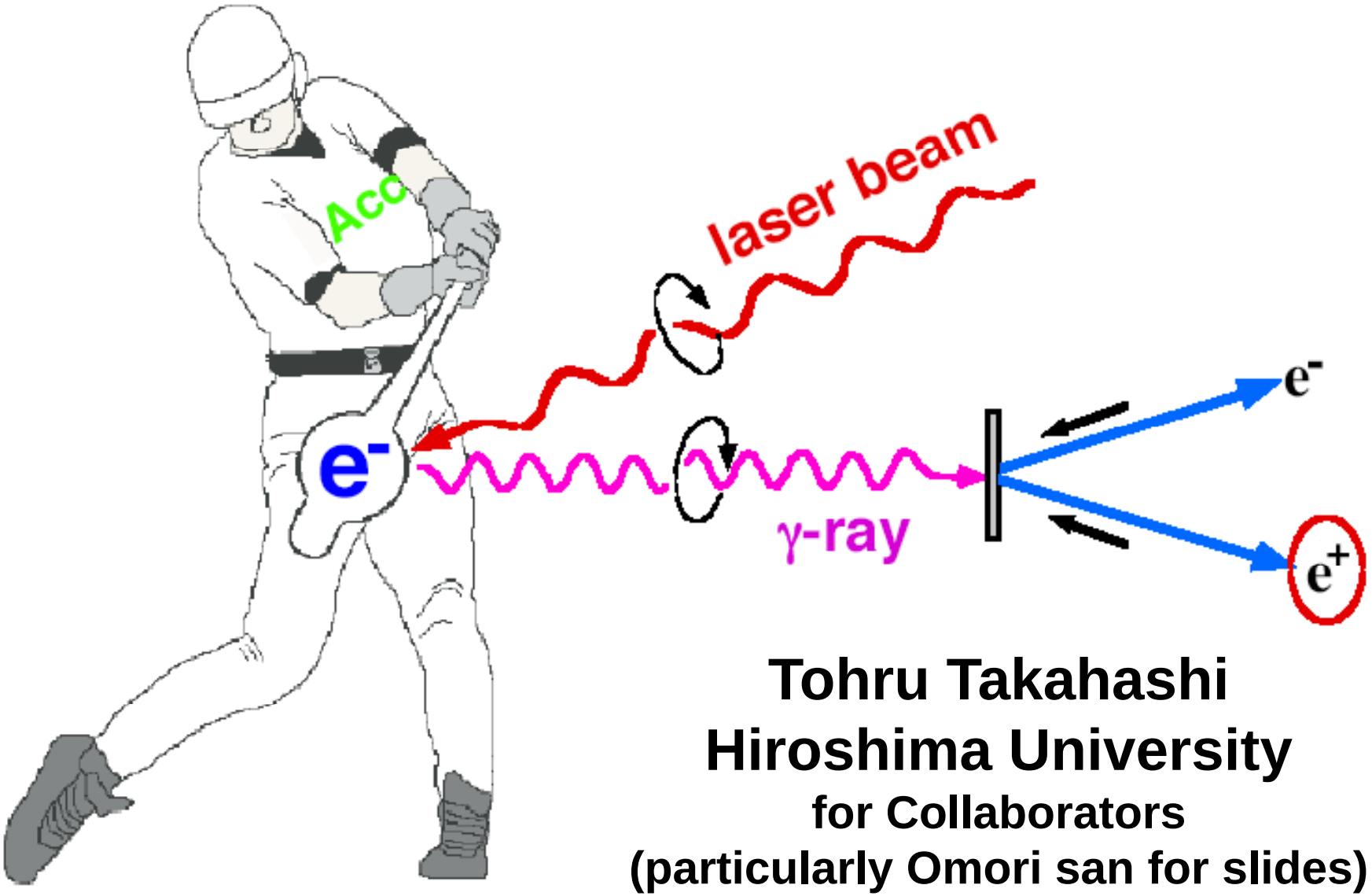
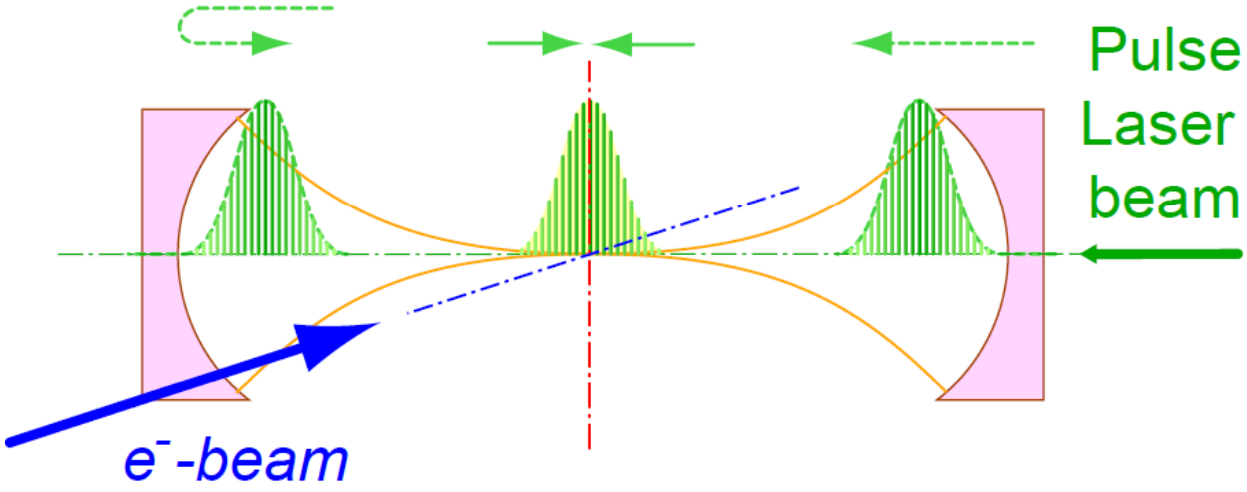
Compton Experiment at ATF



Tohru Takahashi
Hiroshima University
for Collaborators
(particularly Omori san for slides)

