Status of R&D of Optical Cvities at KEK-ATF

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for

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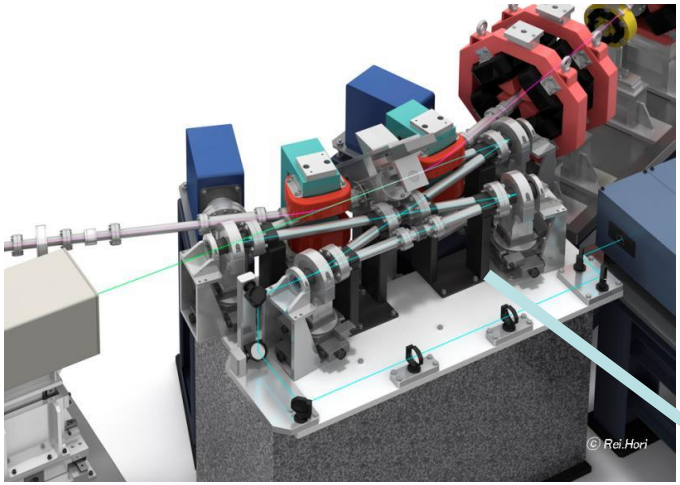
- ►Introduction
- ►Status of the cavity R&D
- ►Out Look

28 May 2013
ECFA2013 DESY

Optical cavity projects at KEK

- 3D4M cavity for gamma ray at ATF
- 2D2M cavity X-ray. LUCX
- 2D4M cavity for X-ray with two cylindrical lenses
- Compact 2D4M cavity for fast laser wire scanner

Quantum Beam Technology Program (QBTP)



