KEK HLRF Status and S1-global

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KEK

Content

- Schedule of STF in KEK
- Current Status of STF-1
- Task of HLRF for STF-1
- Waveguide Component Development
- Toward the S1 Global

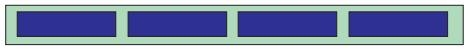
SCRF and STF Plan at KEK

STF0.5 for TESLA-like (done Nov.2007)

STF0.5 for ICHIRO (to finish Mar.2008)

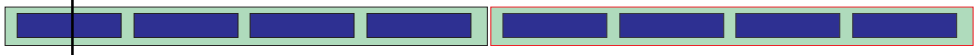
(red color indicates different cryostat)

STF1: for TESLA-like (to finish by end of 2008)



Full S1 Global: (TESLA-like + Europe/USA)

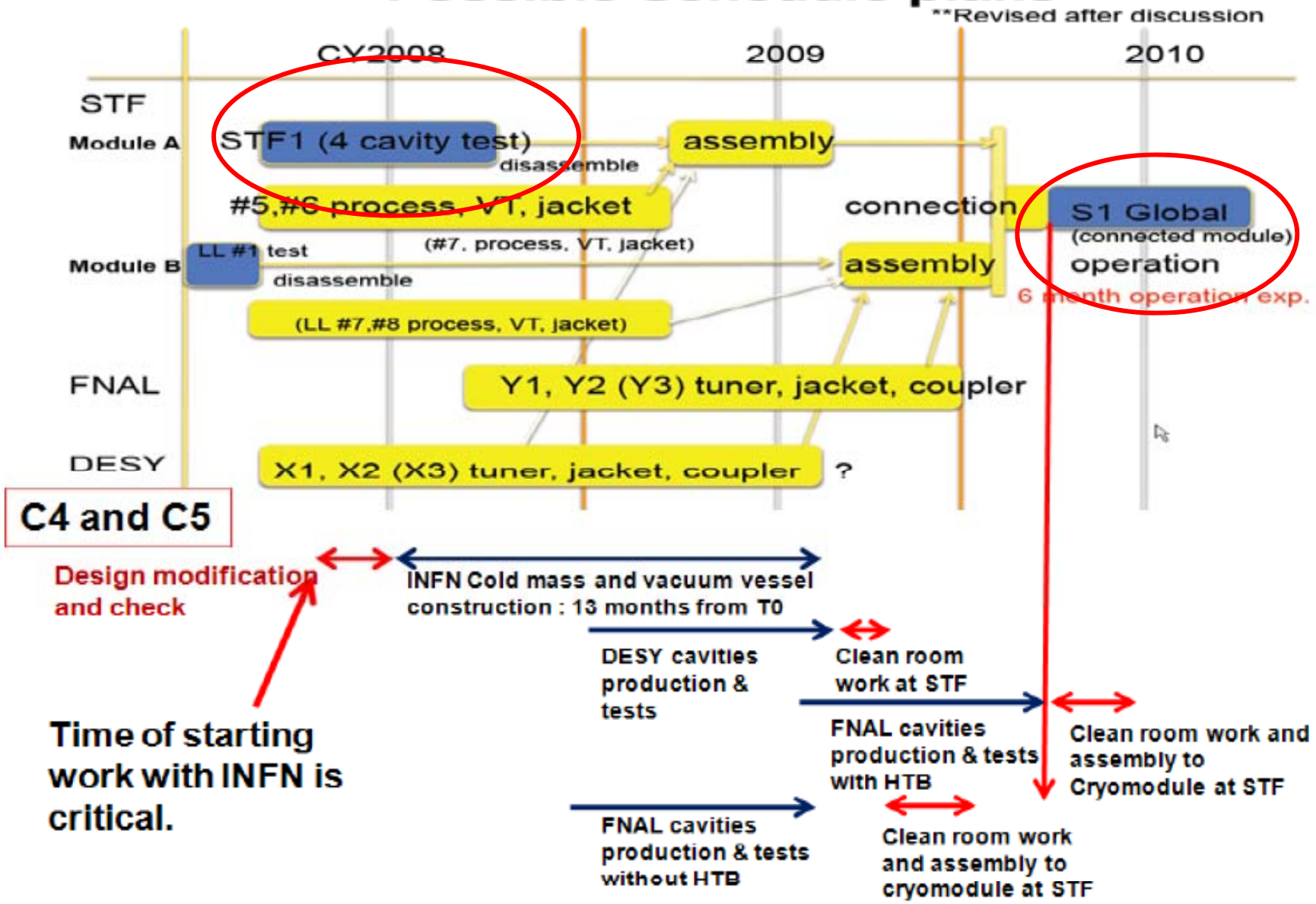
- Under discussing
- To finish in CY2010 if to be done



