Optical Cavity R&D around KEK-ATF

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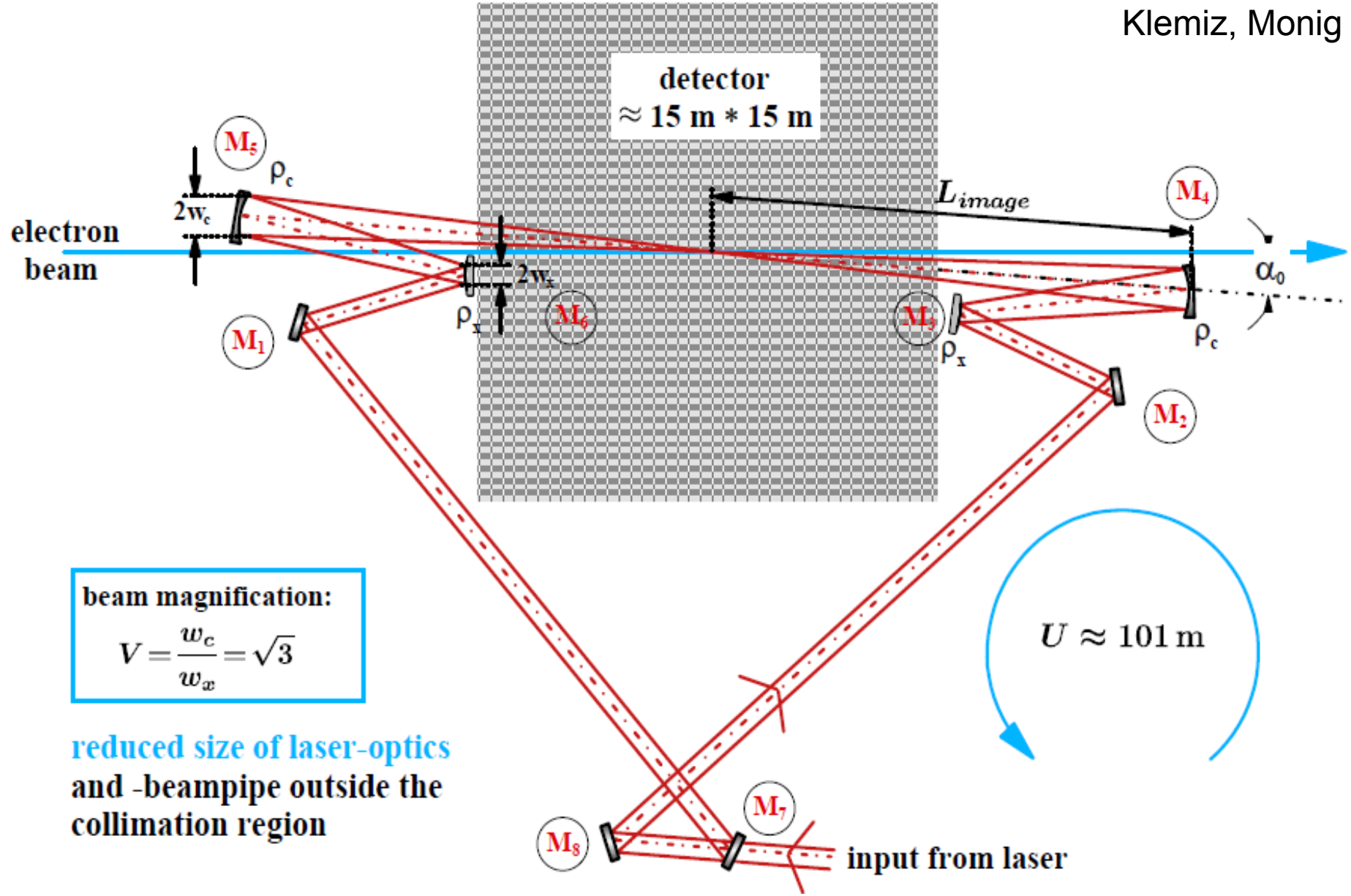
LCWS08
at Chicago

Proposed telescopic, passive, resonant external cavity

Klemiz, Monig



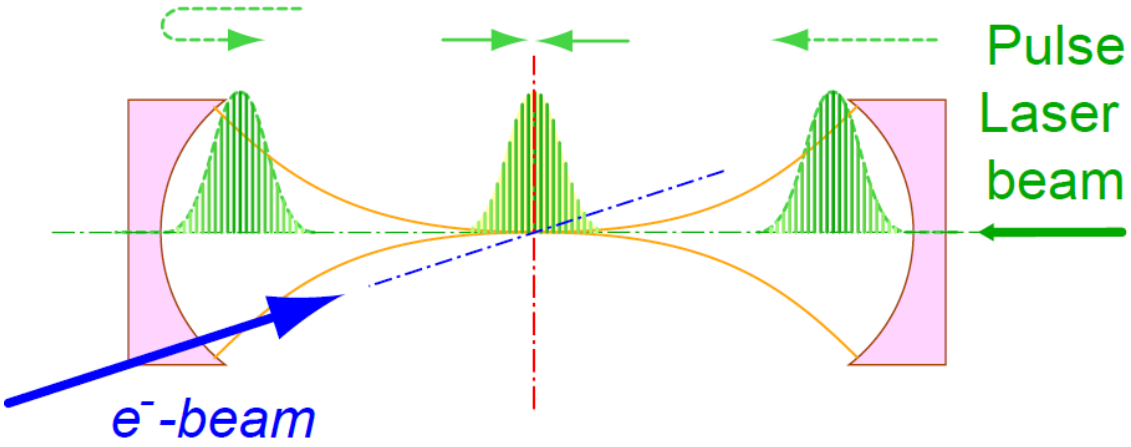
beam magnification:

