

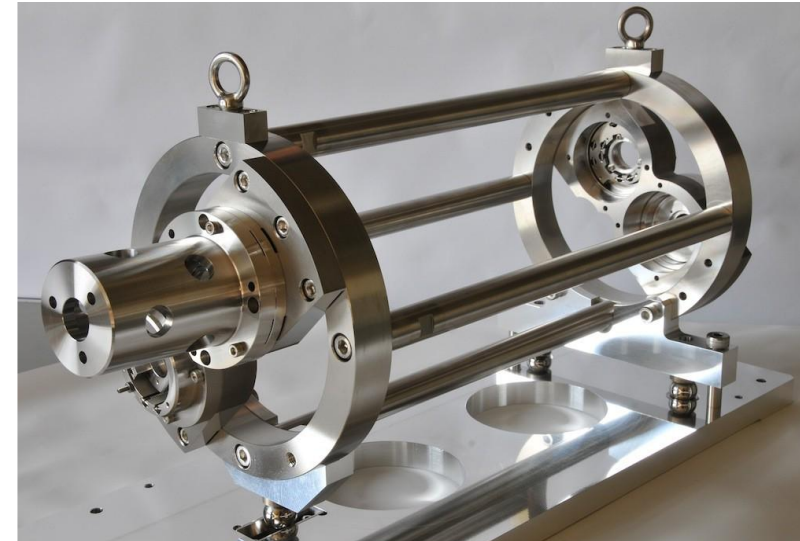
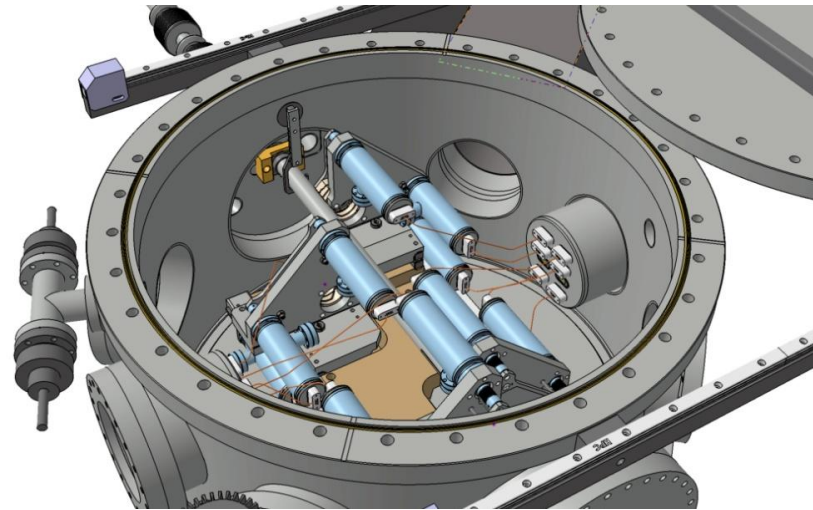
Status and Plan of Compton γ -ray Generation at KEK-ATF