Experimental R/D in ATF

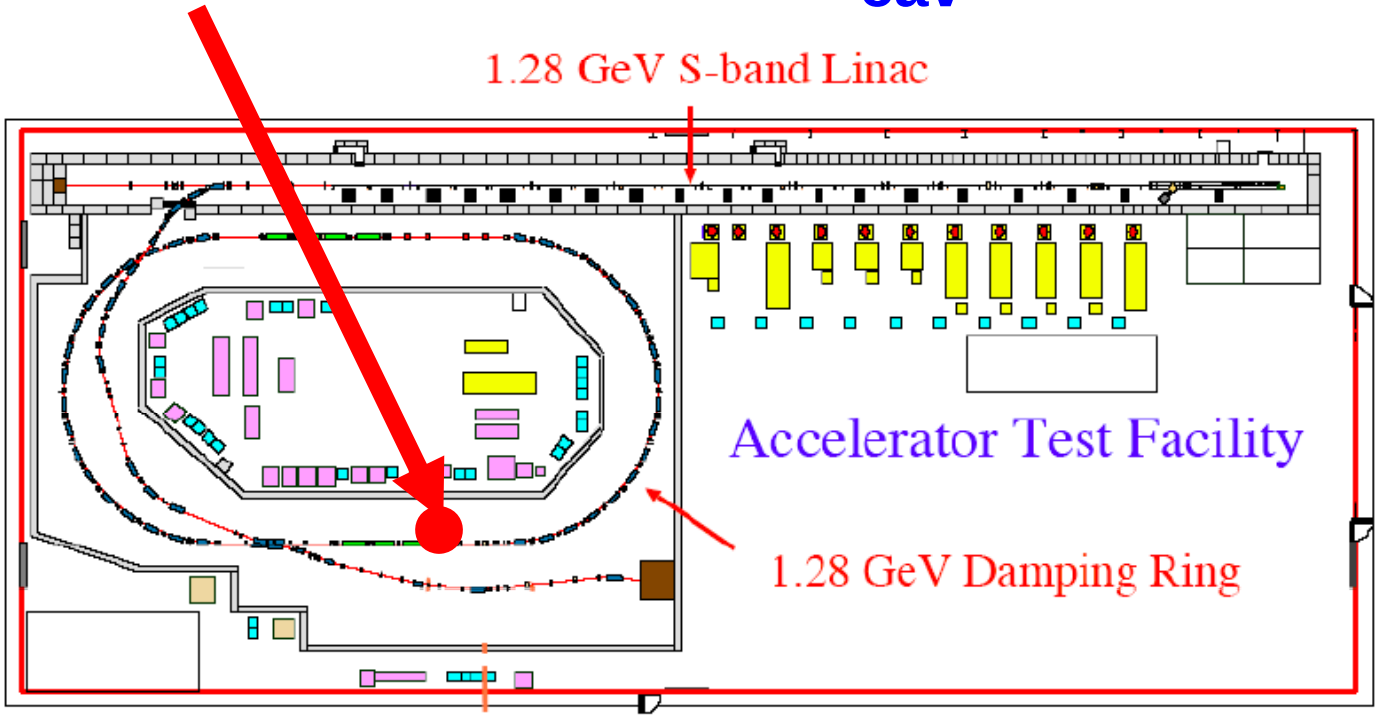
Hiroshima-Waseda-Kyoto-IHEP-KEK



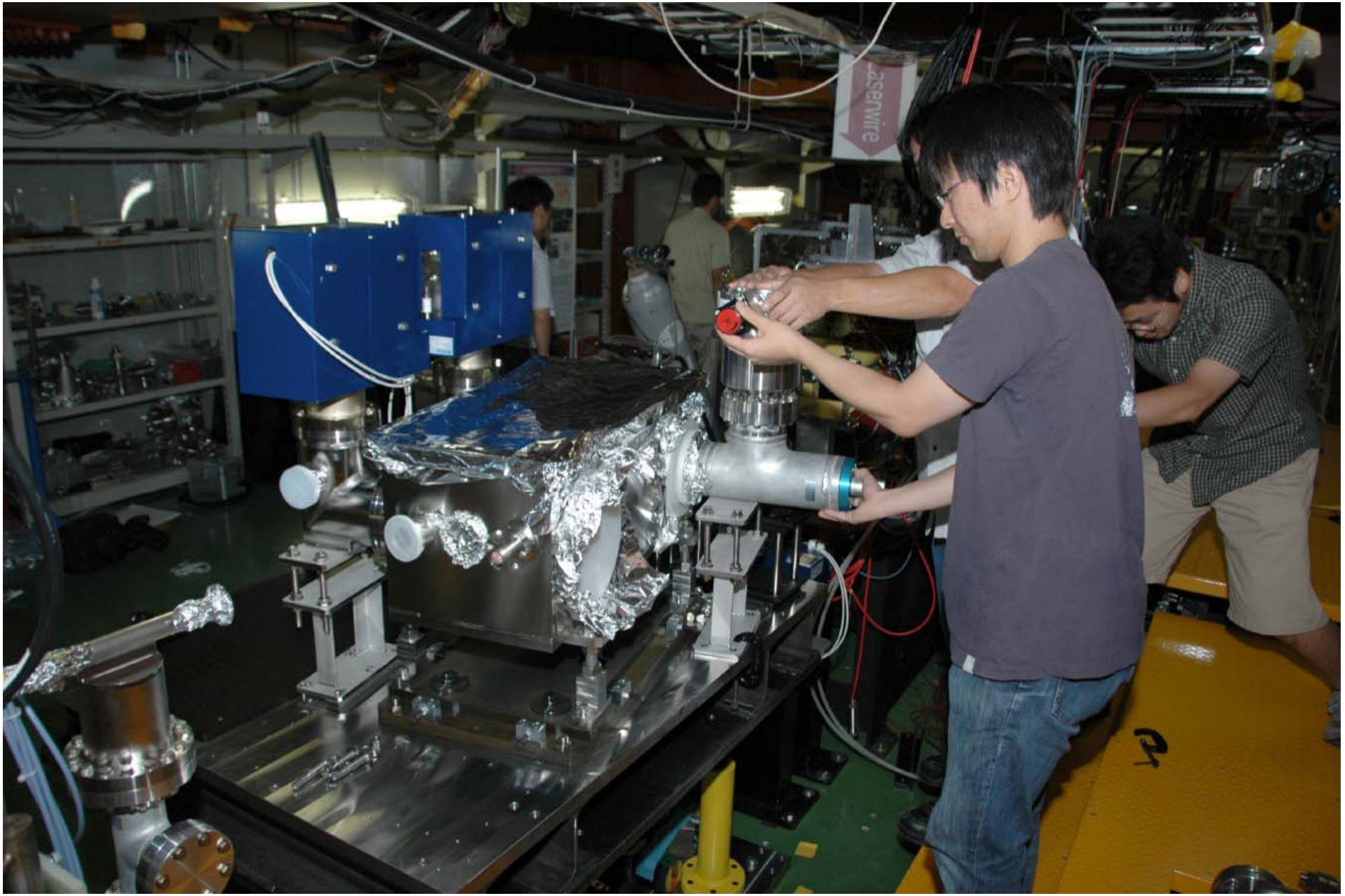
Make a fist prototype 2-mirror cavity

L_{cav} = 420 mm

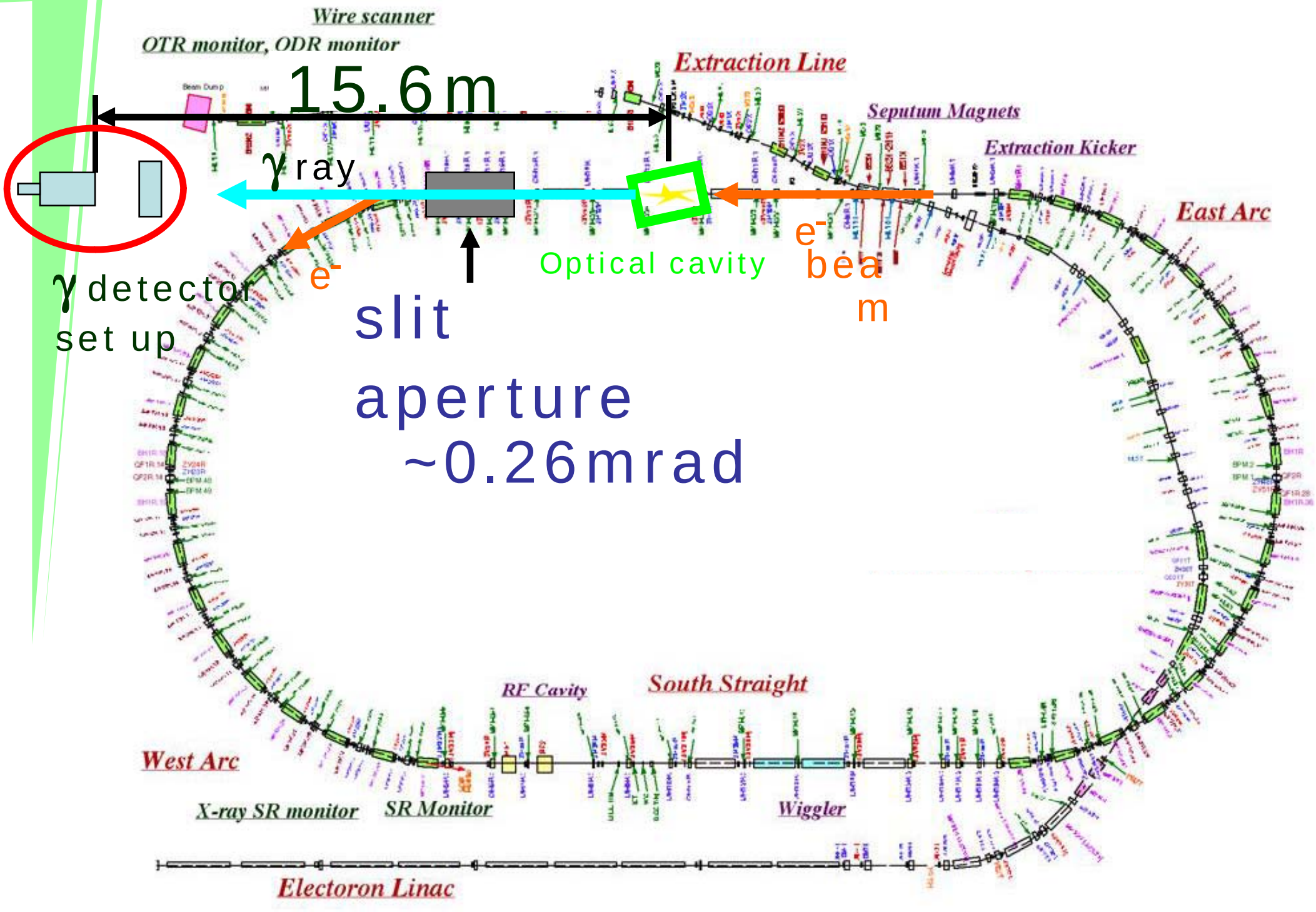
Put it in ATF ring



October 2007: Install the 2-mirror cavity into ATF-DR



Set up at KEK-ATF 1



First 2008 run

~before summer shutdown~

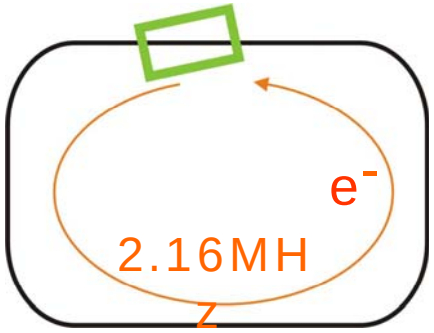
DAQ Schematic

T-light
(Cavity information)

Electron beam
signal(2.16MHz)

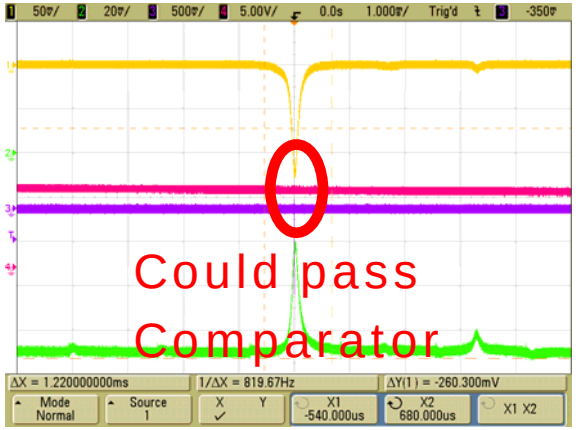
PD

cavity



T = 463ns

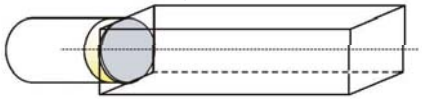
Comparator



Coincidence

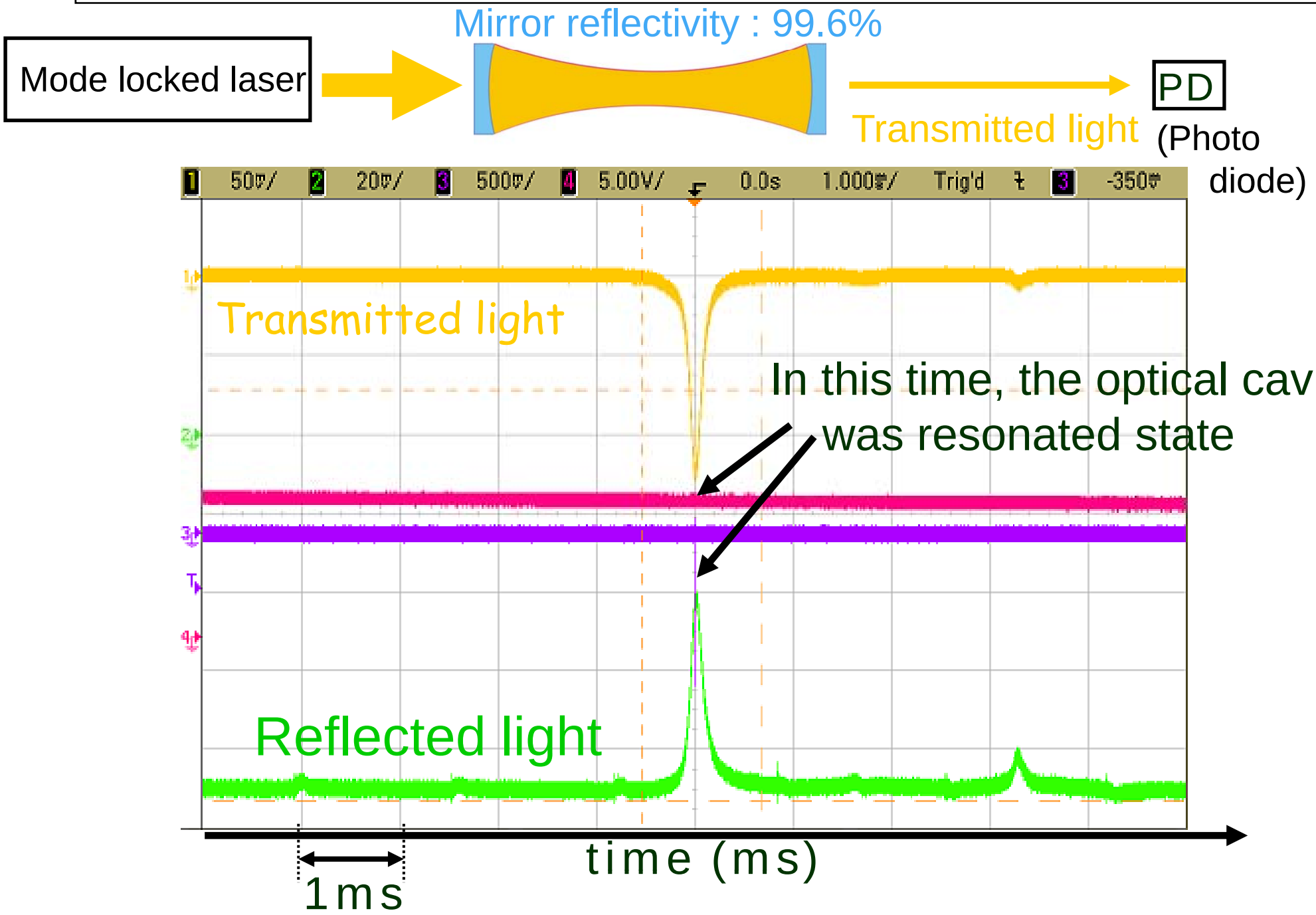
Gate
generator

Gate was opened
for 100ns.



