

Short SR Pulses on UVSOR-II

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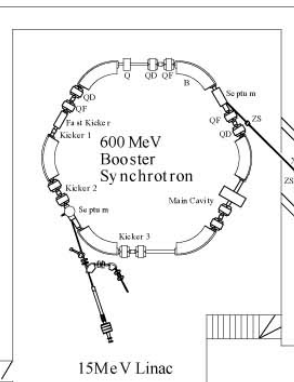
- **Introduction (UVSOR-I and II)**
- **Low- α Operation**
- **Harmonic Cavity**
- **Free Electron Laser**
- **Bunch Slicing**
- **Summary**

History of UVSOR

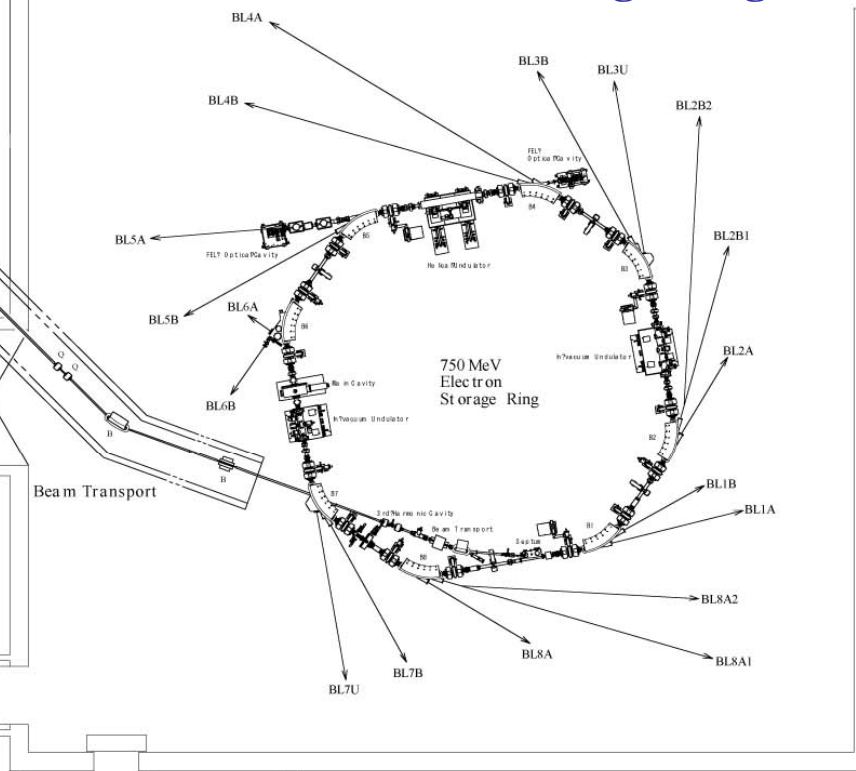
- 1981** Start of Construction
- 1983** Commissioning of Storage Ring
- 1984** Installation of Insertion Devices (undulators and a wiggler)
- 1986** Start of Free Electron Laser
- 1993** FEL 1st Lasing (456 nm)
- 1996** Installation of Helical Undulator / Optical Klystron
FEL Lasing at 239 nm (World Record)
- 2001** FEL Output Power 1.2W (World Record)
- 2002** Installation of an in-vacuum undulator
Start of Users Experiments on FEL
- 2003** Reconstruction to UVSOR-II
Commissioning of UVSOR-II
- 2004** Start of Coherent Terahertz Observation
- 2005** Upgrade of RF Cavity
Start of Bunch-Slicing Experiment
- 2006** Upgrade of Booster Synchrotron to “full energy”

UVSOR Accelerator Complex

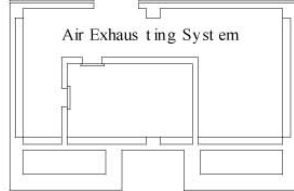
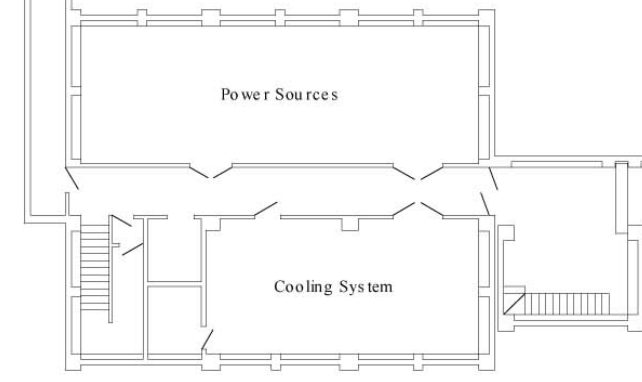
**600MeV Booster
Synchrotron**



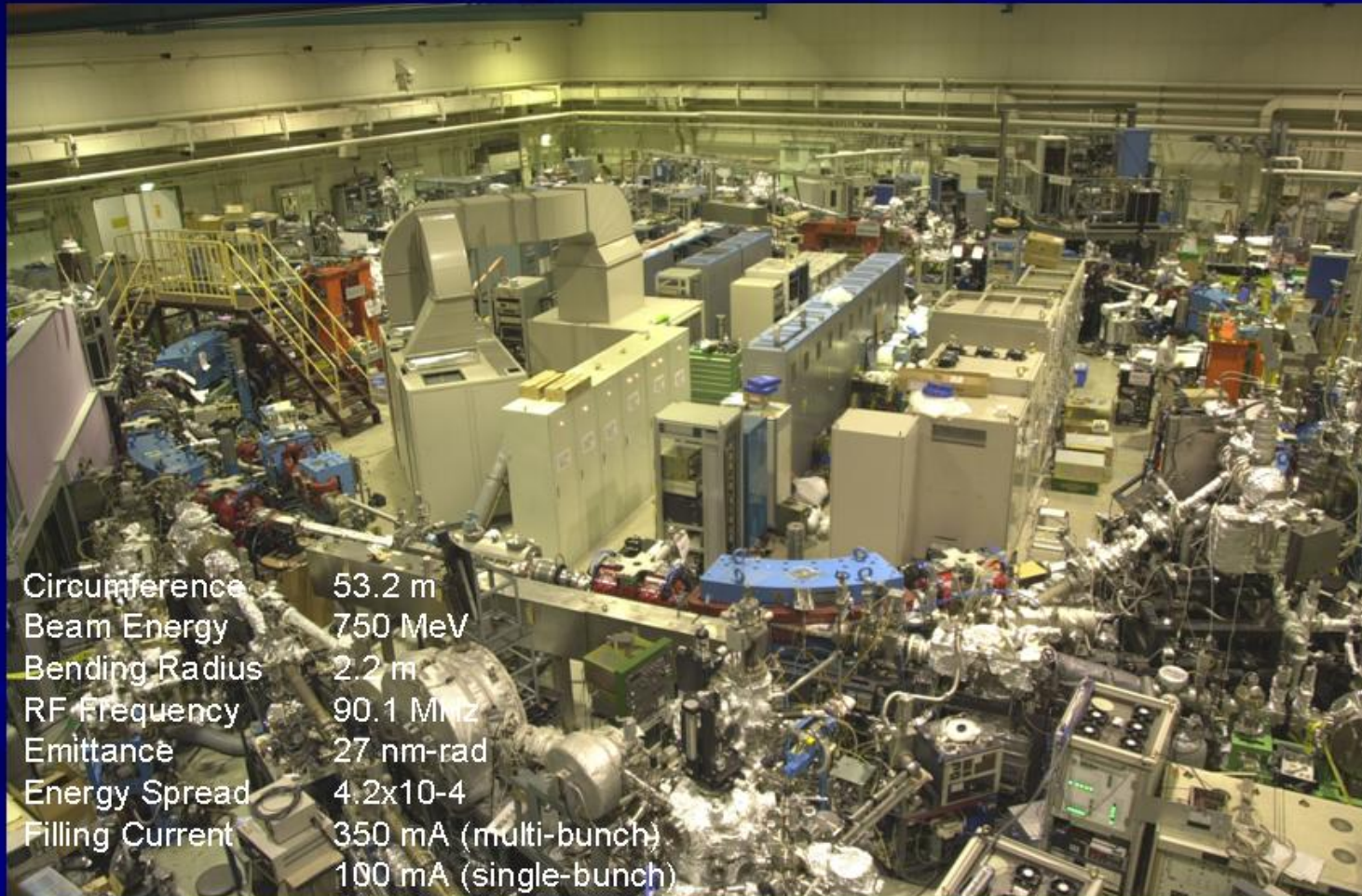
750MeV Storage Ring



15MeV Linac



UVSOR-II Storage Ring and SR Beam-lines



Circumference	53.2 m
Beam Energy	750 MeV
Bending Radius	2.2 m
RF Frequency	90.1 MHz
Emittance	27 nm-rad
Energy Spread	4.2×10^{-4}
Filling Current	350 mA (multi-bunch) 100 mA (single-bunch)