T. Omori & F. Zomer

ECFA LC Workshop at DESY

29-May-2013

ATF session

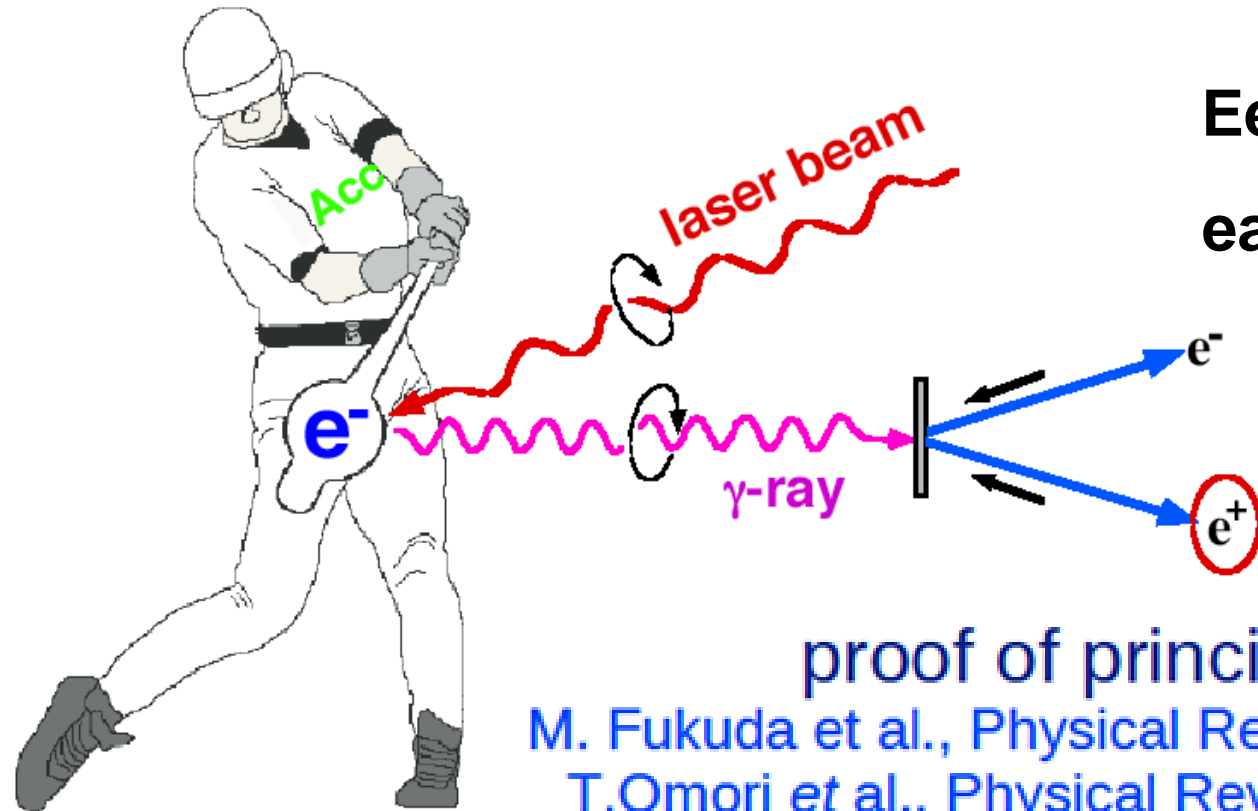


**French Labs. : LAL (Orsay) in Collaboration with
CELIA (Laser lab., Bordeaux) and
LMA (mirror coatings Lab., Lyon)**

**Japanese Labs. : KEK, ATF group,
Hiroshima University**

Introduction

► Polarized e^+ by laser Compton Scheme



$E_e \sim 1 \text{ GeV}$ for 10 MeV gammas
easy to control polarization

proof of principle experiment

M. Fukuda et al., Physical Review Letters 91, 164801 (2003)

T. Omori et al., Physical Review Letters 96, 114801 (2006)

Toward the positron sources

-> increase intensity of gamma rays

Staking Laser Pulses in Optical Cavity

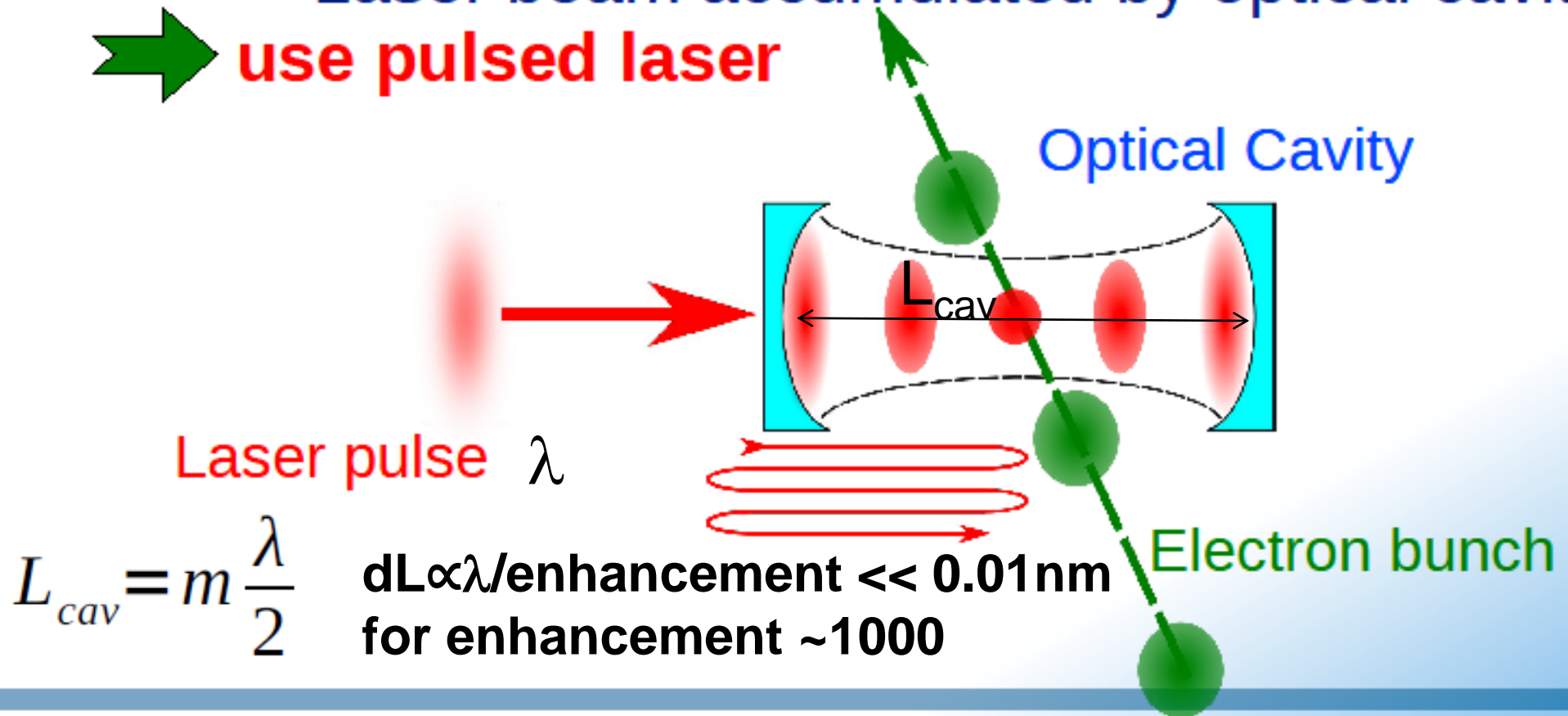
Miyoshi PosiPol2010

Increase power of laser beam at interaction point for increasing gamma yield.

