# Cavity Technical Specification

IWLC2010 WG3 industrialization session
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# 1. Guide-line of the technical specification

(1) Baseline: TESLA cavity with ILC-short length
+ TTF-III coupler

*Baseline of Tuner : will be decided later,
after performance & cost comparison

(2) Performance: need to describe
RF, thermal, Mechanical, Electrical -performance

(3) Procedure: need to describe
Fabrication, Treatment, Inspection, Test -Procedure

(4) Plug-compatibility: describe clear boundary definition

(5) High-pressure-vessel Regulation:
need to describe how to clear it

# 2. Performance specification

We have “specification table” which will be a start point.

| cavity | specification item | specification | unit and comments | further comments |
|---|---|---|---|---|
| RF properties | Frequency | 1.30 | GHz | |
| | Number of cells | 9.00 | cells | |
| | Gradient | 31.50 | MV/m | operational |
| | | 35.00 | MV/m | Vertical test |
| | Q0 | 0.80 | 10^10 | at 35 |
| | | 1.00 | 10^10 | at 31.5 |
| | HOM damping | | Q | decide later |
| | | | R/Q | decide later |
| | Short range wake | | | decide later |
| | Operating temperature | 2.00 | K | |
| Physical properties | Length | 1247 | mm | TESLA-short length |
| | Aperture | | mm | must be compatible with beam dynamics |
| | Alignment accuray | 300.00 | um | rms |
| | Material | Niobium | | |
| | Wall thickness | 2.80 | mm | |
| | Stiffness | | | decide later |
| | Flange/Seal system | | Material | decide later |
| | Maximum overpressure allowed | 2 | bar | |
| | Lorentz force detuning over Flat-top at 35 MV/m | 1.00 | kHz | maximum |
| | Outer diameter He vessel | 230.00 | mm(inner diameter) | Mag shield outside, decide later for precise number |
| | | 230.00 | mm(inner diameter) | KEK Mag shield inside, decide later for precise number |
| | Magnetic shielding | | inside/outside | decide later |

* yellow boxes indicate ‘not fixed’

| tuner | specification item | specification | unit and comments | further 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 | ex) 5 phase, xxA/phase, … | match to driver unit, match to connector pin asignment,… | decide later |
| | Motor location | insdie 4K? / outside 300K? / inside 300K accessible from outside? | need availability discussion, MTBF | decide later |
| | 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, | |
| | | | | |

* yellow boxes indicate ‘not fixed’

| | | | | |
|---|---|---|---|---|
| Fast tuner | Tuning range | >1 | kHz over flat-top at 2K | |
| | Lorentz detuning residuals | <50 | Hz at 31.5MV/m flat-top | (LD and microphinics? or LD only?) :decide later |
| | Actuator specification | ex) low voltage piezo 0-1000V, … | match to driver unit, match to connector pin asignment, … | decide later |
| | Actuator location | insdie 4K?/inside 4K accessible/inside 100K? accesible / inside 300K accessible from outside? | | decide later |
| | Magnetic shielding | <20 | mG at Cavity surface average | |
| | Heat Load in operation | <50 | mW | |
| | 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, ($2x10^{9}$:operational number) | |

* yellow boxes indicate ‘not fixed’

| Coupler | condition | specification | unit and comments | further comments |
|---|---|---|---|---|
| Power requirements | Operation | >400 | kW for 1600 us | |
| | Processing | >1200 | 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 1600us | in Test stand |
| Processing time | warm | <50 | hours | after installation, definition of power/pulse_width target are the same as 'Power Requirement' above. |
| | cold | <30 | hours | after installation, definition of power/pulse_width target are the same as 'Power Requirement' above. |
| Heat loads /coupler | 2K static | < 0.063 | W | |
| | 5K static | < 0.171 | W | depend on tunability |
| | 40 K static | < 1.79 | W | |
| | 2K dynamic | < 0.018 | W | |
| | 5K dynamic | < 0.152 | W | |
| | 40K dynamic | < 6.93 | W | |
| Cavity vacuum integrety | # of windows | 2 | | |
| | bias capablity | yes | | |
| RF Properties | Qext | Yes | tunable | |
| | Tuning range | 1-10 | 10^6 if tunable | |
| Physical envelope | Position | | compatible to TTF-III | decide later |
| | Flange | | compatible to TTF-III | decide later (to cavity, to cryostat) |
| | waveguide | | compatible to TTF-III | decide later |
| | support | | compatible to TTF-III | decide later |
| Instrumentation | vacuum level | >= 1 | | |
| | spark detection | 0 | at window | |
| | electron current detection | >= 1 | at coax | |
| | temperature | >= 1 | at window | |

