Photon Collider testbed at ATF2
~a possible plan~

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Lasers for Photon Colliders

- have to meet
  - **5J/pulse**
  - **337ns separaton 3000bunches/train**
  - **5Hz**

- simple estimate of cost for the laser
  - **to pump 5J ×3000 pulses in 1ms**

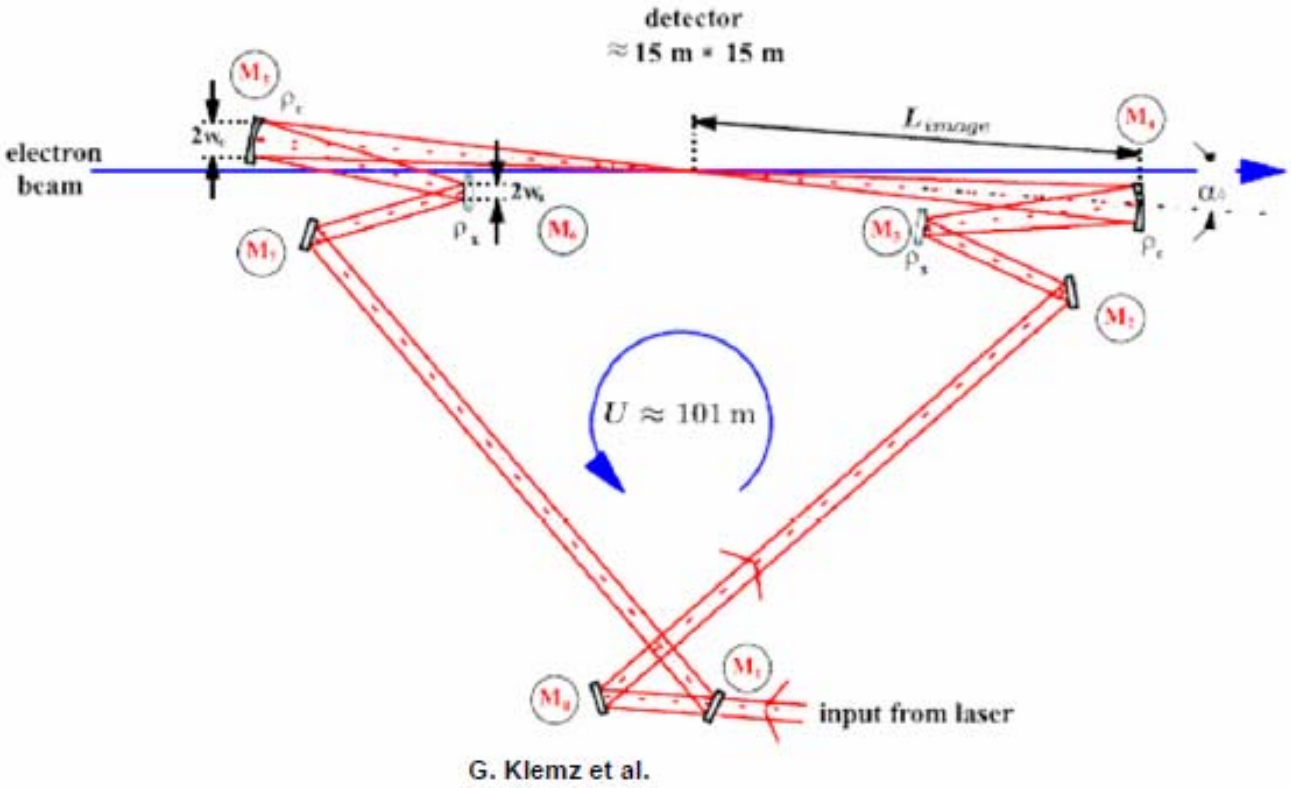
$$pumping \quad power = \frac{5J \times 3000}{1ms \times eff\ (0.3)} = 50MW \square \$250M$$

$5/w

A recirculating cavity can simplify the laser by reducing the required power

Gronberg

Stacking cavity design from MBI / DESY- Zeuthen is designed to reach 9J per bunch



G. Klemz et al.

Laser requirements:

- 5 Hz operation
- 1000+2820 bunches / train
- 40mJ / pulse
- 764 W average power
- 119 kW peak diode power

