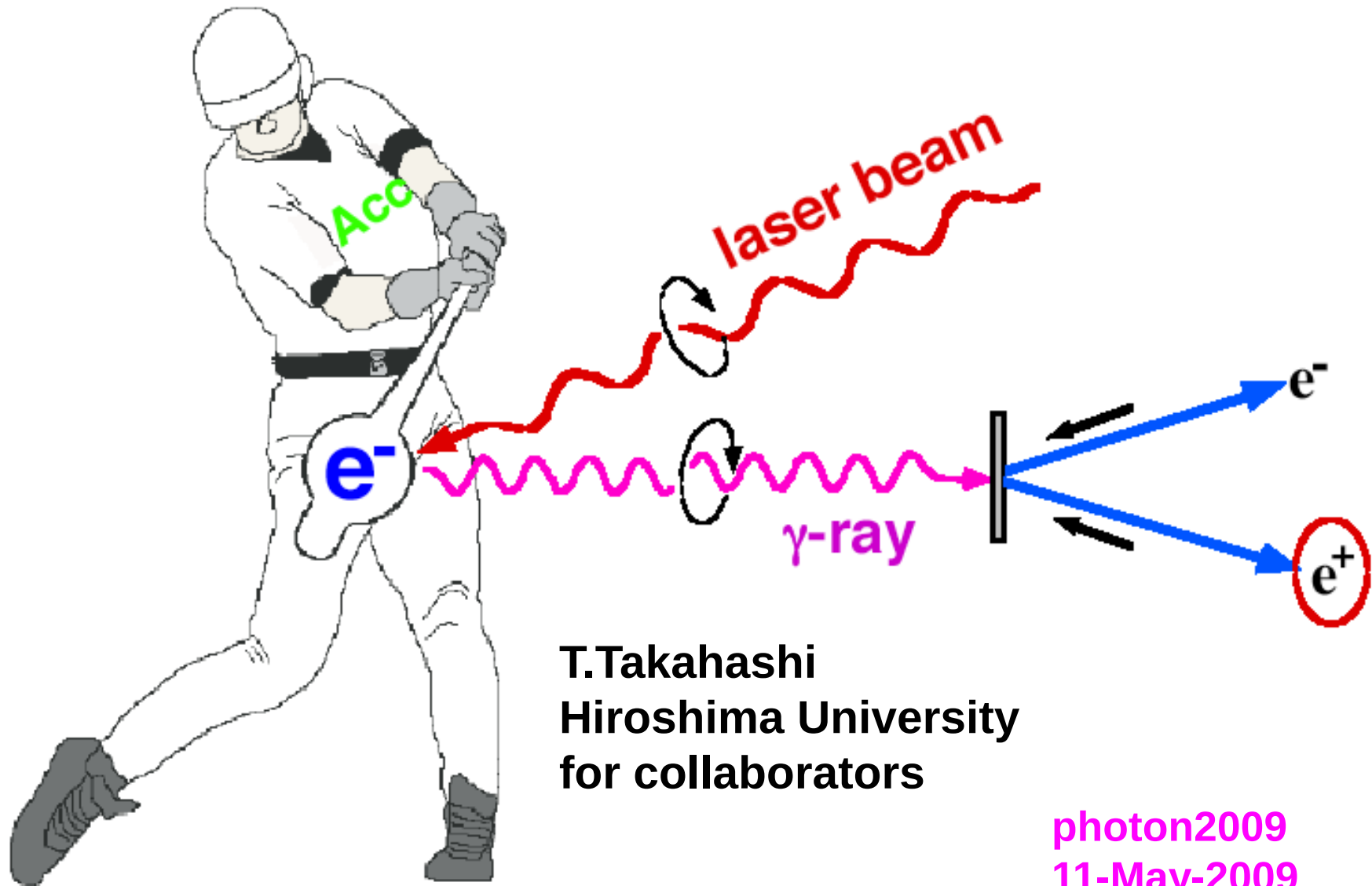


Status of the Compton Experiment at the ATF



T.Takahashi
Hiroshima University
for collaborators

photon2009
11-May-2009

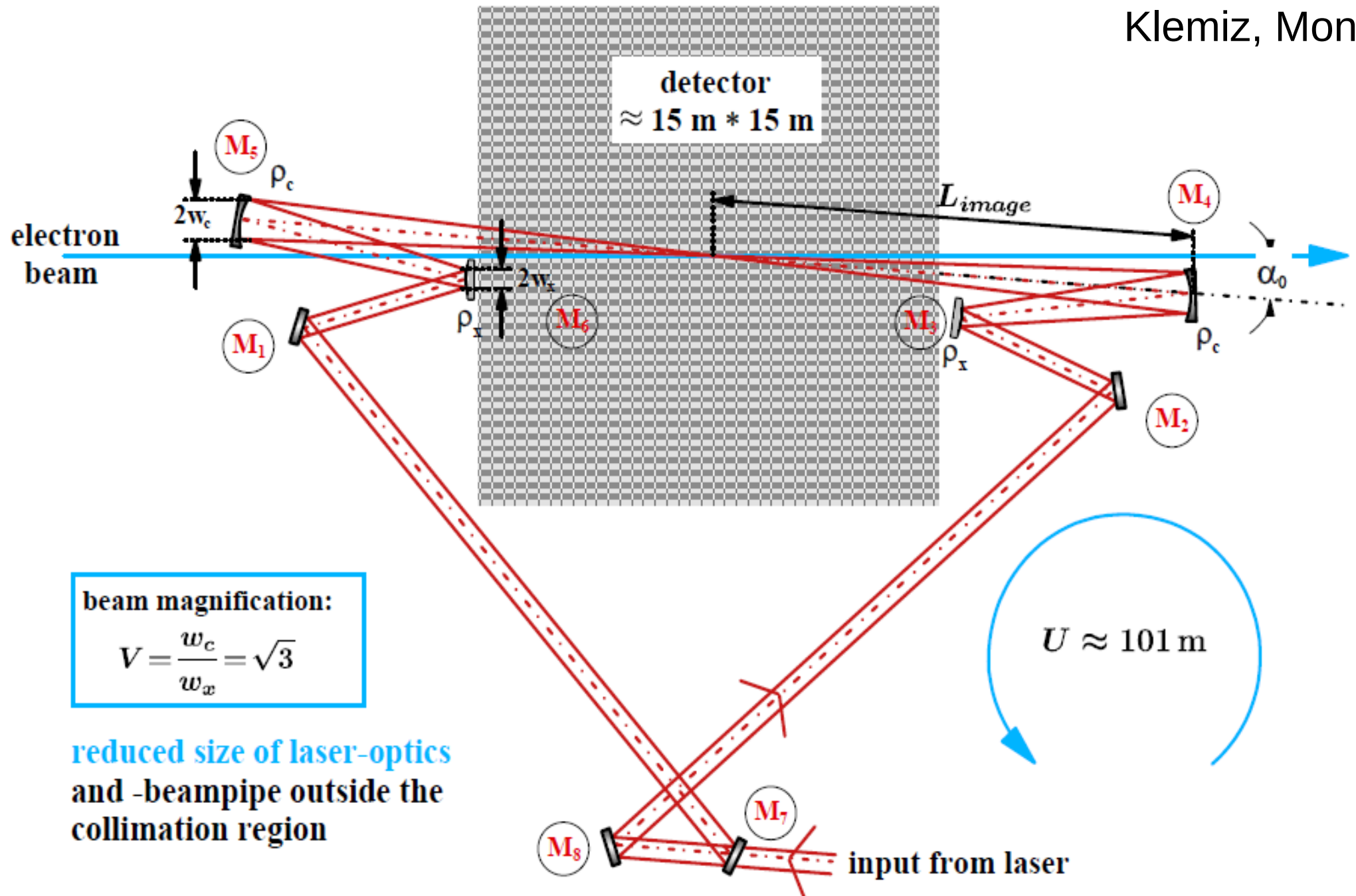


Laser for Photon Colliders at e- γ conversion point

- have to meet requirement of;
 - **5J~10J/pulse, 1-3ps pulse duration**
 - ~2TW peak power
 - **337ns separation 3000bunches/train**
 - $$\text{High pumping power} = \frac{5J \times 3000}{1ms \times \text{eff} (0.3)} = 50MW$$
