R&D programs for High Intense Muon Source

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Objective

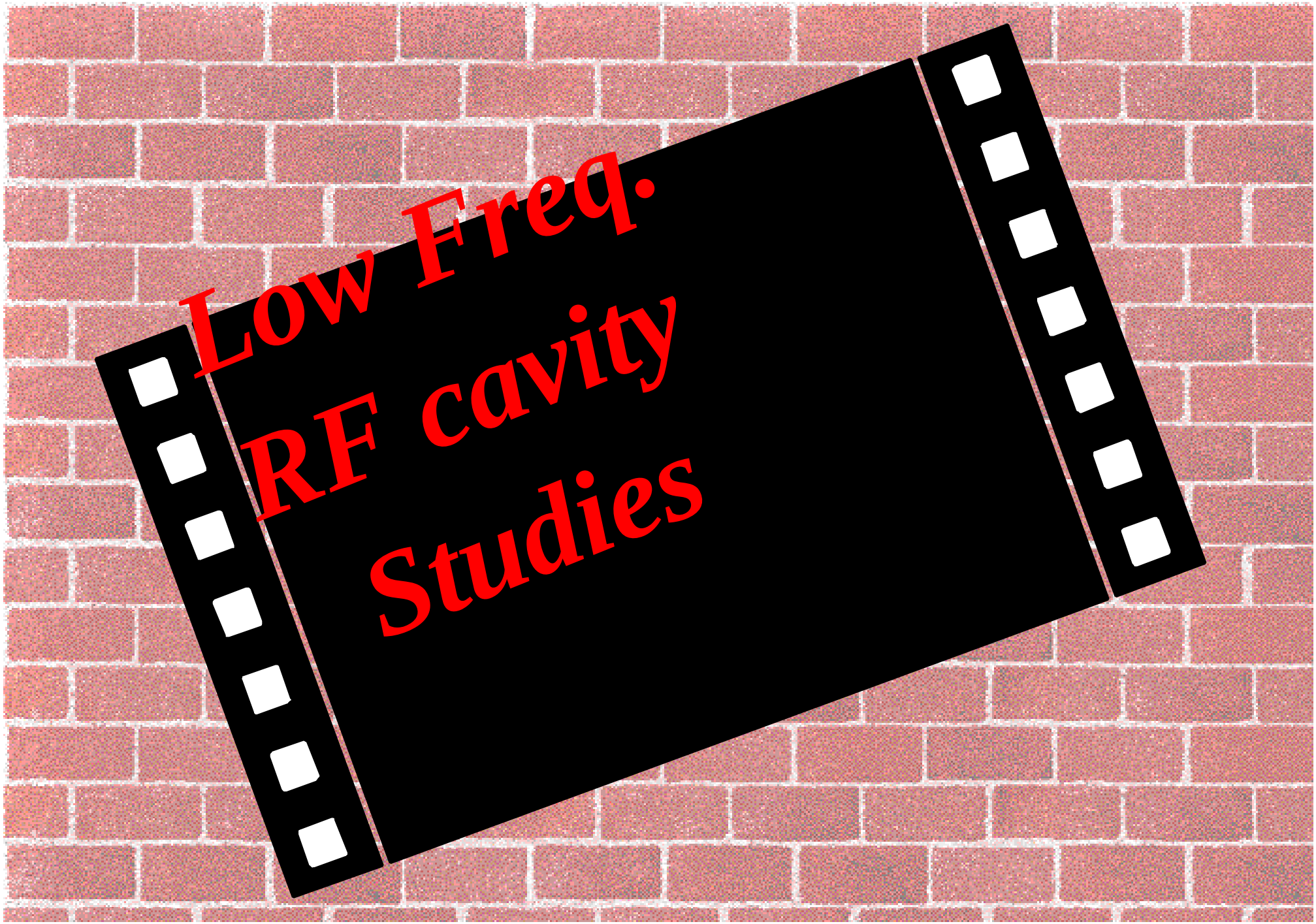
- Objective:Development of high intense muon source based on the phase rotation and muon cooling
  - High Intensity:10^{12}muons/sec (10K times than previous)
  - High Luminosity:Improve beam emittance
- Future Goals
  - Low Energy muon experiments
  - Neutrino Factory
  - Muon collider

R&D Items

- We concentrate on the following two items

- 1) RF cavity of high field gradient at low frequency (a few MHz) for phase rotation scheme.