Configuration of UVSOR-II Storage Ring

Present RF cavity
(will be removed
in spring 2005)

In-vacuum
Undulator (1m)

Harmonic
Cavity

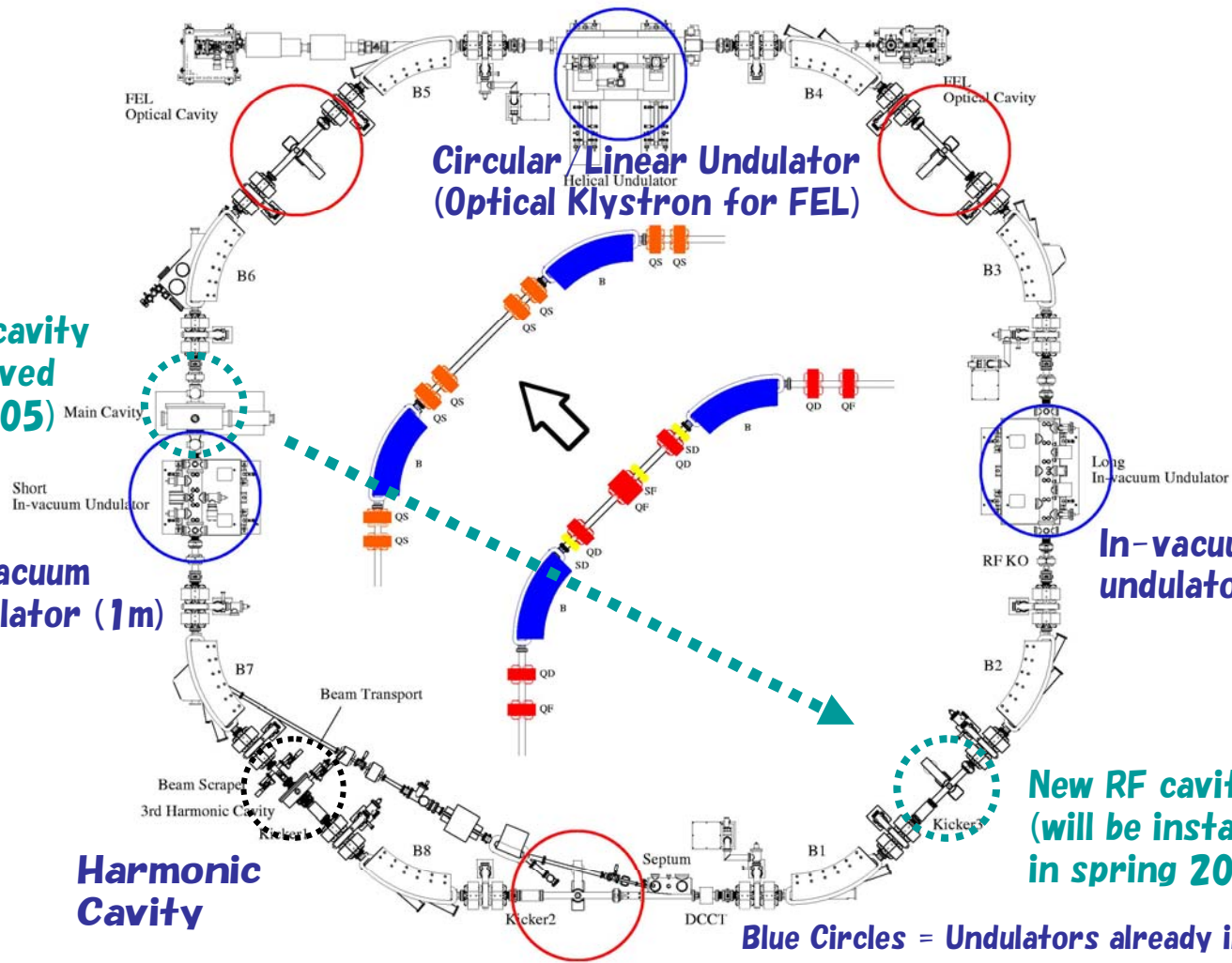
Circular/Linear Undulator
(Optical Klystron for FEL)

In-vacuum
undulator (2m)

New RF cavity
(will be installed
in spring 2005)

Blue Circles = Undulators already installed

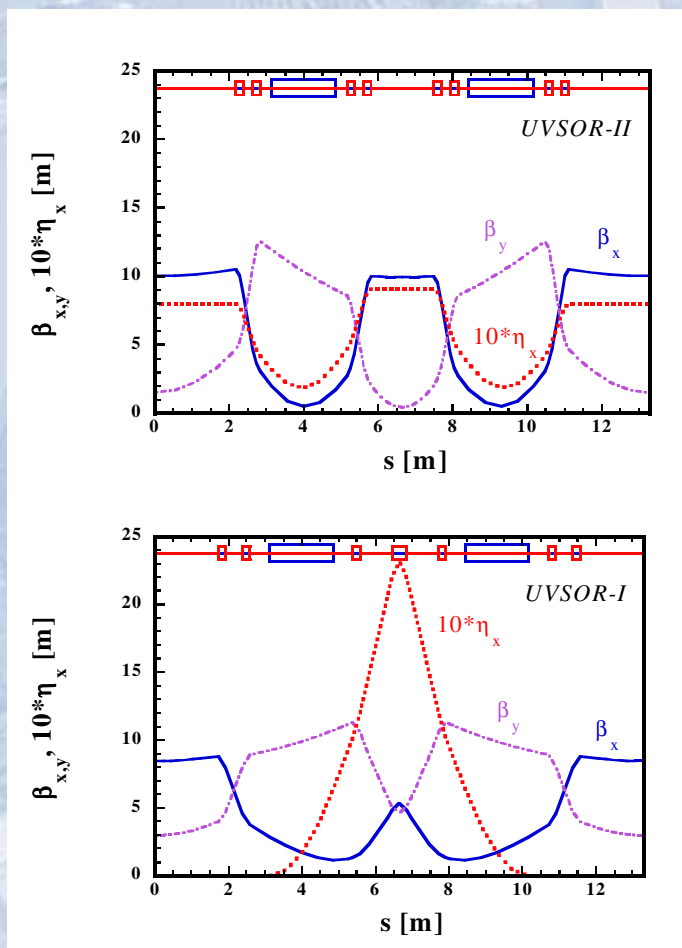
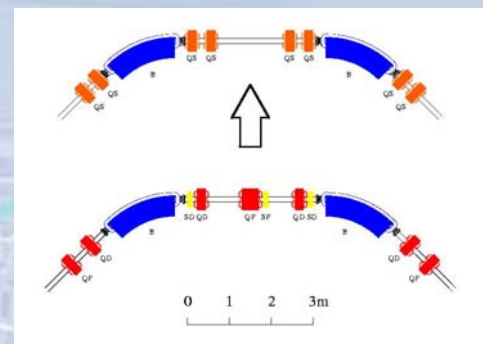
Red Circles = reserved for future Undulators



