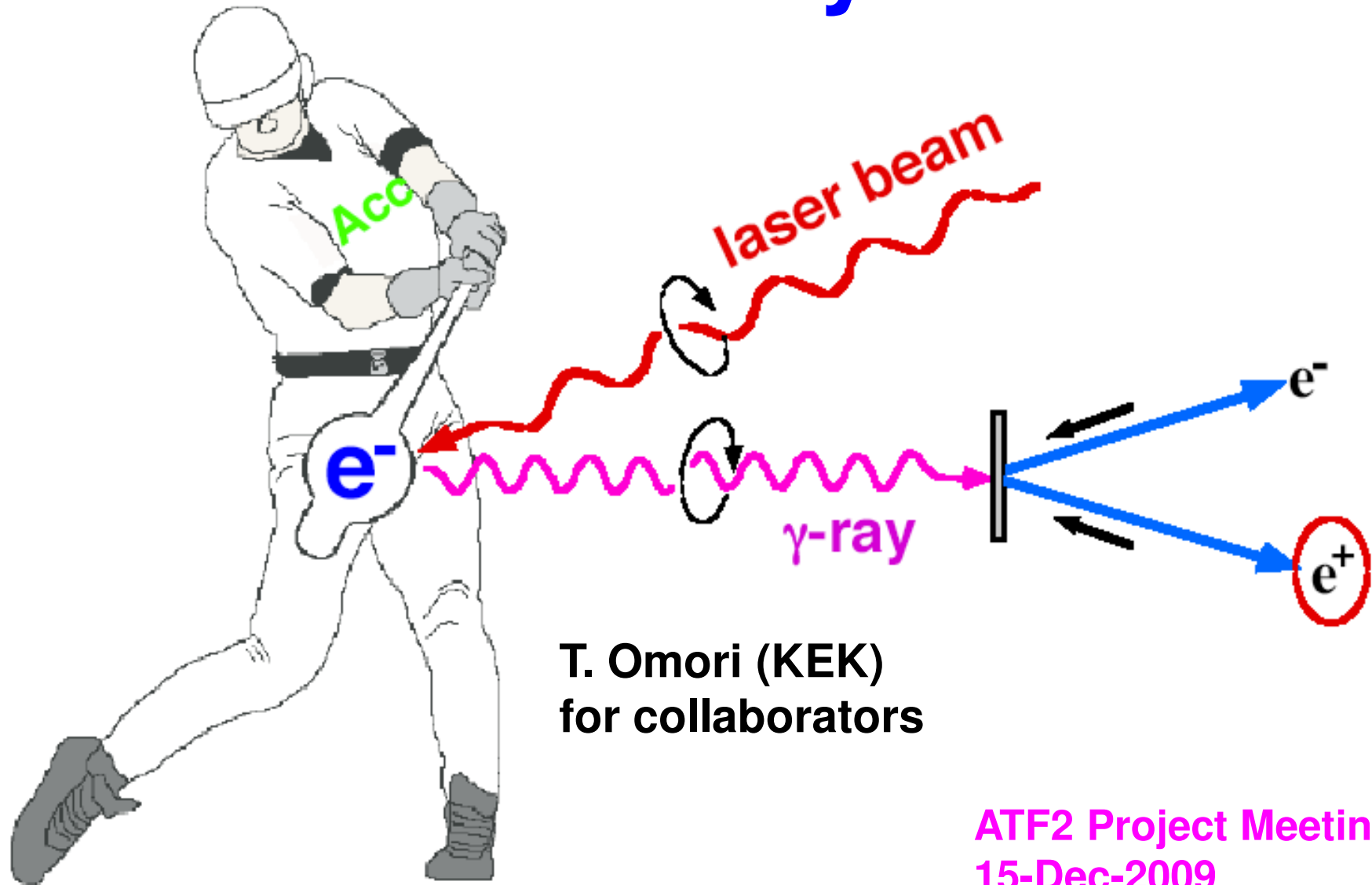


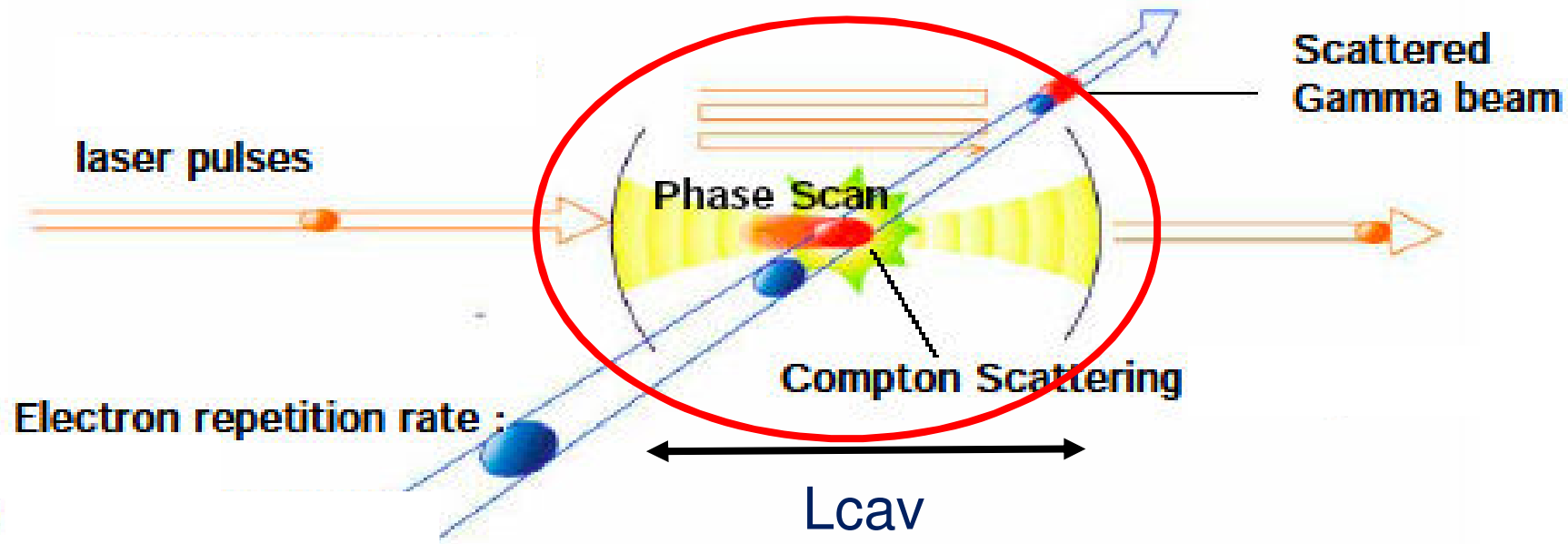
# Compton Experiment at ATF DR 2009 Summary and Plan



T. Omori (KEK)  
for collaborators

ATF2 Project Meeting  
15-Dec-2009

# Optical Cavity for Laser-Compton



**Higher laser power**

$L_{\text{cav}} = n \lambda/2$ ,  $\Delta L < nm$  laser for pulse stacking

->more enhancement the more precision

**Laser should be focused for high power density**

**Efficient laser-Compton scattering**

$\Delta T < ps$

**Accommodate laser cavity in the accelerator**

# Two Prototype Cavities

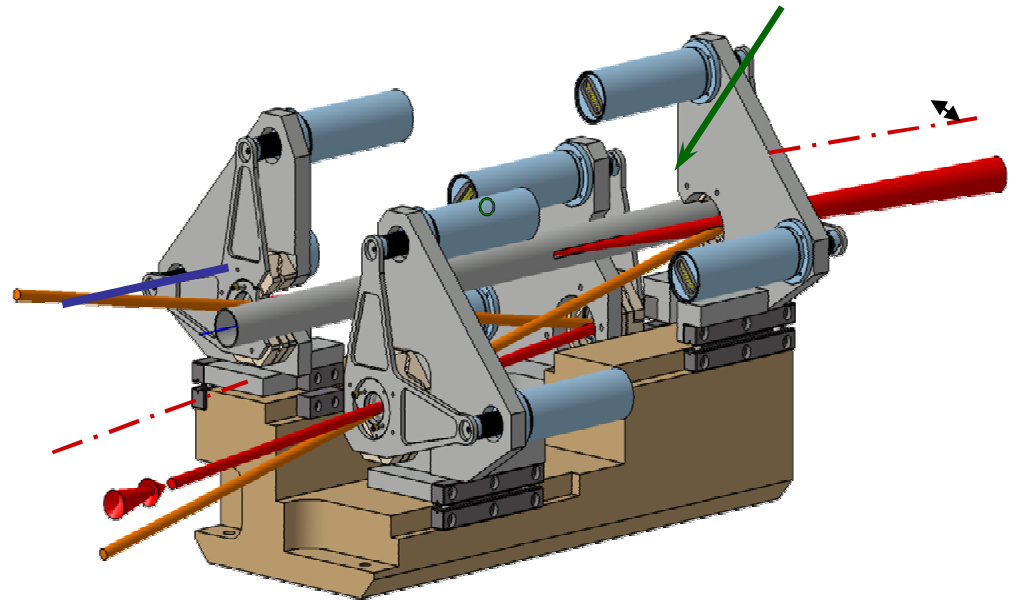
**2-mirror cavity** (Hiroshima / Weseda /  
Kyoto / IHEP / KEK)



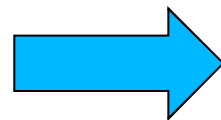
moderate enhancement  
moderate spot size  
simple control

demonstration of  $\gamma$  ray gen.  
accum. exp. w/ cavity and acc.