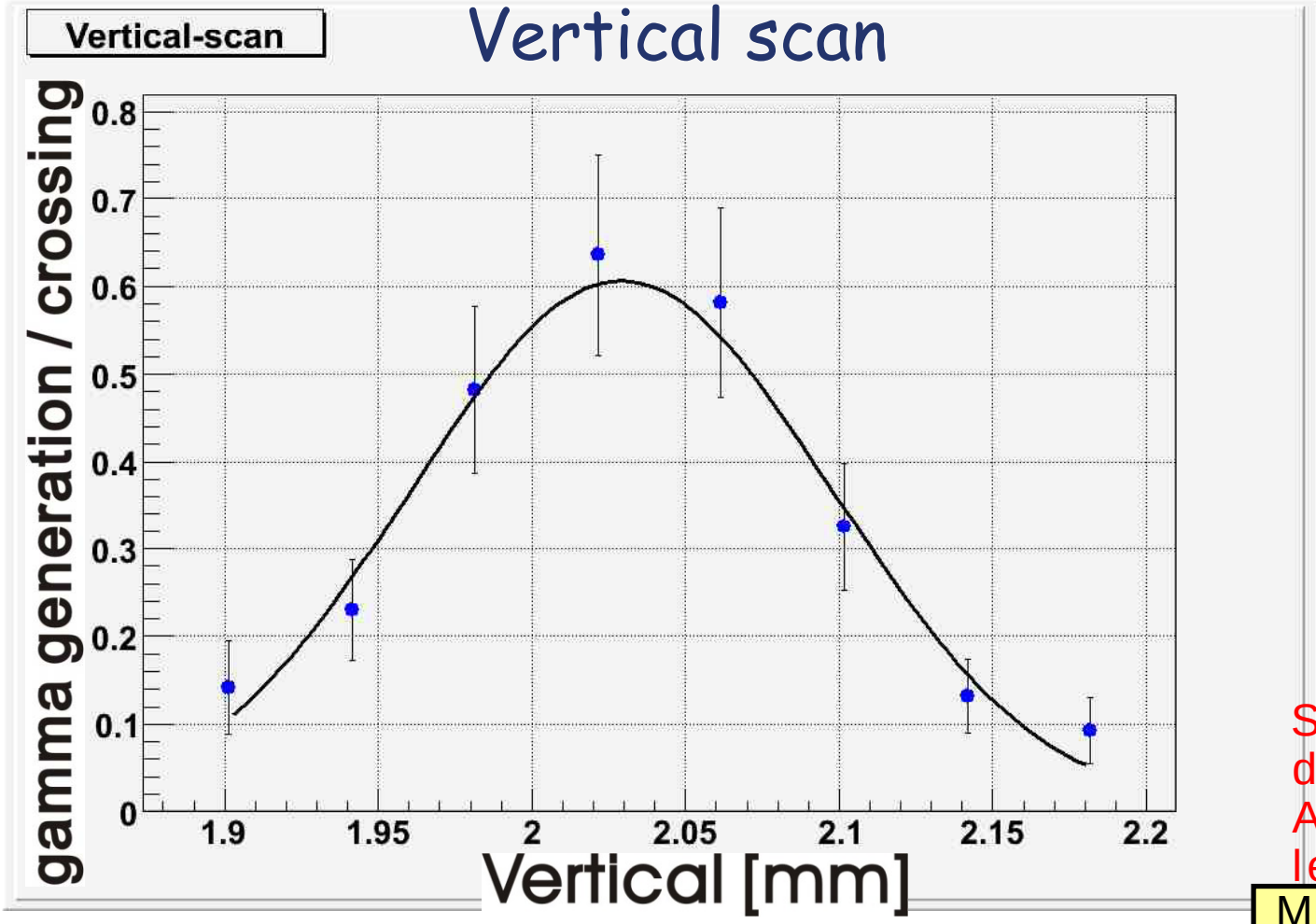
Continued to change the length of the external cavity.
Only picked up the data when the cavity was resonated.

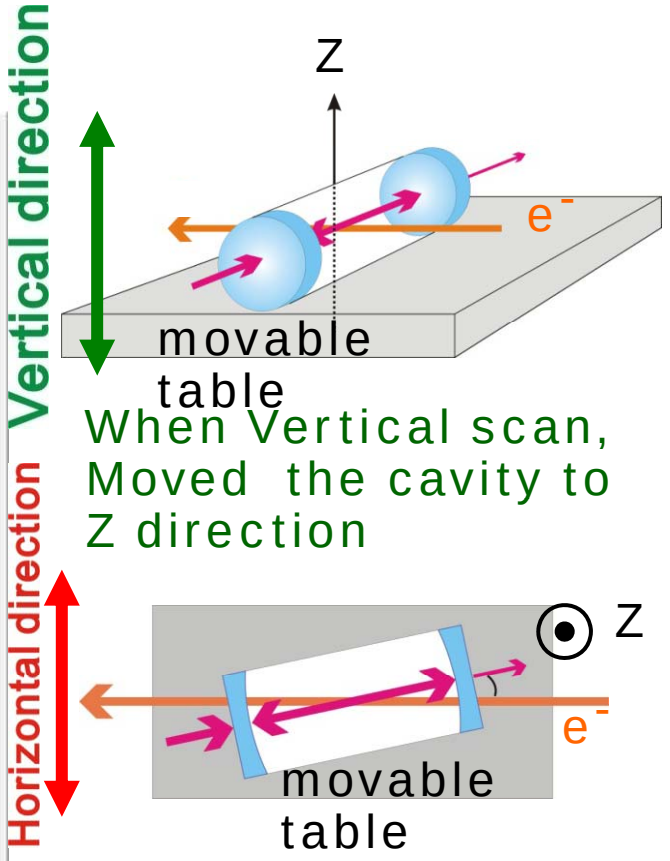
The appearance of light resonance signal



Continued to change the length of the external cavity.

Procedure of measurement 1





① Vertical scan

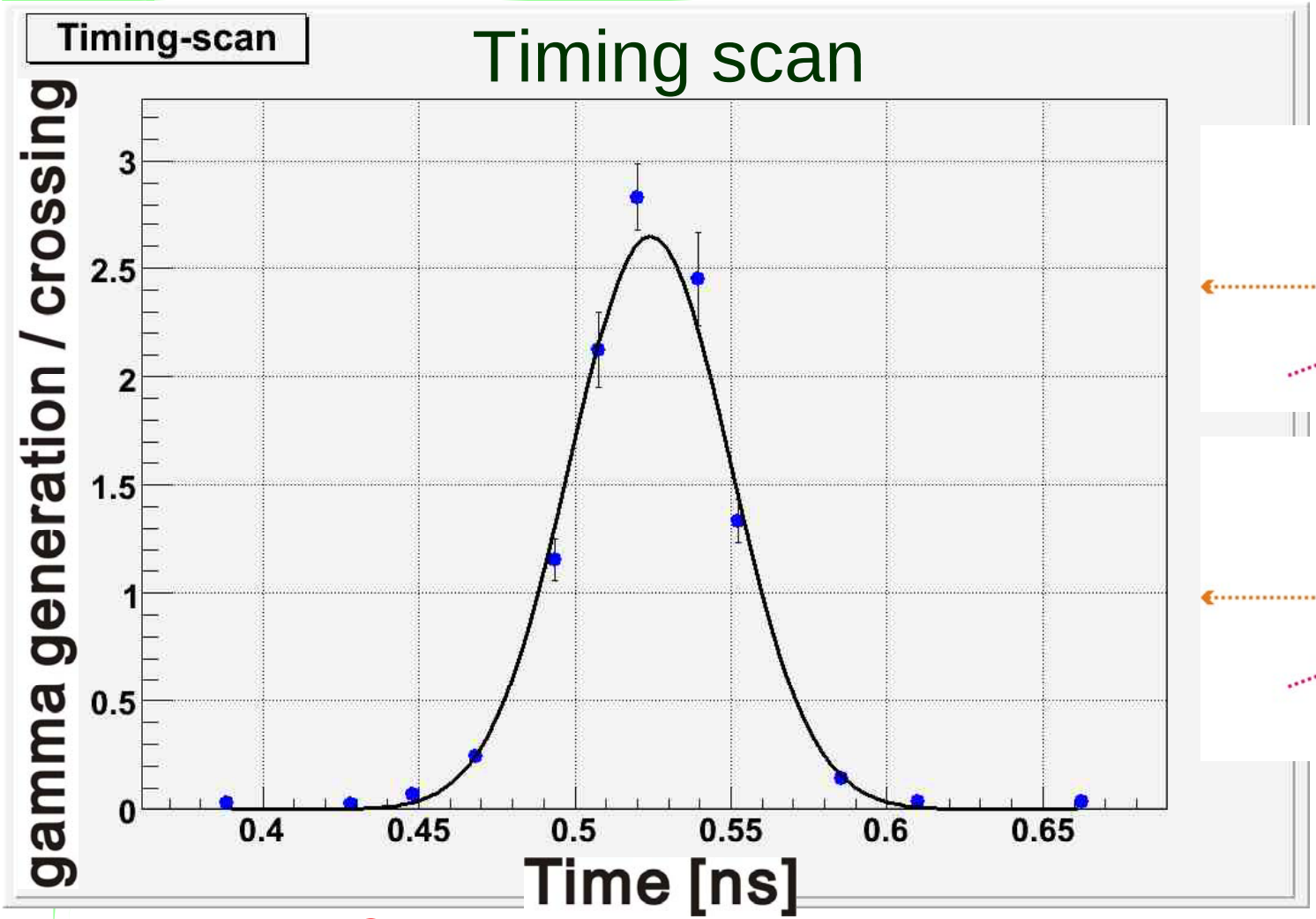
Scanning to the laser vertical position and find the best position to observe gamma

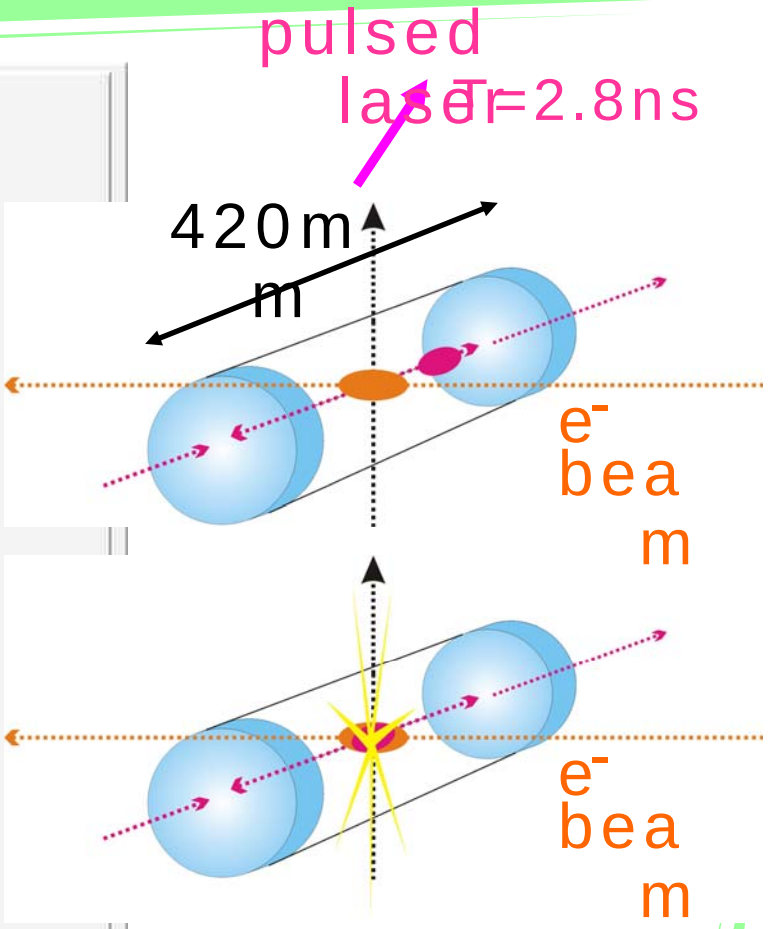
② Horizontal scan

Vertical was fixed to the best position.

Scanning to the Horizontal.

Procedure of measurement 2





③ Timing scan

Vertical and Horizontal were fixed to the best position.

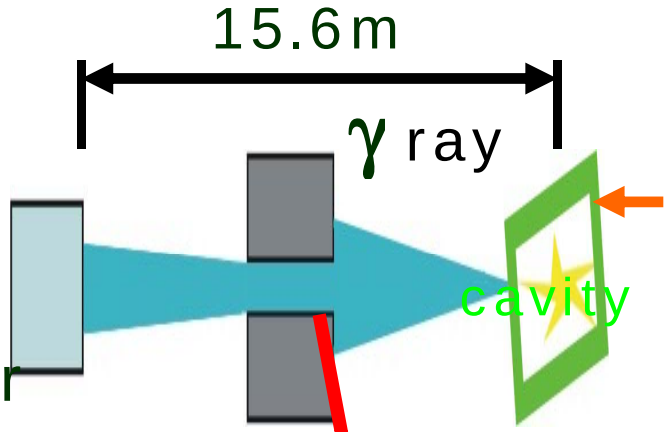
And turned on the switch of phase locked loop .