$$V = \frac{w_c}{w_x} = \sqrt{3}$$

reduced size of laser-optics and -beampipe outside the collimation region

Experimental R/D in ATF

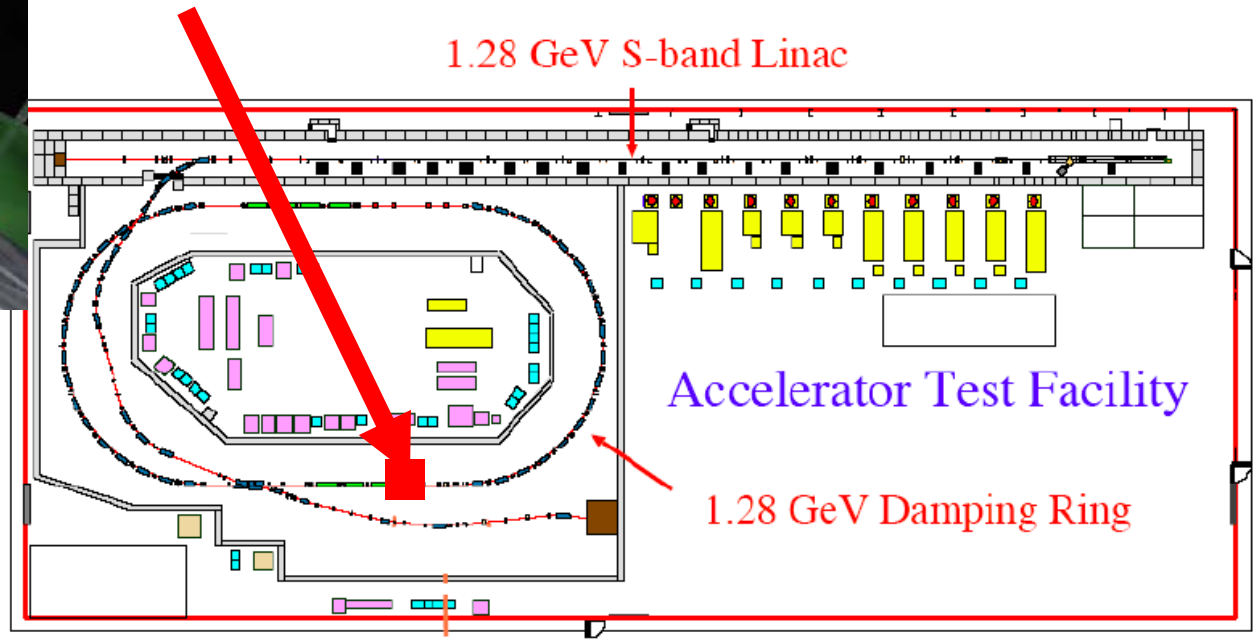
Hiroshima-Waseda-Kyoto-IHEP-KEK