**4-mirror cavities w/LAL**



high enhancement  
small spot size  
complicated control

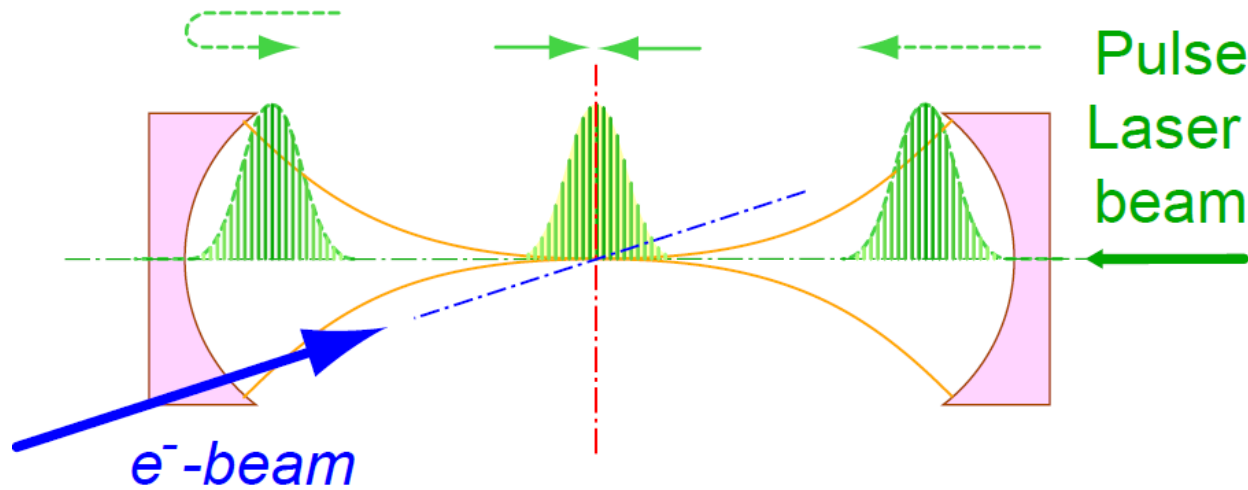


intense  $\gamma$  ray generation

## **2 MIRROR CAVITY STATUS**

# Experimental R/D in ATF

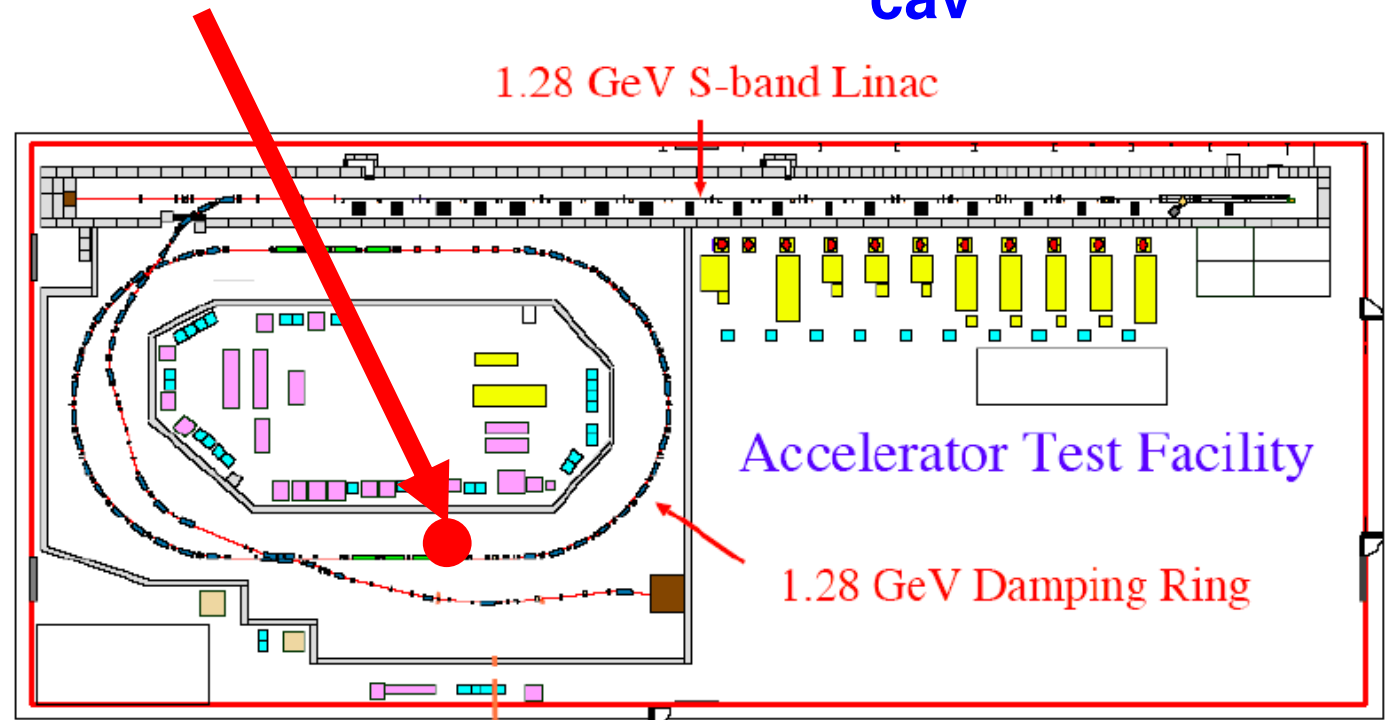
Hiroshima-Waseda-Kyoto-IHEP-KEK



**Make a fist  
prototype  
2-mirror cavity**

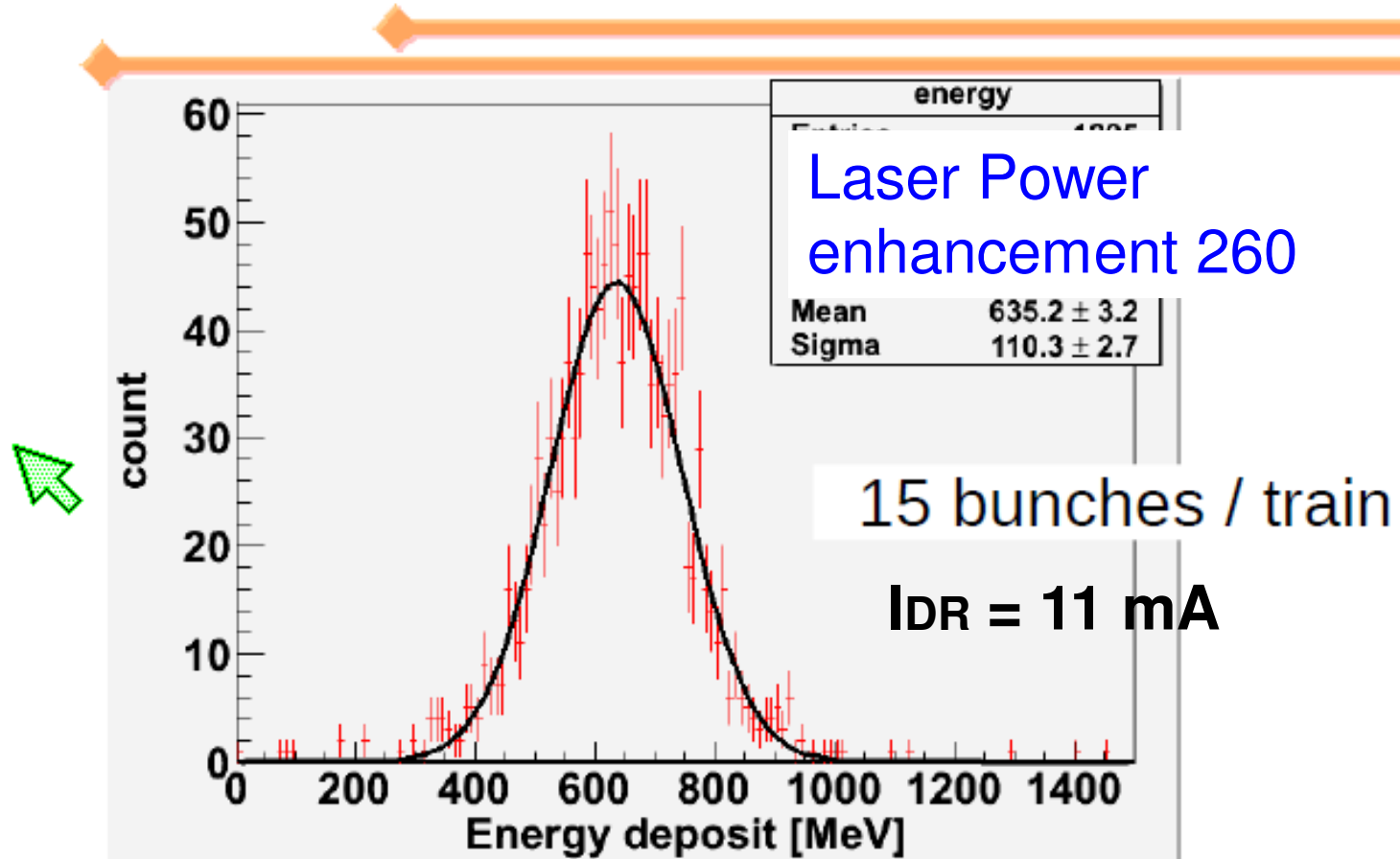
$$L_{\text{cav}} = 420 \text{ mm}$$

**Put it in  
ATF ring**



# Result

Before Summer 2009



We detected 27 gamma-rays / bunch train.  
generation 60 gamma-rays / train to all angle.