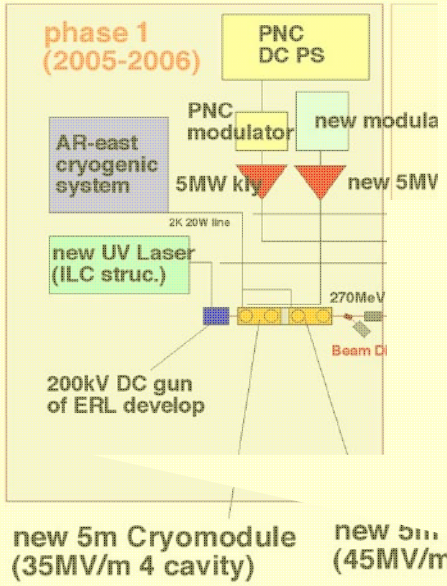
STF2 : design in JFY2010, construction in JFY2012-

(from scratch, not extension of STF1)

Possible Schedule plans



STF(KEK Superconducting RF Test Facility)



STF (Superconducting RF Test Facility)

STF-0.5(Under progress)

One 35MV/m-cavity in a 5m-long Cryomodule

+

One 45MV/m-cavity in a 5m-long Cryomodule

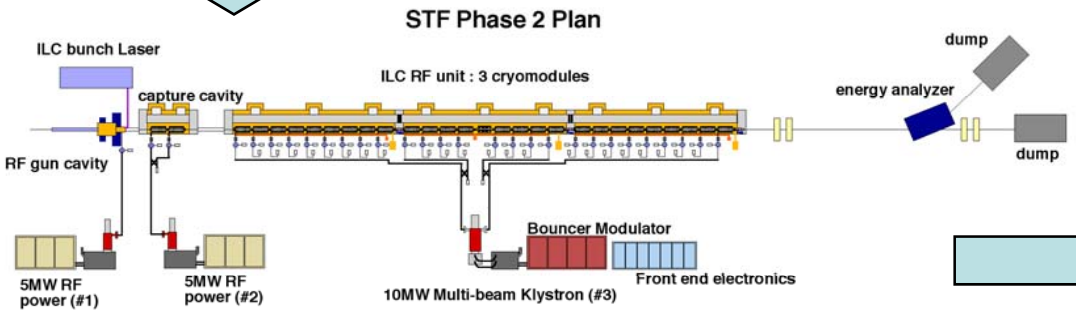
STF-1.0 (2008:Delaying)

Configuration See left figure Necessary Infrastructures for STF (including EP, CP …) will be introduced.

Required RF Components

STF-1.0 (1.3GHz,L-band)

- 5MW Klystron x 1 (Spare x 1)
- Pulse Modulators
  - for 5-MW Klystron
- Power Distribution System (PDS)
  - for 4-Cavity System
  - (another Alternative PDS)
- LLRF (Analogue control, Digital control)