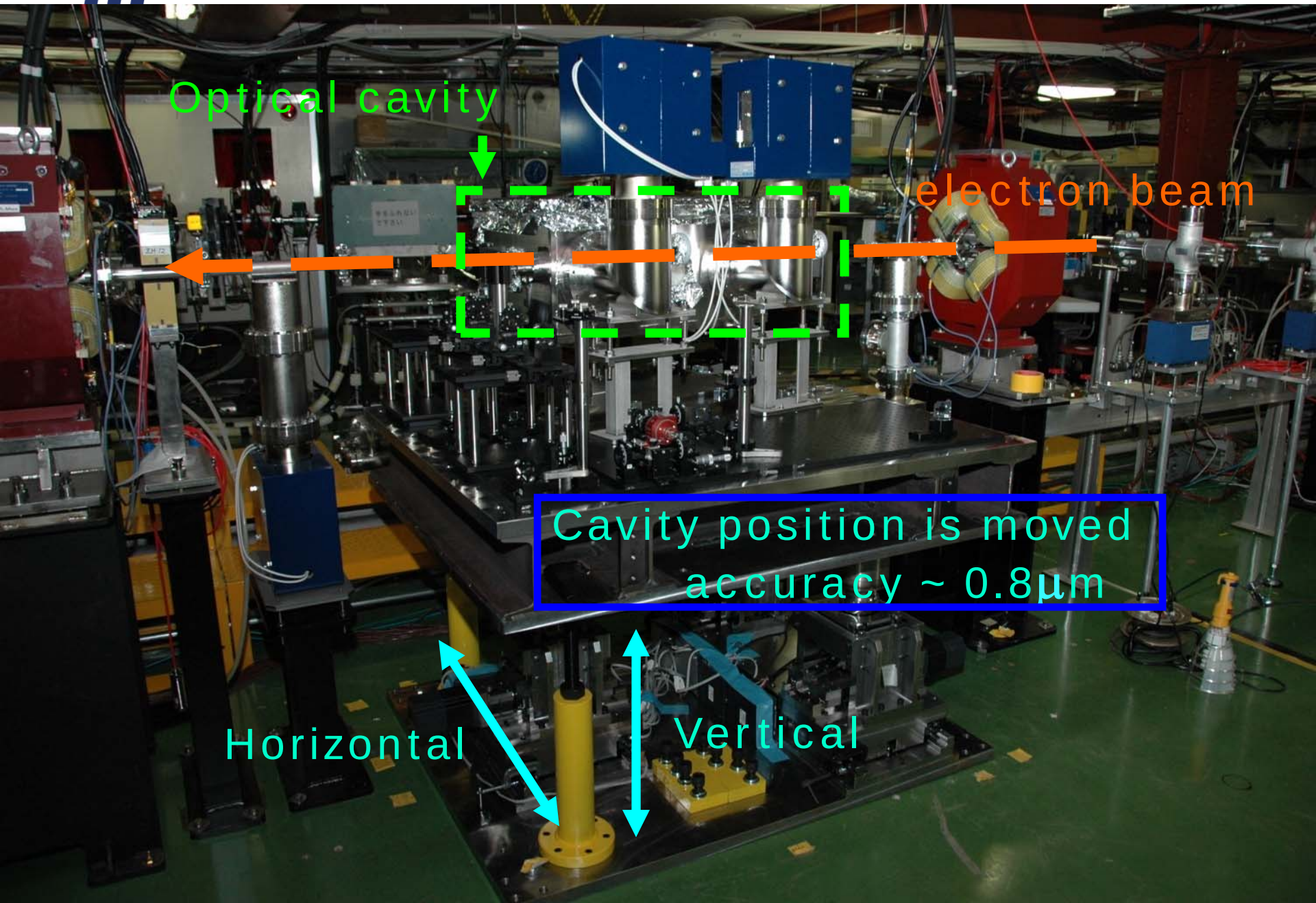
Make a fist prototype 2-mirror cavity

L_{cav} = 420 mm

Put it in ATF ring



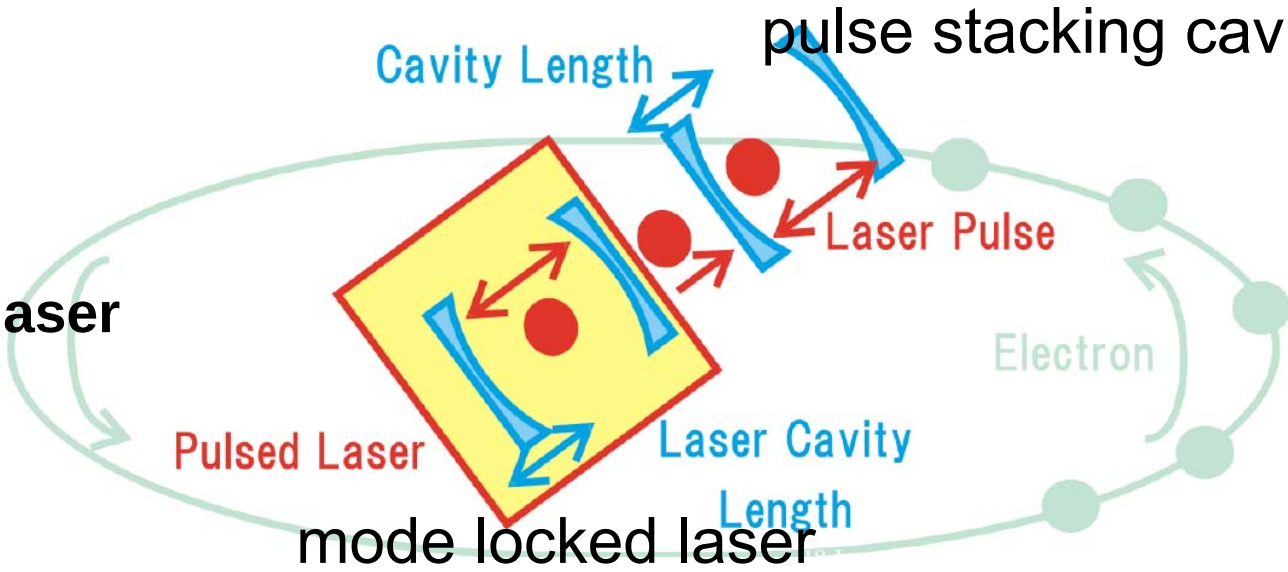
Set up at KEK-ATF



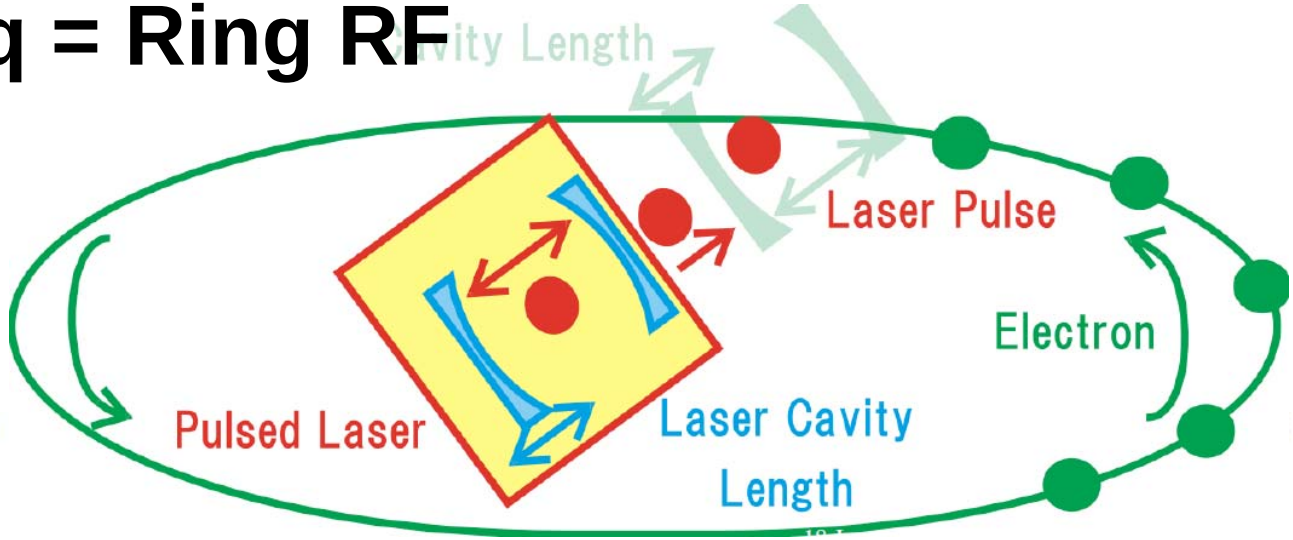
Feedback to Achieve 3 Conditions