 - **5Hz**
 - ~70kW average power
 - **O(10 μ m) focusing**
 - **timing ~1ps**
- too costly to be built by single laser

Proposed telescopic, passive, resonant external cavity

Klemiz, Monig



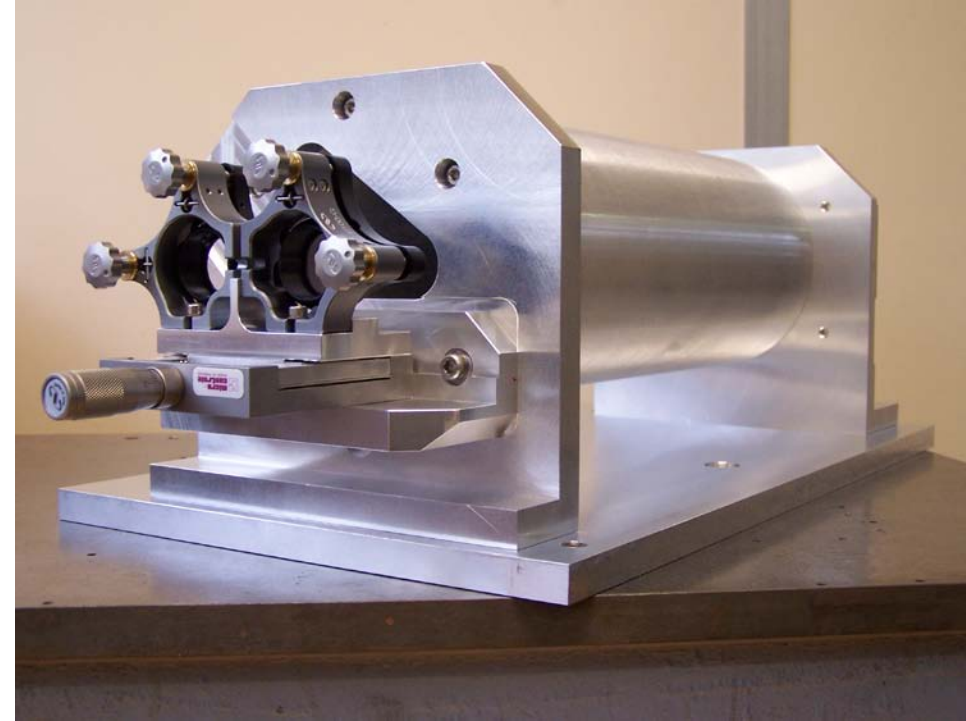
Prototype Cavities

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



moderate enhancement
moderate spot size
simple control

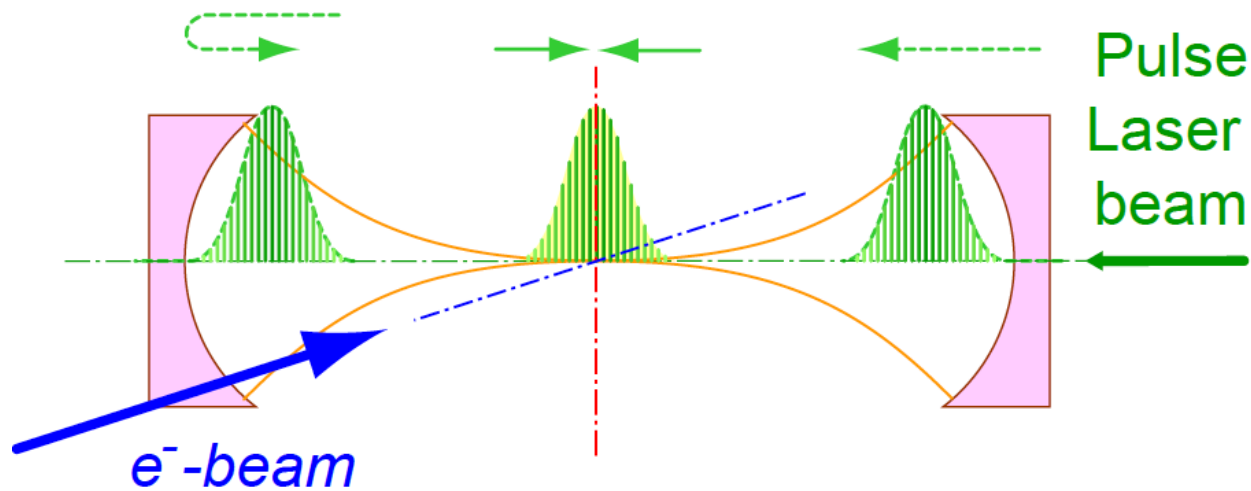
4-mirror cavity (LAL)