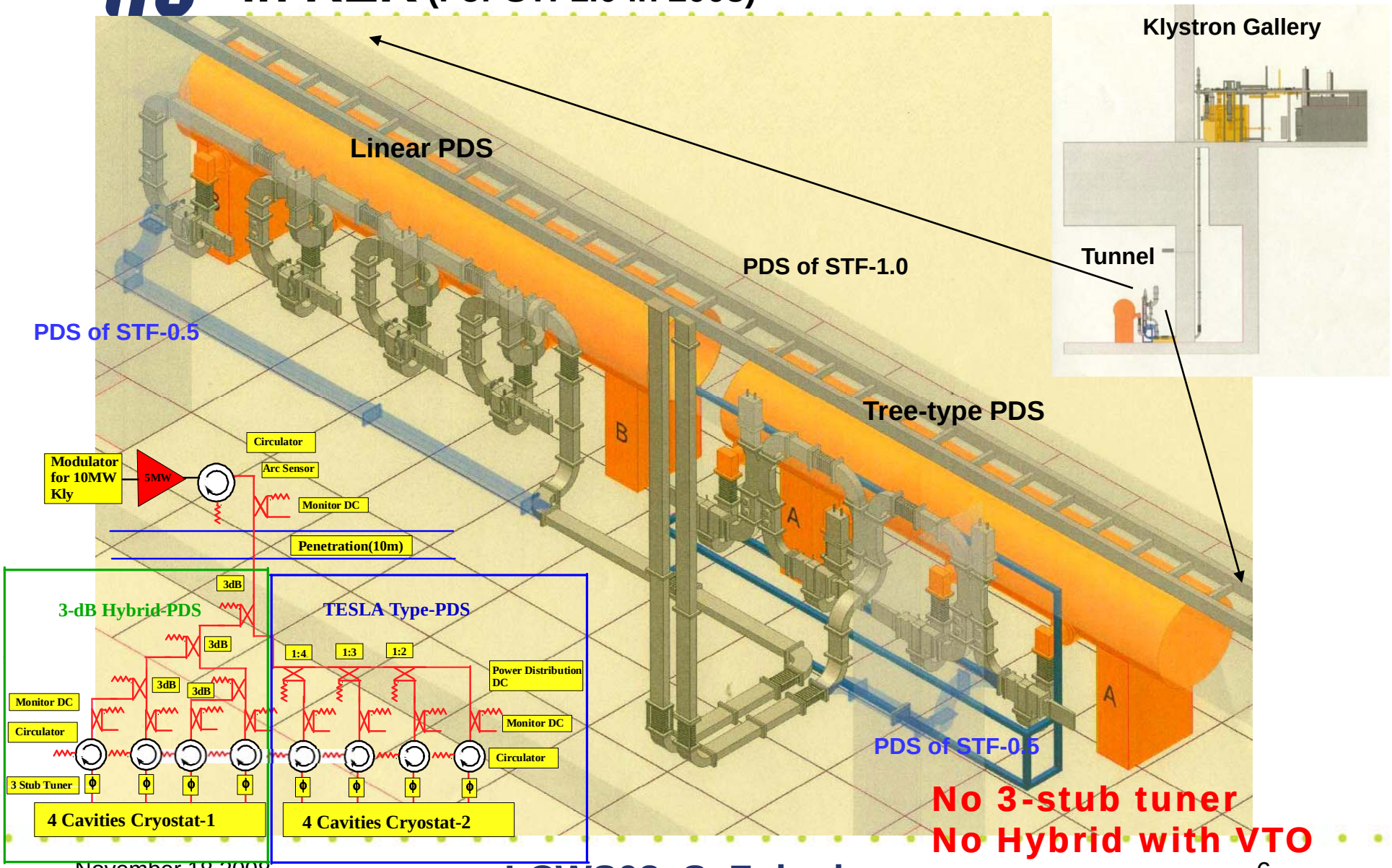


STF-2.0

- 10MW MBK
- Pulse Modulator (New)
- PDS for 26-cavity system
- LLRF

STF-Phase 3.0

Original Plan of Power Distribution System in KEK (For STF1.0 in 2008)



Current PDS for STF-0.5 and STF-1.0

Installed coupler to Cryomodule for the test of STF0.5.
HLRF test for a cavity Was successfully Finished.

STF-0.5 TTF-type cavity system with tree-type PDS

Tree-like PDS (Front)

Linear PDS

Assembled PDSs in KG and waiting for the evaluation test. 4 circulators from Russia and 4 ones from Japan were installed.
A 3dB hybrid with VTO was delivered.

Task of HLRF for STF-1

Current STF-1 tests only 4-TTF-type cavity system.

- Required Power Feeding to
  - **each coupler independently**
  - **each cavity independently**
  - **4 cavities at the same time**
- HLRF Own Program
  - **Evaluation of Tree-type PDS with 3dB VTO**
    - With Circulators
    - Without Circulators
  - **Evaluation of Linear-type PDS**
    - Matching to the cavity with deferent Ql, deferent power capability

STF-1 is now under testing

Up to the end of November

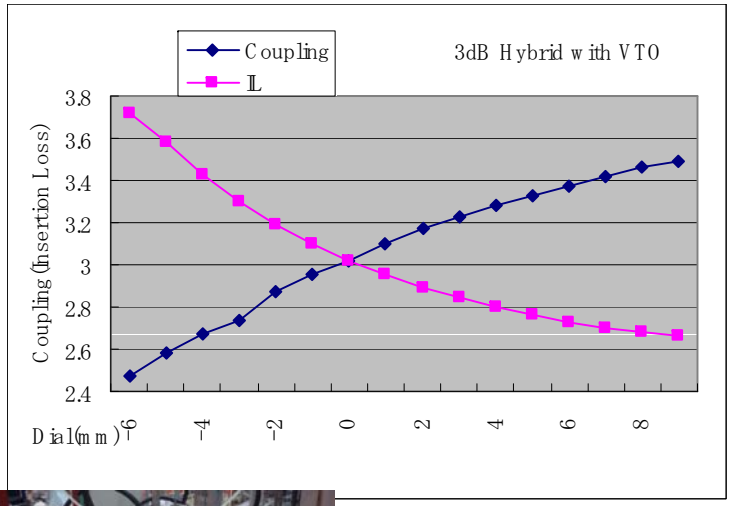
- **Coupler test and cavity test are performed**
- **3 cavities go to 22MV/m**
- **1 cavity goes to 32.9MV/m**