* yellow boxes indicate 'not fixed'

# 3. Procedure specification

(0) Flow-chart of cavity fabrication, treatment, inspection, and testing

## Fabrication Procedure

Need to consider to follow XFEL

(1) Material specification : Nb, Nb-Ti alloy, and Ti
(2) Machining procedure : Nb, Nb-Ti alloy, and Ti
(3) Pressing procedure
(4) Treatment (handling, cleaning, etching) during fabrication
(5) Welding procedure : Nb, Nb-Ti alloy, and Ti
(5) Dumbbell fabrication procedure
(6) End-group fabrication procedure
(7) Welding up into cavity
(8) Inspection specification
(material scan, dimension, surface, frequency, leakage, etc)
(9) Helium Tank fabrication, welding to cavity
(10) Tools and equipment
(11) Laboratory responsibilities

## Treatment Procedure

(1) Cavity handling specification
(2) EP treatment specification
(3) Rinsing treatment specification
(4) Heat treatment specification
(5) Tuning specification
for 9-cell filed, straightness and HOM notch frequency
(6) Surface inspection procedure
(7) Surface repair procedure
(8) Clean-room handling procedure
(9) Attachment parts specification
(Flange, gasket, antenna, pickup, etc)
(10) Tools and equipment for treatment
(11) Laboratory responsibilities

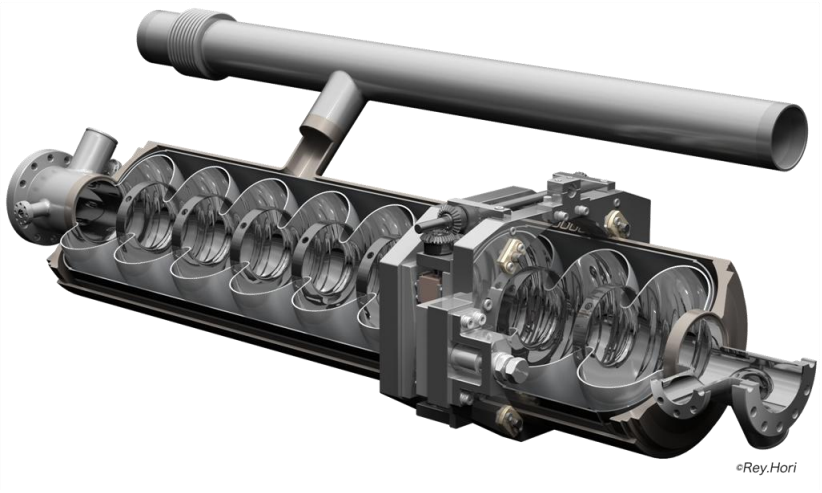
## Test Procedure (Vertical Test)

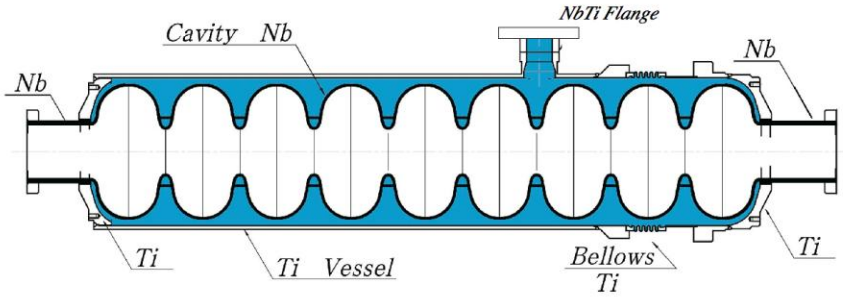
(1) Vertical Test procedure
(2) Support fixture specification
(3) Cryostat specification
(4) Instrumentation specification
(5) Tools and equipment
(6) Laboratory responsibilities