$L_{cav} = n \lambda$

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



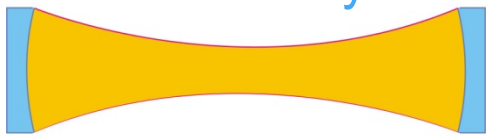
Laser freq = Ring RF



The appearance of light resonance signal

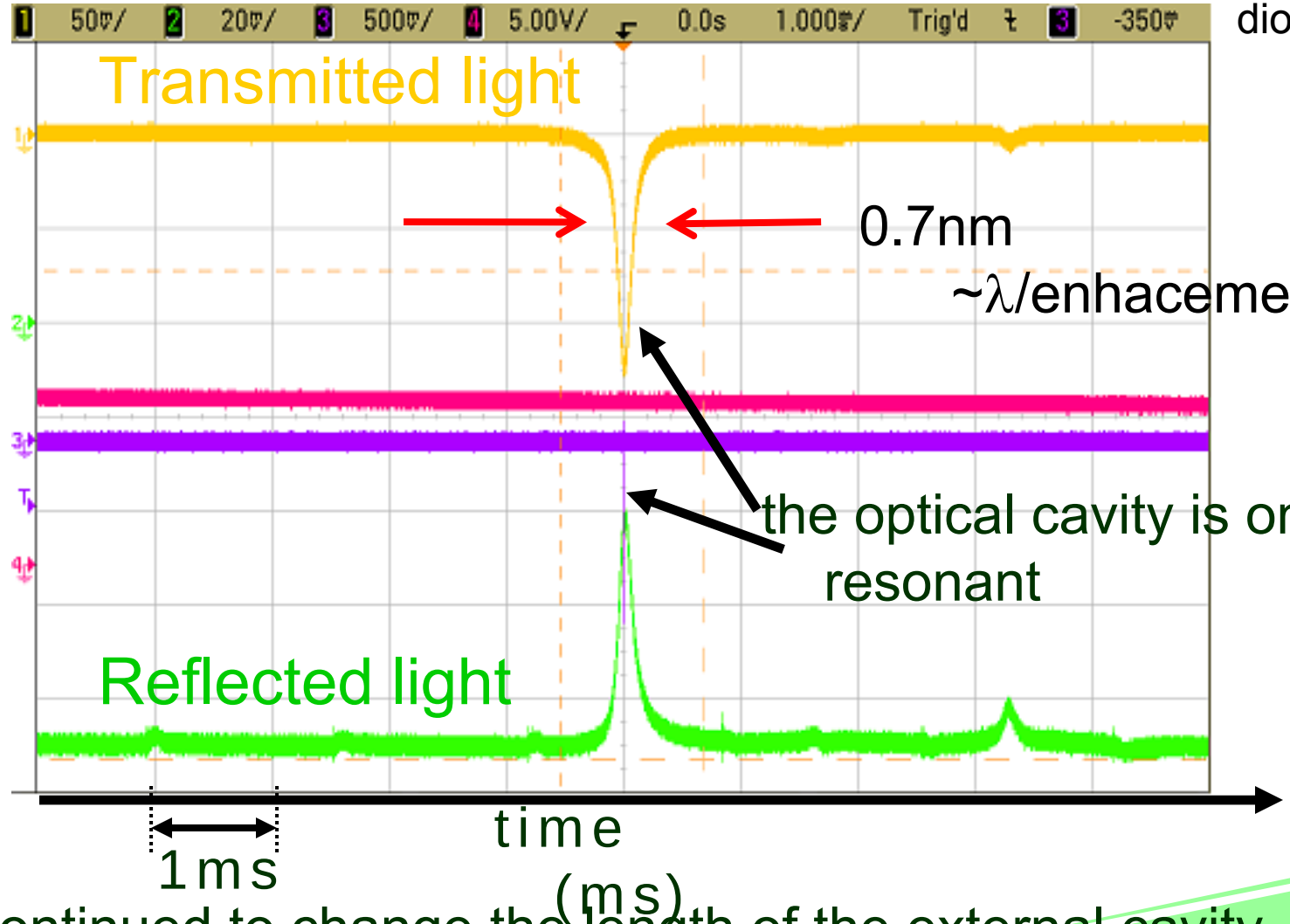
