# Tuner, Coupler WP & specification table

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# Work Package

## Cavity Package

### WP-CP1. Tuner

**Tuner Selection ( Saclay tuner, Brade tuner, Slide-jack tuner, Ball-screw tuner, together with Fast tuner selection)**

**Lorentz detuning compensation (specification, method, required rigidities, fast tuning specification,…)**

**Motor location ( inside/outside/inside with accessible )**

**Piezo location ( inside/ accessible)**

**[Baseline Selection at end of 2008], then detail engineering design.**

### WP-CP2. Coupler

**Baseline coupler : TTF-III (variable coupling)**

**Consideration of fixed coupling for easy installation/handling, cost point of view.**

**Re-visit of port diameter, etc.**

**[Selection of fixed/variable coupling at end of 2008], then detail engineering design.**

# Work Package (cont.)

## WP-CP3. Cavity Magnetic shield

**Magnetic shielding method (inside or outside vessel)**

**[Selection of magnetic shield inside/outside at end of 2008], then detail engineering design.**

## WP-CP4. Cavity vessel

**Vessel material ( material selection, metal junctions, HPV regulation) including alignment method.**

**[Engineering design detail at end of 2009]**

## WP-CP5. Cryomodule Operation ( S1 task )

**Demonstration of 31.5MV/m operation by at least one cryomodule.**

**Possibility of STF phase 1 connected module with cavities from US, EU to be a S1 module (S1 global).**

**[demonstration by end of 2009]**

# Plan for developing WPs and Spec. tables

- Call of EOI for proposed WP,  done. (from IHEP, KEK-WG5 already received, LAL)
- Develop WP, with interested Institute, with resource(?), ~end of November.
- Revise specification profile table, ~end of November.
- Finalize WP & spec. tables, Feb.2008

3 - 7 March, ILC-GDE meeting at Sendai

# Specification tables
# which allow a plug-compatible concept (1)

| tuner | specification item | specification | unit and comments | |
|---|---|---|---|---|
| Slow tuner | Tuning range | >600 | kHz | |
| | Hysteresis in Slow tuning | <10 | μm | |
| | Motor requirement | step-motor use, Power-off Holding, magnetic shielding | | |
| | Motor specification | 5 phase step motor | match to driver unit, match to connector pin asignment | xxA/phase to be specified later. |
| Slow Tuner | Motor location | insdie 4K? / outside 300K? / inside 300K accessible from outside? | need availability discussion, MTBF | need more discussion |
| | Magnetic shielding | <20 | mG at Cavity surface, average on equater | |
| | Heat Load by motor | <50 | mW at 2K | |
| | Physical envelope | do not conflict with GRP, 2-phase line, vessel support, alignment references, Invar rod, flange connection,… | | cable connection, Mag shield |
| | Survive Frequency Change in Lifetime of machine | ~20 Mio. steps | could be total number of steps in 20 years, | |
| | | | | |

# Specification tables
# which allow a plug-compatible concept (2)

Fast Tuner

| | | | | |
|---|---|---|---|---|
| Fast tuner | Tuning range | >1 | kHz over flat-top at 2K | |
| | Lorentz detuning compensation | <100 | Hz at 31.5MV/m flat-top | |
| | Actuator specification | low voltage piezo 0-200V | match to driver unit, match to connector pin asignment | |
| | Actuator location | insdie 4K?/inside 4K accessible/inside 100K? accesible / inside 300K accessible from outside? | | need more discussion |
| | Magnetic shielding | <20 | mG at Cavity surface average | |
| | Heat Load in operation | <50 | mW | measure first, decide later |
| | Physical envelope | do not conflict with GRP, 2-phase line, vessel support, alignment references, Invar rod, flange connection,… | | |
| | Survive Frequency Change in Lifetime of machine | $>10^{10}$ | number of pulses over 20 years, (2E9:operational number) | |