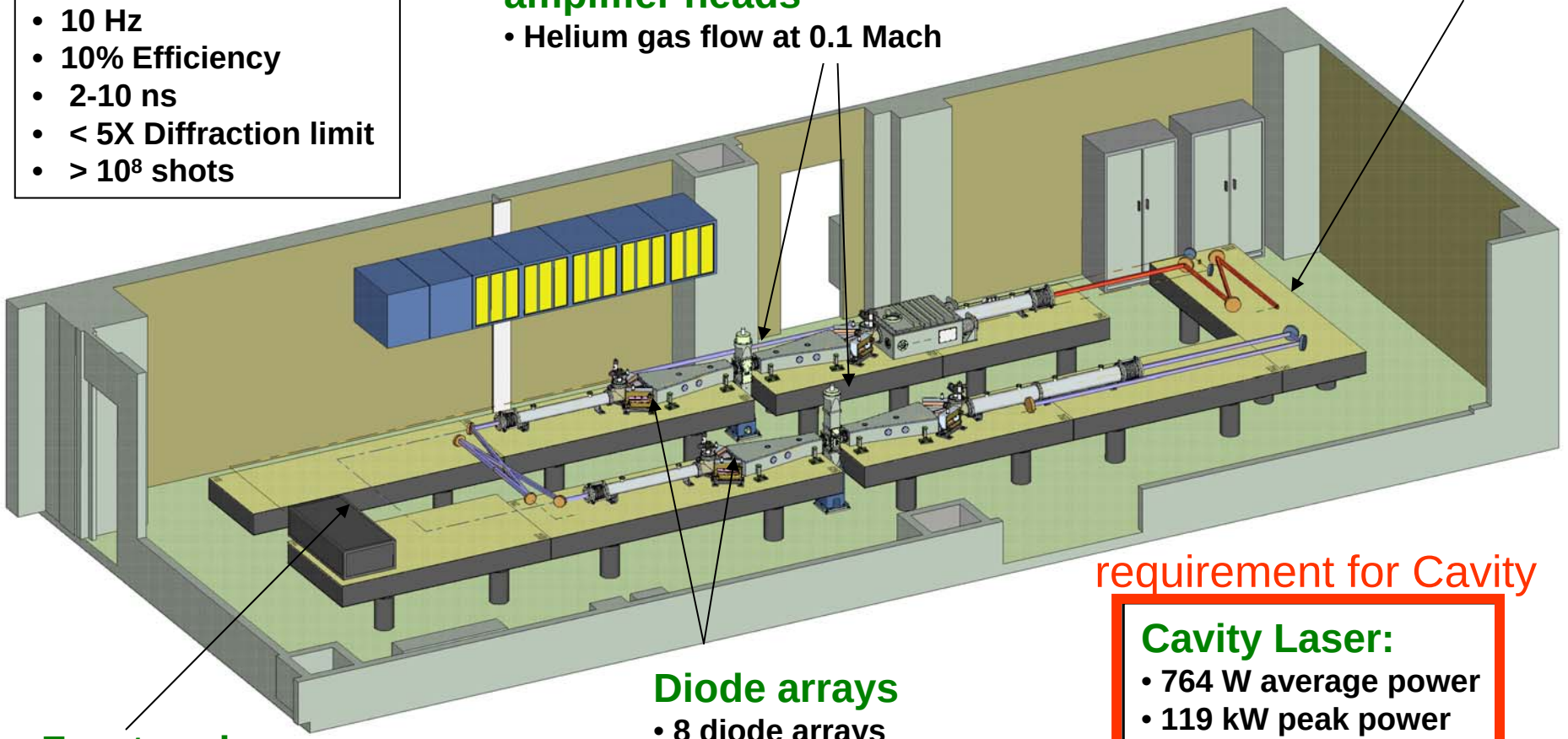
The MERCURY laser already has more average power than we need

Goal:
- 100 J
- 10 Hz
- 10% Efficiency
- 2-10 ns
- < 5X Diffraction limit
- > 10^8 shots

