Recent Status of Linac Facility at Osaka University

A.Saeki

Prof. S.Tagawa group: (Beam Material Science)

S.Seki, T.Kozawa, K.Kobayashi, K.Okamoto, A.Saeki

Prof. G.Isoyama group: (Accelerator Science)

R.Kato, Y.Honda, S.Kashiwagi, N.Kimura

Prof. T.Majima group: (Molecular Excitation Chemistry)

M.Fujitsuka, N.Ichinose, S.Tojo, K.Kawai

Prof. Y.Yoshida group: (Beam Science for Nanofabrication)

J.Yang

Technician:

S.Suemine, T.Yamamoto

Outline

1. Recent renewal of linac facility
2. S-band photocathod RF-gun linac
3. Pulse radiolysis

1. Recent renewal of linac facility

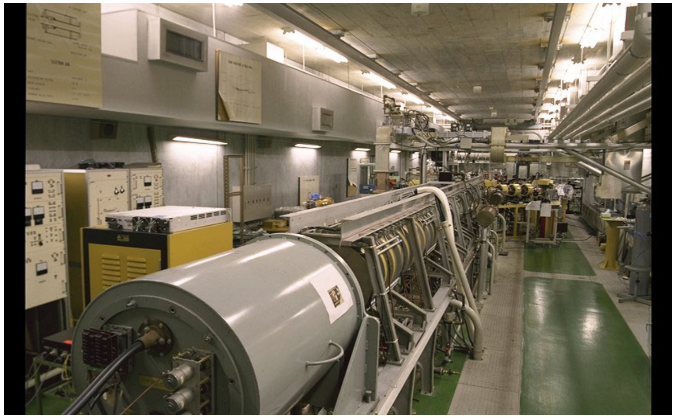
Prof. G.Isoyama group:

R.Kato, Y.Honda, S.Kashiwagi

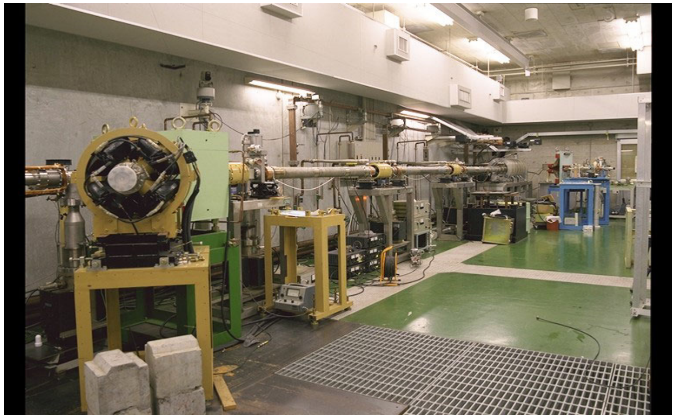
Technician:

S.Suemine, T.Yamamoto

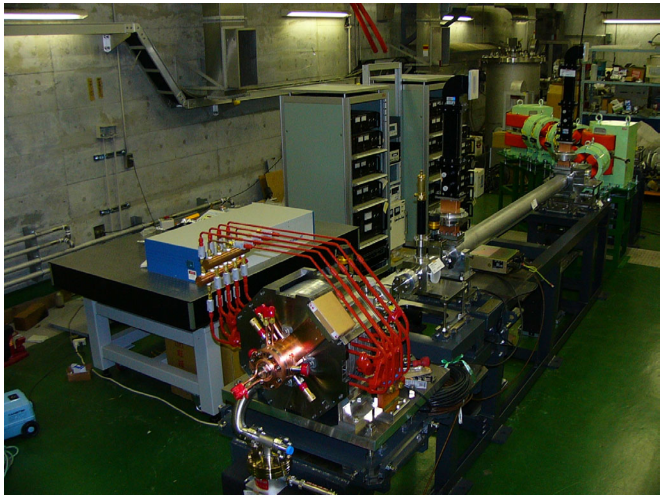
Three linacs



- 38 MeV, L-band linac



- 150 MeV, S-band linac



- 30 MeV, S-band photocathod RF-gun linac

Used for

Pulse radiolysis
FEL, SASE
Positronium Annihilation Lifetime Spectroscopy

Recent renewal

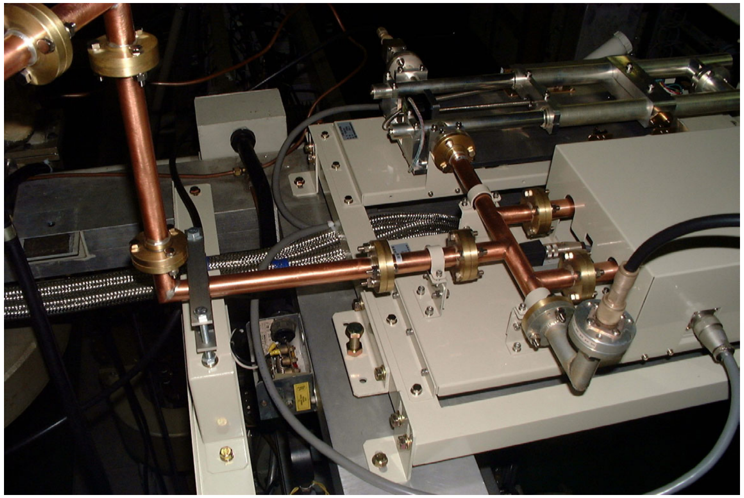
- RF system
  - Klystron
  - Pulse modulator for the klystron
  - Wave guide system
  - Three amplifiers for the sub-harmonic buncher system
  - Master oscillator
- Magnet system
  - Power supplies for the Helmholtz coils, the bending magnets, the quadrupole magnets, steering coils.
- Computer control system
- Timing system
- Facility
  - Interlock system for radiation safety
  - High precision cooling water system (< ±0.03 ° C)
  - High precision air conditioner for the klystron room
  - AVR for the AC200V line for the klystron modulator

- Previous system
  - 5 MW klystron (Toshiba, E3775A) for the prebuncher and the buncher
  - 20 MW klystron (Thomson, TV-2022A) for the acceleration tube.
- New system
  - 30 MW klystron (Thales, TV-2022E) for the all.

Pulse Modulator for Klystron

- V_{max} = 295 kV, I_{max} = 275 A
- Pulse Width 4 μs / 8 μs
  - Long pulse mode for FEL
  - 2 modes changeable by remote control.
- Flatness of the flat top < 0.2 % (< 0.1 %)
- Pulse-to-pulse fluctuations< 0.1 % (< 0.05 %)
- Repetition
  - 60 pps for the short pulse mode
  - 30 pps for the long pulse mode
- Inverter type HV generator
  - Stable and efficient
- Thyratron Switch
  - To be replaced with SSD
- Remote control using FL-net.