➔ **enhancement with optical cavity**

Laser beam accumulated by optical cavity

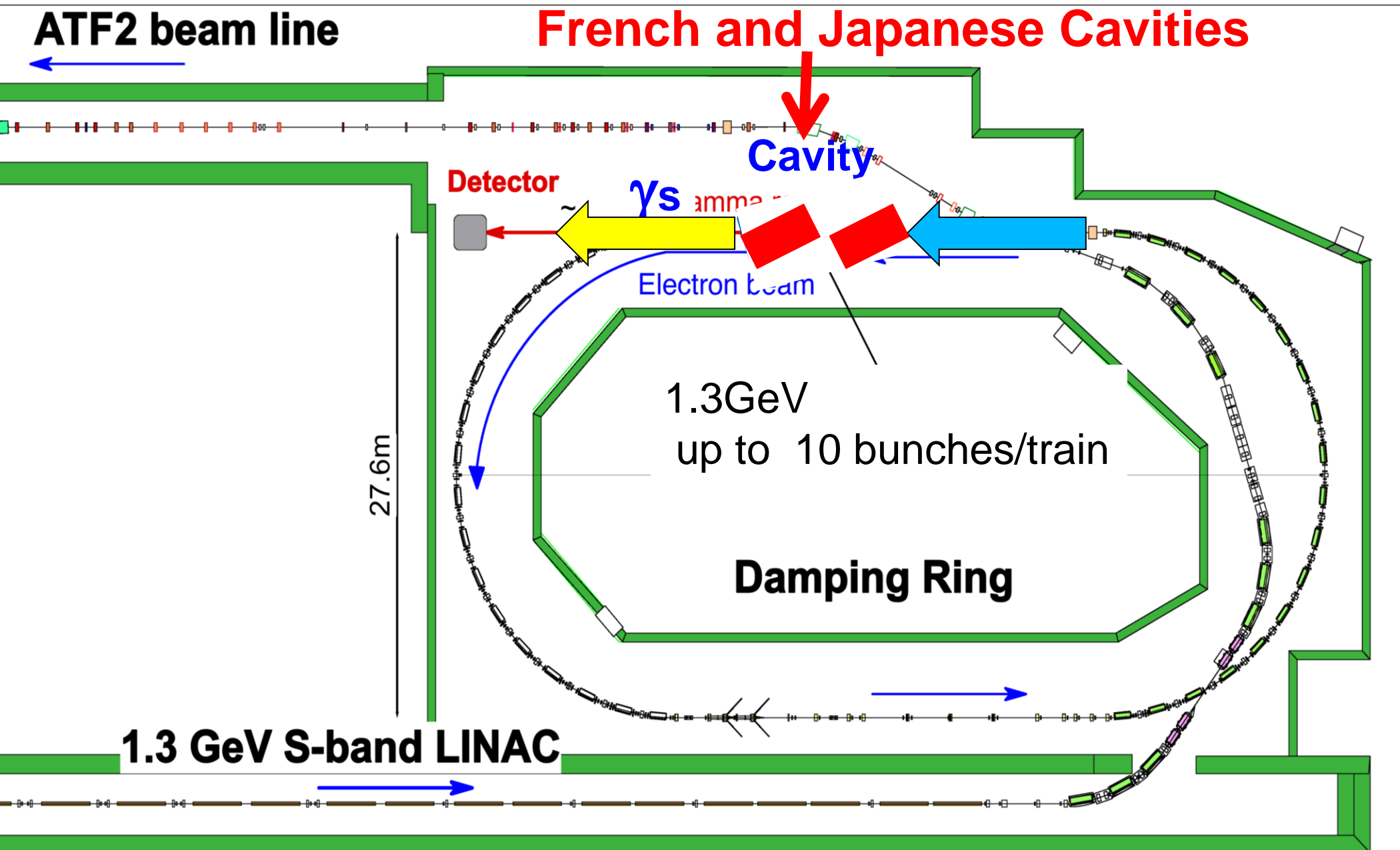
➔ **use pulsed laser**



$$L_{cav} = m \frac{\lambda}{2}$$

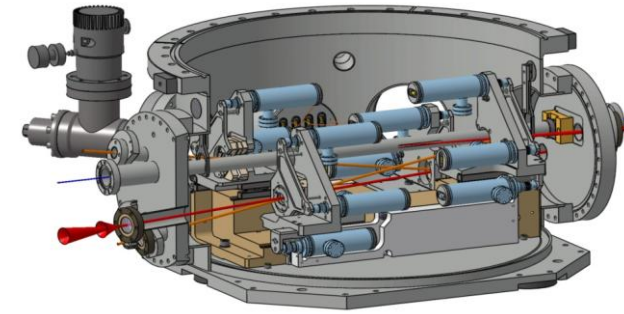
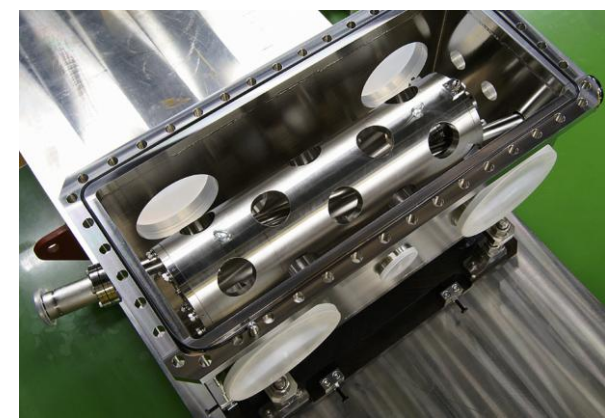
$dL \propto \lambda / \text{enhancement} \ll 0.01 \text{ nm}$
for enhancement ~ 1000