Gas-cooled amplifier heads
- Helium gas flow at 0.1 Mach

Gronberg

Output



Front-end
- 300 mJ

Diode arrays
- 8 diode arrays
- 6624 diodes total
- 730 kW peak power

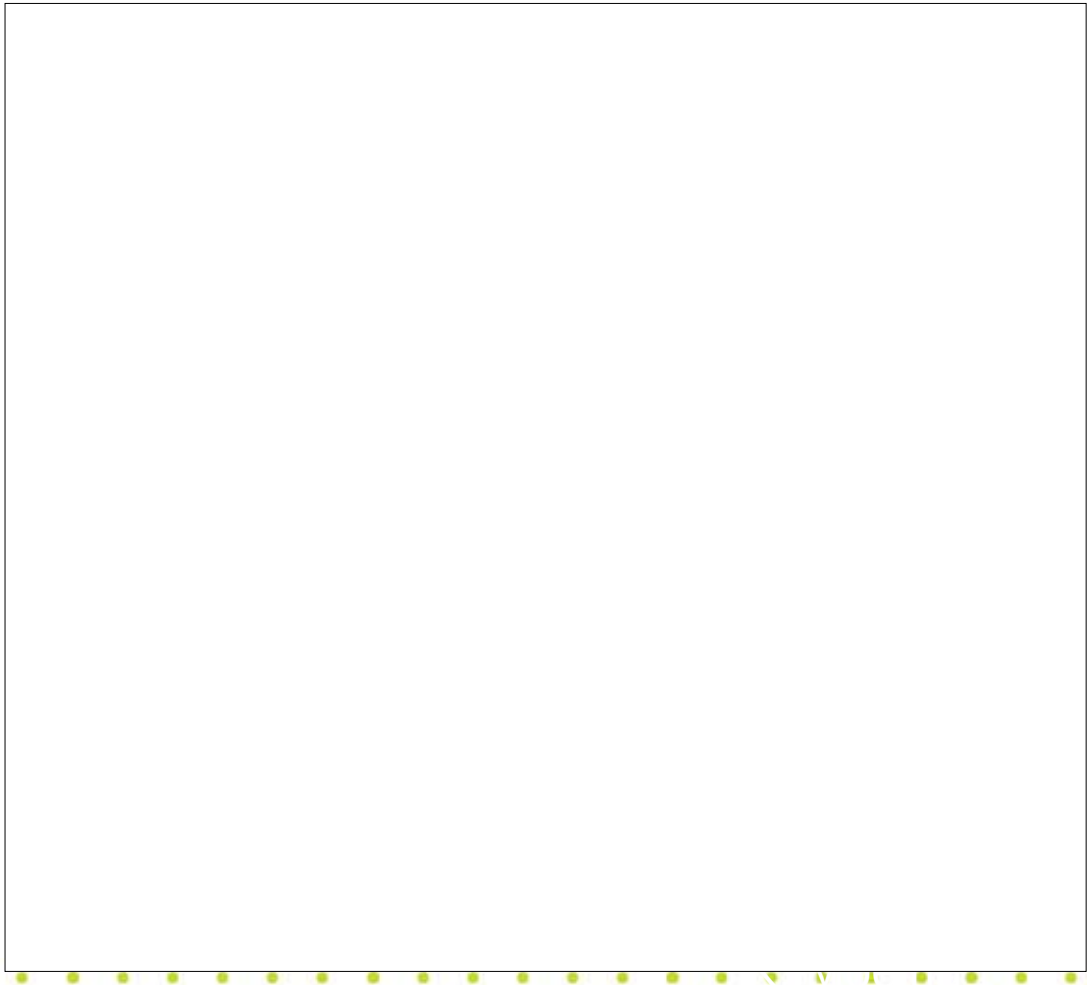
requirement for Cavity

Cavity Laser:
- 764 W average power
- 119 kW peak power

Pulse Stacking Cavity

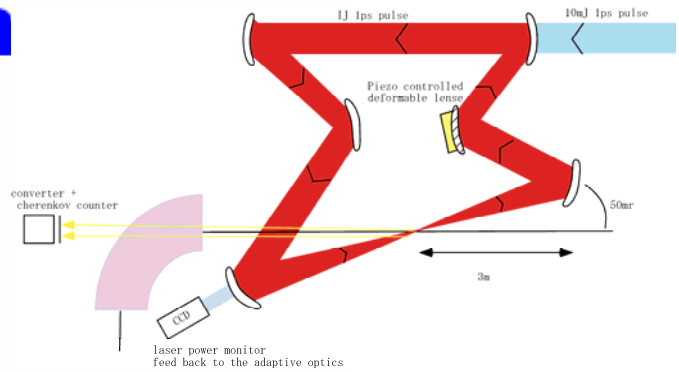
- need extensive R&D
  - power enhancement
  - focus down to 5 mm

w/ 100 long ring cavity
is challenging

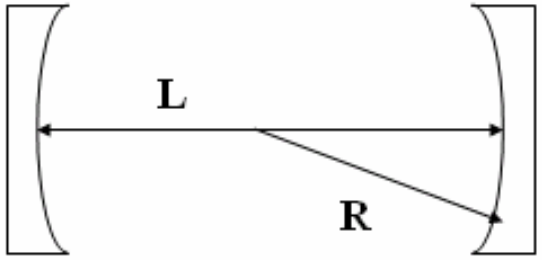


tolerance is very small

Laser stacking cavity with Two Spherical Mirrors



Choice of R and spot size



$L = 420.00$ mm

resonator is stable here

Omori

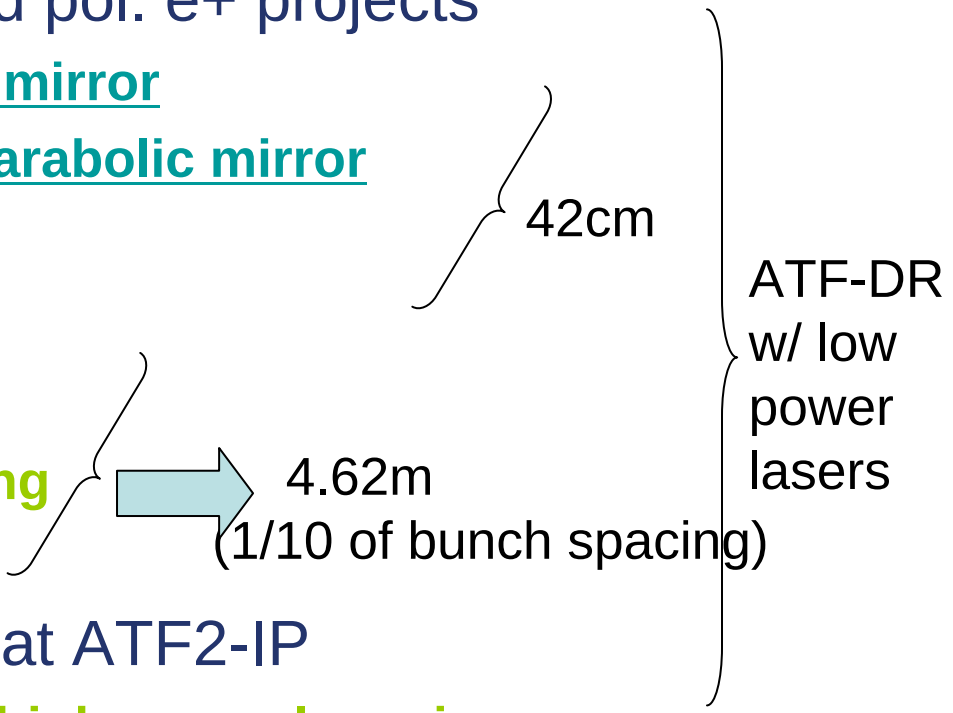
Mirror R (mm)	rms laser spot size (micron)
250	88
211	35
210.5	30
210.1	20
210.01	11
210.001	6

