

**Two-Mirror Cavity  
studies with e<sup>-</sup> beam  
&  
Four mirror cavities**

# Prototype Cavities

T. Takahashi

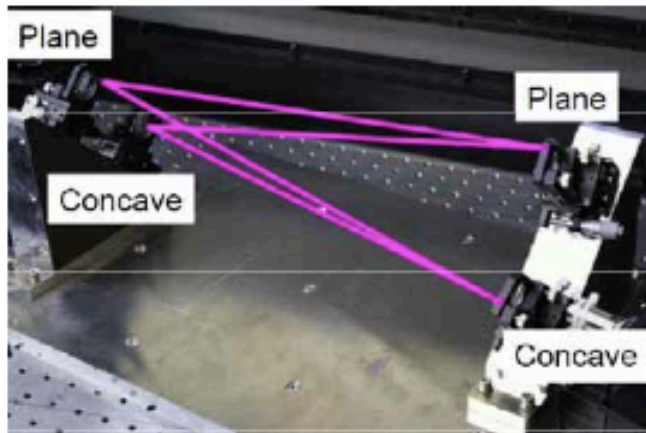
## 2-mirror cavity at KEK ATF

moderate enhancement  
moderate spot size  
simple control



experiences  
with  
accelerator

## 4-mirror test bed at KEK



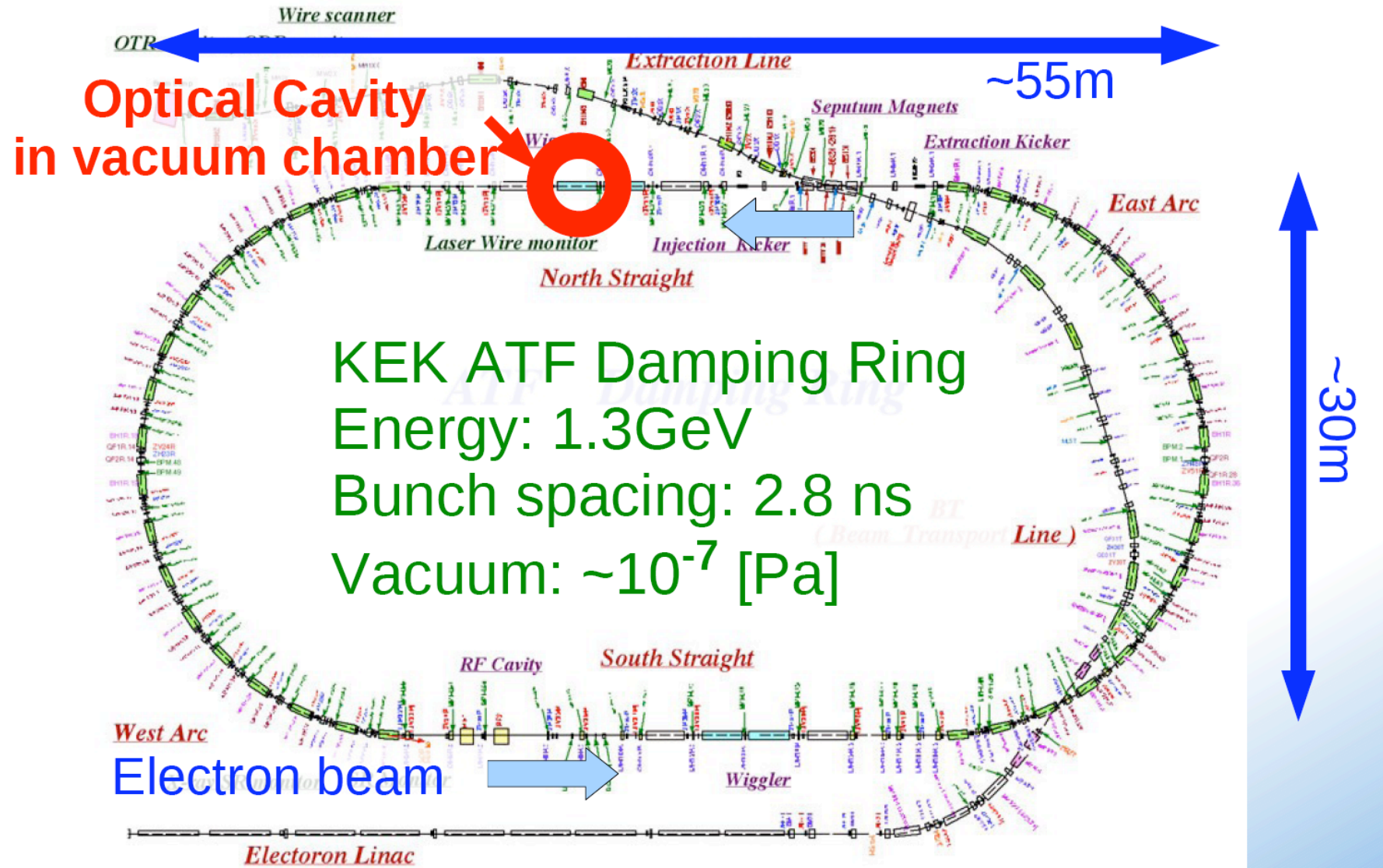
## 4-mirror cavity at LAL



Japanese-French collaboration

**high enhancement, small spot size**

# Two-Mirror Cavity in ATF



# Results in November 2009

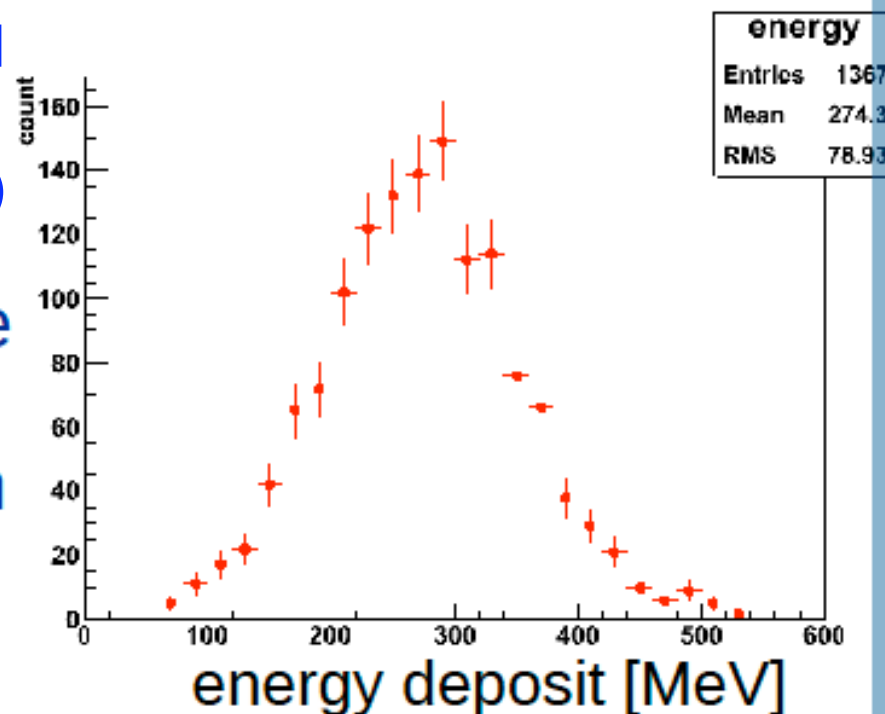
Reported in ATF2 meeting in December 2009