# 4. Plug Compatibility in the specification

We have “Plug-compatibility specification”
which will be a start point.

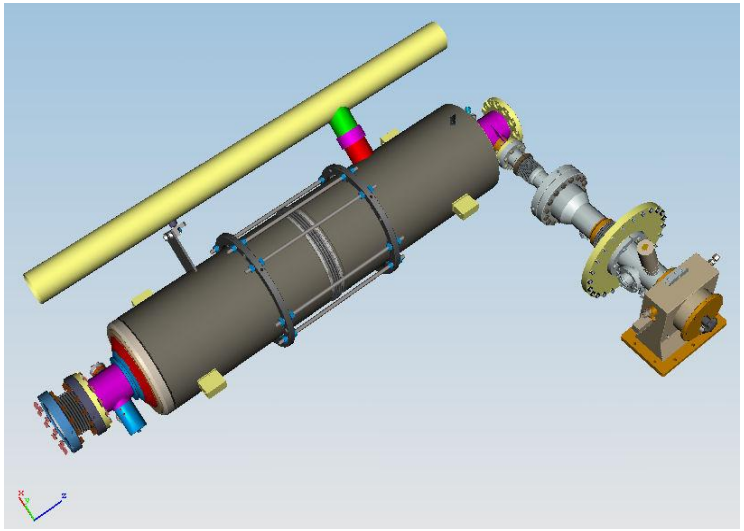
# Plug compatible conditions at Cavity package

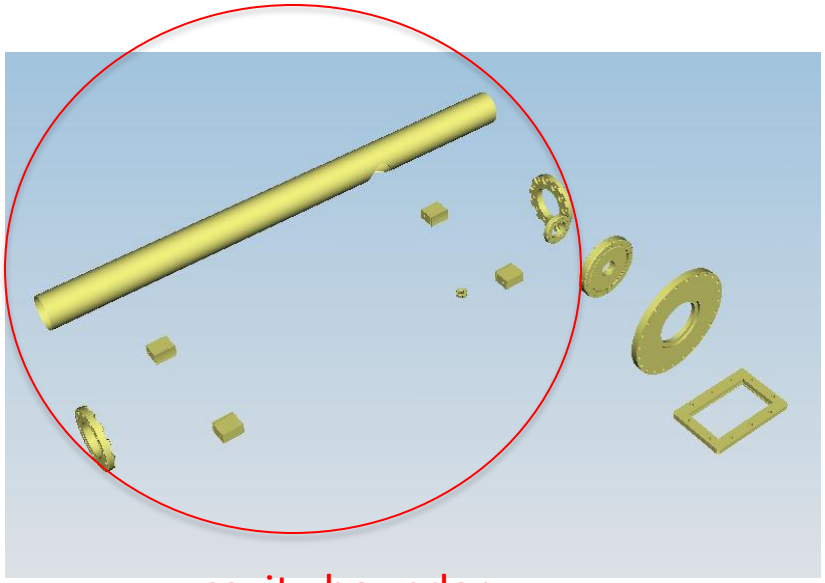



| Item | Can be flexible | Plug-compatible |
|---|---|---|
| Cavity shape | TESLA / LL / RE | |
| Length | | Required |
| Beam pipe dia | | Required |
| Flange | | Required |
| Tuner | blade/ slide-jack | |
| Coupler flange | | Required |
| He–in-line joint | | Required |
| | | |
| | | |