Master Oscillator



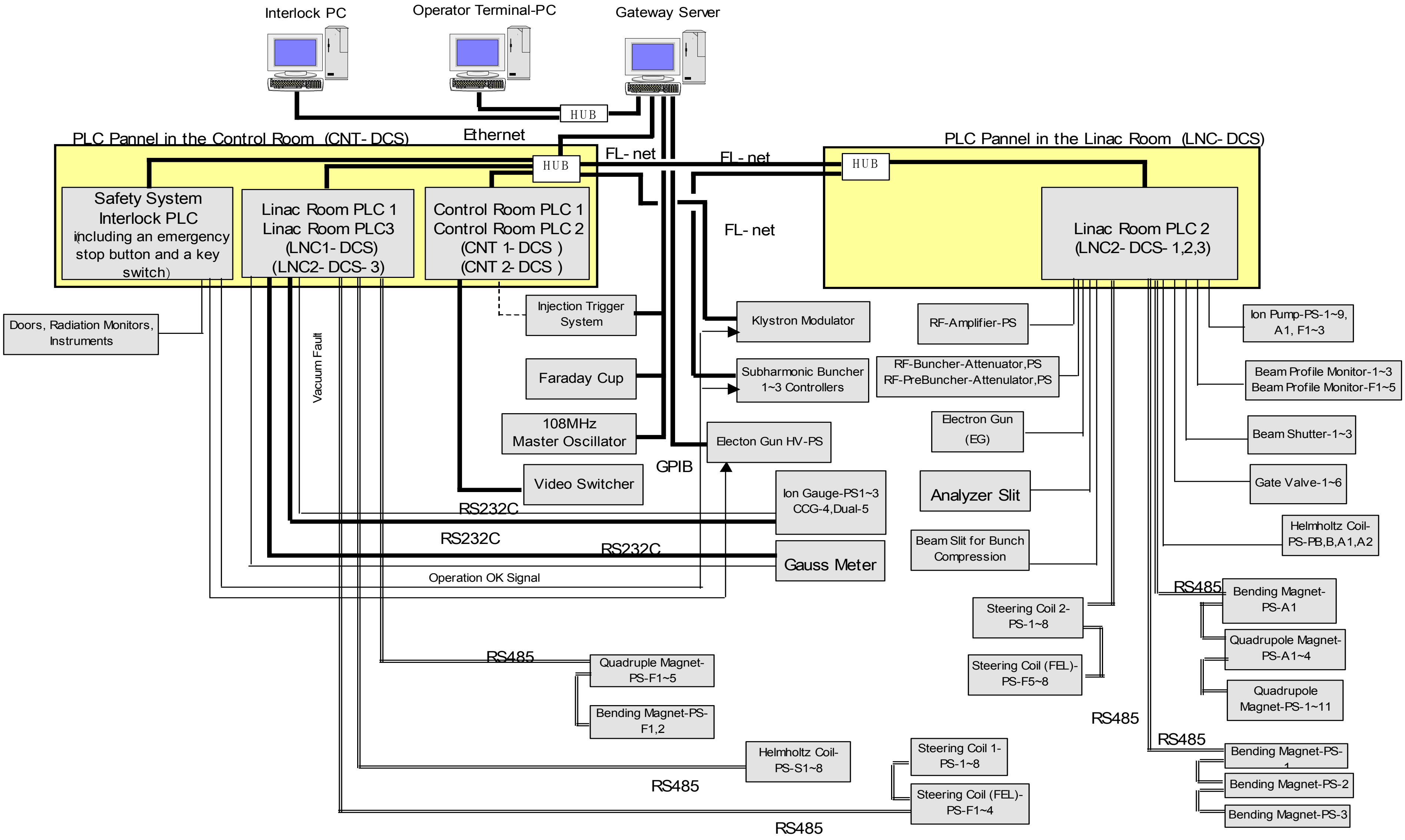
PRS10 Rubidium Frequency Standard

- *Ultra Low phase noise (<-130 dBc/Hz at 10 Hz)*
- *Time-tags or phase-locks to a 1 pps input*
- *72 hour stratum 1 level holdover*
- *RS232 for diagnostics, control and calibration*
- *Long lamp life and established reliability*
- *Low cost ($1495, Quantity 1, U.S. list)*

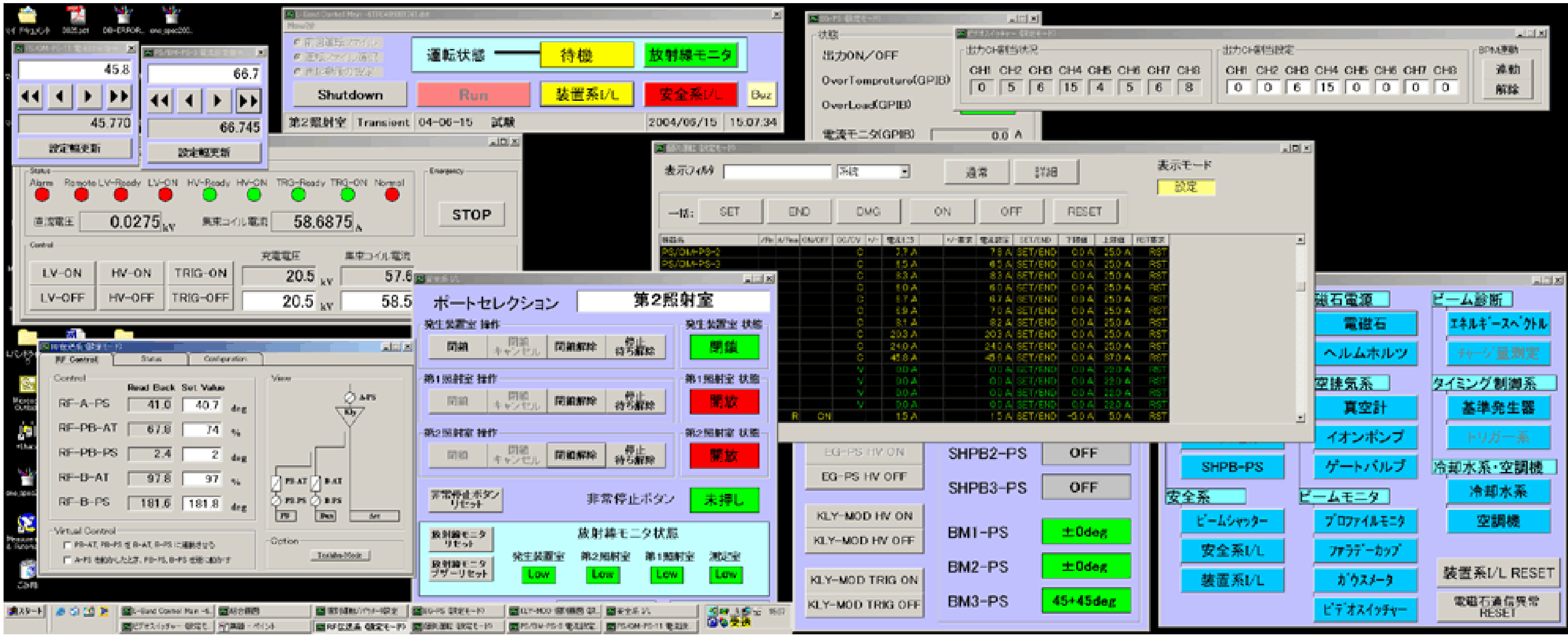
The PRS10 is an ultra-low phase noise 10 MHz rubidium disciplined crystal oscillator.

