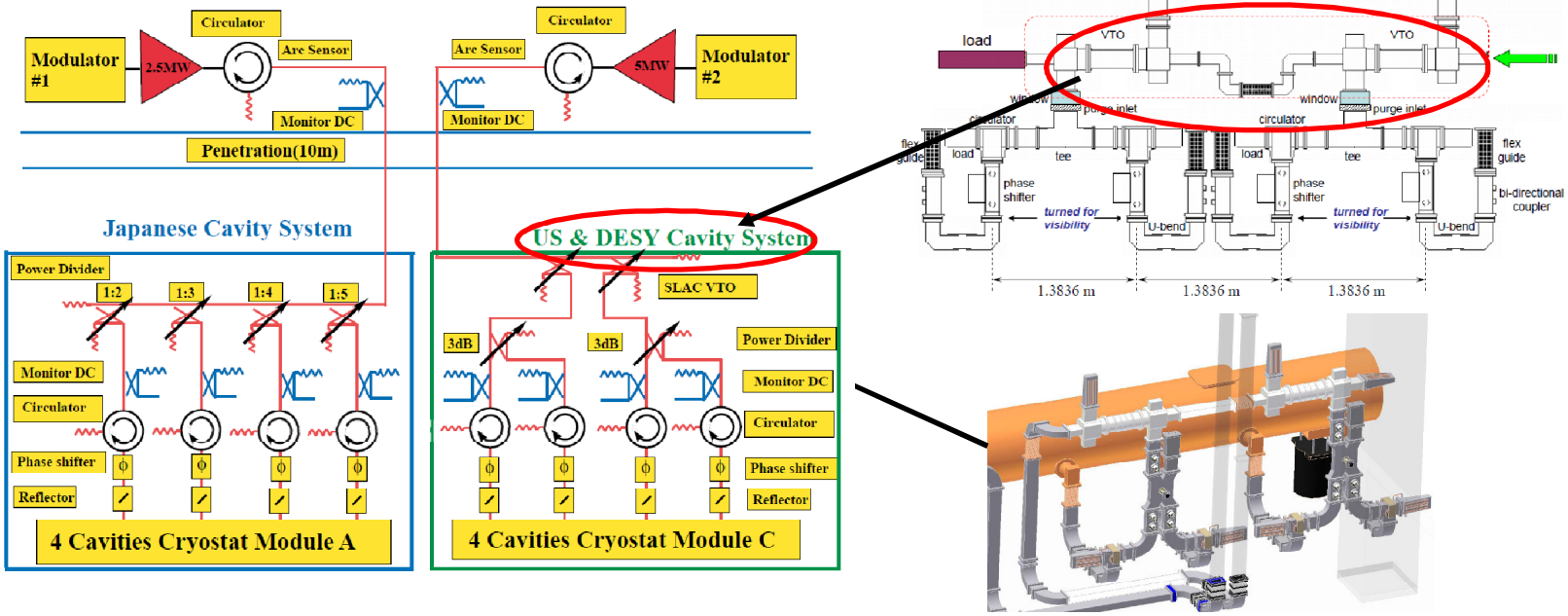
- Two RF Stations will be available at the period of S1 global.
  - **#1 2.5 MW available: mainly used for coupler processing**
  - **#2 5MW available**
  - **#3 10MW from Horizontal MBK – Maybe not operable**
- In order to have an efficient program for cavity evaluation, 2 RF stations (#1 & #2) will be used.
- Individual coupler processing and cavity processing, two 4-successive runs will be possible.
- Ql adjustment by phase-shifter and reflector after circulator, and a variable tap-off hybrid will be used for power variation.



