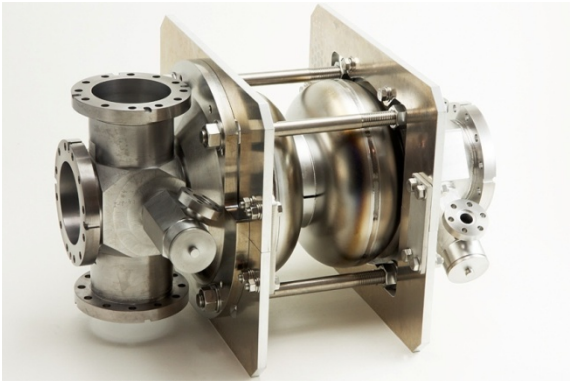
Compact ERL Linac



Members for ERL Main linac

K. Umemori, T. Furuya, H, Sakai, T. Takahashi (KEK),
K. Shinoe (ISSP, University of Tokyo),
M. Sawamura (JAEA-ERL)

Members for ERL Injector

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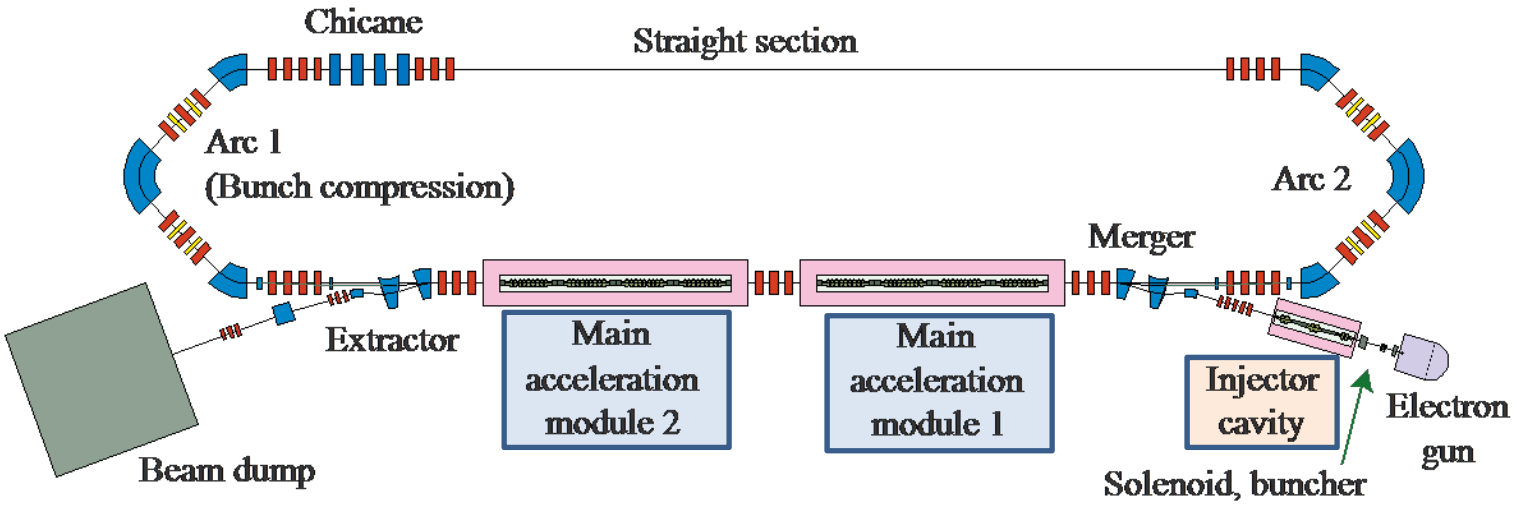
K. Watanabe, Y. Yamamoto (KEK)

Schematic design of Compact ERL (under discussion)

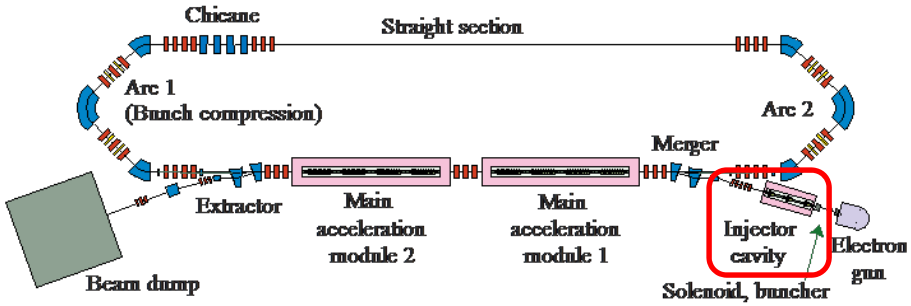


Compact ERL is a test accelerator to demonstrate performance needed for future 5-GeV class ERL X-ray light sources.

