Update of R&D Optical Cvities at KEK-ATF

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for

KEK, Hiroshima University
LAL (Orsay) in Collaboration withCELIA (Laser lab., Bordeaux) and LMA (coatings Lab., Lyon)

- ►Introduction
- ►Status of the cavity R&D
- ►Recent activities
- ►Out Look

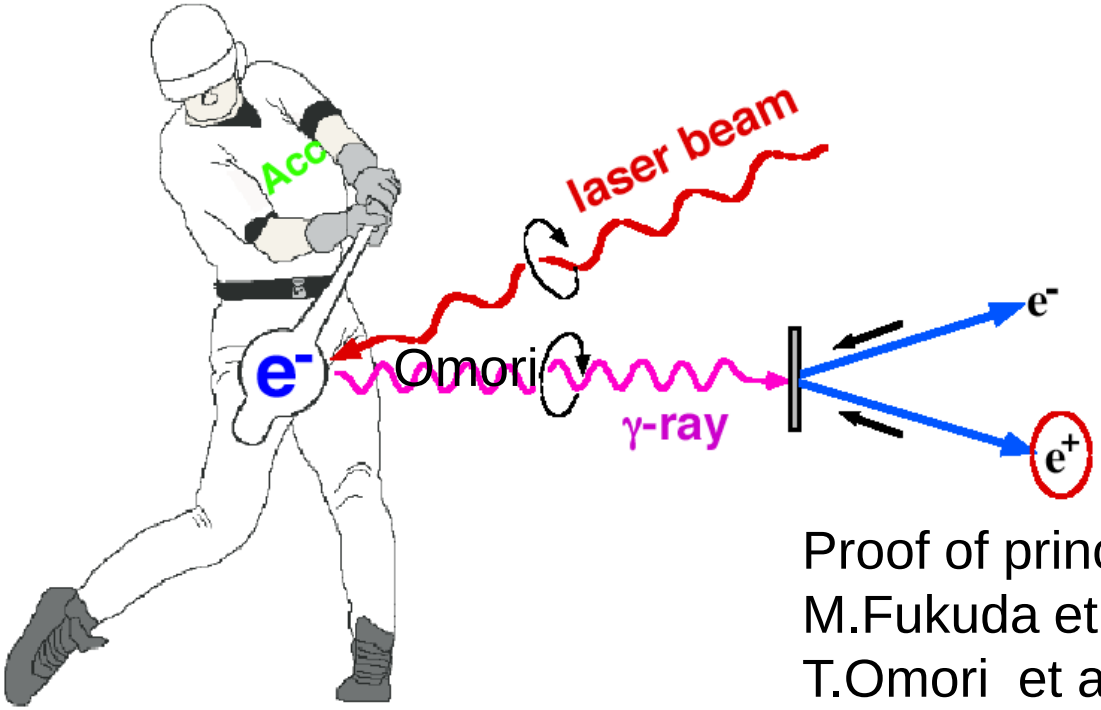
November 13 2013
LCWS2013

Compton at KEK ATF

- Polarized e+ by laser Compton Scheme

  Ee~1GeV for 10MeV gammas