STF Building Klystron Gallery

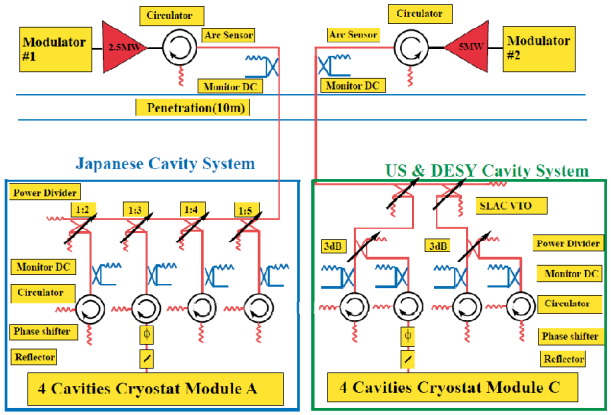
Possible PDS Scheme for S1 global

SLAC VTO – already delivered from SLAC

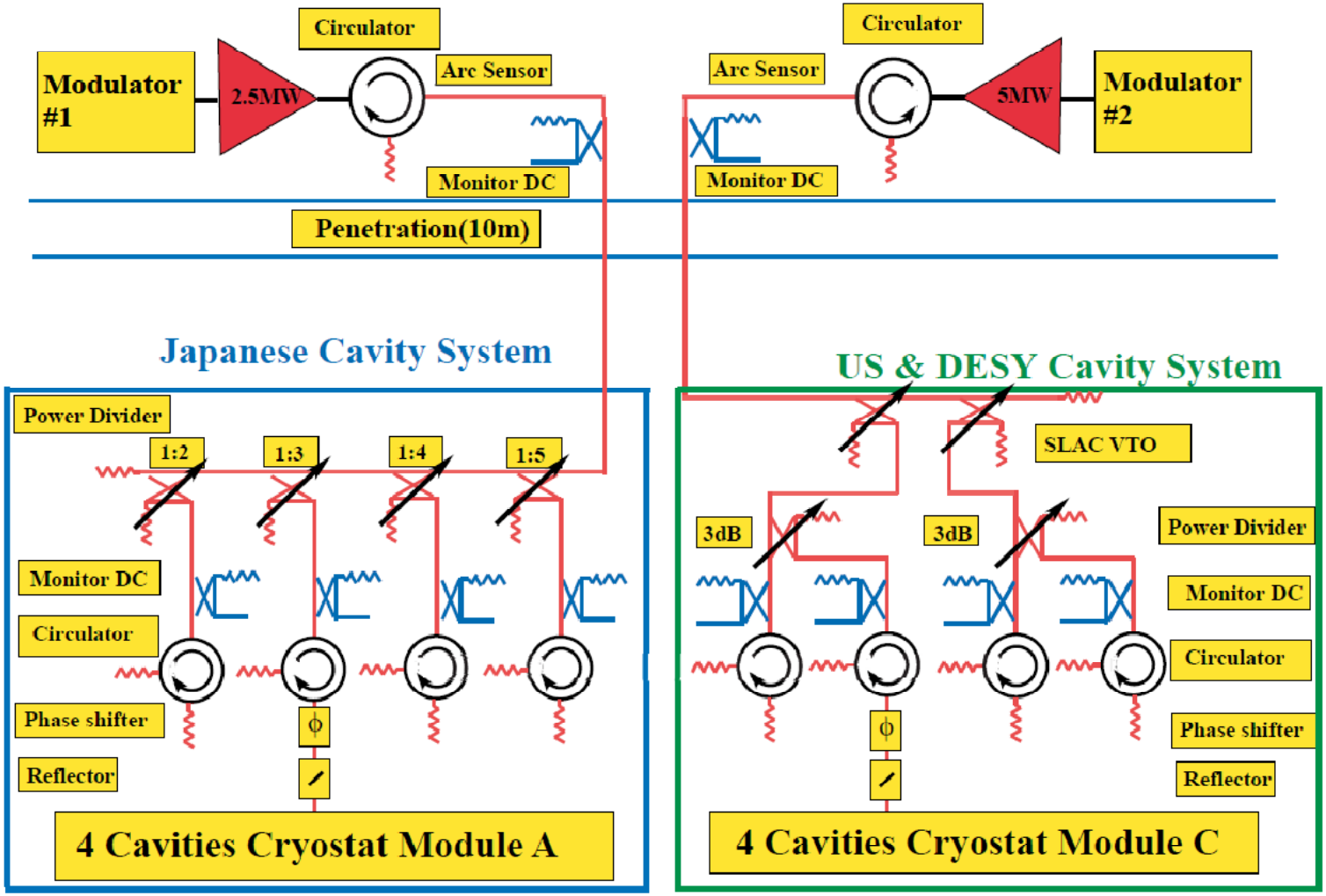


For S1 global, KEK cavities are tested using KEK's PDS and EU&US cavities are tested using SLAC VTO. All power dividers enable us to vary the power including the SLAC VTO (0-100%) and Ql is also adjustable.