# Cavity boundary



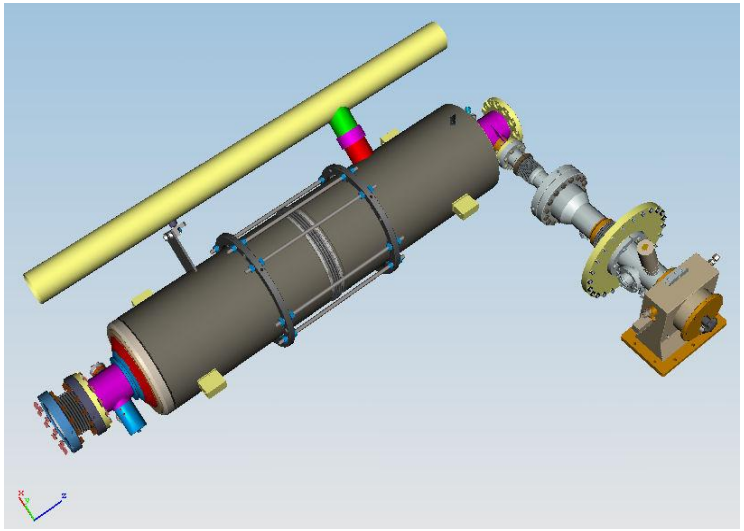


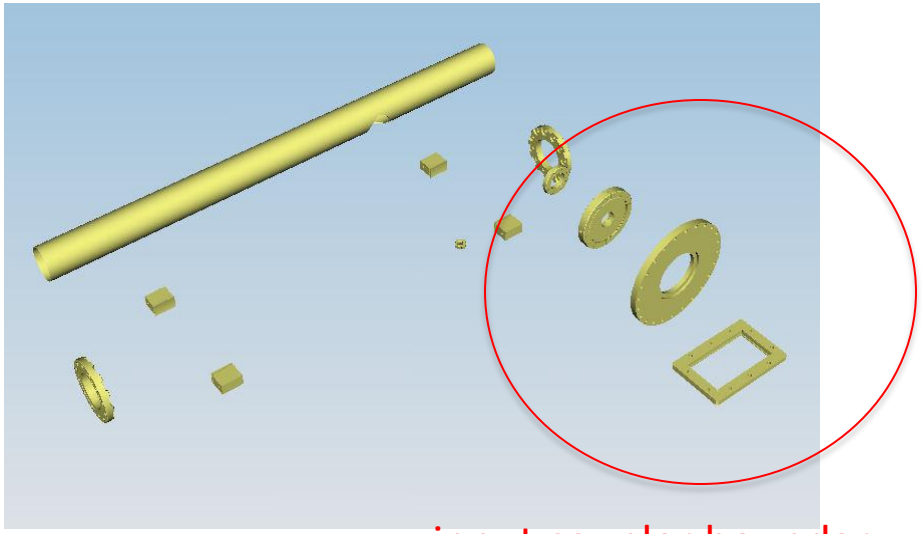
cavity boundary

(1) beam pipe port flange
(2) coupler port flange
(3) 4 support tabs
(4) He pipes

# Input coupler boundary

BCD: TTF3 coupler





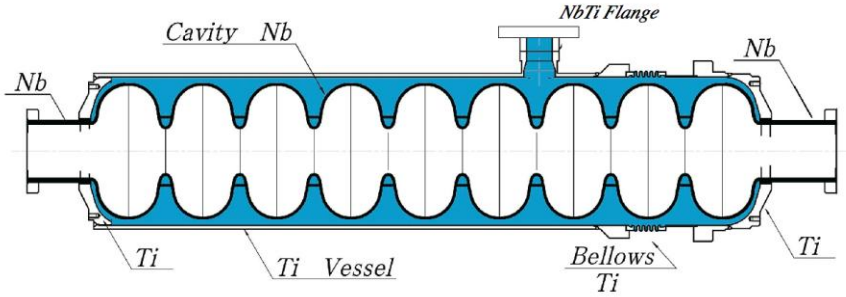
input coupler boundary

(1) cavity port flange
(2) cold/warm part interface flange
(3) cryostat vessel flange
(4) waveguide flange