- 2) LH2 absorber for muon ion cooling


Low Freq.
RF cavity
Studies

Low freq. High field grad. RF

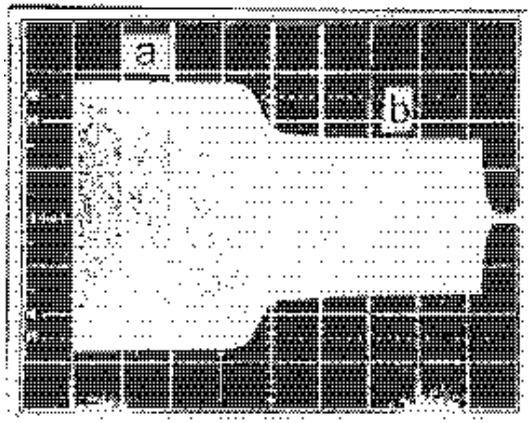
- Objective: RF cavity of high field gradient 0.5-1.0MV/m at a few MHz
  - Operated with Burst-mode
- Why necessary?
  - Wide timing-spread of captured low energy muon/pion
  - High field gradient for phase rotation within muon life
  - Especially for FFAG-based neutrino factory

Development of RF cavity

- Two approaches
  - Ferrite-loaded Cavity (Japan)
    - New type of Ferrite SY25(TDK)
  - Dielectric material-loaded Cavity(US)
    - Celamic loaded cavity

Ferrite-loaded Cavity R&D

- New ferrite SY25(TDK):
  - New NiZn Ferrite with rich Cobalt oxide
    - large mQF product
    - High shunt impedance
- High Loss Effect



  - High loss effect in the ferrite core. About 1.2 msec from rf-on, rf voltage drops to 60 % of the initial value.

High Loss effect does not cause serious problem within 1m sec acceleration time for burst-mode operation of Neutrino factory.