R have to be exactly L/2

Step by step plan

1. Cavities for Compton based pol. e+ projects
   - **Fabry-Perot type spherical mirror**
   - **Fabry-Perot type off-axis parabolic mirror**

2. Extension of pol. e+ cavity
   - **×10 scale of Pol e+**
   - **ring cavity for 154ns spacing**

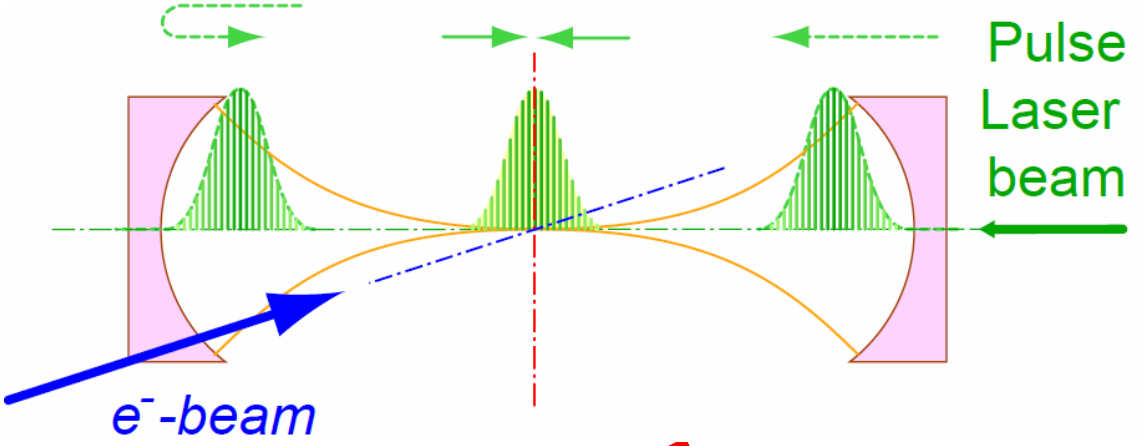


3. Cavity w/ high power laser at ATF2-IP
   - **not possible at ATF-DR as high power laser is destructive target**

4. 100m size will be tested w/o e- beam

Plan: Exprmntl R/D at ATF

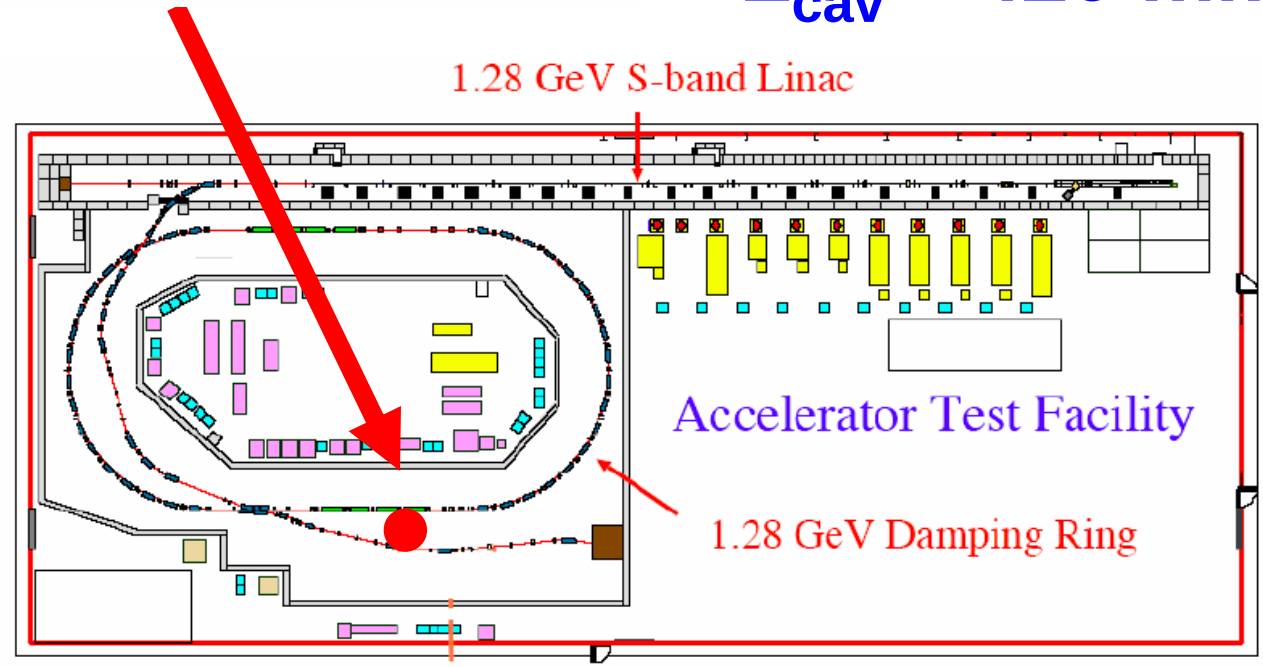
Hiroshima-LAL-IPN-CERN-Kyoto-Waseda-KEK Omori