Compton Experiments at ATF

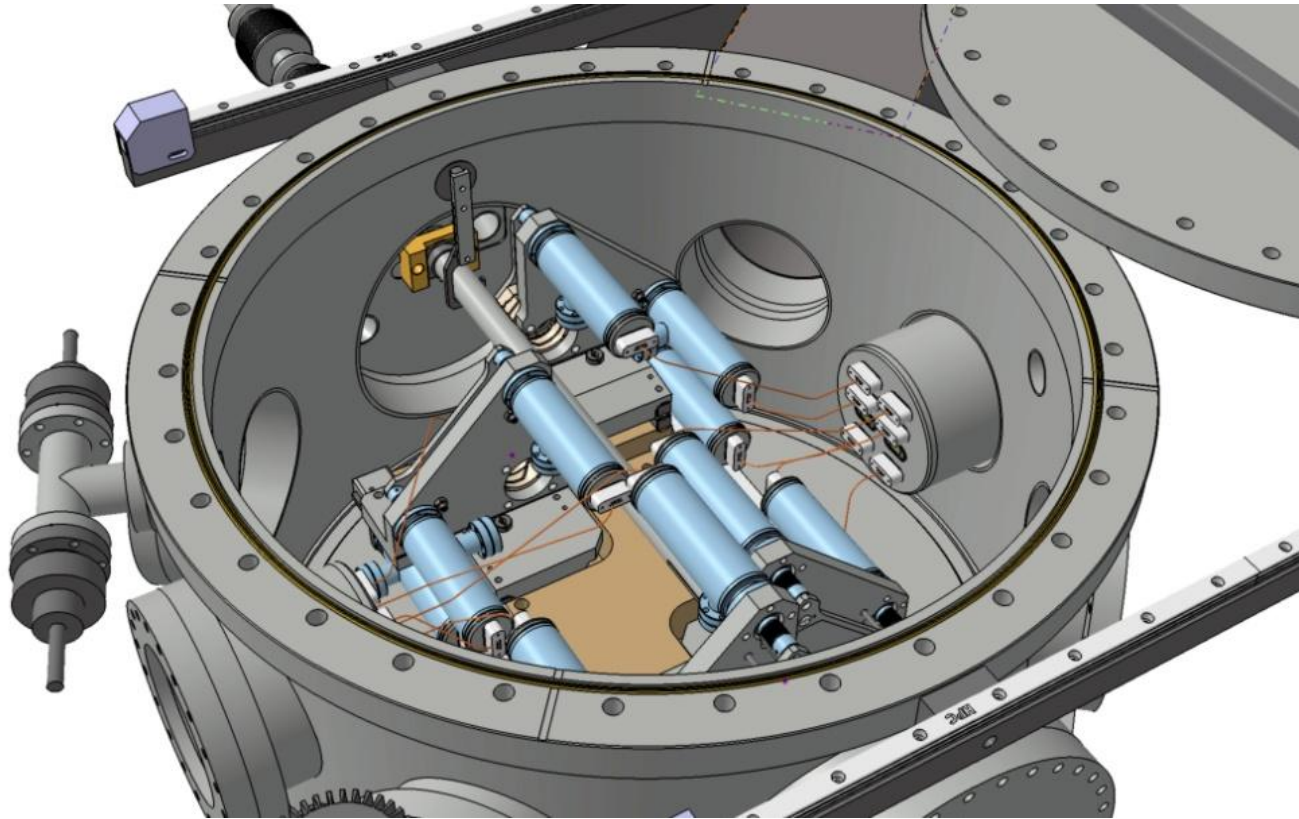


Brief History

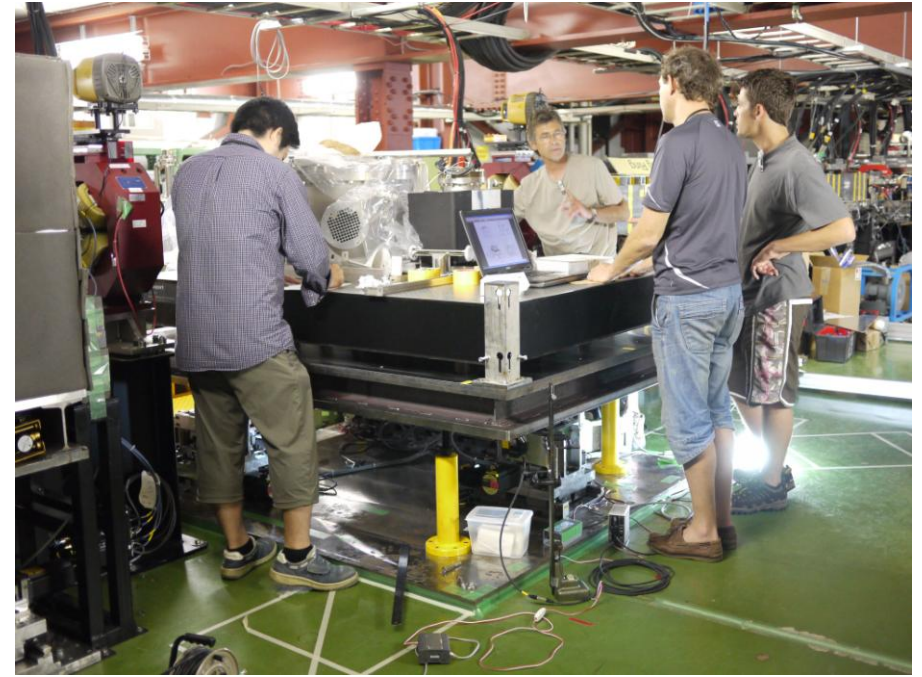
- ▶ 2007: 2-Mirror cavity installed
 - 2.5kW 30 γ rays generated/train
- ▶ 2010: French 4-Mirror cavity installed
 - γ rays confirmed
- ▶ 2011: The Earthquake
 - No major damage to our equipments.
- ▶ 2011: KEK-Hiroshima 4-mirror cavity installed
 - γ rays confirmed
- ▶ Early 2012: Multi-bunch gamma-rays measurement (K-H cavity)
- ▶ 2012: 128 photons/train observed (K-H cavity)