Enhancement factor tripled (250  $\rightarrow$  760),  
accumulated power increased from 500W to 1.48kW.

Higher reflection mirror installed  
in summer 2009.

(99.6%, 99.6%)  $\rightarrow$  (99.6%, 99.9%)

10.9 gamma-rays / train are  
detected  
with single bunch operation  
( $I \sim 2.2\text{mA}$ ).



# Two-Mirror cavity in 2010

## 1) Try multi-bunch collision

But results were not so good.

Multi-bunch instability.

It seemed that situation became worse than 2008.

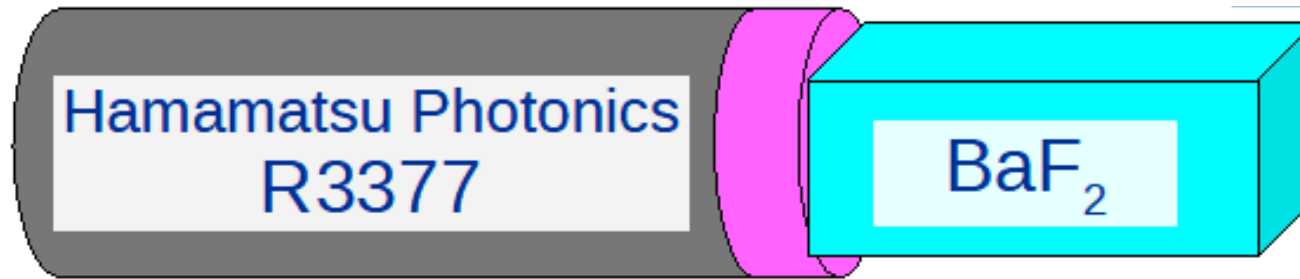
(In 2008, we made single, 5,10, 15-bunch collision.)