➡  $60 \times 2.16 \text{ MHz} \sim 1.2 \times 10^8$  [gamma / second]  
Revolution

# data summary

**Before Summer 2009**

bunch /train	current [mA]	Stacked Laser power[W]	$\gamma$ s/train	expectation	normalized $\gamma$ s/A/W
1	2.2	$437 \pm 2$	$5.4 \pm 0.3$	$4.9 \pm 0.3$	$5.6 \pm 0.3$
5	4.7	$432 \pm 2$	$10.6 \pm 0.1$	$10.5 \pm 0.5$	$5.3 \pm 0.1$
10	8.5	$470 \pm 2$	$19.0 \pm 0.1$	$21 \pm 1$	$4.8 \pm 0.1$
15	11	$498 \pm 2$	$26.9 \pm 0.1$	$29 \pm 1$	$4.8 \pm 0.1$

Normalized  $\gamma$  yield seems to decrease as # bunches/train goes up

 Bunch (size, timing) fluctuation in the ATF suspected

# Summer 2009

- One of the Mirror was replaced with the higher reflectivity one

- 99.6% -> 99.9%
- power enhancement

- 260 -> ~630

(  
99.6% 99.9%

- more precise controll required (~0.1nm)

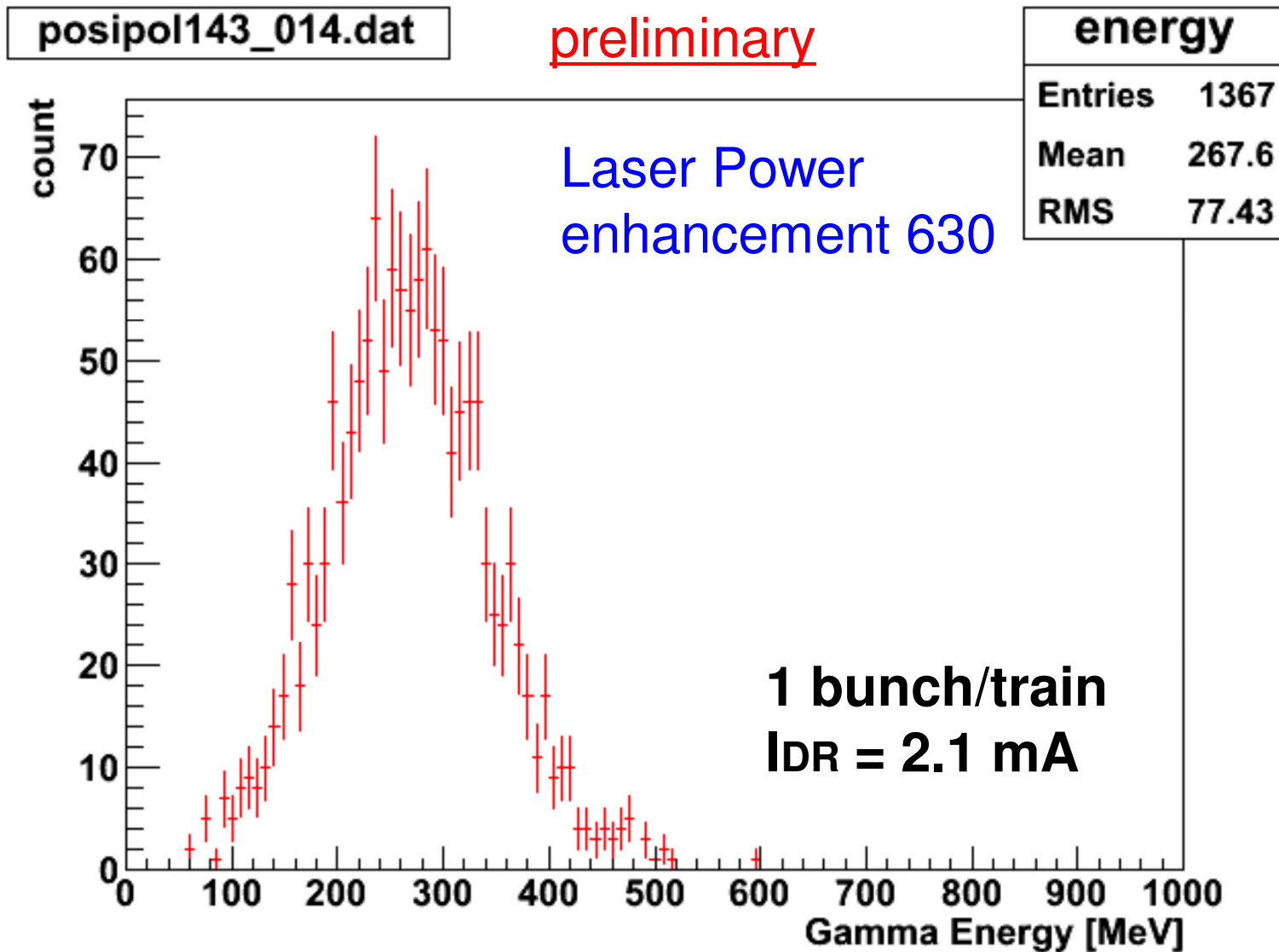
- Status of the cavity w/ new mirror

- Finess ~2000 with feedback on before vacuum on
- now in preparation for beam
- hope to get 3 times more photons by the end of the year