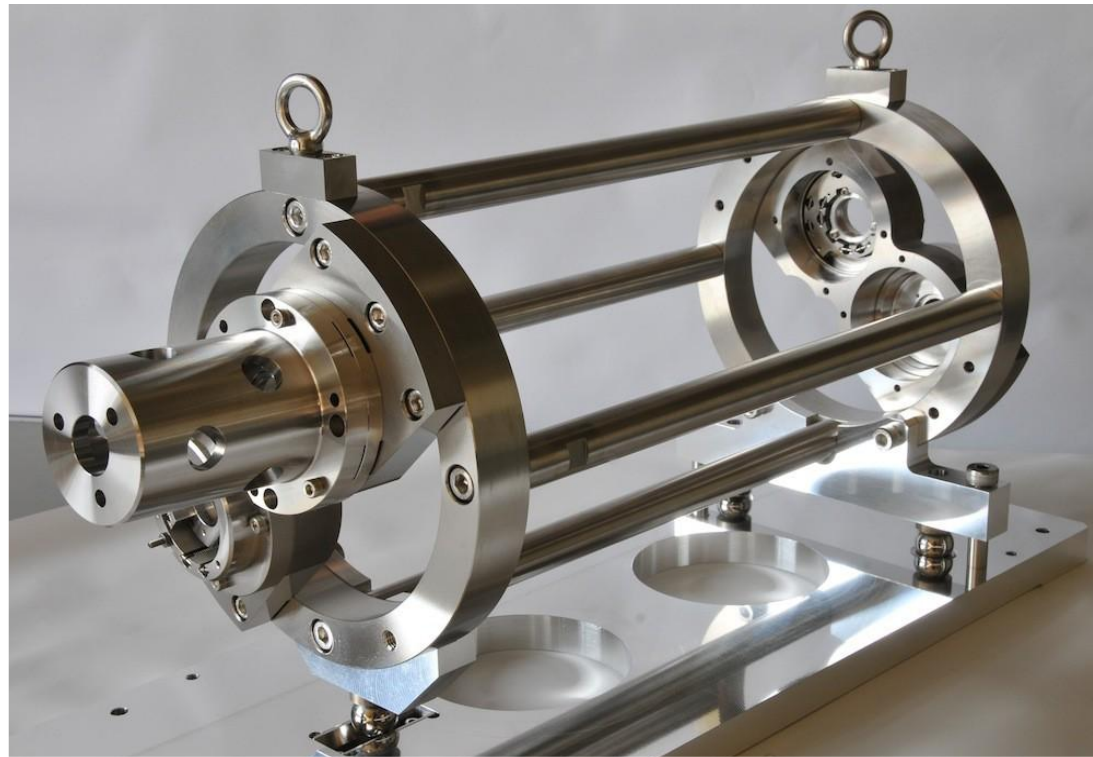
French 4-mirror Cavity



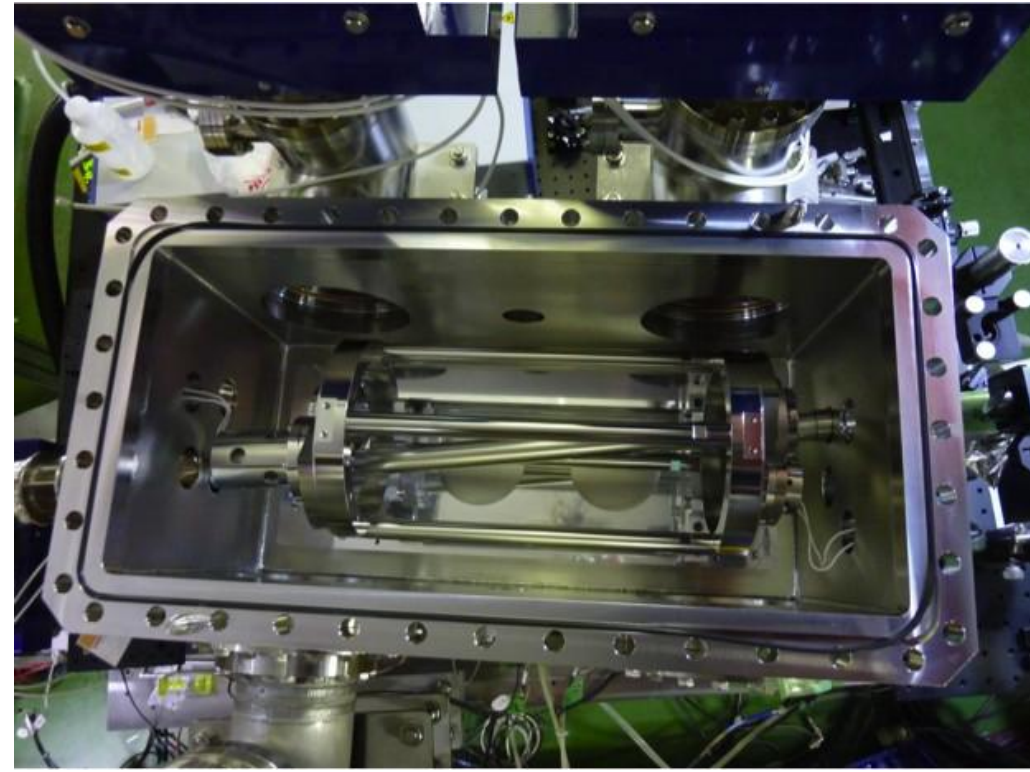