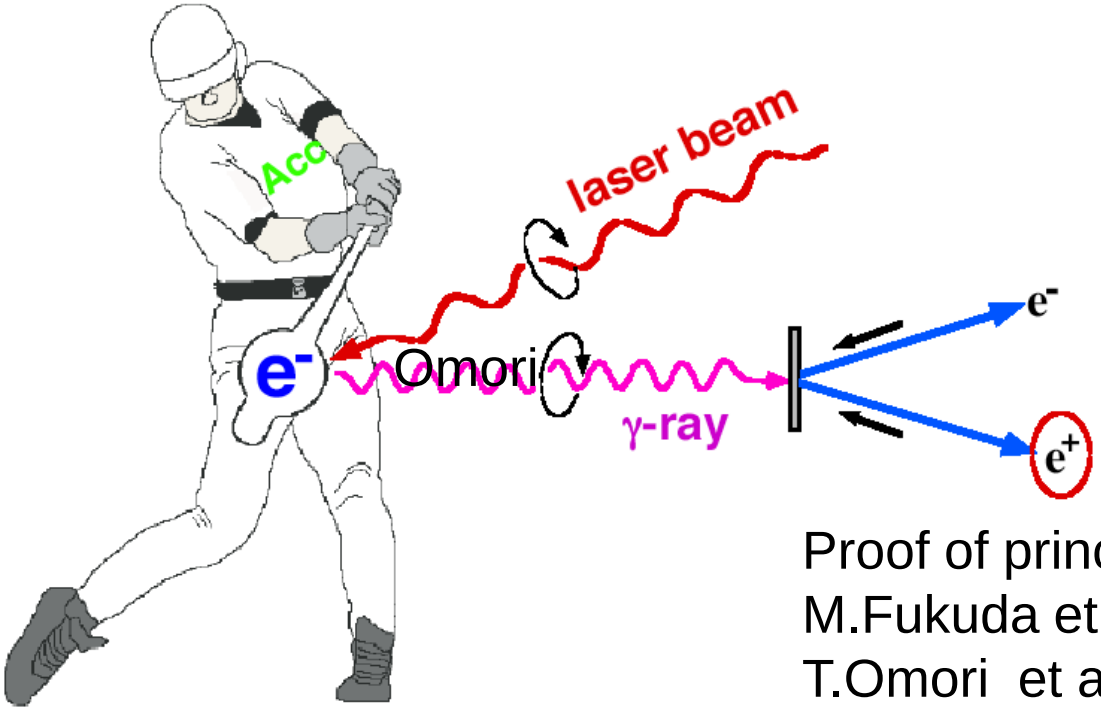
First Compton X ray in
March 2013

Compton at KEK ATF

- Polarized e+ by laser Compton Scheme

  Ee~1GeV for 10MeV gammas

  controllability of polarization

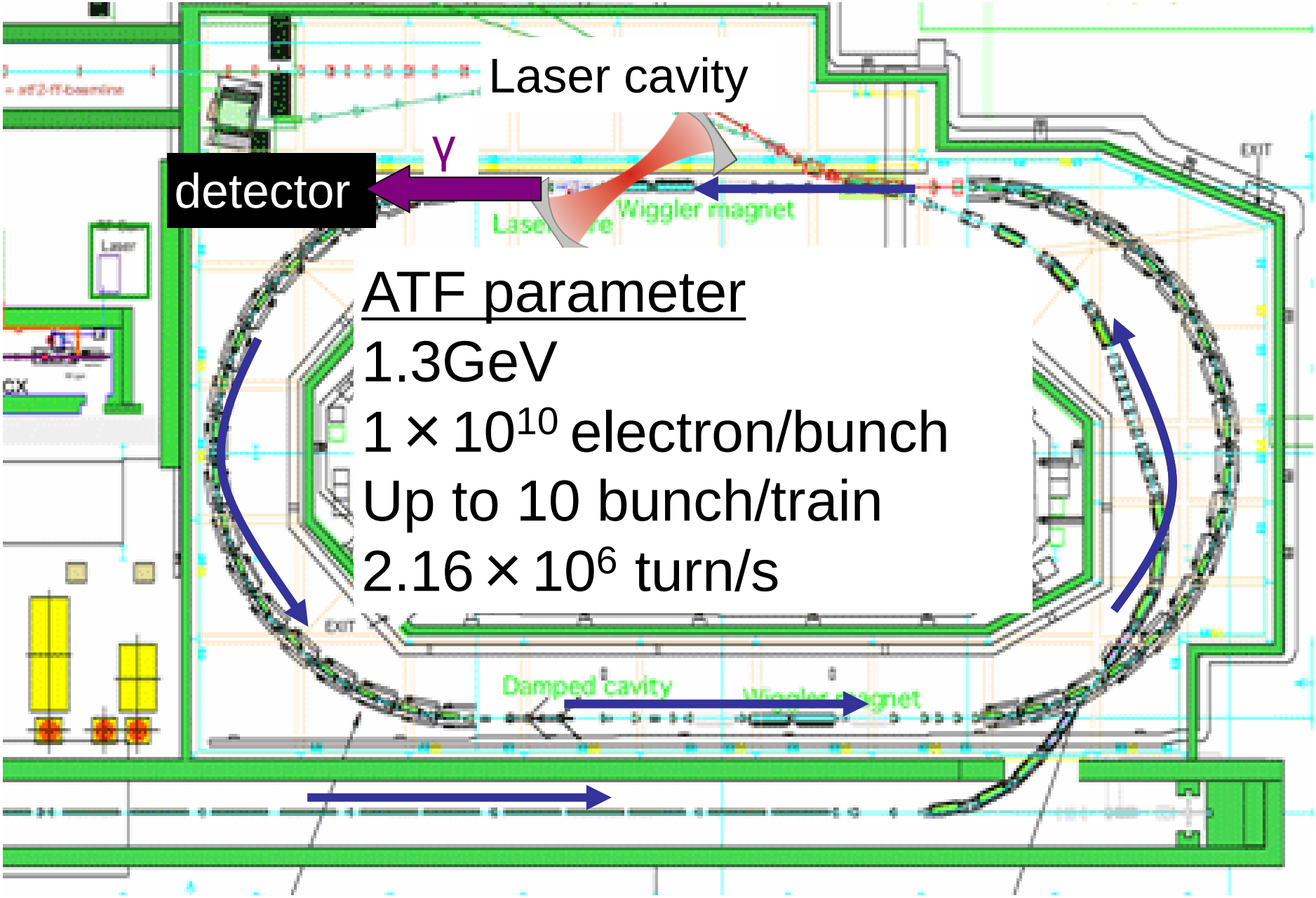


Proof of principle
M.Fukuda et al., Phys. Rev. Letts. 91, 16480(2003)
T.Omori et al., Phys. Rev. Letts. 96, 114801(2006)

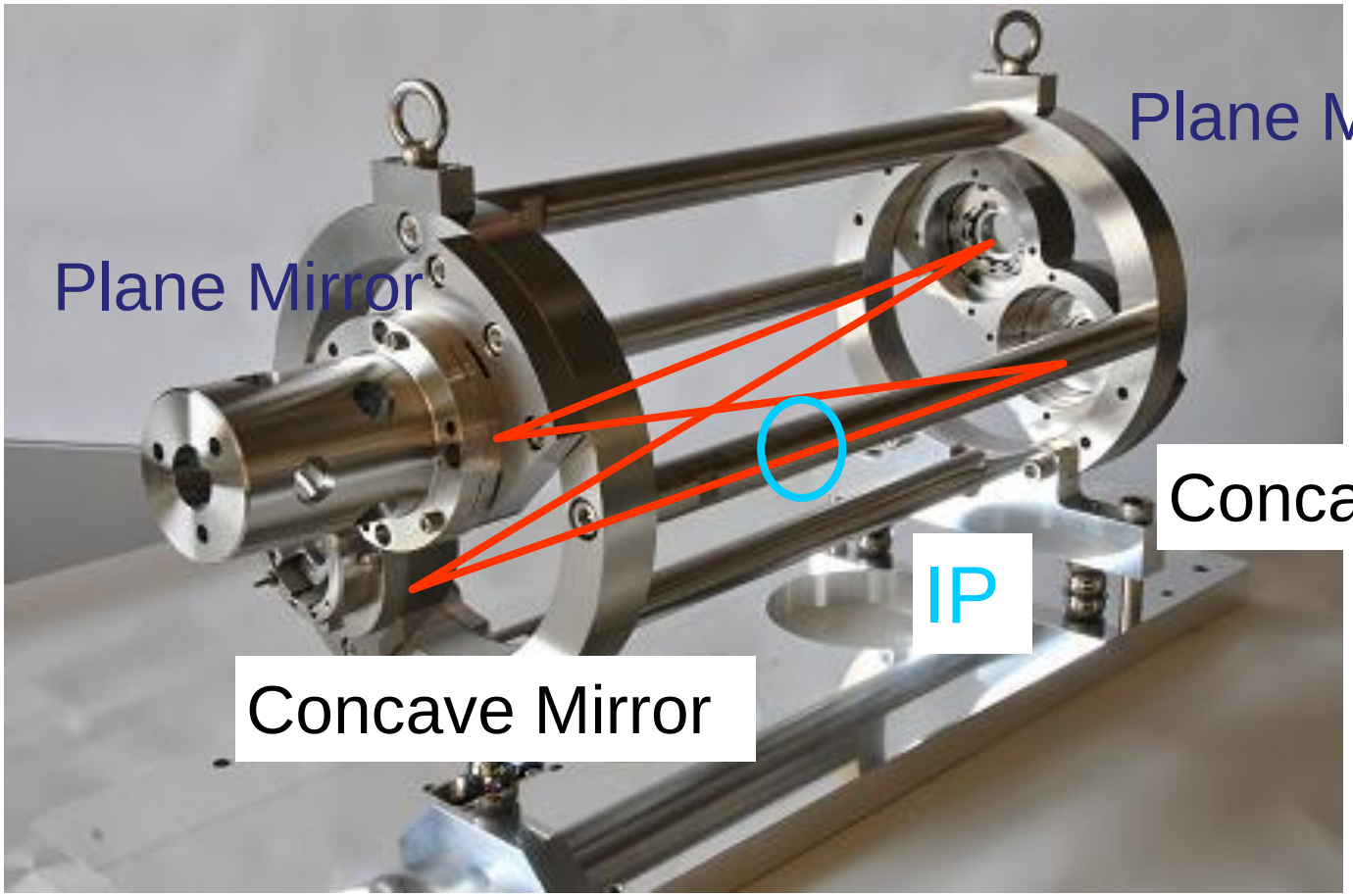