Make a fist prototype single cavity

L_{cav} = 420 mm

Put it in ATF ring



Laser Pulse Stacking Cavity

Omori

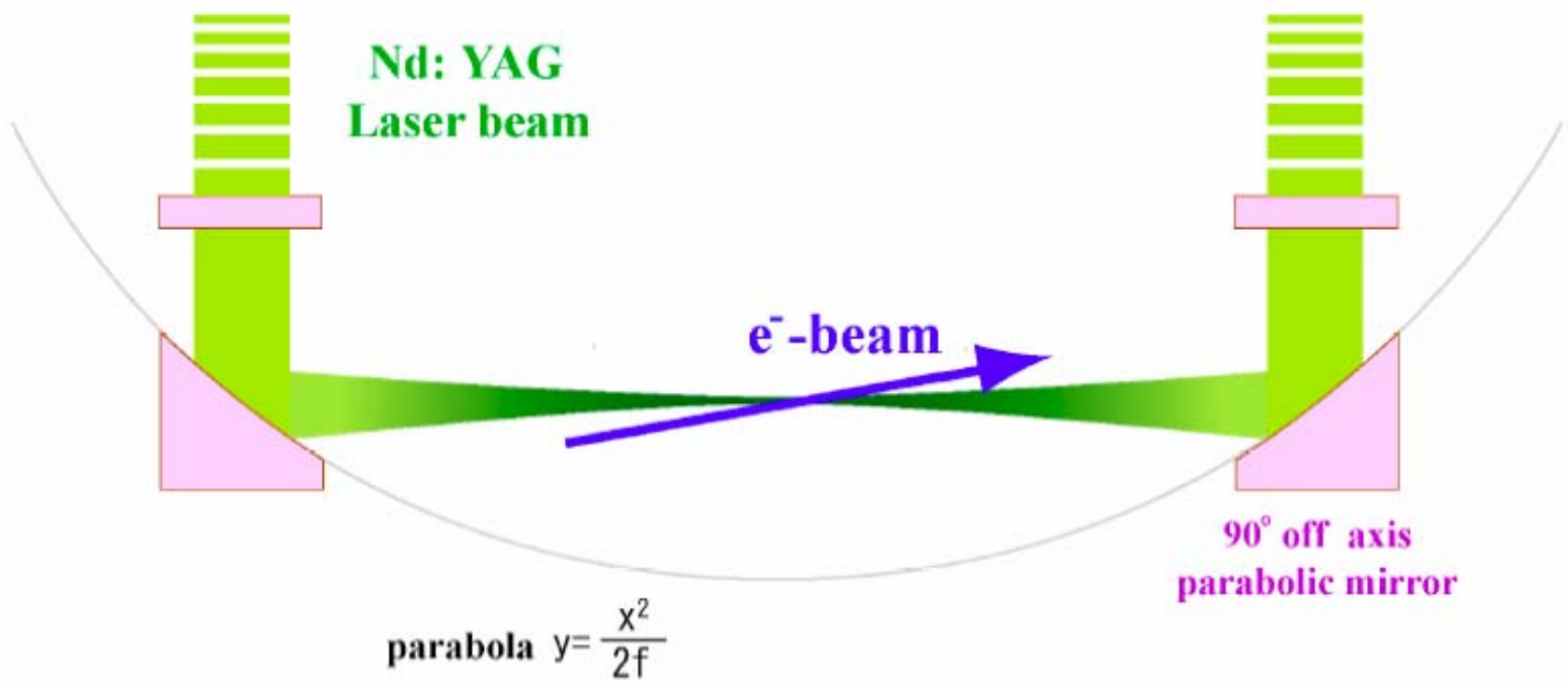
Fabry-perot Resonator

Input laser (YAGlaser)