Mirror reflectivity : 99.6%

Mode locked laser



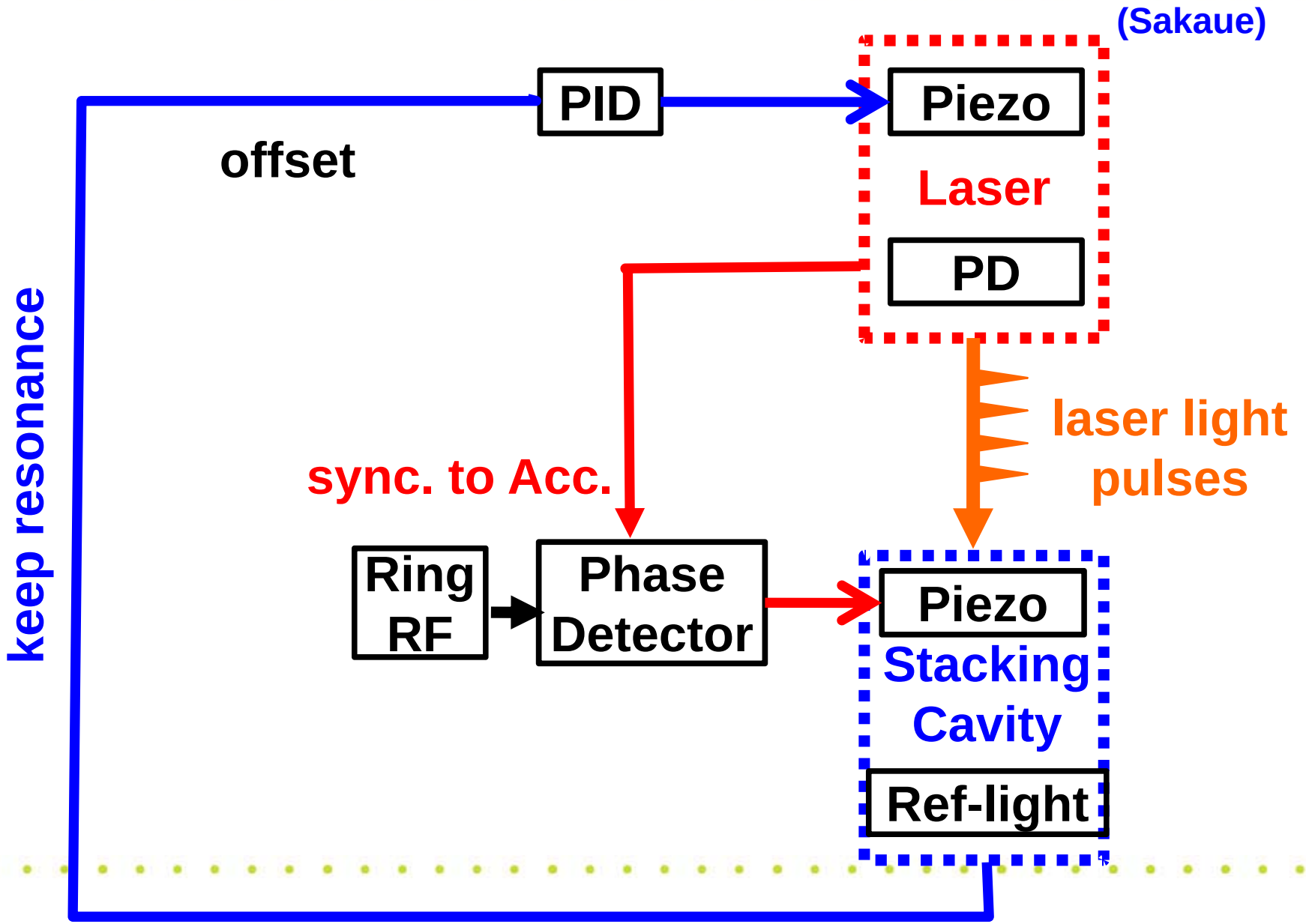
Transmitted light

PD (Photo diode)

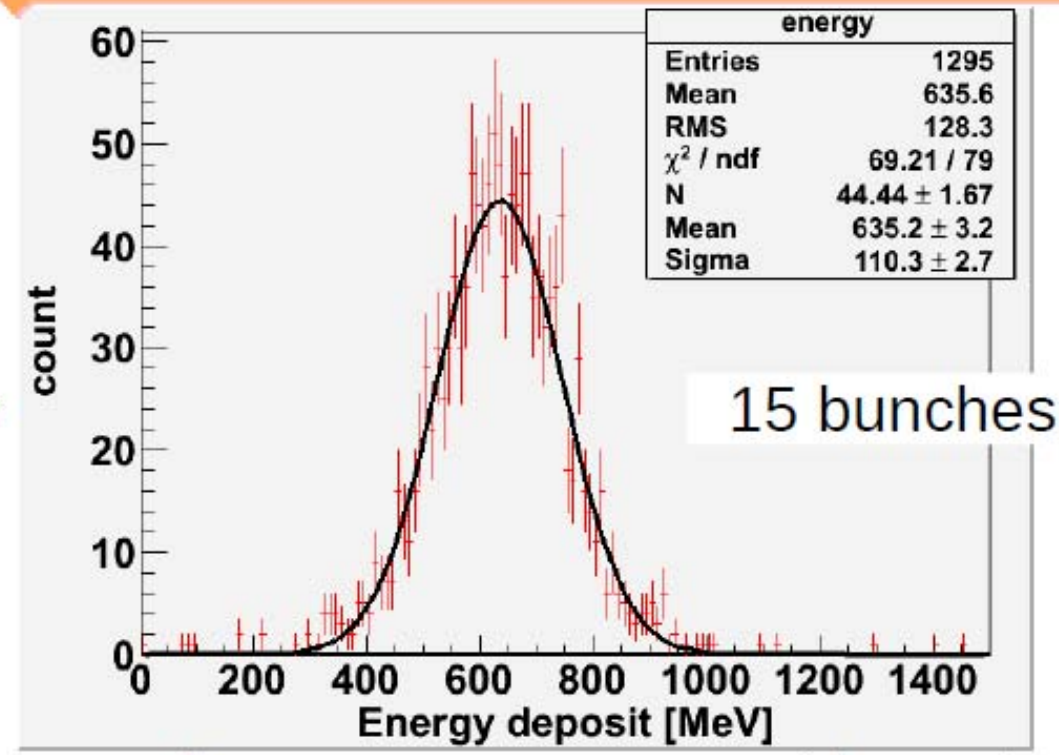


Continued to change the length of the external cavity.