Toward the positron sources

—> increase intensity of ©rays

Setup at the KEK-ATF



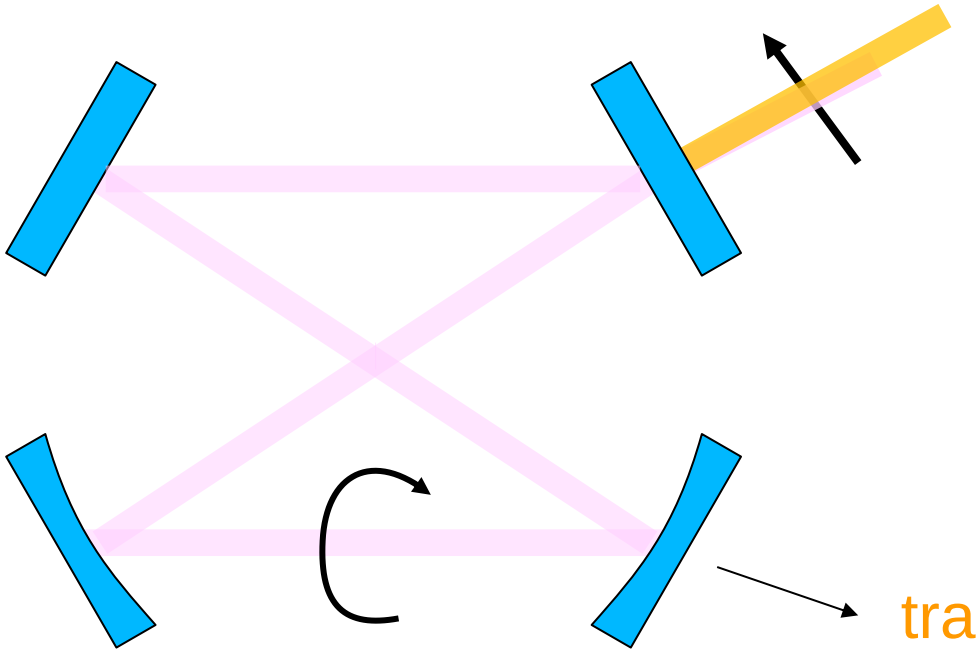
The Optical Cavity



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

3 Dimensional 4 Mirror Cavity

- Resonates only for circular polarization
  - geometric phase due to twisted pass
  - cavity only resonates with circular polarization
  - usable for pol. switching