# Result

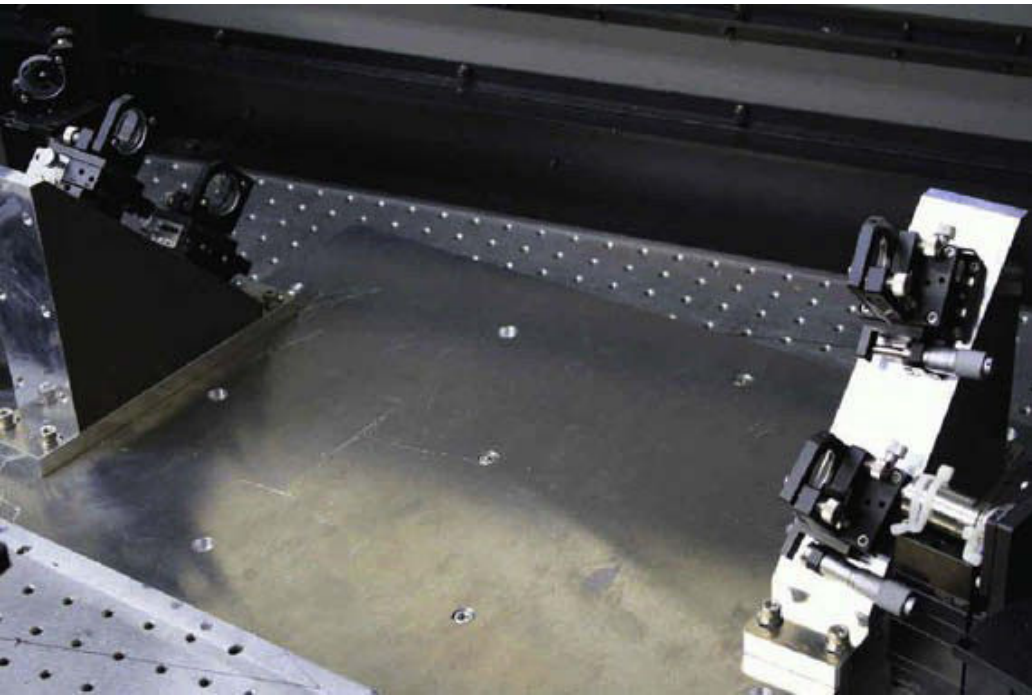
November 2009



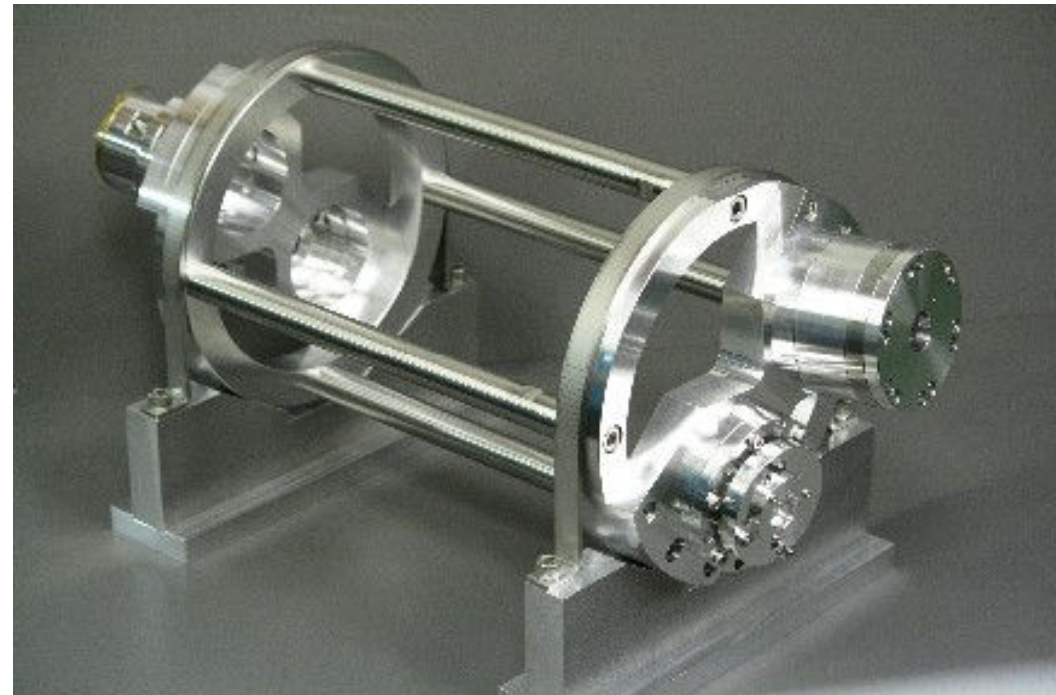
We detected 11 gammas/train

# 4 MIRROR CAVITY STATUS

March 2009

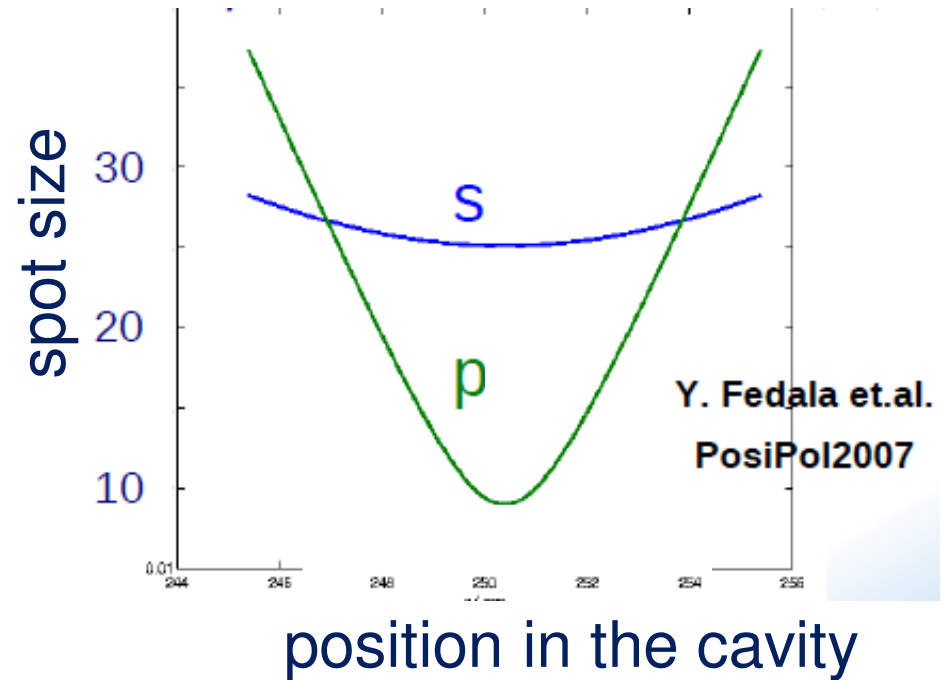


August 2009



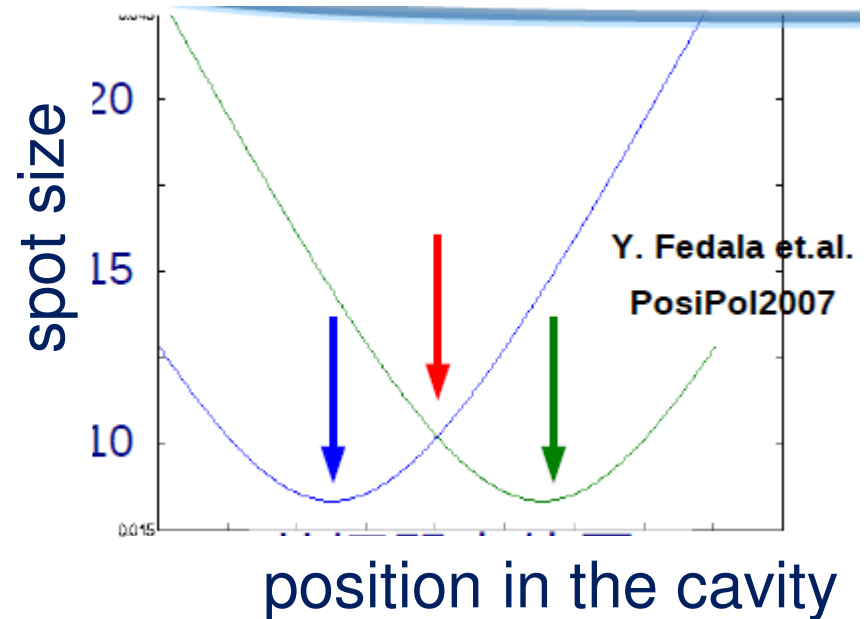
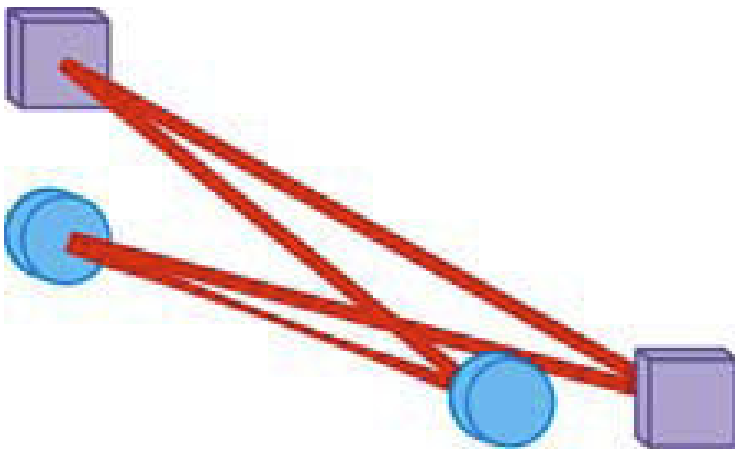
# 2D configuration

2D 4mirror cavity has astigmatism.

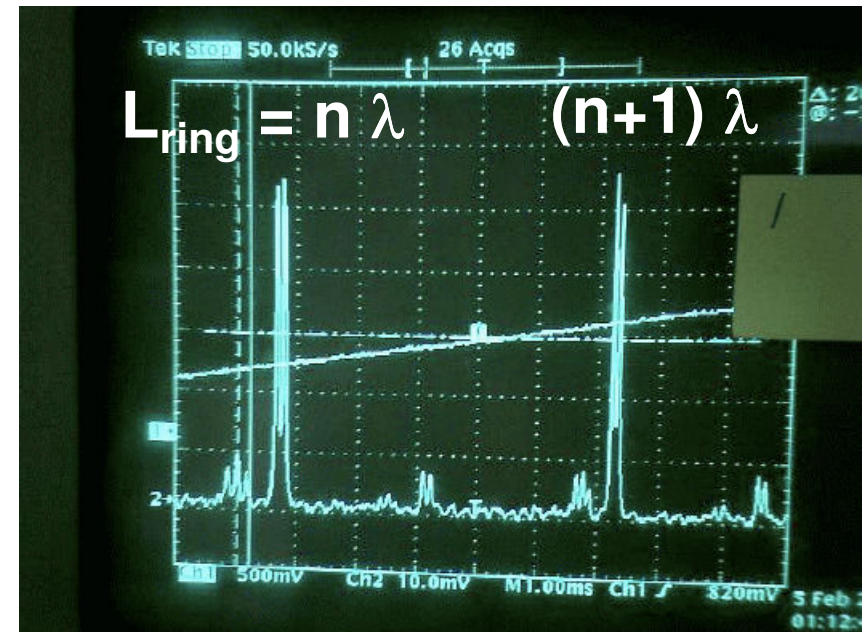
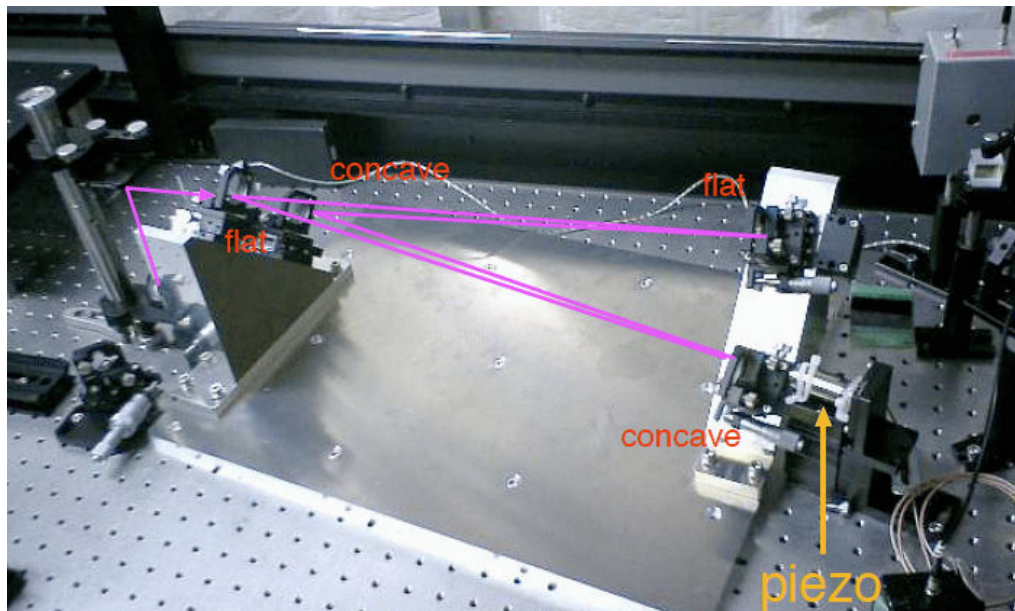
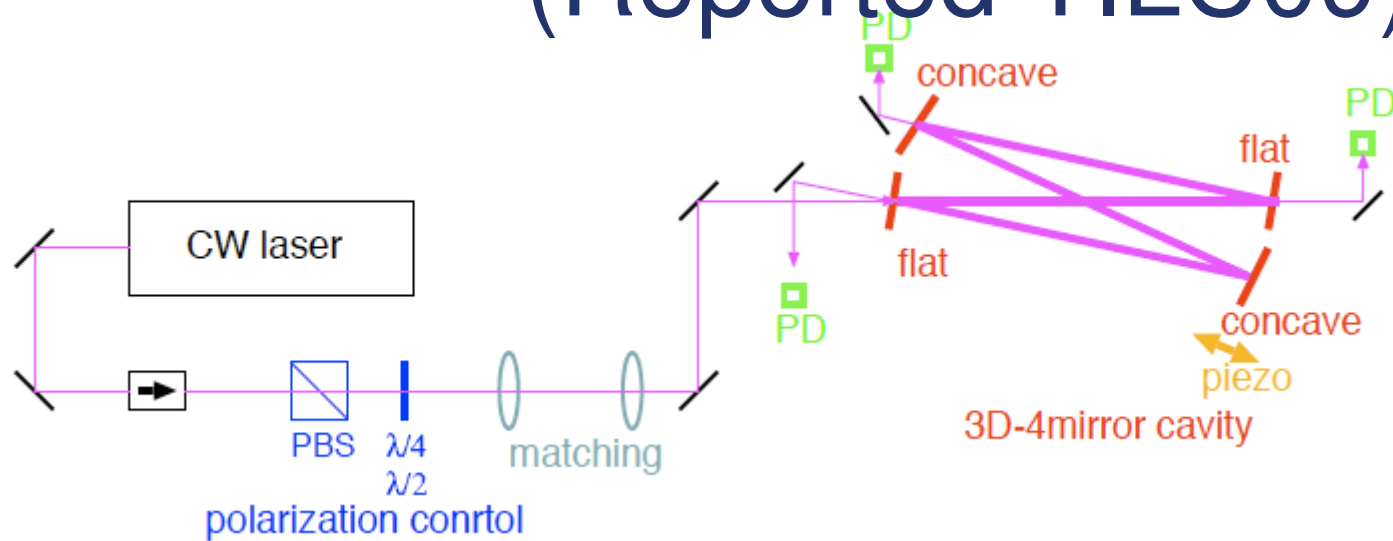


