Cavity Specification Table

23 Oct 2007
FNAL

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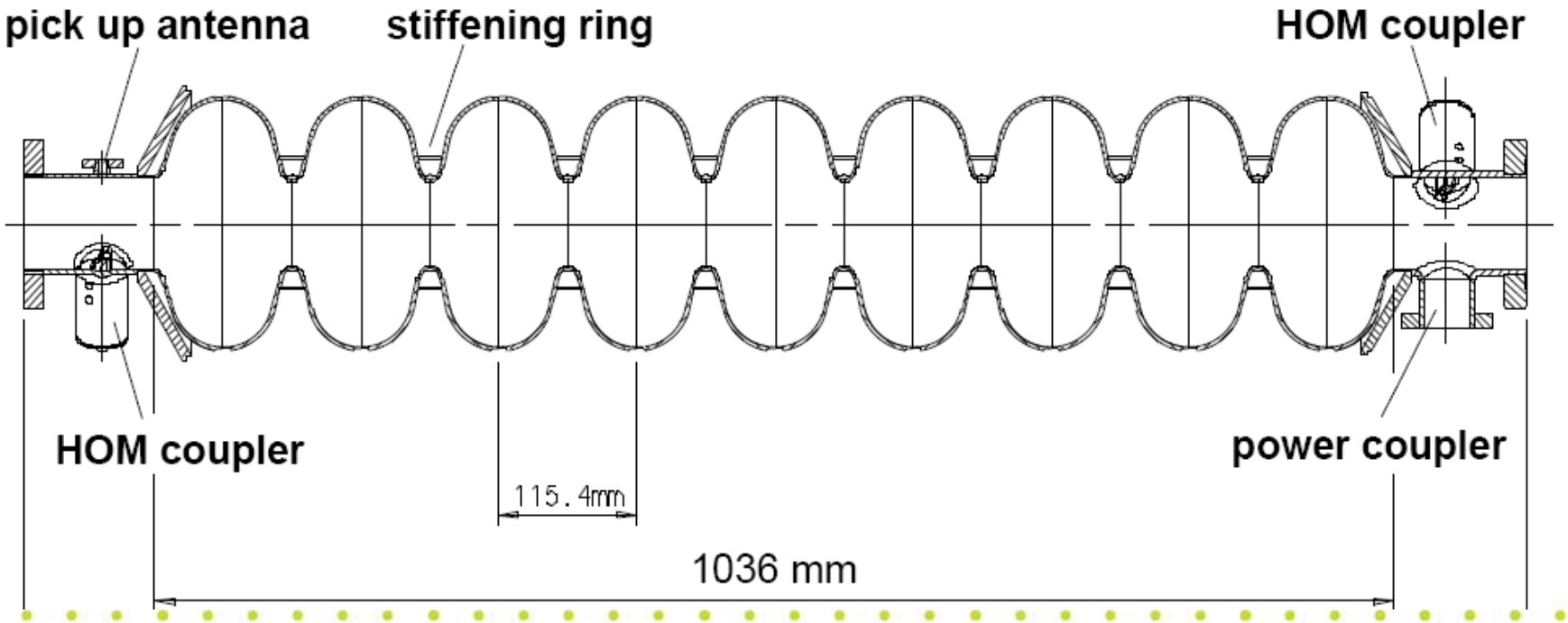
DESY

Disclaimer

- This is a proposal for discussion

Assumptions

- Outer dimensions
  - **Critical for cavity package and module groups**
- RF Specification
  - **When the cavity stays within its mechanical bounds possibly less critical for the interfaces to other systems**
  - **Likely exception: Iris diameter is beam dynamics issue**