# Specification tables
# which allow a plug-compatible concept (3)

Coupler

| specification items | condition | specification | unit and comments | | |
|---|---|---|---|---|---|
| Power requirements | Operation | >400 | kW for 1300 us | | |
| | Proccessing | >1000 | kW upto 400 us | need after vac break, & cool-down | |
| | | >600 | kW larger than 400 us | need after vac break, & cool-down | |
| | Processing with reflection mode | >600 | kW for 1300us | in Test stand | |
| | | | | | |
| Processing time | warm | <50 | hours | after installation | |
| | cold | <30 | hours | after installation | |
| | | | | | |
| Heat loads /coupler | 2K static | <0.1 | W | | decide later |
| | 5K static | <0.5 | W | depend on tunability | decide later |
| | 80 K static | <3 | W | | decide later |
| | 5K dynamic | <0.3 | W | | decide later |
| | 80K dynamic | <3 | W | | decide later |
| | | | | | |
| Cavity vacuum integrety | | 2 | # of windows | | |
| | | NO | bias capablity | | |
| | | | | | |
| RF Properties | Qext | Yes/No | tunable | | need more discussion,decide later |
| | Tuning range | 1-10 | 10^6 if tunable | | need more discussion,decide later |
| | | | | | |
| Physical envelope | Position | | compatible to TTF-III | | |
| | Flange | | compatible to TTF-III | | to cavity, to cryostat |
| | waveguide | | compatible to TTF-III | | |
| | support | | compatible to TTF-III | | |
| | | | | | |
| Instrumentation | | | | | |
| vacuum level | | >1 | | | |
| spark detection | | 0 | at window | | |
| electron current detection | | >1 | at coax | | |
| temperature | | >1 | at window | | |

# Specification Table

Determine the design profiles/outlines.

To be used for  the plug compatible design.

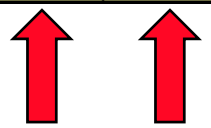
The plug compatible design, the alternate design must meet this specification table.

They should demonstrate the specification with required number of validation test.

# Survey Results (abbreviated)

Rich Stanek

| Validation Survey | NOTE: Vallidation tests occur after all R&D and prototype work is complete & design change is mature enough to be considered as change to baseline | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| If you make a change in this → | Cavity Shape LL OR RE | Cavity Material Large Small Grain | Magnet Shield Location | Quad Design | Quad Position | BPM Design | He Vesssel SS vs. Ti | Tuner Design | Coupler Design | Pipe Size (dia) | Rad Shield Design | Support Design Transport fixture | Instrumentation | Align System |
| You validate the change by doing this ↓ | | | | | | | | | | | | | | |
| Can design change be made without testing? (Y/N) | N | N | N | N | N (few Y) | N | N | N | N | Y (few N) | Split | N | N | N |
| Number of components fabricated & tested? | 24-30 | 30 | 10 | 1-3 | 3 | 3 | 24-30 | 10 | 24 | 1 | 1-3 | 1-3 | 1 | 1 |
| Does design change require only component level testing? (Y/N) Component level testing equals Vert or Horiz testing or cycle test | N | Y (V&H) | N | N | N | N | Split (H) | N | N | N | Split | N | N | N |
| Hours of component level testing? | | 1000hrs | | 40hrs | | 500hrs | 1000hrs | 1000hrs | 1000hrs | | | 250 hrs | 250 hrs | |
| Does design change require testing in cryomodules (without beam)? (Y/N) | Y | N | Y | Y | Y | Y | Y (few N) | Y | Y | Y | Y | Y | Y | Y |
| Number of cryomodules? | 3 | | 1 | 1 | 3 | 3 | 3 | 1-3 | 3 | 1 | 1 | 1-3 | 1-3 | 1 |
| Does design change require testing in RF Unit/String test (with beam)? (Y/N) | Y | N | N | N | Split | Y | N | Split | Split | N | N | N | N (few y) | N |
| Hours of string testing? | 1000hrs | 0 | 0 | 0 | 1000hrs | 1000hrs | 0 | 1000hrs | 500hrs | 0 | 0 | 0 | 100hrs | 0 |



Results from survey can be used to identify dependencies in design schedule

# Tuner selection

✔1. Identify the down-selection item.