Proposed Layout for S1 Global



Coupler Processing and Cavity Survey

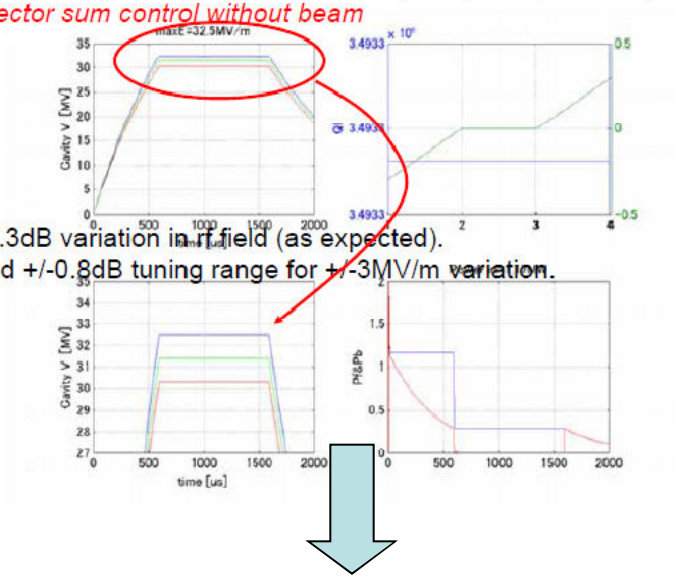


Variation in Loaded Q

Rf distribution and cavity field gradient

(simulation assumption)

- *4 cavities are driven.*
- *All cavities have same loaded Q (no variation).*
- *Rf distribution to cavities are -6.3dB, -6dB, -6dB, -5.7dB. (+-0.3dB)*
- *Vector sum control without beam*

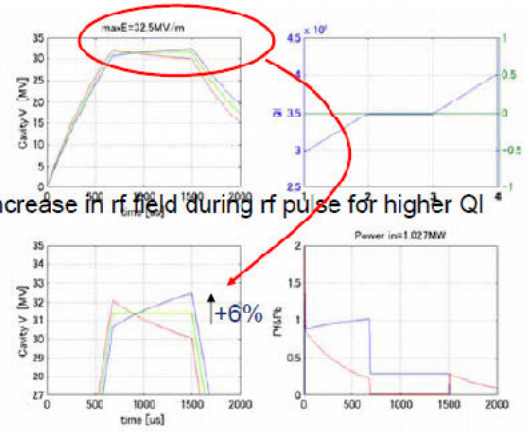


- +/-0.3dB variation in rf field (as expected).

-> need +/-0.8dB tuning range for +/-3MV/m variation.

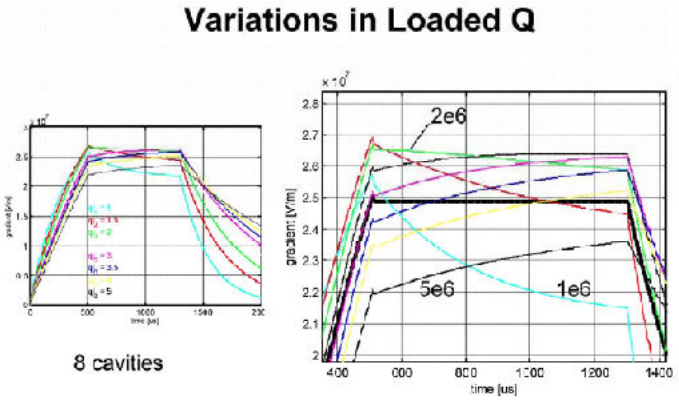
QI variation and cavity field gradient

- *All cavities have same rf distribution (-6dB).*
- *Loaded Q variation of the cavities are -15%,0%,0% and 15%. (+-15%)*
- *Nominal loaded Q is 3.49e6.*
- *Vector sum control without beam*



- +6% increase in rf field during rf pulse for higher QI

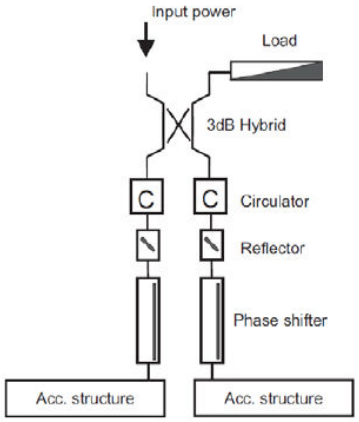
Variations in Loaded Q



8 cavities

By adjusting the QI, flat cavity V
Is achieved. By adjusting the power
Level, maximum cavity field gradient
Of each cavity will be expected.

QI Adjustment mechanism is introduced

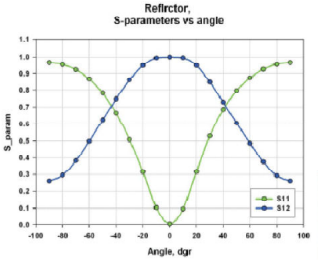


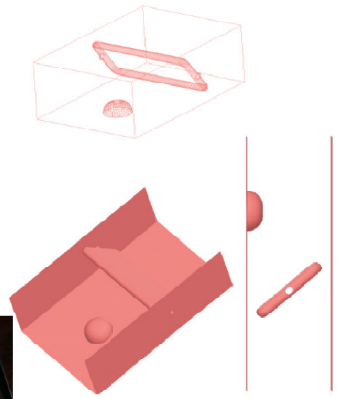
QI Adjustment is possible to use the reflector and phase shifter as shown in left figure.