high enhancement
small spot size
complicated control

Experimental R/D in ATF

Hiroshima-Waseda-Kyoto-IHEP-KEK

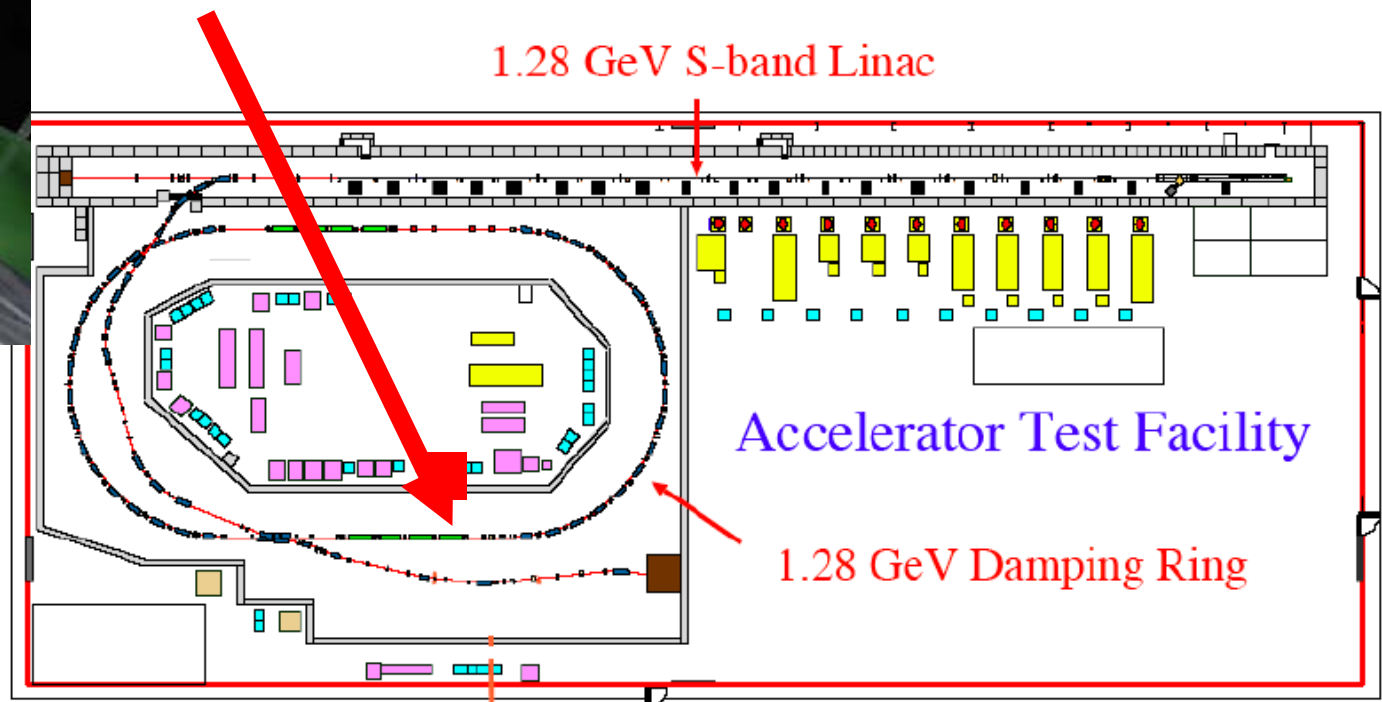


Make a fist
prototype
2-mirror cavity

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

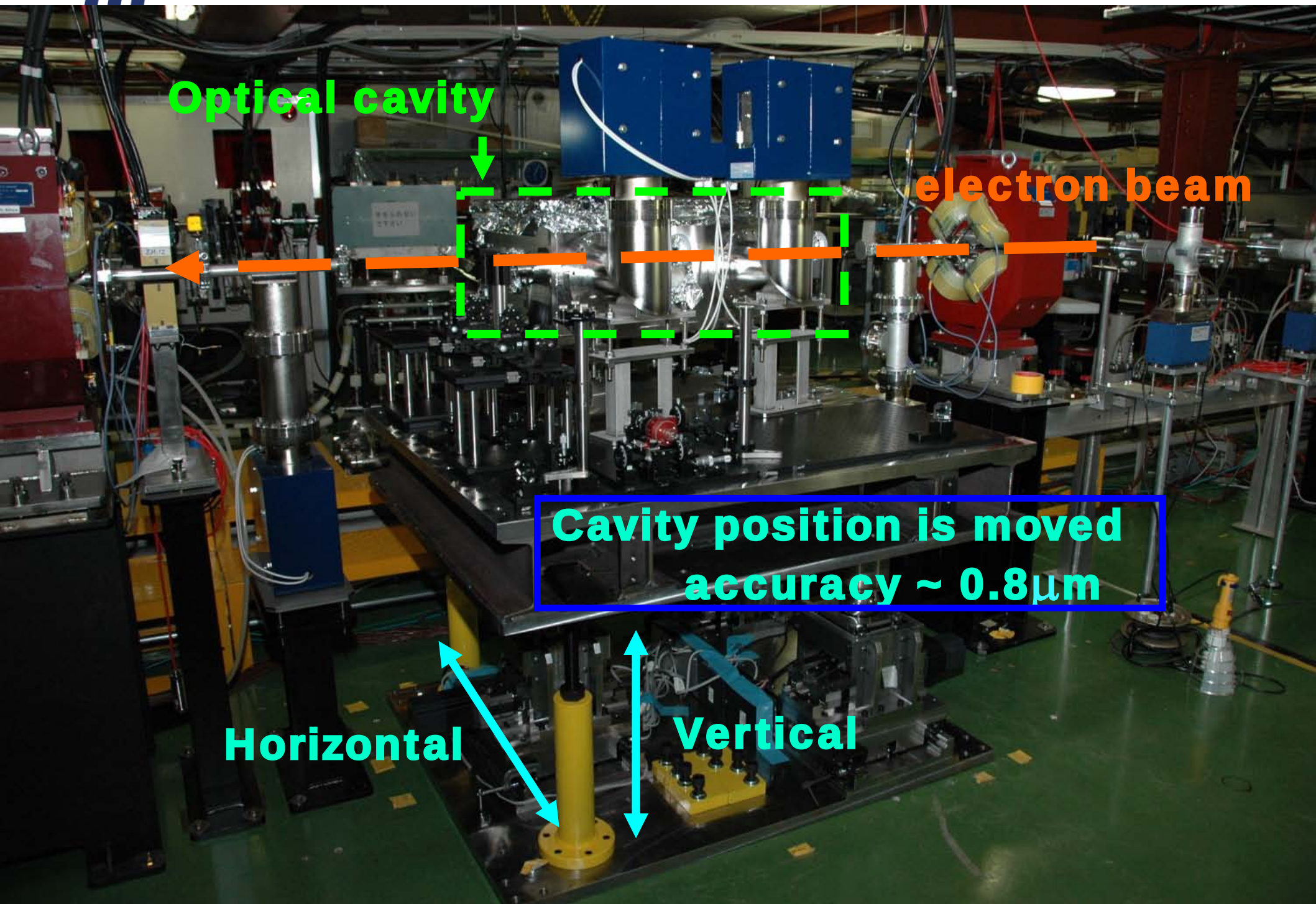


Put it in
ATF ring





Set up at KEK-ATF



Optical cavity

electron beam