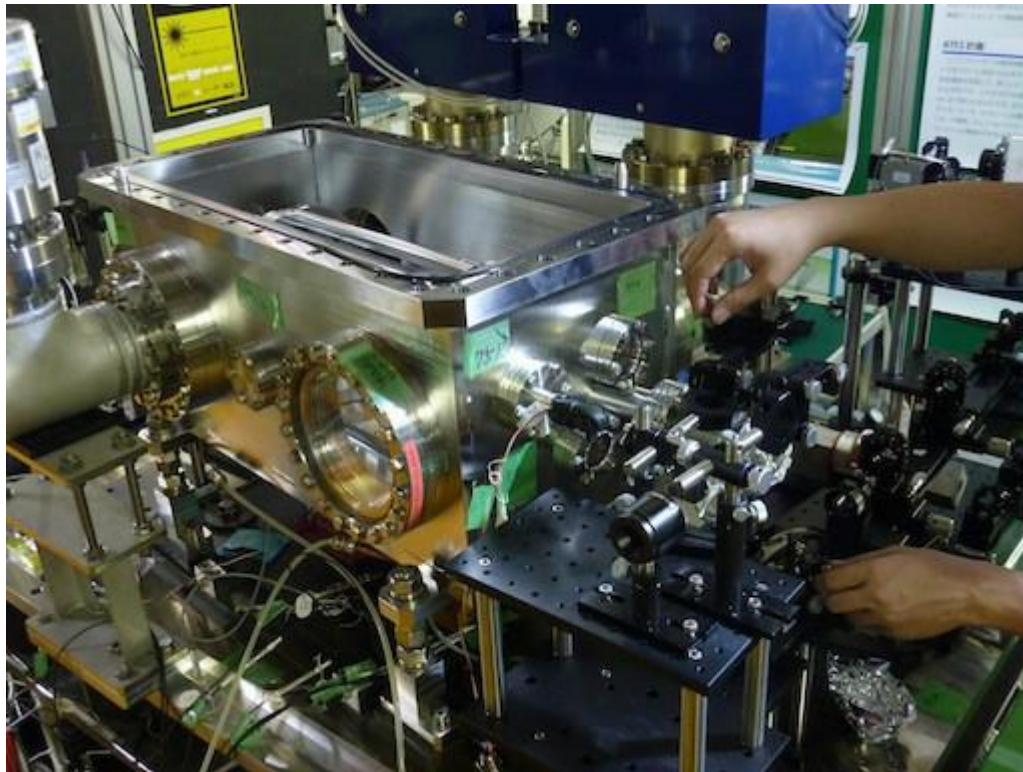
2010 Summer: French cavity Installation