Reflector

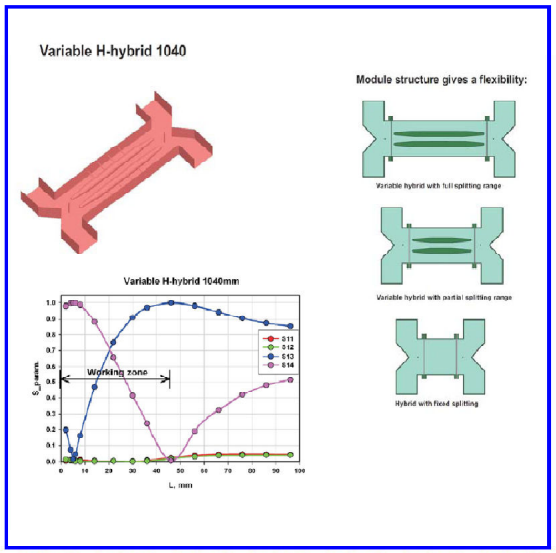
Parameters:

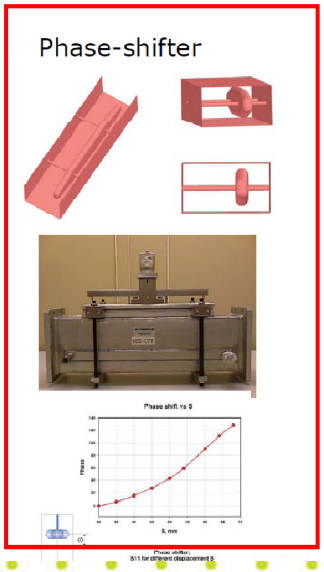
Max. Power (no reflection) 2 MW
S11 renge 0 - 0.97
S12 rerenge 1 - 0.26





Phase shifter



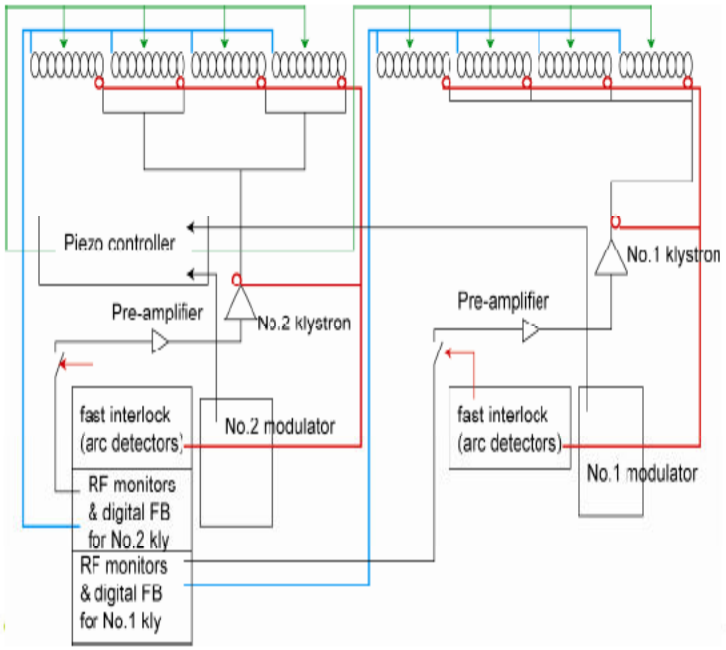


We expect that QI is adjusted by individual tuner and ϕ & reflector is auxiliary function.

LLRF Study at S1-Global
(More detail->S. Michizono's talk)