Beam Optics of UVSOR-I&II

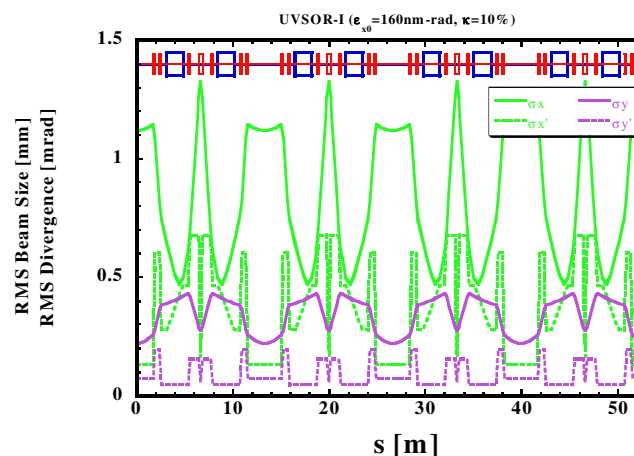
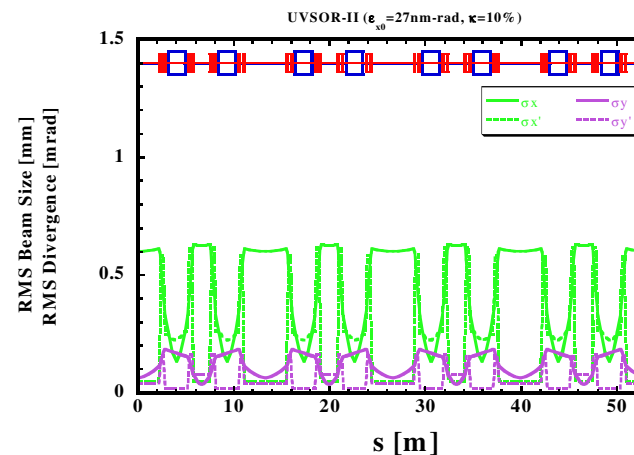
UVSOR-II

UVSOR-I



UVSOR-II
 $\epsilon_{x0}=27\text{nm-rad}$

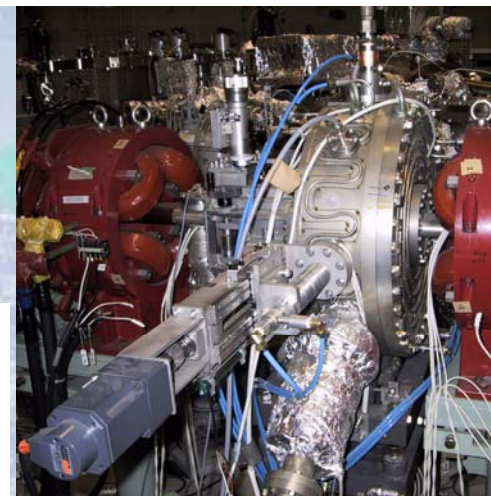
UVSOR-I
 $\epsilon_{x0}=160\text{nm-rad}$



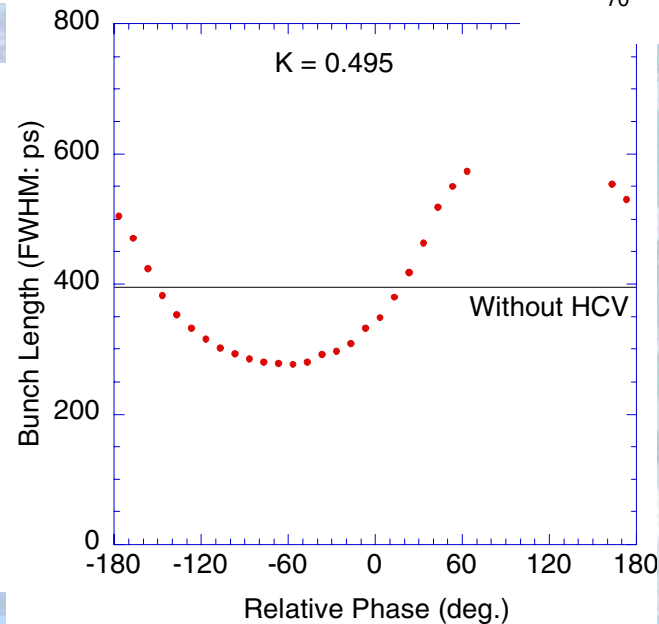
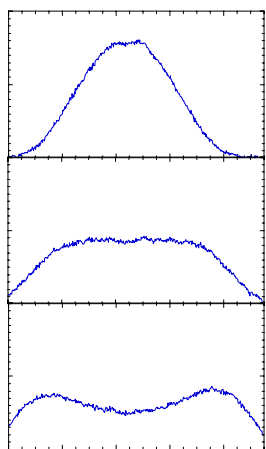
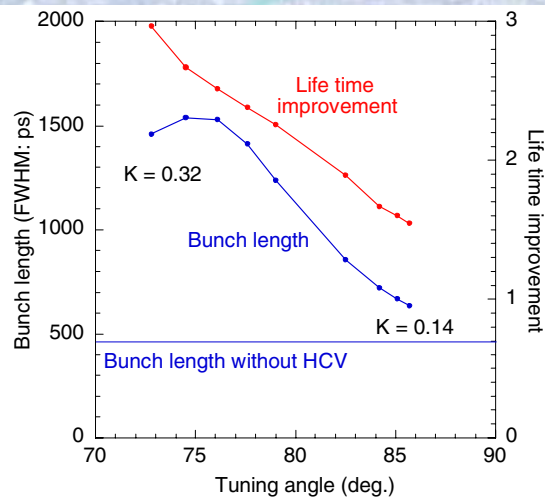
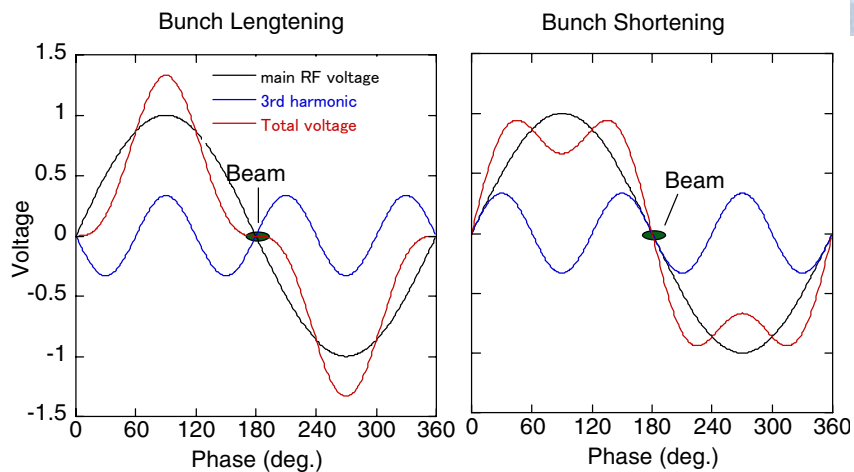


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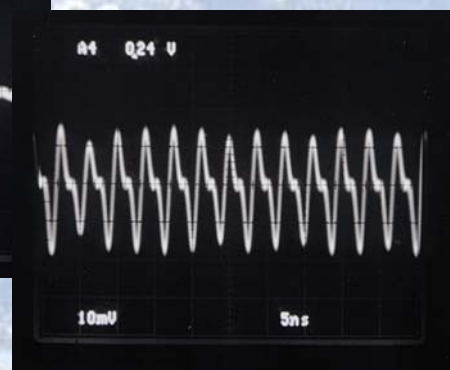
Bunch Length Control by Harmonic Cavity