The device fulfills a variety of communication, syn-

Computer control system



GUI of Computer control system



All parameters are automatically saved, so that they can be restored in the next operation.

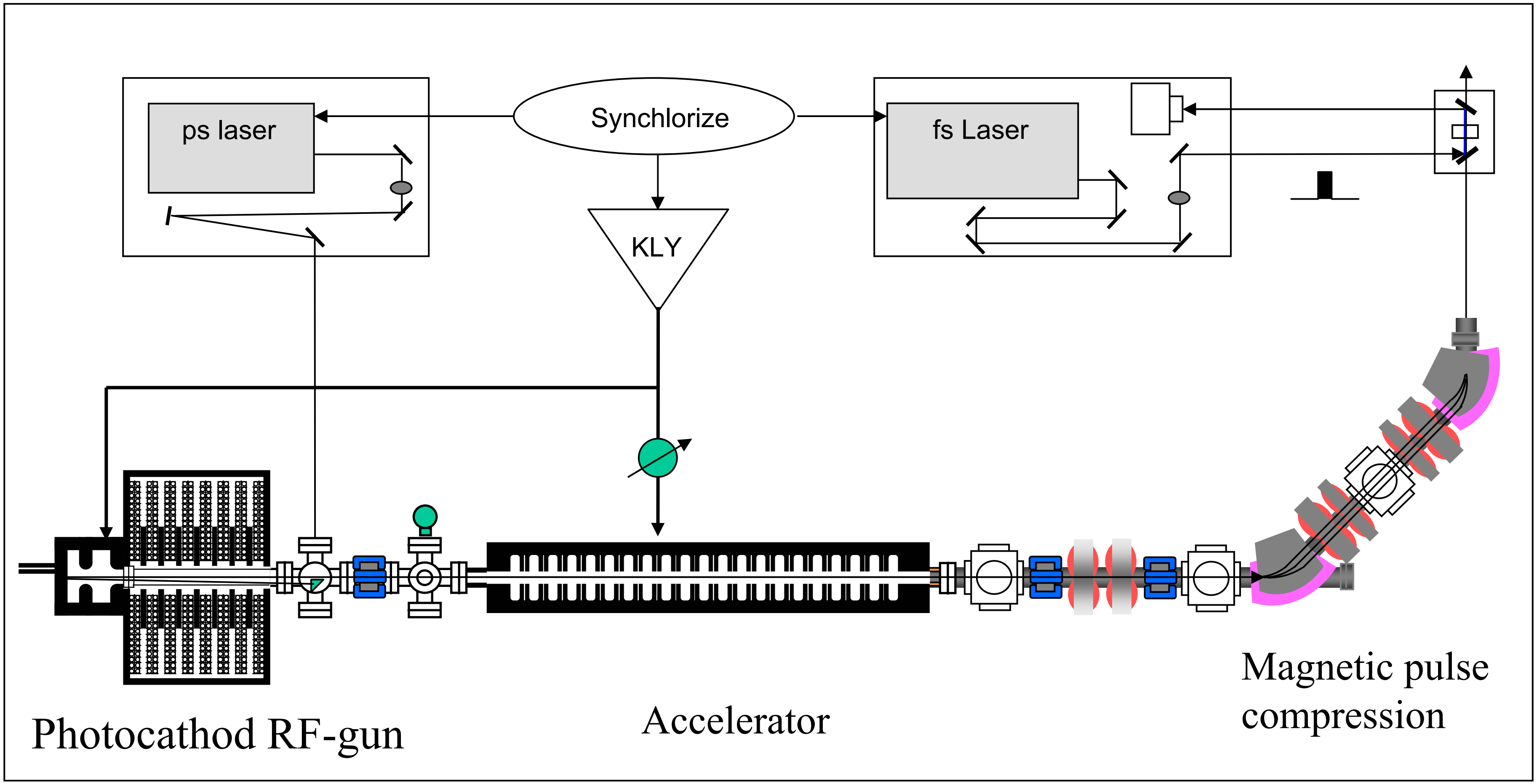
2. S-band photocathod RF-gun linac

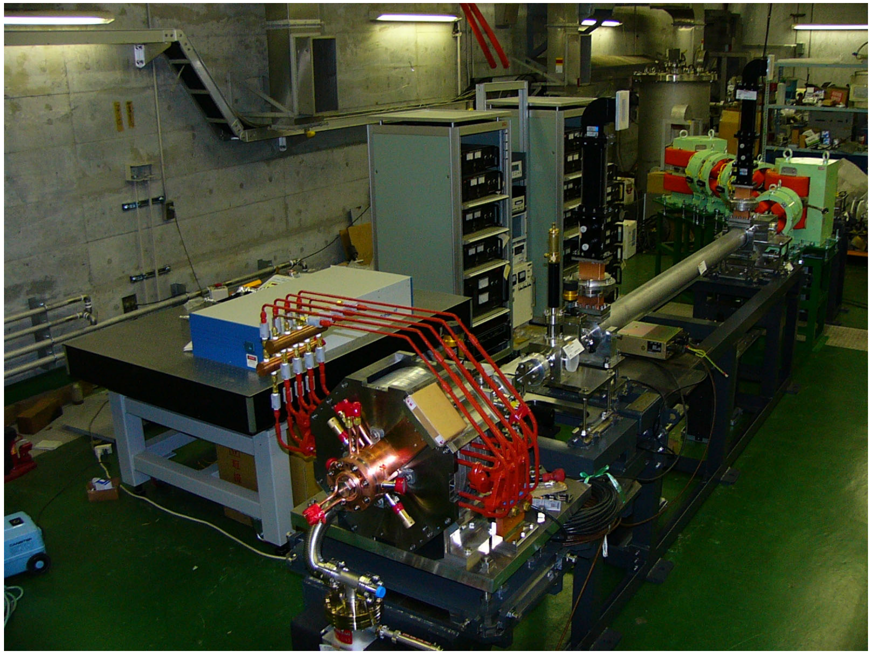