transmitted light

circumference of the cavity

4 mirror cavities are at the ATF

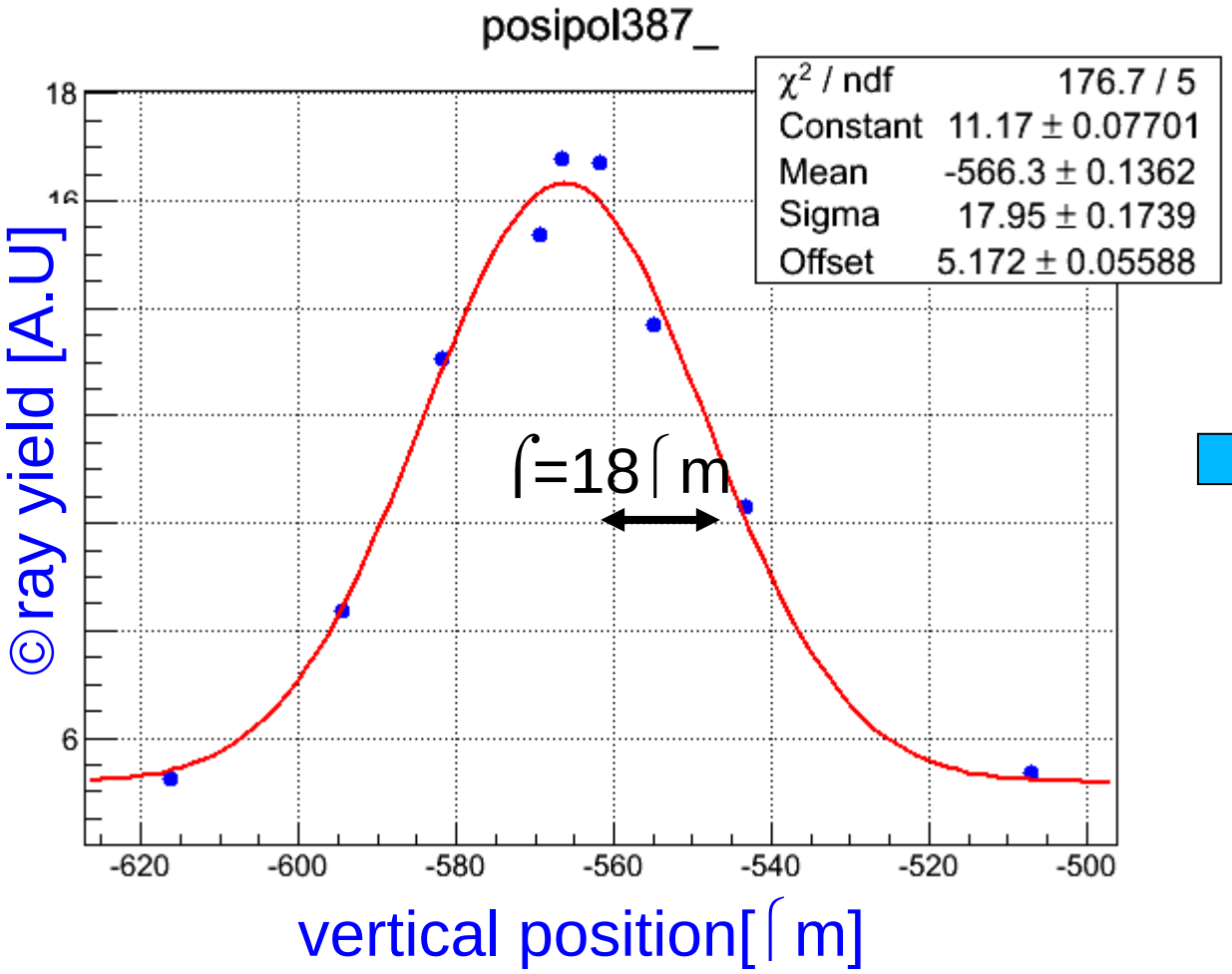
KEK-Hiroshima
installed 2011

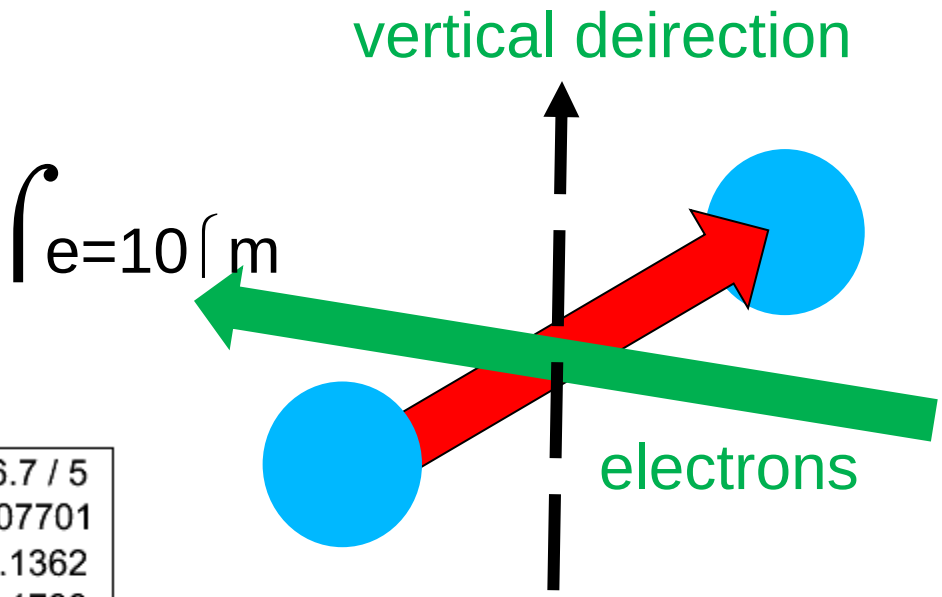
relatively simple control system
employs new feed back scheme