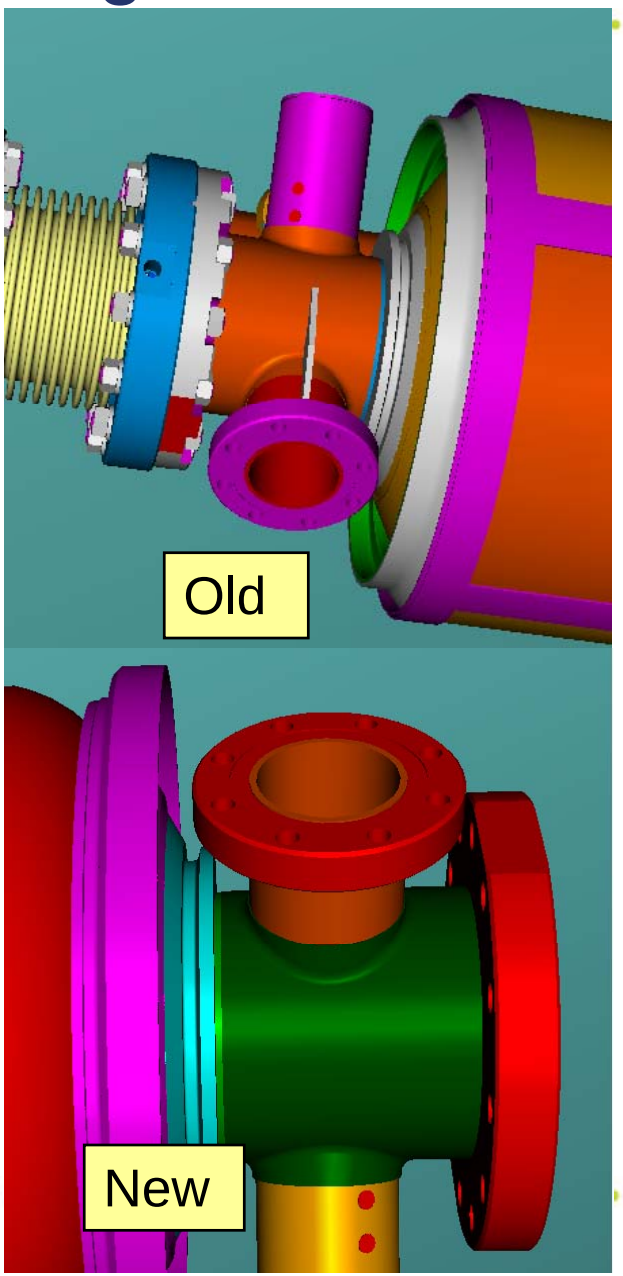


Outer Dimensions - Fixed and Changeable

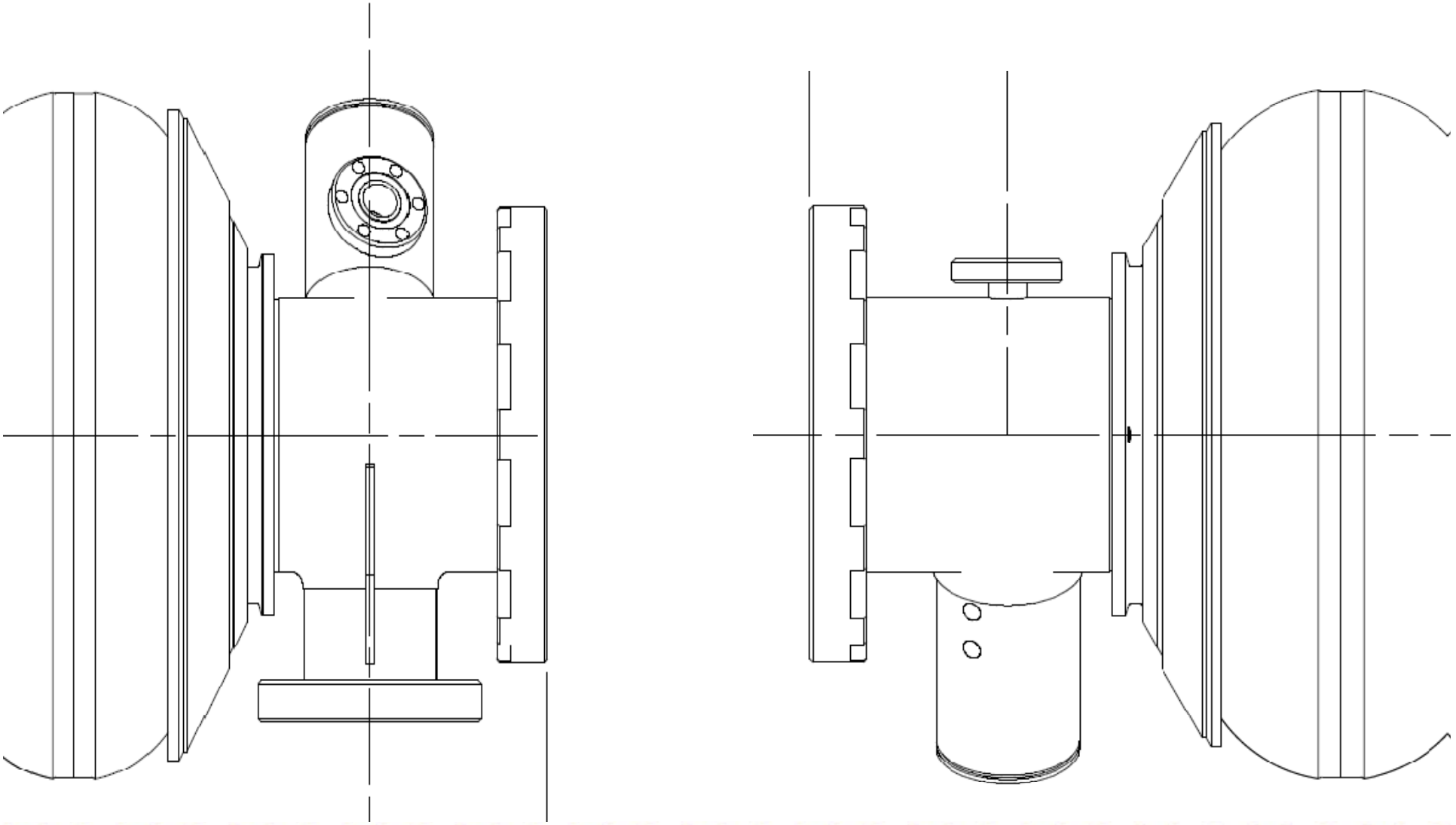
- Straight forward (?):
  - **Length: 1247 mm**
    - Short TESLA-type (for comparison XFEL 1276mm)
    - Should rather define a slot slength
      - what matters for the module is the position of the cavities and the coupler ports
  - **Maximum Outer Diameter:**
    - Cells: 210 mm
    - HOM coupler: 232 mm
      - Max. Radius is 116 mm
    - Insufficient information for cavity systems
      - Position of magnet shielding is not fixed
- More difficult
  - **Beam tube flange size and sealing system**
  - **Coupler port position and diameter**
  - **HOM port location, RF connector position**
  - **Connection to He Vessel**

Beam tube and Flange Design

- Beamtube
  - **'Tesla short' diameter: 78 mm**
    - go to industrial size?
- Flange system
  - **6 flanges total**
    - see XFEL example
  - **Several sealing systems available**
    - Choice should take into account
      - Reliability
      - Potential re-assembly for re-test
  - **Need WP to make a proposal**
    - By When?
- Interconnecting bellow
  - **after definition of flange system into module group's responsibility**