Measurement of SY25 Data

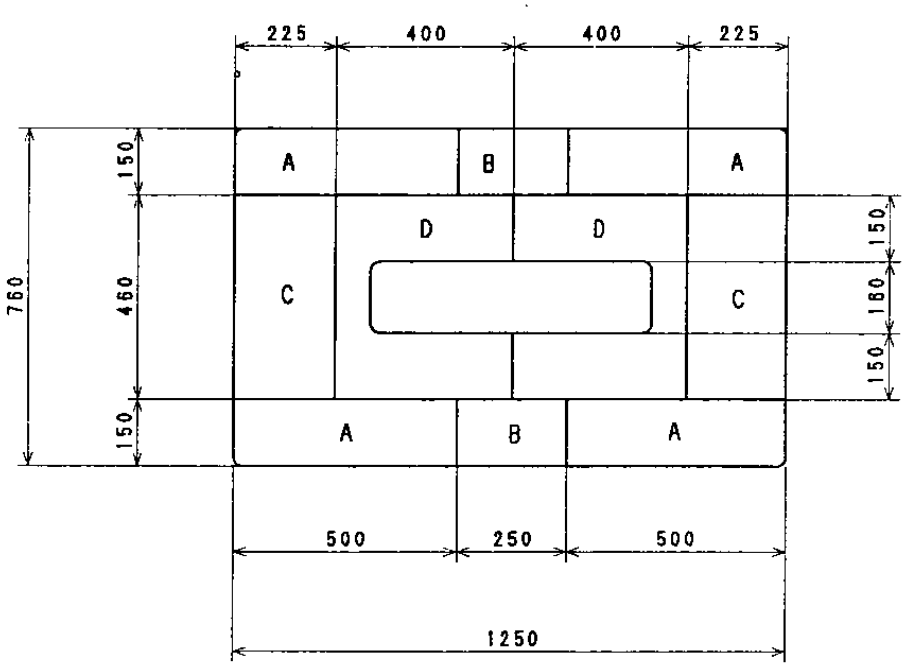
- Dimension

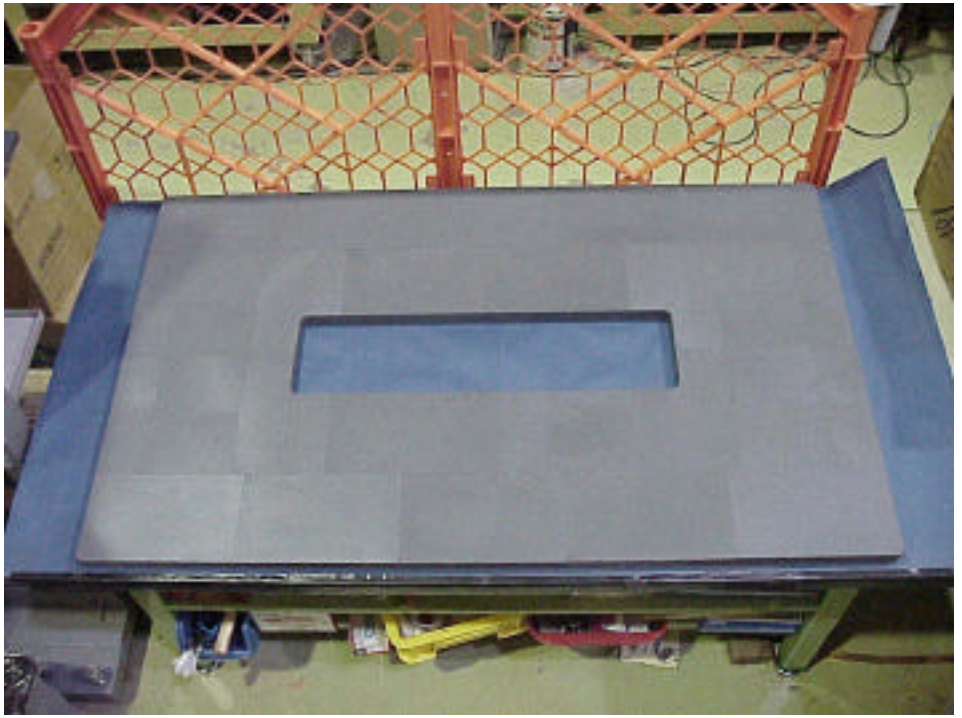
Sample core	Proto-type core
Outer:30mm	Length:1250 mm
Inner:18 mm	Height:760 mm
Thickness:8 mm	Thickness:25 mm
	Length of bore: 640 mm
	Height of bore 160 mm

- Measurement:
  - Measurement of impedance at the end of coil wound around core.