Cross-feedback=Closed loop



Result



15 bunches / train

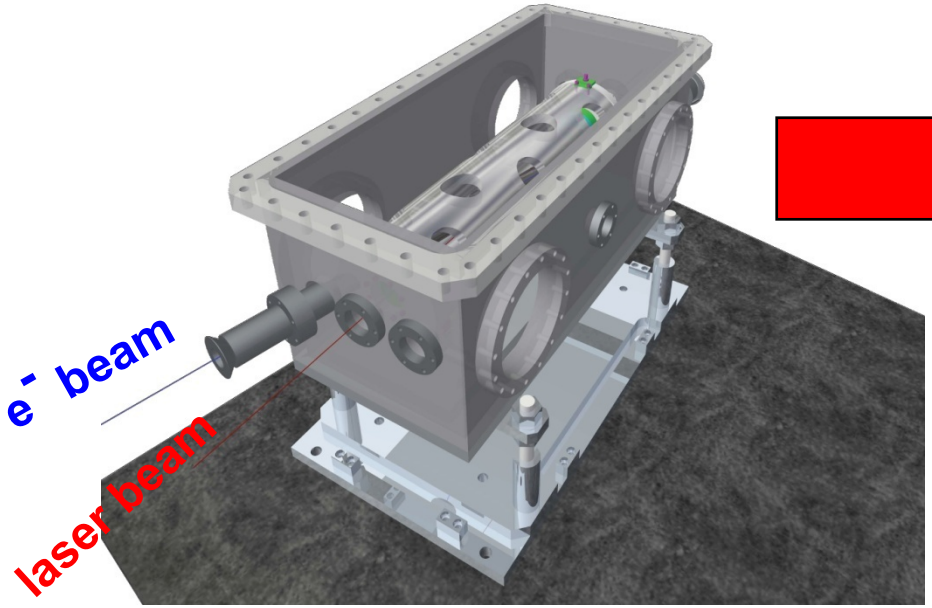
We detected 27 gamma-rays / bunch train.
generation 60 gamma-rays / train to all angle.

60×2.16MHz ~ 1.2×10^8 [gamma / second]

Revolution

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

2-mirror cavity

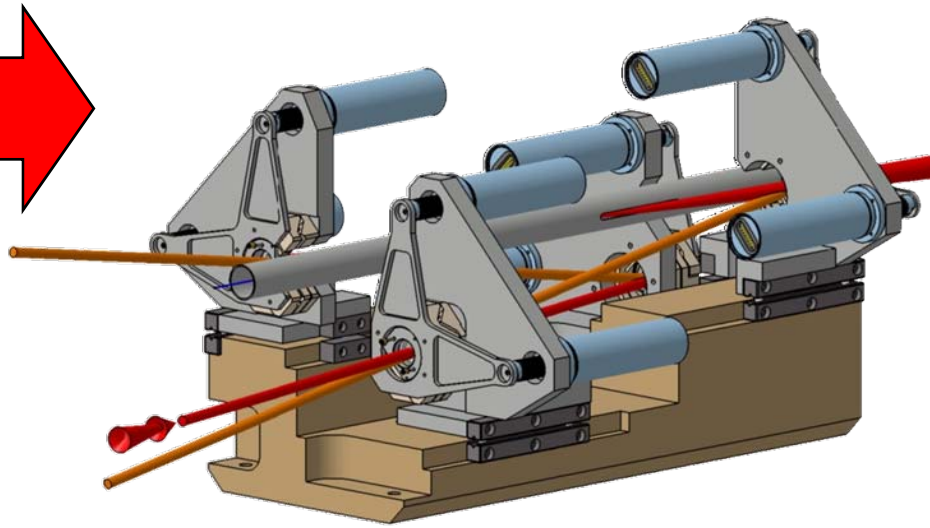


Spot size = 30 um

Enhance = 1000

difficult to achieve both high enhancement and small spot

4-mirror cavity



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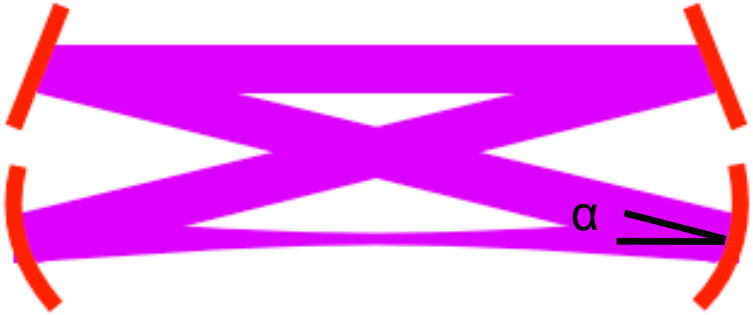
Spot size = 10 um

