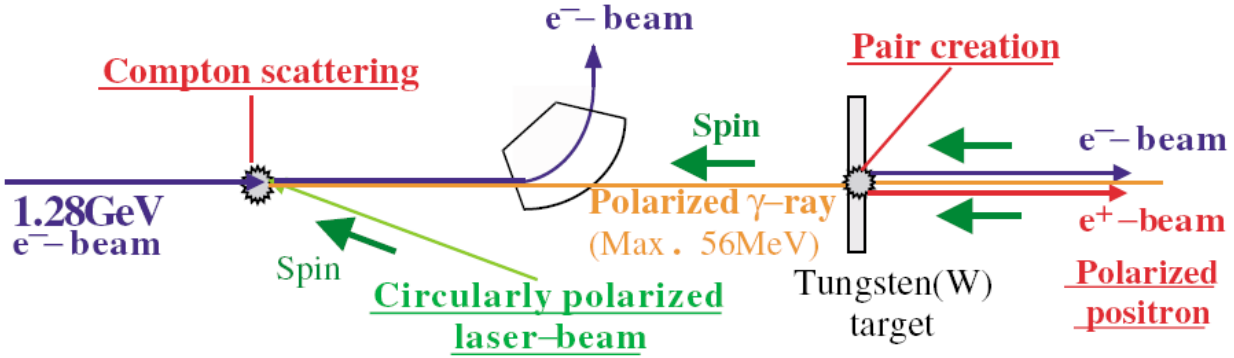
Applications of a high finesse Fabry Perot Cavity for the ILC

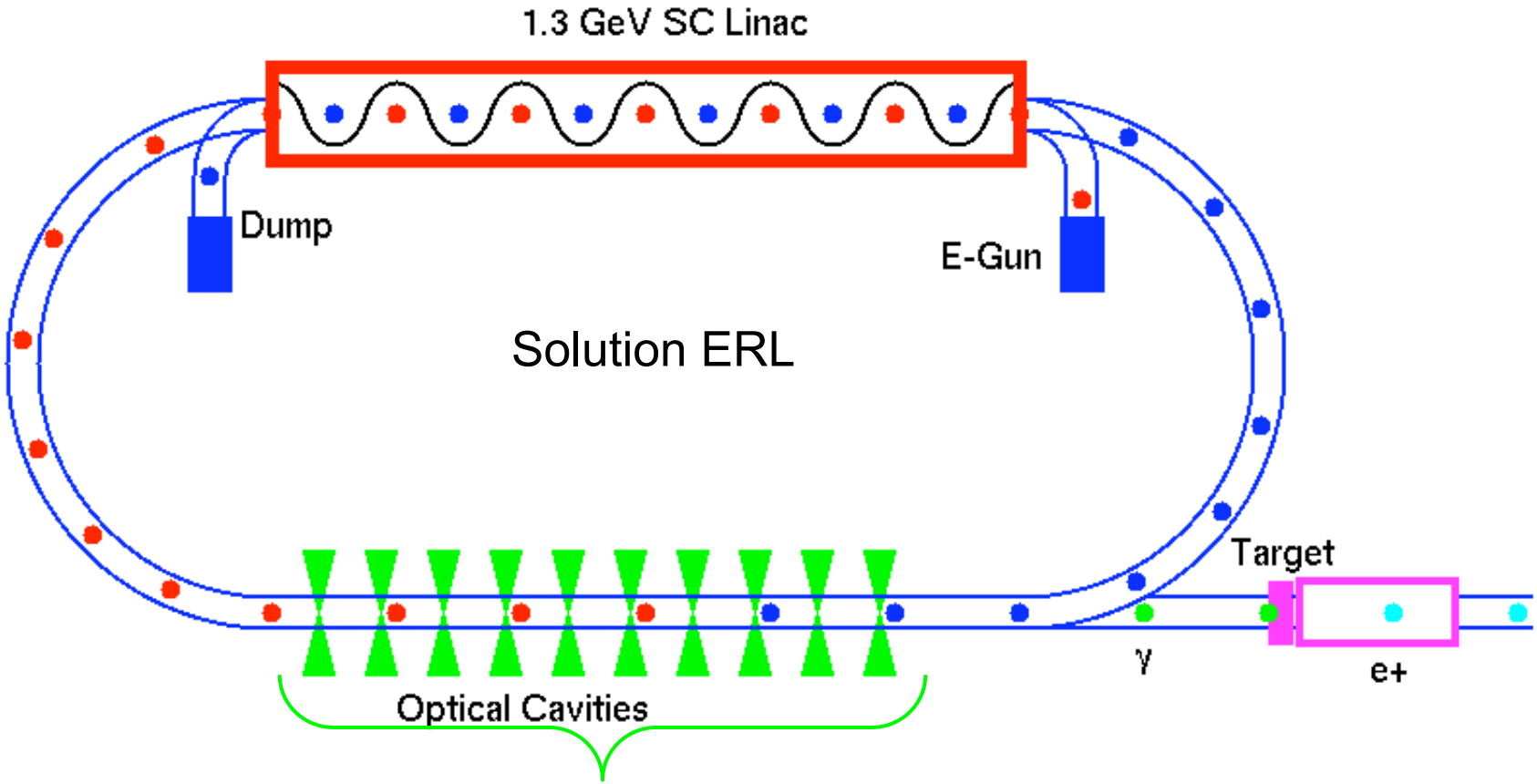
Japanese Labs. : KEK, ATF group,
Hiroshima University
French Labs. : LAL (Orsay) in Collaboration with
CELIA (Laser lab., Bordeaux) and
LMA (mirror coatings Lab., Lyon)

- Introduction
- Status of the cavity R&D
  - at ATF
  - at LAL/Orsay

Introduction : polarised positron source for ILC/CLIC

KEK scheme:

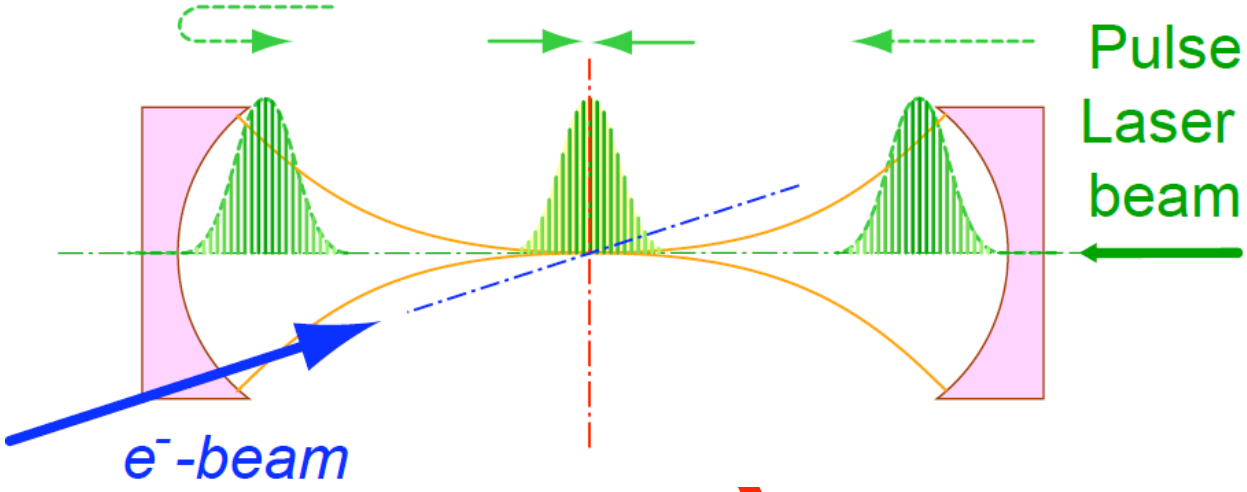




0.6J/pulse@1ps@60MHz ➔ <P>=36MW !!! per cavity ➔ **R&D !** (KEK, LAL)