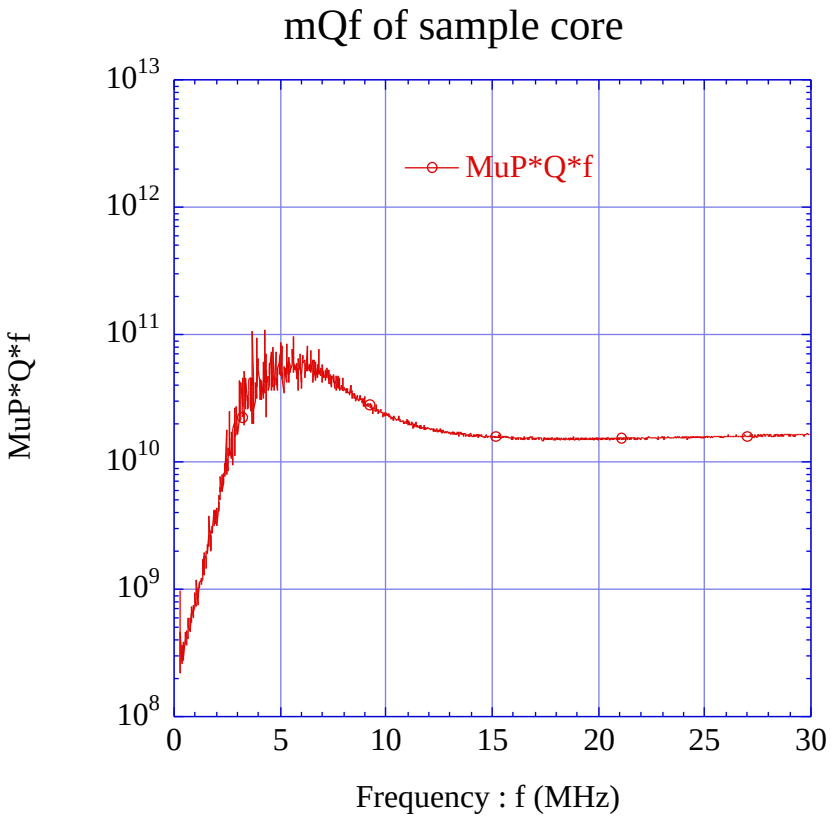
Large prototype of SY25 core

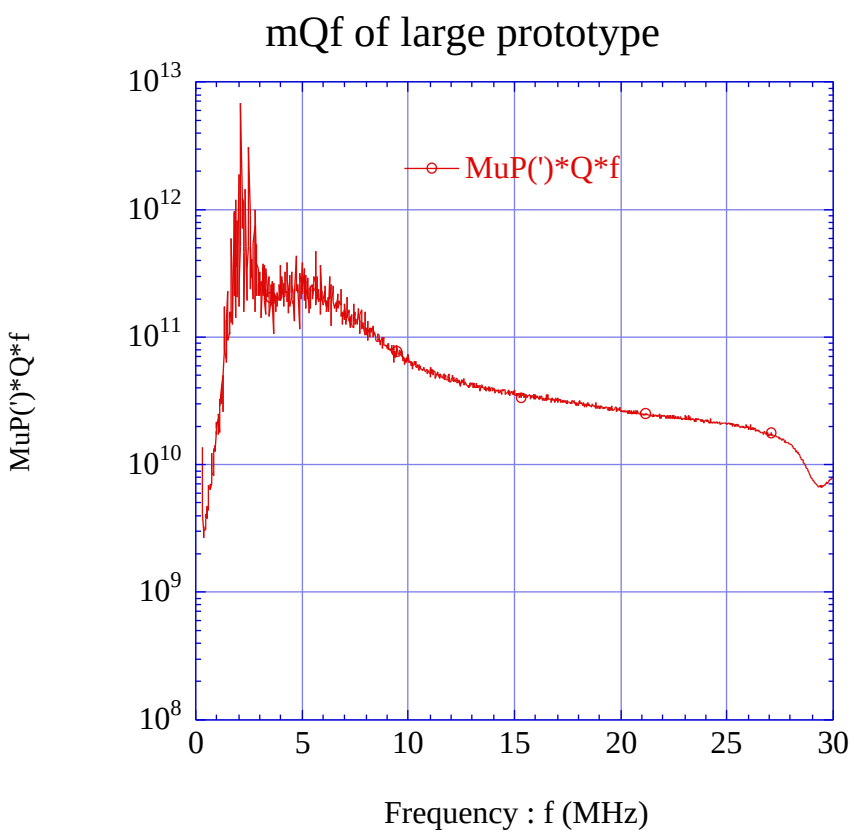
- Real size





Measurement of μQf





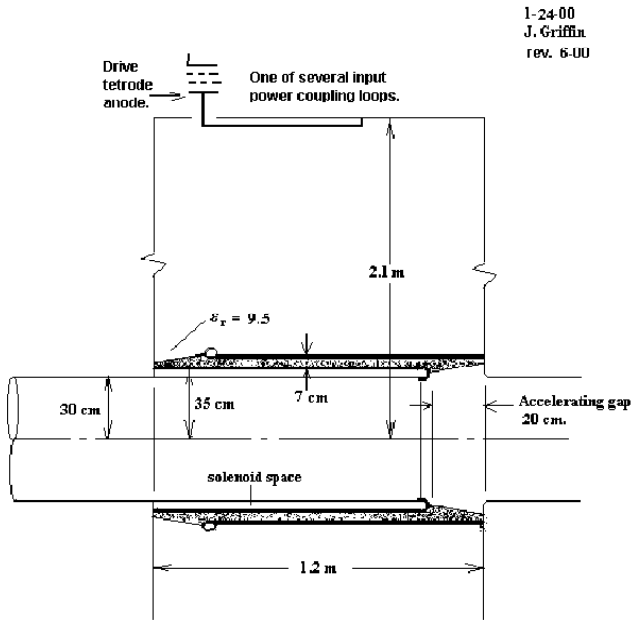
High shunt impedance for 2-8MHz range

Schedule of SY25 study

- High power test with RF
  - Optimize combination of SY25
  - Load test using two SY25 core
  - Power test at 1-2 kW with a matching circuit.
    - Temperature and change of property
  - High power test at 10 kW, if possible

