R&D Status of Optical Cavity for ILC Polarized e+

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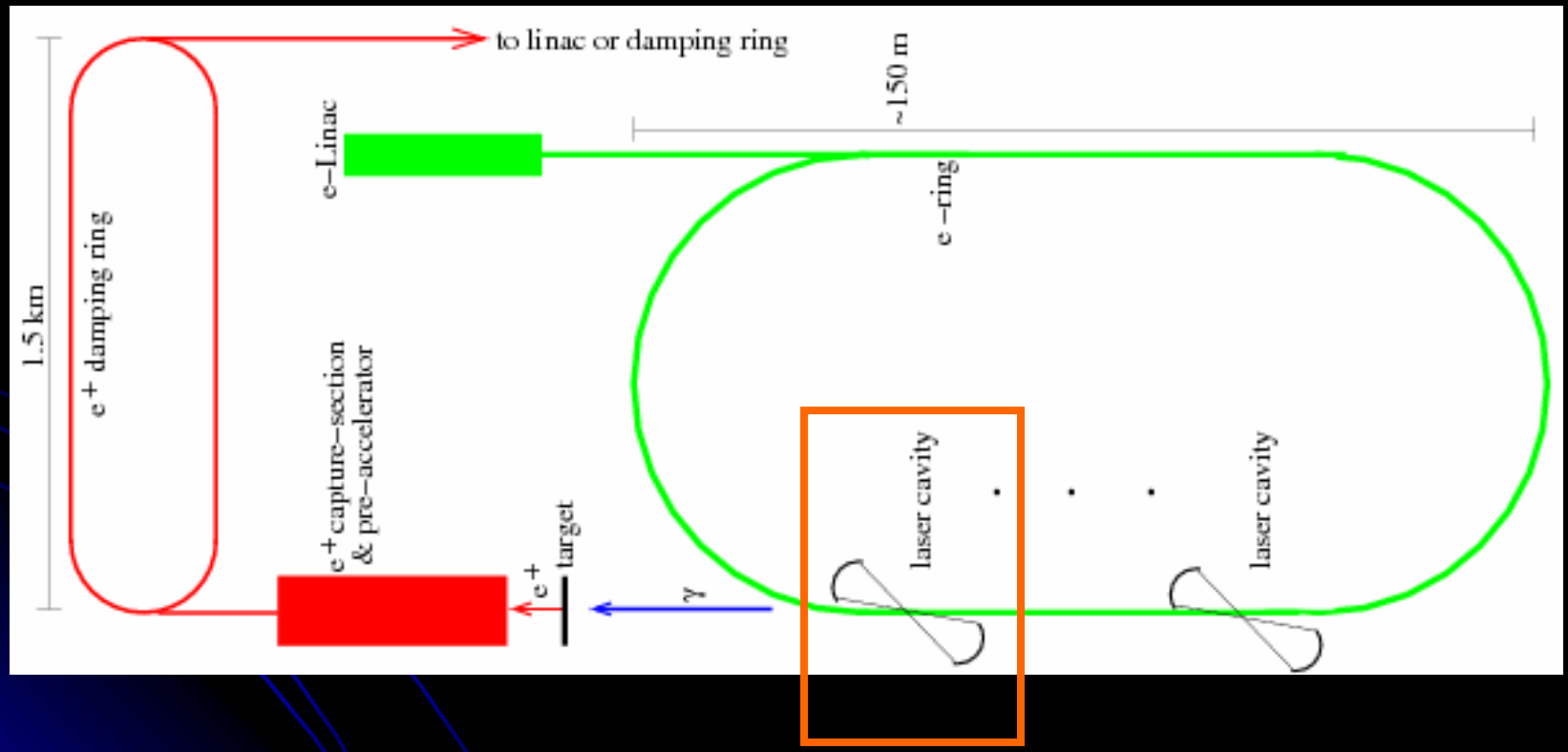
Polarized e+ generation in optical cavities