LAL-Orsay
installed summer 2010

sophisticated control
digital PDH feedback

Laser spot size
15⌠m achieved

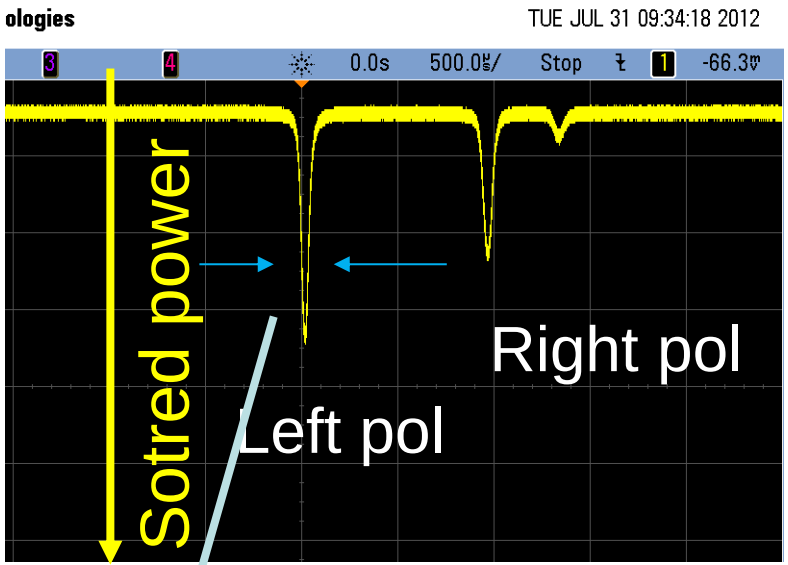


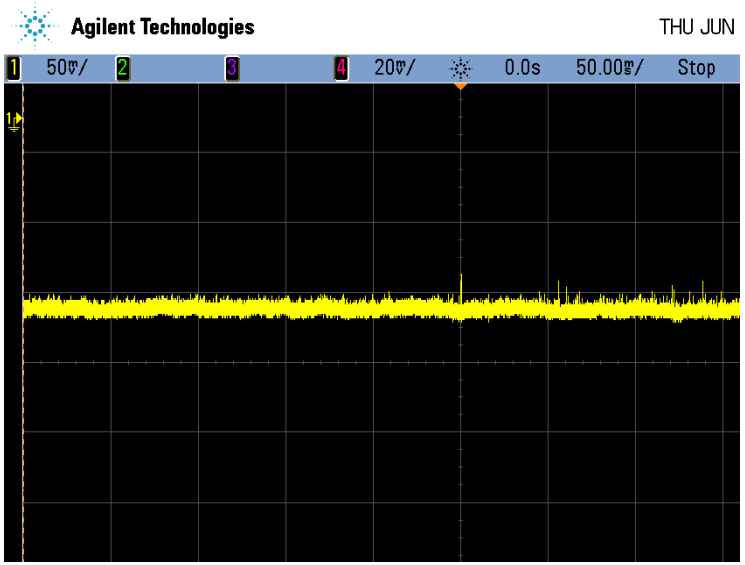


⌠L=13⌠m

it was 30⌠m w/ 2 M cavity

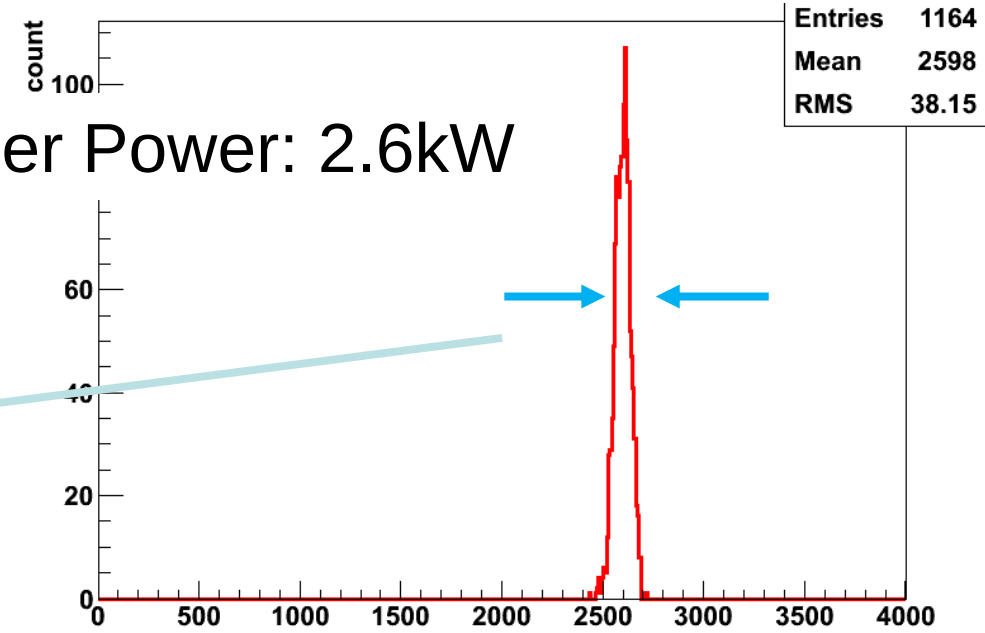
Stored Laser Power in the cavity





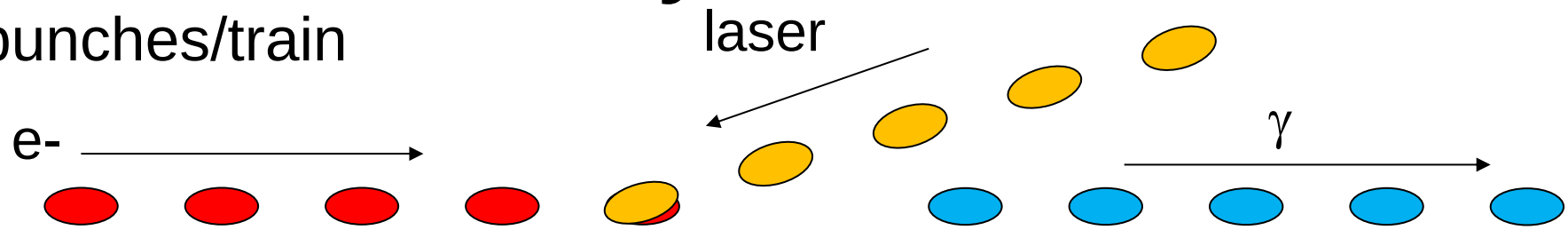
must control
ΔL<<110pm