- Energy 0.75 mJ / bunch
- 3.077 nsec bunch spacing
- train length = 50 μsec

Cavity

- Enhancement Factor =1000

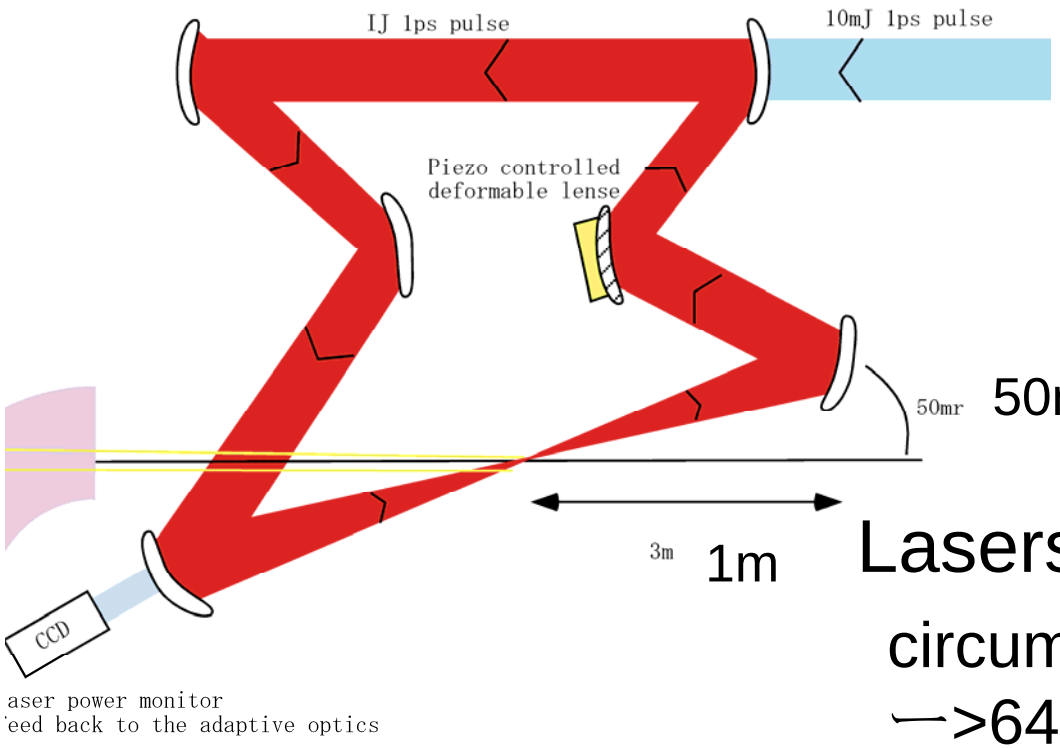


Laser pulse in cavity

- 750 mJ/bunch
- single bunch in a cavity

Ring cavity at ATF-DR

-after we learn a lot from PosiPol cavities-



For 154ns spacing:
1/10 scale (15.4ns)

A laser pulse hits once in
10 turns

Lasers

circumference 4.62m (15.4ns)
—>64.9MHz

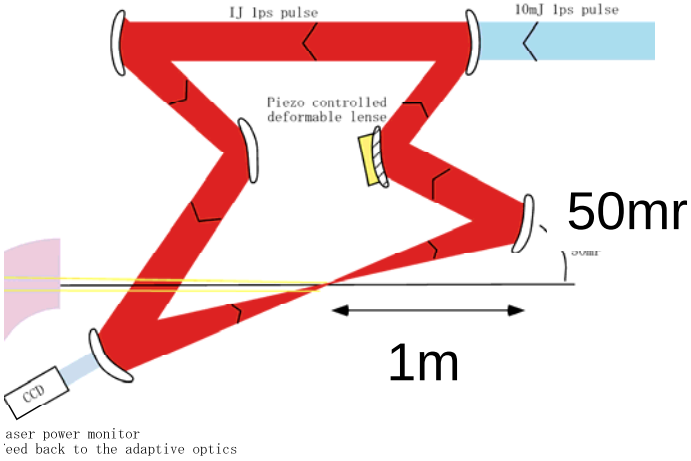
very similar to
PosiPol experiment

10W mode locked,,,154nJ/pulse
->15.4μJ/pulse w/ 100 pulse stacking

2400γ/xing

Ring cavity+High power at ATF2-IP

Cavity can be the same as ATF-DR but the laser is not



we want 50mJ/pulse for the laser (5J/pulse in cavity)

⇒ 64.9MHz ×50mJ=3.245kW

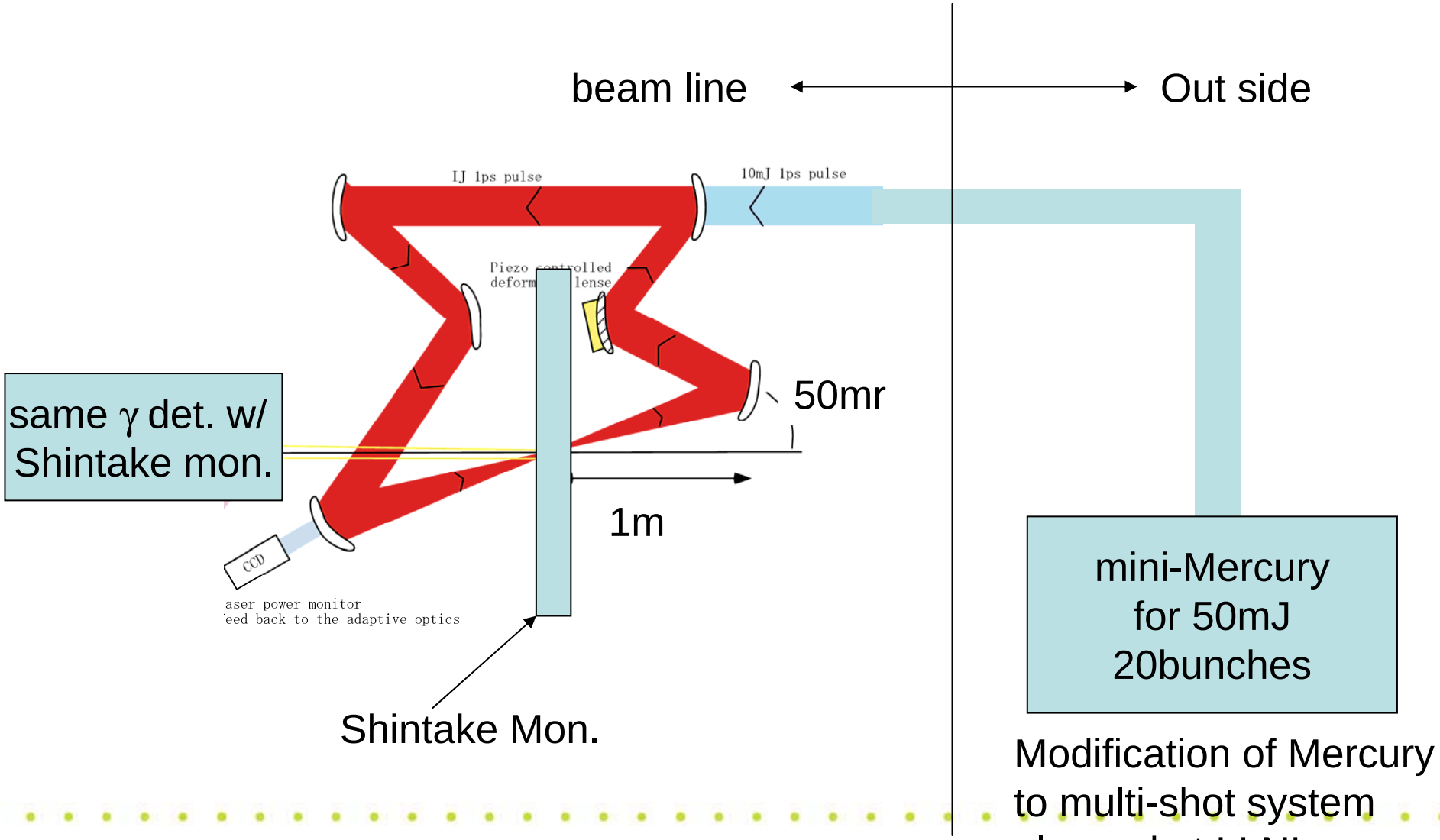
Continuous pumping (64.9MHz)of the cavity is not wise:
just for 20 bunches (for a train)