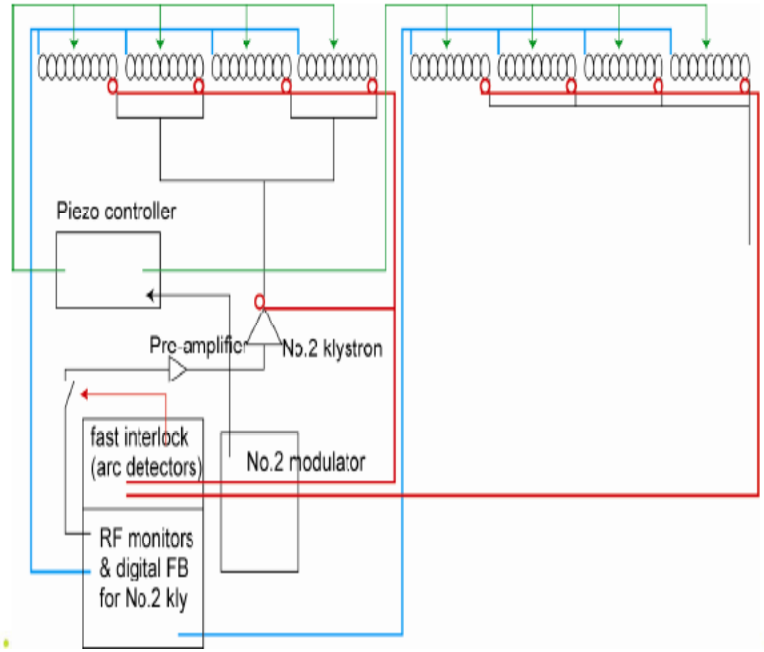
1st Stage of S1-Global LLRF

- Each 4-cavities is driven by a klystron (in order to reduce the conditioning time).
- Digital LLRF controls are located near No.2 klystron.
- Only fast interlock (MPS) system will be located at #1 klystron.



2nd stage of S1-global LLRF

All the cavities are driven by #2 klystron (5MW Output).



DRFS Demonstration
(For 3 week)

DRFS Test in S1 Global

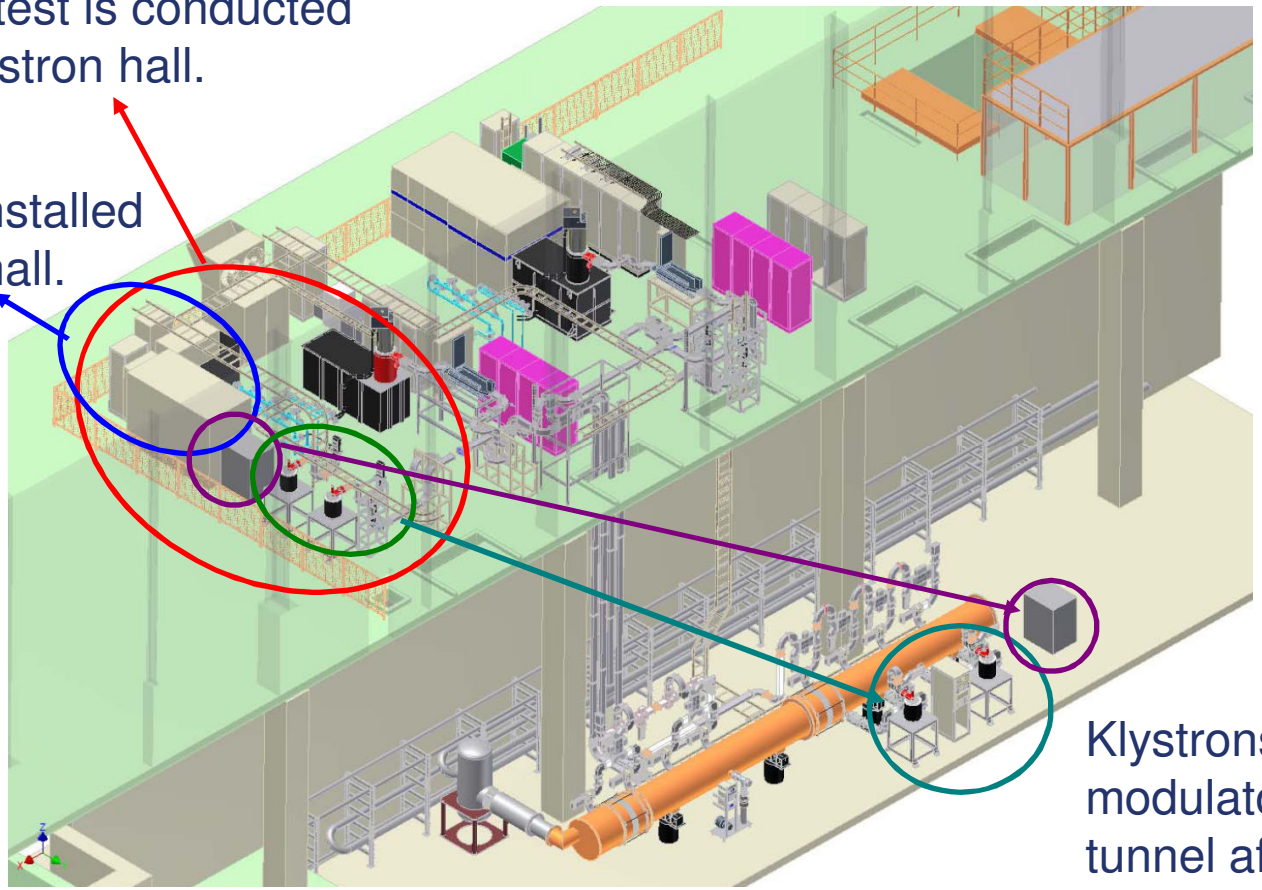
- Original plan of 4 weeks in S1 global will be reduced to 2 weeks plan because of LLRF program.
- Instead, DRFS test period will increase from 1 week to 3 weeks.
- Demonstration of 2-klystron DRFS system
- 1/3 of DRFS test periods are exhausted with setup of DRFS system: MA klystrons, MA modulator, cabling etc.
- Running of basic operation.
- Evaluation of high-voltage relay
- Crowbar operation trial
- RF performance in PDS test without circulator
- LLRF control for the 5% voltage drop due to the bouncer-circuit-less operation