  controllability of polarization

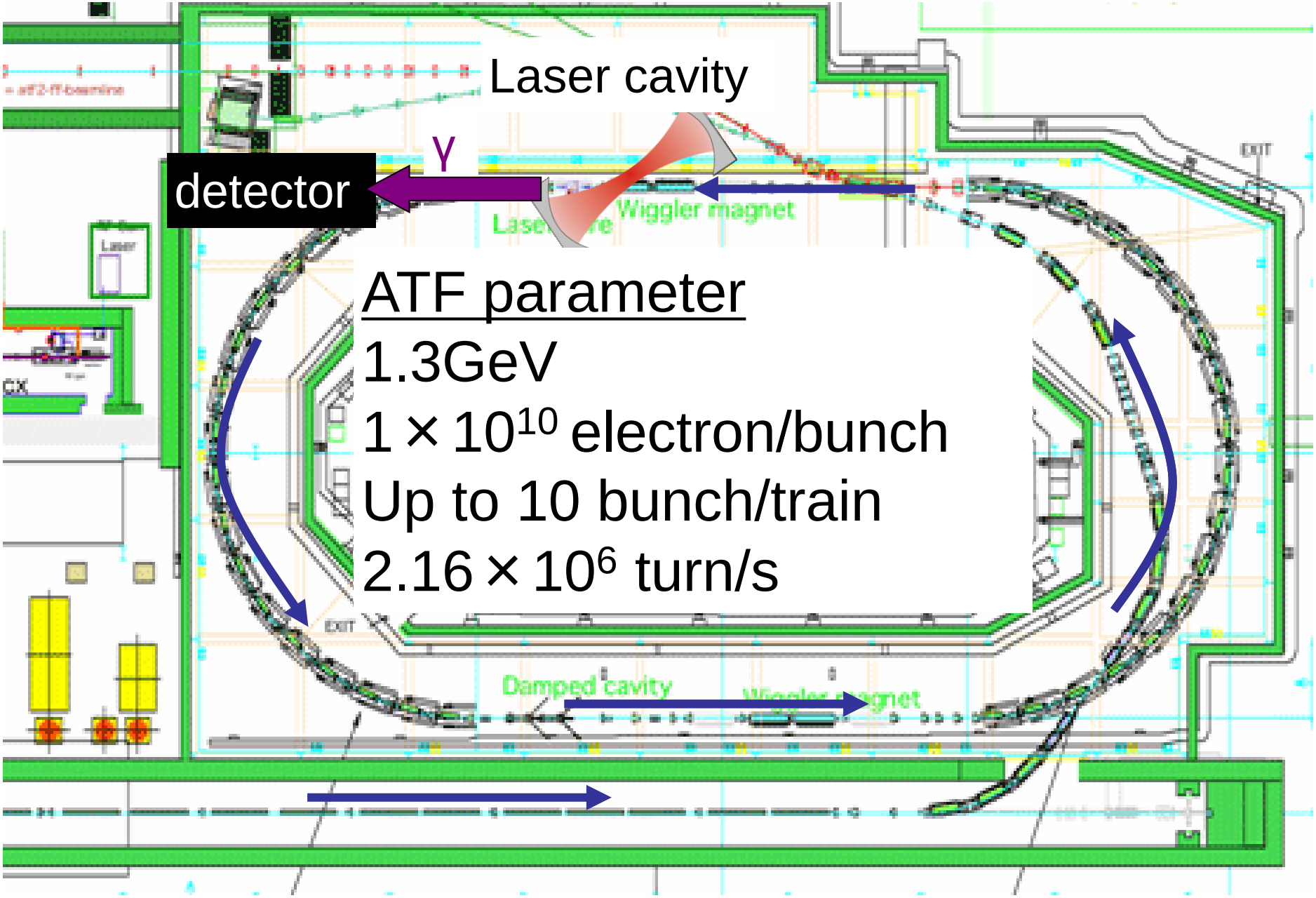


Proof of principle
M.Fukuda et al., Phys. Rev. Letts. 91, 16480(2003)
T.Omori et al., Phys. Rev. Letts. 96, 114801(2006)

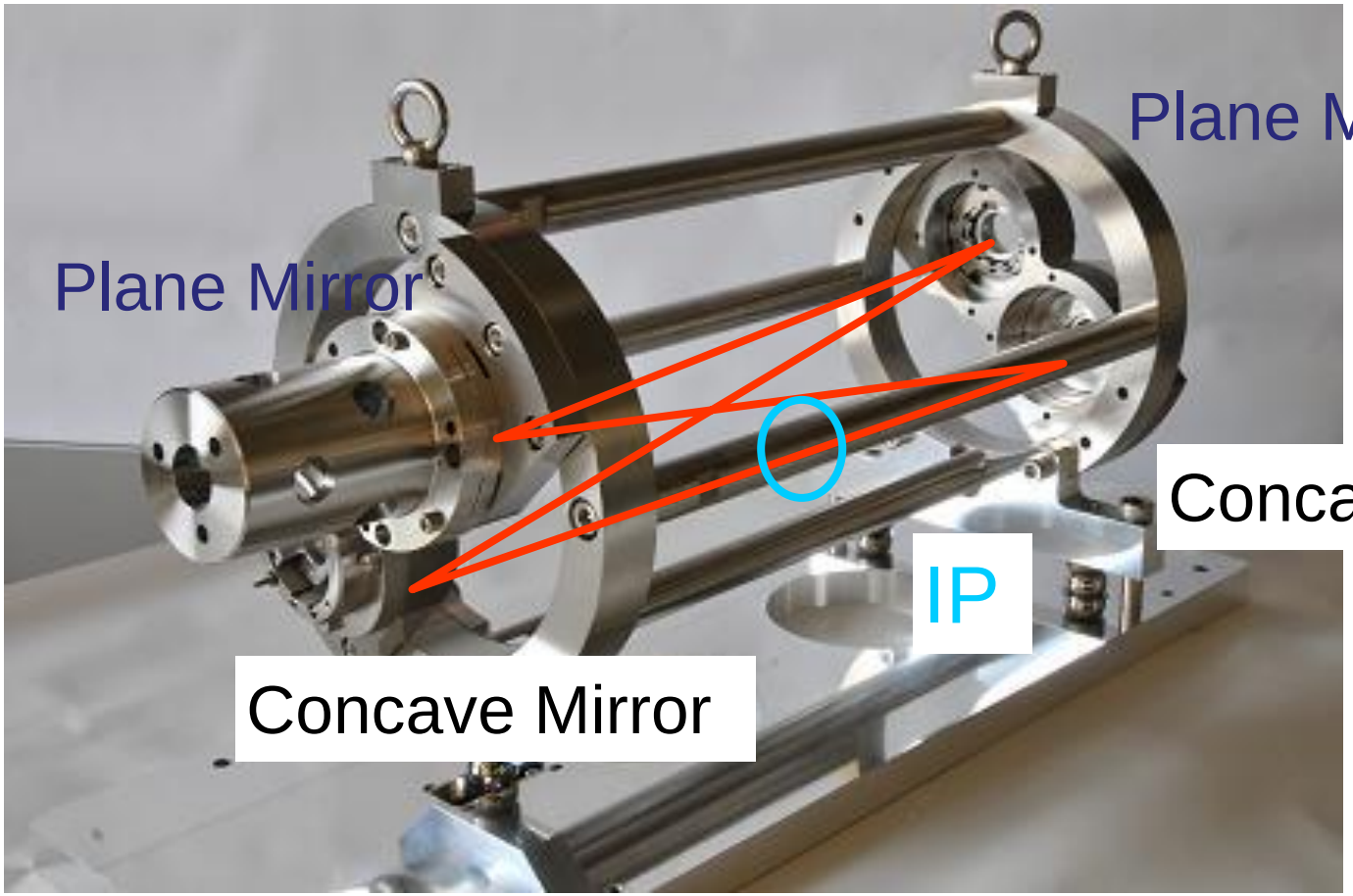
Toward the positron sources

—> increase intensity of γ rays

Setup at the KEK-ATF



The Optical Cavity



Main Parameters
Circumference:1.68m
Finesse:4040(Measured)
Power Enhansement:1230