Experimental R/D in ATF

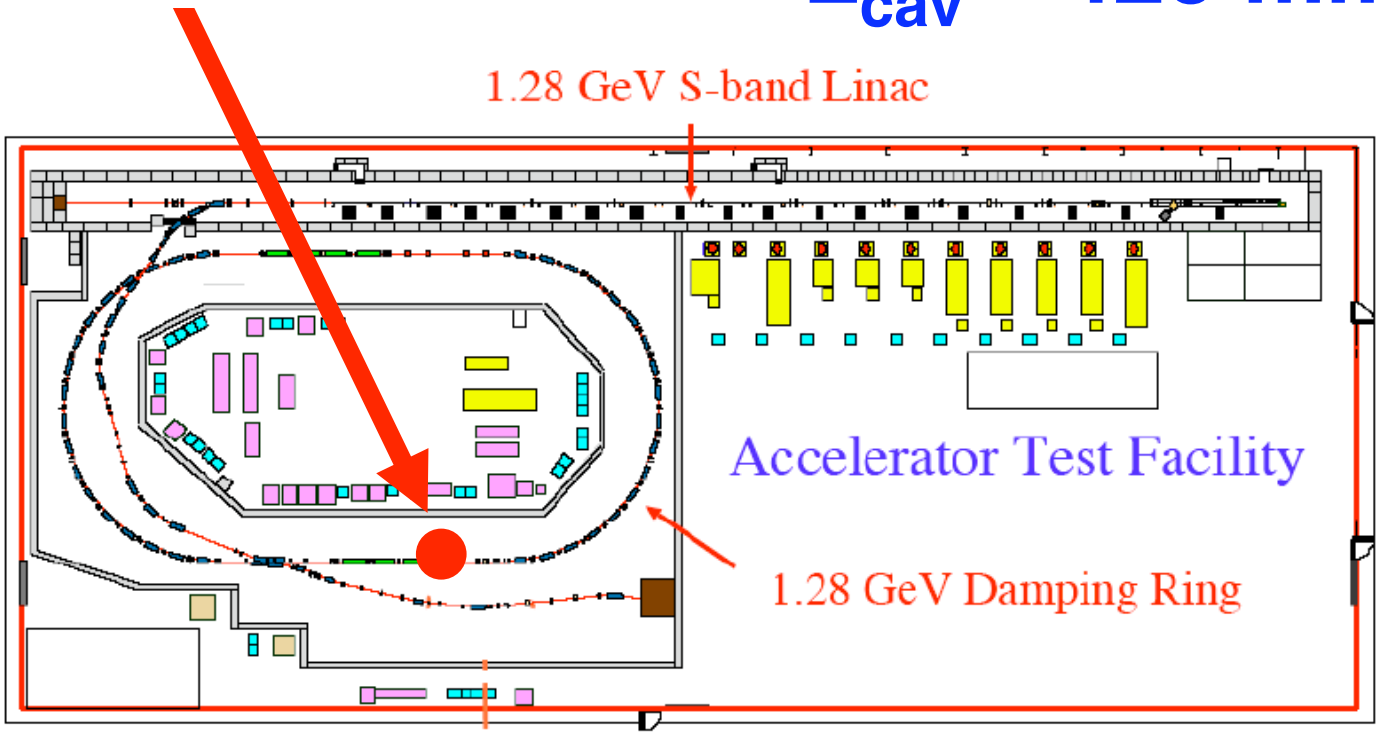
Hiroshima-Waseda-Kyoto-IHEP-KEK



Make a fist prototype 2-mirror cavity

L_{cav} = 420 mm

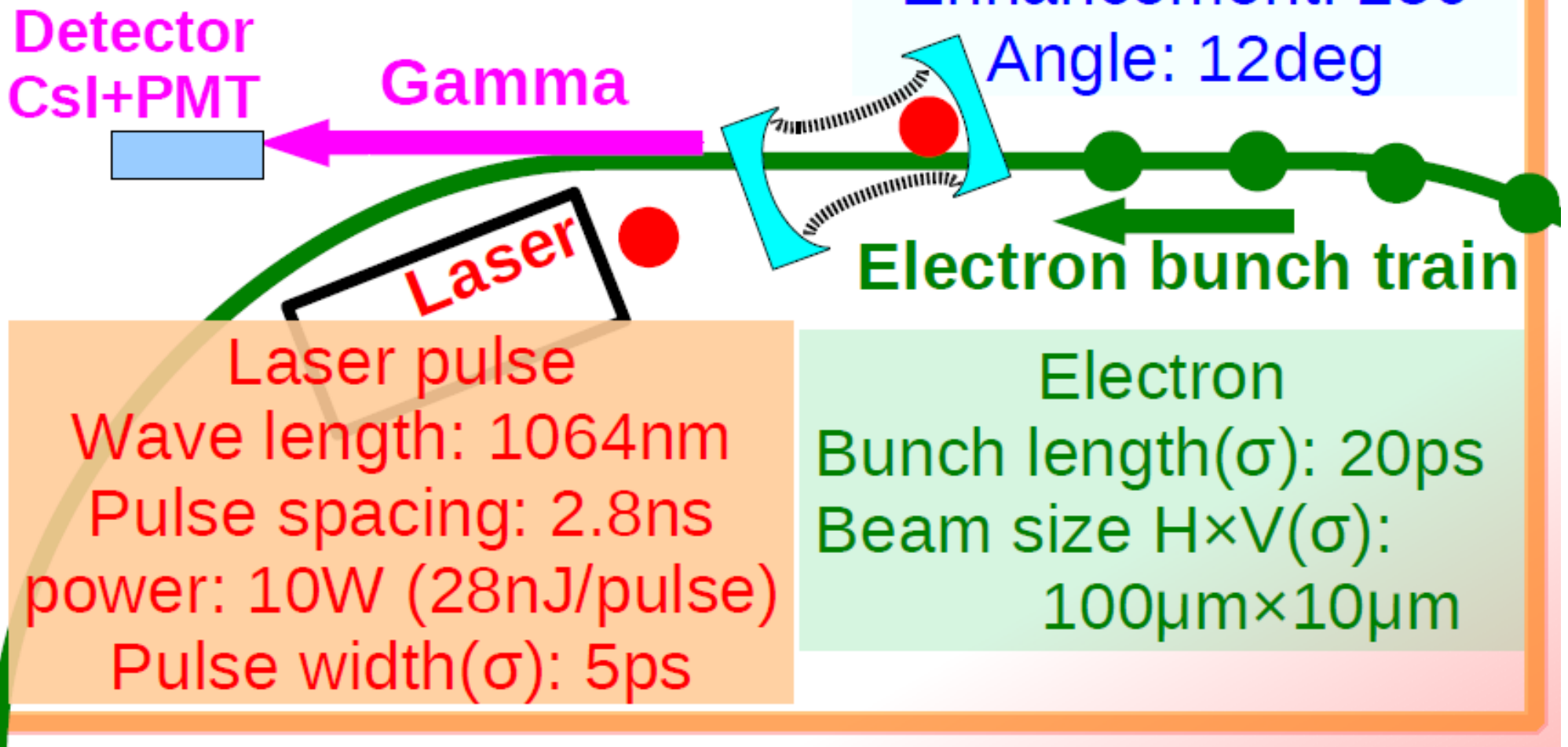
Put it in ATF ring



Experimental Setup

Gamma ray
Energy: 16~28MeV in aperture
Average: 23MeV

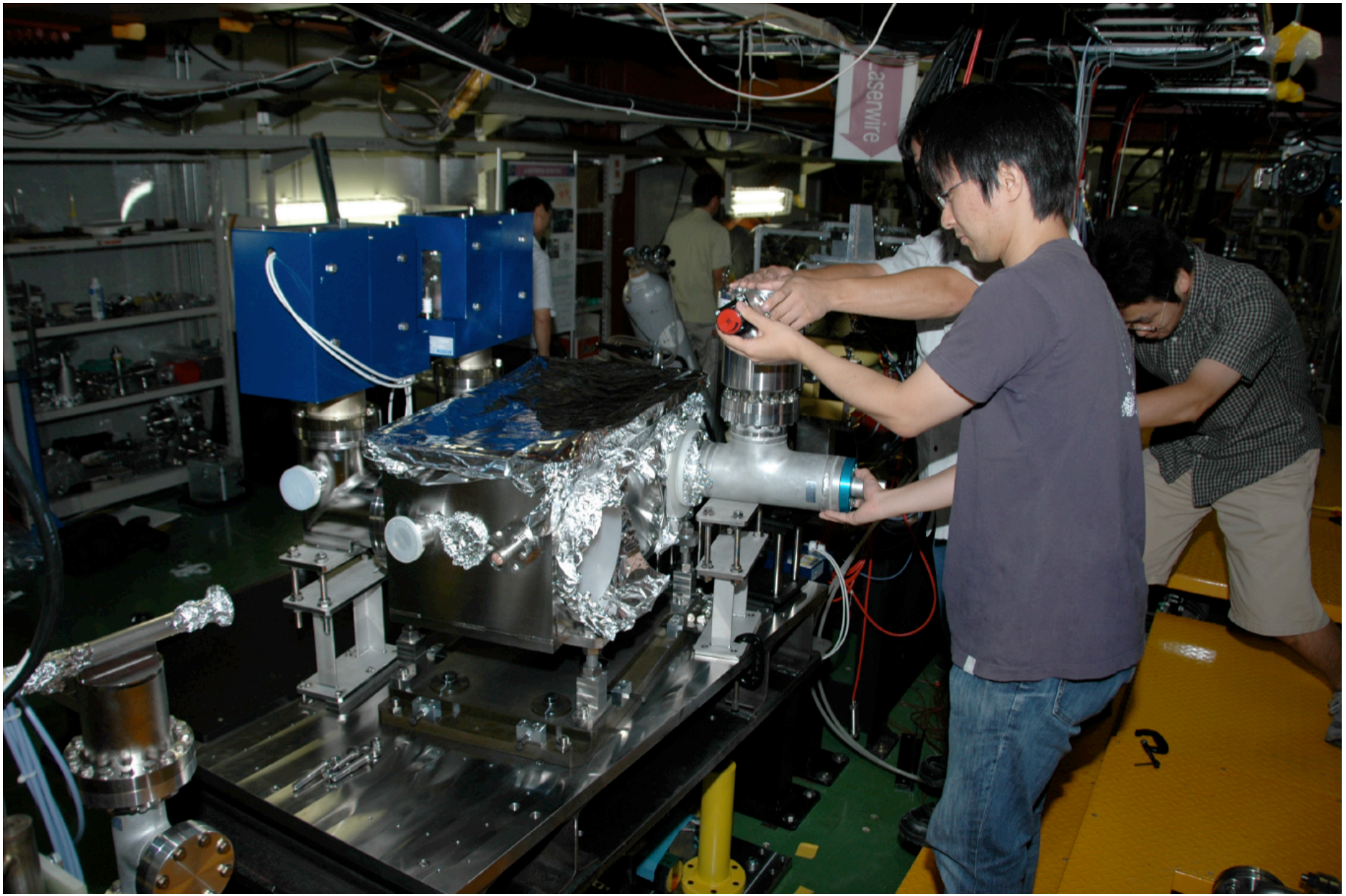