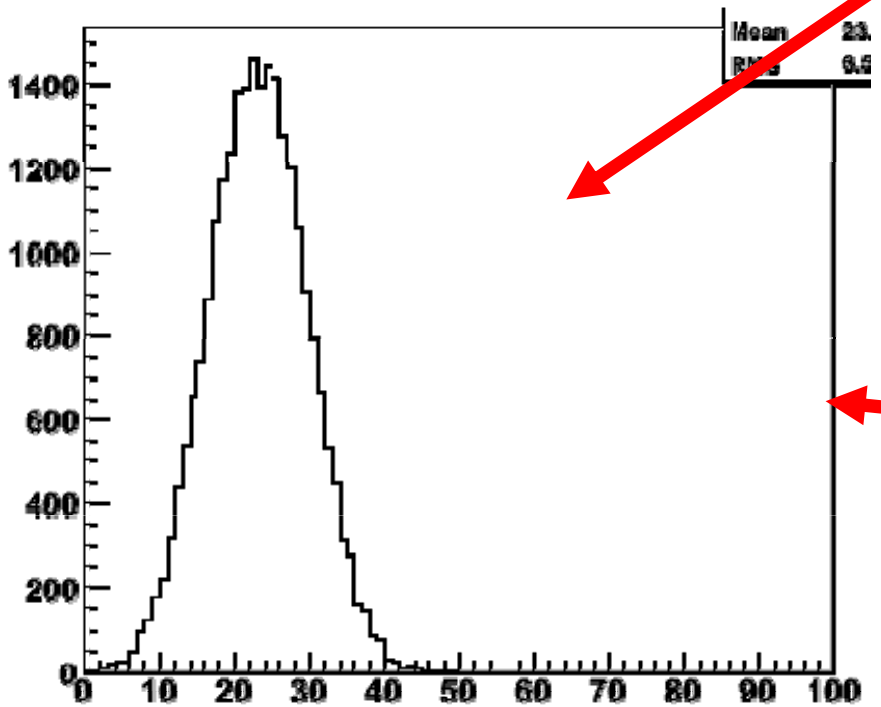
After that scanning phase.

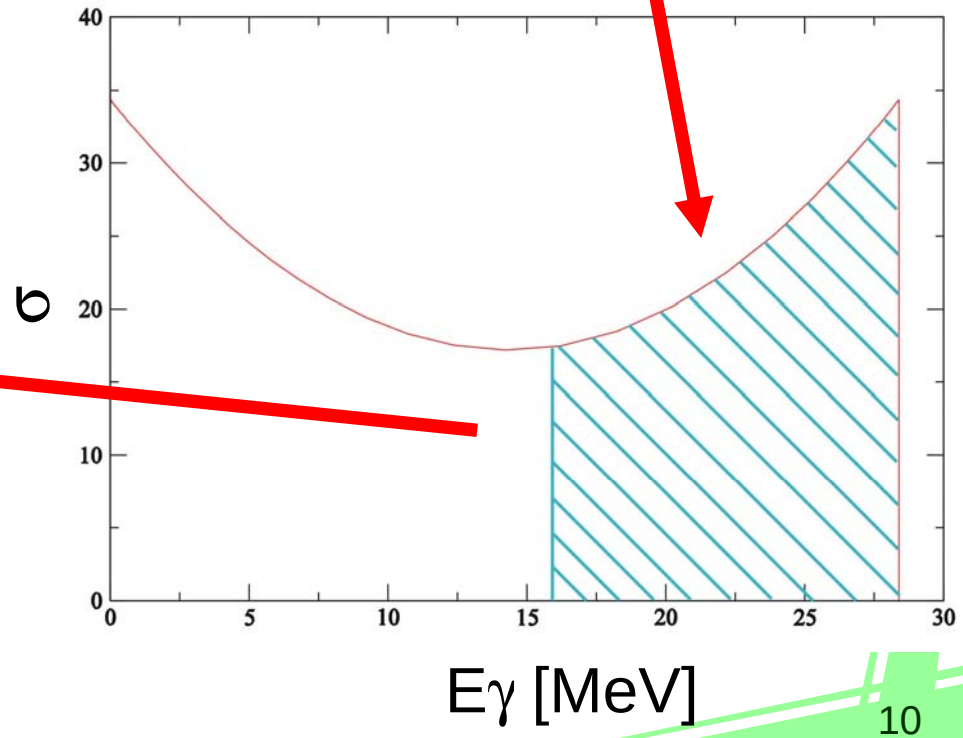
We found the best collision point

Gamma Energy distribution 1

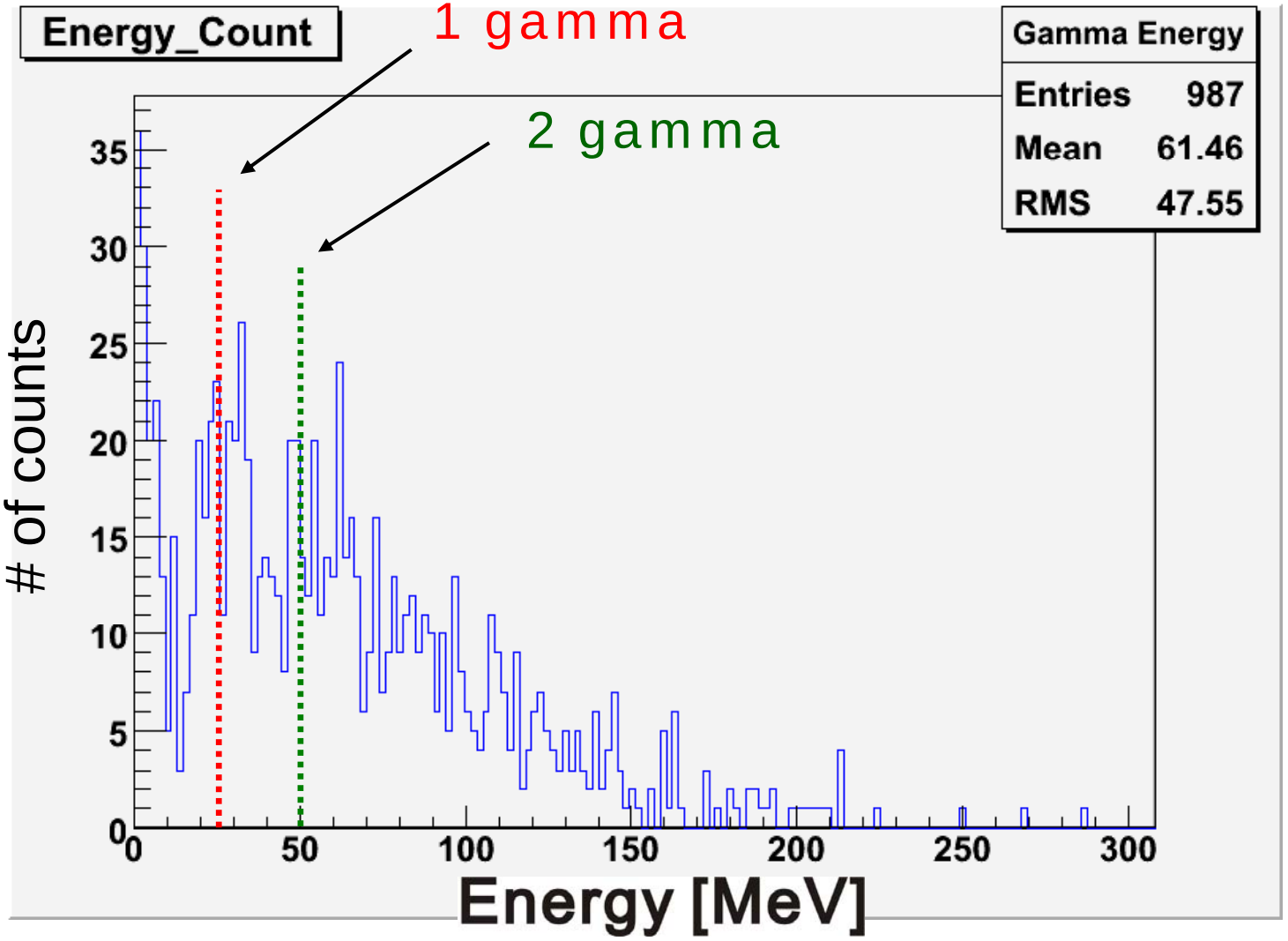
obserbed spectrum for single γ is:
E(mean) ~23MeV
σ =6MeV







Gamma Energy distribution 2



This graph shows the appearance of gamma energy distribution.

one of gamma had 16~28 MeV energy.

The number of gamma

date	bunch	the number of electron	transmitted power	stack power estimate	γ
		1/ pulse (included in one train)	W	W	
2008/ 4/ 22	20	2.6E+10 (in 20 bunches)	1.55	388	3.1
2008/ 5/ 27	1	7.2E+9 (in 1 bunch)	1.09	272	3.27

Mirror reflectivity : 99.6% ⟶ stack power = $\frac{\text{transmitted power}}{1 - 0.996}$

bunch distance : 2.8 ns

We estimated the number of gamma to use a simulation software “CAIN”.

20 bunches :	experiment	γ~3.1	simulated by CAIN γ ~ 20
1 bunch :	experiment	γ~3.3	simulated by CAIN γ ~ 4.5

In the case of 1 bunch, the number of gamma seems to consist comparing our experiment data with estimate by CAIN.

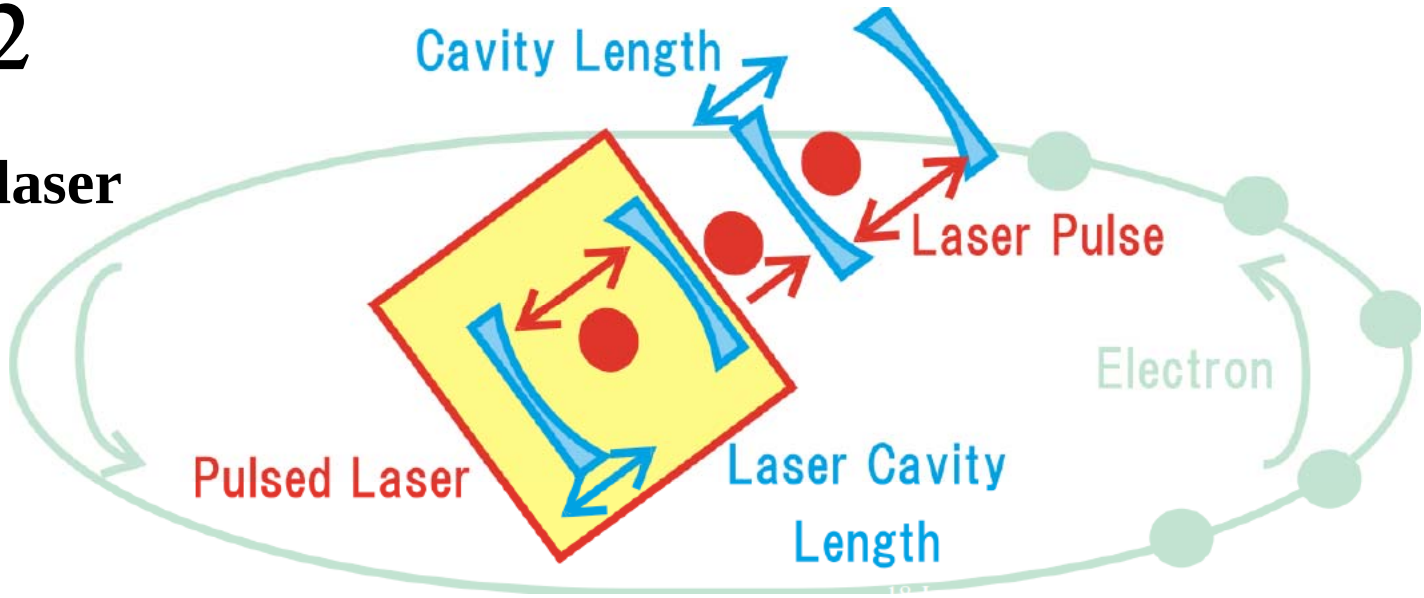
However, the data of 20bunches were inconsistent.The reason of this,there was a possibility that not every electron bunches were collided.