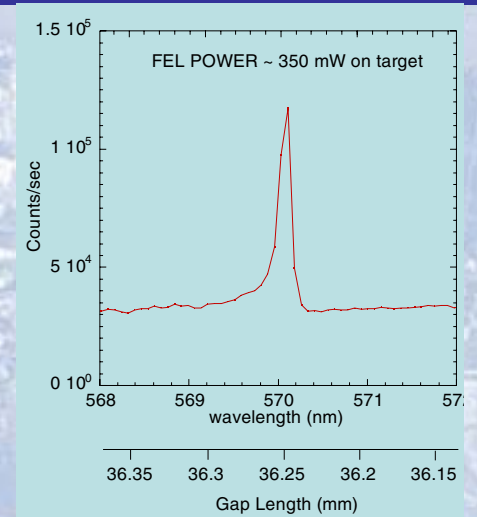
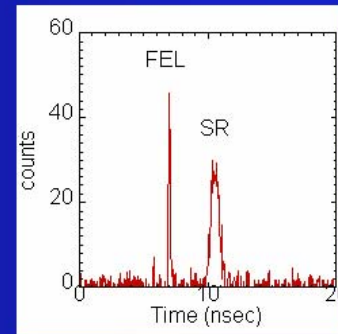
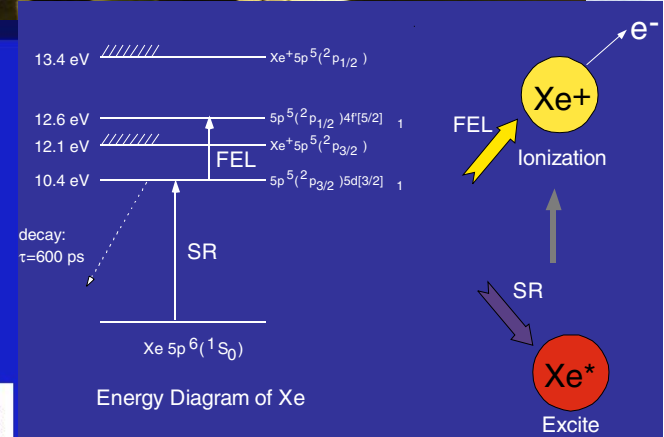
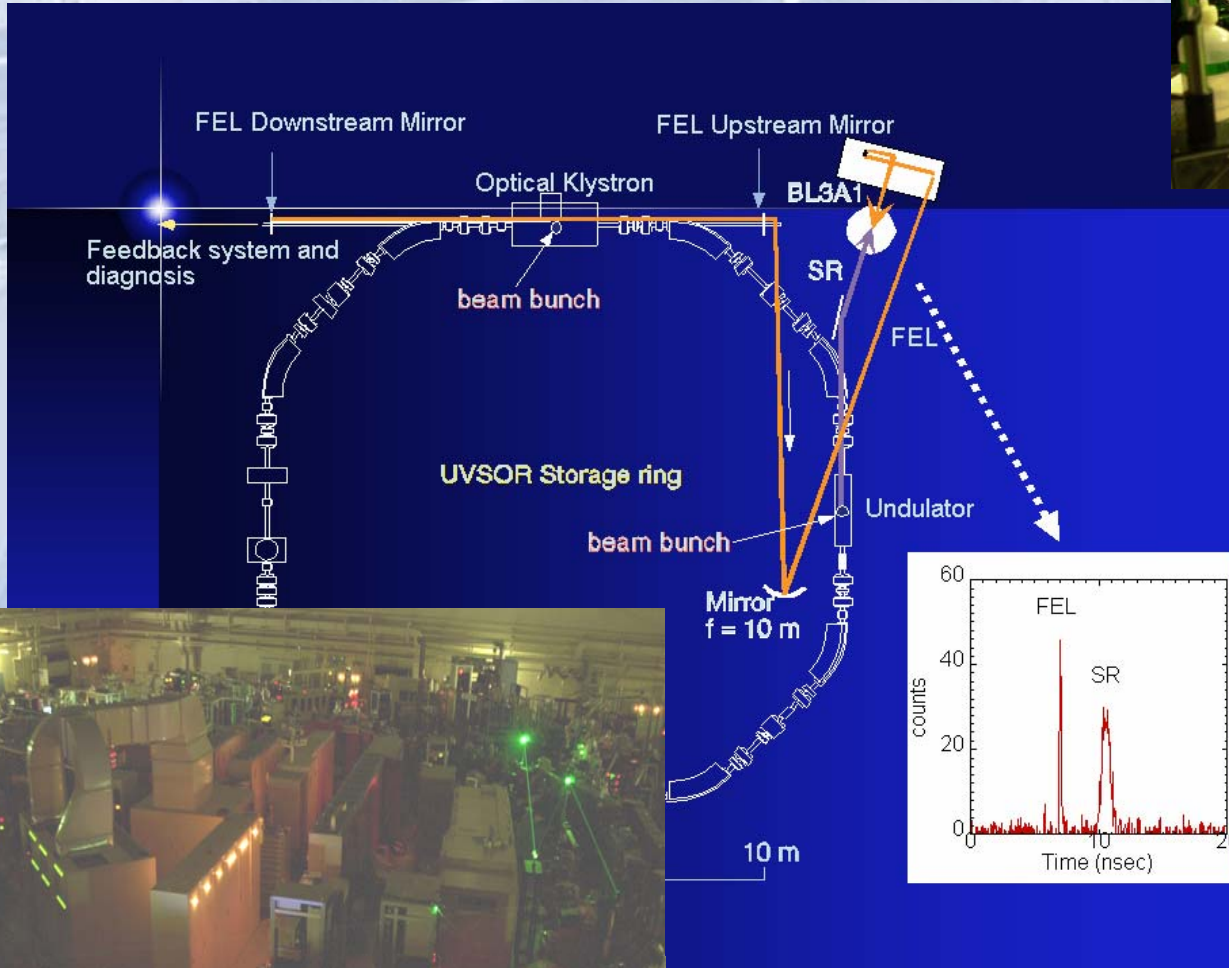
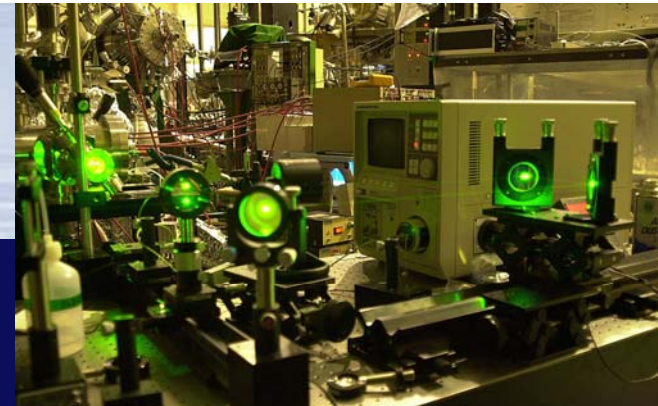
3rd Harmonic Cavity (270MHz)