**Cavity position is moved
accuracy ~ 0.8μm**

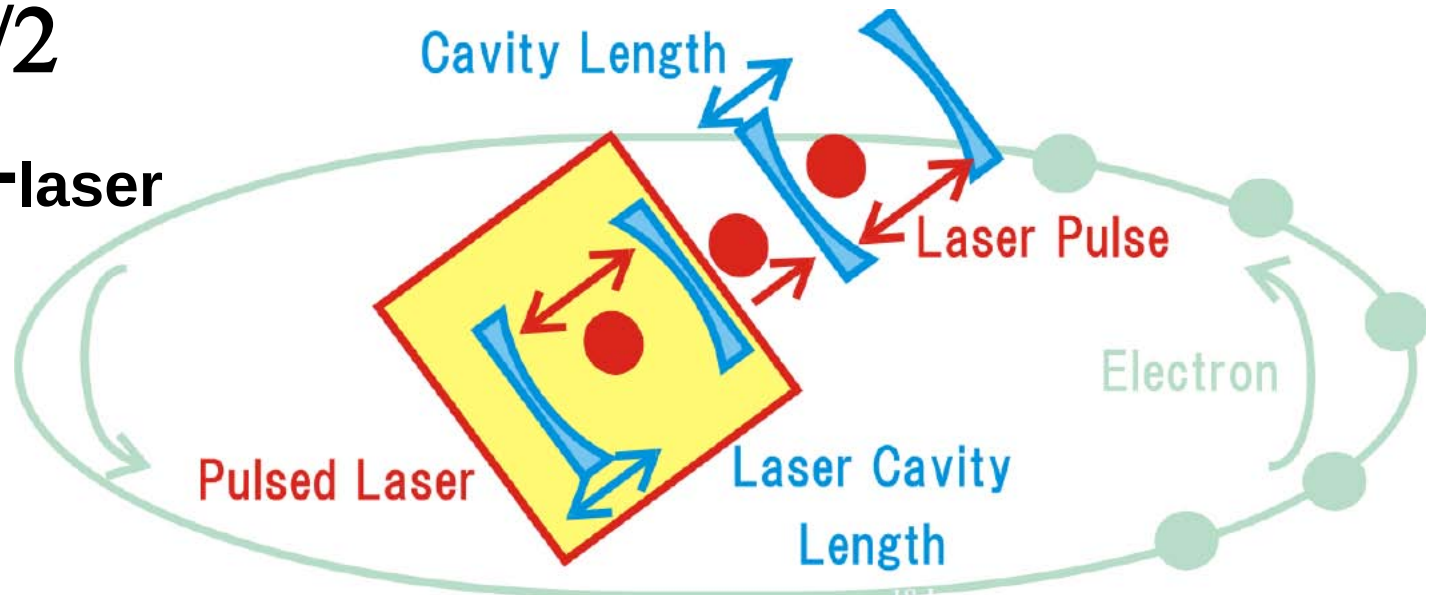
Horizontal

Vertical

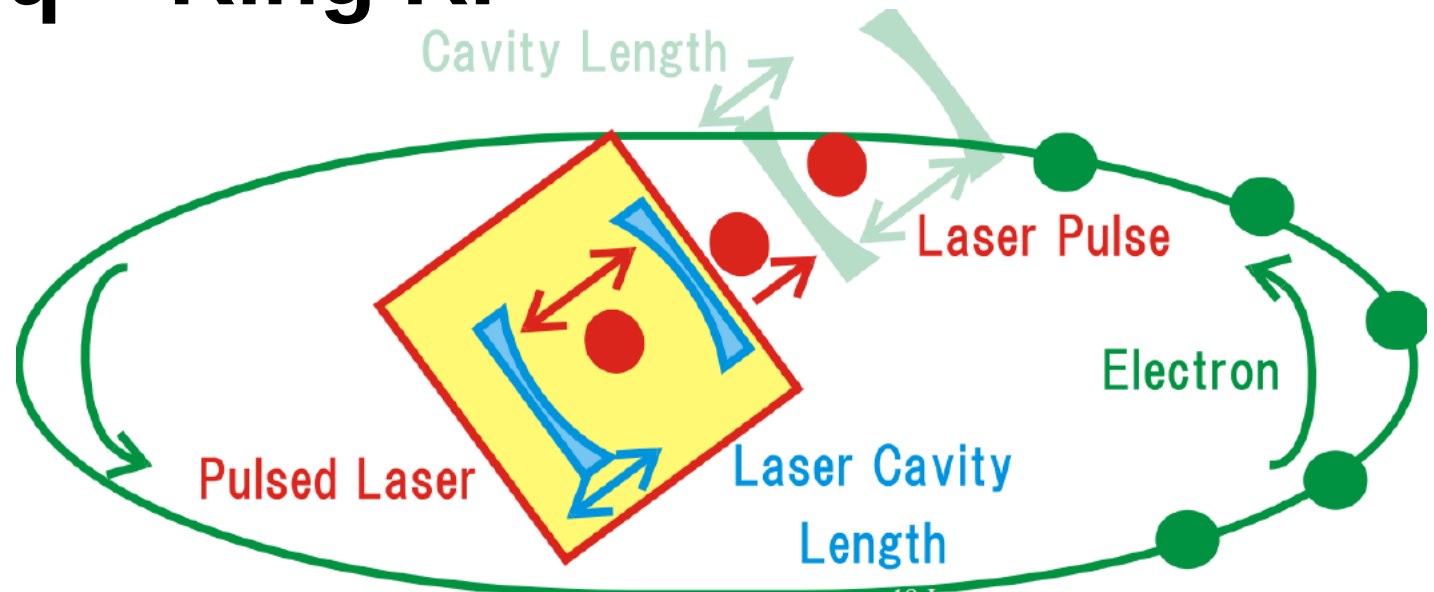
Feedback to Achieve 3 Conditions

$$L_{\text{cav}} = n \lambda / 2$$

$$L_{\text{cav}} = m L_{\text{laser}}$$



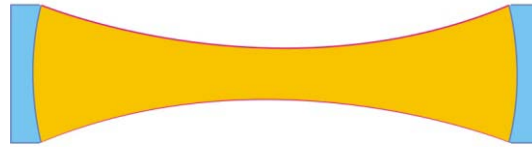
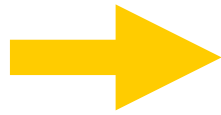
Laser freq = Ring RF