Novmber - December run

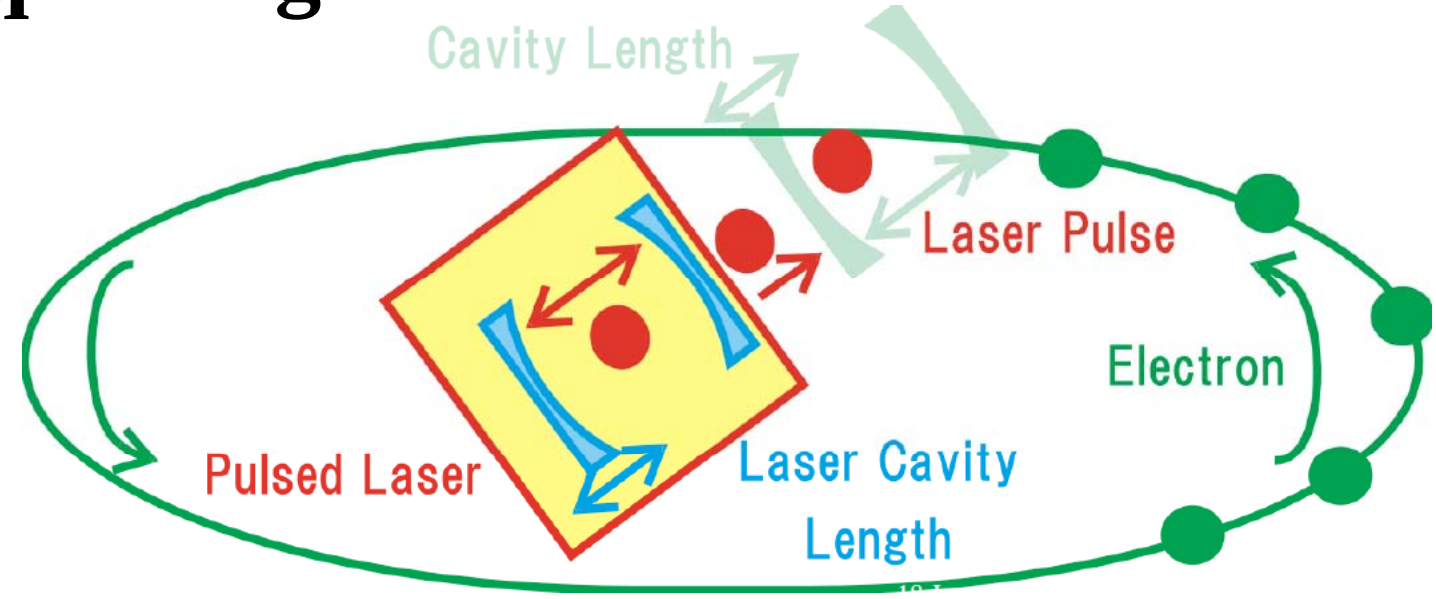
Feedback to Achieve 3 Conditions

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

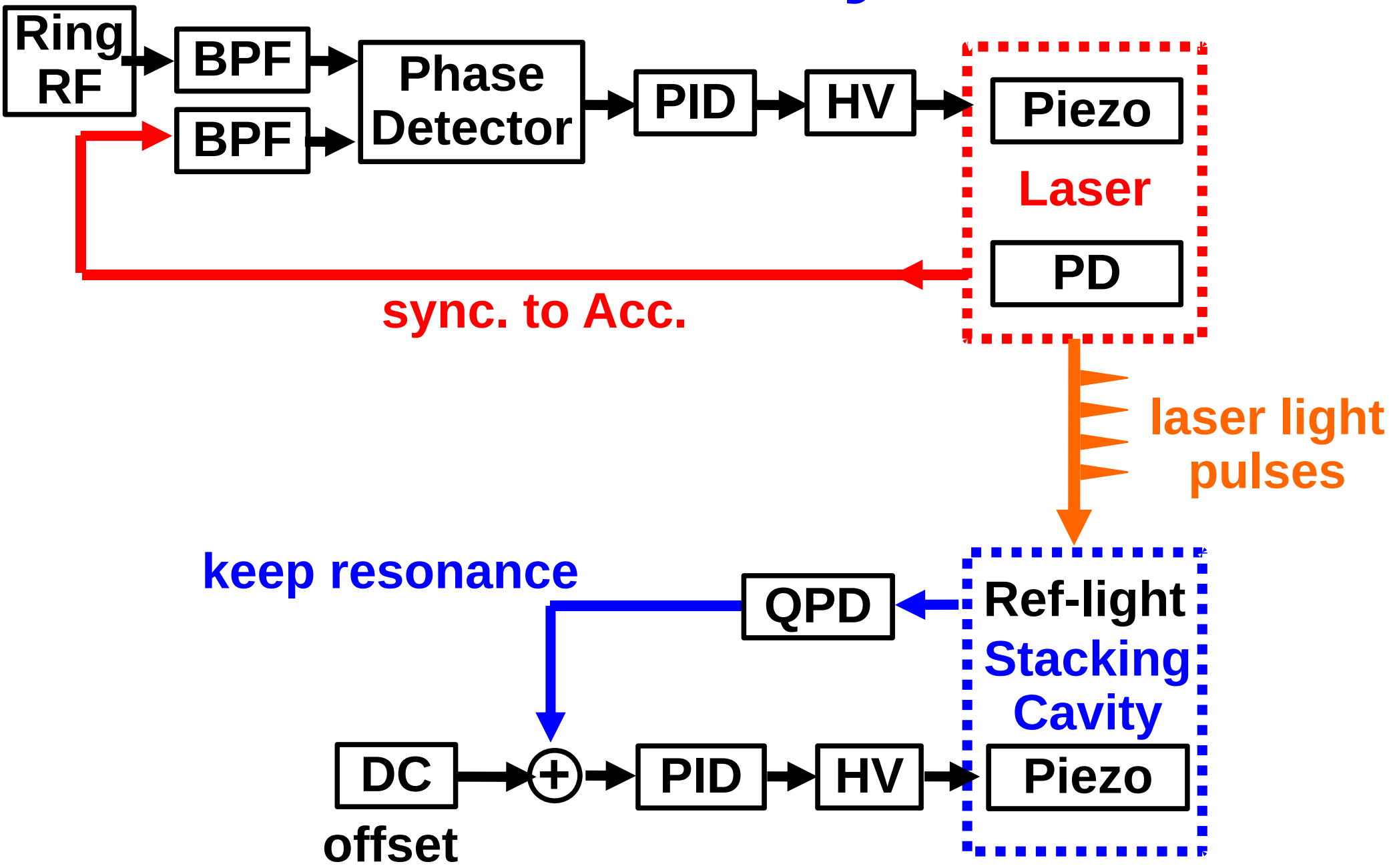
$L_{cav} = m L_{laser}$



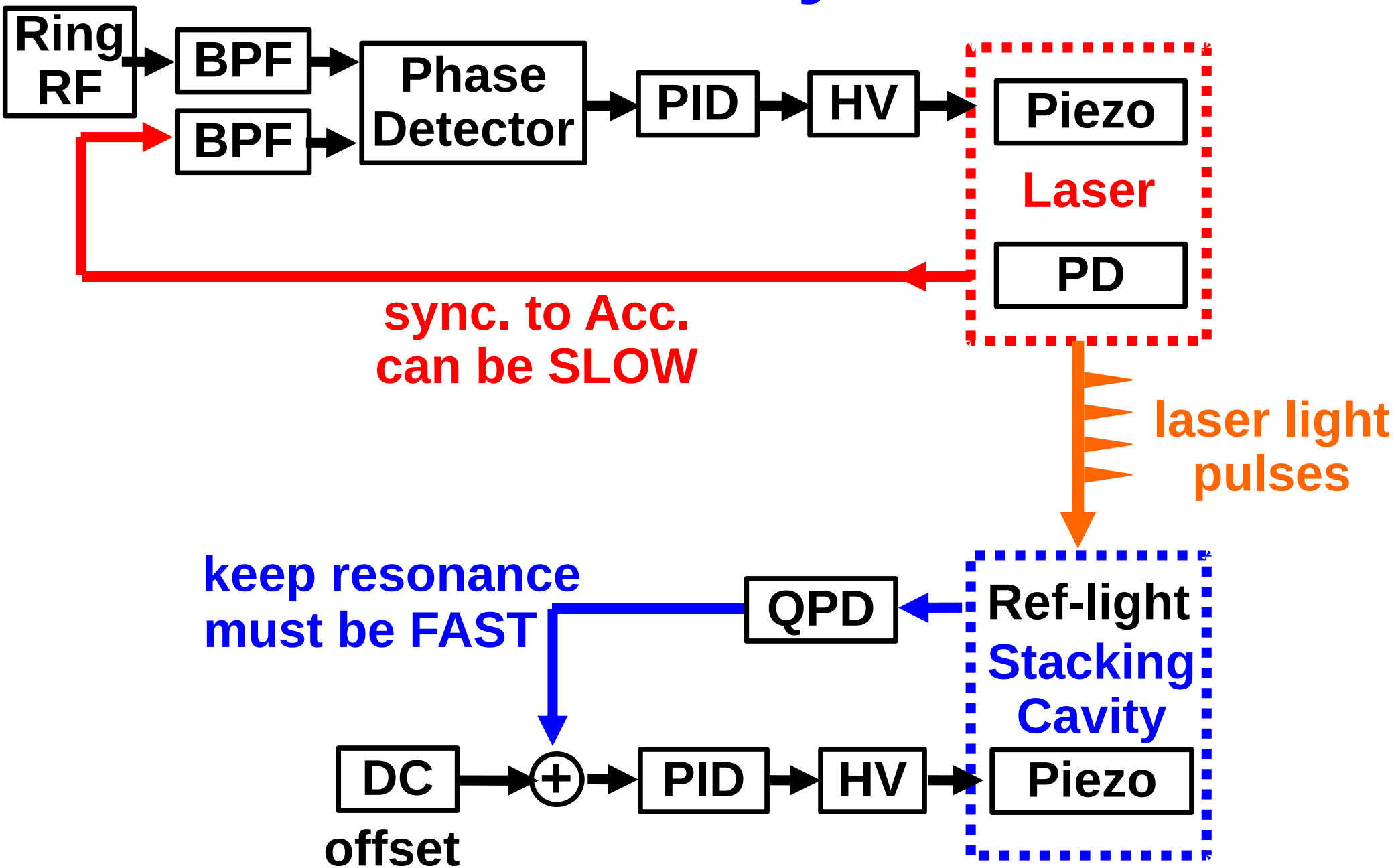