Beam Storage with 90 MHz RF and 270 MHz RF



Storage Ring Free Electron Laser Pump(SR)–Probe(FEL) Experiment

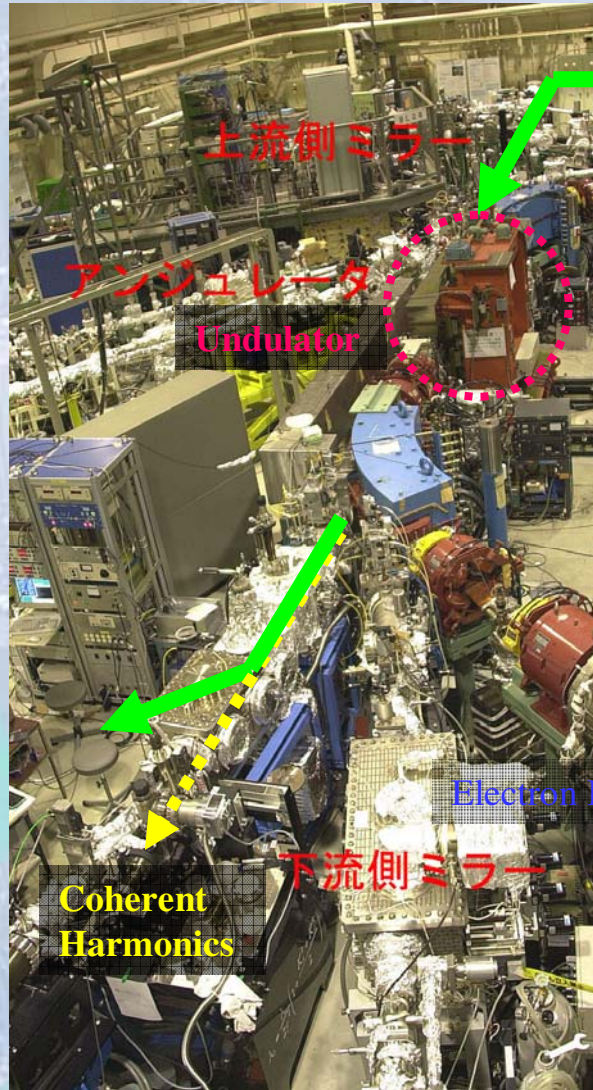
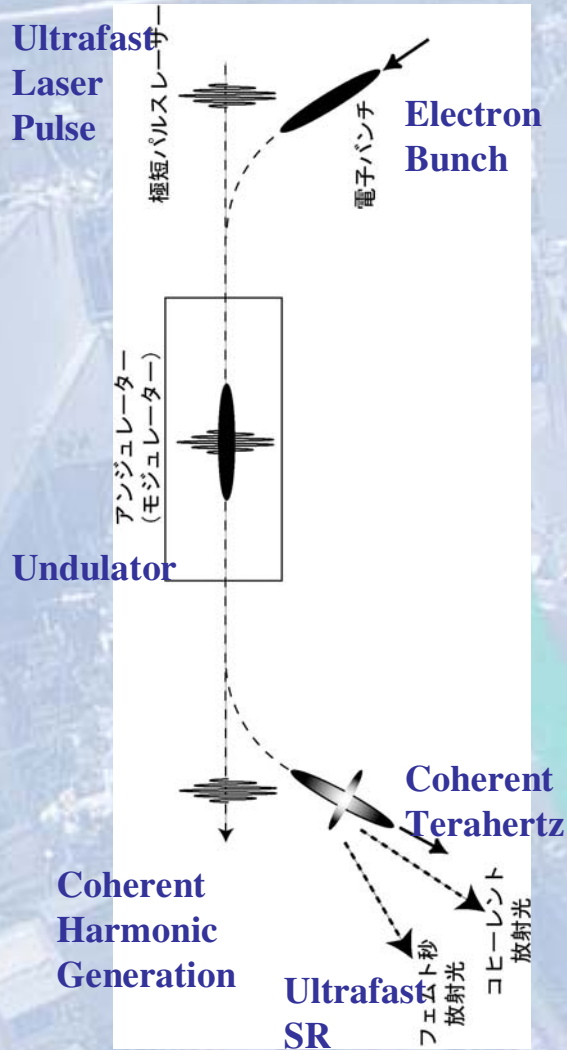


T. Gejo et al., NIM A 528
(2004), 627-631

Bunch Slicing at UVSOR-II

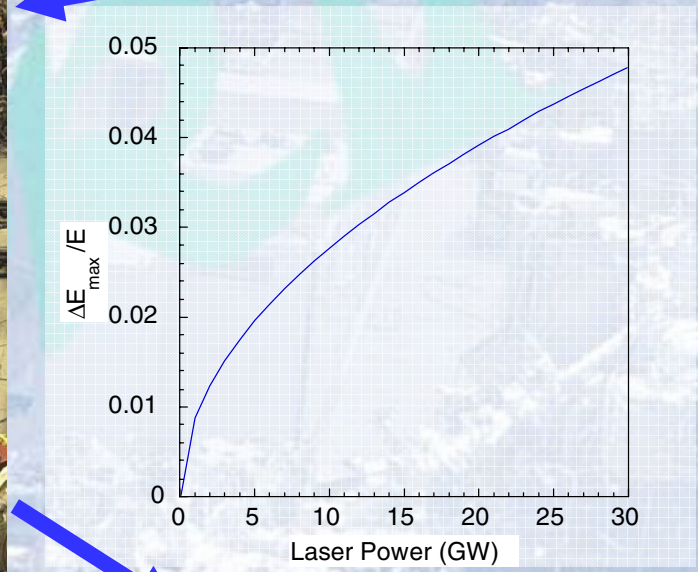
(will be started in this summer)

Laser parameters
 Pulse Energy 2.5mJ/pulse
 Pulse Width 100fs - ~1ps
 Rep. Rate 1kHz
 (synchronized with 90.1 MHz)
 Wavelength 750 - 840 nm