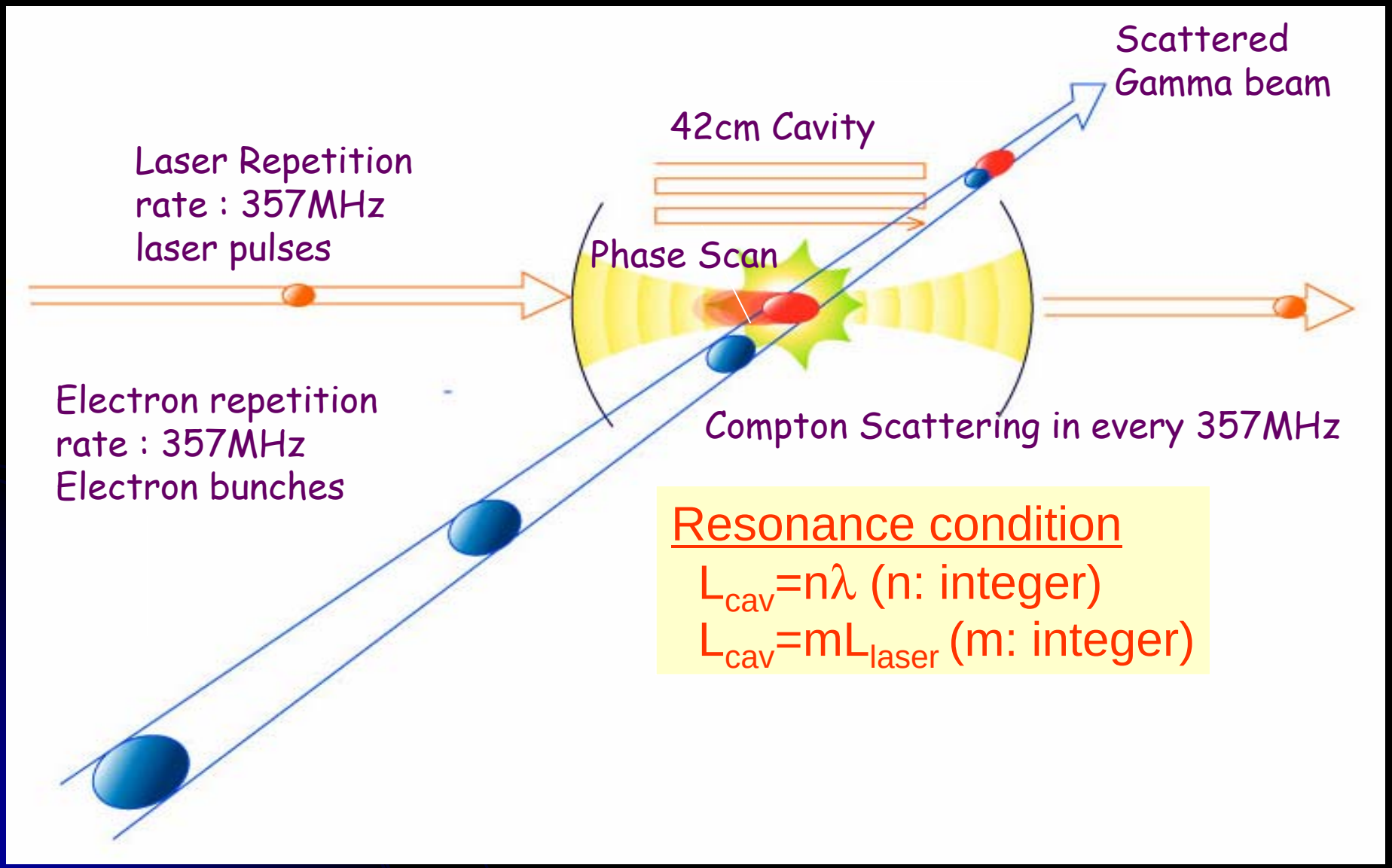
- Refer to Urakawa and Omori's talk



R & D Issues of optical cavities

- To achieve high γ yield
  - Use mode-locked (pulse) laser synchronized with electron repetition rate (bunch spacing)
  - High multiplication factor (power gain) <- high reflectivity mirrors and feedback system
  - Smaller waist size
  - Smaller crossing angle

Pulse stacking cavity



Resonance condition

$L_{cav}=n\lambda$ (n: integer)