Enhance = 10000

2D configuration

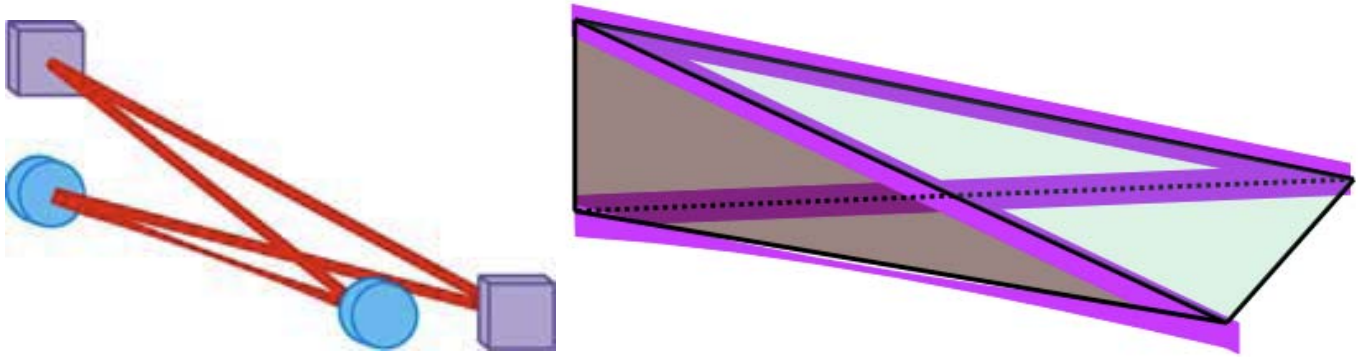


$$f_t = \frac{\rho}{2}\cos(\alpha/2)$$

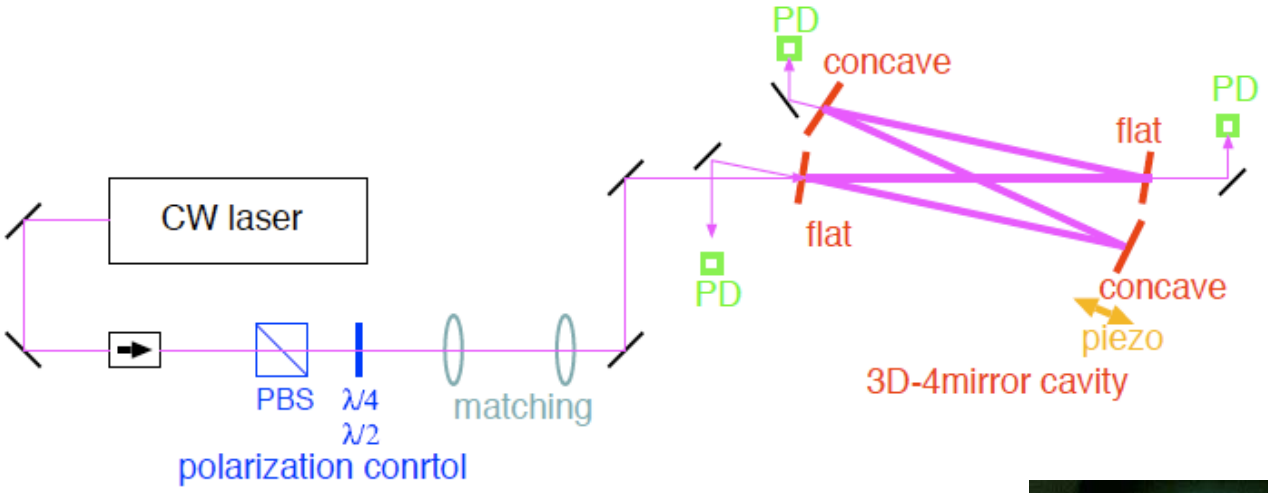
$$f_s = \frac{\rho}{2\cos(\alpha/2)}$$

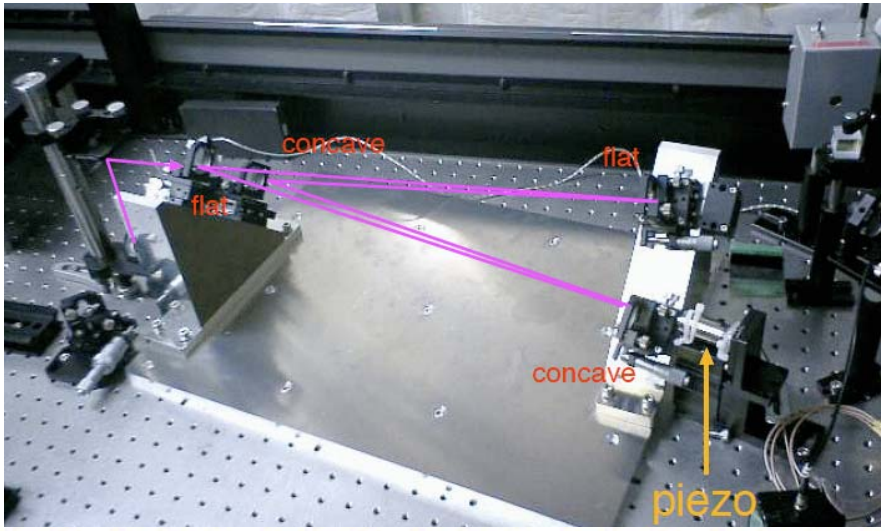
Focal points for horizontal and vertical are not same