Layout for DRFS in S1-Global

First test is conducted
In klystron hall.

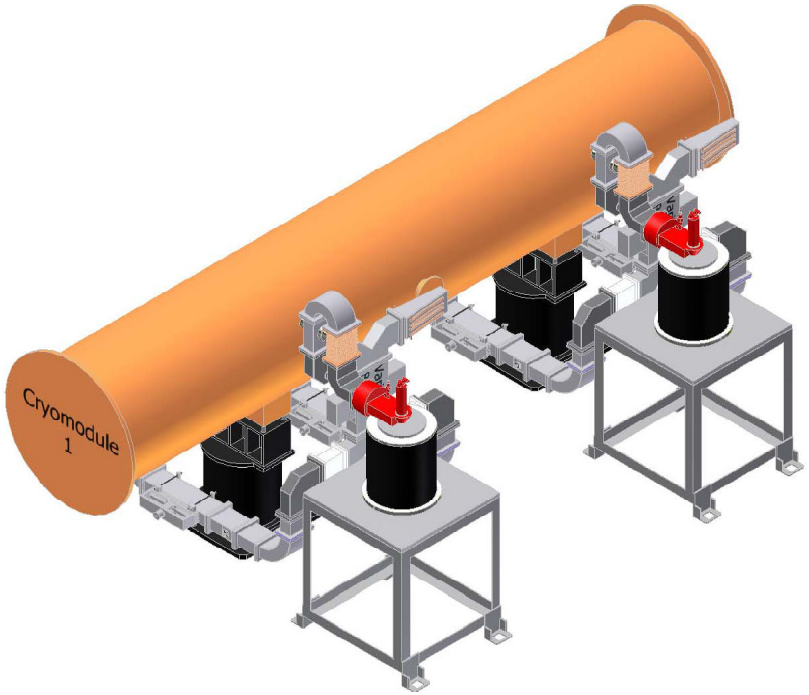
DC P/S is installed
In klystron hall.

DC cable of
30m



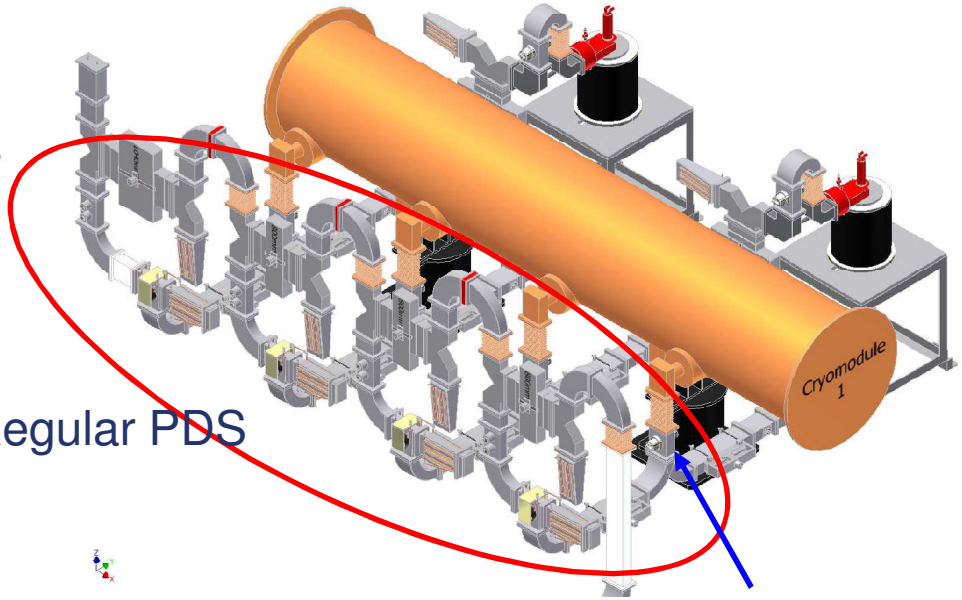
Klystrons and MA
modulator are moved to
tunnel after the first test
And used for S1-gloabl.