## 2) Prepare bunch-by bunch measurement in multi-bunch collision

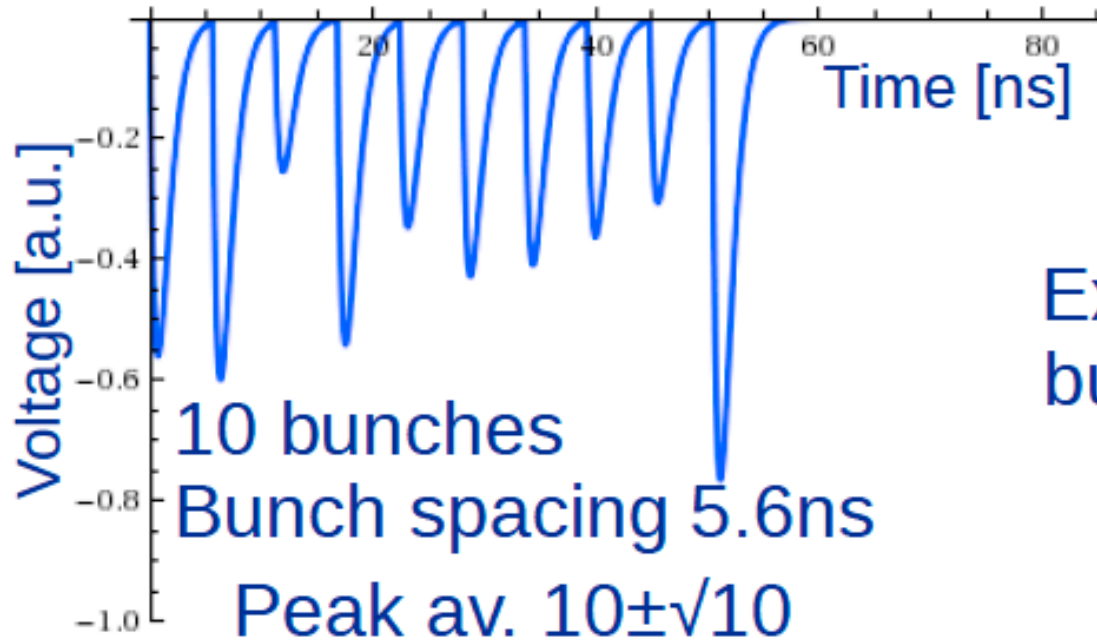
Built a new detector

# New Gamma-ray Detector

For Bunch-by-Bunch measurements



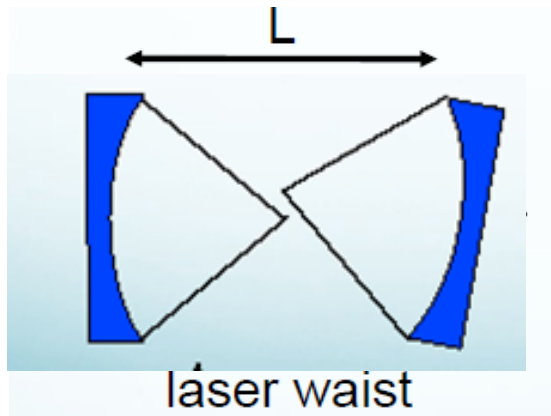
Result of simulation



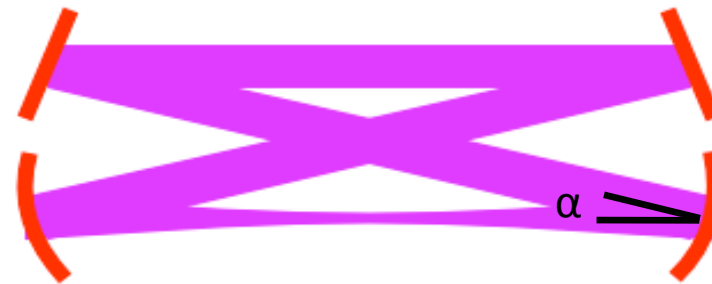
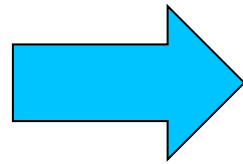
Expected to obtain  
bunch information.