Ultrafast Laser Pulse

Electron Bunch

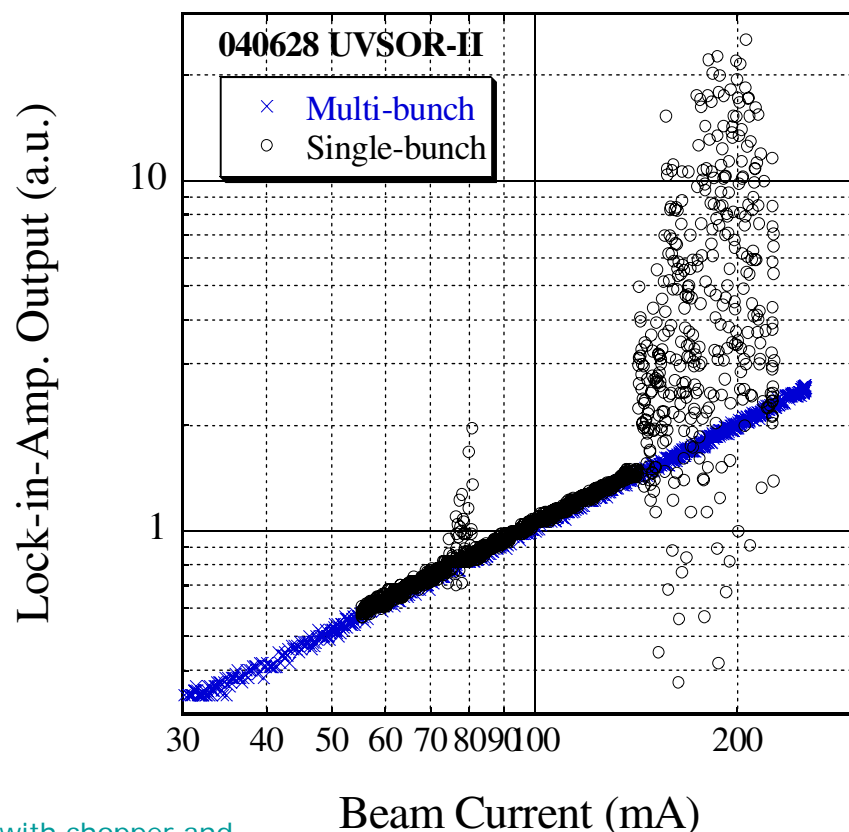


Electron Bunch

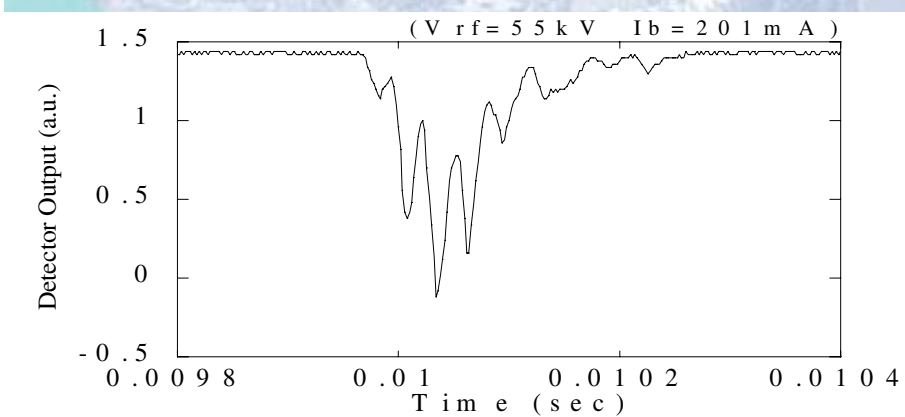
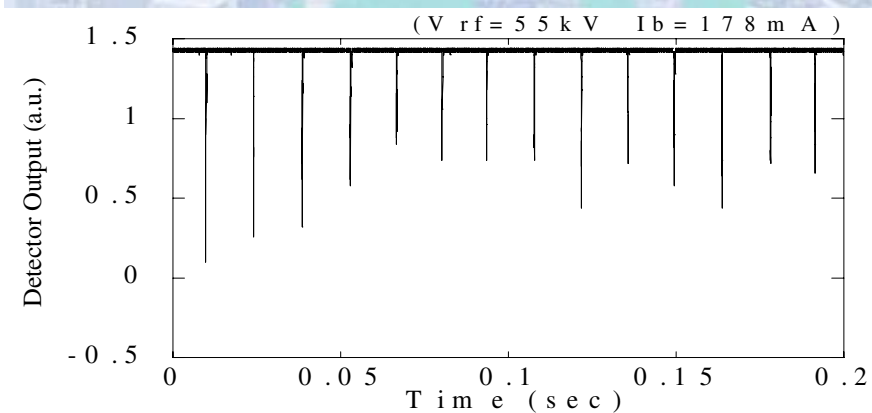
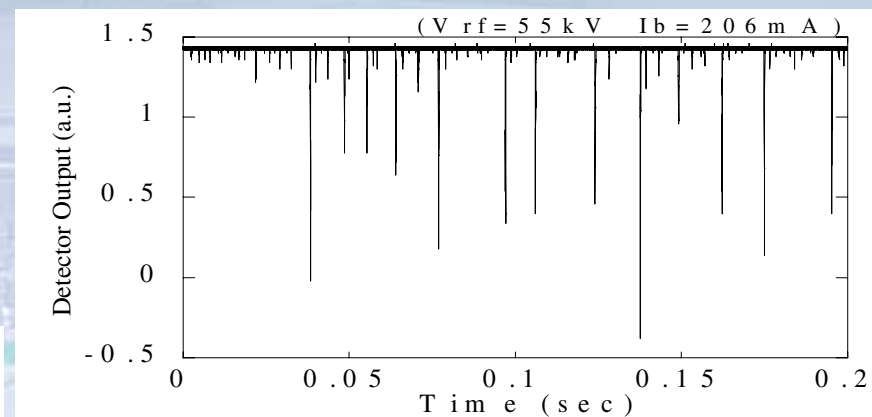
Ultrafast SR

Coherent Terahertz

Detection of Terahertz Bursts at UVSOR-II

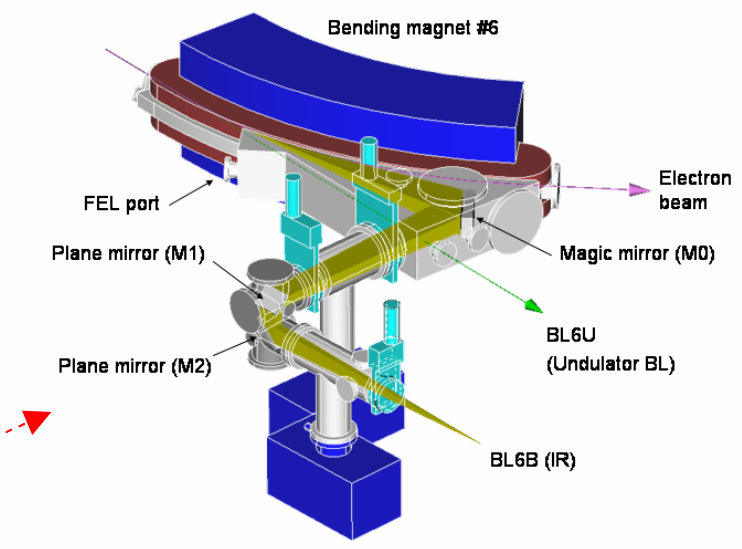
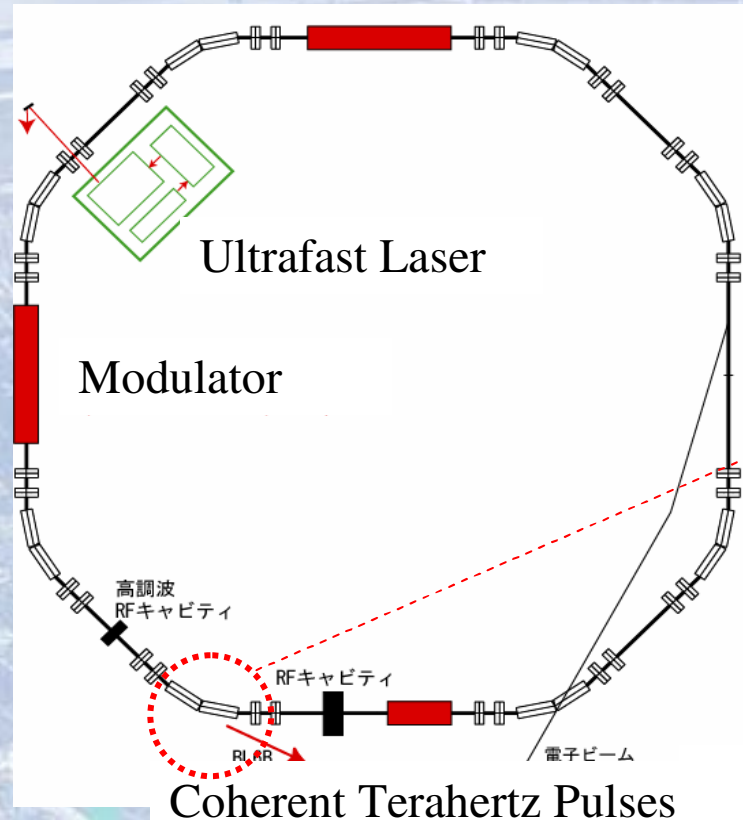
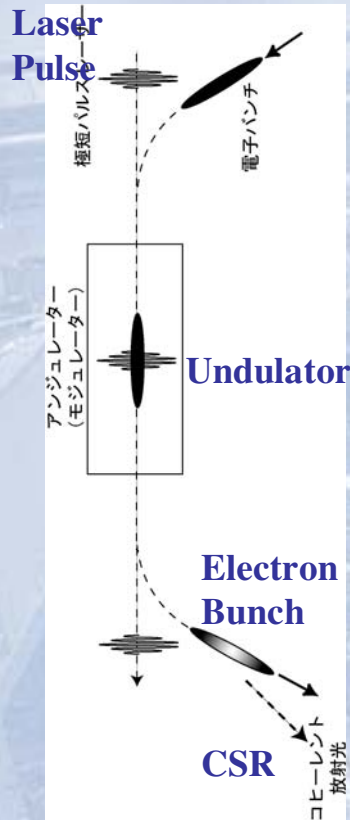


with chopper and
lock-in-amplifier
(frequency 100Hz)