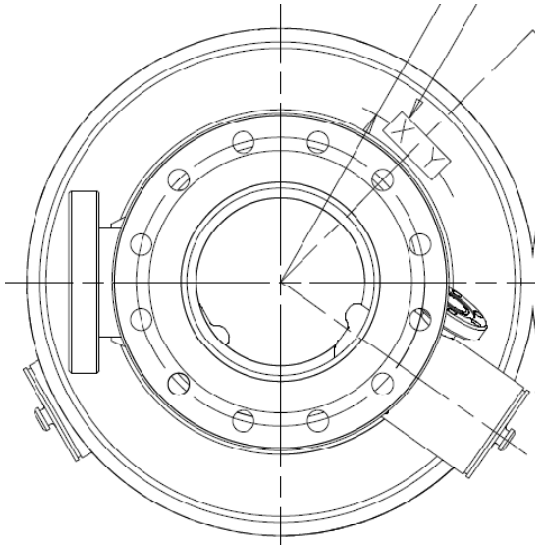


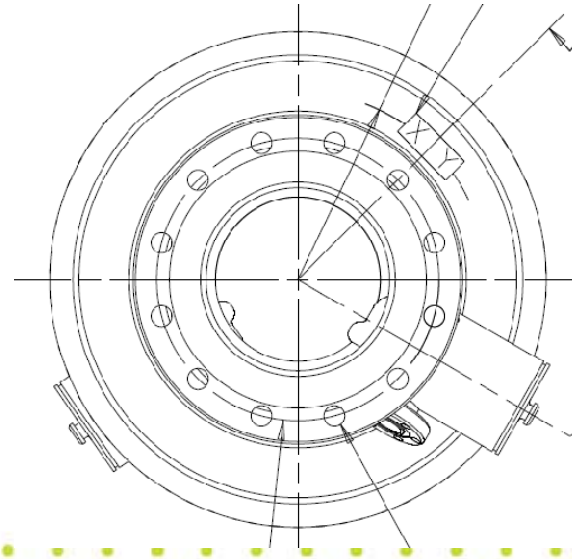
Coupler Port Location



Coupler Port Location

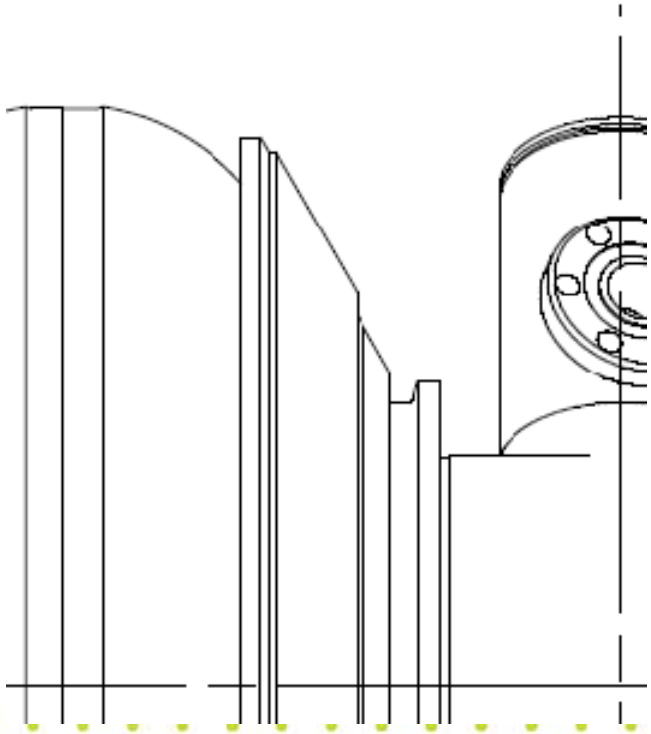
- Issues
  - **Wake-potential needs further look**
  - **Port position**
    - Depends on thickness of conical disk and shielding position
  - **Port size**
    - Do we need larger power capability?
  - **Cabling**
    - With tuner not at extreme position this is relaxed





Definition of weld position for tank

- Tank welding after performance test
  - **Conical disks part of the bare cavity**
  - **Tank material need be welded to disk**
    - do we have to do outside etch?
  - **Magnetic shield position?**



Referencing the Cavities

- ‘Refererence ring‘ is one of the more expensive parts in the fabrications
  - **are there better options than this?**
  - **Cavity supports are attaching to reference ring**

Magnetic shield

- need number to be provided to cavity systems

Maximum allowed pressure

- 4 bar He vessel
  - **cold, vacuum inside**
    - agreed
- 2 bar (1.3 bar KEK number)
  - **warm, vacuum inside ?**
    - not clear !!!