Optical Cavity
Cavity length: 420mm
Waist size(σ): 30μm
Enhancement: 250
Angle: 12deg



Laser pulse
Wave length: 1064nm
Pulse spacing: 2.8ns
power: 10W (28nJ/pulse)
Pulse width(σ): 5ps

Electron
Bunch length(σ): 20ps
Beam size H×V(σ):
100μm×10μm

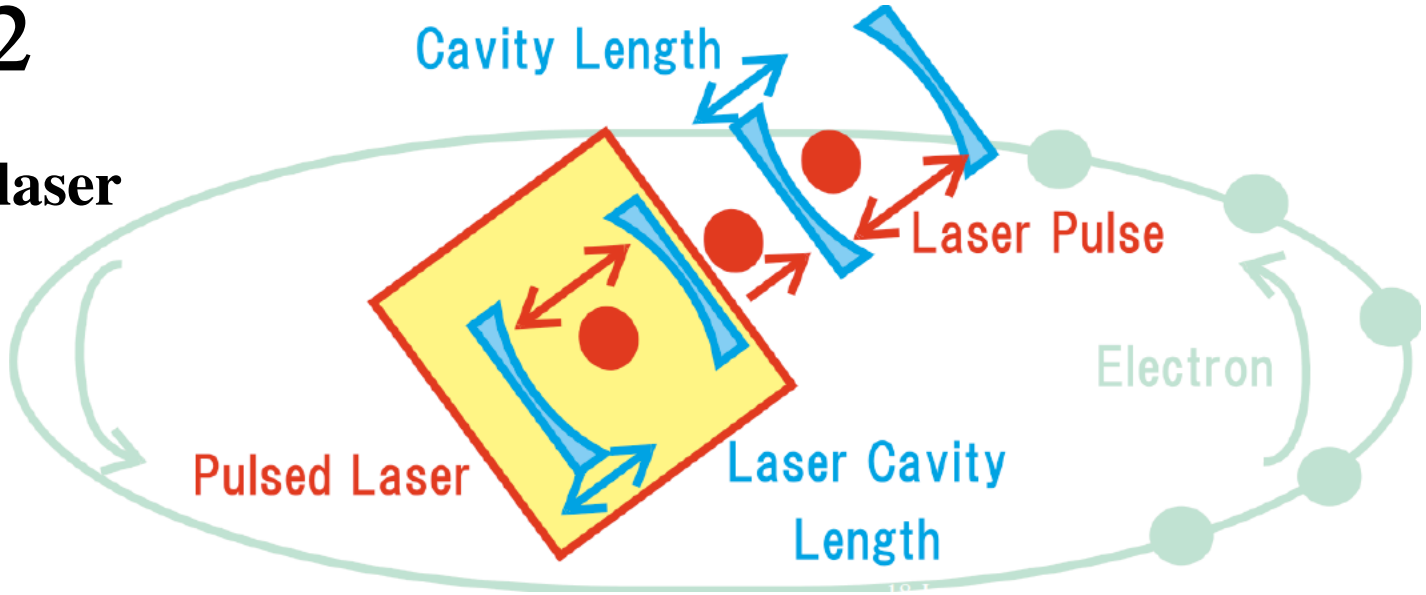
October 2007: Install the 2-mirror cavity into ATF-DR