achieved
ΔL<<8pm

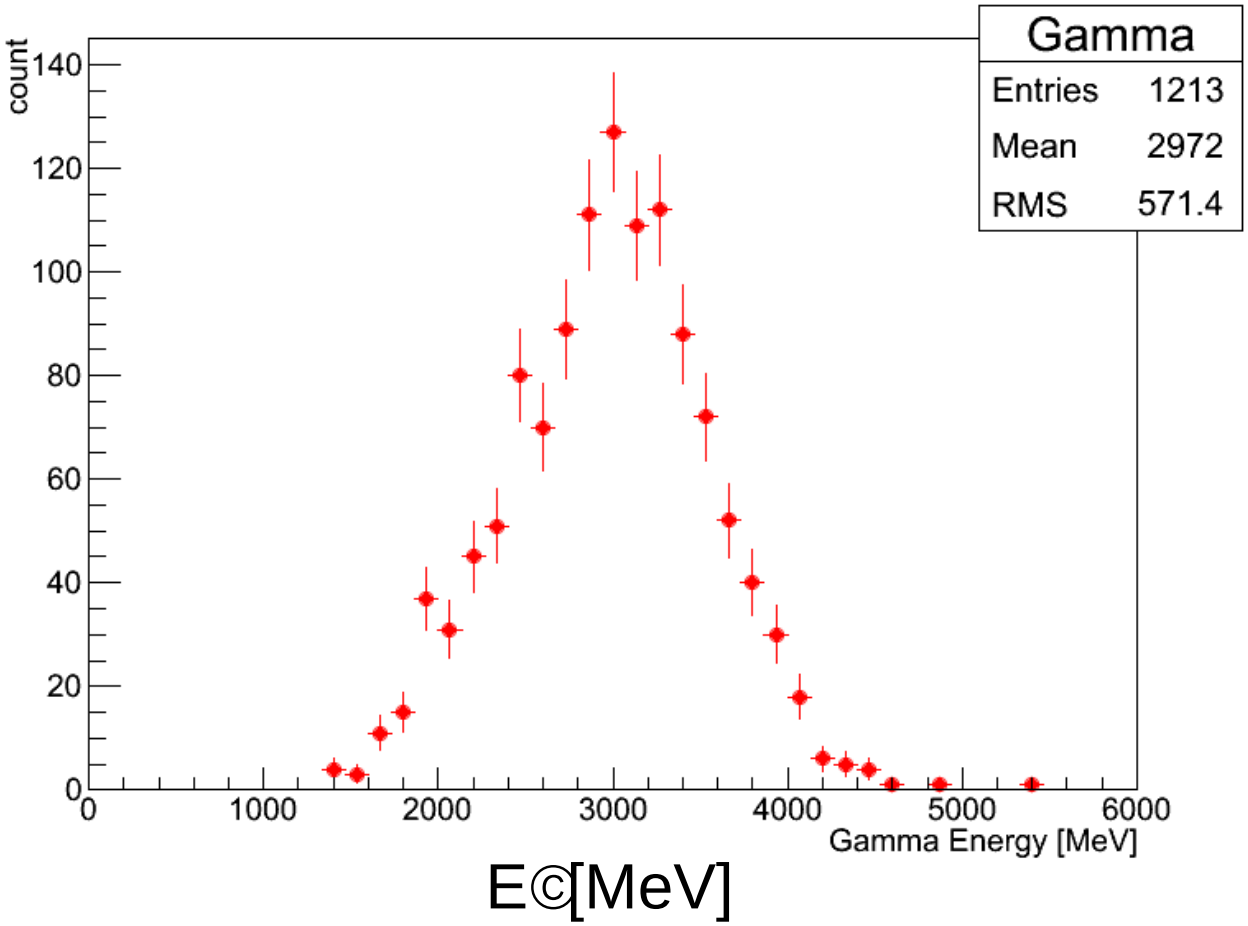


©ray Generation

5bunches/train



5.6ns



2970±20 MeV

⇒ ~120γs / train

ATF 2.16MHz

~2.6×10⁸/sec

E©[MeV]

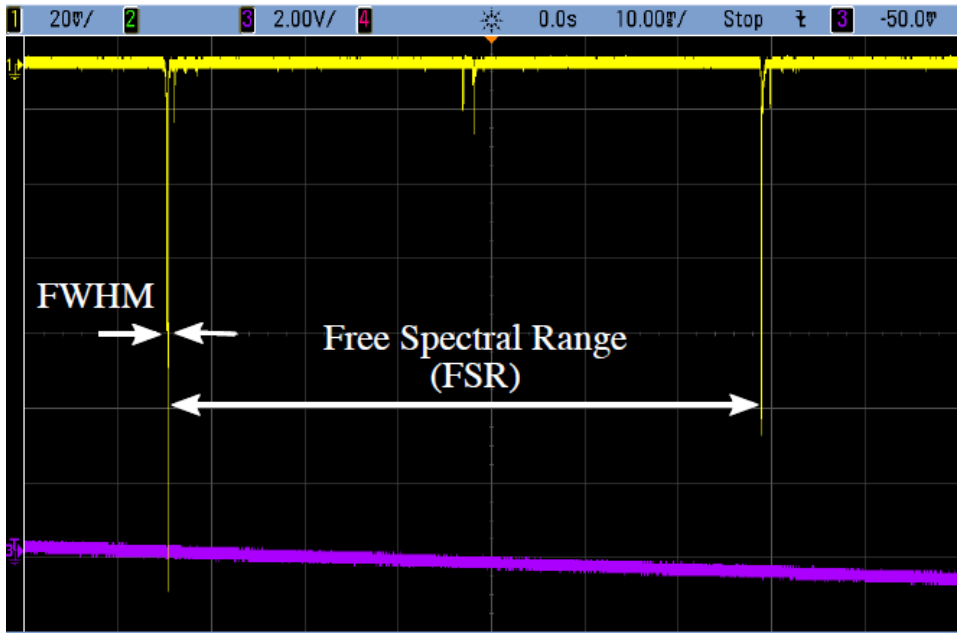
Quantitative Understanding of the Cavity

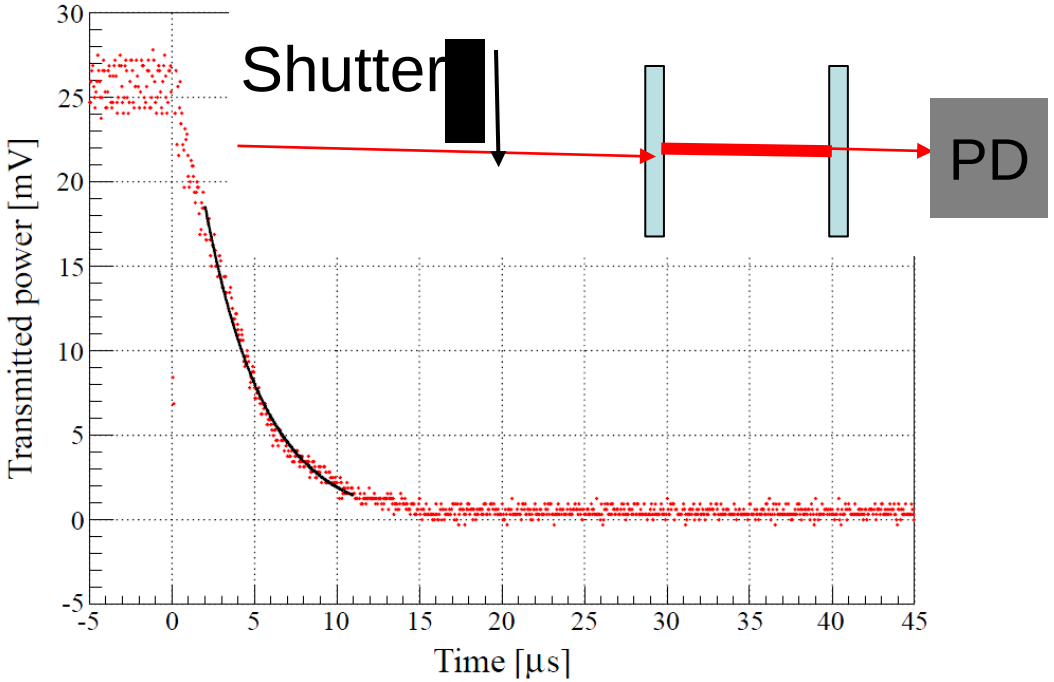
- **Finesse**
  - Airy function
  - Life time of the laser light in the cavity