4 mirror cavities are at the ATF

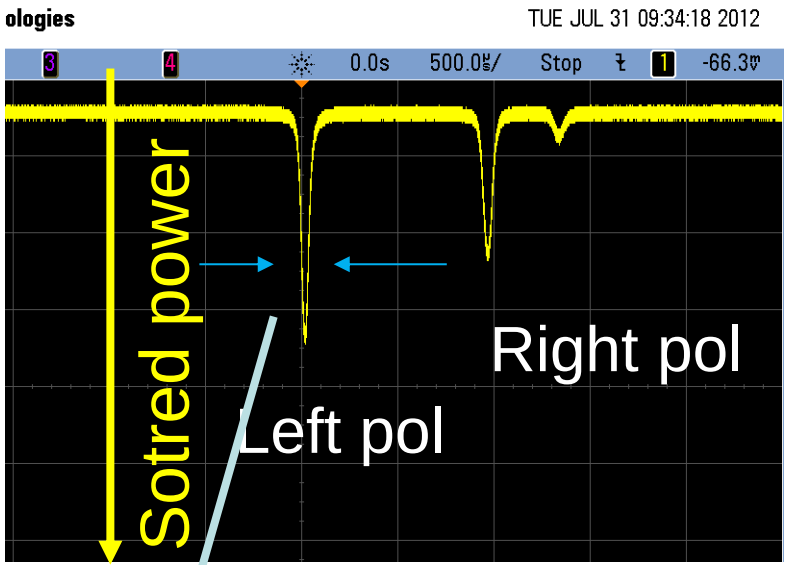
KEK-Hiroshima
installed 2011

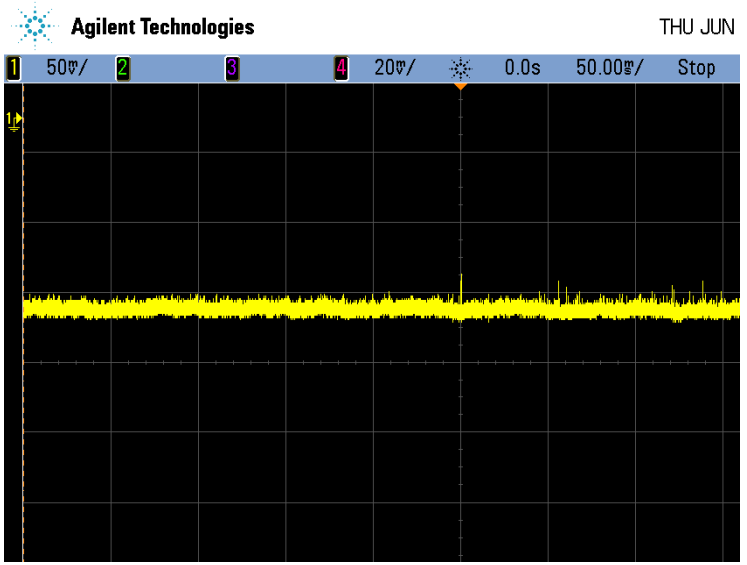
relatively simple control system
employs new feed back scheme