Klystron and PDS in DRFS of S1 Global



View from the klystron side
(corridor side)

View from the regular PDS side



Regular PDS

Disconnect point from regular
PDS to PDS of DRFS

DRFS Power Supply/Modulator

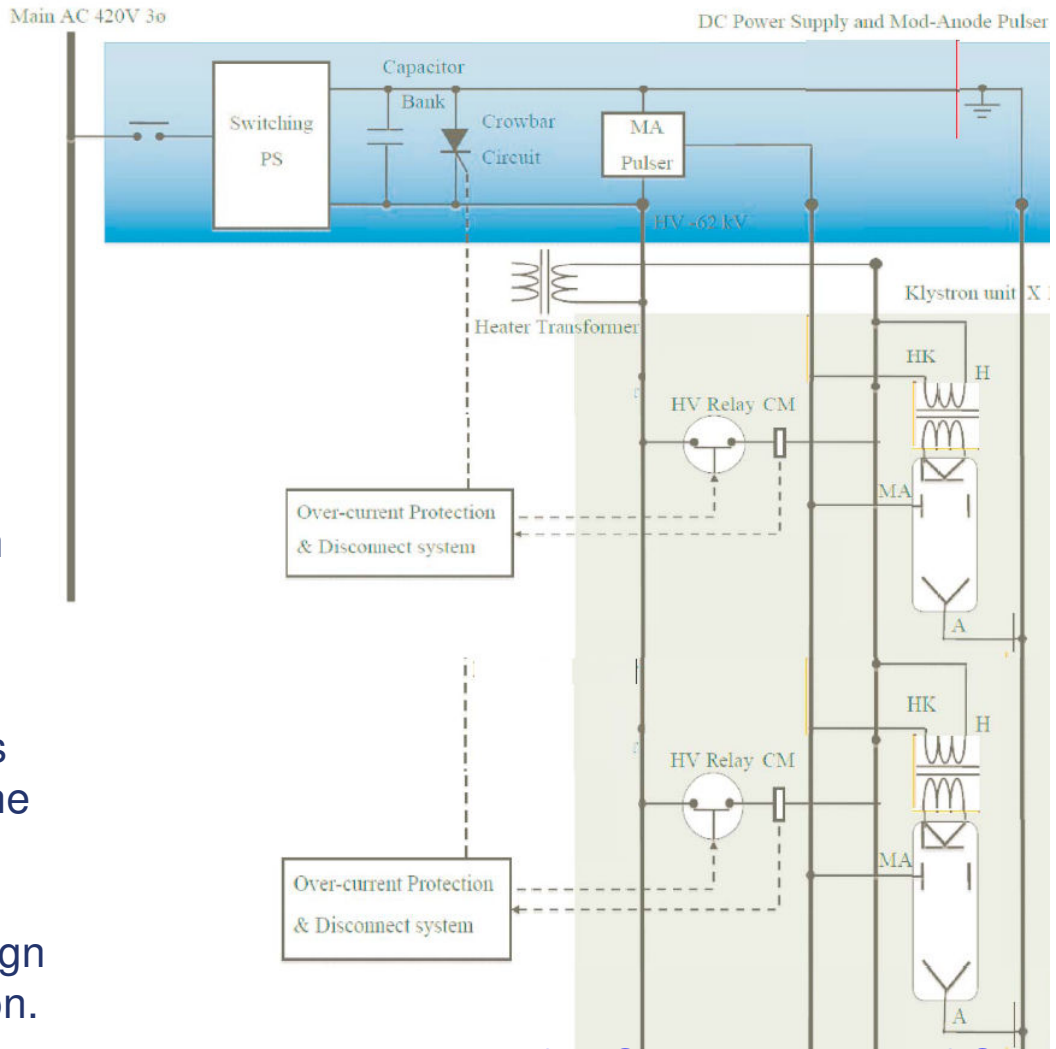
In FY09, prototype DC modulator And MA modulator are ordered.

Capability for 2 klystron loads

Due to small budget, bouncer circuit are not used in S1-G. Compensation of sag for RF is covered by LLRF feedback.
(If this attempt is successful, reduction of capacitors are benefit for cost).

Crowbar circuit using thyratron is introduced. Possibility for crowbar-less is tested. This is strongly depend on the klystron durability for HV discharge.