The appearance of light resonance signal

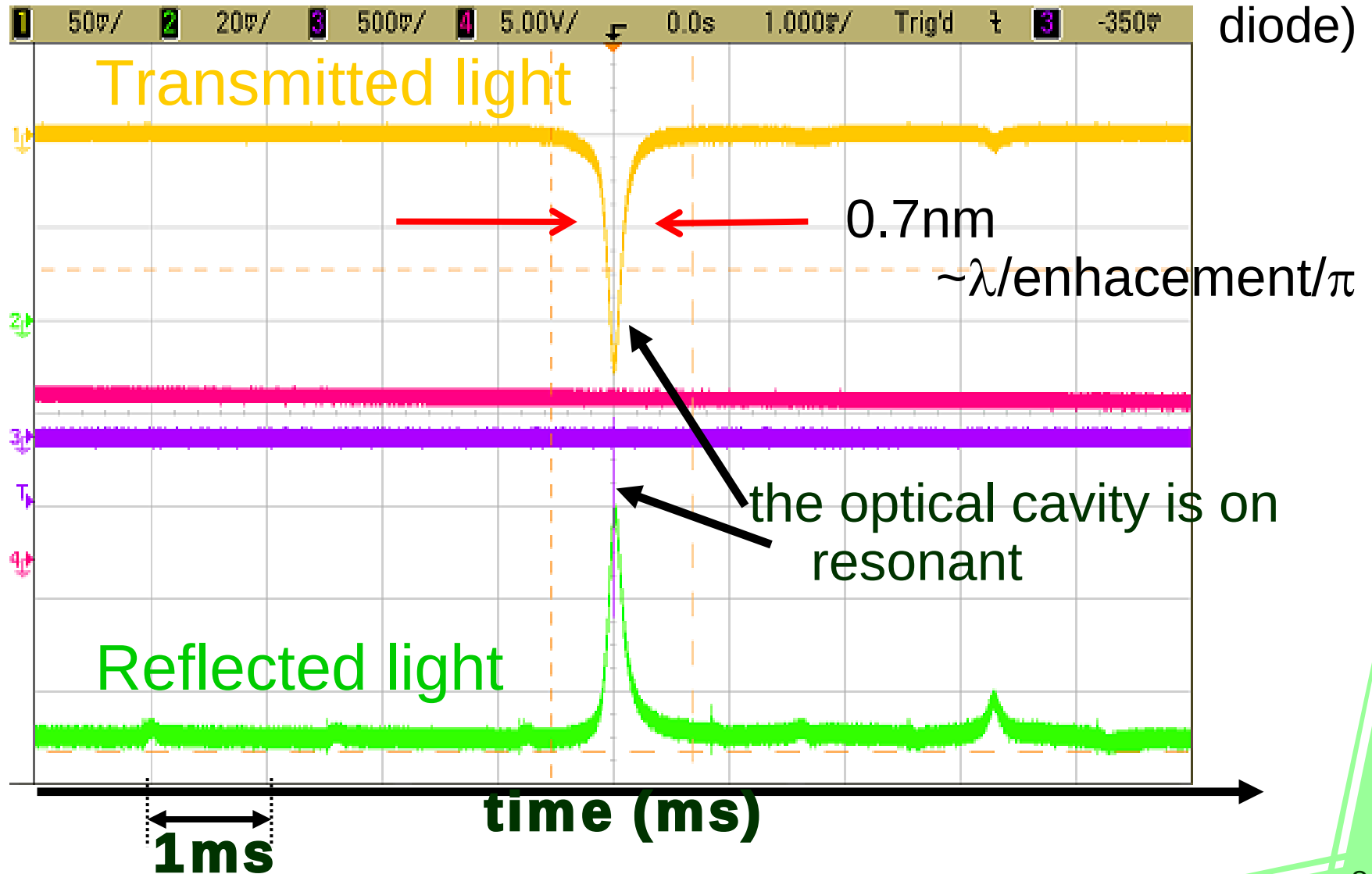
Mirror reflectivity : 99.6%

Mode locked
laser



Transmitted light

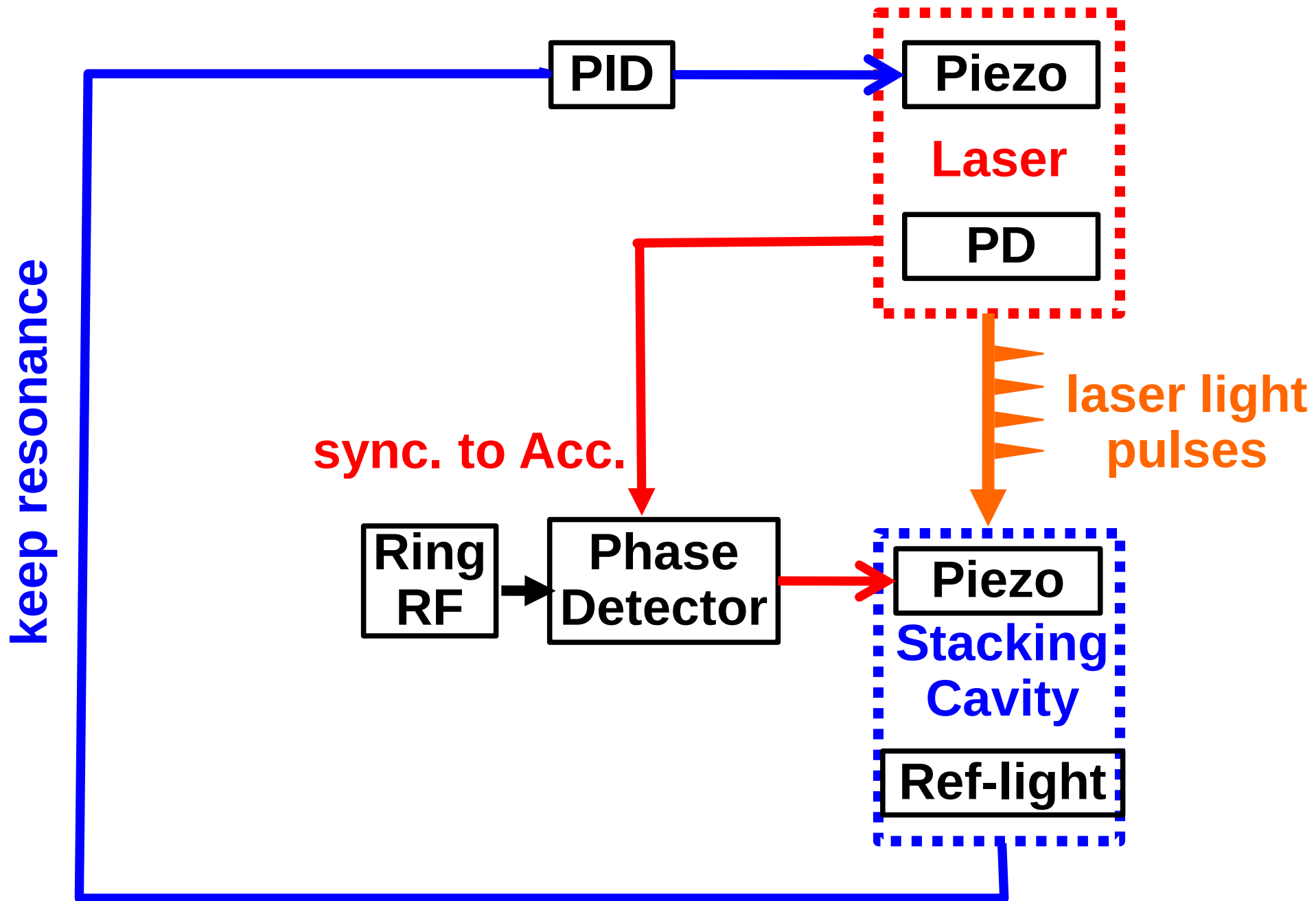
PD
(Photo
diode)