# Four-Mirror Cavities

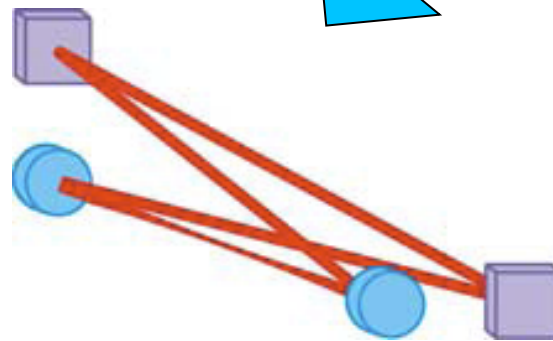
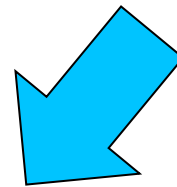
# We should go to 3D 4 mirror ring cavity to get small spot size



2 mirrors is not stable for small spot size



2d 4M has astigmatism and eigenmode polarisation instability at high finesse



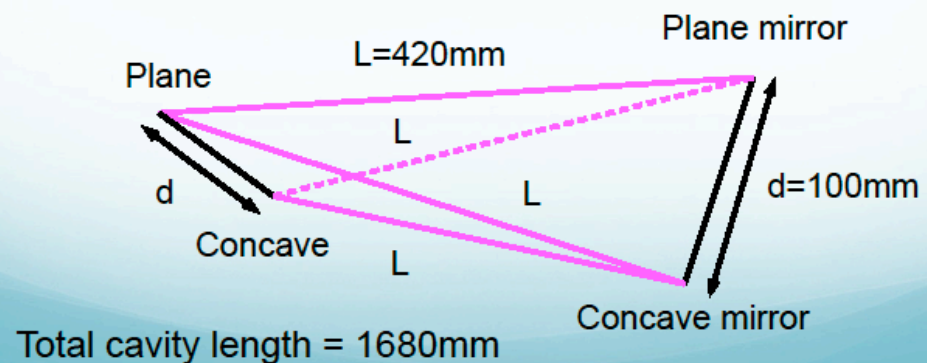
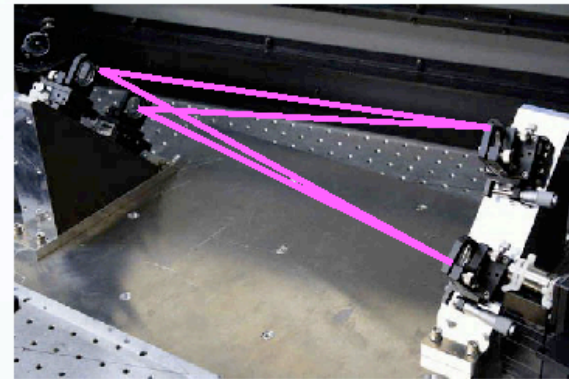
3D (or twisted)  
4M ring cavity  
→ circularly polarised eigen modes



# 4M cavity test bed at KEK

- in 4M ring cavity, photons travel twisted path.
  - There is a non zero geometric phase after a round trip
    - the cavity only resonate with L or R handed state