KEK-Hiroshima 4-mirror Cavity



2011 Autumn: KEK-Hiroshima Cavity Installation



Two 4-mirror cavities are at the ATF

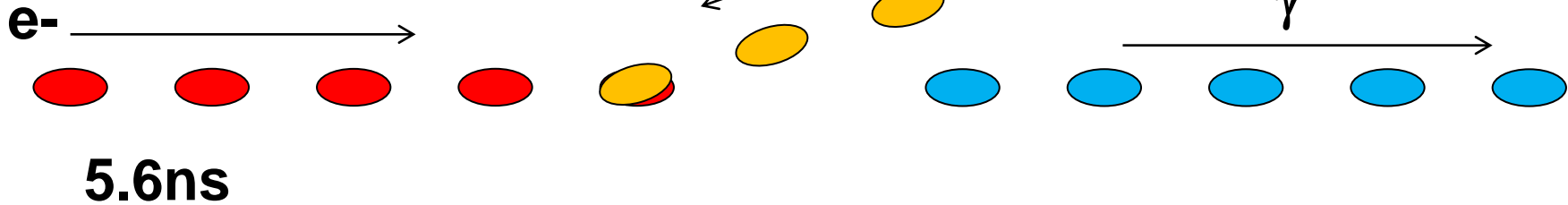
KEK-Hiroshima
installed autumn 2011
relatively simple control system
employs new feed back scheme