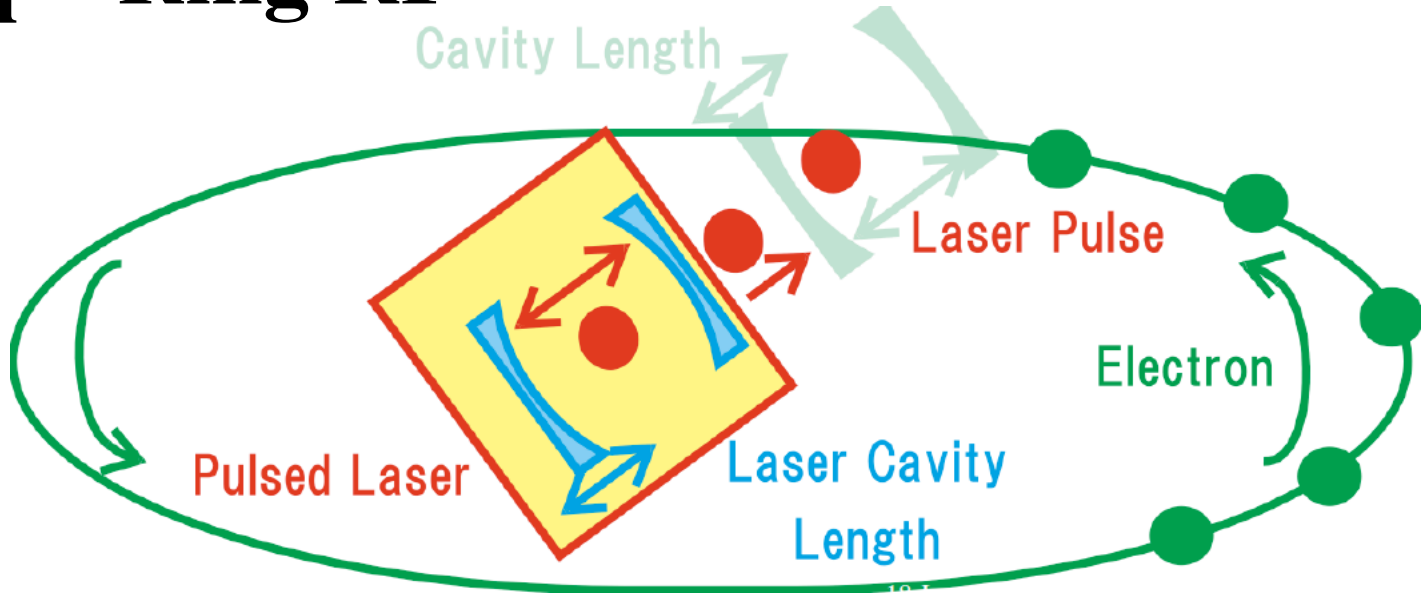
Feedback to Achieve 3 Conditions

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

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



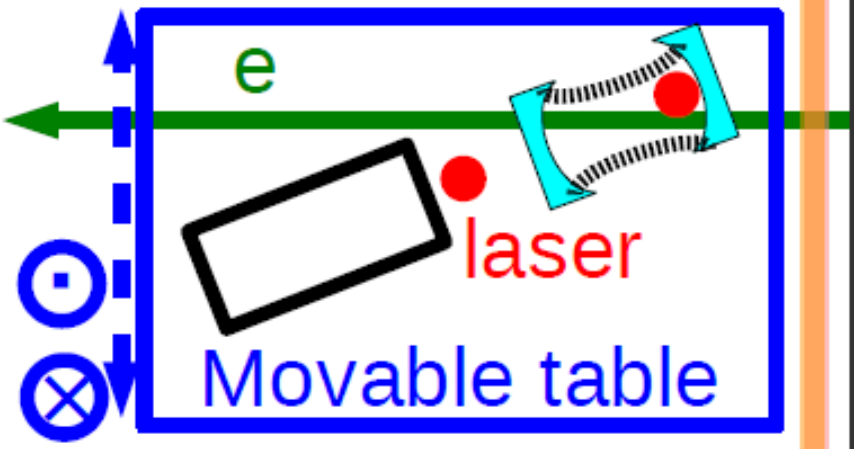
Laser freq = Ring RF

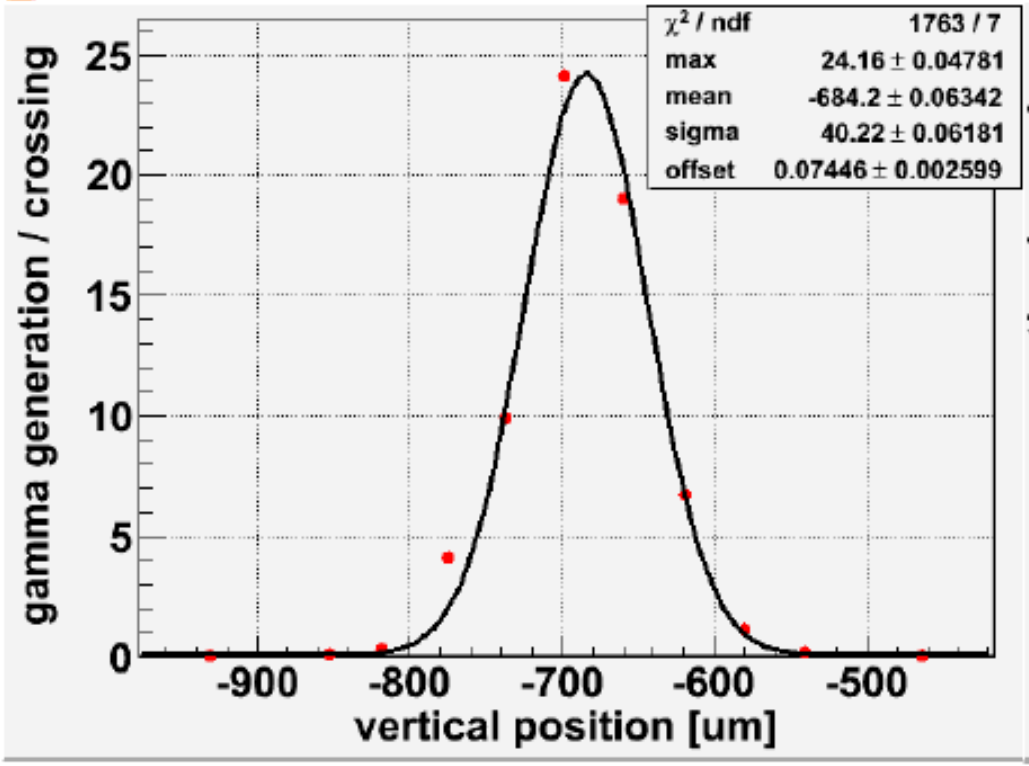


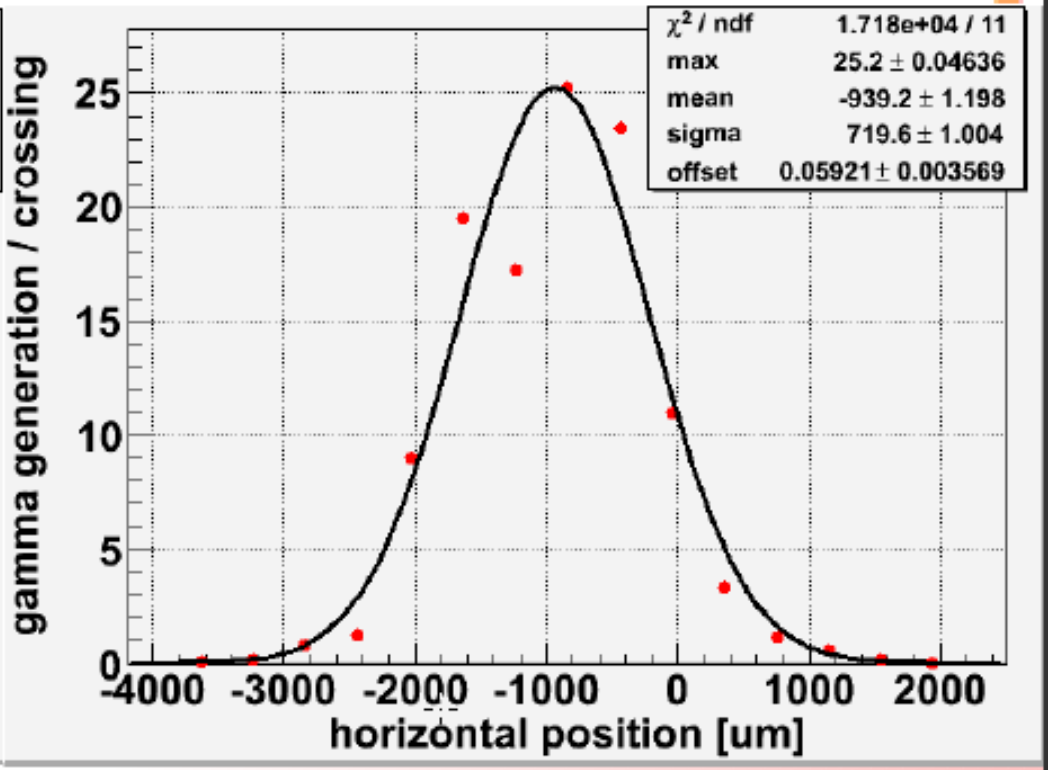
Find Optimum Position

First, scanning cavity position.