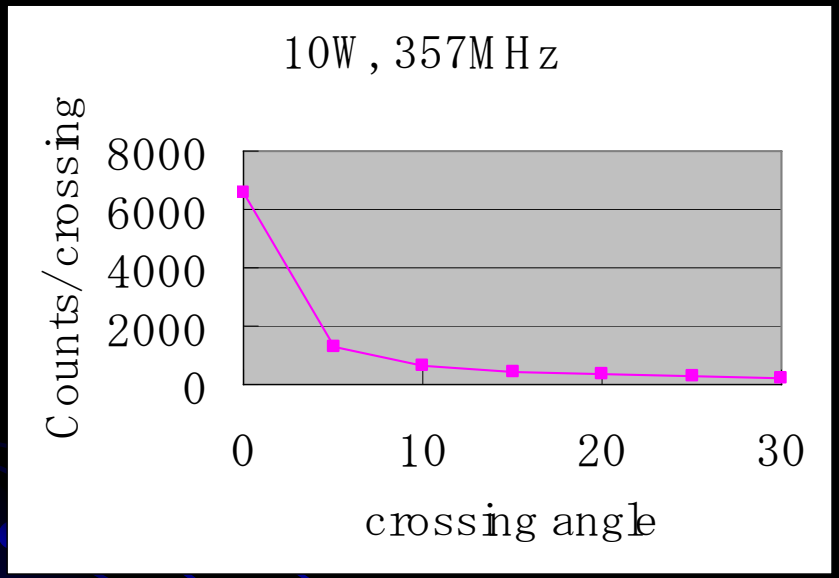
$L_{cav}=mL_{laser}$ (m: integer)

Basic parameters

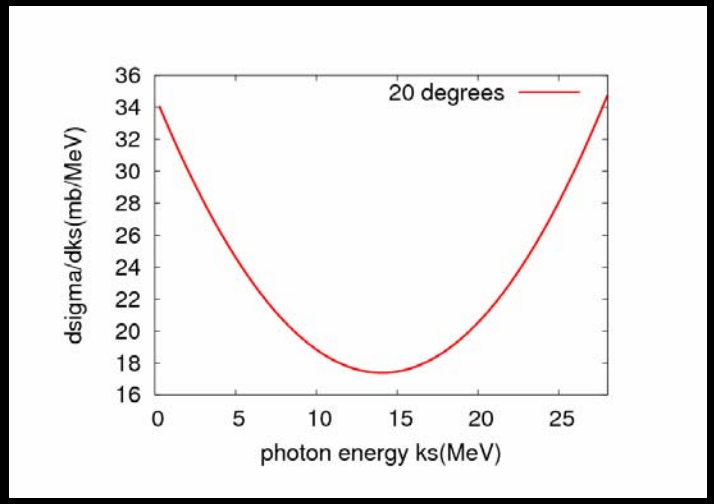
	ILC Proposal (Posipol2006) YAG case	Next experiment (October 2006~) at KEK-ATF	Past experiment (Takezawa et al., 2004) at KEK-ATF
Electron Energy (GeV)	1.3	1.3	1.3
Ne/bunch	6.2E10	2.0E10	1.0E10
Electron repetition rate (MHz)	325	357	357
Hor. Beam size (rms,us)	25	79	79
Ver. Beam size (rms,us)	5	6	6
Bunch length (rms,mm)	5	9	9
Laser type (wavelength)	YAG(1064nm)	YAG(1064nm)	YAG(1064nm)
Laser frequency (MHz)	325	357	357
Laser radius (rms, um)	5	29	125
Laser pulse width (rms,mm)	0.9	0.9	0.9
Laser pulse power /cavity	0.75mJ x 1000	28nJ(10W) x 1000	1nJ(0.3W) x 65
Number of laser cavities	30	1	1
Crossing angle (degree)	8	10	90

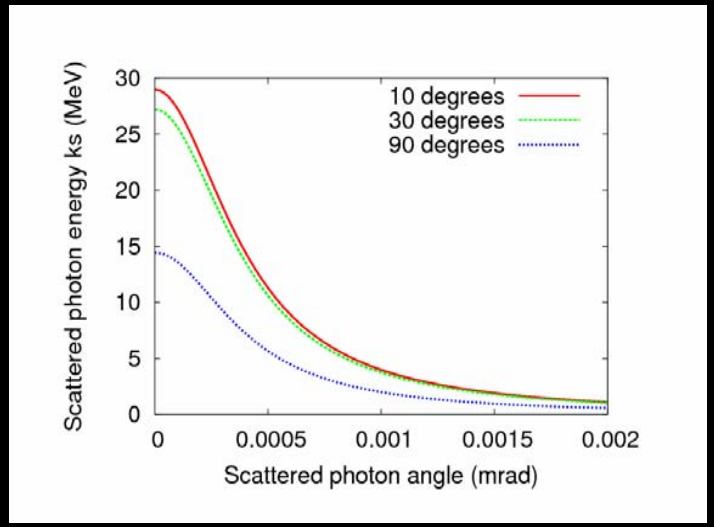
Expected number of events and energy spectrum