# 3D configuration

go to 3D config. to avoid astigmatism

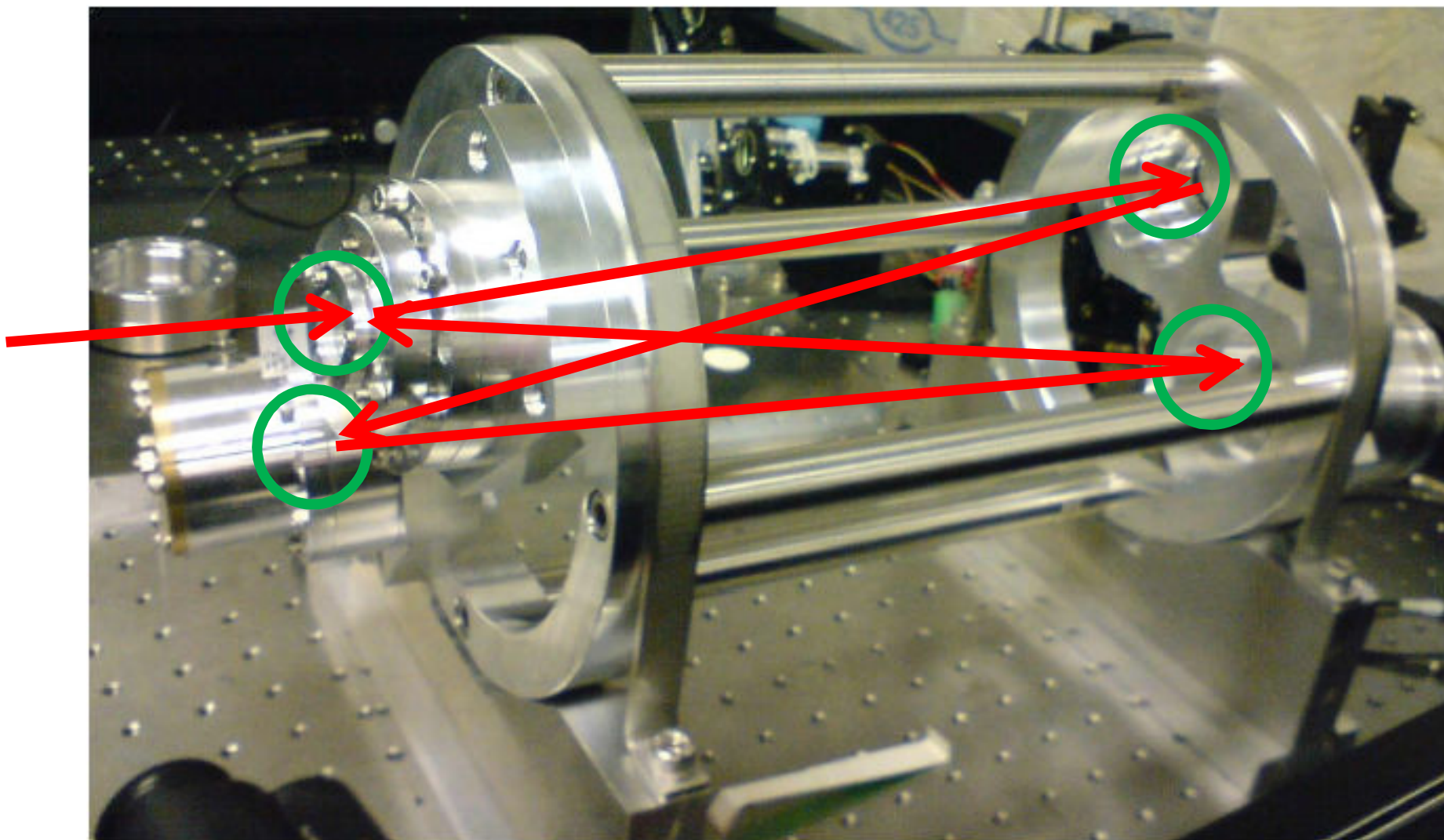


# R&D of 4 mirrors cavity started at KEK (Reported TILC09)





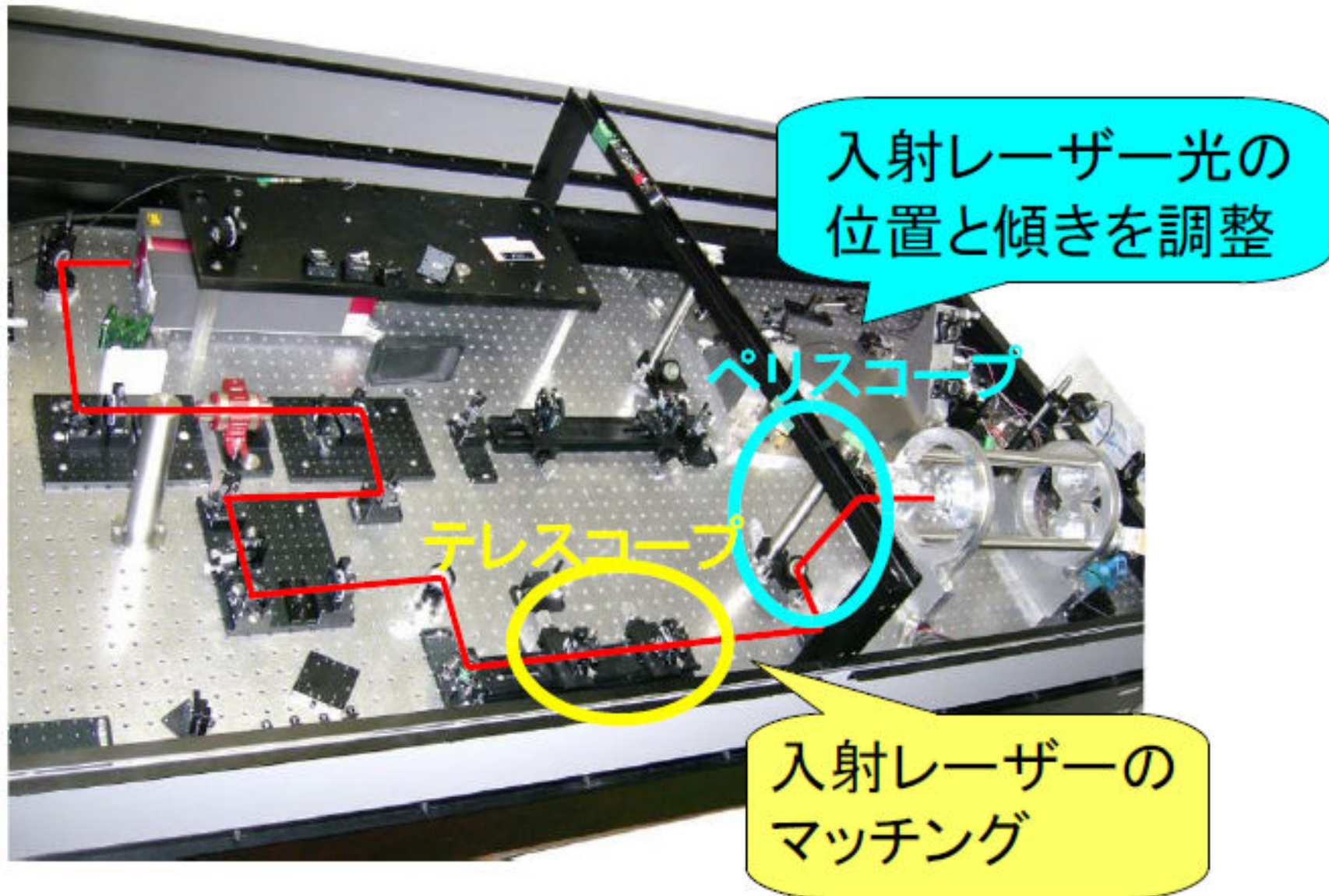
# prototype 4 mirror cavity Constructed



[illegible]