LAL-Orsay
installed summer 2010
sophisticated control
digital PDH feedback



γ -ray Generation / electron

5 bunches/train



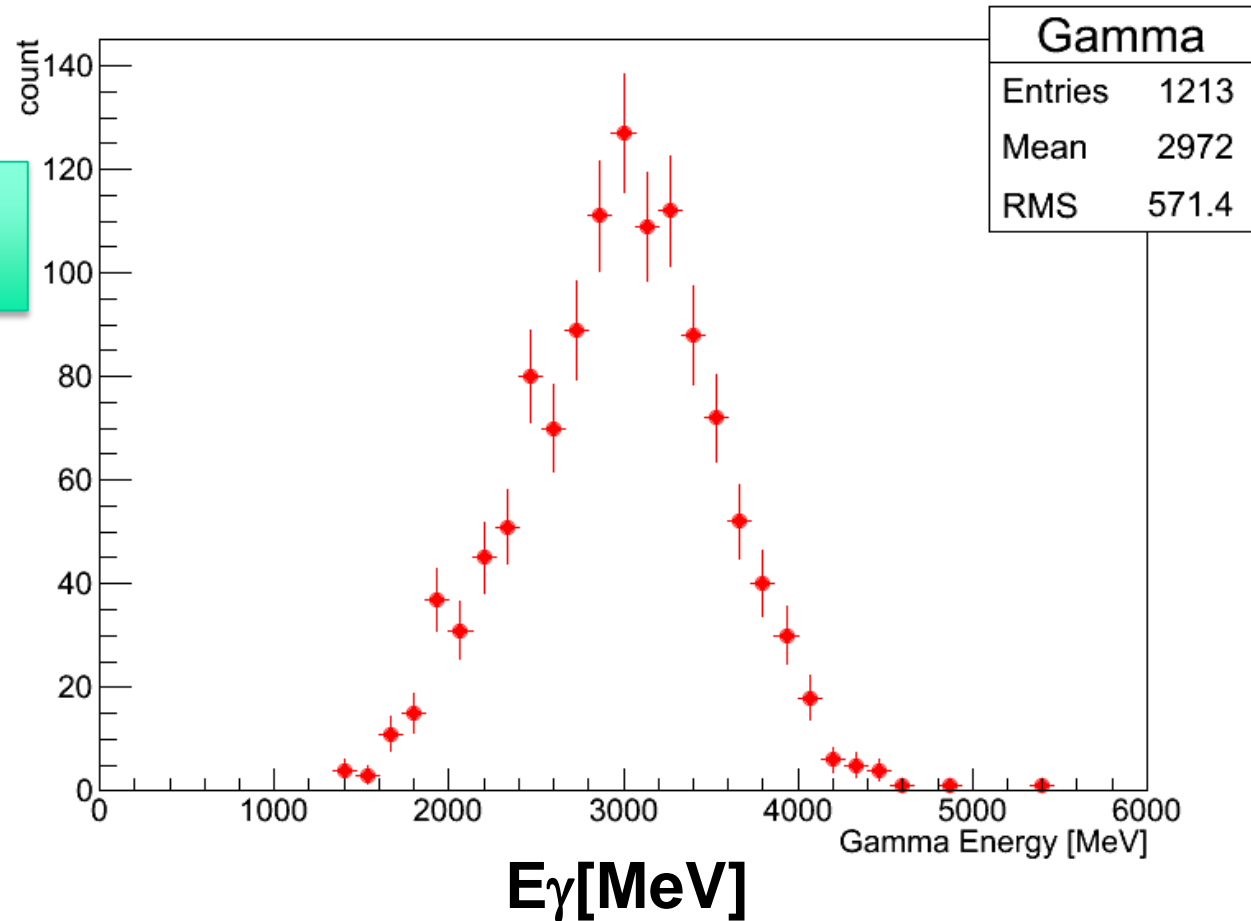
Results with Hiroshima/KEK
4-mirror cavity

2970 ± 20 MeV

$\Rightarrow \sim 128 \gamma$ /train

ATF 2.16 MHz

$\sim 2.6 \times 10^8$ /sec



Status and plan of French Cavity

(1) Status

2010 Summer Installed

2010 Nov-Dec Gamma observed

2011 The Earthquake and Improvements

Laser breakdown → new laser with CEP control

2012 Try to go higher finesse: 30000

Decrease of coupling in Vac.

CEP? Send the Laser to LAL

Simulation support CEP is cause.

**2013 30000 finesse ok with new laser
& 50W laser amplifier ok**

(2) Plan

Summer 2013: Re Install whole system at ATF

Status and plan of KEK-Hiroshima Cavity

(1) Status:

2011 Autumn: Installed

2012 Multi-bunch g-ray generation:

Finesse: 4040 (enhance 1200)

Store 2.6 kW with 1.4% stability

$N_\gamma=128/\text{train}$ (x4 of two-M cavity)

Small laser spot achieved $10 \times 27 \mu\text{m}^2$

(Very stable. But not round as intended.)

(2) Plan:

Finesse 48,000 (16600 enhancement)

Digital Feedback (ongoing)

Summary

- ▶ Optical Cavity at the ATF is in progress for Polarized positron source for the ILC
 - Good collaboration between France - Japan team
 - information / technology exchange
- ▶ R&D of 4 mirror ring cavities are in progress
 - Sophisticated mechanism aiming very high laser power enhancement ... French team
 - Relatively simple but new cavity control practical experience w/ the ATF ... Japanese team
- ▶ More to come
 - more laser power, more γ rays
 - maturity toward the system