HLRF Own Program from December

- **Evaluation of Tree-type PDS with 3dB VTO**
  - With Circulators
  - Without Circulators---LLRF vector sum control
    ---investigation changing the hybrid isolation
- **Evaluation of Linear-type PDS**
  - Optimization of Ql by Adopting Reflector and Phase-shifter

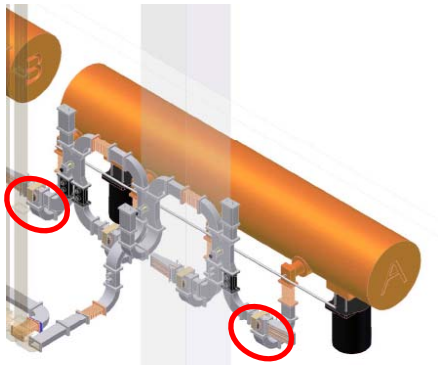
Test of tree-type PDS

3dB/4.7dB Hybrid with VTO (KEK)
:cheep & Simple.
+-10% variable
Isolation is also variable from 25 to 40dB.



6dB with VTO is not available. 3dB with VTO is employed to tree-type PDS

Insertion of button
Is varied



Tree-Type PDS employs 3dB hybrid with VTO.
One 3dB hybrid connected
To a pair of cavities.
•4 circulators system
•2 circulators system (red one is taken out)
•No circulators system

Elimination of circulator is important task,
But interference by reflected power
Is studied. This is Depend on the Isolation of hybrid.

Possibility of elimination of circulator

Interference is evaluated by LLRF vector sum control Under changing the isolation

Consideration of S1 and S1-global at STF

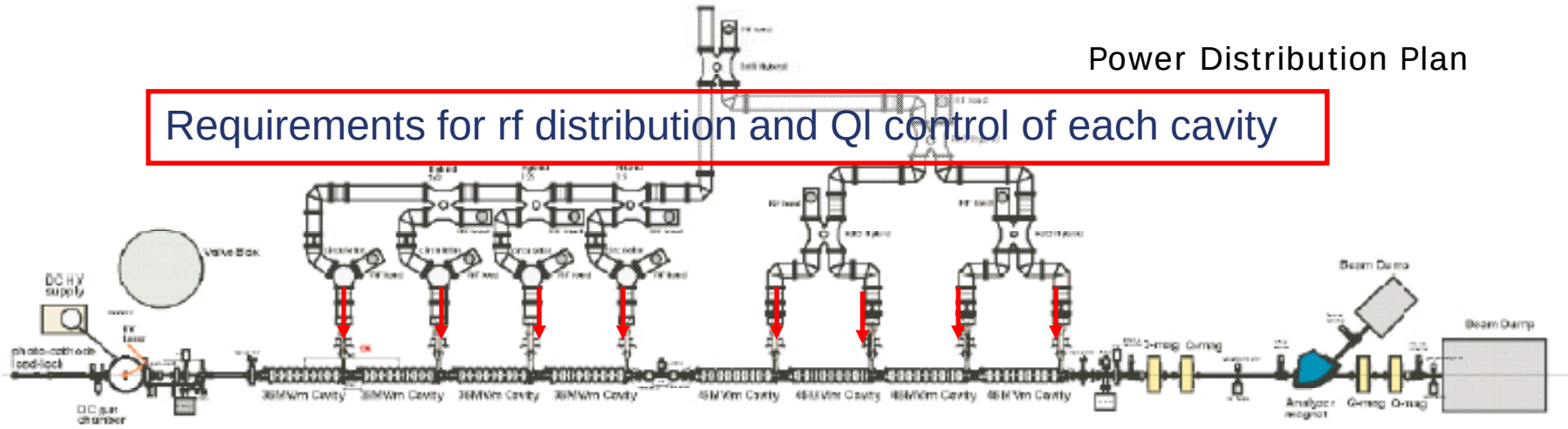
- **Eight** cavities will be installed. → **S1:4cavities/S1 Global:8 cavities**

(Assumption)

- *Average gradient should be 31.5 MV/m.*
- *Cavities are operated without beam (no beam loading).*
- *Cavity operating gradient can be depend on the performance of each cavity and it ranges from 28.5 MV/m to 34.5 MV/m.* → ***S1: 22 to 32.9 MV/m***
- *Loaded Q of each cavity varies **+/-15%.** RF distribution ratio can be controlled by fine tuning (to some extent).*