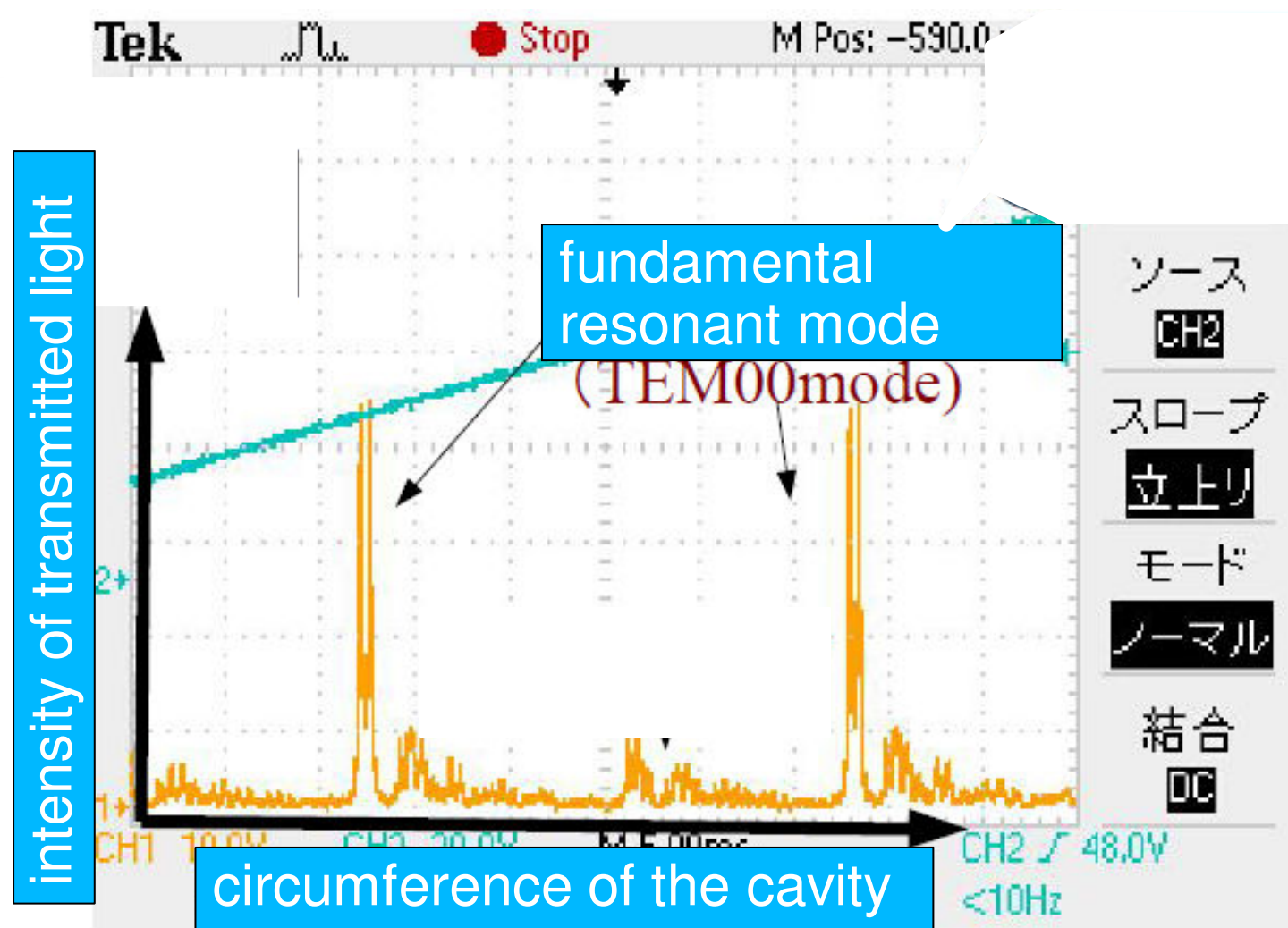
Objective: to establish method of:  
mirror alignment, control cavity length  
→ feed back to the beam compatible cavity