LAL-Orsay
installed summer 2010

sophisticated control
digital PDH feedback

Stored Laser Power in the cavity

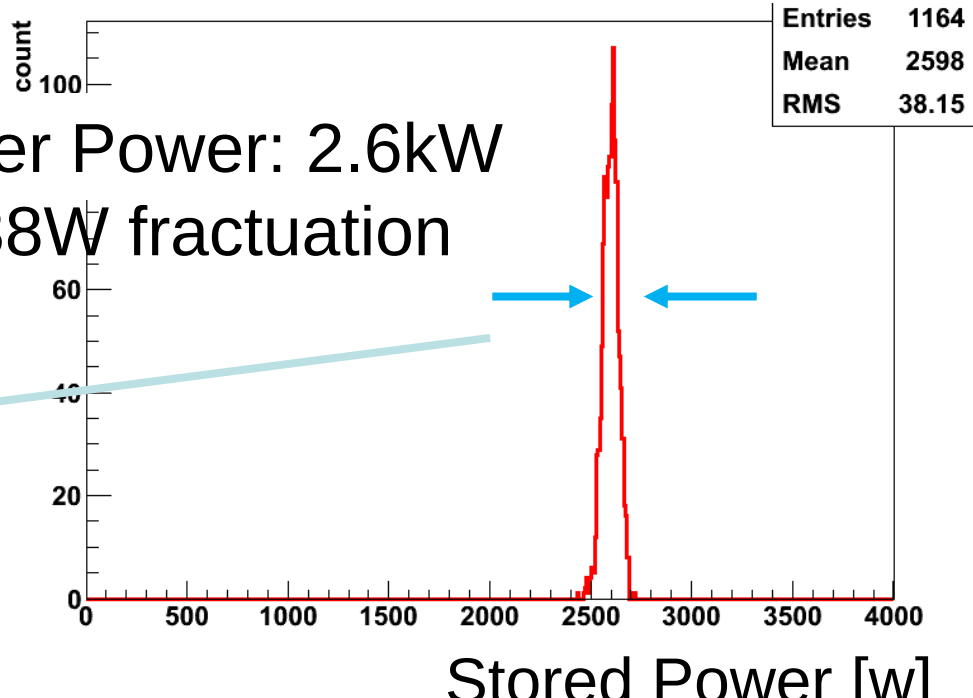




must control
ΔL<<110pm

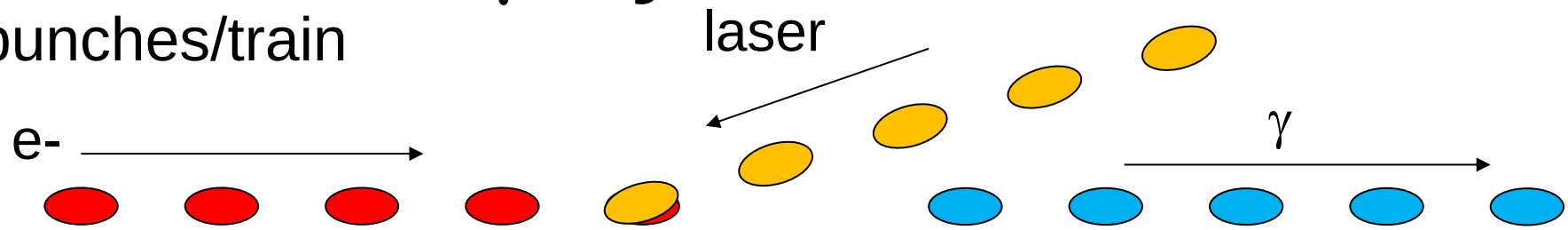
achieved
ΔL<<8pm

Laser Power: 2.6kW