- Energy 60 – 200 MV
- Current 100mA
- Emittance 0.1～1mm mrad

Superconducting cavies are key components to realize successful ERL operation.

Injector



Required parameters for injector linac cavity

- Frequency 1.3 GHz
- Eacc = 14.5 MV/m
- High current CW operation, 100mA

Accelerate up to 5～10 MeV with three 2-cell cavities.

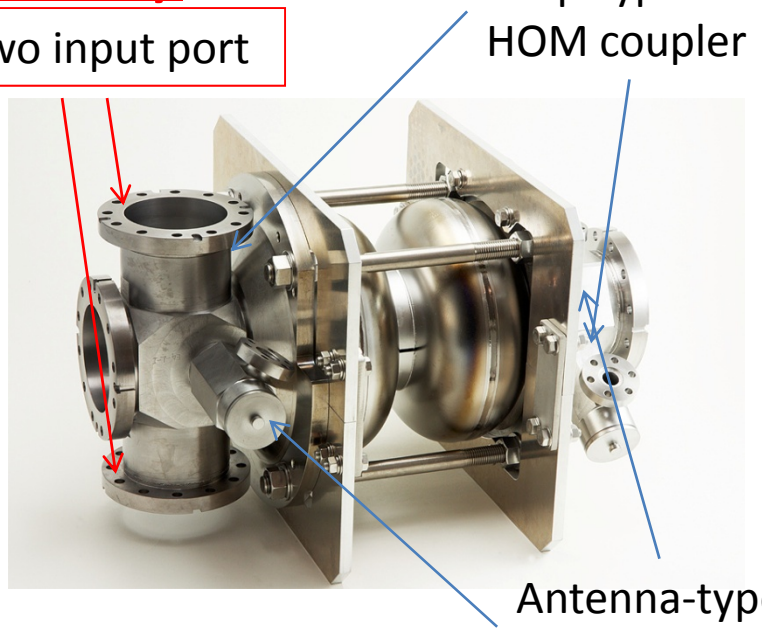
Input coupler should handle total of 1MW.

- Double feed for each cavity
- Input power : 167 kW/coupler

Harmful HOMs are suppressed with 4 or 5 HOM couplers for each cavity.

See poster TUPO056 by K. Watanabe

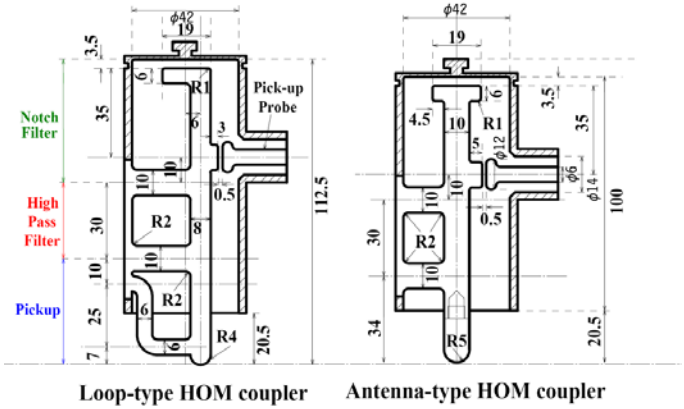
2-cell injector cavity



- Same cell shape with STF-BL cavity and slightly enlarged beampipe
- Two input port for each cavity
- Two types, loop and antenna, of HOM couplers are applied
- 4 or 5 HOM couplers per one cavity

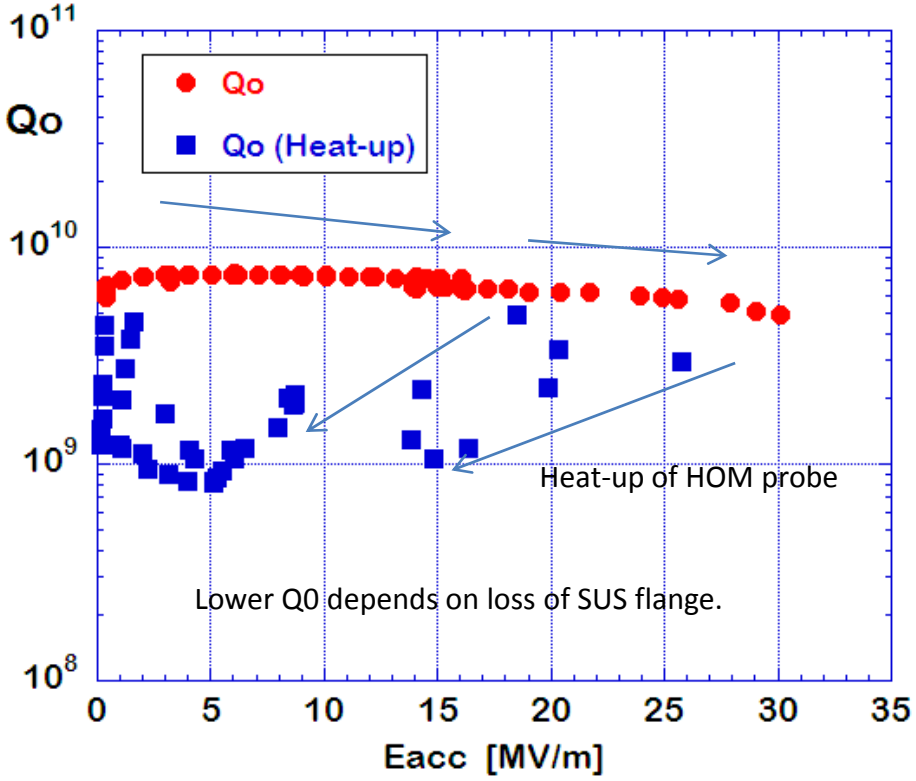
Basic cavity Parameters for Injector at KEK