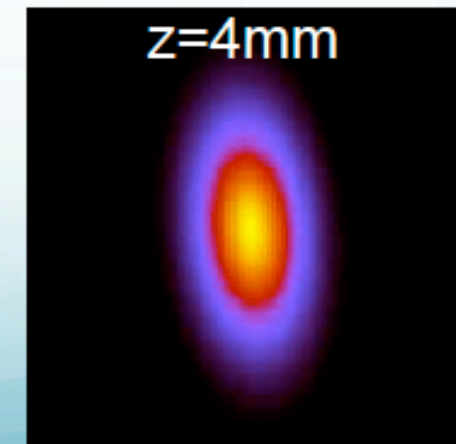
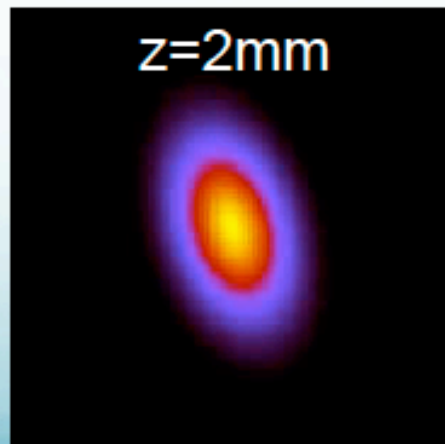
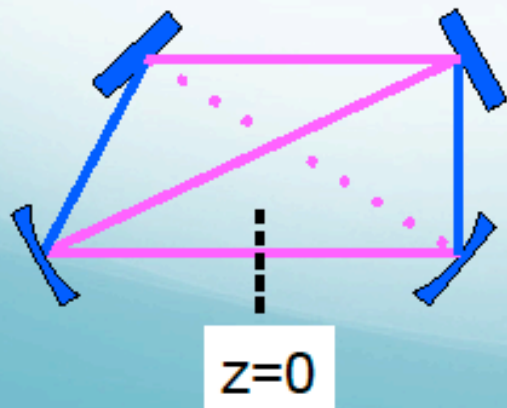
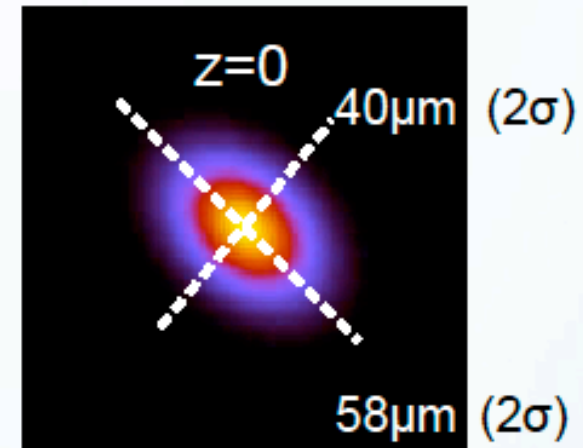
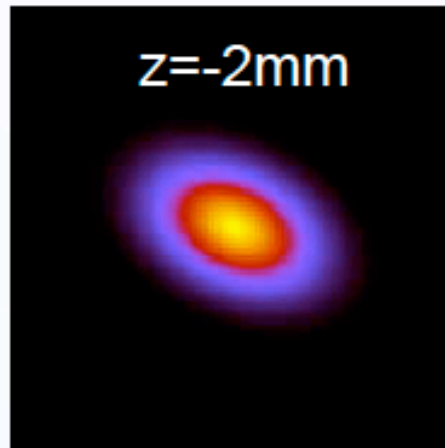
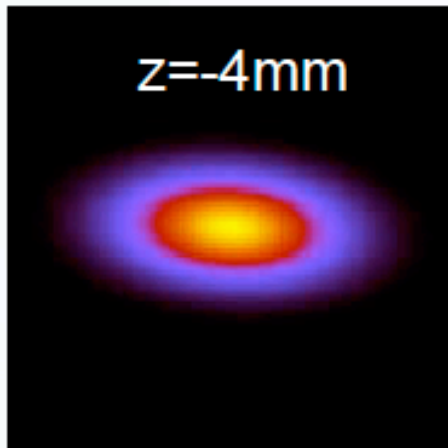
need detail study by the comparison of measurements and calculation.