find optimum transverse position for e beam



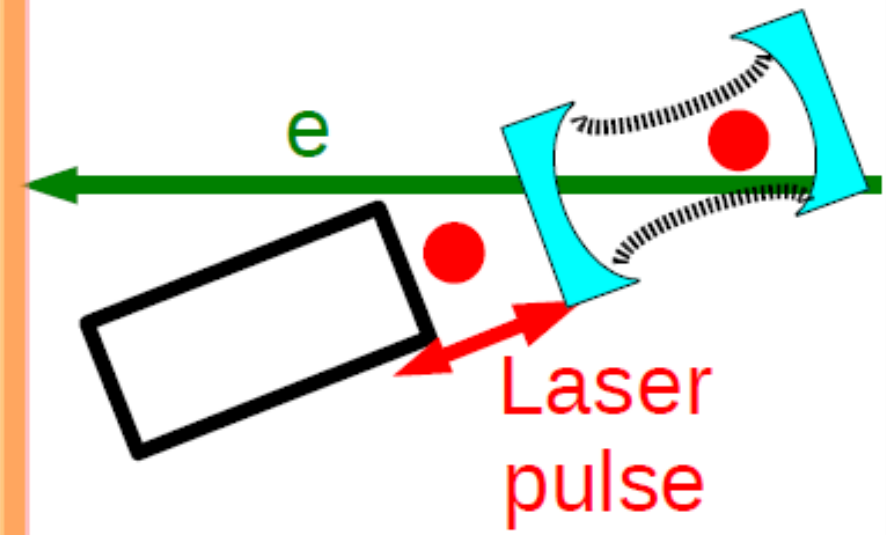


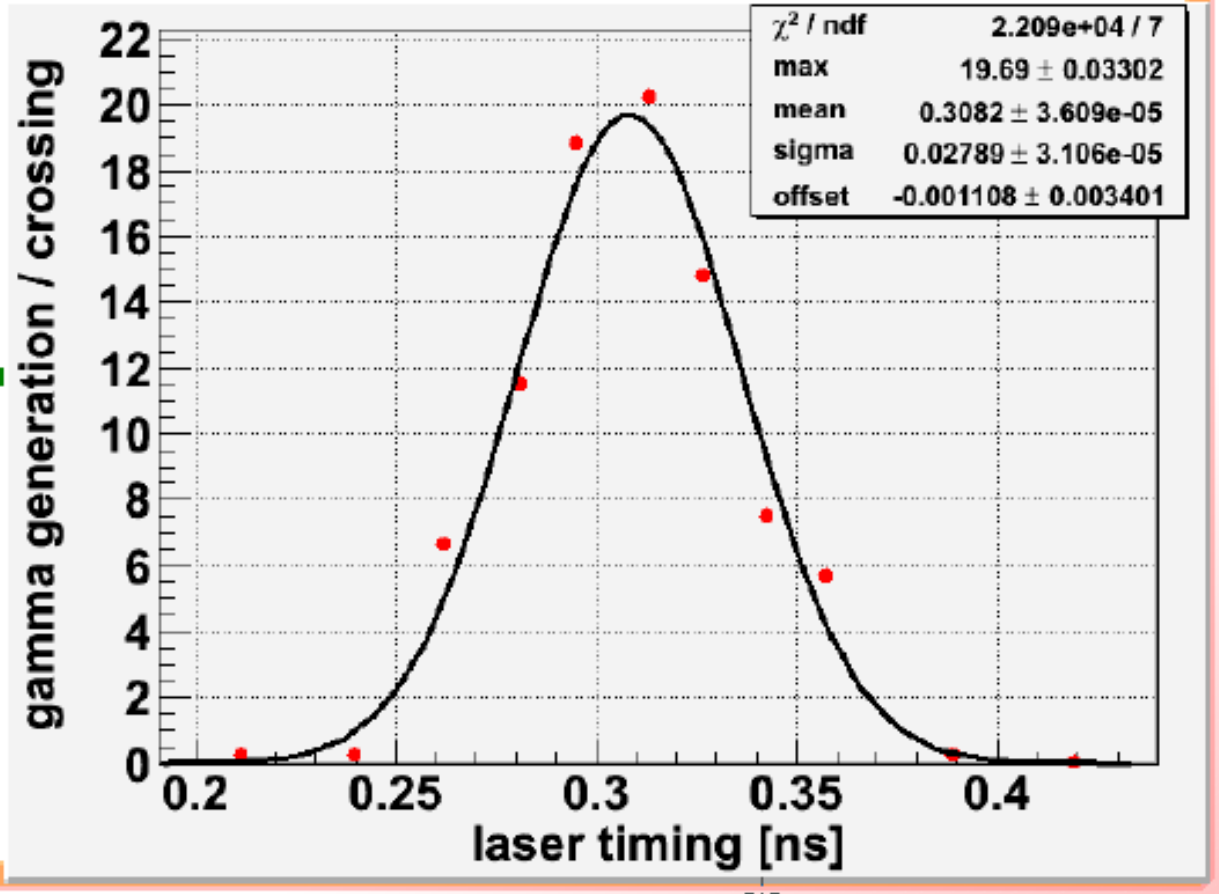


Find Optimum Position

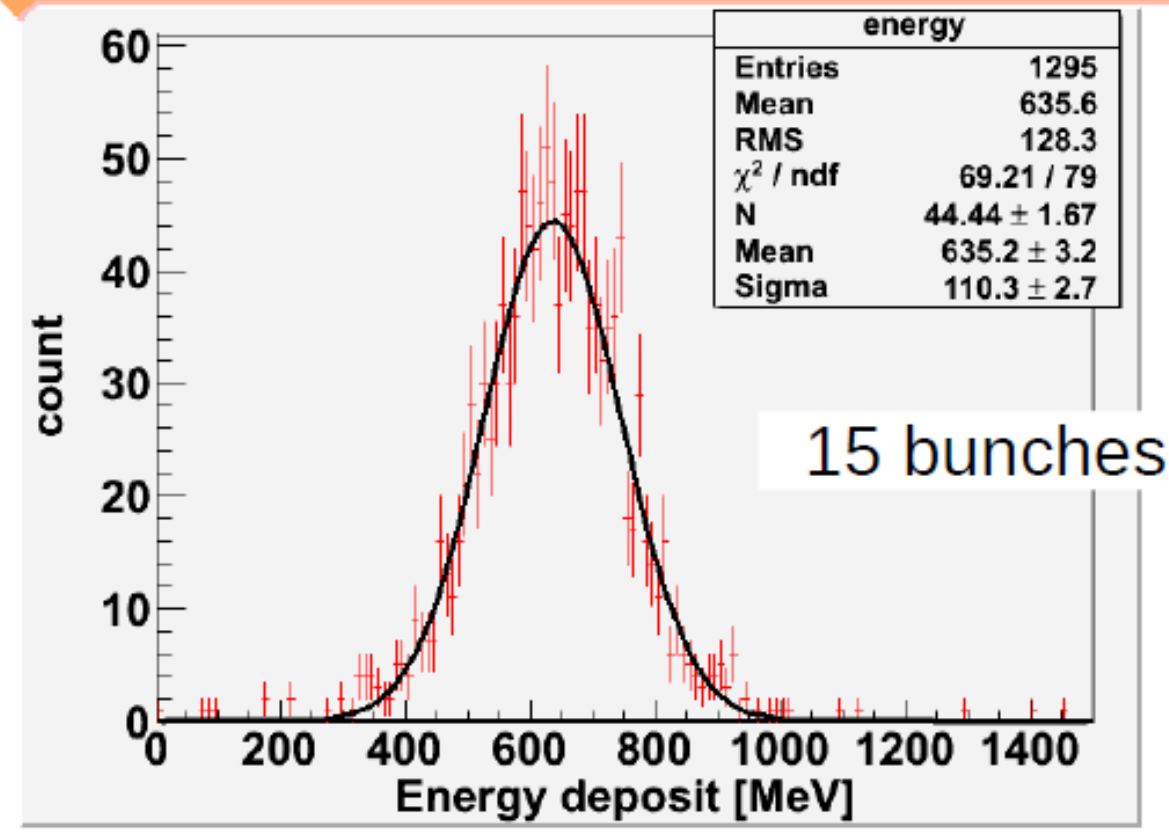
scanning laser pulse timing

--> find optimum 3D (transverse & timing) position for e beam





Result



15 bunches / train

We detected 27 gamma-rays / bunch train.
generation 60 gamma-rays / train to all angle.