- **Stored Power in the cavity**
  - From injection power
  - From transmitted power

- **Profile at the interaction point**
  - Using Compton gamma (laser-wire)
  - Estimate from a measured laser light profile

Finesse





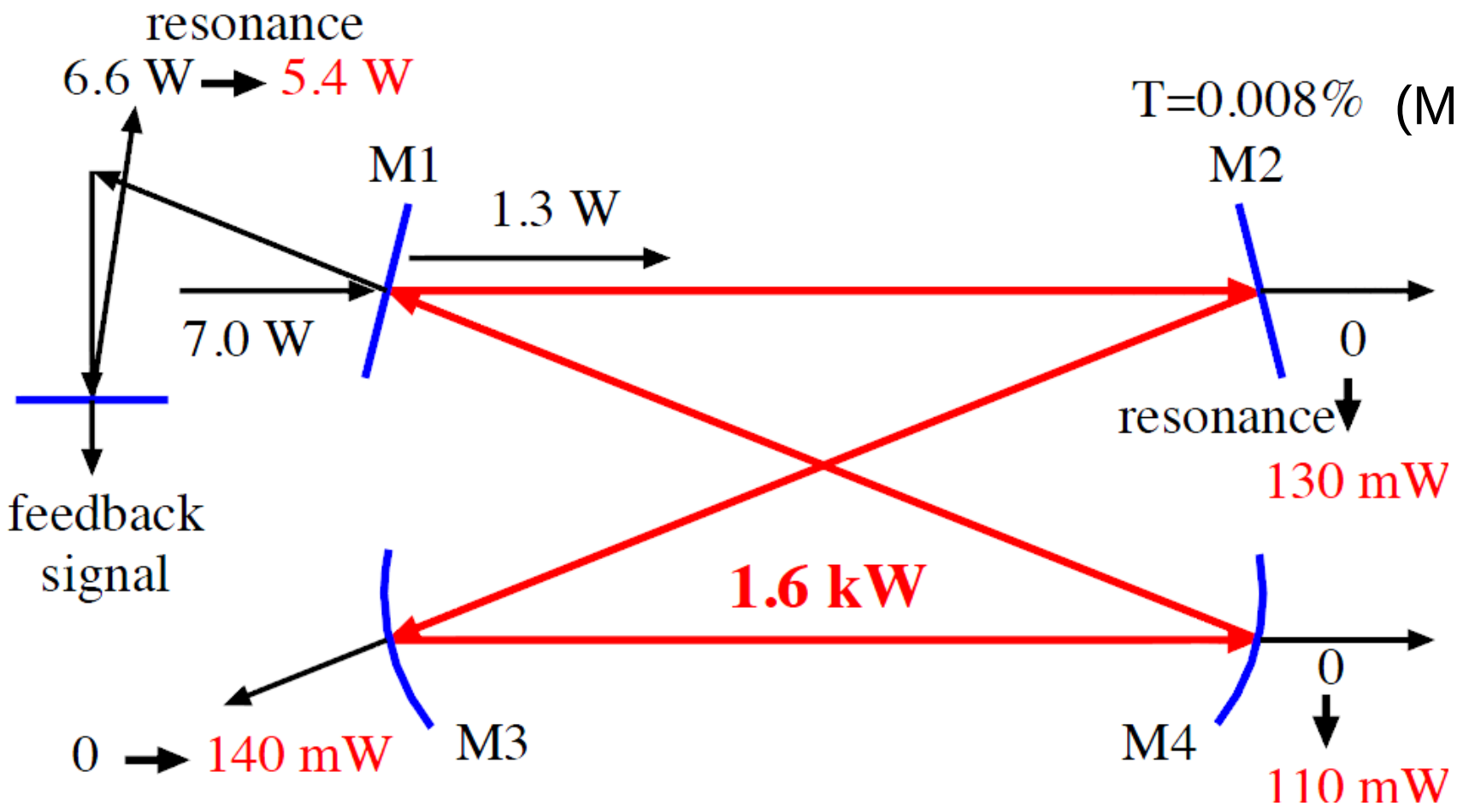
Airy Function

Finesse: FWHM / FSR
=4040±420

Life time of the laser light

2πcτ / L
=4040±110

Stored Power

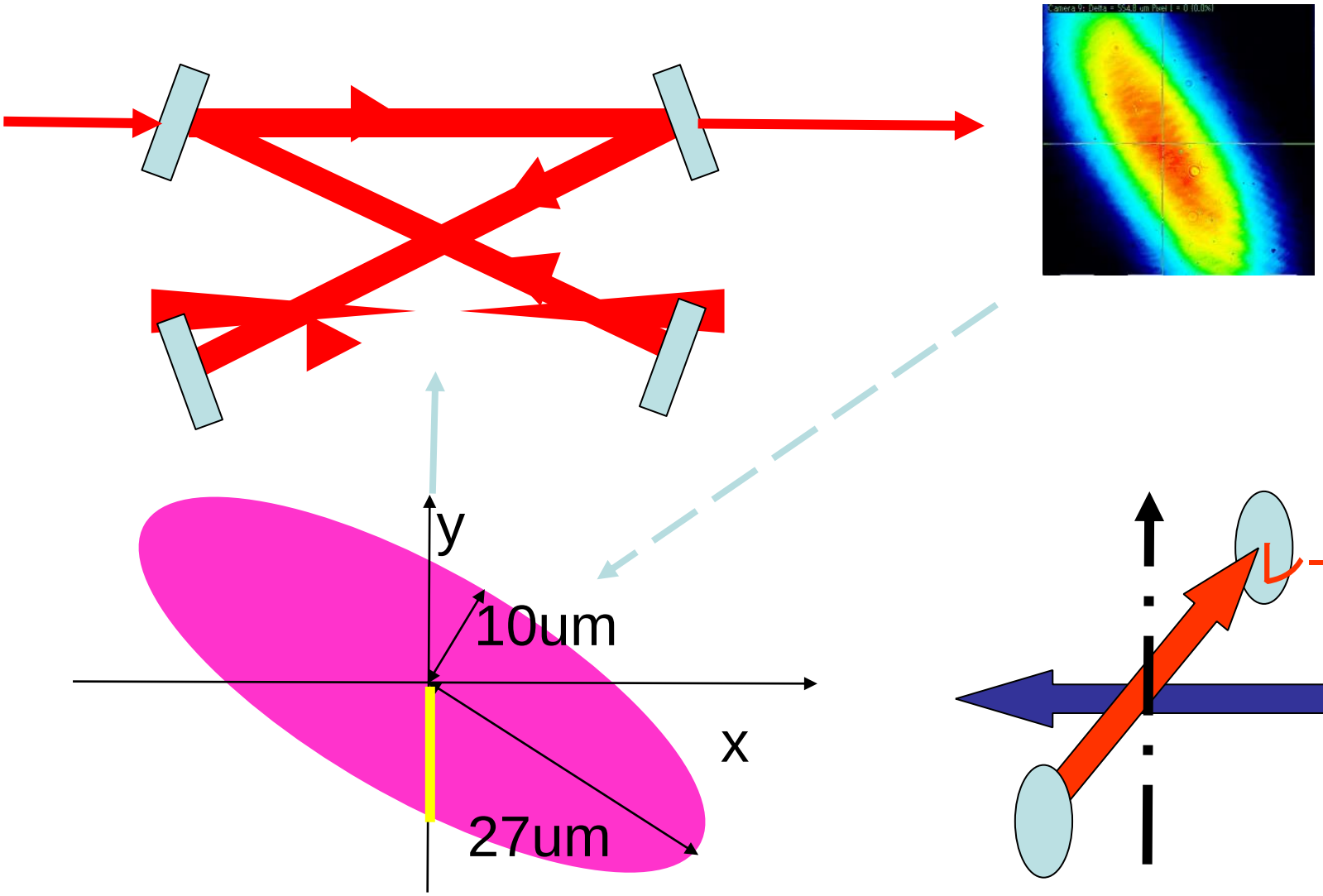


Two Estimates are consistent

Injection(1.3W) × Enhancement(1230) =1.6kW

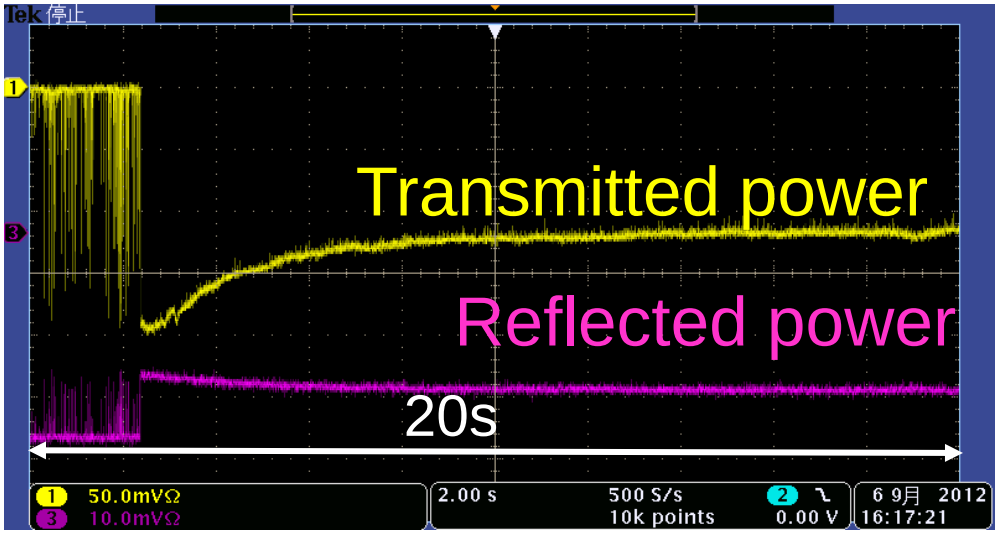
Transmitted(130mW) / Transmittance(0.008%) =1.6kW