Power Distribution Plan

Requirements for rf distribution and Ql control of each cavity



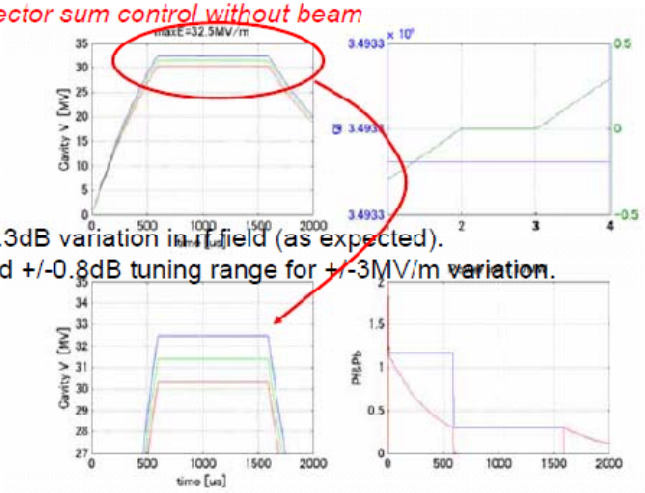
Linear Power Distribution Plain view Tree-like Distribution

Simulation for the cavity with different gradient and QI

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*

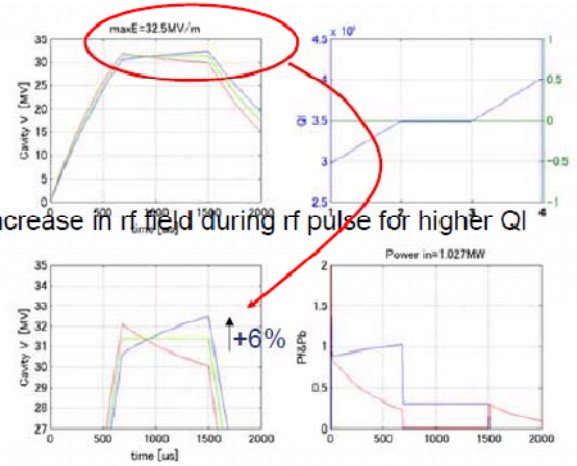


- +/-0.3dB variation in rf field (as expected).

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

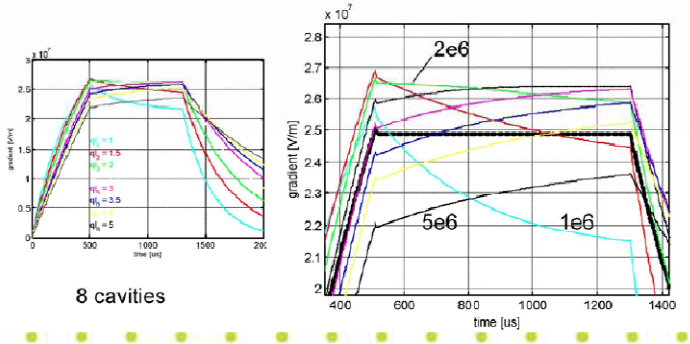
QI variation and cavity field gradient

- *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*



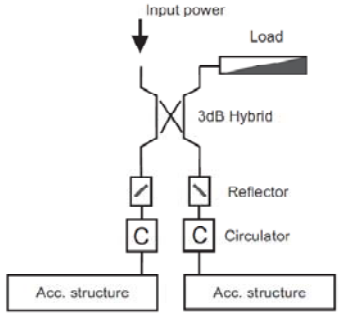
- +6% increase in rf field during rf pulse for higher QI

Variations in Loaded Q



8 cavities

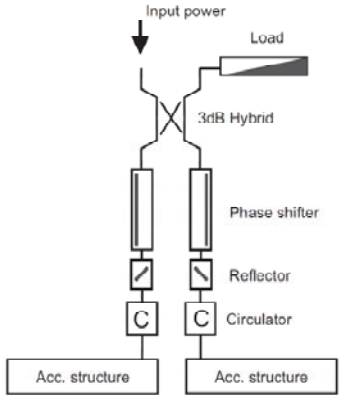
Optimizing Methods for cavity system having different quenching level and QI



Solution 1 (minimal):

Power control, no phase control, no Q control.

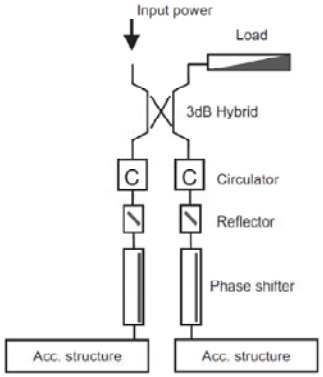
Equipment: 1 reflector / acc. structure.



Solution 2:

Power control, phase control, no Q control.

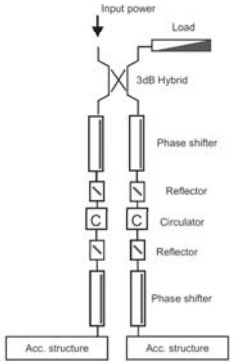
Equipment: (reflector + phase shifter) / acc. structure.