60×2.16MHz ~ 1.2×10^8 [gamma / second]

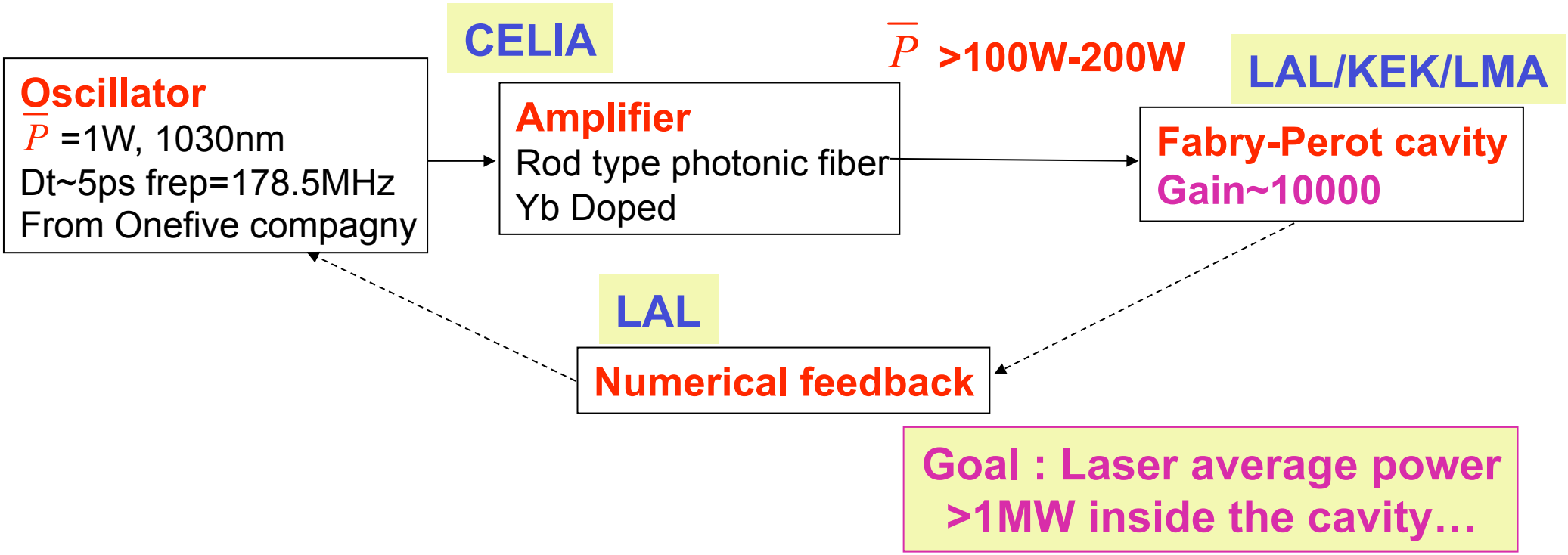
Revolution

Summary of R&D in Japan

- Optical Cavity at the ATF is in progress
  - **Successful to generate gamma rays with**
    - stable operation of the Cavity in the ATF
    - no disturbance for the ATF beams
    - enhancement of 250
    - 27 gammas / crossing
- Short term plan is to get 1000 enhancement by high reflection mirror (99.6% -> 99.9%)
- R&D of 4 mirror ring cavity has been started
  - **aming 10000 enhancement and 5μm sport size**

Four-mirror cavity & high power laser LAL/ Orsay R&D
Funded by ANR beginning 2009

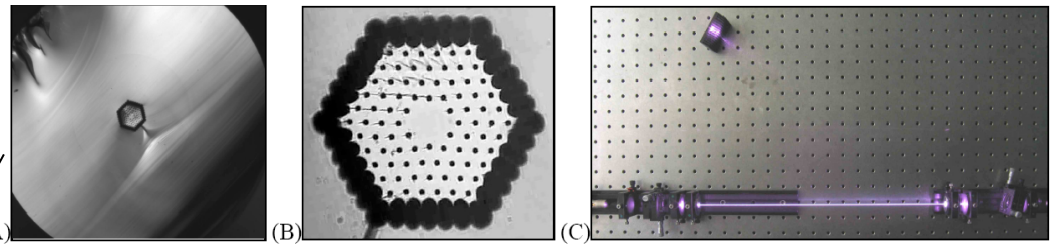
1. Setup the following system at Bordeaux/Orsay



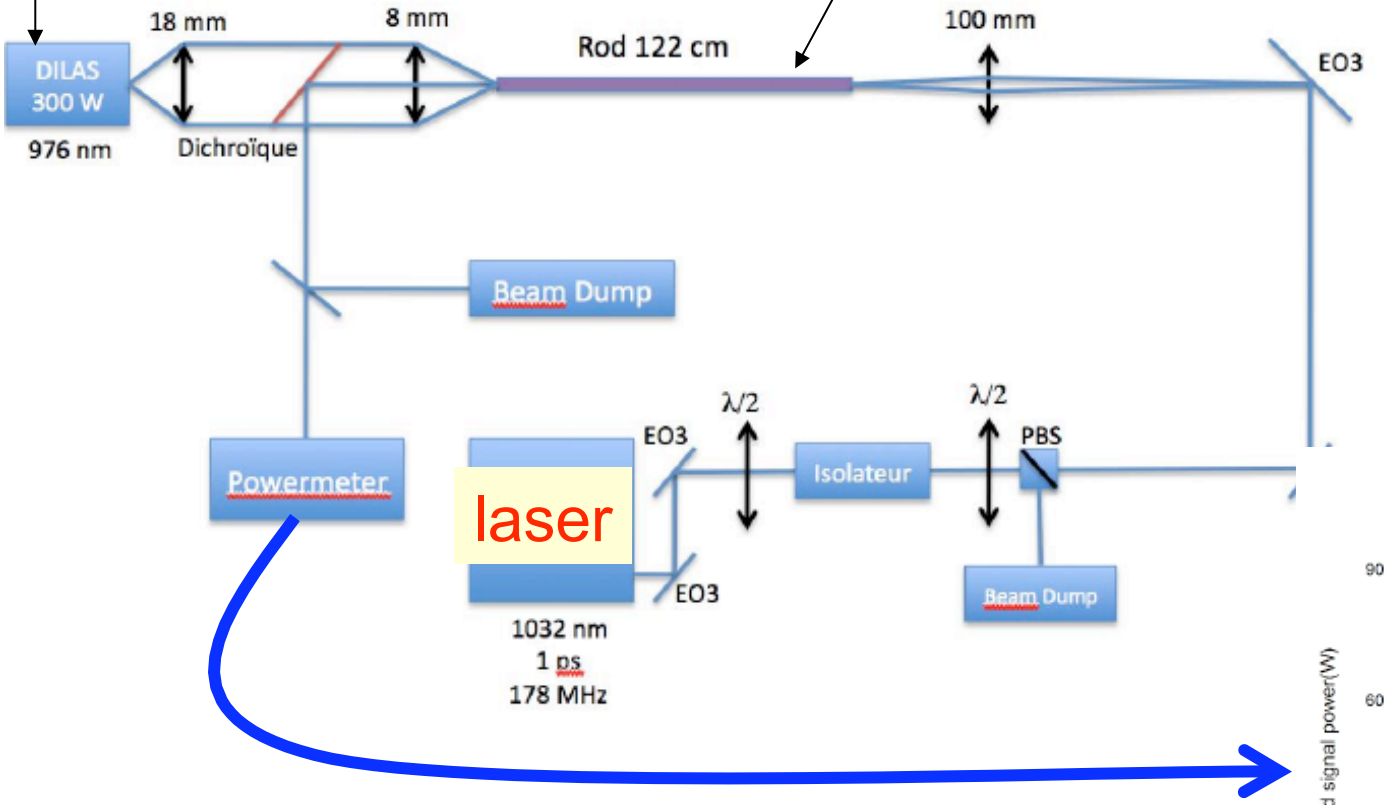
2. Installation of the system at ATF/KEK in collaboration with the ATF group

Laser amplification R&D at CELIA/Bordeaux

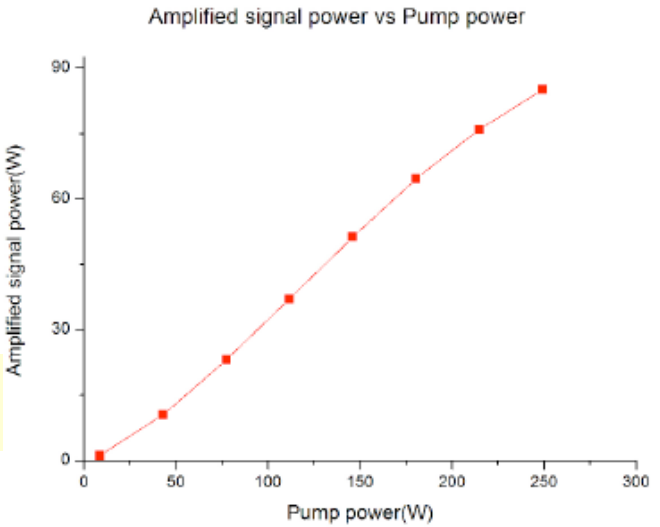
•Laser amplifier = large rod type Yb doped microstructured fibre