Frequency	1.3	GHz
Number of Cell	2	
R/Q	205	
Operating Gradient	14.5	MV/m
Number of Input coupler	2	
Coupler power	167	kW
Coupler coupling	3.3×10^5	
Number of HOM coupler	5	
Operating Temperature	2	K

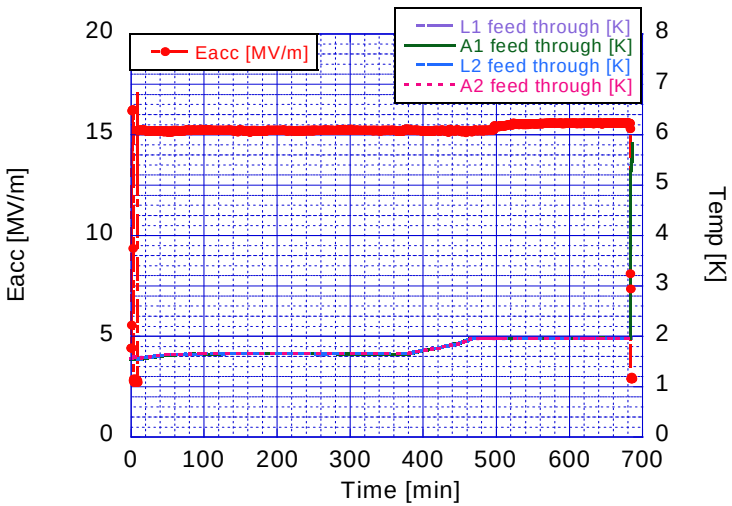


Results of vertical test

Results of 1st vertical test (2009.Apr)



- Eacc achieved to 30 MV/m.
- Heating of HOM probe at high Eacc

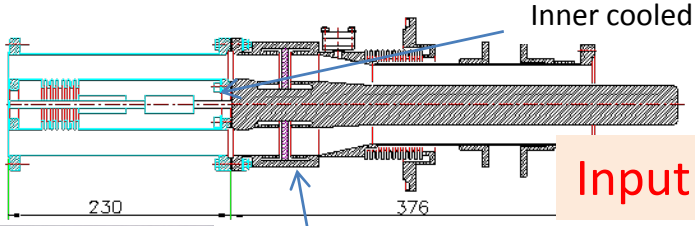


Could keep Eacc = 15 MV/m for 11 hours without HOM probe heating

Cryomodule (Input coupler, tuner)

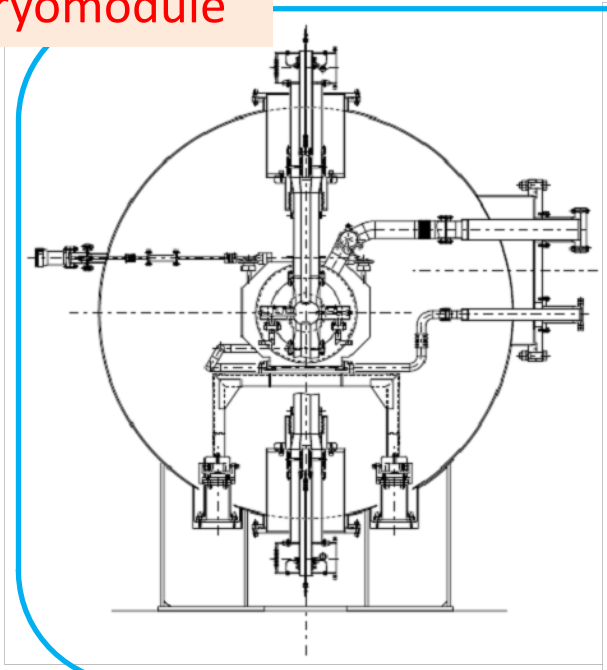
- Design of cryomodule is almost completed.
- Input couplers will be tested this autumn with 300 kW klystron.