Solution 3:

No power control, no phase control, Q control.

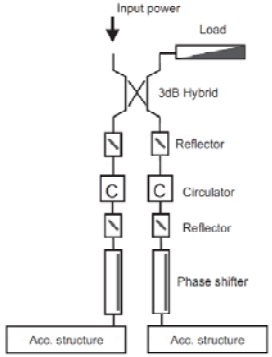
Equipment: (reflector + phase shifter) / acc. structure.



Solution 5:

Power control, phase control, Q control.

Equipment: (2 x reflector +2 x phase shifter) / acc. structure.

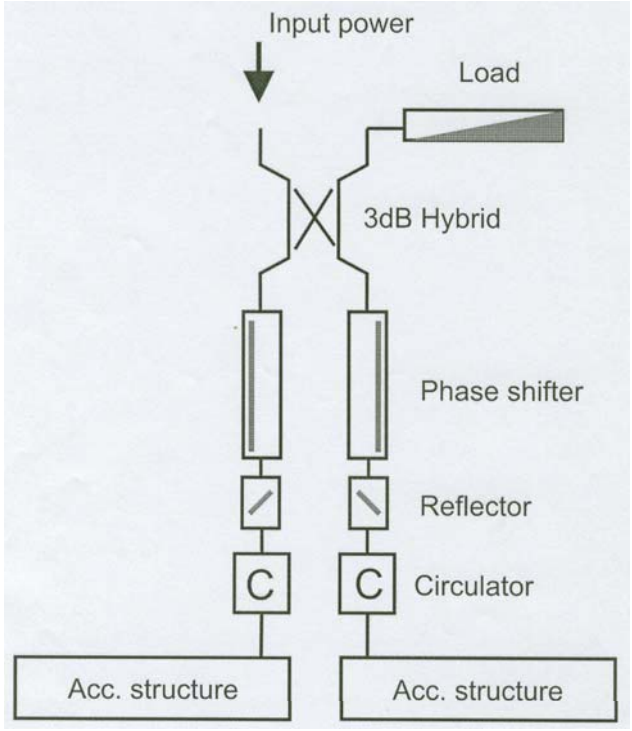


Solution 4:

Power control, no phase control, Q control.

Equipment: (2 x reflector + phase shifter) / acc. structure.

Alternative power divider with VTO applicable to the KEK STF1.0



KEK's cavity has no-Q tuner.

In Linear PDS, pair of reflector and phase shifter After circulator are Used.

In S1, Ql is tried to be matched

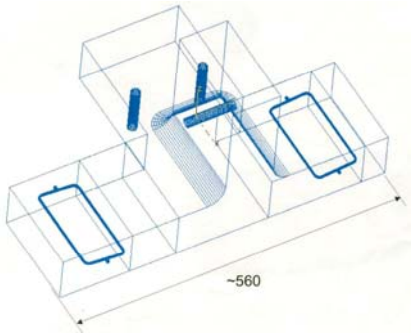
Applicable to ILC PDS such as 9-cavity?

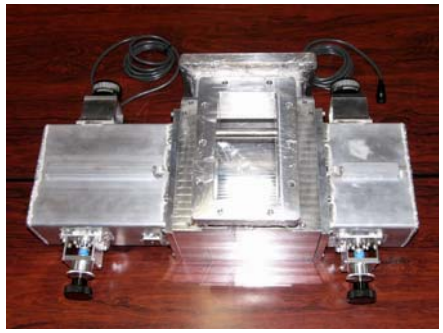
How about the circulator elimination?

Cost comparison Between the elimination of coupler tuner and this system.