Average power = 50mJ×20×repetition = as low as 1W (or less)

Peak laser pumping power = $\frac{50mJ \times 20}{1ms \times eff\ (0.3)} = 3.3kW$

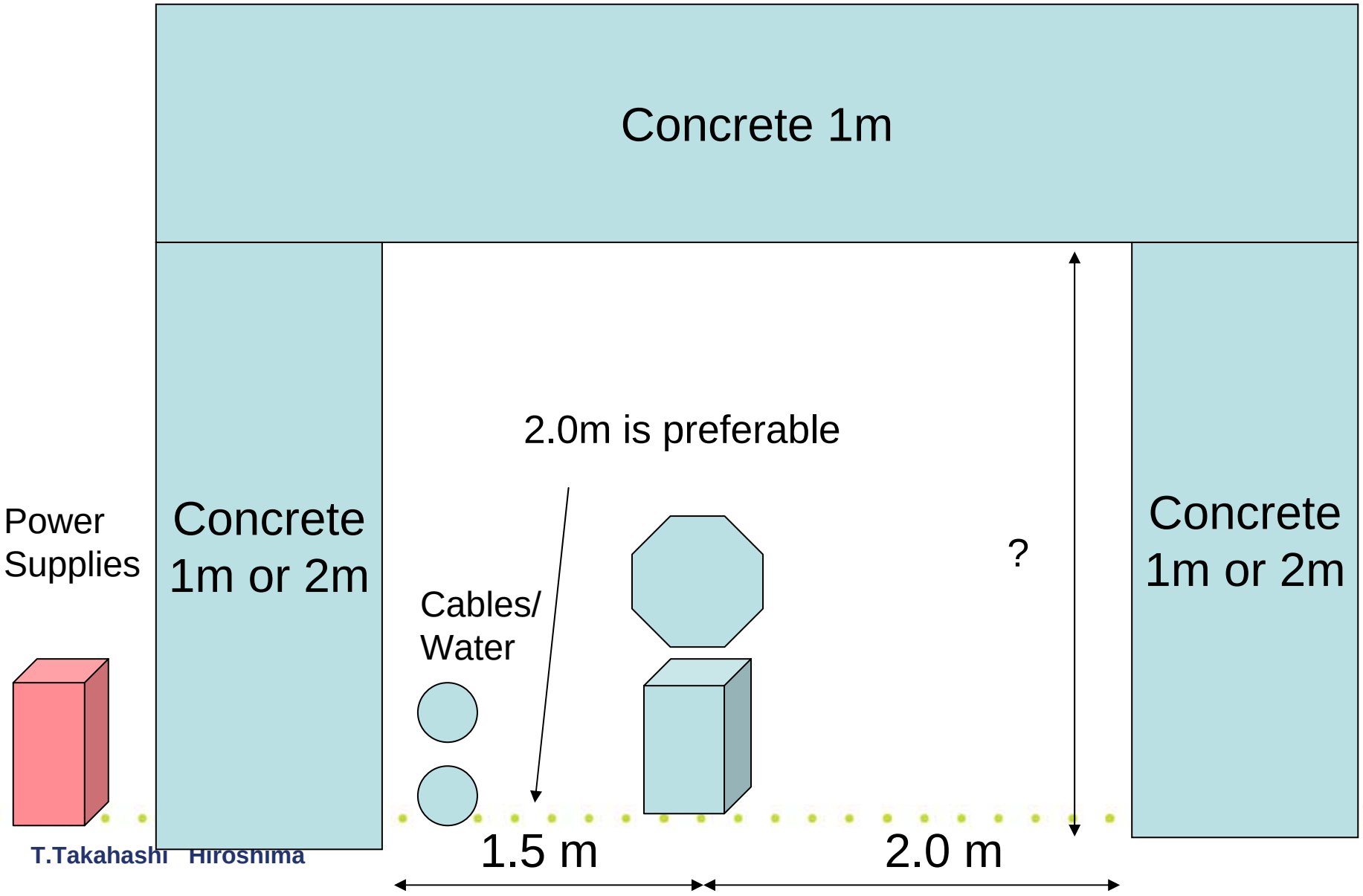
need mini-Mercury amplifier?