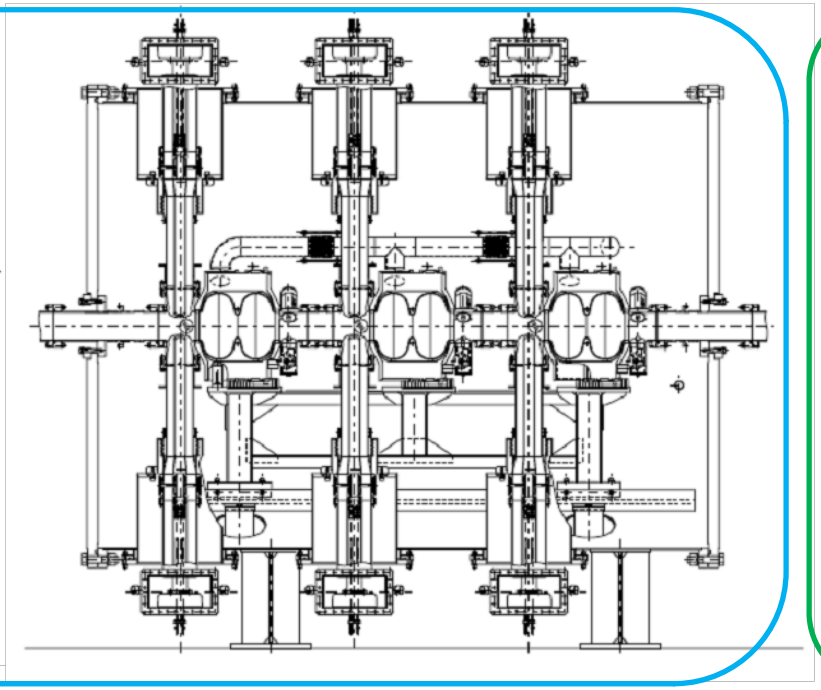
Input coupler



TRISTAN-type ceramic window

Cryomodule

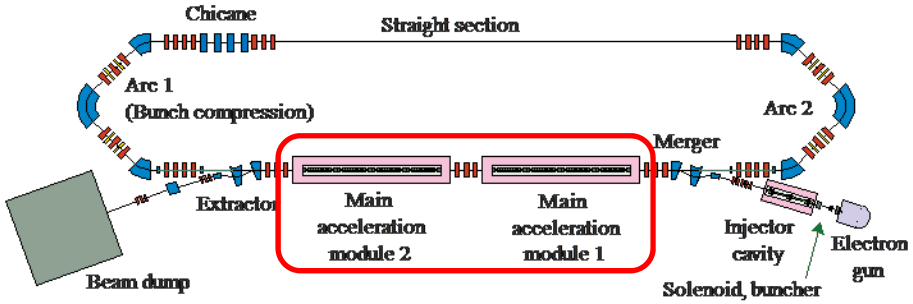




Tuner

Slide-Jack tuner and Piezo

Main Linac



Required parameters for main linac cavity

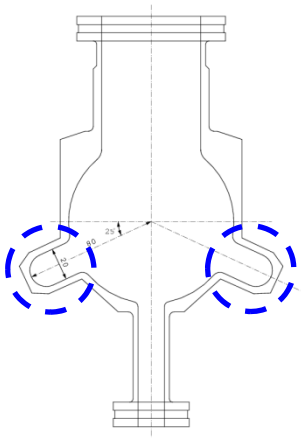
- Frequency 1.3 GHz
- Eacc = 15 ～ 20 MV/m
- Energy recovery
- High current CW operation, >100mA

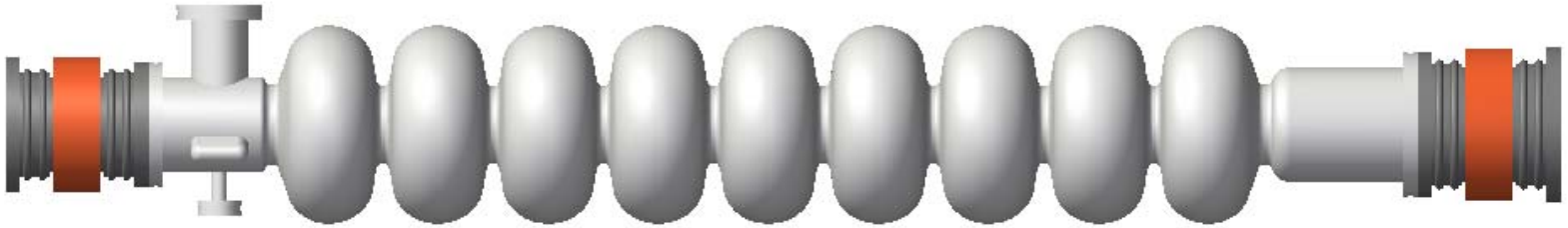
Due to CW high current operation, strong HOM damping is essential to avoid beam instabilities and large heat loads.