w/ 38W fractuation



γray Generation

5bunches/train



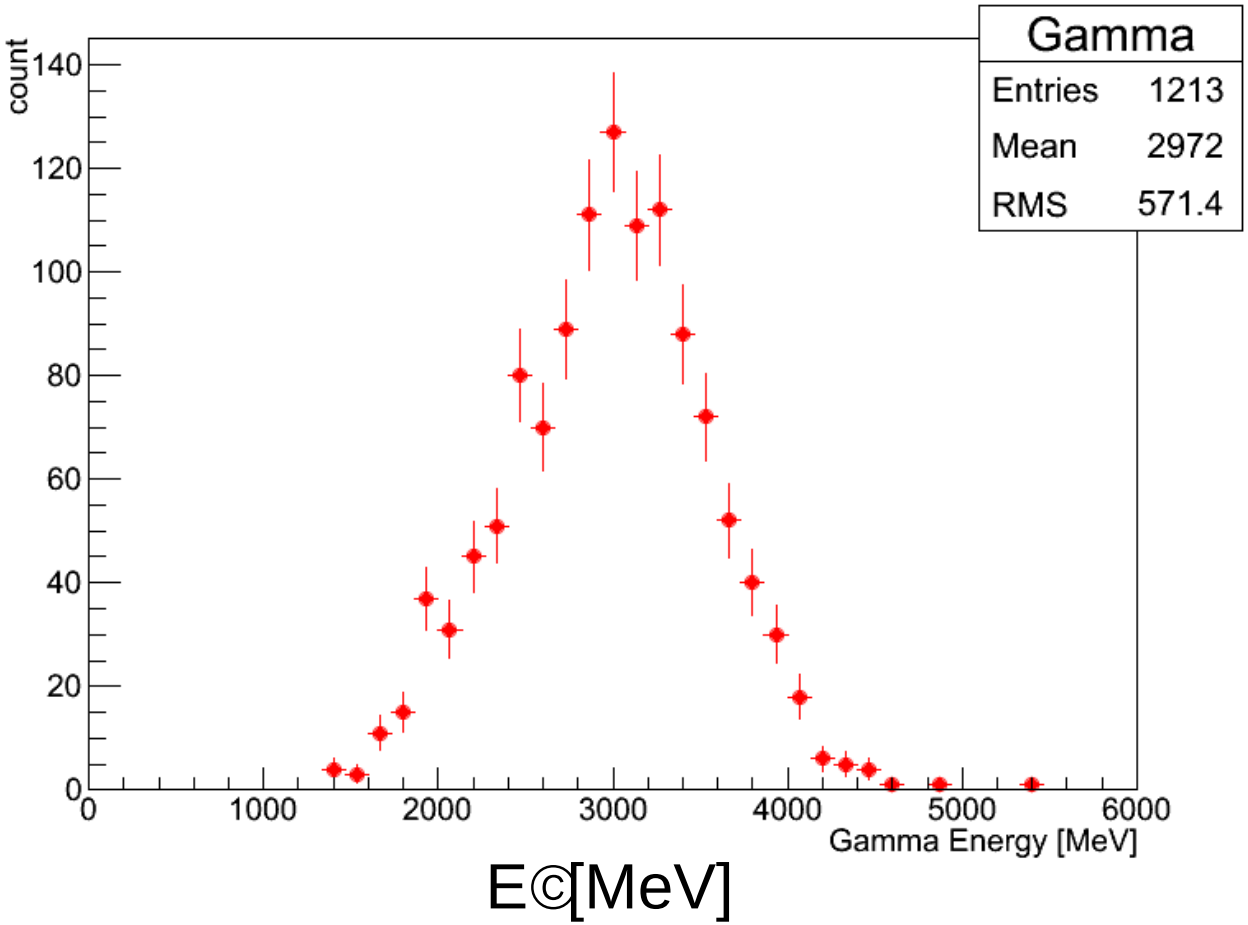
5.6ns

2970±20 MeV

⇒ ~120γs / train

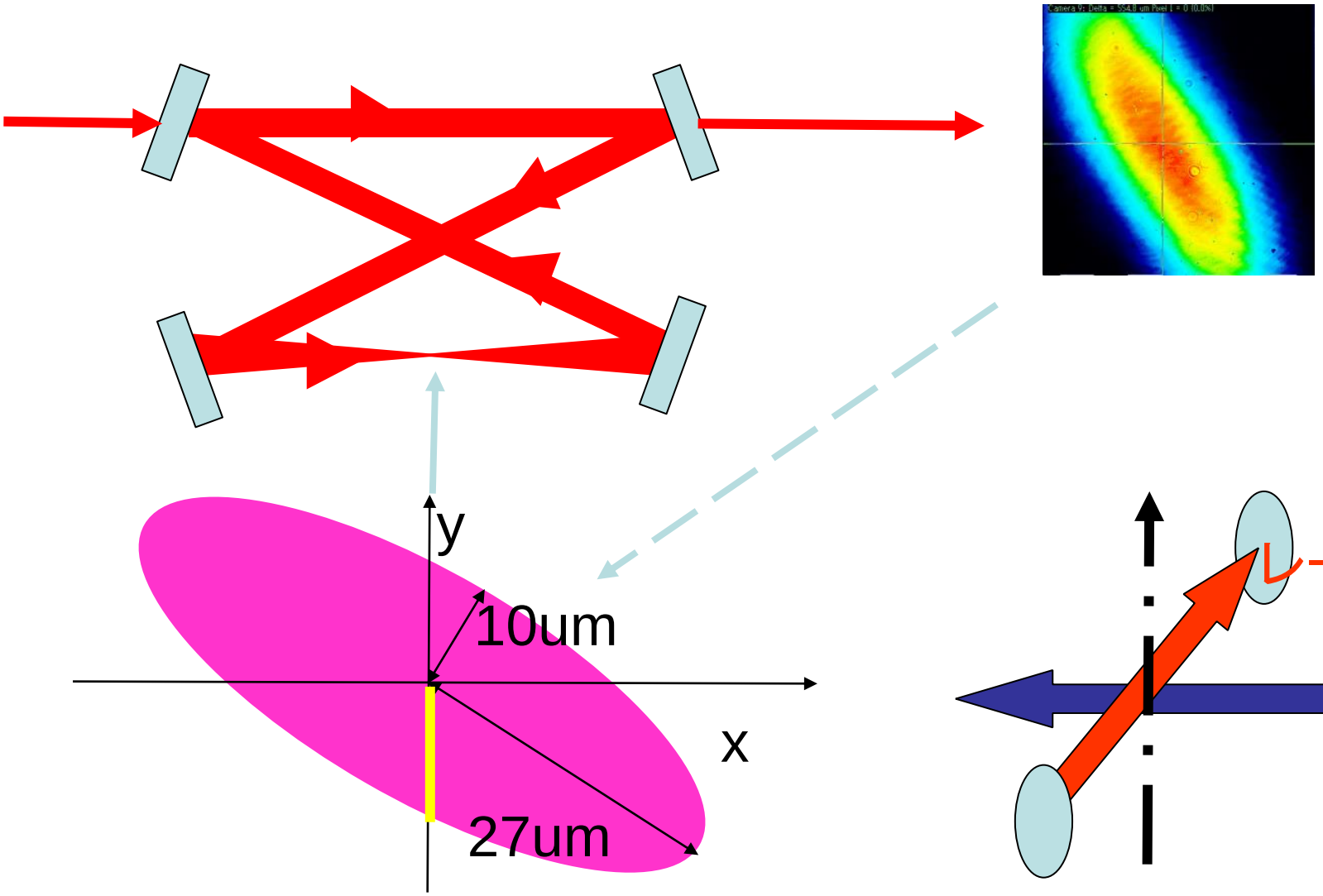
ATF 2.16MHz

~2.6×10⁸/sec



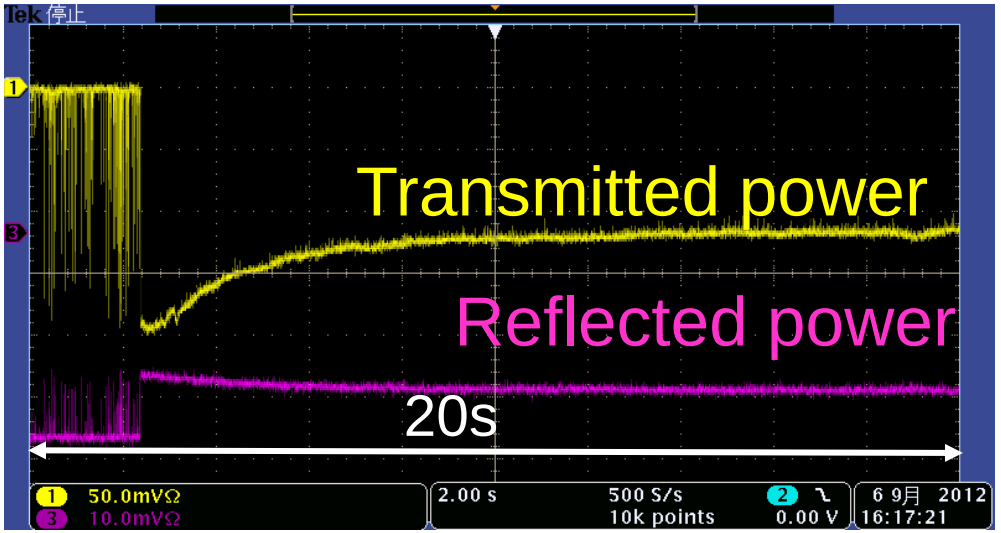
E©[MeV]