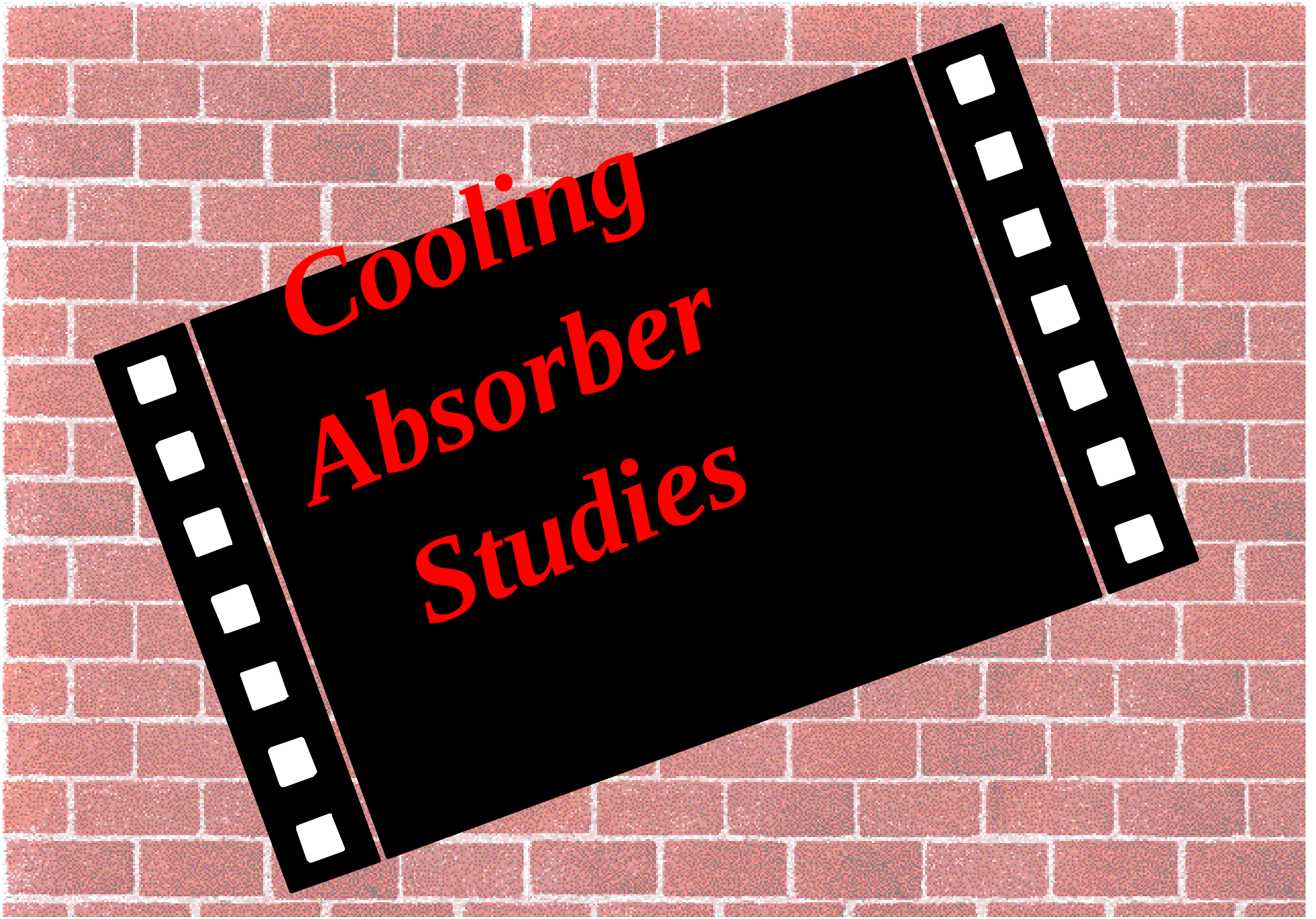
Ceramic-loaded Cavity R&D

- goal: R&D of an RF cavity of 0.5-1.0 MV/m at 7.5 MHz with a high dielectric constant ceramic.



conceptual design
by J.Griffin (FNAL)

- Challenges
  - bulk properties
    - sufficient dielectric strength (internal breakdown)
  - structure design
    - sparking between conductors and ceramic
- Fermilab is responsible.
  - K. Koba at FNAL.