Total of eight 9-cell cavities are planned.
To achieve 200MeV, 2-turn ERL is under discussion.

KEK-ERL model-2 Cavity

1) Cell shape is optimized to reduce HOM impedances
   - ➢Iris diameter 80mm, elliptical shape at equator
   - ➢Cell diameter 206.6mm
2) Eccentric-fluted beampipe
   - ➢Suppress Quadrupole HOMs
3) Large beampipes mounted with RF absorber
   - ➢Bempipe diameter 100mm and 120mm



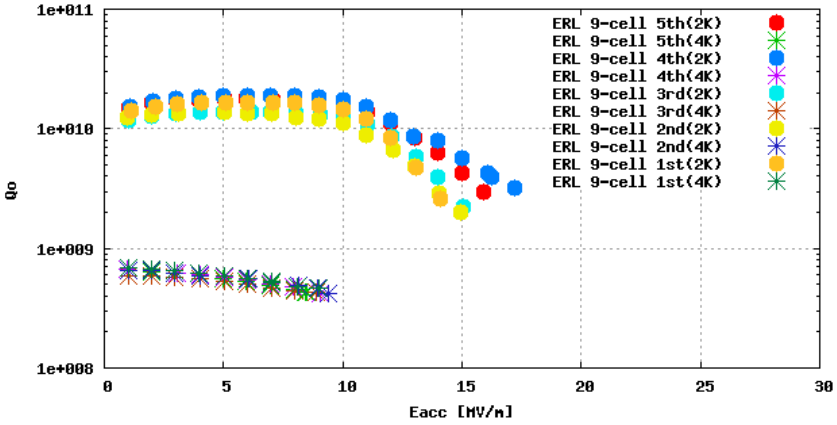


Main parameters for the acceleration mode

Frequency	1300 MHz	Coupling	3.8 %
Rsh/Q	897 Ω	Qo x Rs	289 Ω
Ep/Eacc	3.0	Hp/Eacc	42.5 Oe/(MV/m)

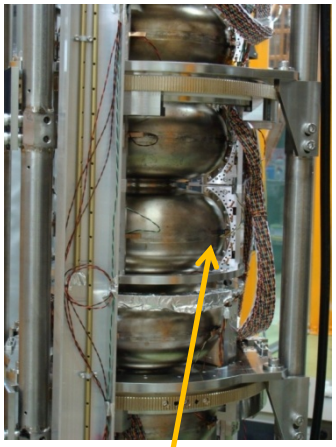
Results of vertical tests

Qo-Eacc



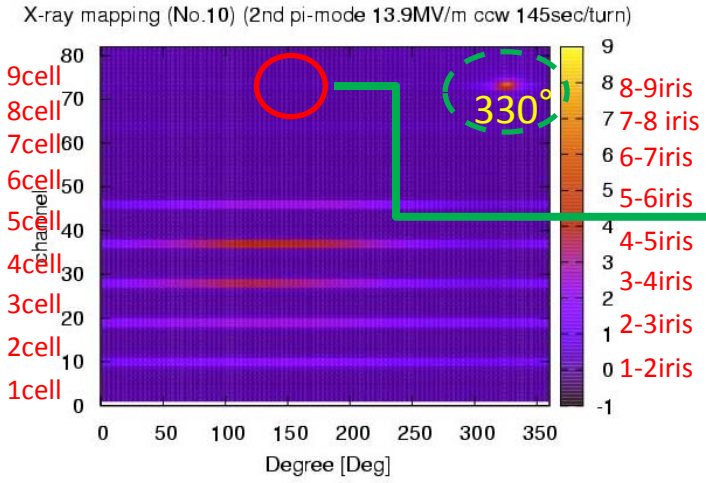
- Maximum Eacc = 15 ~ 17 MV/m
- Eacc was limited by field emission
- Large X-ray signals were observed