3 types of phase shifter are developed in KEK

Phase-shifter 1

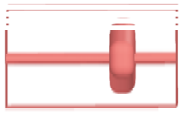


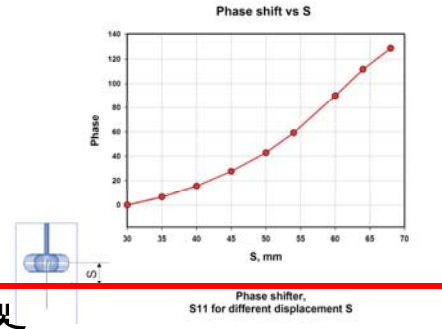


Phase-shifter 2

フラップ部分

Phase-shifter 3





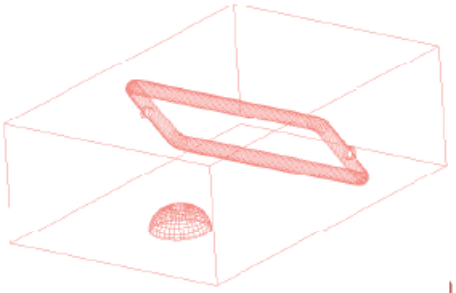
全体図

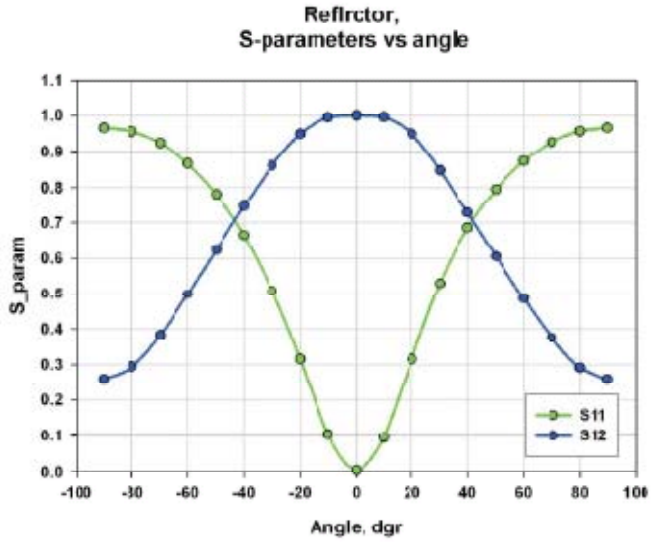
マルチフラップによる位相器

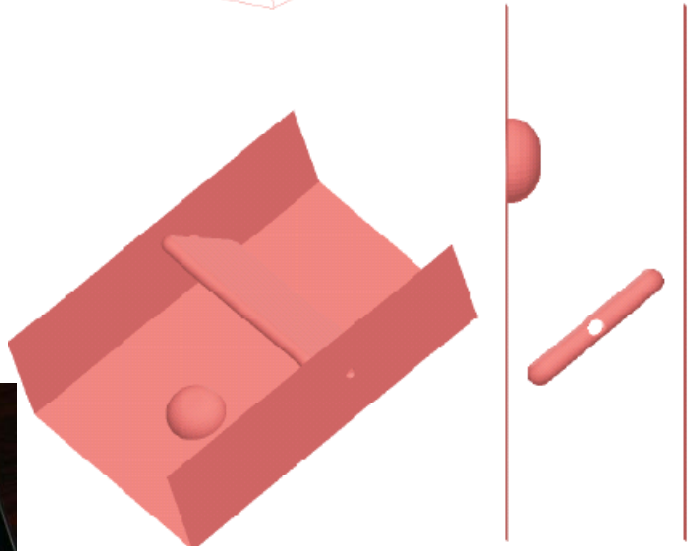
Reflector (S. Kazakov)

Parameters:

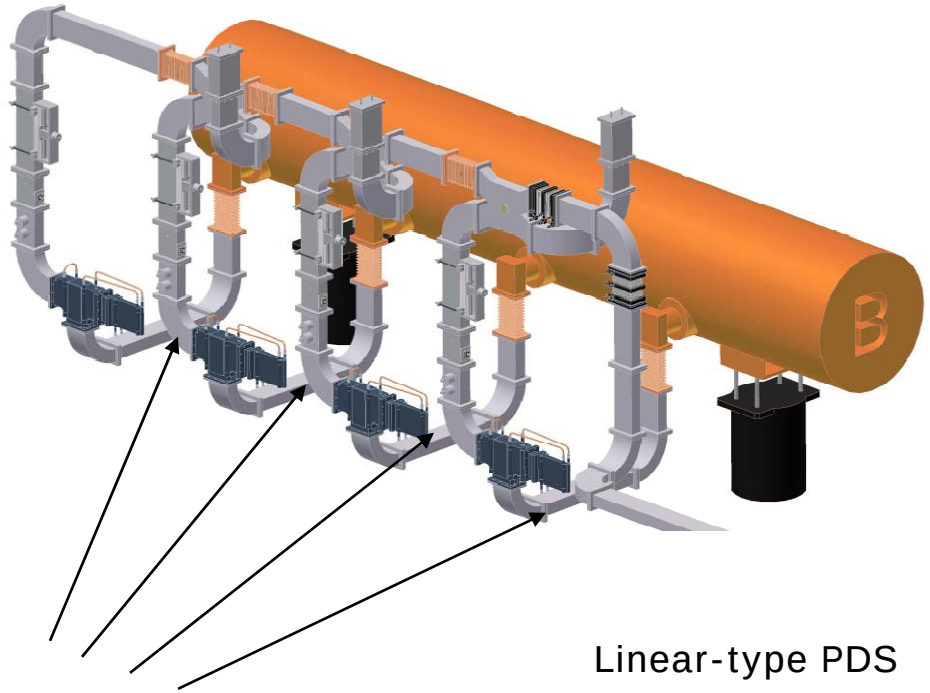
Max. Power (no reflection) 2 MW
S11 renge 0 - 0.97
S12 rerenge 1 - 0.26