# Calculation of the laser profile inside the cavity

Calculation  $\delta=0.2\text{mm}$

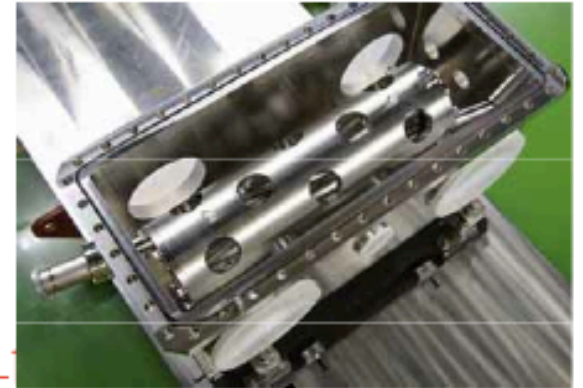
Akagi PosiPol2010



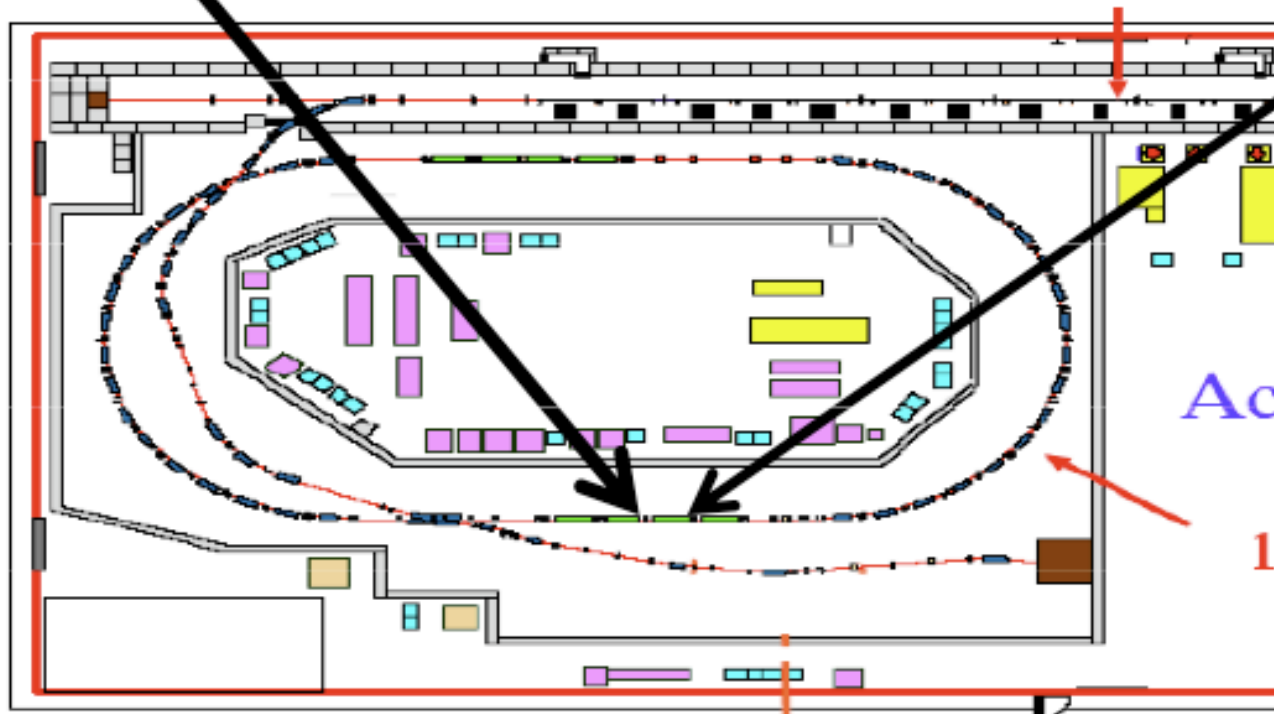
systematic study is underway at KEK-Hiroshima