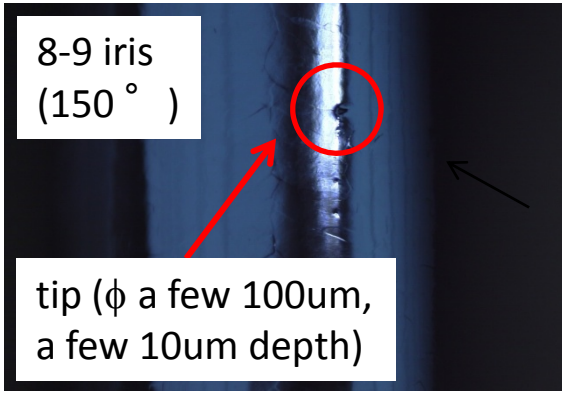
Rotating mapping system



Array of Si PIN diode

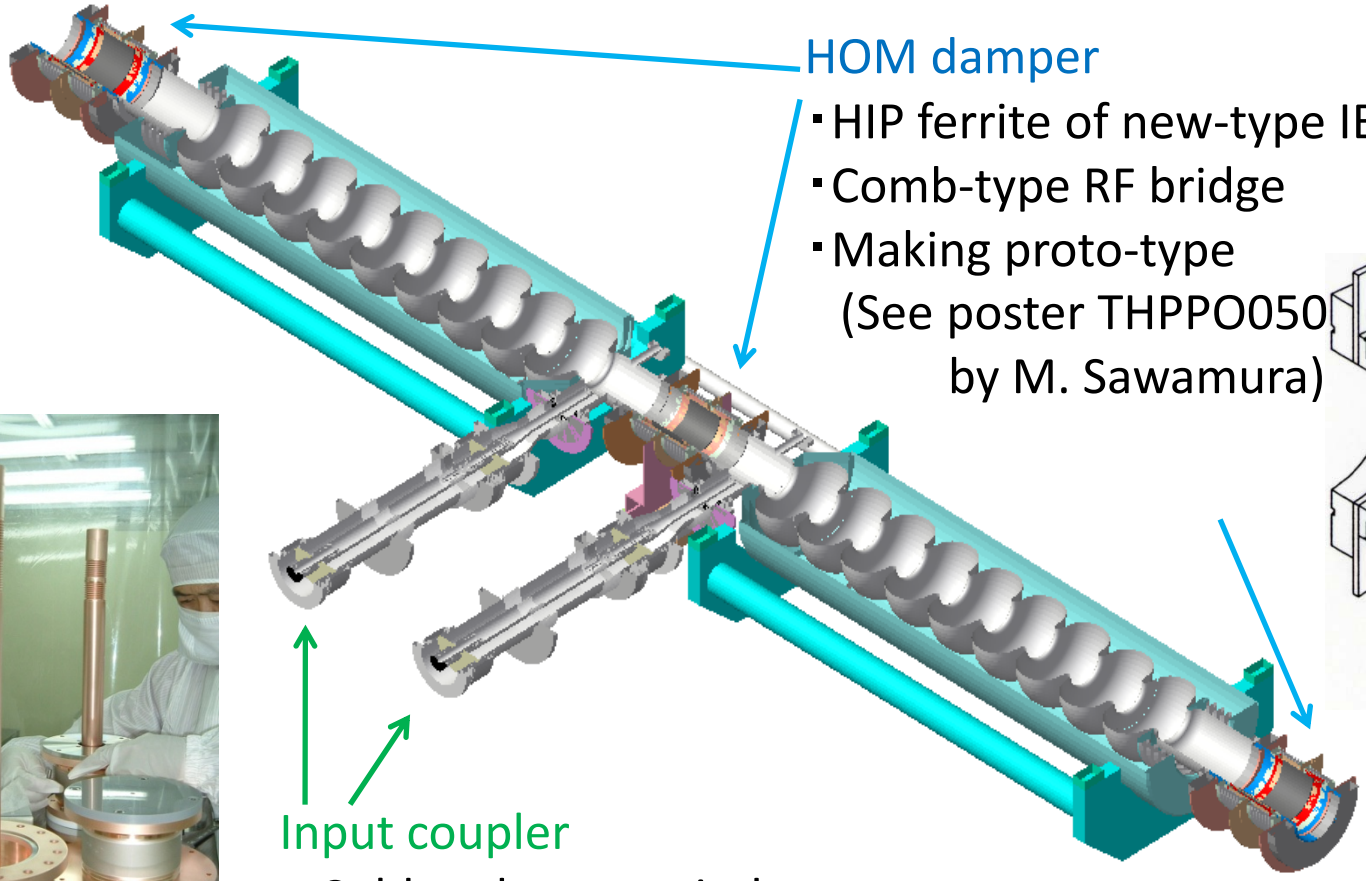
Result of X-ray mapping





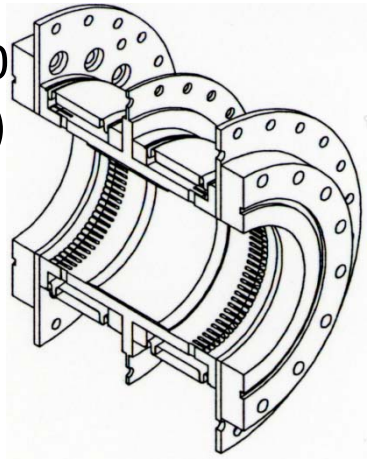
See poster TUPPO055 by K. Umemori

Cryomodule development



HOM damper

- HIP ferrite of new-type IB004
- Comb-type RF bridge
- Making proto-type
  (See poster THPPO050 by M. Sawamura)