# Prototype cavity on the optical table





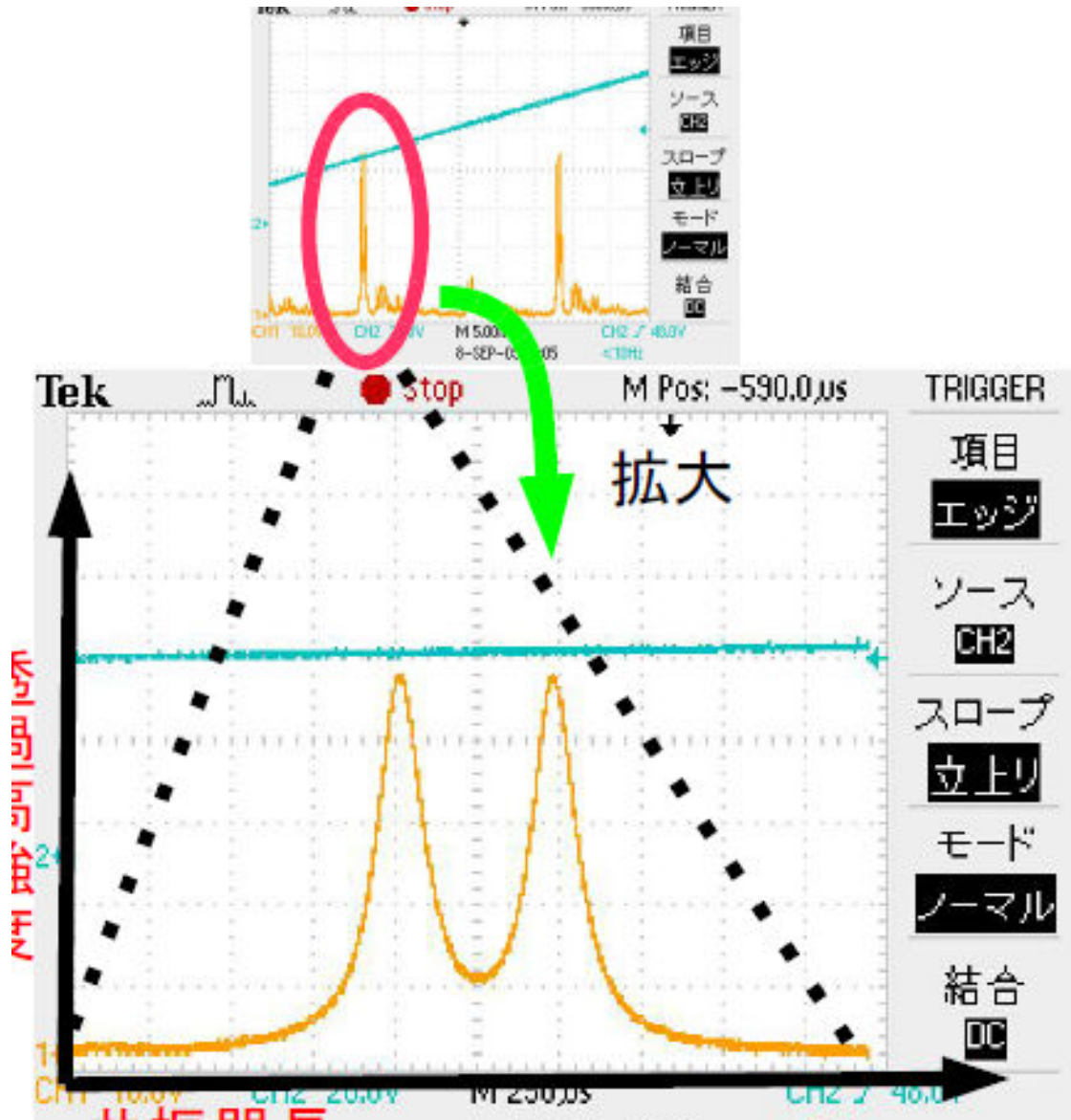
# status of initial tests



resonance of the cavity with injecting laser observed



# two peaks



- two separated resonant peaks

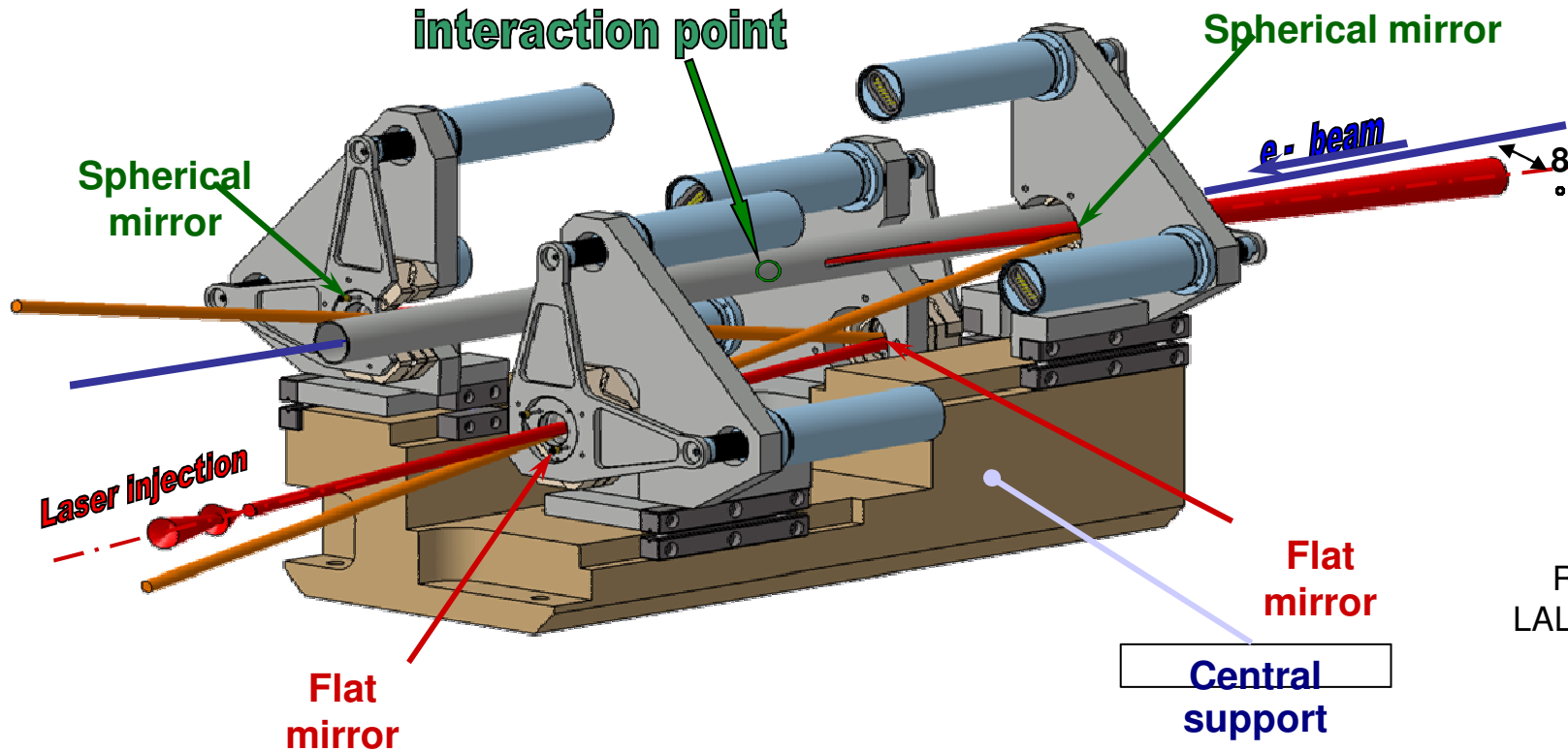
each corresponds to  
left or right handed polarization

- 3D cavity only resonates with circular polarization due to geometric phase

Useful to:

- generate circularly pol.  $\gamma$ s
- fast switching

# Staus of the LAL cavity



R. Cizeron  
LAL 30/01/2008

French colleagues visited KEK in July.  
discussed detail of the installation procedure  
setting up at the ATF beam line



working to install the cavity in summer 2010

# Summary

- ▶ 2 mirror cavity to demonstrate photon generation and to accumulate experience w/ beams
  - Before summer 2009
    - enhancement of 260, 27 gammas / crossing
  - High reflection mirror (summer 2009)  
(99.6%, 99.6%) ->(99.9%, 99.9%)
    - beam with enhancement ~630
- ▶ 4 mirror ring cavity for higher enhancement and small spot size
  - Basic test on optical table
  - First prototype at KEK and being tested
  - Installation of LAL cavity will be summer 2010

# Beam Time Request in 2010-2011

## ► Jan.-Jun. 2010

- 1 shift/week (in average) with the current two mirror cavity (99.6%, 99.9%)

## ► Summer 2010

- Install LAL 4-mirror cavity.
- Upgrade the two mirror cavity --> (99.9%, 99.9%)

## ► Oct. 2010-Jun. 2011

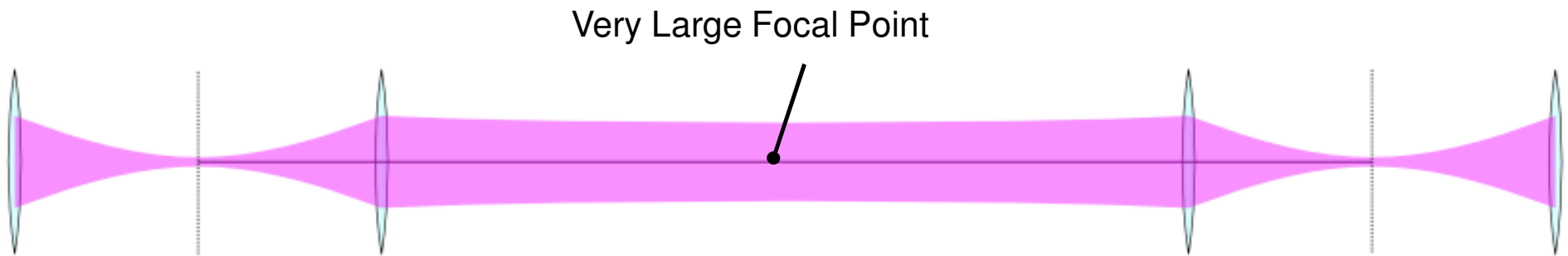
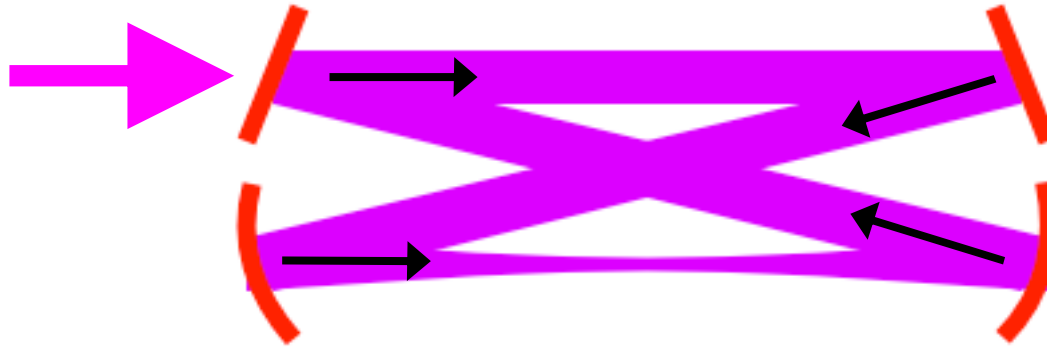
- 1 shift/week (in average) with upgraded 2-mirror cavity.
- 1 shift/week (in average) with LAL 4-mirror cavity.

## ► Summer 2011 and later

- Not decided yet

# Backup Slides

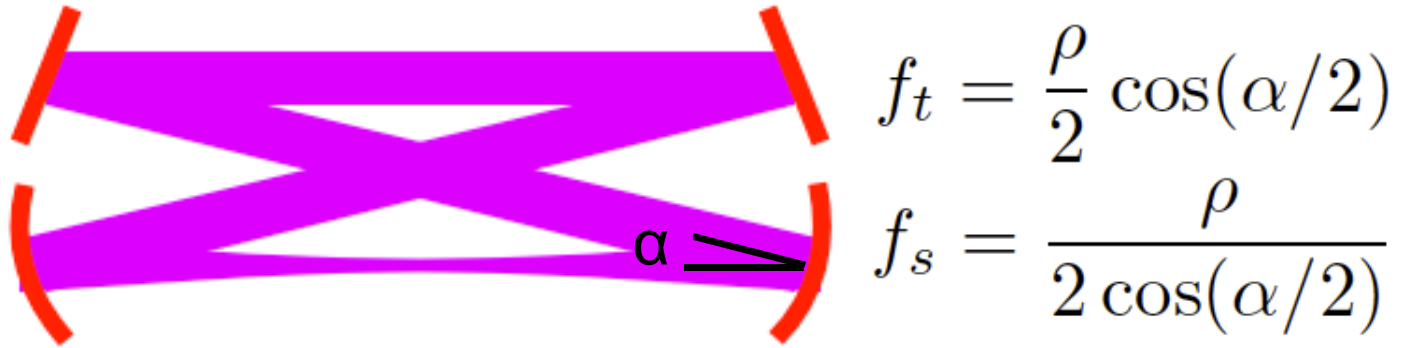
# 4-mirror ring cavity



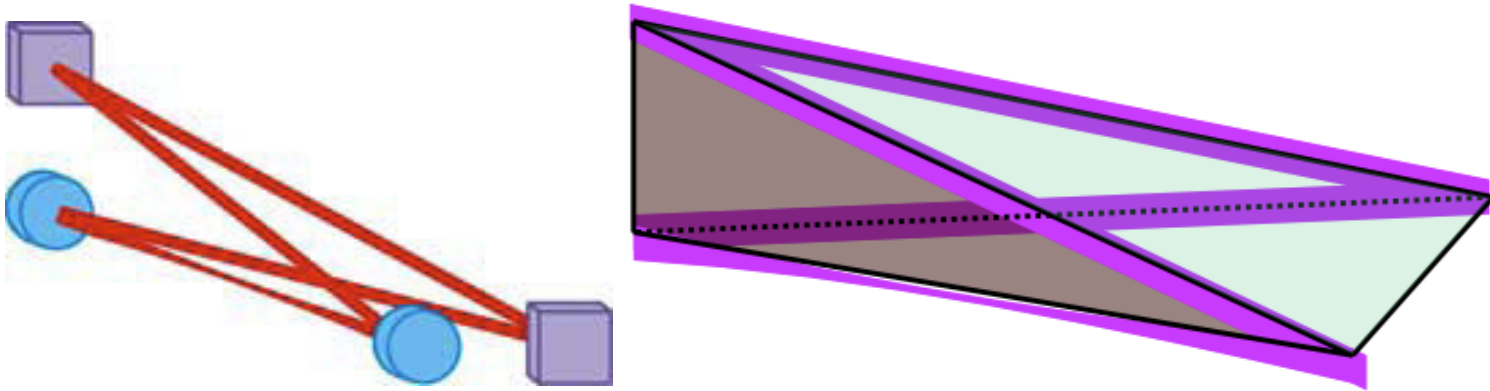
Equivalent Optics of the 4-mirror Cavity