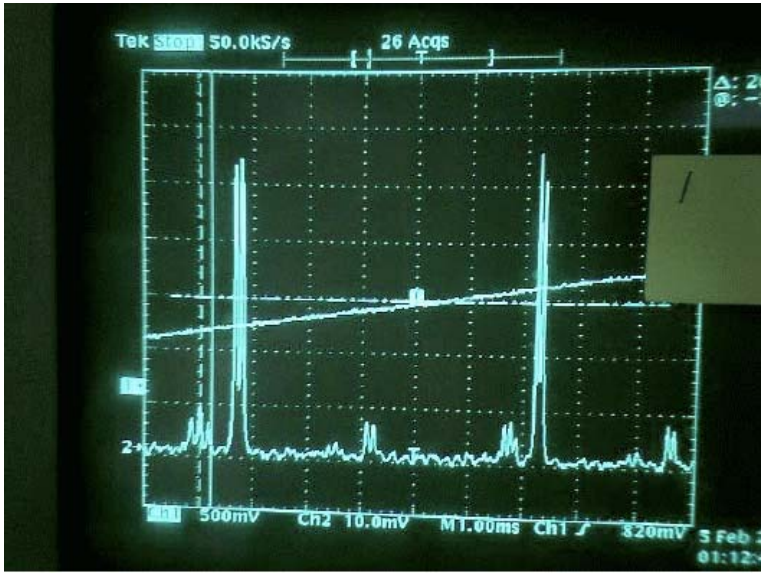
3D configuration



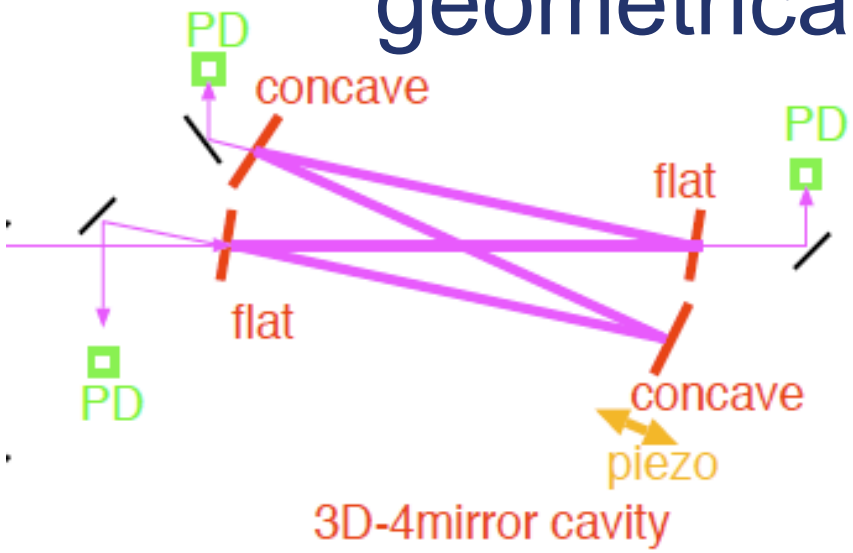
R&D of 4 mirrors cavity started



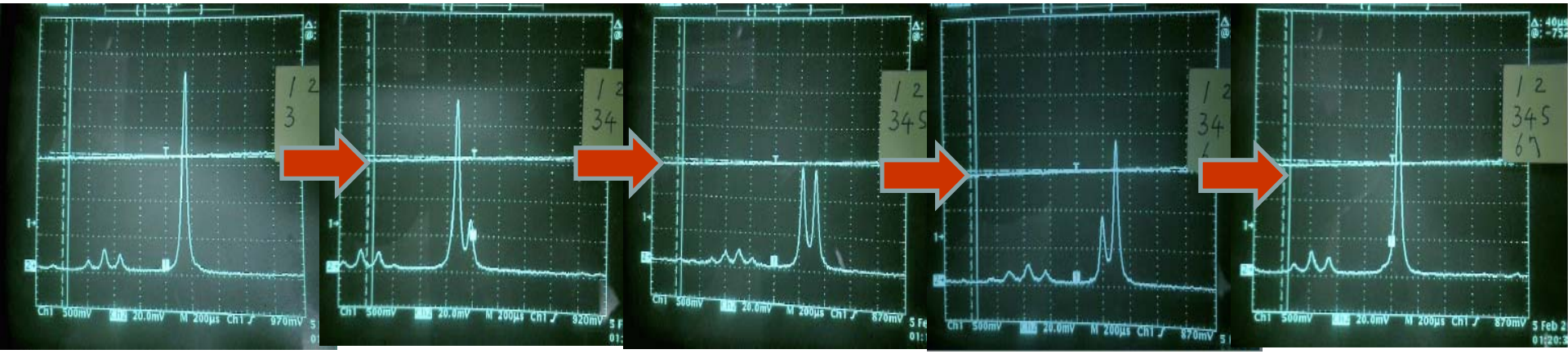




Two resonat peaks due to geometrical phase



Right Linear Left



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
    - polarization

Optical Cavity R&D around ATF

- O(10MeV) γs for Compton Based Polarized Positron source.
- Hard X ray (~30keV) sources
  - **LUCX project**
- New 5 year project
  - **Compact X ray source w/ SRF electron accelerator and pulse stacking cavity.**

Accumulating technique and experiences w/ cavity and accelerators.
ring cavities are being planned as next step

data summary

bunch /train	current [mA]	Stacked Laser power[W]	γs/crossing	exectation	normarized γs/A/W
15	11	498.2±0.4	27.6±0.1	30~45	5.04±0.02
10	8.5	469.8±0.4	20.2±0.1	22~33	5.06±0.03
5	4.7	423.4±0.8	11.3±0.1	11~17	5.68±0.05
1	2.2	436.8±0.4	5.4±0.3	5~8	5.6±0.3

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

Bunch (size, timing) fluctuation in the ATF suspected