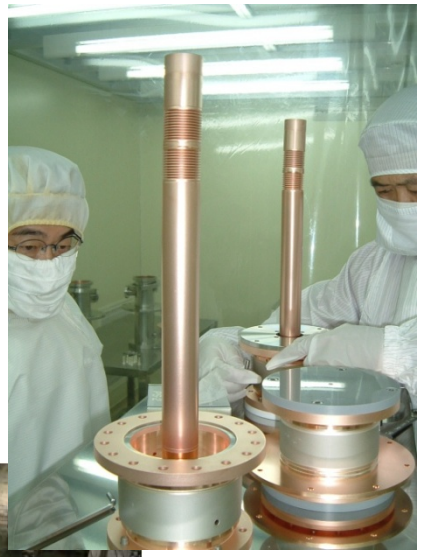


Input coupler

- Cold and warm window
- HA997 ceramic is used
- High power tests are in progress

(See poster THPPO047 by H. Sakai)

Input coupler

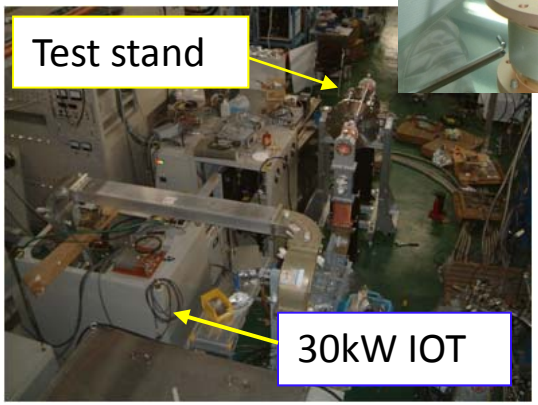


- Principle parameters

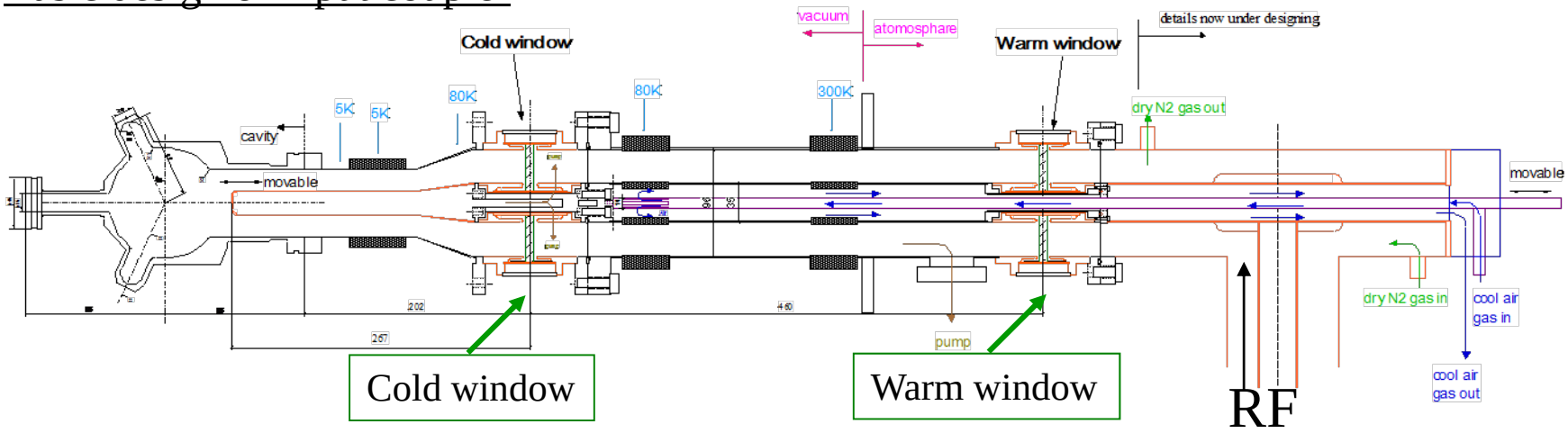
  Input power:20kW(Max. Eacc=20MV/m)

  QL : $5 \times 10^6 - 2 \times 10^7$(Variable coupling)

- HA997 ceramic is used
- Test stand was constructed
- High power tests are in progress for the components, such as ceramics and bellows.