Laser freq = Ring RF



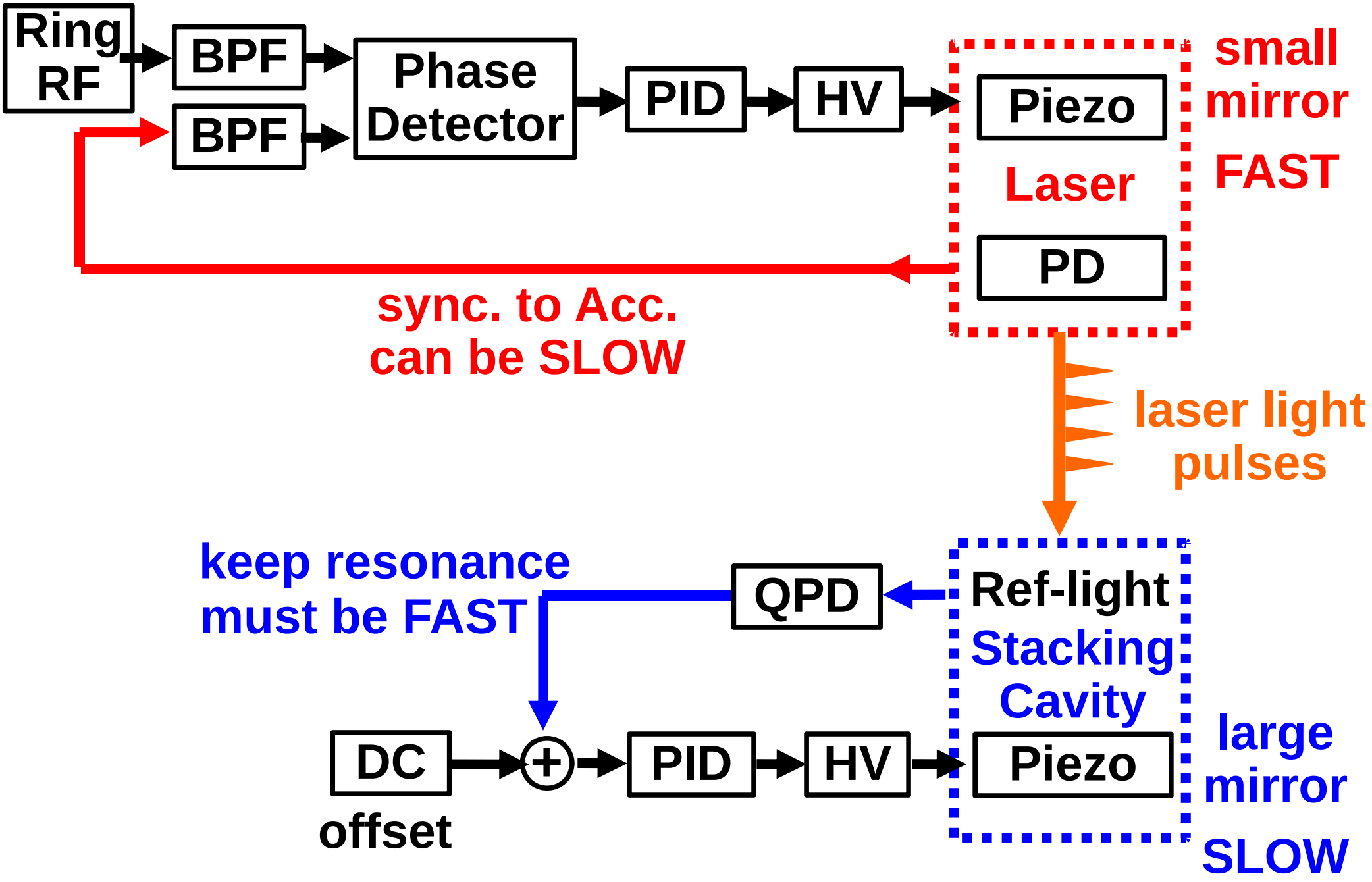
Previous Ssytem



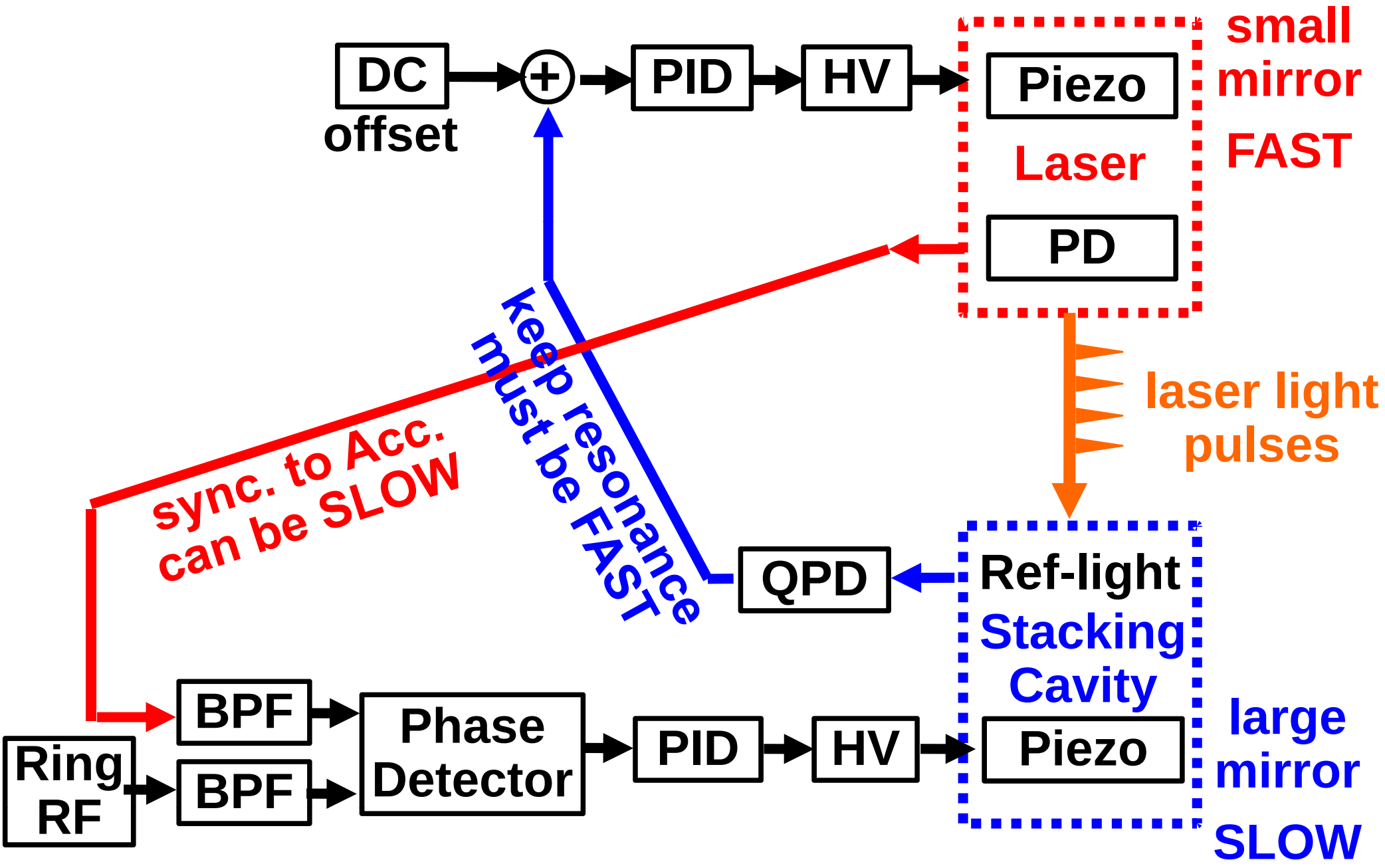
Previous System



Normal Solution

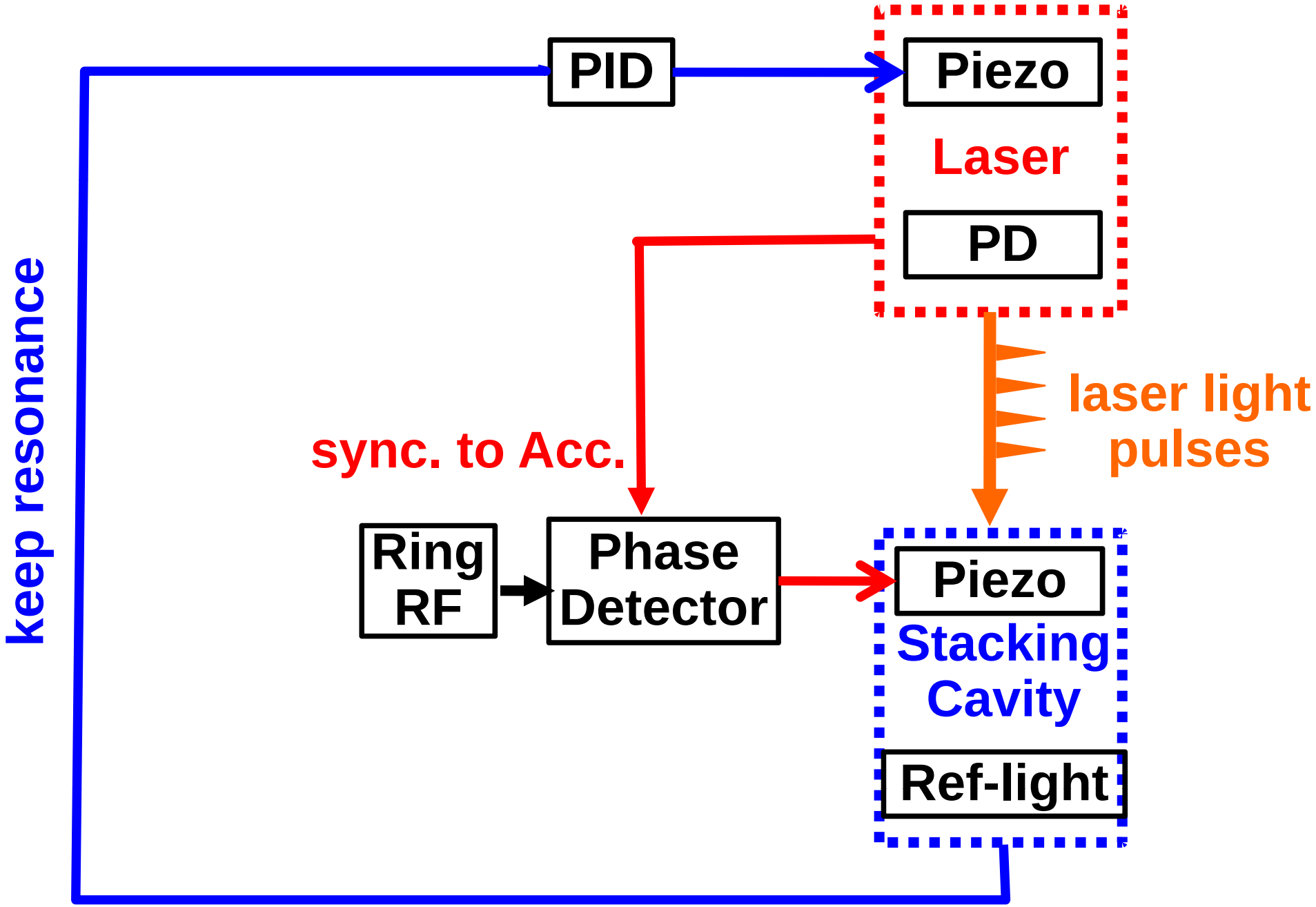


Cross-feedback Solution (Sakaue)