- Action item:
  - **compile list for different conditions**

ILC Cavity RF Parameters - Overview

Parameter	Value
Type of accelerating structure	Standing Wave
Accelerating Mode	TM_{010}, π mode
Fundamental Frequency	1.300 GHz
Average installed gradient	31.5 MV/m
Qualification gradient	35.0 MV/m
Installed quality factor	$\geq 1 \times 10^{10}$
Quality factor during qualification	$\geq 0.8 \times 10^{10}$
Active length	1.038 m
Number of cells	9
Cell to cell coupling	1.87%
Iris diameter	70 mm
R/Q	1036 Ω
Geometry factor	270 Ω
E_{peak}/E_{acc}	2.0
B_{peak}/E_{acc}	4.26 mT $MV^{-1}m^{-1}$
Tuning range	$\pm$300 kHz
$\Delta f/\Delta L$	315 kHz/mm
Number of HOM couplers	2

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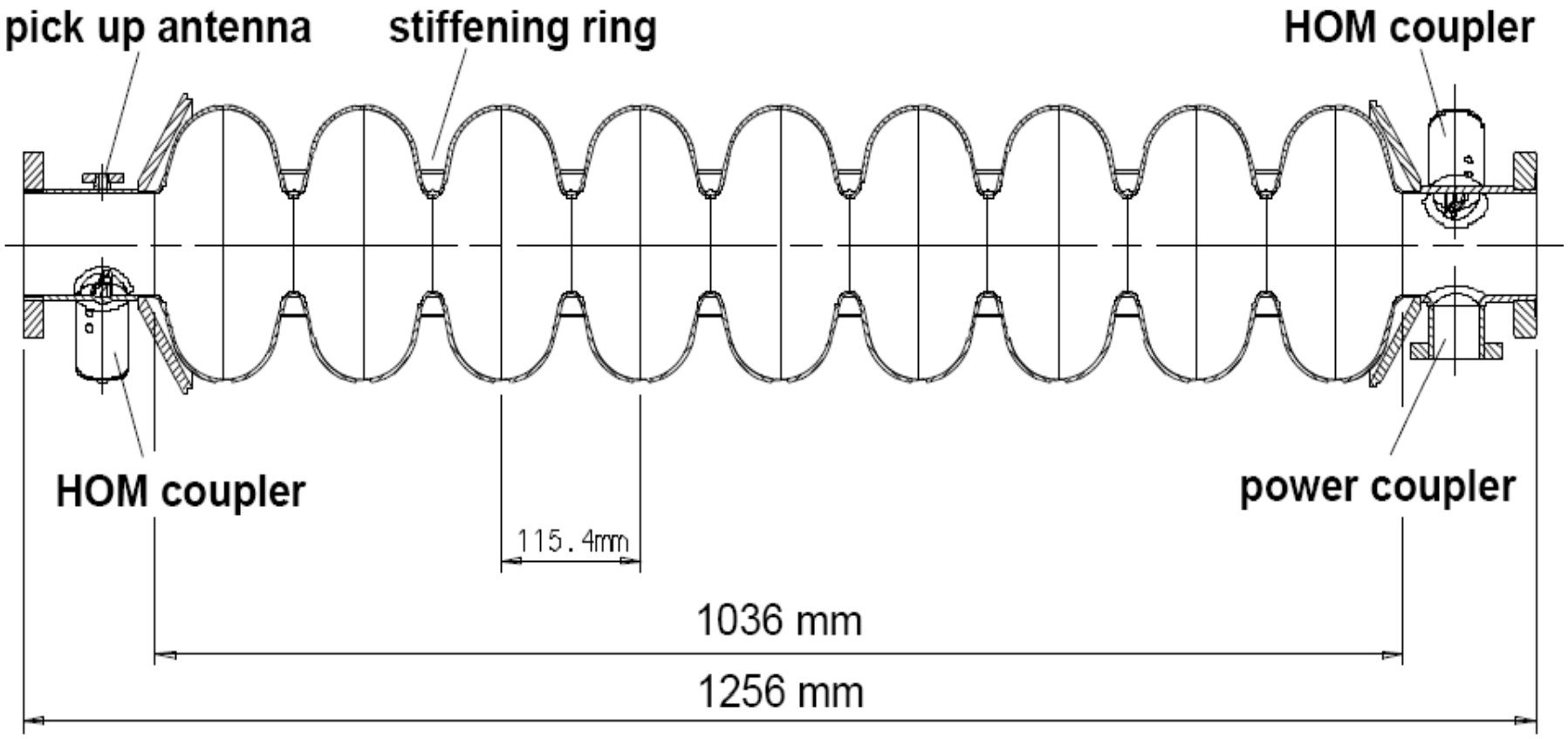
TESLA Cavity