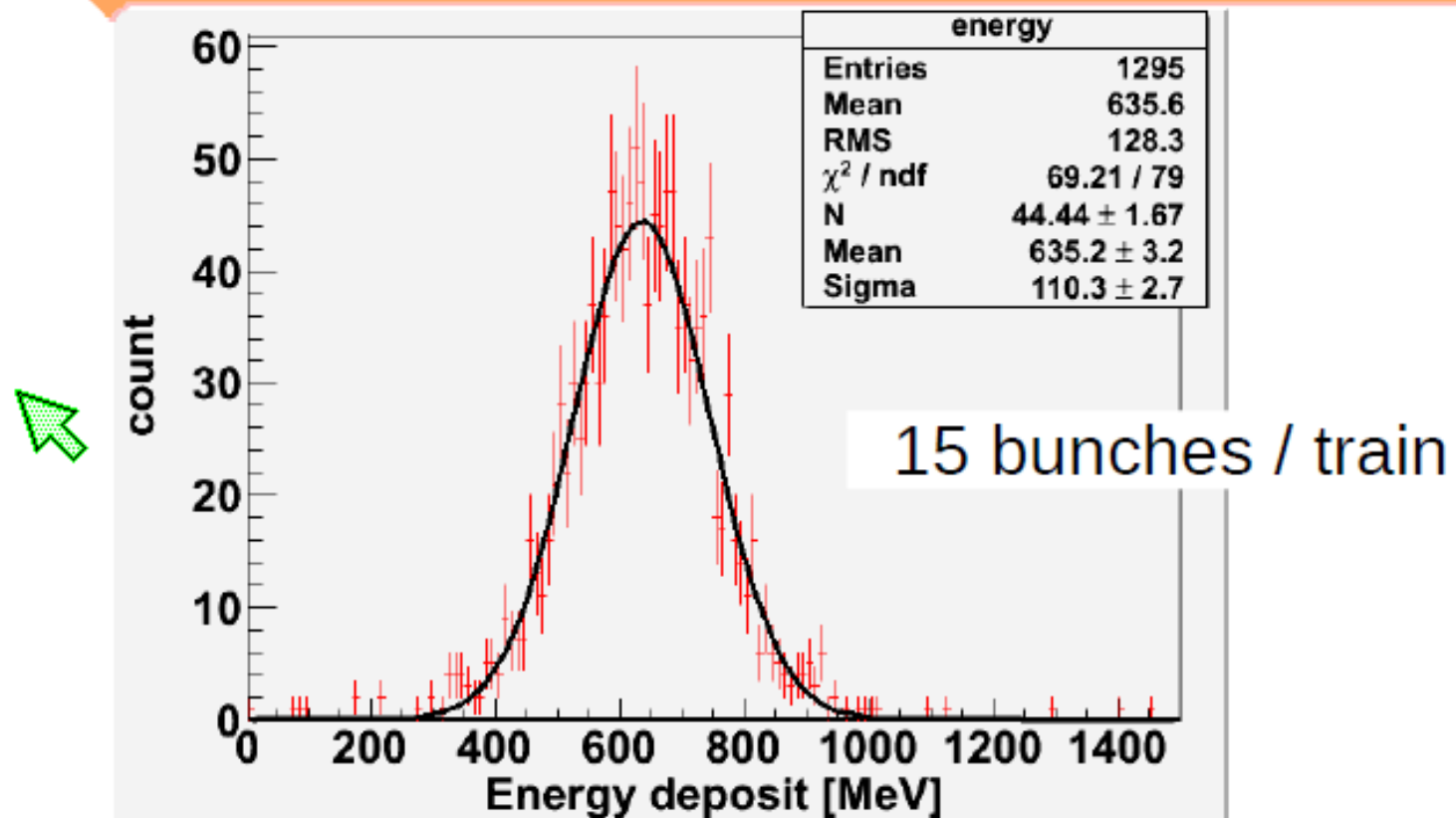
Continued to change the length of the external cavity.

Cross-feedback=Closed loop

(Sakaue)



Result



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

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

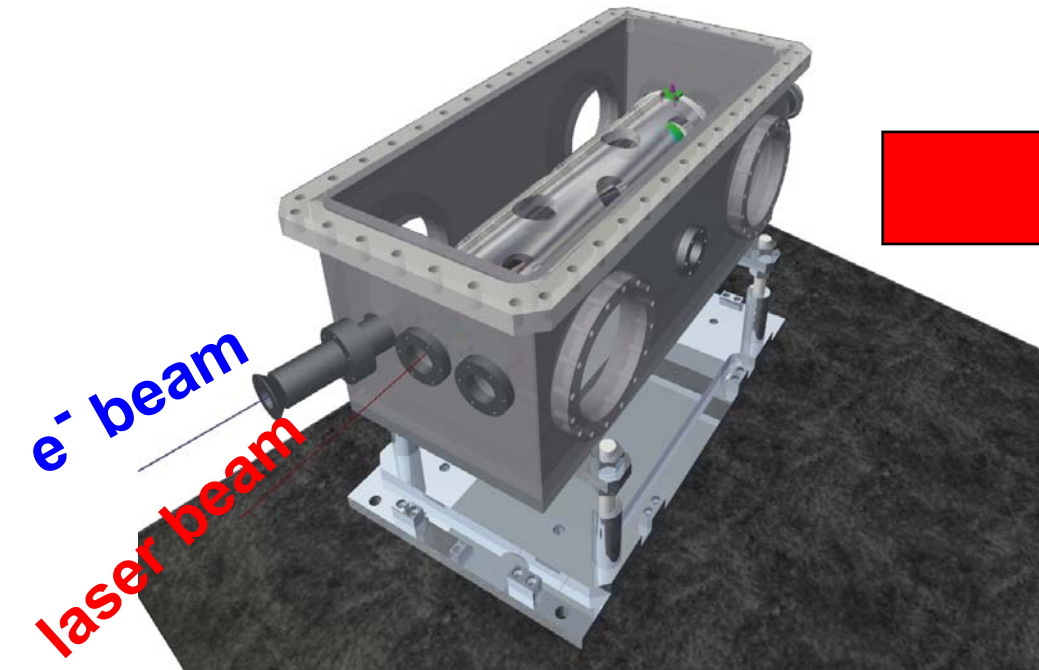
Normalized γ yield seems to decrease as # bunches/train goes up



Bunch (size, timing) fluctuation in the ATF suspected

2-mirror-cav to 4-mirror-cav.