Bunch length ＝9mm (rms)

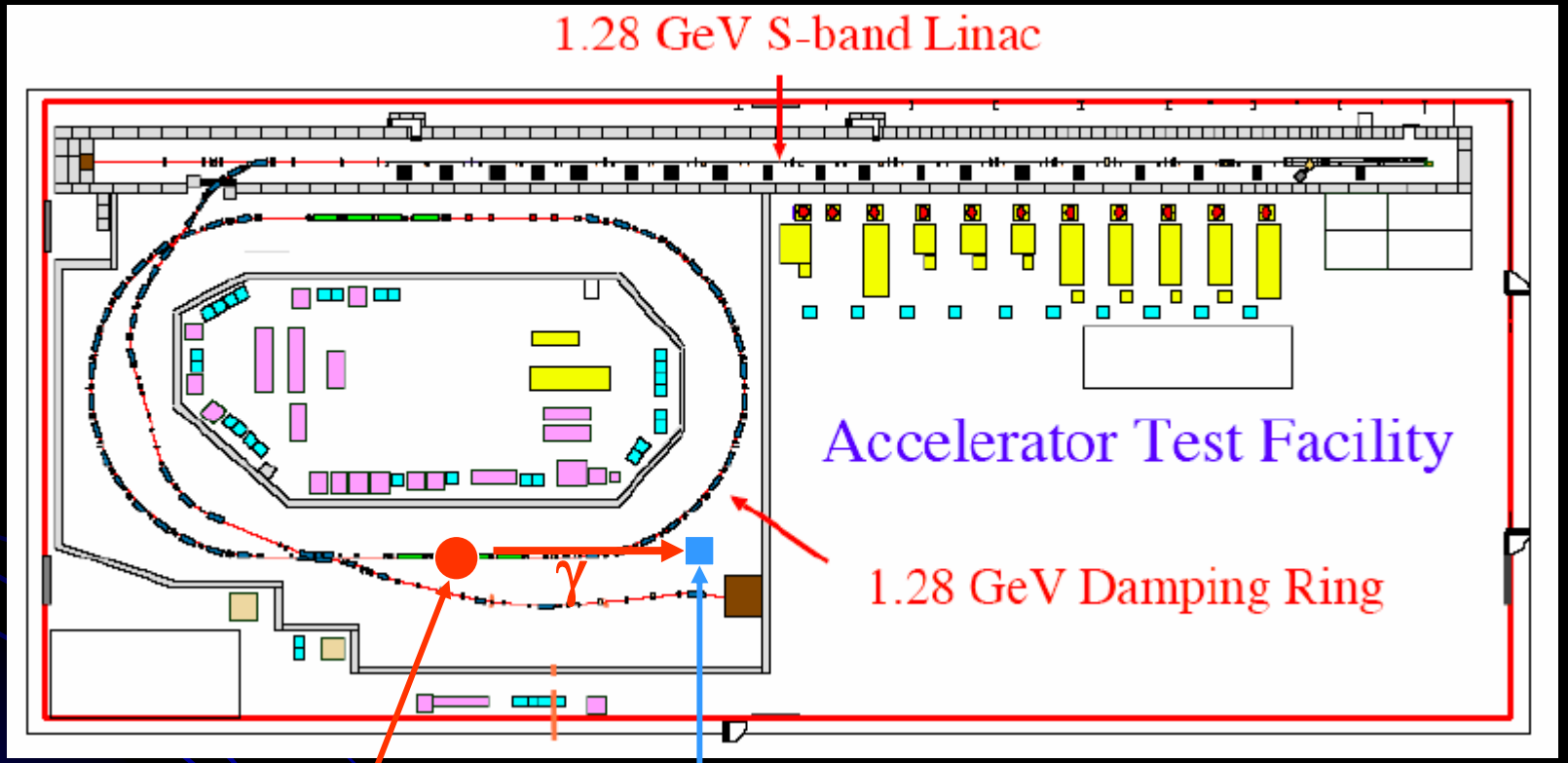


Calculated by T. Takahashi





KEK-ATF Damping Ring

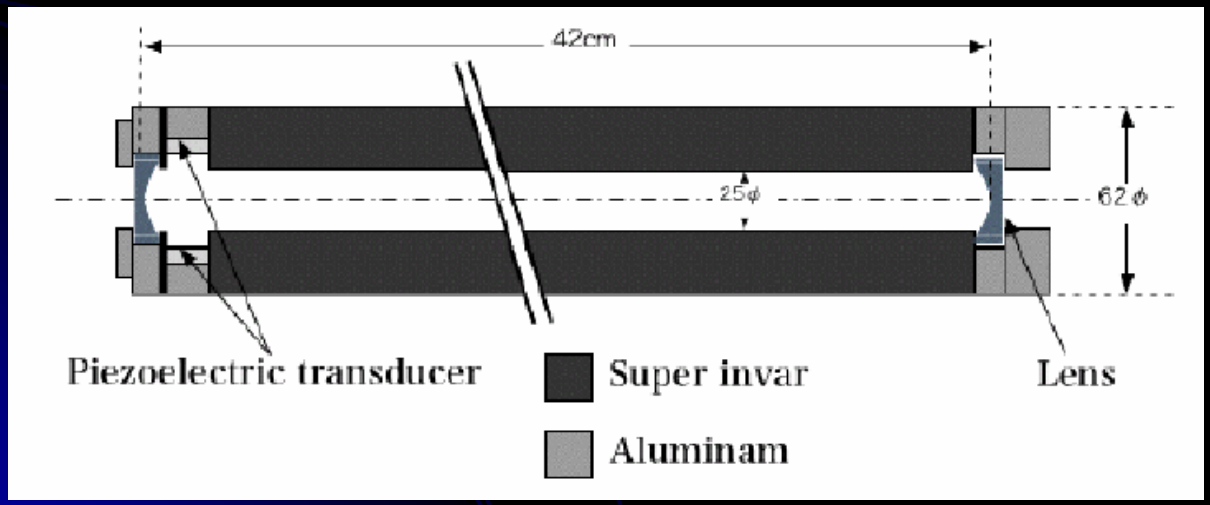


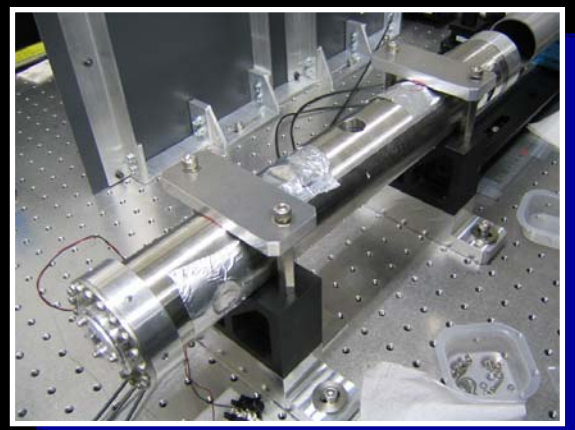