400W
pump diode

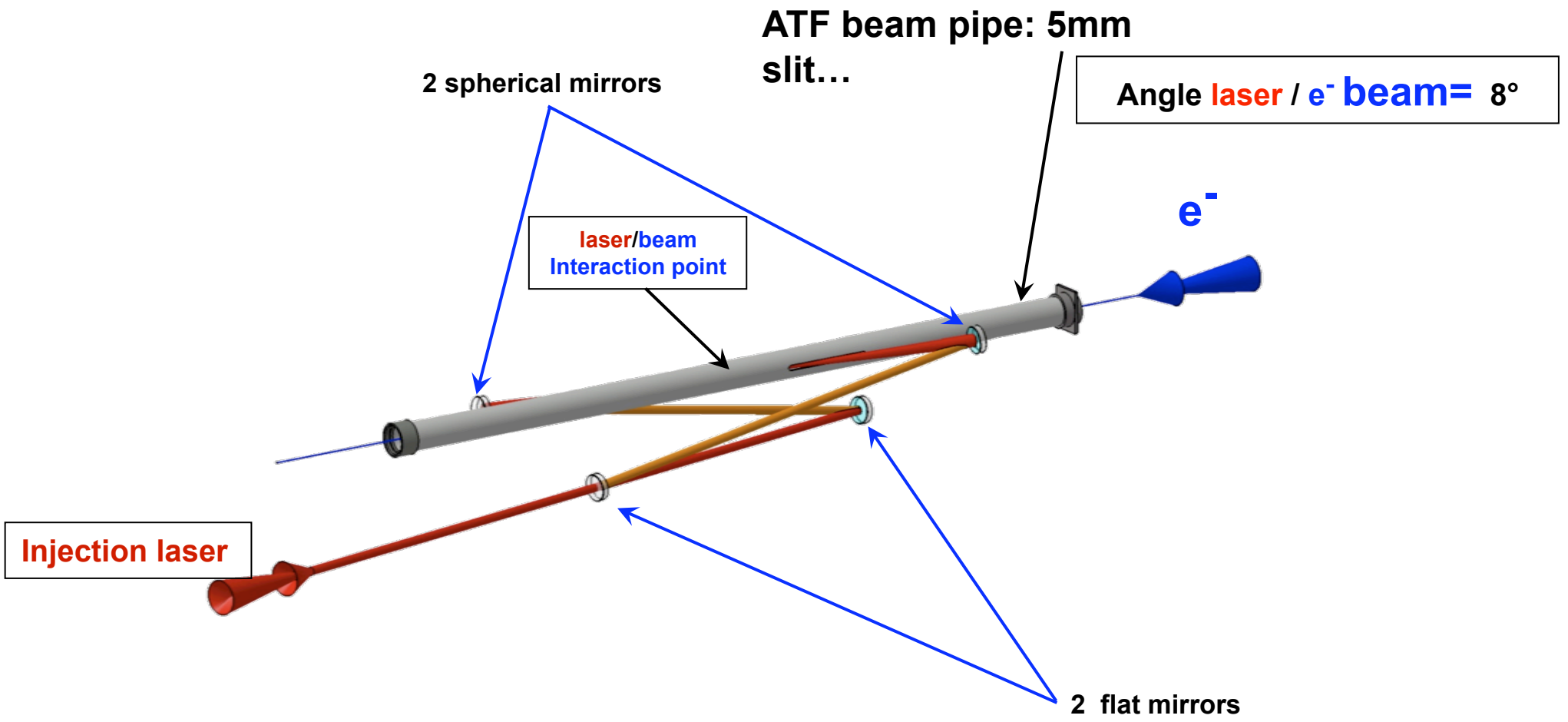


First results
(without CPA)
~100W average
power@178MHz



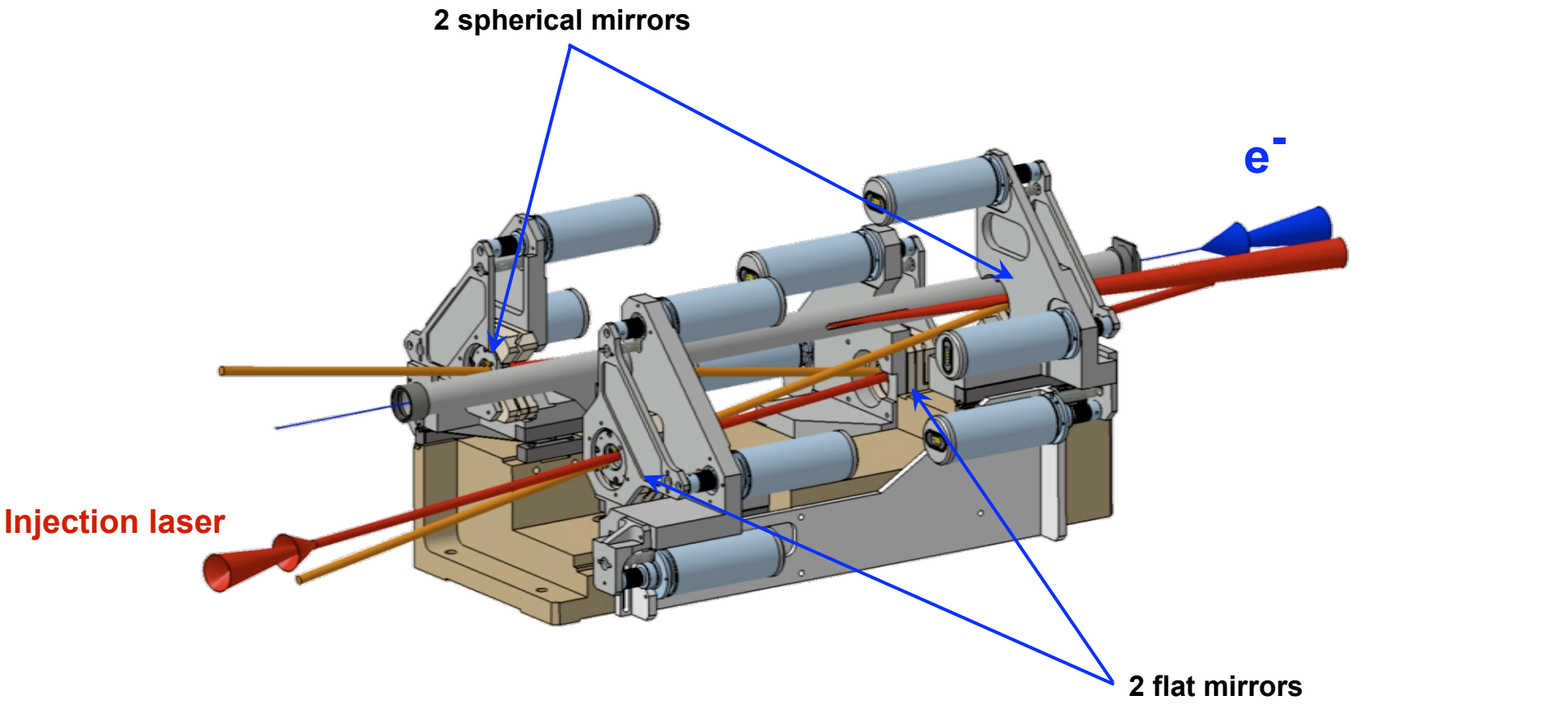
Goal : 150W **stable** average power @ 178MHz