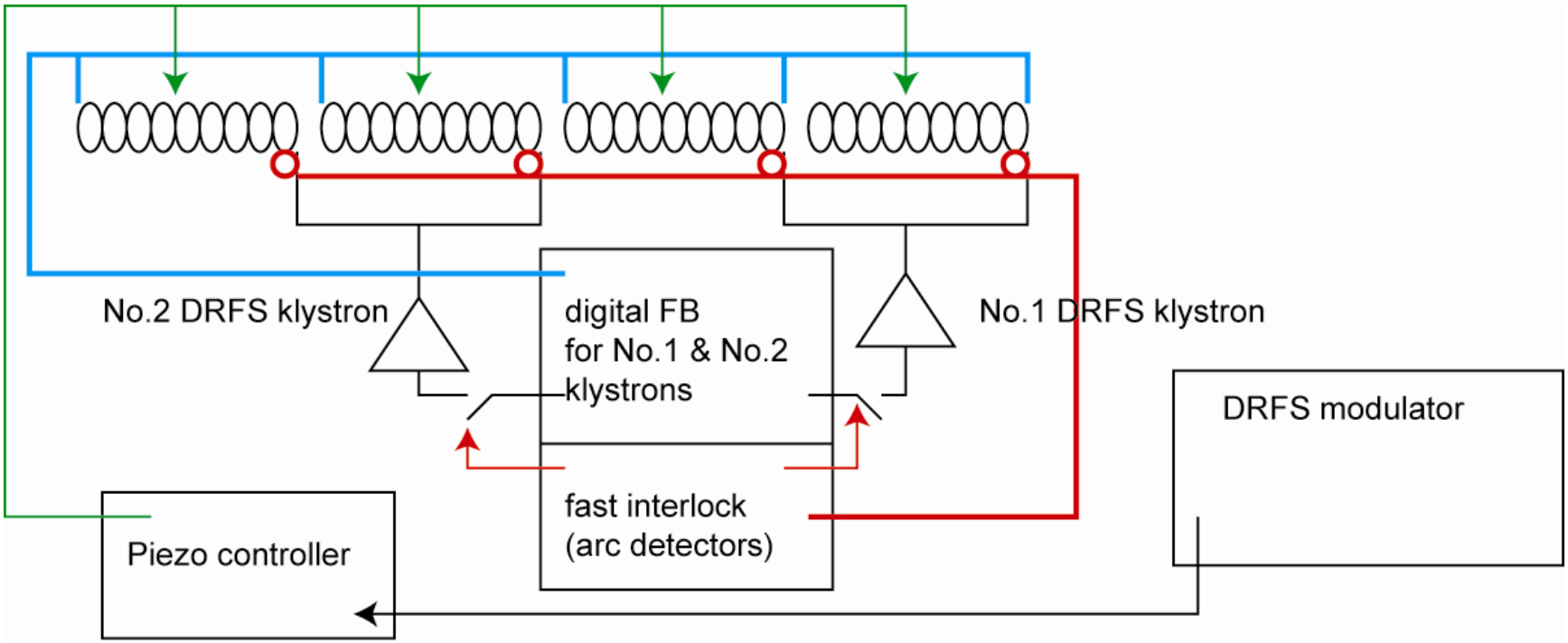
MA modulator is based on J-Parc design and studied the shunt resistor reduction. (strong effect for cost)



Basic Diagram of P/S& modulator of S1-G

Global S1 3rd stage

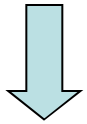
- New digital LLRF systems (uTCA) will be installed to the tunnel.
- Fast interlock will be also located at the tunnel.
- Piezo compensation from the ground level



Important LLRF Theme in DRFS

- In S1-global, due to the budget short, P/S doesn't employ voltage sag compensation (bouncer circuit). This results in 5% voltage droop and causes RF phase variation.

  LLRF feedback tries to compensate this phase variation.



  If this attempt goes well, capacitors of DC P/S can decrease the amount of corresponding to 5% sag. (Cost saving effect).

- DRFS without circulator requires the pair of cavities of which property are almost same. In DRFS, LLRF studies the effect of cavity pairing. Also diagnosis of QI using the position of pulse tail waveform.

  Detail will be described in S. Michizono's talk.

Summary

- Preparation of S1 global testing including the time schedule is reported.
- Purpose of S1 global is to demonstrate SC cavities are operated with average maximum accelerating field with the internal collaboration.
- In order to fulfill this purpose, HLRF introduce Ql and power adjustable way using reflector and phase-shifter. This will help for all cavities to achieve the maximum performance.
- PDS plan for the S1 global is shown in this report.
- SLAC VTO will be planed to be introduced for EU and UA cavity system
- LLRF plan for S1 global is also reported
- DRFS test period is increased to 3 weeks and test plan is explained.