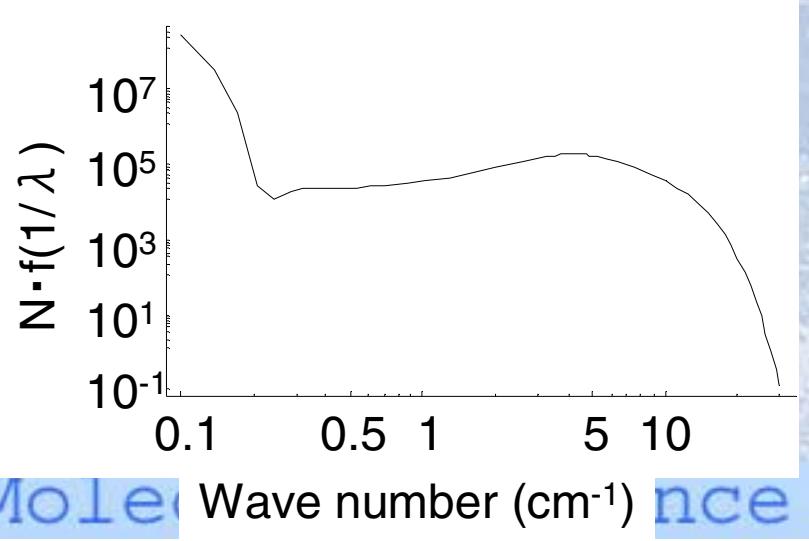
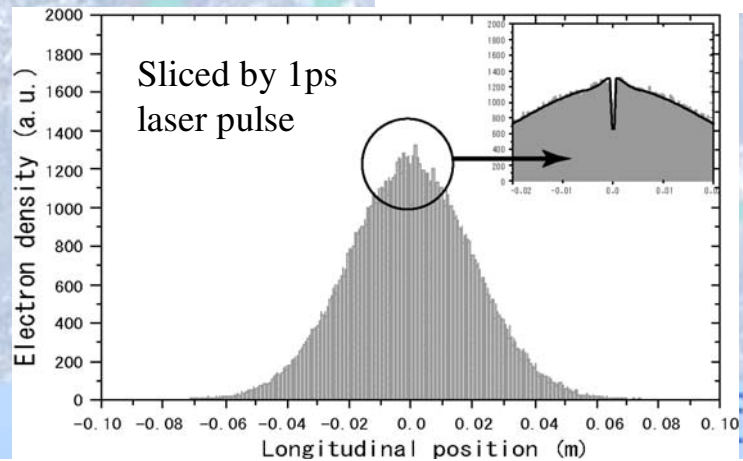


Peak Intensity $\sim 10000 \times$ normal SR

Coherent Terahertz Pulses by Bunch Slicing



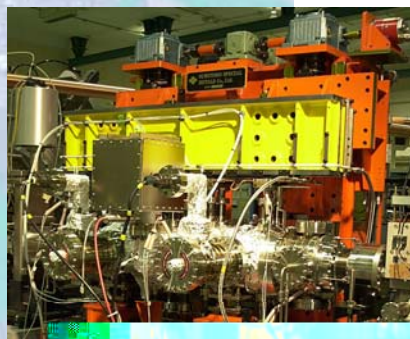
UVSOR-BL6B IR Beamline
(S. Kimura et al., AIP Conf. Proc. 705 (2003),



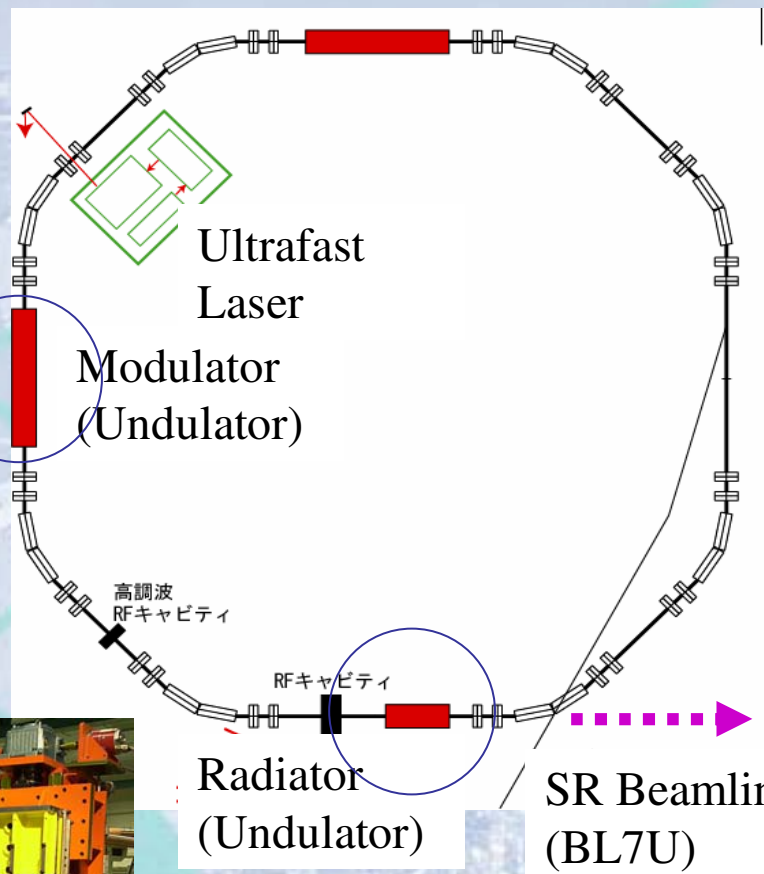
Short SR Pulses by Bunch Slicing (1st Phase)



UVSOR-U5 Linear/Helical Undulator
 Number of periods 18
 Period length 110 mm
 Magnetic Length 2351.2 mm
 Deflection parameter (K)
 (helical mode) 0.07 – 4.6
 (linear mode) 0.15 – 8.5



UVSOR-U7 In-vacuum Undulator
 Period Length 36 mm
 Number of Periods 26
 Magnetic Length 936 mm
 Deflection Parameter (K) 0.19-2.0

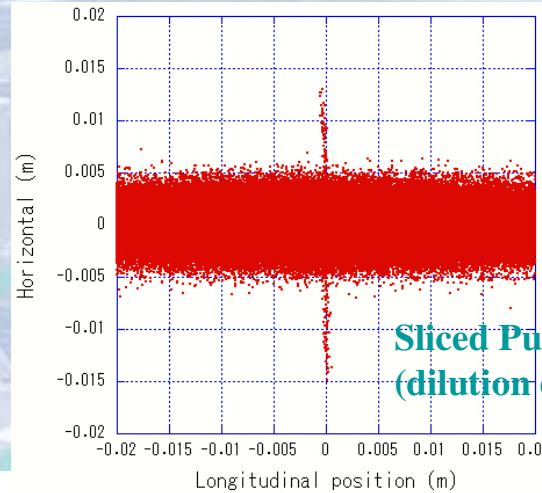


Expected Performance (Rough Estimation)

Photon Energy	100-500eV
Photon Flux	1E6-7 ph/s/0.1%b.w
Repetition Rate	1kHz
Pulse Length	<1psec