Start experiment in October 2006

Compton Cavity

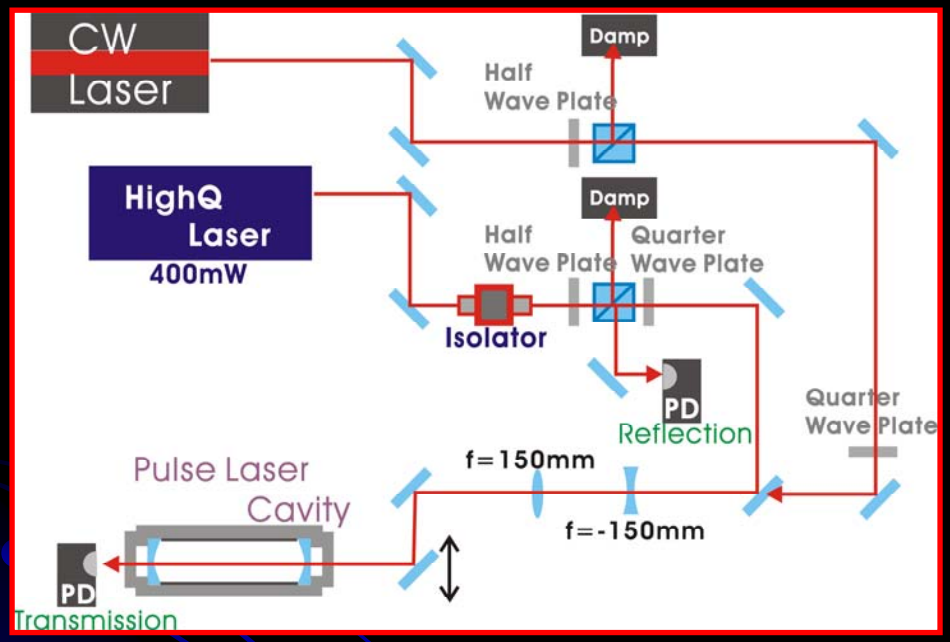
Cavity:	Super Invar
Cavity length:	420 mm
Mirrors:	
Reflectivity:	99.9% (gain =1000)
Curvature:	210.5 mm (w_0 = 59 μ m)