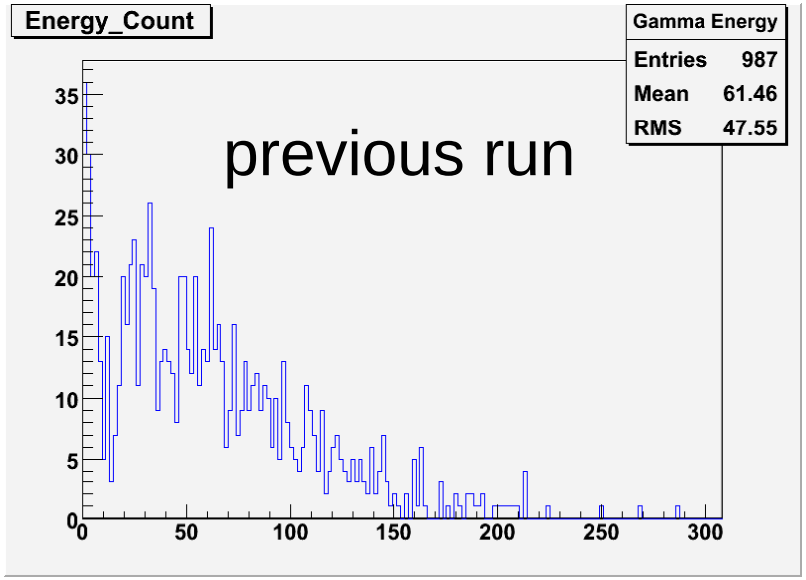


Cross-feedback=Closed loop

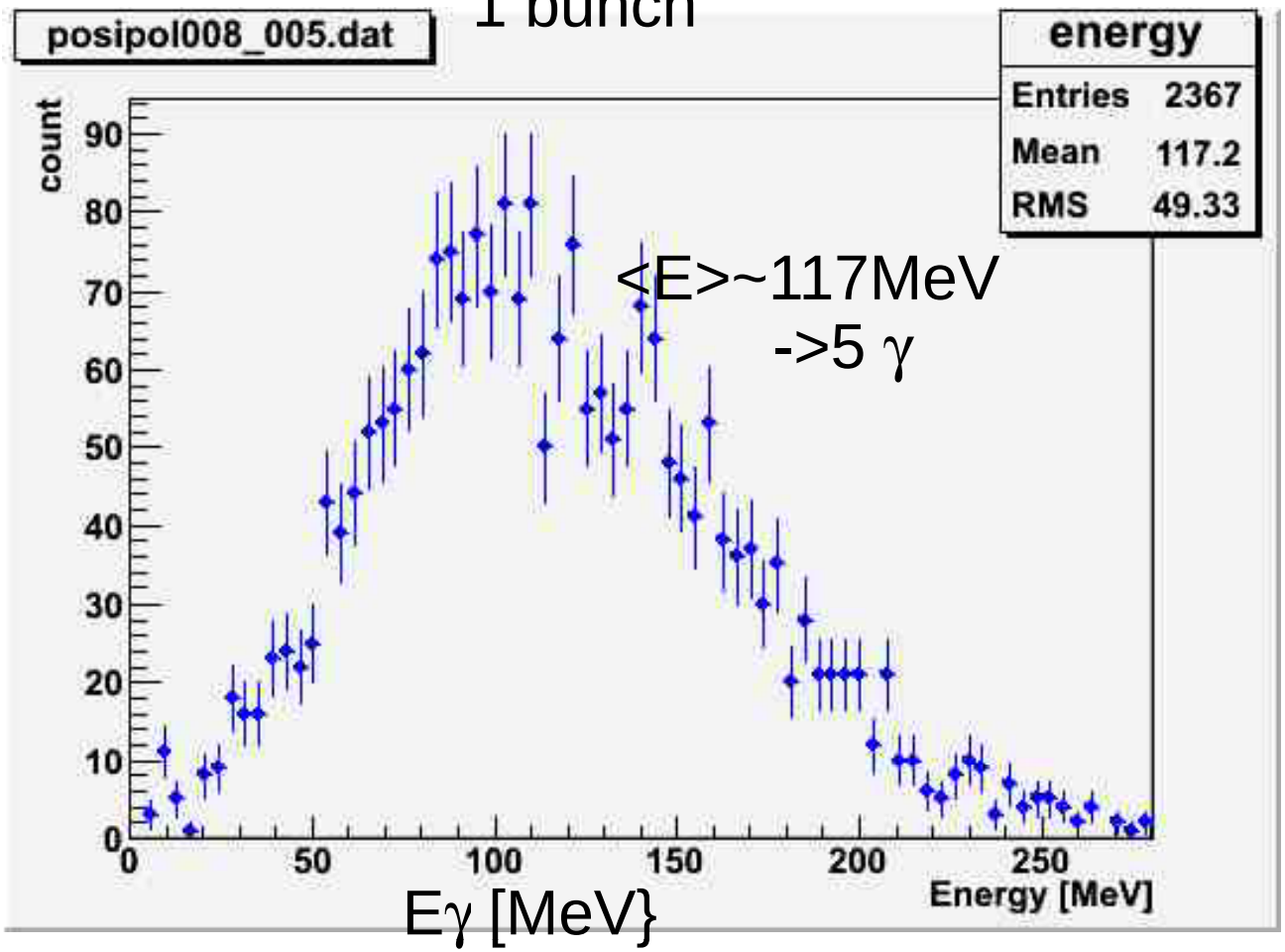
(Sakaue)



Energy Distribution



1 bunch



Now, looks multiple photon genearation in laser-electron collision

data summary

date	electron	number of electrons	stacked power	# of g
	bunches	/pulse	[W]	/crossing
2008/11/20	1	7.2E9	413	5.1
2008/11/20	2	1.2E10	291	6.2

The number of γ : 6.2 × 2.16×10E+6 [/second]

Simulated by Cain 1bunch γ : 5.7 2

bunches :6.7

Rough consistency check

γ ÷ the number of electron ÷ stack power

1 bunch 1.715×10^-12/e/W

2 bunches 1.718×10^-12/e/W

1 bunch data and 2 bunches data seem to consistent

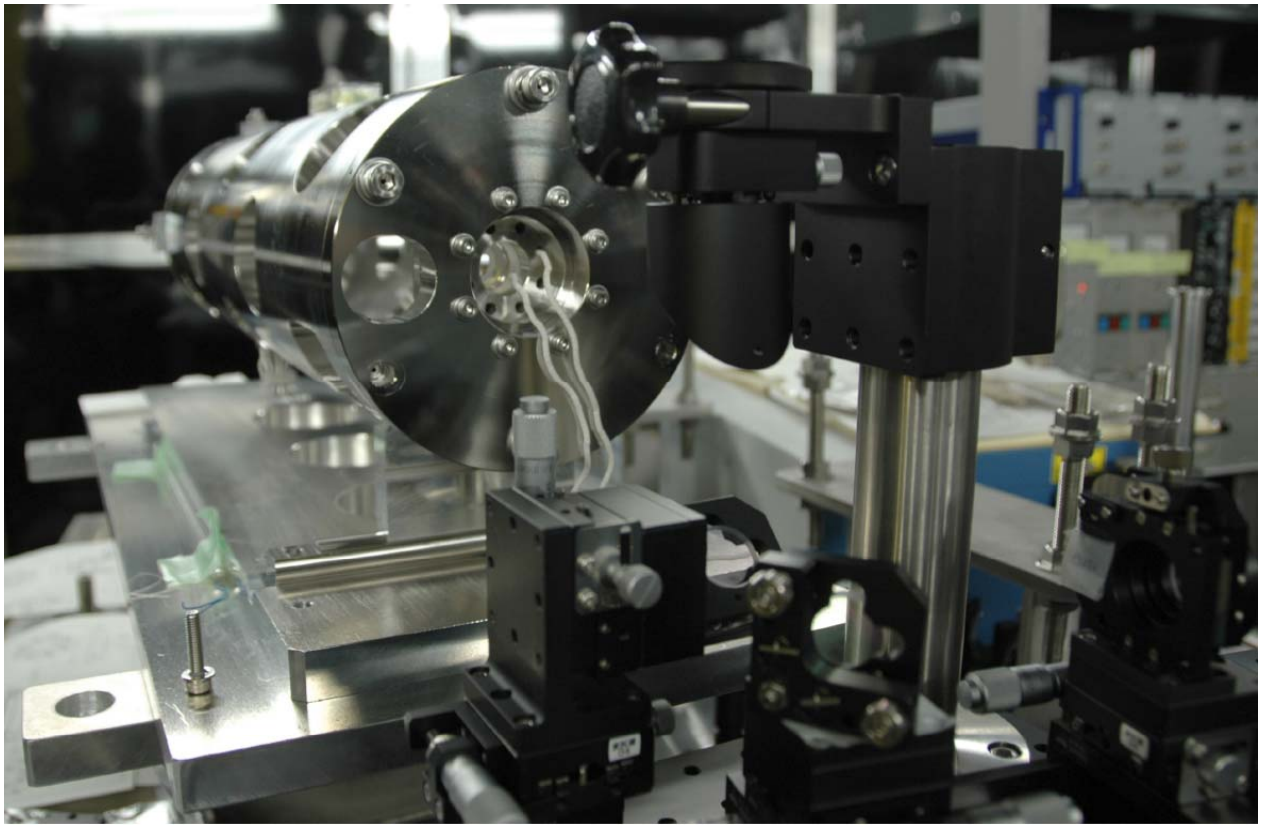
Summary

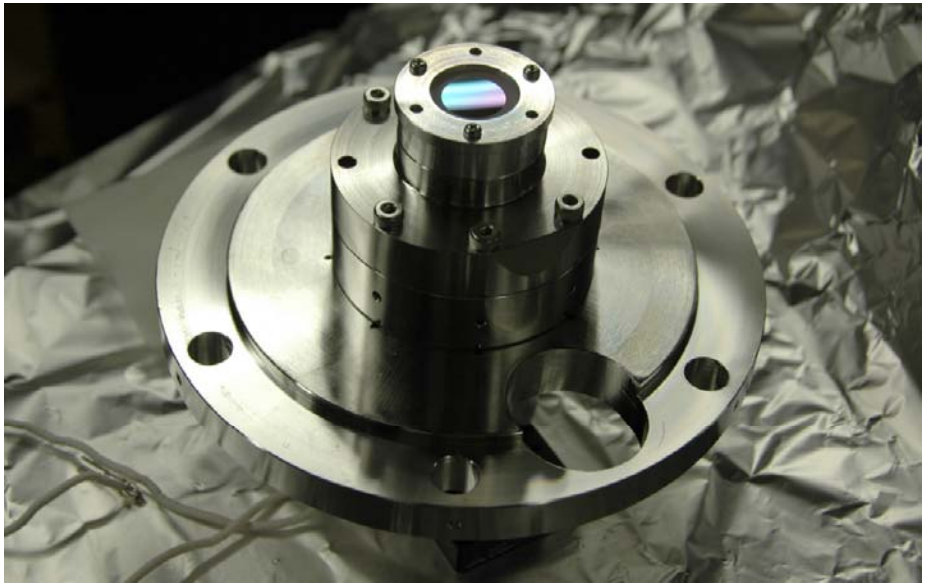
1. Success : Resonance Feedback + Phase Lock on Acc RF
   - Before Summer
     - No feedback
       - Trigger : Acc + Transmitted Light
   - Present
     - Separeted Feedback ---> Crossed(loop)-feedback
     - Resonance Feedback + Phase Lock on ACC RF
       - Trigger : Acc

2. Collision Experiment on going
   - 5 gamma / crossing (single-bunch op.)
   - 6 gamma / crossing (two-bunch op.)
     - Consistent: Experiment <--> CAIN simulation
     - Consistent: single-bunch <--> two-bunch

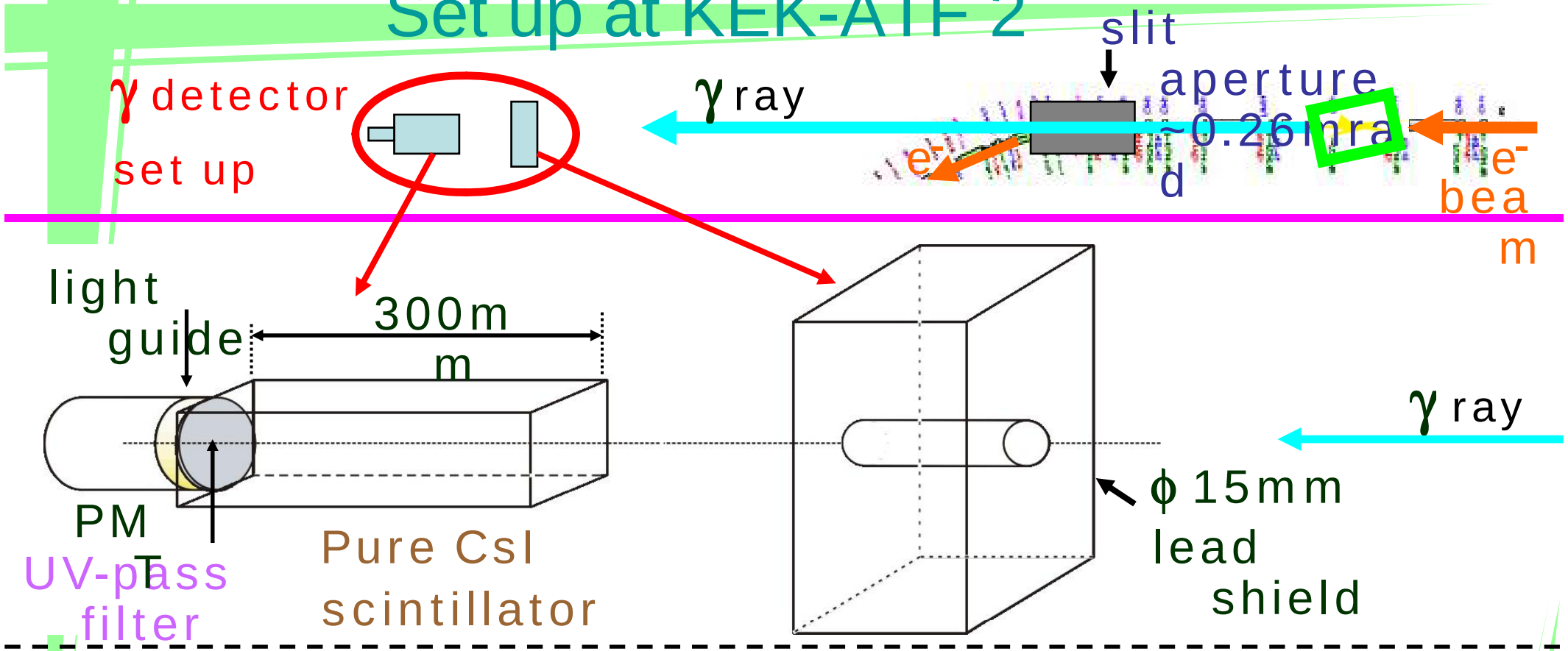
We are now tying take up to 20 buch data

Summer 2007: Assembling the Optical Cavity





Set up at KEK-ATF 2



Pure CsI : The maximum emission wavelength : 315nm
Emission decay time : 10-16ns

UV-pass filter : Only pass the ultraviolet light.