Prof. Y.Yoshida group:
J.Yang

Prof. S.Tagawa group:

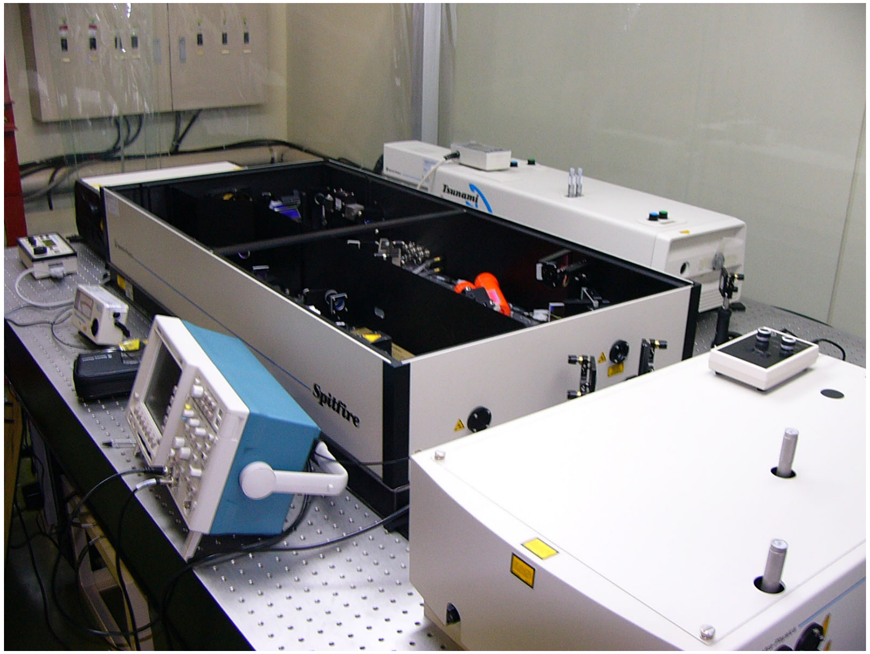
T.Kozawa

Photochathod RF-gun linac





Linac



fs laser

ps laser

3. Pulse radiolysis

Prof. S.Tagawa group:

S.Seki, T.Kozawa, K.Kobayashi, K.Okamoto, A.Saeki

Prof. Y.Yoshida group:

Prof. T.Majima group:

M.Fujitsuka, N.Ichinose, S.Tojo, K.Kawai

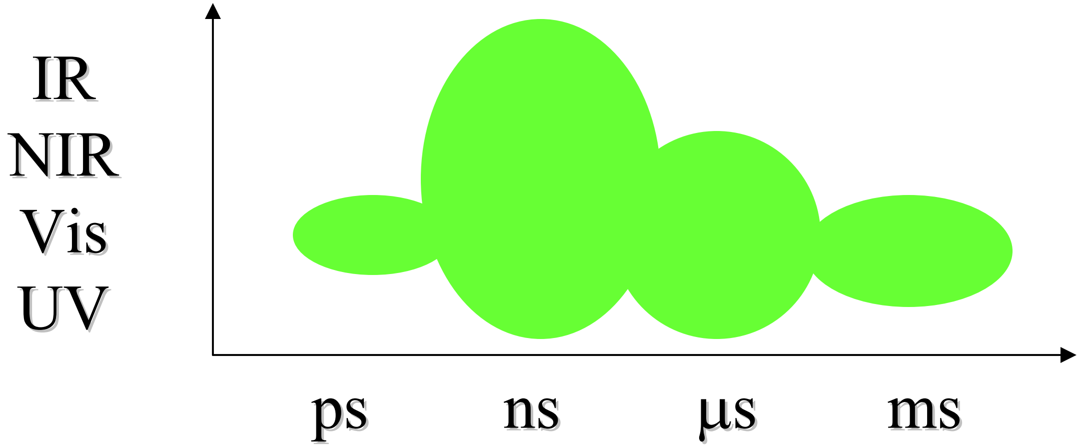
History of Pulse Radiolysis at Osaka Univ.

ns system

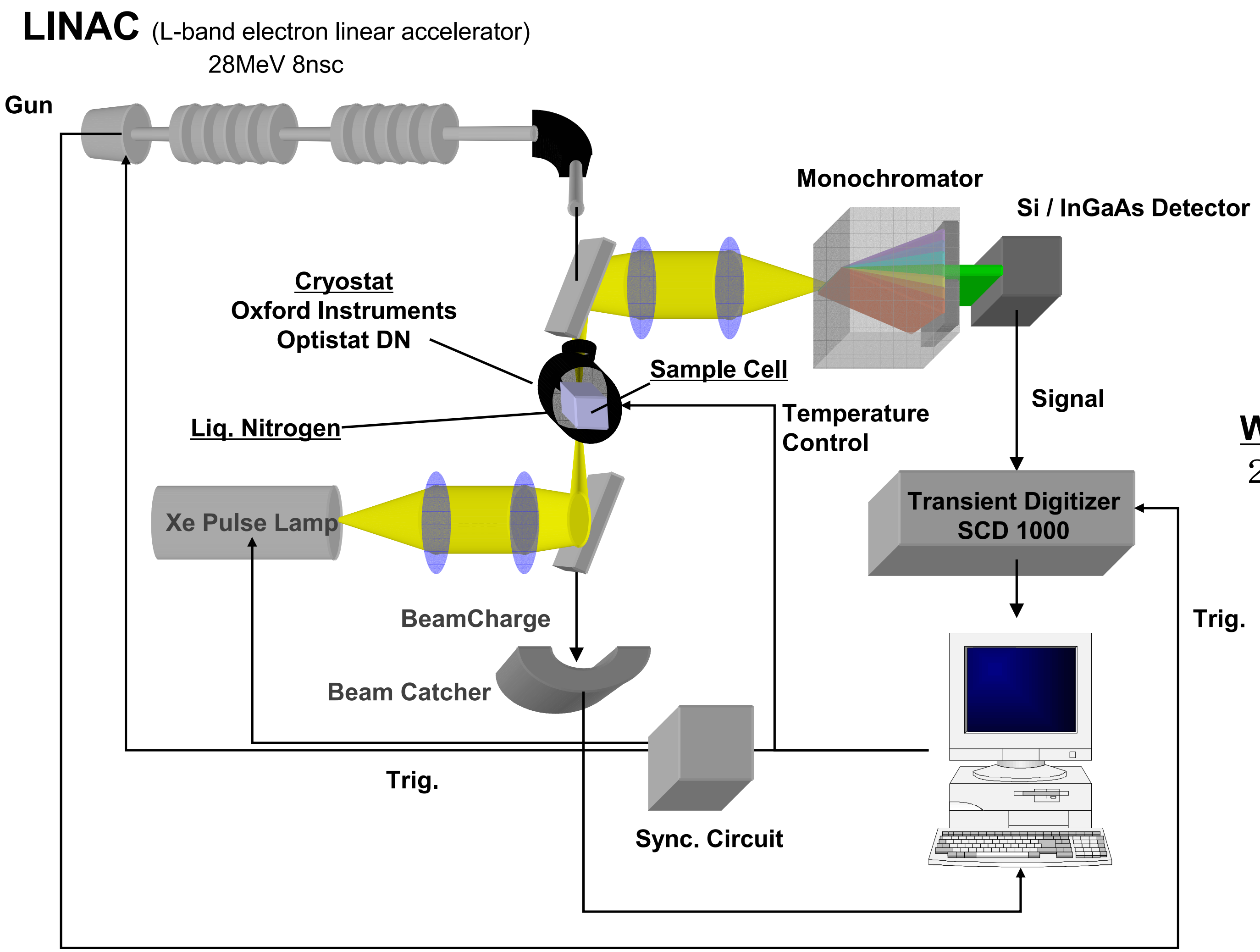
UV, Vis 1994
NIR, 1995
Low-temp, NIR, Vis, 1997
IR, 1998
UV, Vis, ns-ms, 2001