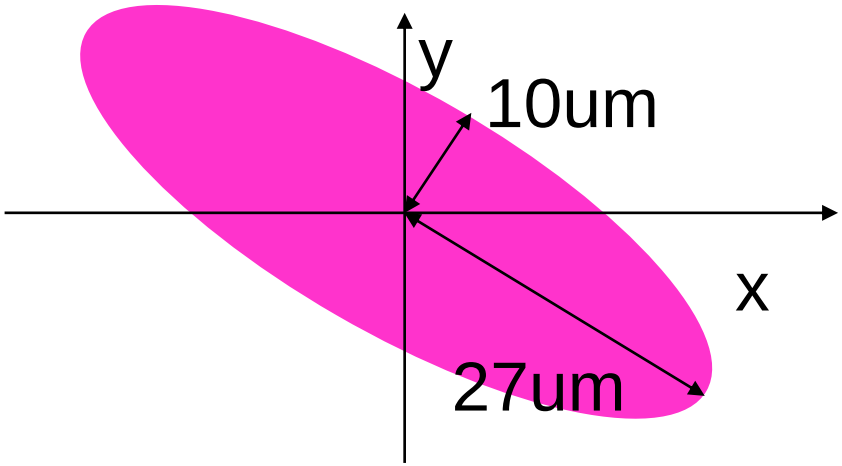
Profile of the laser light at the IP



Calculated 16um
Measured 13um

Issues





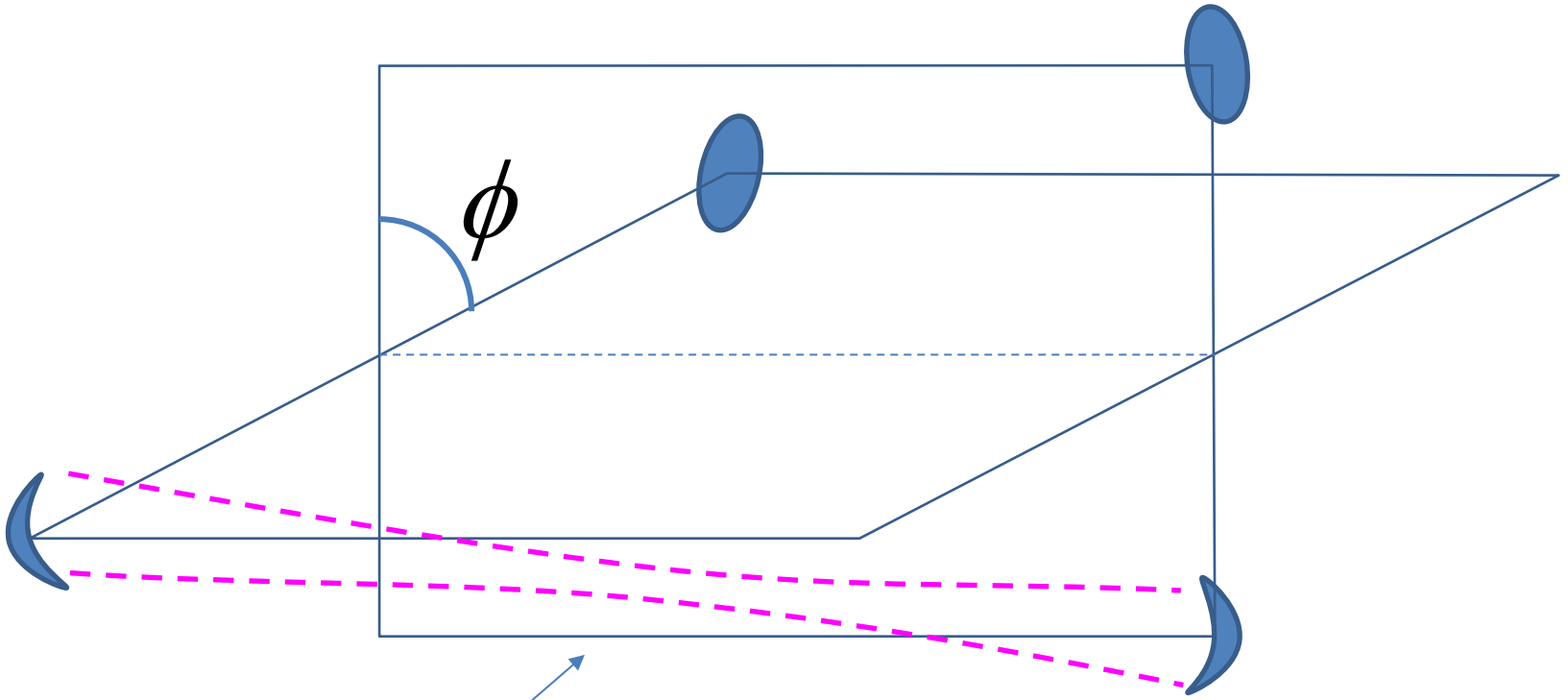
- Possibly a thermal effect

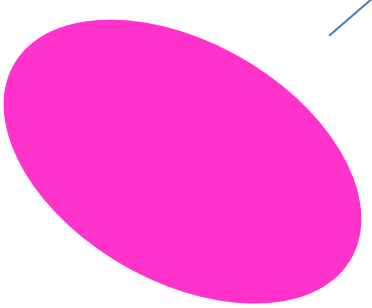
due to (unexpected) power loss on mirrors