4 mirror cavity design for KEK

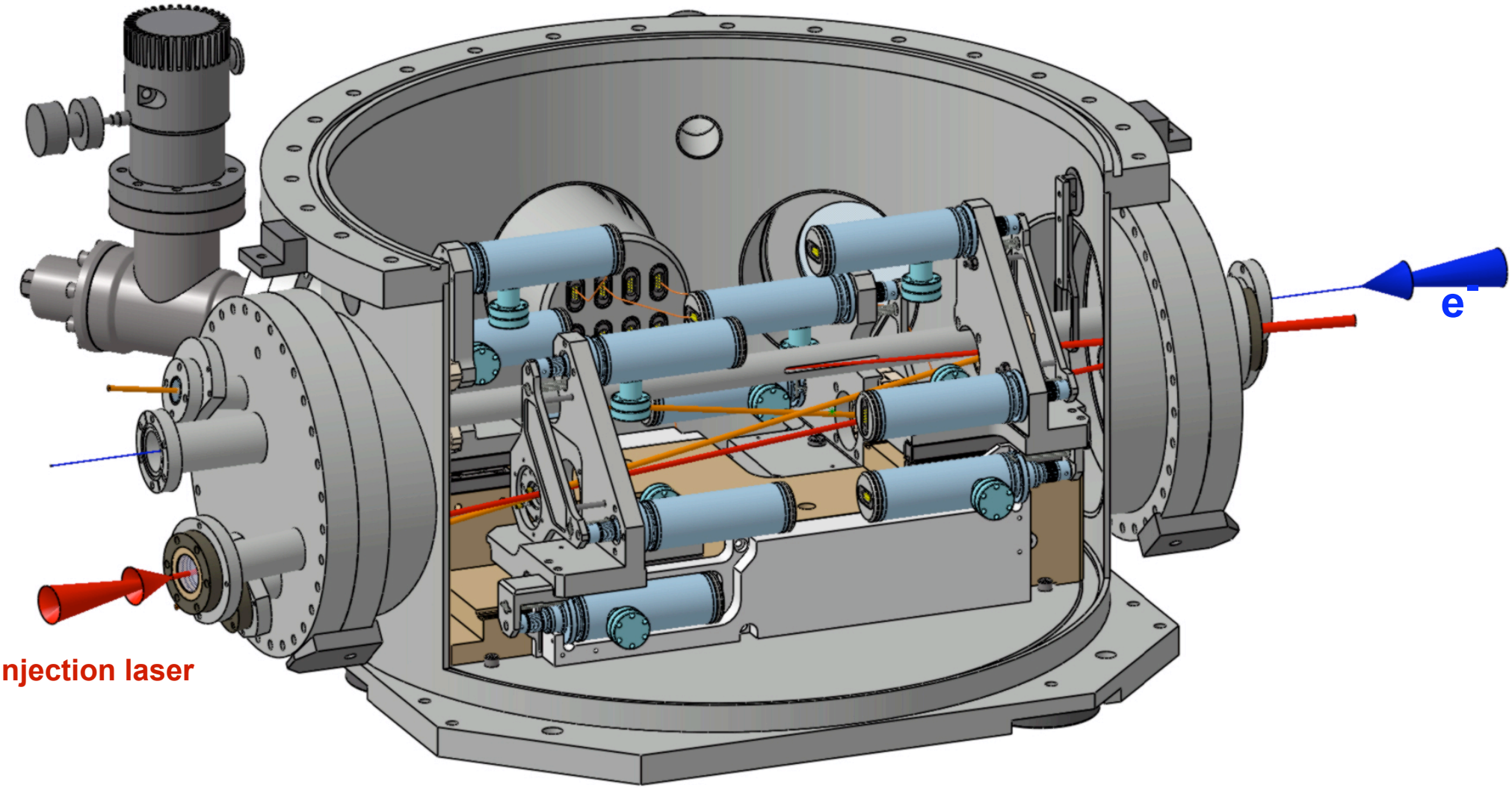


4 mirror cavity for KEK

Mirror positioning system

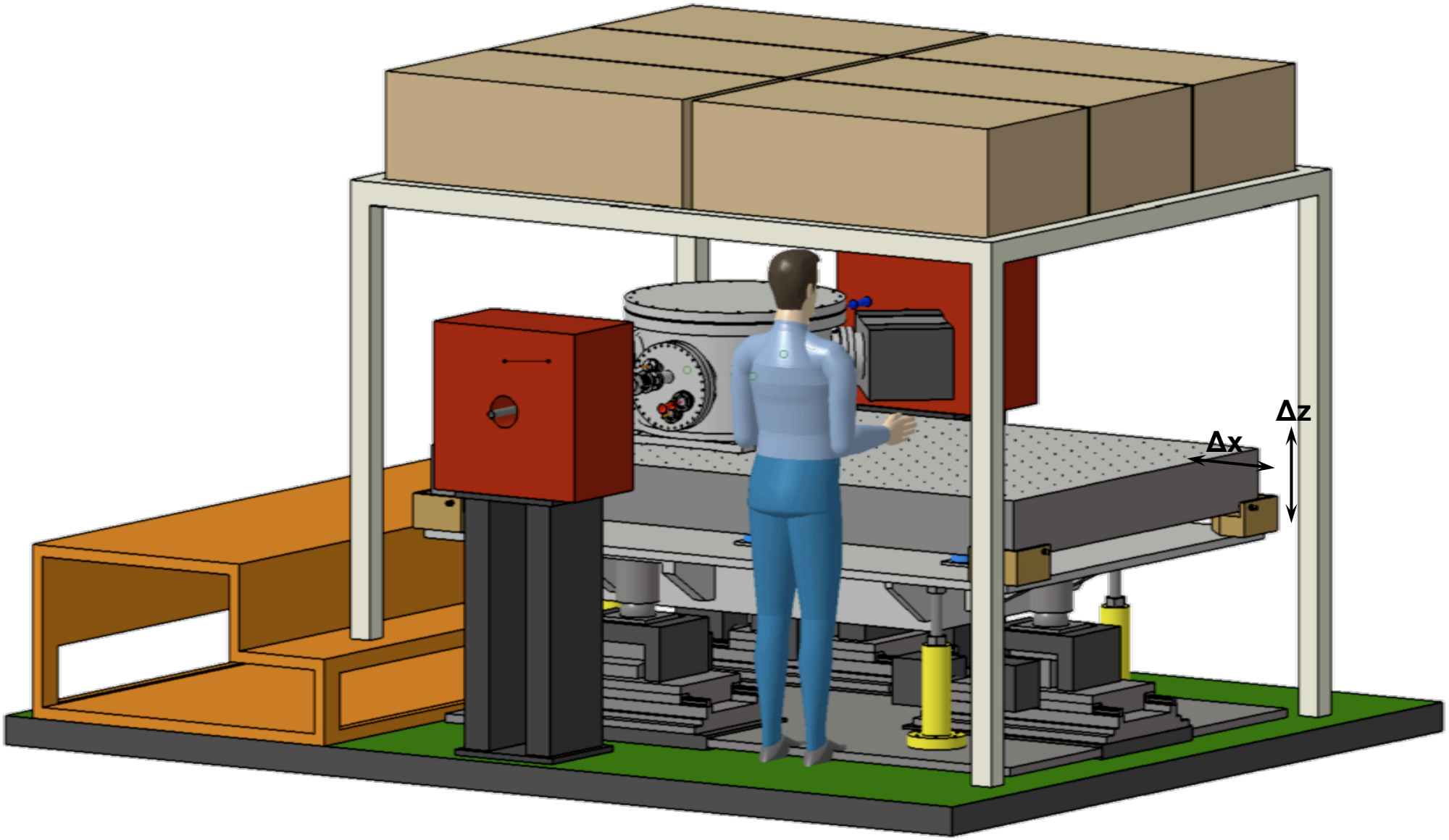


Vacuum vessel for KEK and mirror mounting system



Drawing & tests finished
Construction started (LAL workshop & Caburn Compagny)
➔ will be delivered at LAL on Sept. 2009

Implantation at ATF



Summary of R&D in France

- At CELIA and LAL work has started on
  - Laser amplification
  - Four mirror cavity construction
- Funded by the french agency ANR
- Planning
  - Technical mission CELIA&LAL→KEK: () July 2009
  - Cavity assembly at LAL: Sept. 2009
  - Injection of high 150W laser: Oct. 2009
  - Installation at KEK : summer 2009

    ➔Funding will be requested for technical missions at KEK in 2010