2-mirror cavity

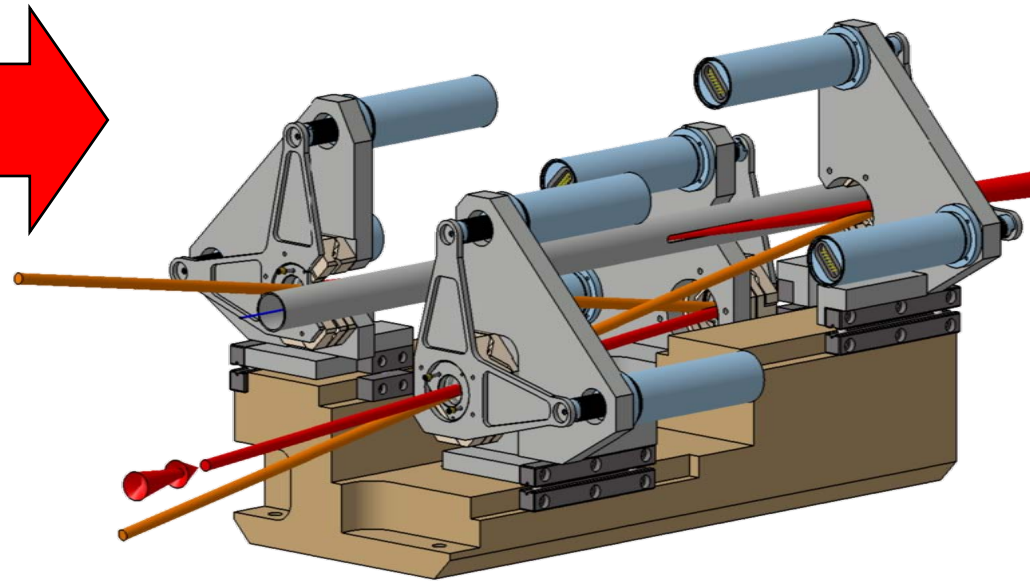


Spot size = 30 μm

Enhance = 1000

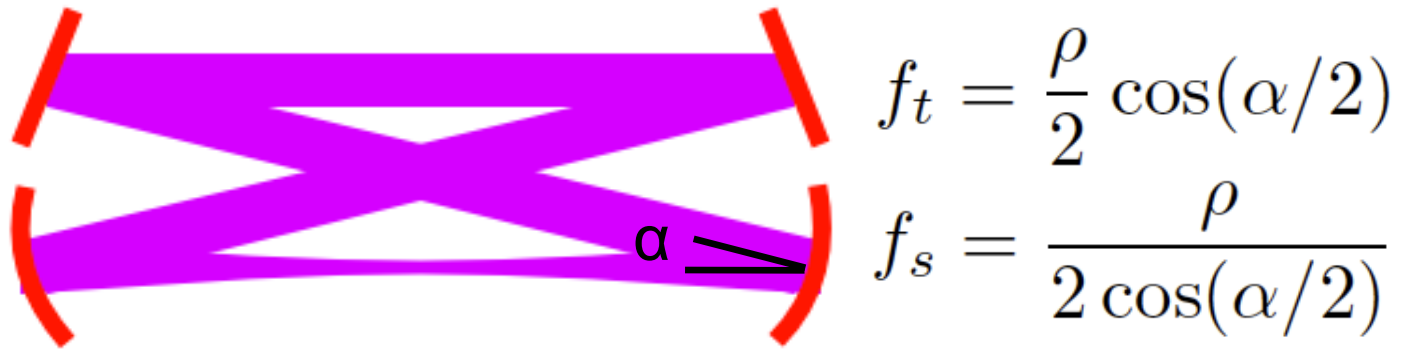
difficult to achieve both
high enhancement and
small spot

4-mirror cavity



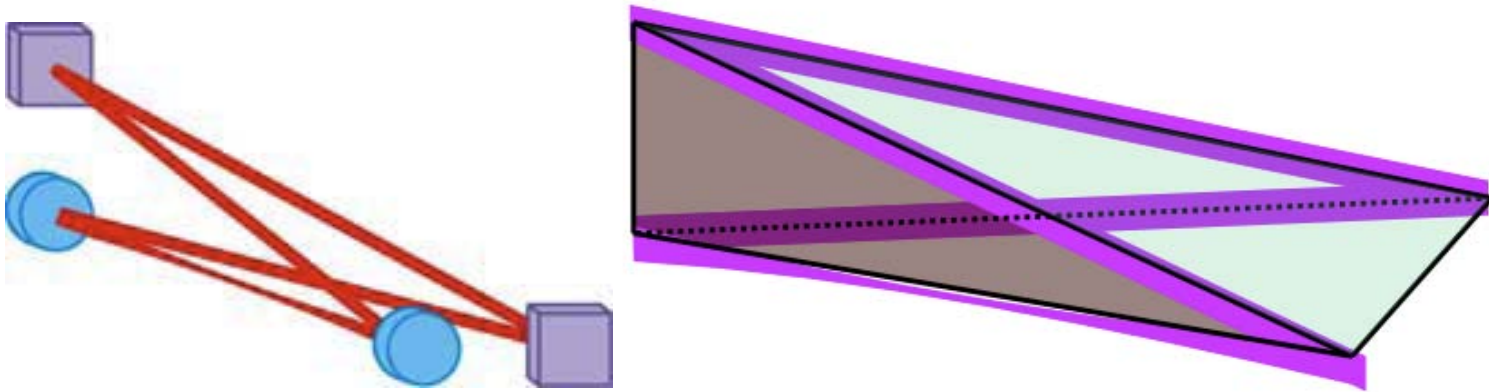
Spot size = ^{R. Cizeron} 10 μm
Enhance = 10000

2D configuration

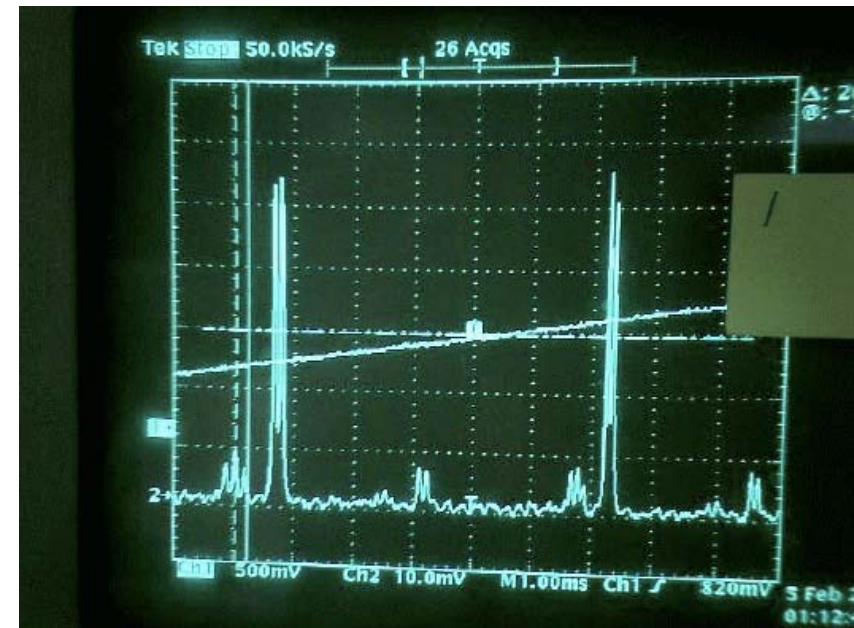
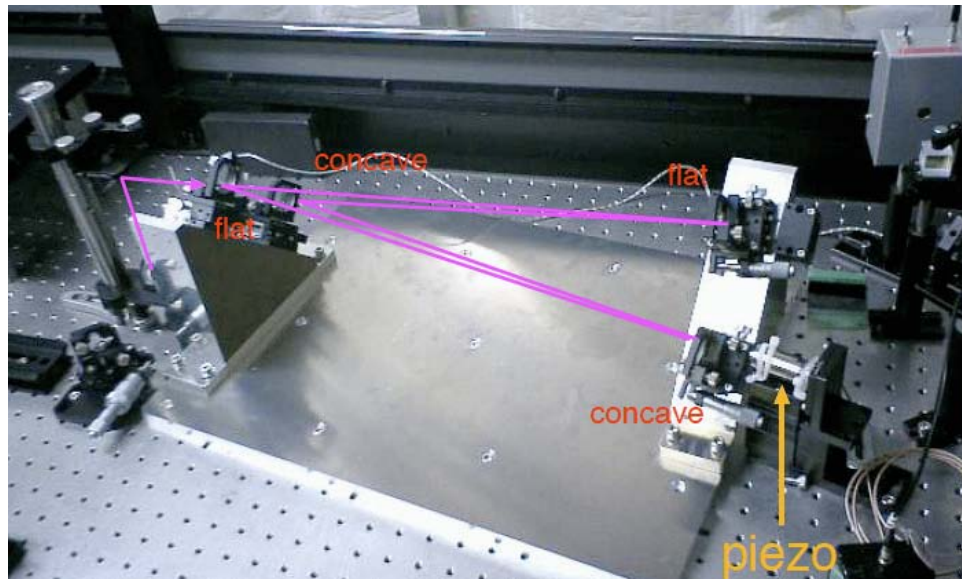
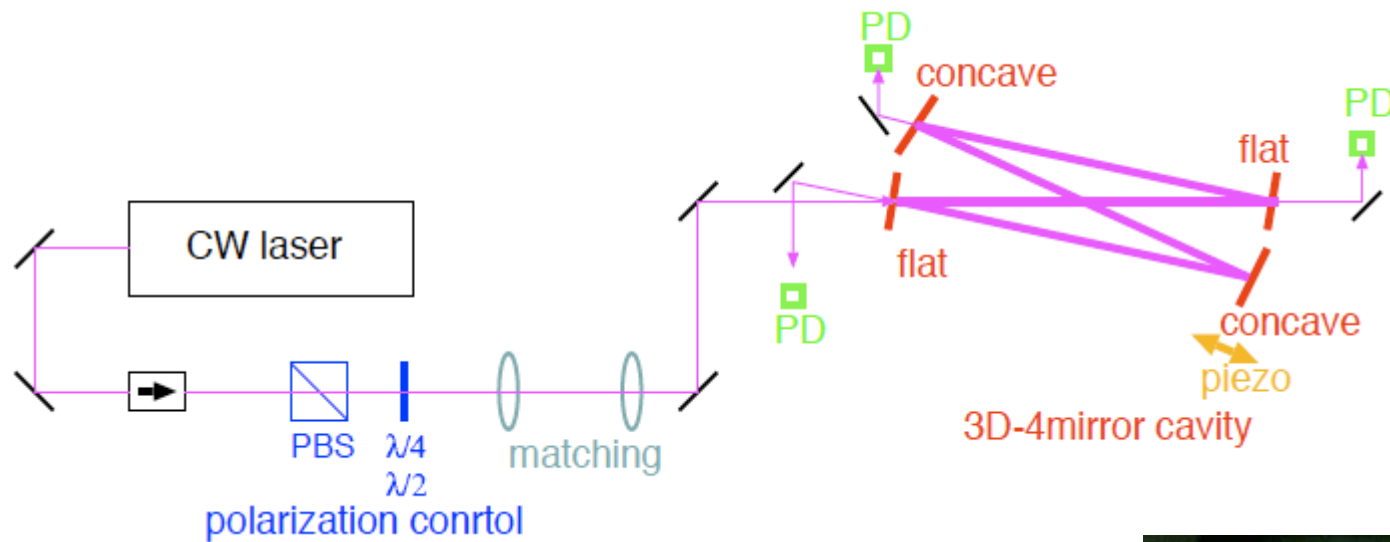