Cooling
Absorber
Studies

Issues on LH2 absorber

- Cooling for thermal load
  - 6W/cm from dE/dX of muon
    - 100 W should be removed for one stage of cooling (thickness 15~20cm).
    - Desigined by Illinois Institute of Technology and Japanese group
- Transparent window

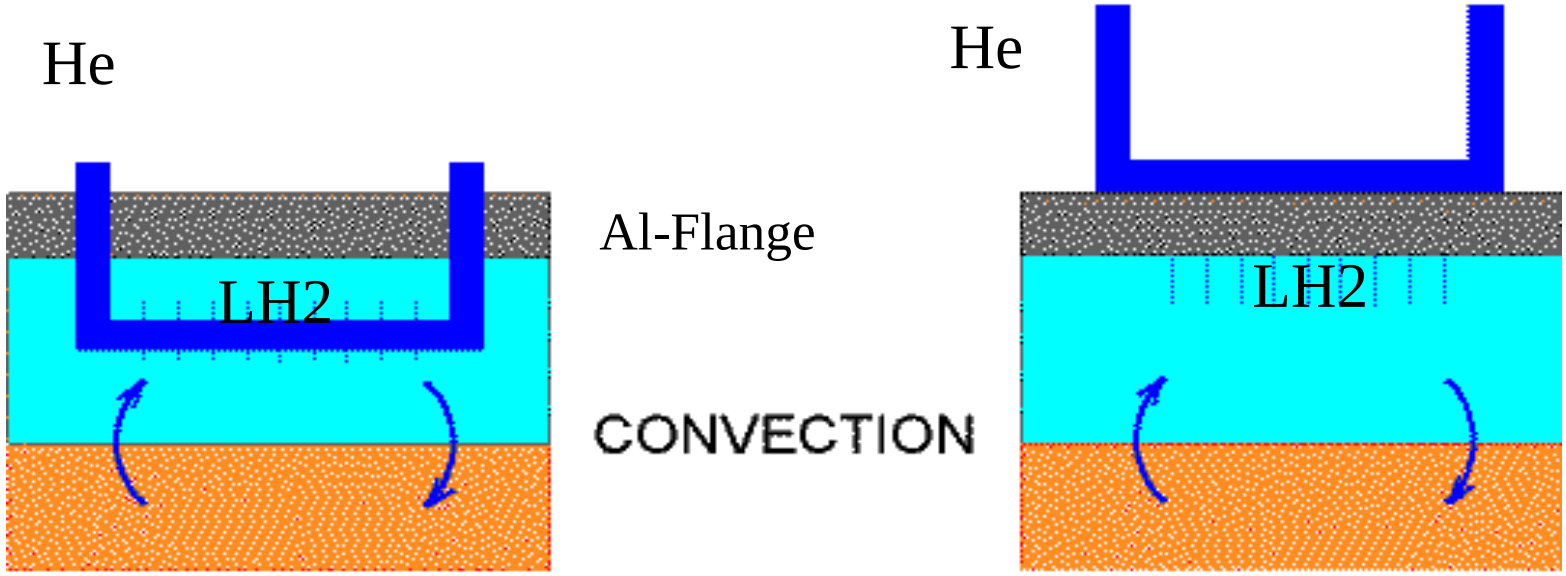
Two types of absorber

- External Heat Exchange Type
  - Forced flow of liquid H2 with exernal heat exchange
  - US
- Internal Heat Exchange Type
  - Heat exchange inside absorber with liquid helium.
  - Japan