Possible Plan at ATF2-IP

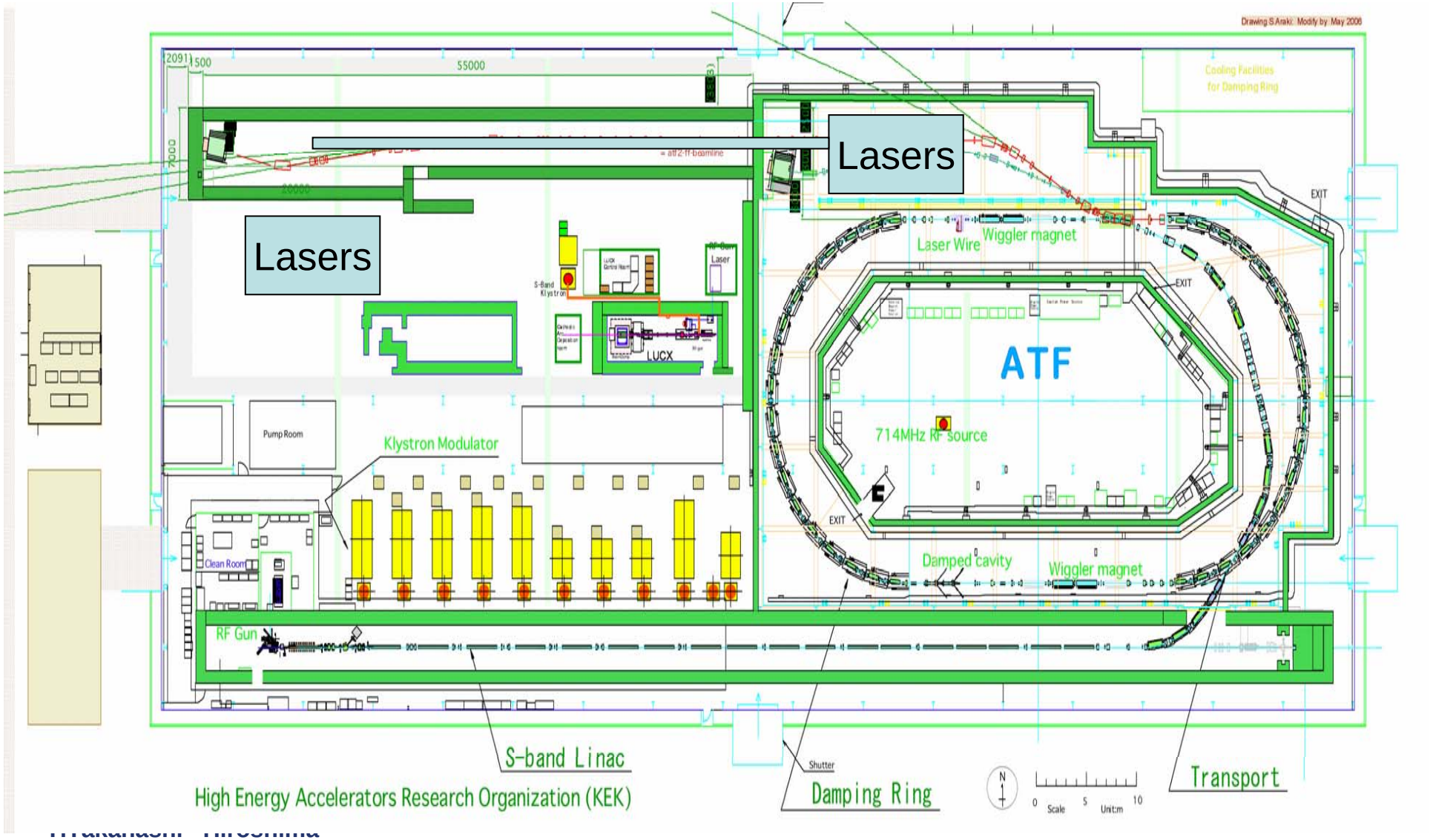


Modification of Mercury to multi-shot system planned at LLNL

IP Area


Concrete 1m
Concrete 1m or 2m
Concrete 1m or 2m
2.0m is preferable
Power Supplies
Cables/ Water
?
1.5 m
2.0 m

ATF2-Layout


Lasers
Lasers
ATF
Laser Wire
Wiggler magnet
714MHz RF source
Damped cavity
Wiggler magnet
Klystron Modulator
Pump Room
Clean Room
RF Gun
LUCX
S-band Linac
Damping Ring
Transport
Cooling Facilities for Damping Ring
EXIT
High Energy Accelerators Research Organization (KEK)

Summary

- Starting after pol e- experiment at ATF-DR
  - **×10 scale cavity,,, O(\20M?)**
  - **same level laser ,,, ~\20M**

  } 2008 ~2009?

- ATF2-IP
  - **same cavity**
  - **same laser**
  - **install mini-Mercury O($M? , M?)**

  } 2009 2010?

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