Focal points for horizontal and vertical are not same

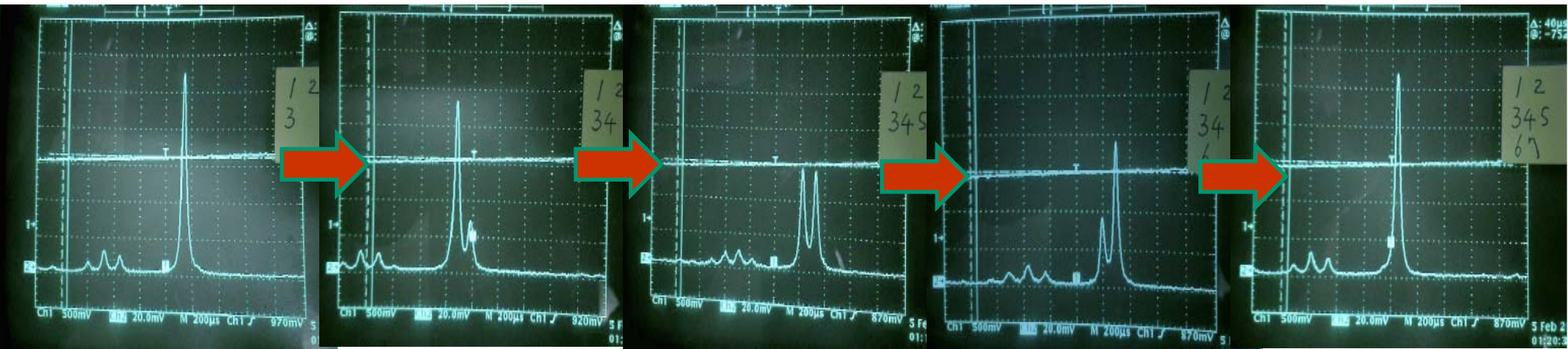
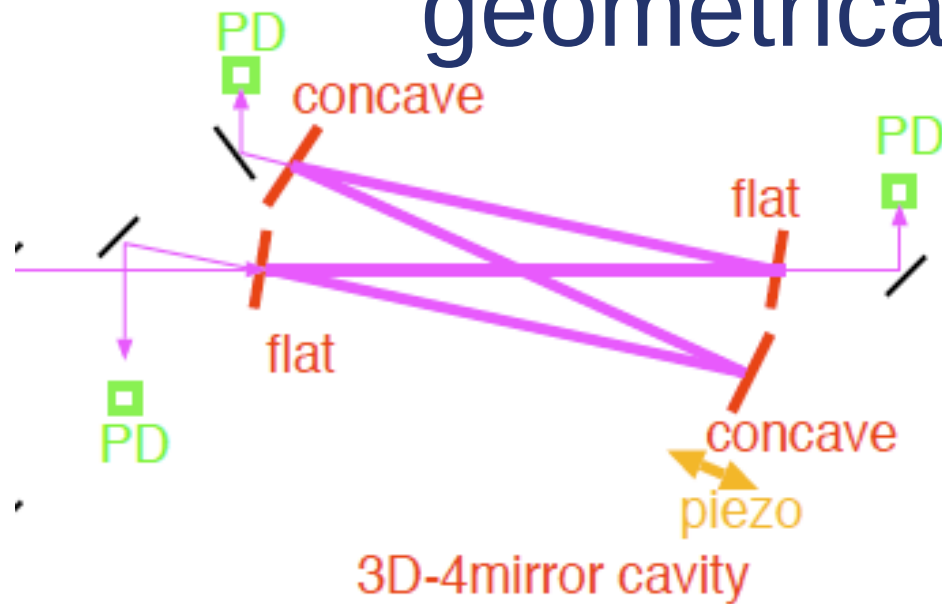
3D configuration



R&D of 4 mirrors cavity started



Two resonant peaks due to geometrical phase



Summary and prospects

- ▶ photon generation by Laser pulse stacking cavity / accelerator has been demonstrated both for
 - Polarized electron source (PosiPol)
 - hard x ray generation (LUCX)
- ▶ A project for x ray source has started
- ▶ All projects going to 4 mirror ring cavity
 - Technique with Ring cavity and e-beam will be accumulated in next 3-4year
- ▶ Specific study is for 100 m long cavity is necessary
 - supporting 1m scale mirrors
 - adaptive optics to maintain phase front
 - Feed back experiment to cavity design
 - 3 Dimensional cavity