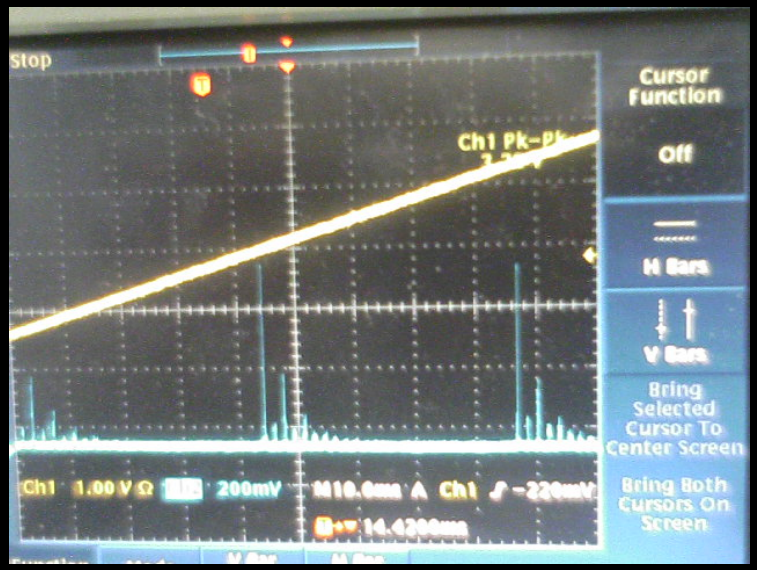
Curv.	w_0(μm)
250	176
210.5	**59**
210.1	39
210.01	22
210.001	12





Test bench status (small waist size)