✔2. Identify the proposal & proposer of the technology.

3. Make comparison tables for advantages & disadvantages from each proposer.

4. PM Make  fair-minded comparison table to be filled in by each proposer.

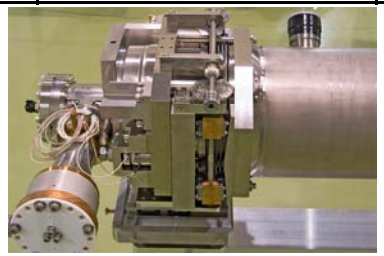
5. PM decide the technology according to the table.

# comparison table for baseline tuner selection

**Need to develop the table!**

| Slow Tuner | | | | | |
|---|---|---|---|---|---|
| | | TTF | INFN/FNAL | STF | STF |
| | | **Saclay -1** | **Blade** | **Slide Jack** | **Ball Screw** |
| | | Lifetime Test (~ 0.1mm x 10000 Times) is necessary. | | | |
| Mechanism | | Double Lever | Blade+Lever+Screw | Wedge+Screw+Gear | Screw+Worm Gear |
| | | | Blade has the potential Problem of Fatigue? | | Life time of Coating? |
| Stiffens | N / μm | 40 | 25 | 290 | 1000 |
| | | Seems not stiff enough | Seems not stiff. If used to TESLA Cavity DLD at Flat-Top becomes ~900Hz. | | |
| Stroke | mm | | < 2 | 3.5 | Long enough |
| Location | | Beam Pipe | Jacket Cylinder | Jacket Cylinder | Jacket Cylinder |
| | | The room for tuner is small. Top Heavy. Alignment? | | | |
| Cost | | | | | |






Cont.

| Fast Tuner | | | | | |
|---|---|---|---|---|---|
| | | TTF | INFN/FNAL | STF | STF |
| | | **Saclay -1** | **Blade** | **Slide Jack** | **Ball Screw** |
| | | Piezo(200V) | Piezo(200V) | Piezo(150V) | Piezo+Blade |
| | | | Speed ? | | Blade has the potential Problem of Fatigue. Speed ? |
| | | NORIAC (1 Spare) | NORIAC (1 Spare) | Piezo Mechanic x 1 | Piezo Mechanic x 1 |
| Size | mm | 10 x 10 x 26 | 10 x 10 x 38 | φ20 x 18 | |
| Stiffness | N / μm | 105 | 70 | 500 | |
| Max. Load | kN | 4 | 4 | 14 | |
| Stroke:RT | μm | 40 | 60 | 20 | |
| Stroke:2k | μm | 4 | 6 | 2 | |
| Compensation | μm | 3.4 | 6 | 1 | |
| Speed | | | | | |
| Delay | | 0.6 msec. | | | |
| | | | | | |
| **Repairability** | | | | | |
| Motor | | need Disassemble | need Disassemble | Outside | Accessible? |
| Piezo | | need Disassemble | need Disassemble | Repairable | Accessible? |
| | | US Study on this Subject exists. | | | |
| | | How to check Piezos just we install. There are no experience for long term operation in Pulsed mode. Life time Test is necessary. | | | |

**Would like to call Tuner discussion as follows;**

for DESY (Saclay) Tuner,
for INFN Tuner,
for KEK (Noguchi) Tuner,
….  Later, KEK (Higashi) Tuner,

discussion of Lorentz detuning compensation.

discussion of motor/piezo maintainability.

**Would like to call Coupler discussion as follows;**

for strategy of using fixed coupling

for improvement of coupler process.