Basic design of input coupler

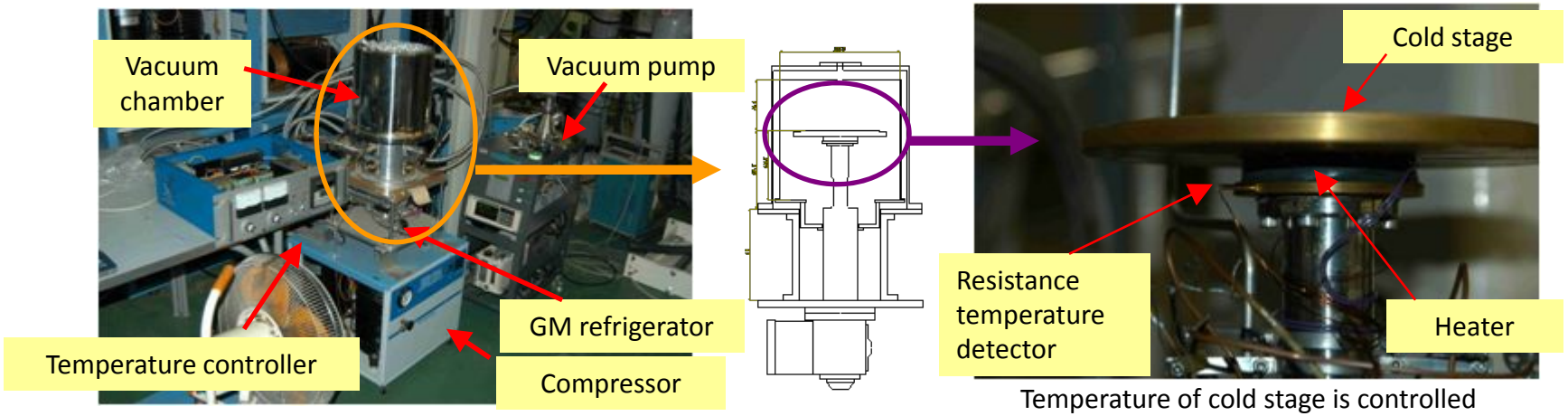


HOM damper

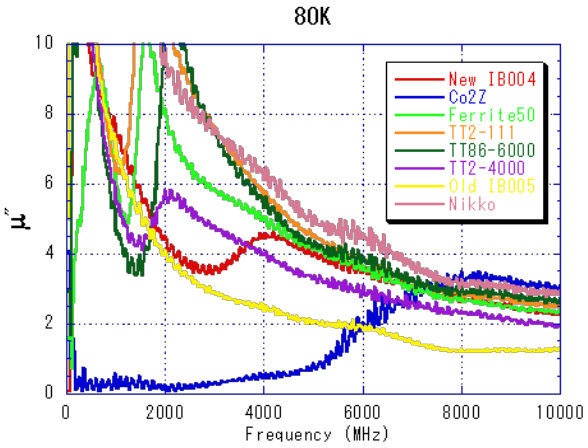
Low temperature measurement of RF absorber's characteristics

- RF absorber should work at 80K
- Temperature dependence was measured while cooling with refrigerator

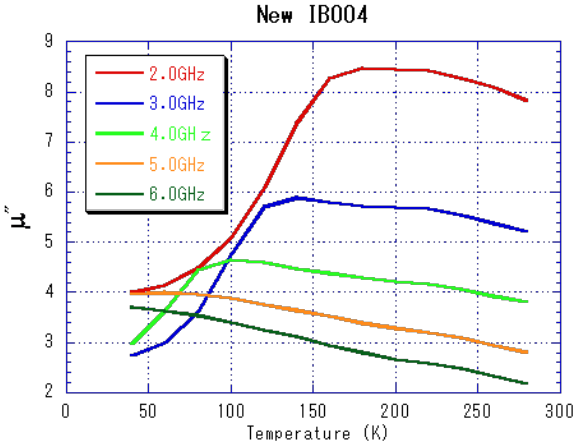
Ferrite sample



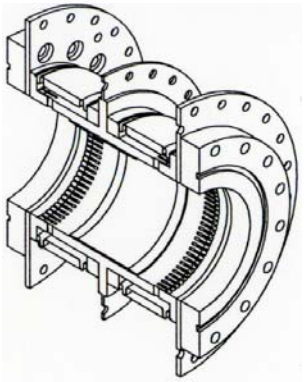
Temperature of cold stage is controlled



Ferrite μ" at 80K



Temperature and frequency dependence of IB004 ferrite



- HIP ferrite of new-type IB004
- Comb-type RF bridge
- Making proto-type

Summary

Injector

- Two-cell injector cavity was fabricated.
- First vertical test was done and Eacc reached to 30 MV/m.
- While heating problem occurred at high Eacc, it was possible to keep 15 MV/m for 11 hours.
- Input couplers were fabricated and will be tested soon.
- Design of cryomodule is almost completed.

Main linac

- 9-cell Nb cavity was fabricated and vertical tests were performed. Cavity was suffered from field emission.
- X-ray mapping system works well and observed X-ray trace.
- Cryomodule design is under way.
- High power test stand was constructed. Component test is in progress for input coupler.
- Low temperature measurements were done for several RF absorbers. Making a prototype of HOM damper