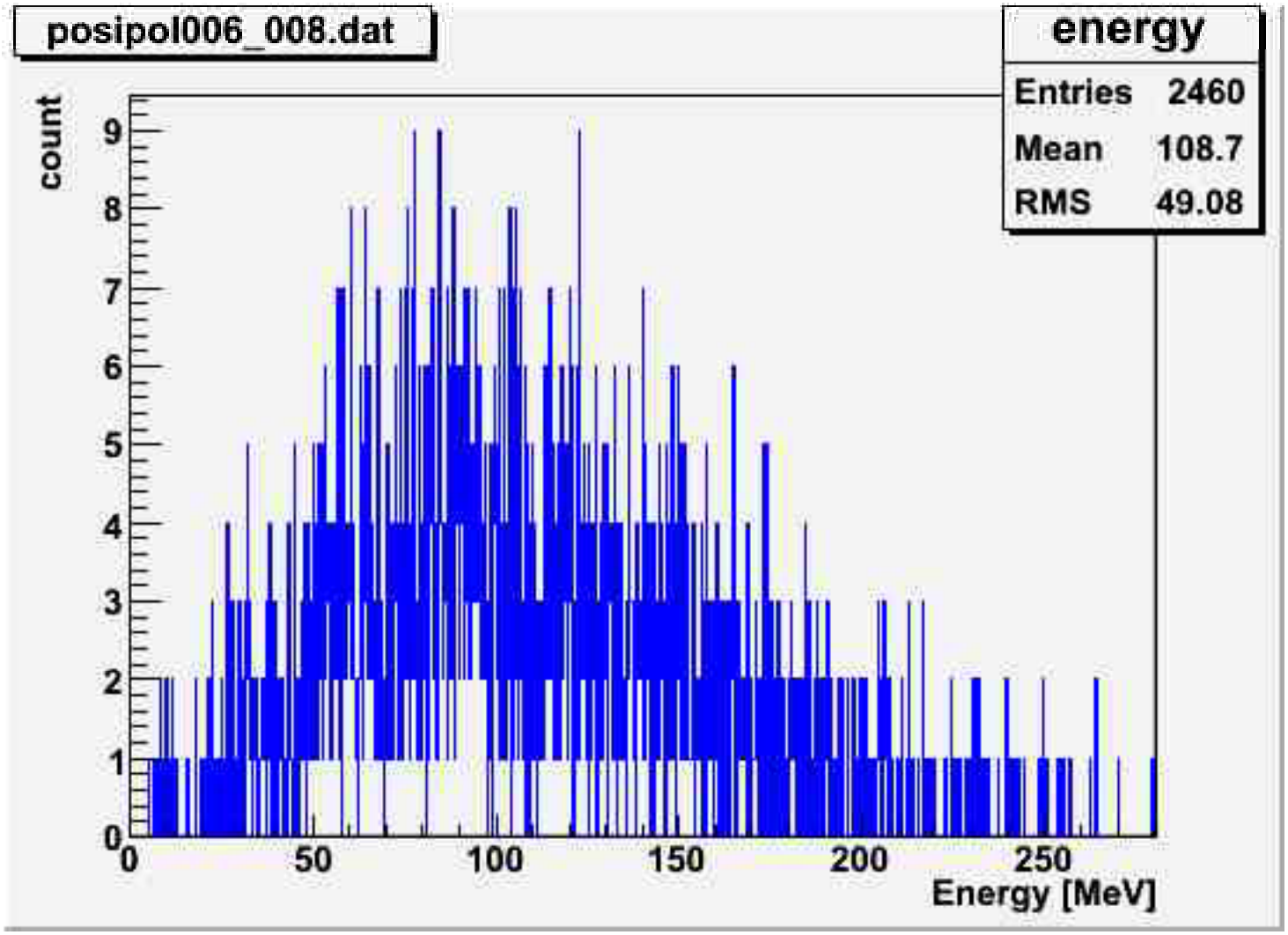
Emission decay time is enough to be faster than the data taking time and electron frequency.

data taking time : 100ns

electron frequency : 2.16MHz ~ 463 ns

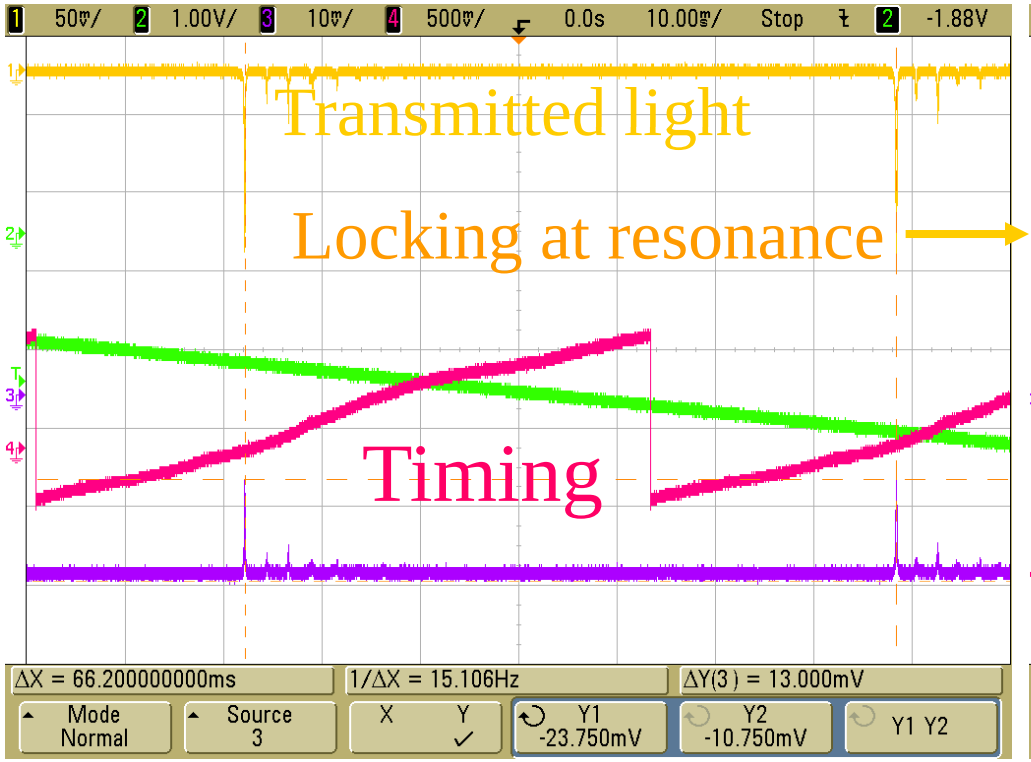
Energy Distribution

single-bunch operation



Optical cavity condition

In summer time, we succeeded to keep condition of optical cavity timing lock and locking at resonance point.

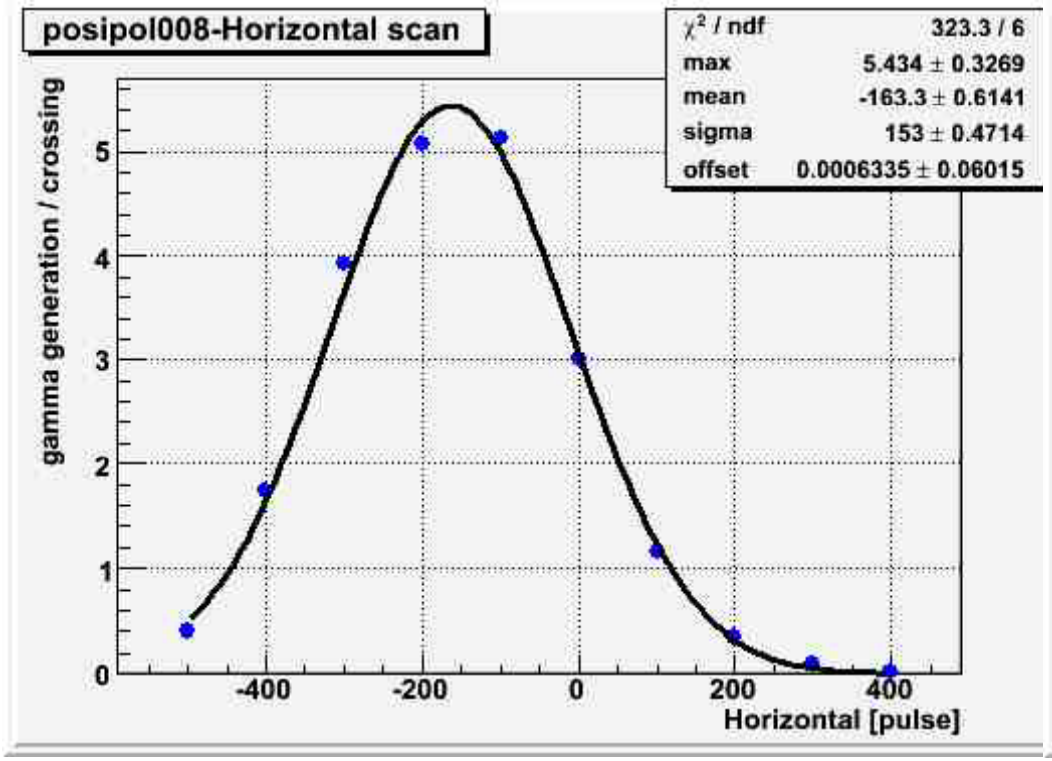


Last week beam time, Optical cavity was to keep condition timing lock and locking at resonance point.

Best collision point data in 1 bunch and 2 bunches

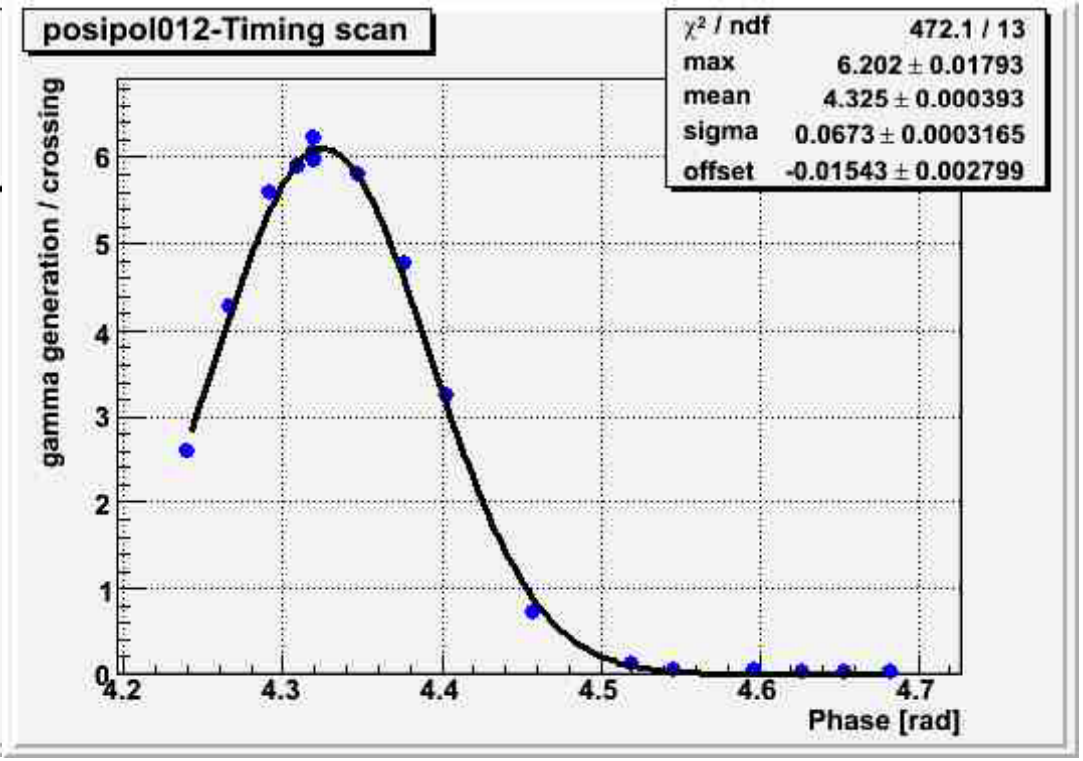
1 bunch

Scanning to Horizontal position



2 bunches

Scanning to Timing



After that, we tried to take 3 bunches data.

However, gamma detector was broken.

↓

Now, gamma detector is recovered.

Laser Stacking Optical Cavity in Vacuum Chamber