Linear –type PDS for STF-1



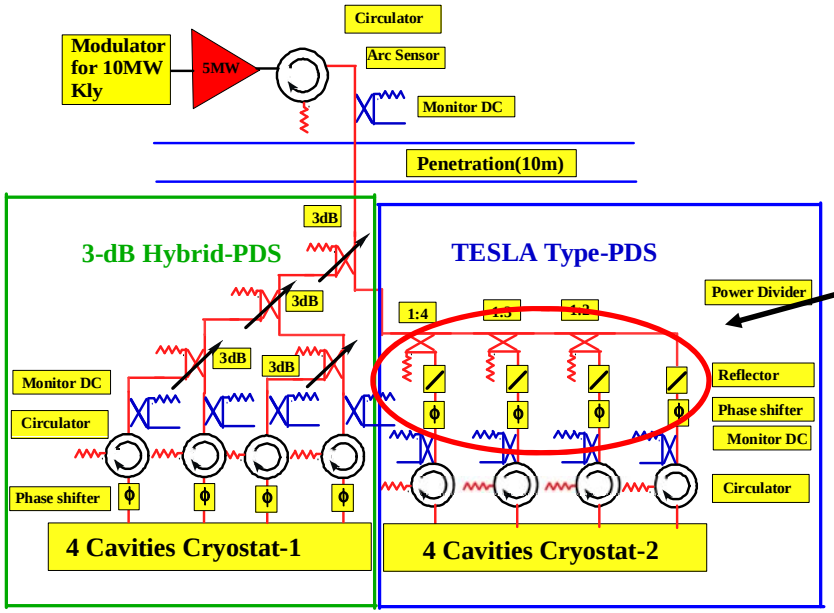
Insertion of reflectors and circulators

Linear-type PDS

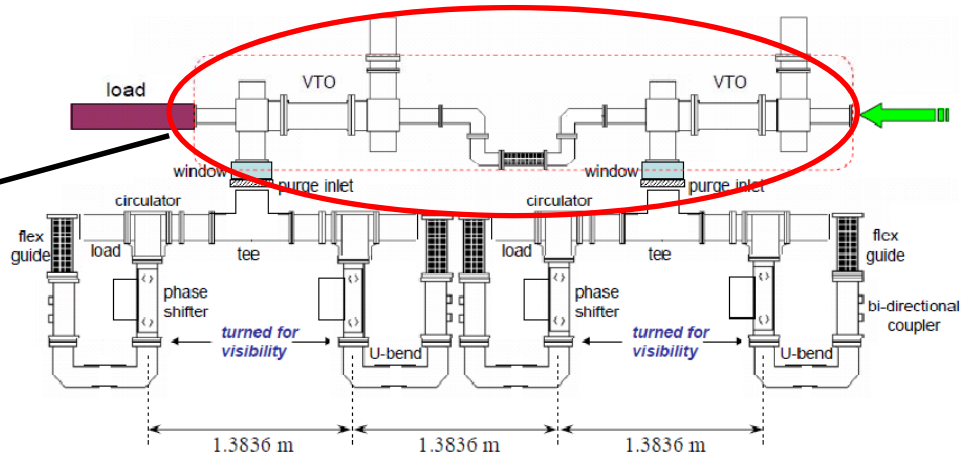
- Variable Ql
- Variable Power

Possible PDS Scheme for S1 & S1 global

Possible scheme



SLAC VTO



S1 may be changed to S1-half: only 4 cavity, then one among the 3-dB hybrid PDS and the TESLA type PDS is enough. Three types of Phase shifter,i.e.,3-stub tuner, DESY type and KEK type, are tested. For S1 global, KEK cavities are tested using KEK's PDS and EU&US cavities are tested using SLAC VTO.

Cavities for S1-global in KEK

- Expecting Cavities for S1-global
  - **2 Cryomodules with 8 Cavities**
    - 4 from Asia including Ichiro Cavity(?)

    -> No coupler tuner (Fixed coupler),

    Power divider with VTO (+-10%?)
    - **2 from EU**

      2 from US

    -> With coupler tuner, Power divider (SLAC VTO)
  - **Cavities with different dimension with different gradient**
  - **Interface between the coupler and waveguide**

Summary

- S1 testing is under going and current status is reported.
- HLRF testing is planed in STF-1, including the circulator elimination and 2 different PDS's checking.
- Ql and power changing way using reflector and phase-shifter is introduced.
- Development of waveguide components such as reflector and phase-shifter is introduced.
- HLRF plan for S1 global is reported
- SLAC VTO is planed to be introduced for EU and UA cavity system