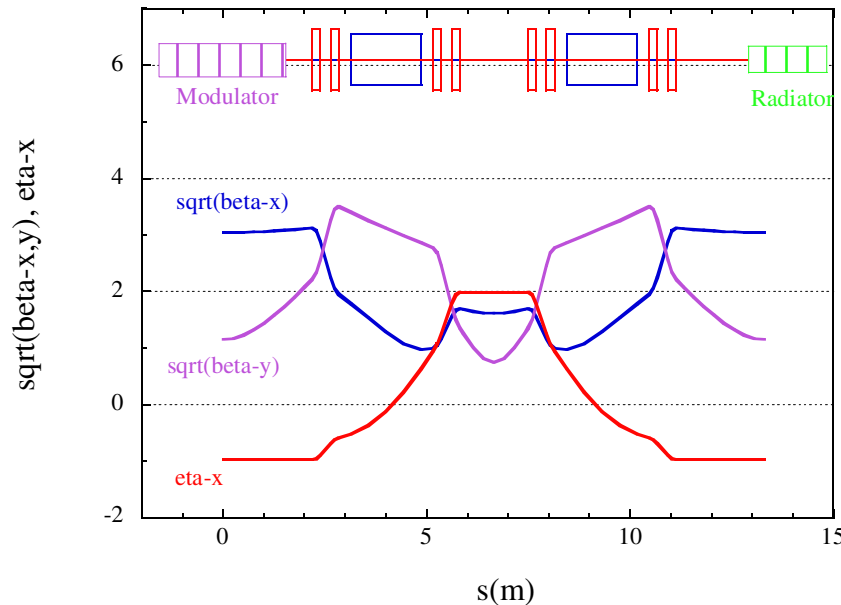
Magnetic Lattice for Short SR Pulses by Bunch Slicing (1st Phase)

globally negative- α but
locally isochronous
between modulator and
radiator

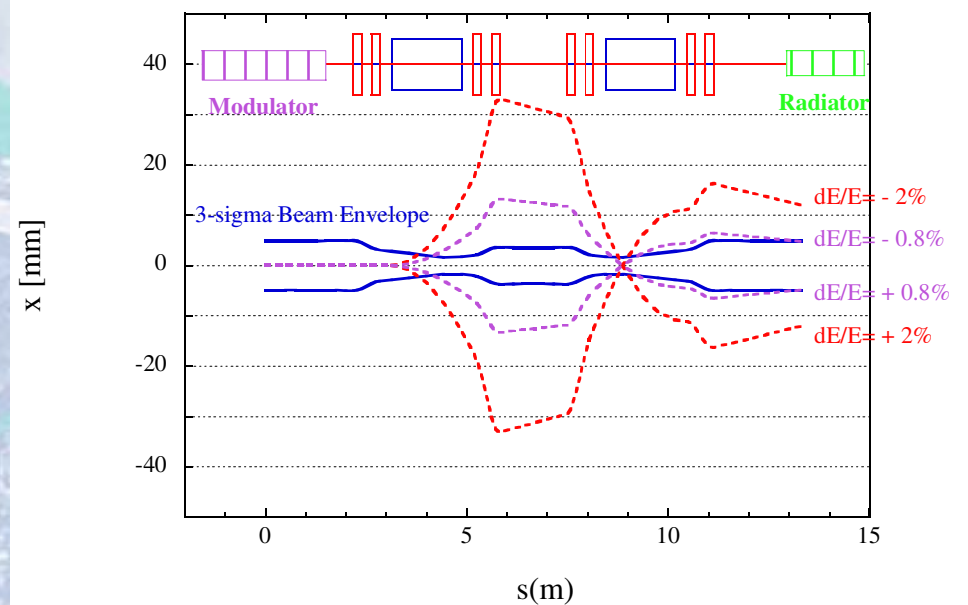


Sliced Pulse \sim several 100 fs \gg Laser Pulse
(dilution due to the emittance)

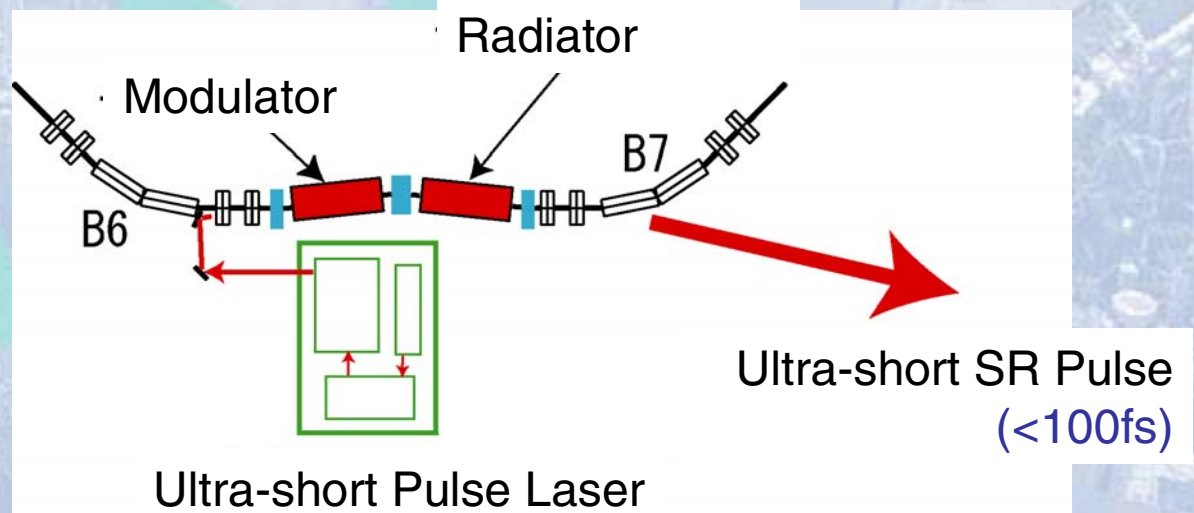
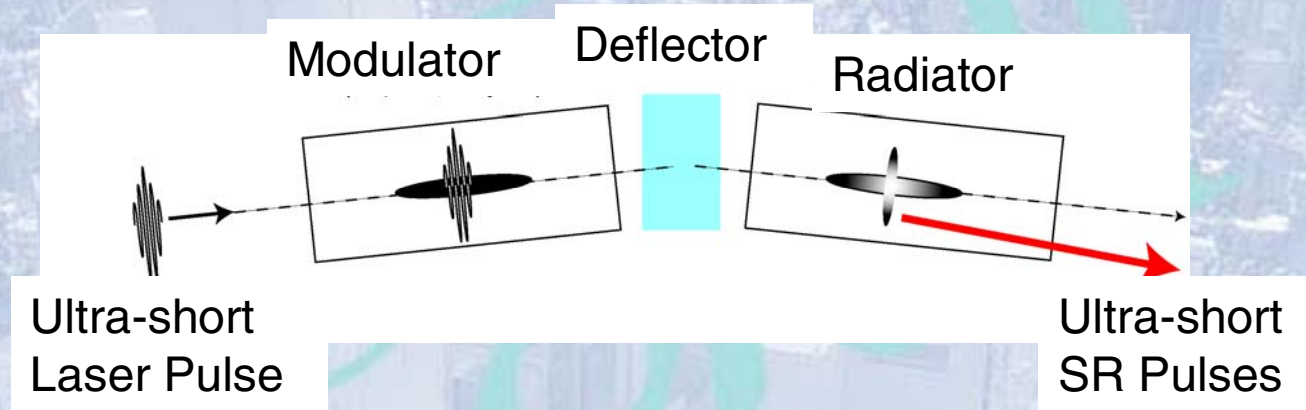
UVSOR-II negative alpha lattice (alpha= - 0.0071)



UVSOR-II negative-alpha lattice (alpha= - 0.0071)



Short SR Pulses by Bunch Slicing (2nd Phase ?)



Summary

-- (Long and) Short Pulses on UVSOR-II --

- **SR Pulses of 100ps~1ns by Harmonic Cavity**
- **SR Pulses $< \sim 10$ ps by low- α**
- **Vis.-UV Coherent Pulses $< \sim 5$ ps by Free Electron Laser
(11.2MHz, synchronized with SR pulses)**
- **Coherent Terahertz Pulses $< \sim 1$ ps by Bunch Slicing
(1kHz, synchronized with ultrafast laser pulses)**
- **SR Pulses $< \sim 1$ ps by Bunch Slicing (1st Phase)
(1kHz, synchronized with ultrafast laser pulses)**
- **SR Pulses ~ 100 fs by Bunch Slicing (2nd Phase)
(1kHz, synchronized with ultrafast laser pulses)**
- **Many other possibilities using Storage Ring and Ultrafast Laser**

The bunch slicing experiment will be started in this summer.

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