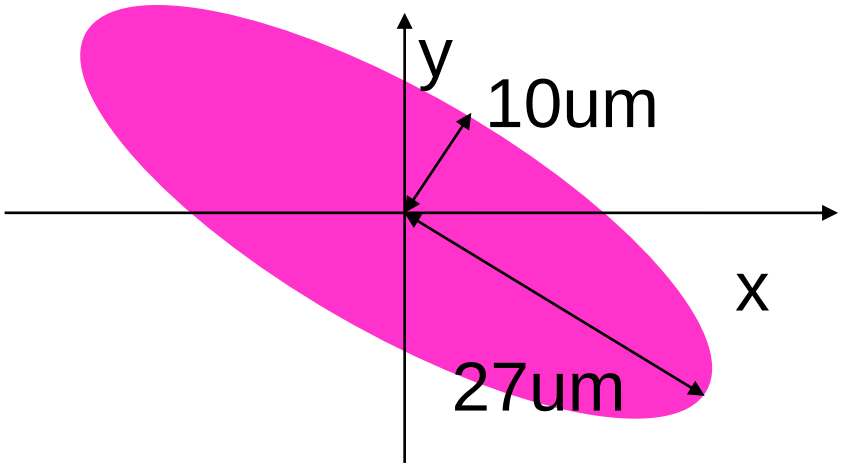
Profile of the laser light at the IP



Calculated 16um
Measured 13um

Issues





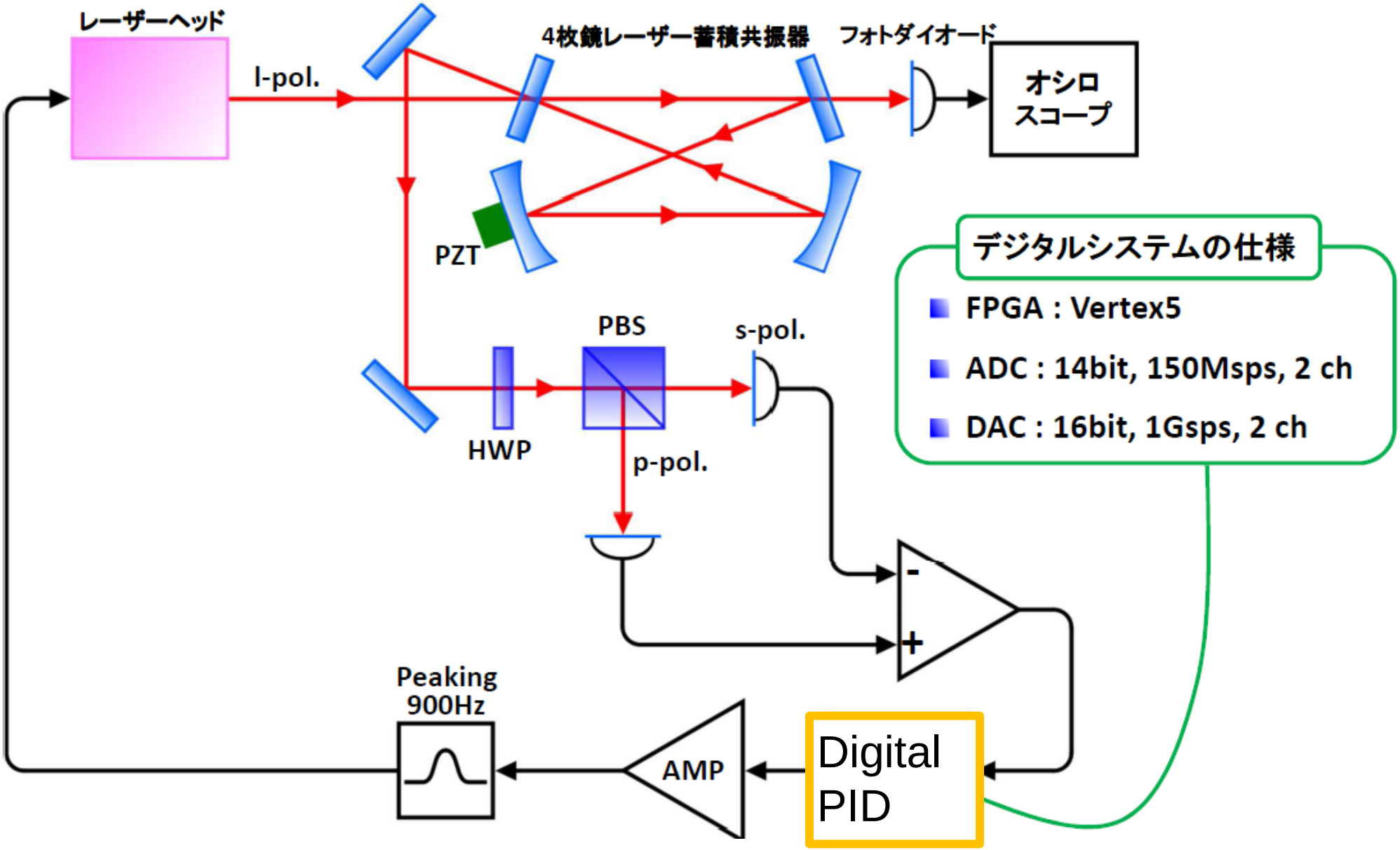
・Possible thermal effect

(unexpected) losses on mirrors
→distortion

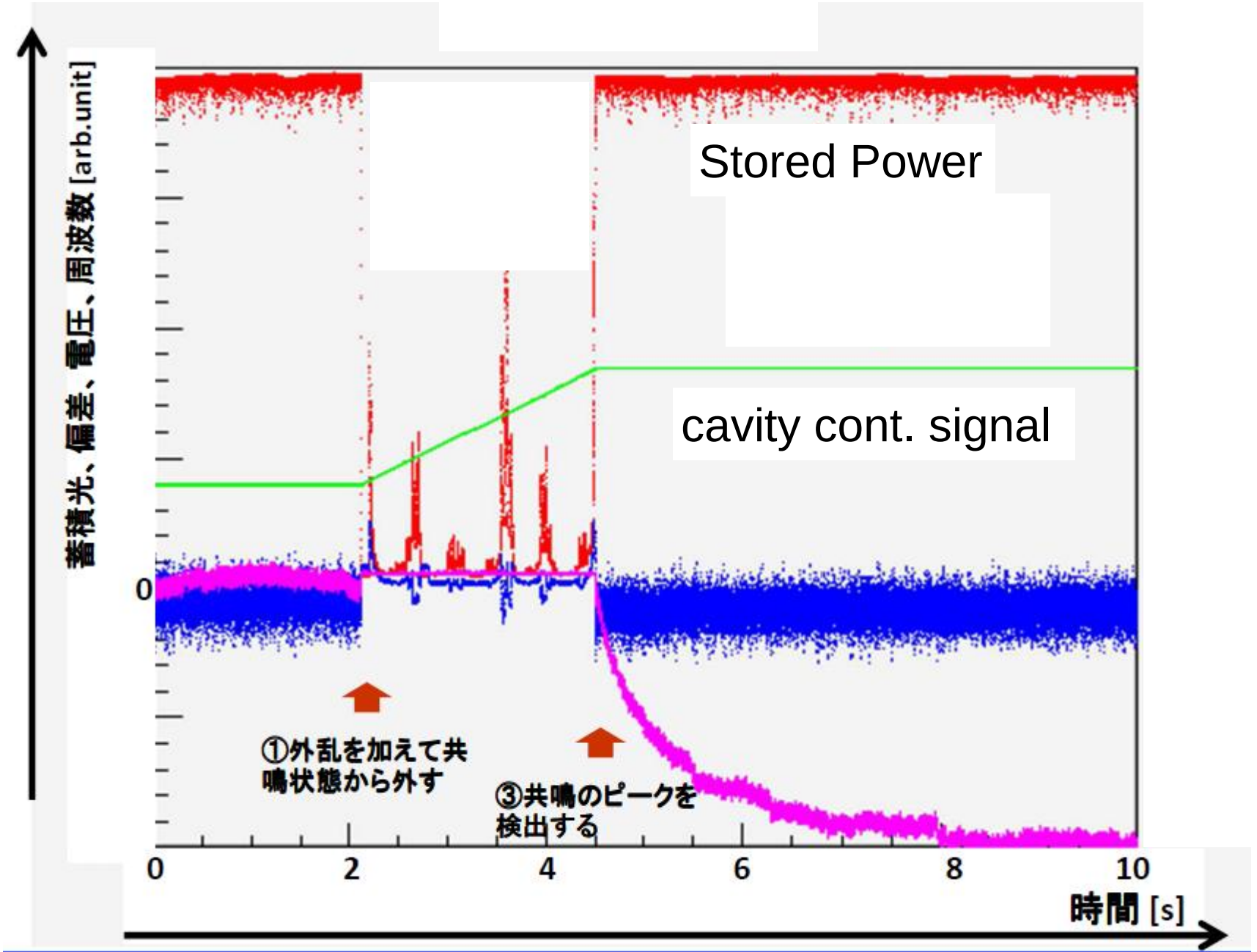
・Profile at the IP

Design: circle
-> alignment

Digital Feecdback system



Automatic Restoration



Summary and Prospect

- So far
  - 2.6kW stored w/ enhancement of 1230
  - Highly stable　ΔL～4pm
  - vertical laser size at the IP　13㎛
  - 120g/5bunches -> ~2.6×10^8/sec
  - Digital Feedback
- Quantitative understanding
  - Finesse
  - Powers
  - Profile

Summary and Prospect

- Issues
  - Laser profile at the IP
  - possible thermal effect
- Near term plan
  - test Laser profile issue
  - low loss mirrors
  - Higher finesse

Resonance Finding