Two Internal Exchange Type

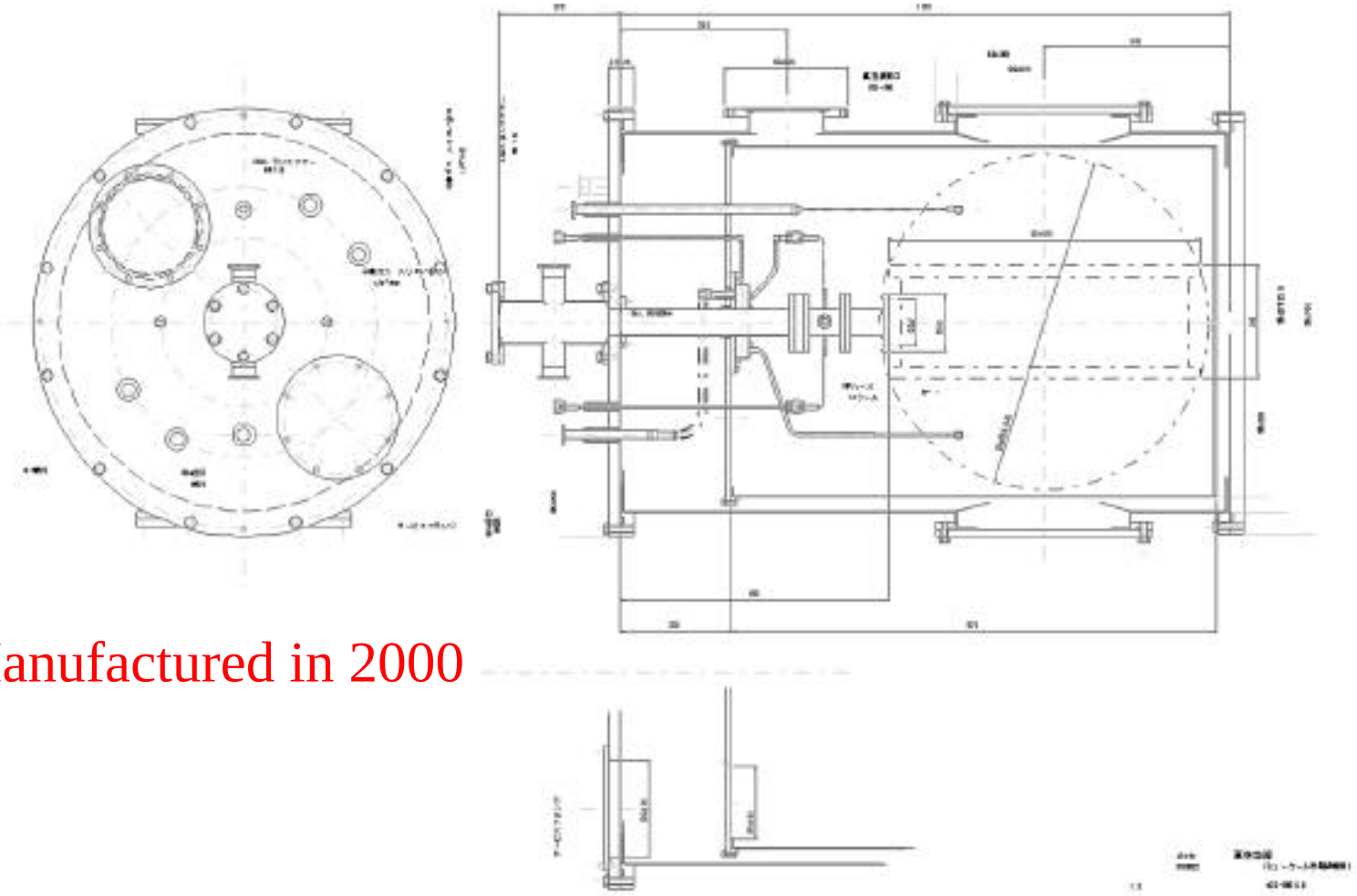
TYPE-I

TYPE-II



He inlet temperature:	14 K	5 - 10K (needs test)
Heat exchanger area:	small	big ?
He flow rate:	high	low (1/5 – 1/10)
flow control:	not required (Tin >14K)	required (over cool)

Cryostat for test of absorber



Manufactured in 2000

Cold test of absorber

- Test of Internal Heat Exchange Type-II and Type-I
  - Heater test
    - Measurement of convective heat transfer
    - Optimize of flow rate and temperature of LHe
  - Test with Ne
    - Test with LH2 is now under consideration.
      - Japanese law is rather strict

MUCOOL Beam test schedule

Year 2001	Year 2002	Year 2003
200MHz Rf design and high power test . Design of super-conducting solenoid Construction of a new laboratory (Lab-G at FNAL) Test of two proto-type of absorbers.	Finish 200Mz RF. Finish Super-con solenoid. Manufacture of proto-type of absorber Design and construction of beam monitor	Test with proton beam Beam test with magnetic field and RF.

Budget for R&D

- Previous fiscal year (2000)
  - RF cavity:4 million yen
  - LH2 absorber:6 million yen
- 2001
  - Budget was already Approved!
  - The same amount as previous

Summary of R&D plans in 2001

- RF cavity of high field gradient at low freq.
  - Ferrite-loaded:
    - Test of SY25 cavity, rf power tests (at KEK)
  - Ceramic-loaded:
    - construction of a scale model and high rf power station (at Fermilab)
- LH2 absorber
  - Construct and test a prototype of internal heat exchange type (at KEK)

Announcement!

- NuFACT01 will be held in JAPAN,

  May 24-30, 2001
- Everybody is welcome!
- Local collaboration meeting in Japanese style?