TESLA General RF Parameters

Type of accelerating structure	Standing wave
Accelerating mode	TM_{010}, π mode
Fundamental frequency	1300 MHz
Design gradient E_{acc}	25 MV/m
Quality factor Q_0	$>5 \times 10^9$
Active length L	1.038 m
Number of cells	9
Cell-to-cell coupling	1.87%
Iris diameter	70 mm
Geometry factor	270 Ω
R/Q	518 Ω
E_{peak}/E_{acc}	2.0
B_{peak}/E_{acc}	4.26 mT MV^{-1} m^{-1}
Tuning range	±300 kHz
$\Delta f/\Delta L$	315 kHz/mm
Lorentz force detuning at 25 MV/m	≈600 Hz
Q_{ext} of input coupler	3×10^6
Cavity bandwidth at $Q_{ext} = 3 \times 10^6$	430 Hz
rf pulse duration	1330 μs
Repetition rate	5 Hz
Fill time	530 μs
Beam acceleration time	800 μs
rf power peak/average	208 kW/1.4 kW

TESLA HOM Specification

Number of HOM couplers	2
Cavity longitudinal loss factor $k_{\parallel}$	
for $\sigma_z = 0.7$ mm	10.2 V/pC
Cavity transversal loss factor $k_{\perp}$	
for $\sigma_z = 0.7$ mm	15.1 $\mathrm{V\,pC^{-1}\,m^{-1}}$
Parasitic modes with the highest	
impedance: type	$\mathrm{TM_{011}}$
$\pi/9$ (R/Q)/frequency	80 Ω/2454 MHz
$2\pi/9$ (R/Q)/frequency	67 Ω/2443 MHz
Bellows longitudinal loss factor $k_{\parallel}$	
for $\sigma_z = 0.7$ mm	1.54 V/pC
Bellows transversal loss factor $k_{\perp}$	
for $\sigma_z = 0.7$ mm	1.97 $\mathrm{V\,pC^{-1}\,m^{-1}}$

ACD/Plugin Proposal

GDE Meeting FNAL

23.10.2007

Lutz Lilje

ACD Boundary Conditions and Testing

- Boundary condition
  - **Mechanical part has been discussed before**
  - **RF design needs some feedback mechanism with Beam dynamics**
    - would be best before cavities are built

- Testing of alternate Cavities requires (according to Rich's list)
  - **Cavity shape:**
    - 24-30 cavities in 3 modules with beam including
      - Low-power performance test
      - High-power test (individual or full module)
      - HOM testing with beam
  - **Cavity material:**
    - Cost-benefit analysis
    - 30 cavities in bench tests (low-power and high-power),
      - Performance test
      - Getting experience with pulsed operation
      - no module or beam test needed
  - **Cavity 'Design For Manufacturing' (similar to XFEL)**
    - Minor design changes for easier welding, simpler machining etc.
    - Few cavities in bench tests, if at all
  - **For other changes**
    - Needs discussion