- Profile at the IP

must revisit optical property in the cavity

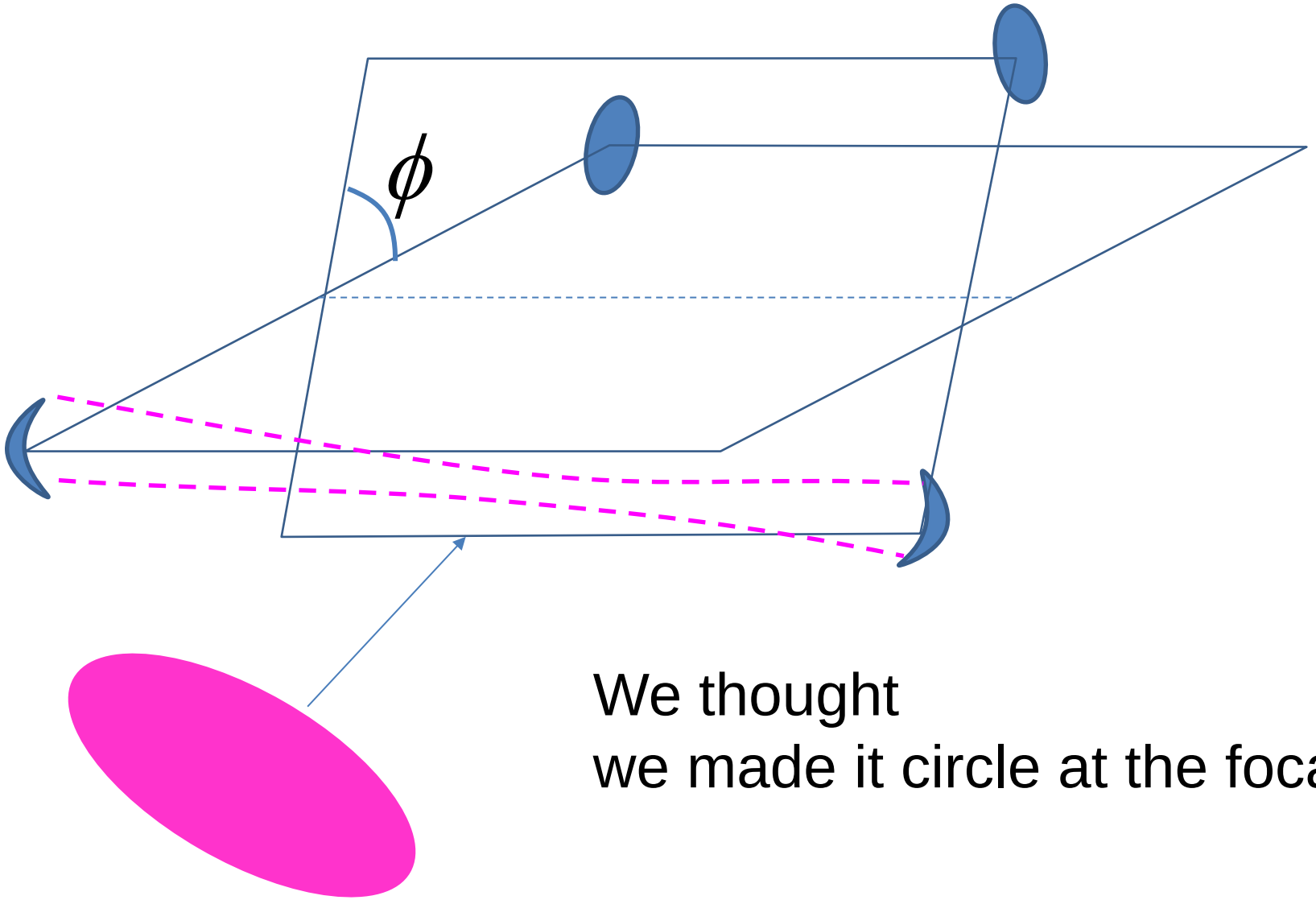
Beam Profile in the cavity





Profile at the focal point depends on ϕ

Beam Profile in the cavity

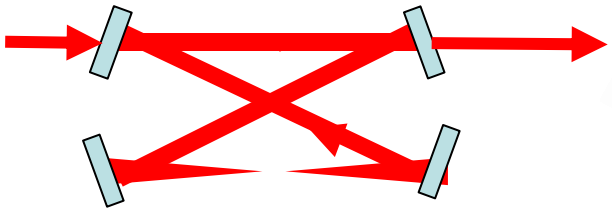


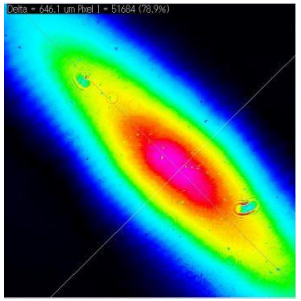
We thought
we made it circle at the focal point,,,,,

Propagation of the laser light

- Calculation
  - transfer matrix
  - Propagation of EM waves in the cavity
  - Systematic measurements
    - $\phi = 87.5^\circ, 90^\circ, 92.5$