# 5. High-pressure-vessel Regulation

Regulation application for only cavity helium vessel

-> small volume (small P*V value) made application more simple

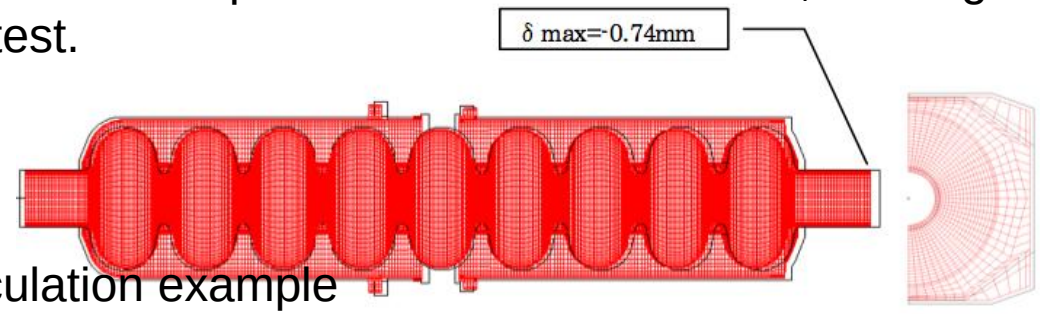


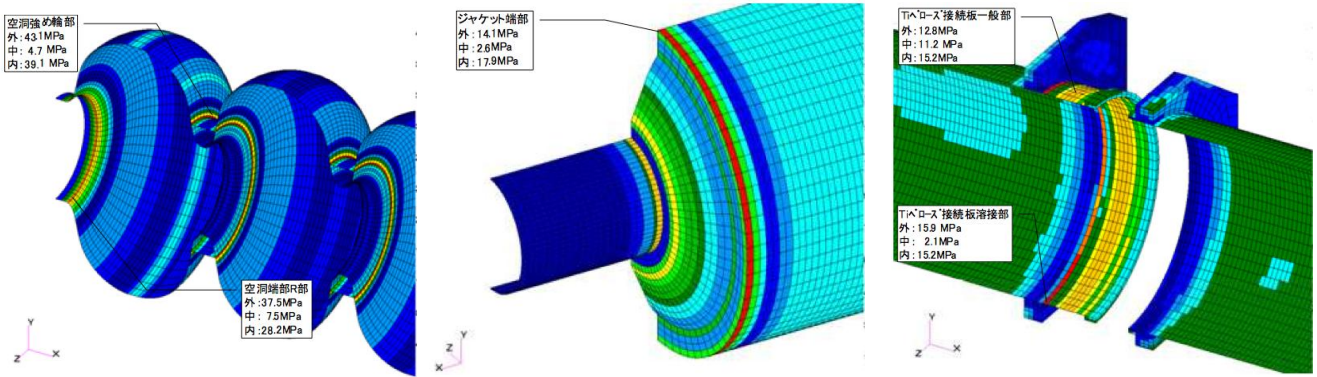

Nb, Ti at 2K use ; not a matter

(KEK case)

Still we need to evaluate pressure-stress calculation, welding record and inspection, and pressure test.

This is a calculation example



# 6. Cost down

The specification should include a room for cost down.

For example ; ( Just an idea )

Make Nb material -> 2.8mm sheet
and make cell by press,
make pipes by deep-drawing and burring.

Make Nb HOM antenna by press-cut from sheet material,
Make Nb-Ti flange by press-cut from sheet material,

Make number of welding minimum

Make machining minimum

Make one parts fabrication in one company
Make press-cut process in the material company

# Development of
# cavity technical specification document

Need to develop;

Flow-chart of cavity fabrication, treatment,
Inspection and testing,
Industry fabrication model.

Need decision of open column of the specification table.

Then, we can start writing down the document.

end