# CELIA & LAL cavity is coming to KEK

T. Takahashi

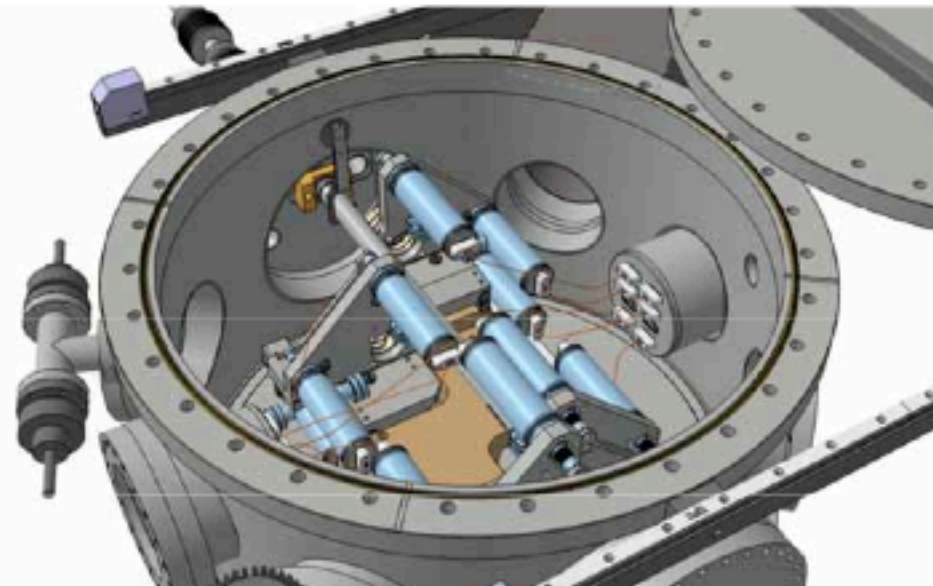


1.28 GeV S-

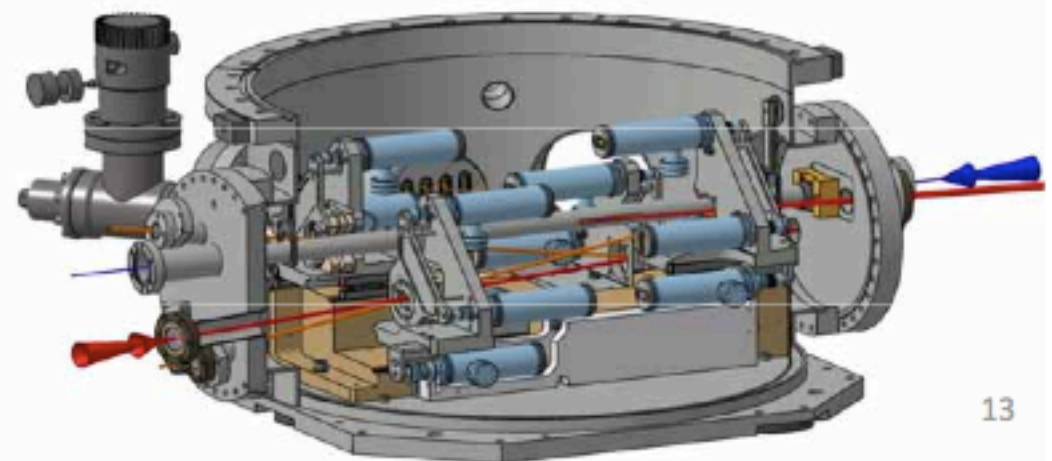


# Cavité Fabry-Perot mounting (in a class 10 clean room)

Zomer PosiPol2010

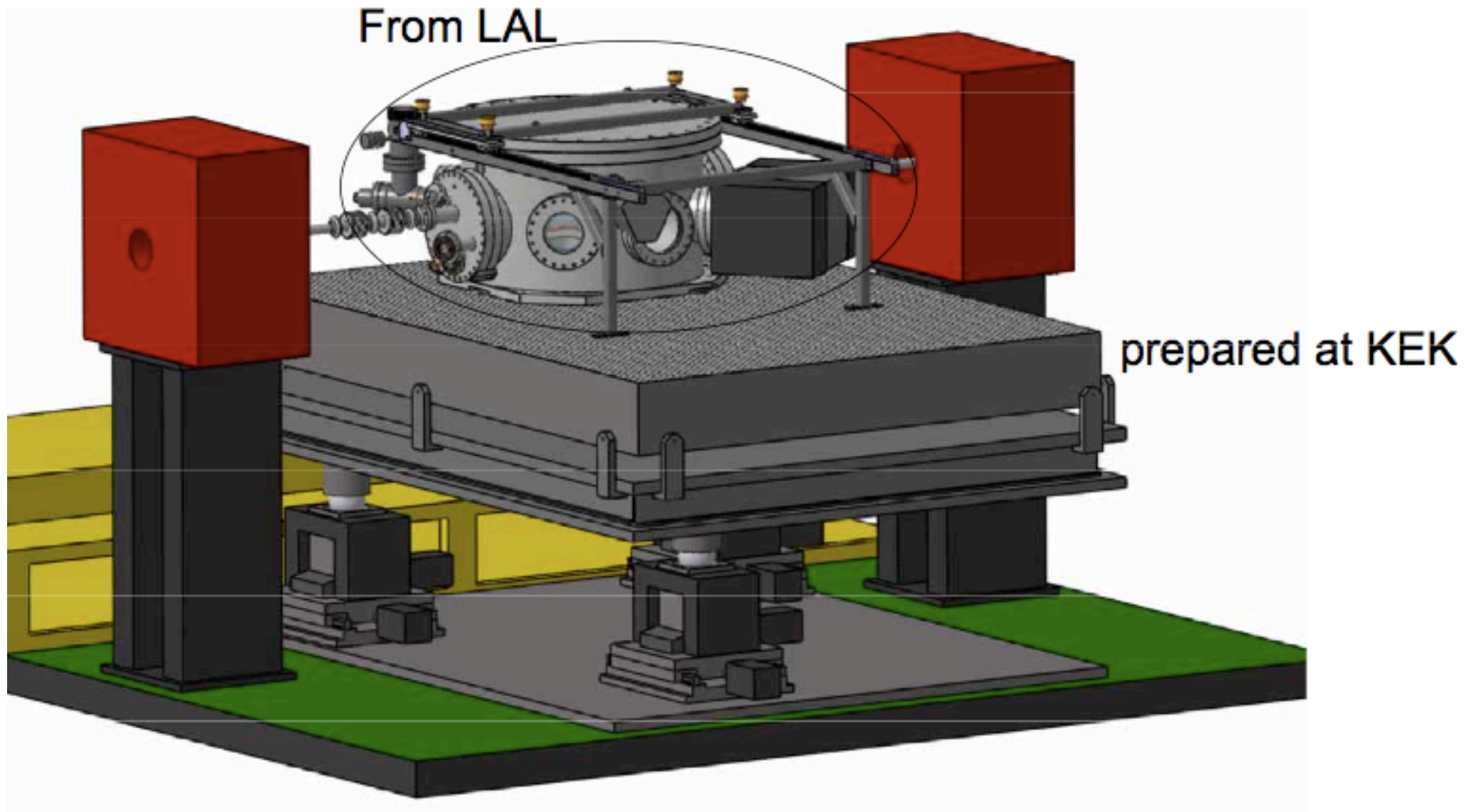


Viton joint & turbo Pump →  $\sim 10^{-7}$  mbar



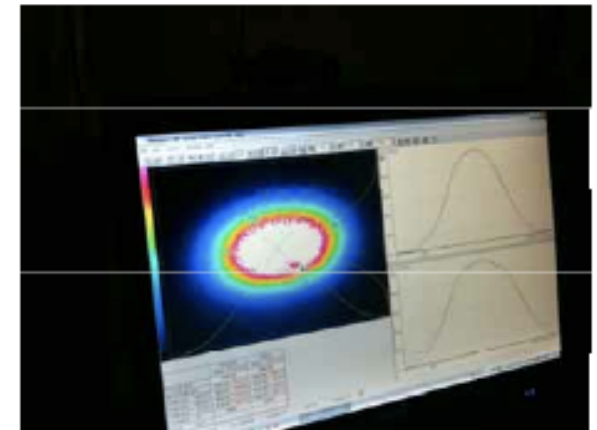
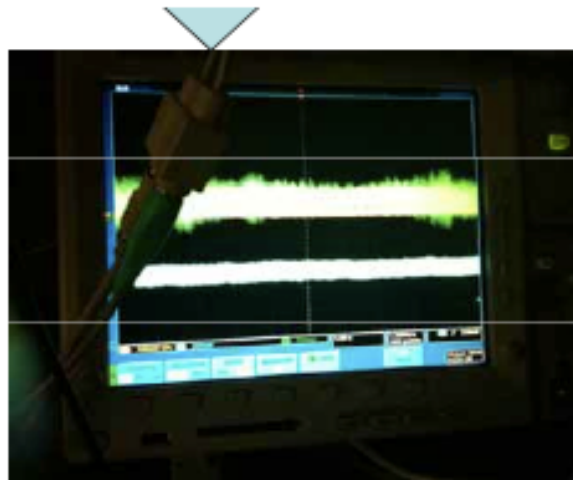
# Cavity implementation in ATF

Zomer PosiPol2010



# Status

- 4M cavity of gain  $>1000$  locked at LAL on 21th june 2010 with
  - 0.2ps @178.5 MHz 250mW oscillator amplified up to few Watts using Yd doped fiber
  - **All apparatus was ready in june 2010 and was shipped from LAL to KEK on 28th june**



# Planning

There were extensive discussion between French and Japanese side for installation during July to August

realistic procedure

schedule

safety

Then finally reached consensus

T. Takahashi

- CELIA&LAL team (8 people) will arrive on 26th July for installation
  - Connection to ATF will start on 26th August if vacuum tests ok
- 1 Phd and 1 ingeneer will be located at KEK permanently in 2010-2011 (F. Labaye, D. Jehanno)
- **Operation plans**
  - First step : 50W amplified laser and 1000 cavity gain
  - Second step : increase laser power up to 100W-200W
  - Third step : increase cavity gain up to 10000