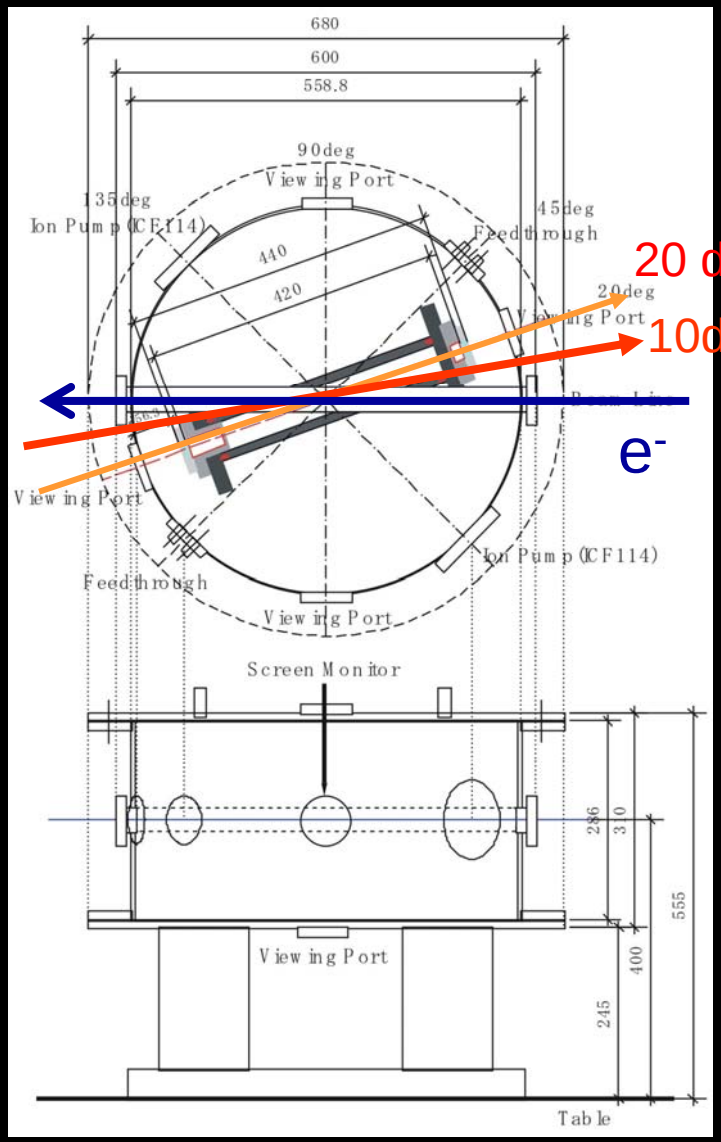




- Successfully accumulate CW laser in 420mm cavity with mirror curvature of 210.5mm and 99.7% reflectivity.

Chamber design

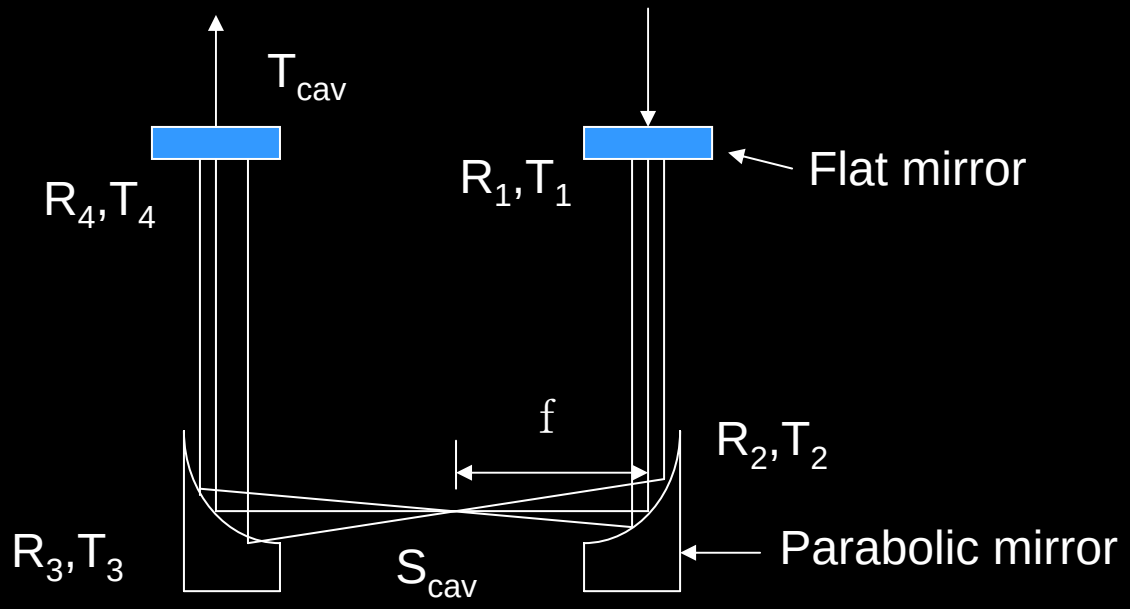
- Sakaue's design for the LUCX experiment (next talk) will be our baseline.
- We aim to achieve crossing angle of 10 degrees.



Milestones

- May 2006~
  - Make a moving table for the Compton cavity and optical setup -> control the collision point within 1μm accuracy
  - Design and build a vacuum chamber and Compton cavity
  - Achieve 59μm waist size (29μm in rms) with 99.9% reflectivity mirrors and feedback system in the test bench
- August 2006~
  - Install the chamber
- October 2006~
  - Install 10W laser
  - Start experiment

Optical cavity using parabolic mirrors



- Can independently adjust waist size and cavity length
- Matching is relatively easier
- $S_{cav} \sim R_2(1+R_3^2R_4)/(1-R_2^2R_3^2R_4)$ -> Reflectivity of parabolic mirrors should be large (close to 1)
- High-reflectivity (~99.5%) parabolic mirrors are expensive (~$30k/mirror) and smaller off-axis angle (<=20 degrees)