**tolerance : 4-mirror = 100 x 2-mirror**

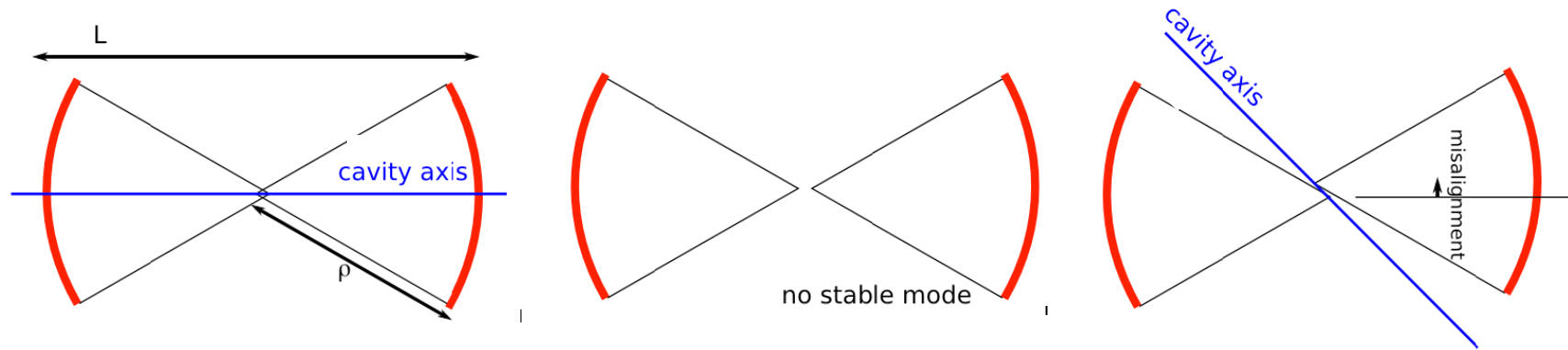
## 2D configuration



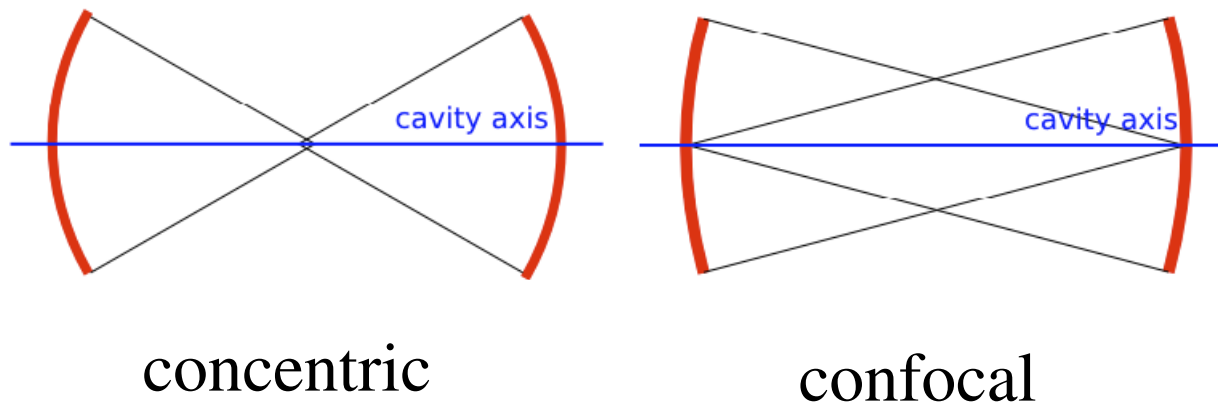
## 3D configuration



# Tolerance of 2-mirror cavity



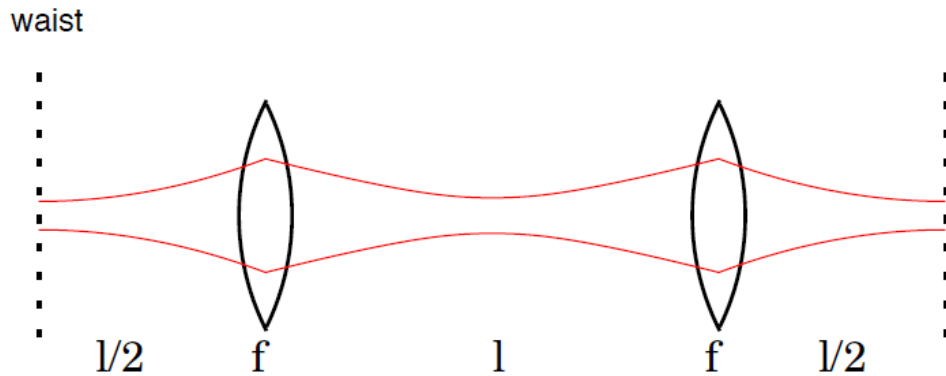
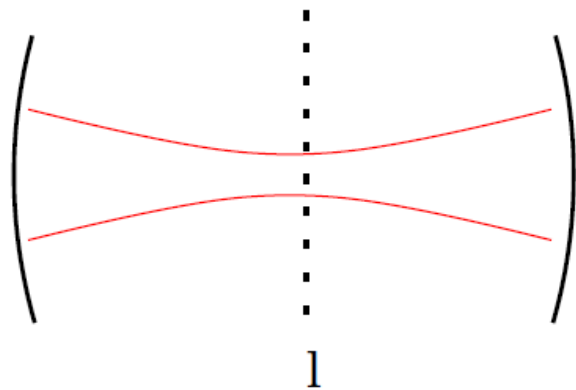
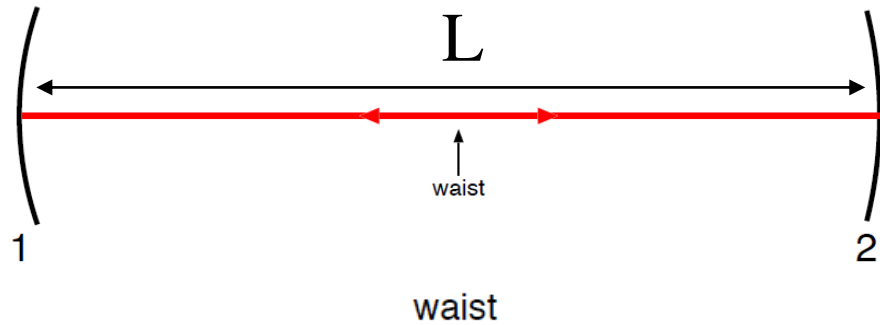
## Concentric Configuration and Confocal Configuration





# 2-mirror cavity

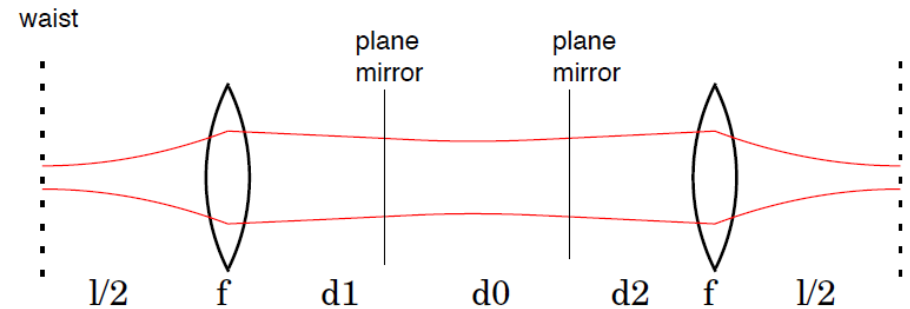
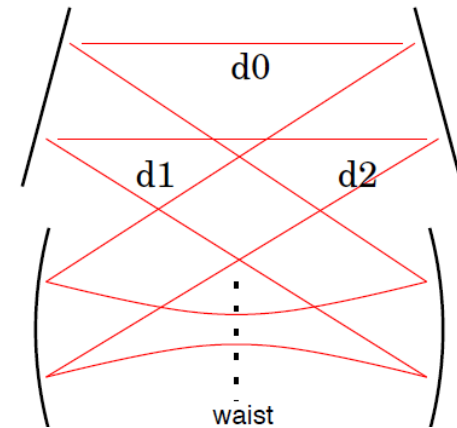
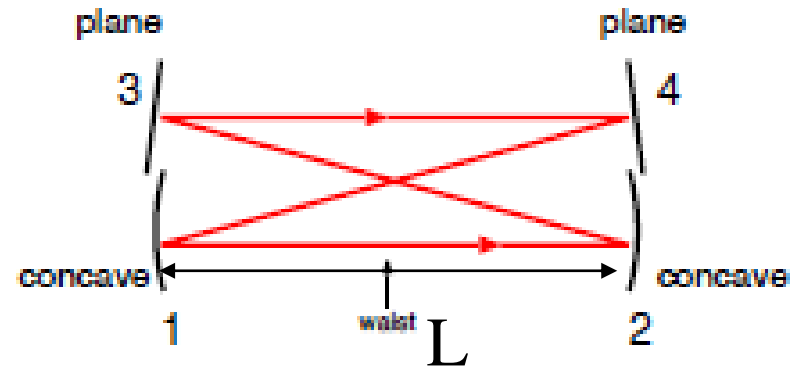
$$R1=R2=L/2$$



concentric

# 4-mirror cavity

$$R1=R2=L$$



confocal