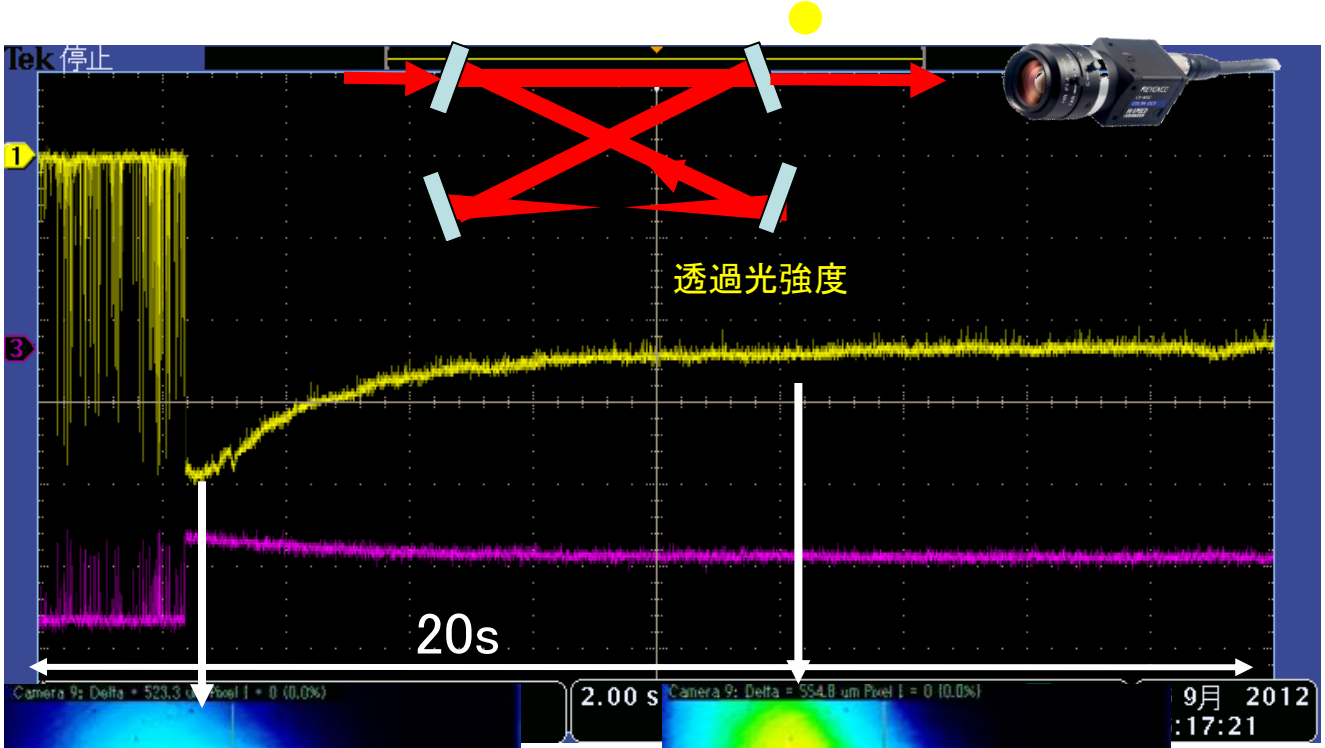
Measuremennsof the profiles

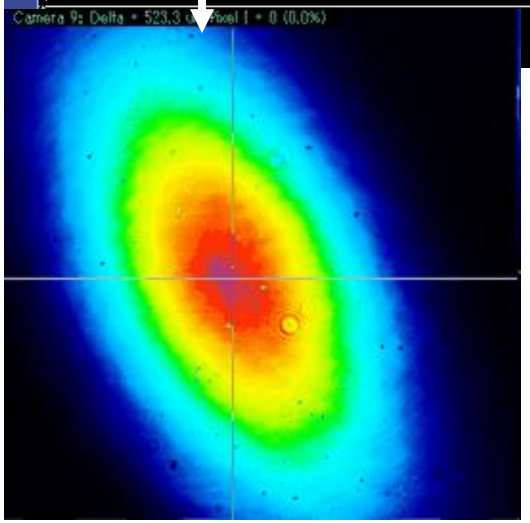




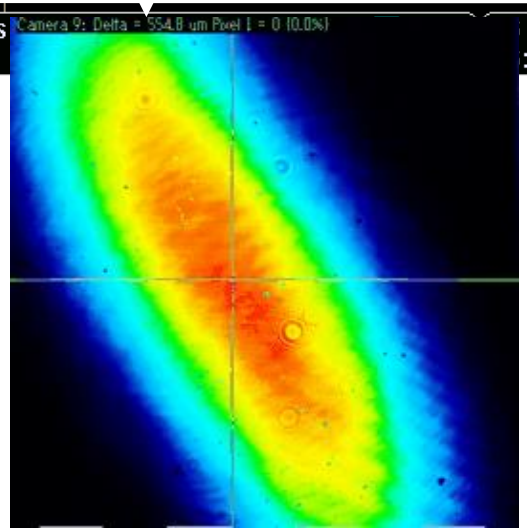
		$\phi = 87.5°$	$\phi = 90°$	$\phi = 92.5°$
Calculation Major axis（μm）	1	941.4	939.6	937.5
	2	938.7	941.6	939.5
Minor aixs（μm）	1	775.5	775.5	775.7
	2	708.3	774.6	919.9
Angle Relative to 90	1	+1.17°		-1.16°
	2	+0.28°		+35.13°
Measured Major axis		944	937	939
Minor aixs		532	546	507
Angle Relative to 90		-0.9°		-9.1°

Deforemation of Mirrors





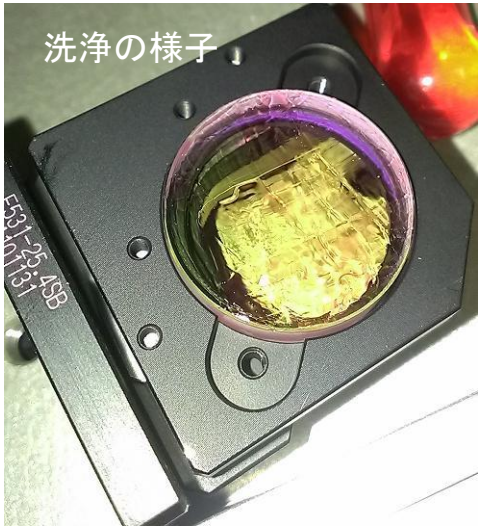
蓄積開始直後

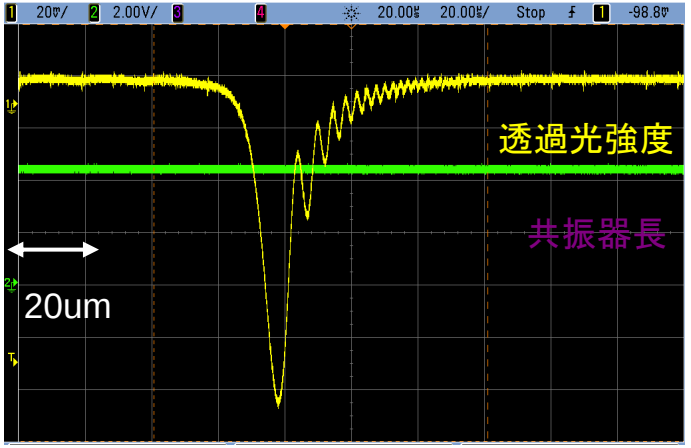


強度安定後

Low loss mirrors are essential to increase power

Cleaning the mirrors





Before

$$R = 0.999846 \pm 0.000003 \quad \text{（損失：50ppm）}$$

After

$$R = 0.999864 \pm 0.000003 \quad \text{（損失：30ppm）}$$

What next ?

- For positron sources, we need;
  - more than 100 times more power in the cavity
  - a few tens of more
    - power enhancement
    - injection laser power

- Mirrors with
  - higher reflectivity
  - low loss

Future prospect

- Try high reflectivity mirror
  - w/ careful handling
  - Trying 3000~5000 power enhancement this year
    -> more than 10,000 in next a few years

- Low loss mirrors
  - collaboration with NAO (gravitational wave guys)
  - careful investigation of commercial mirrors
  - develop mirrors (substrates) by ourselves?

Summary

- Current 3D4M cavity works well
  - we have basic technologies in our hand
- but
  - optical properties yet to be understood
  - mirrors should be studied for high power storage

- Issues are clear
  - step back once to basic study(PHYSICS) to go forward