ps system (stroboscopic)

Laser-linac synchronized, 1995
Vis, 1998
Pulse compression, 1998
Jitter compensation, 1999
Improvement of S/N ratio, 2001



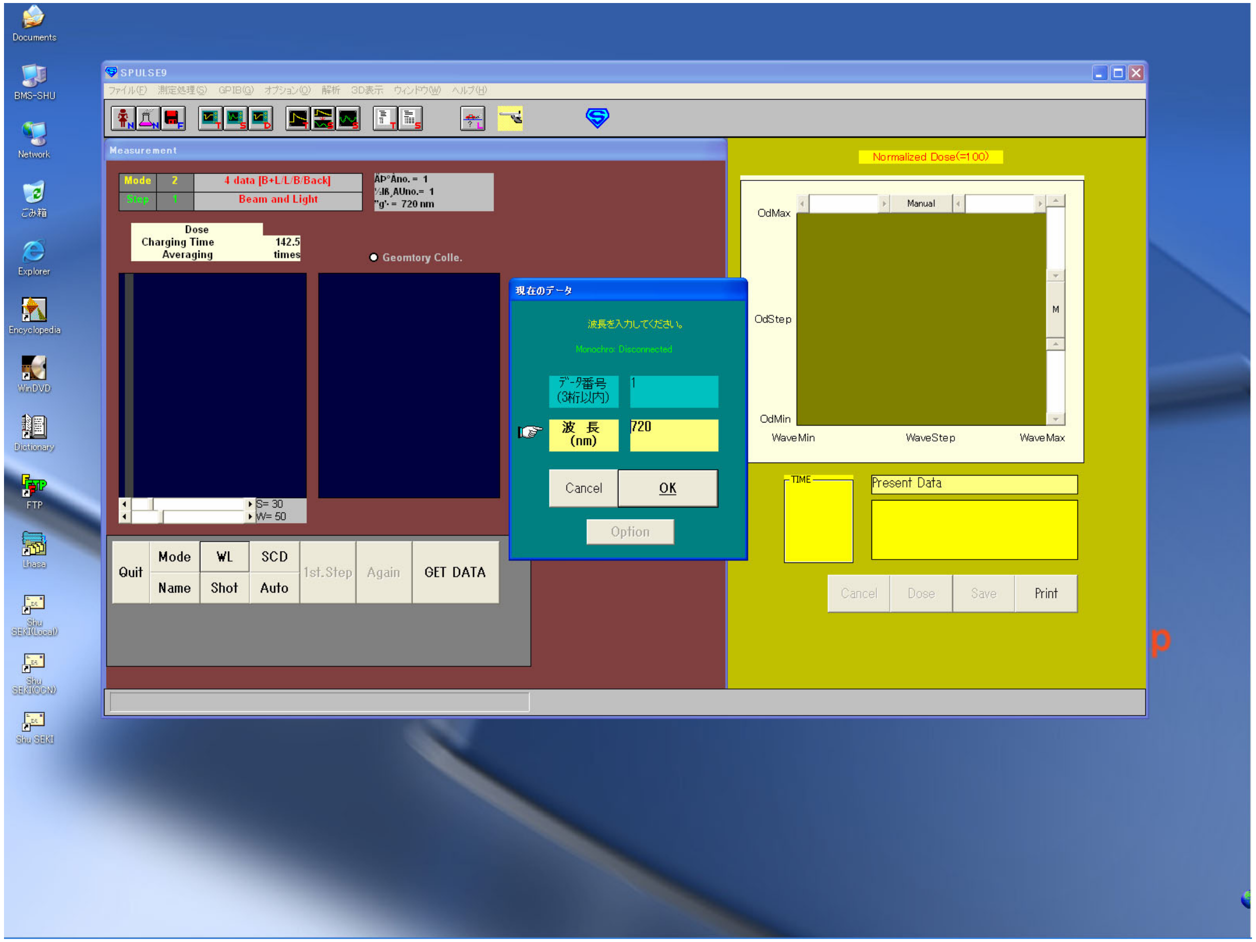
ns pulse radiolysis



Wavelength Range

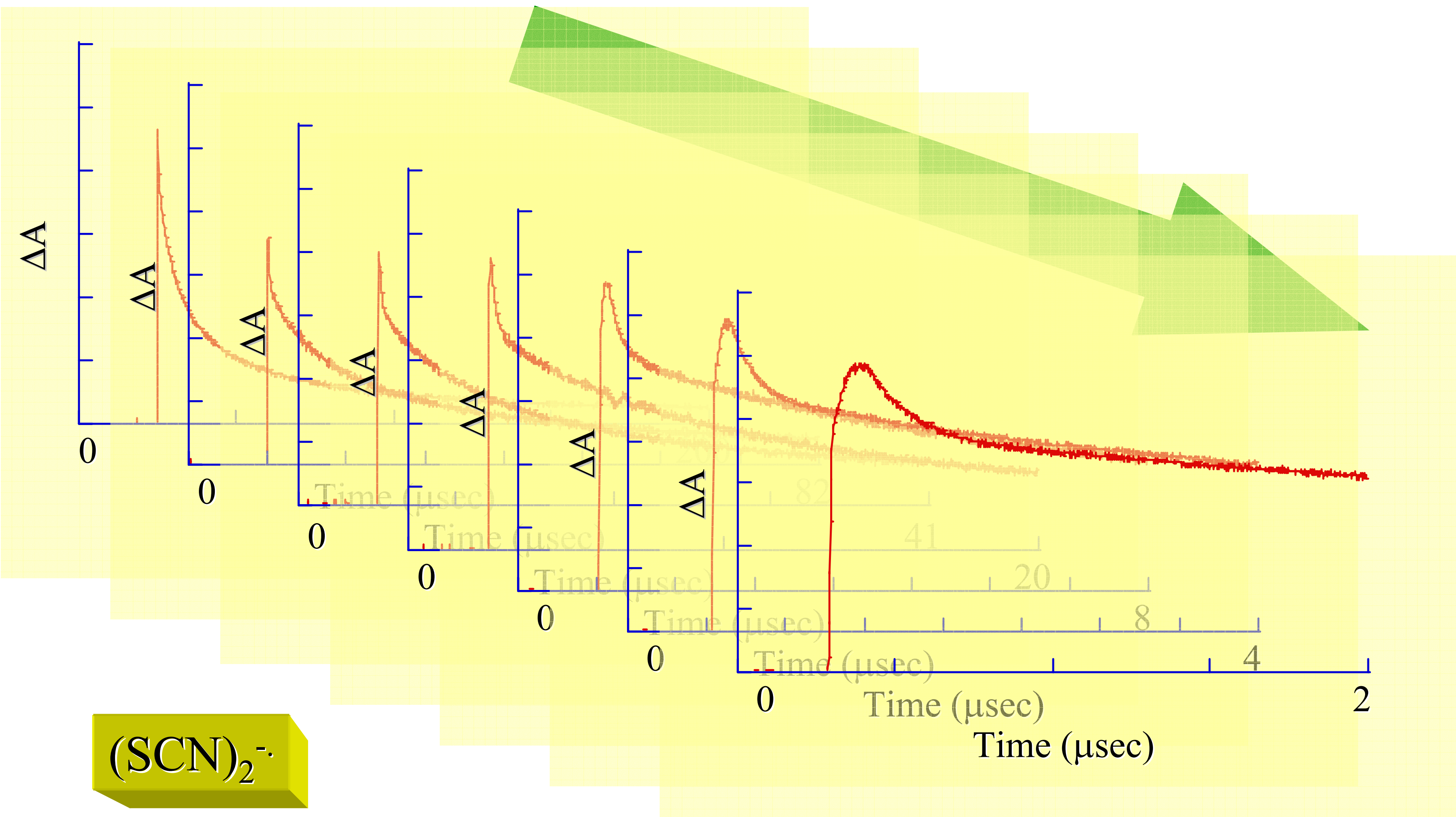
２５０ｎｍ～２１００ｎ

ns pulse radiolysis



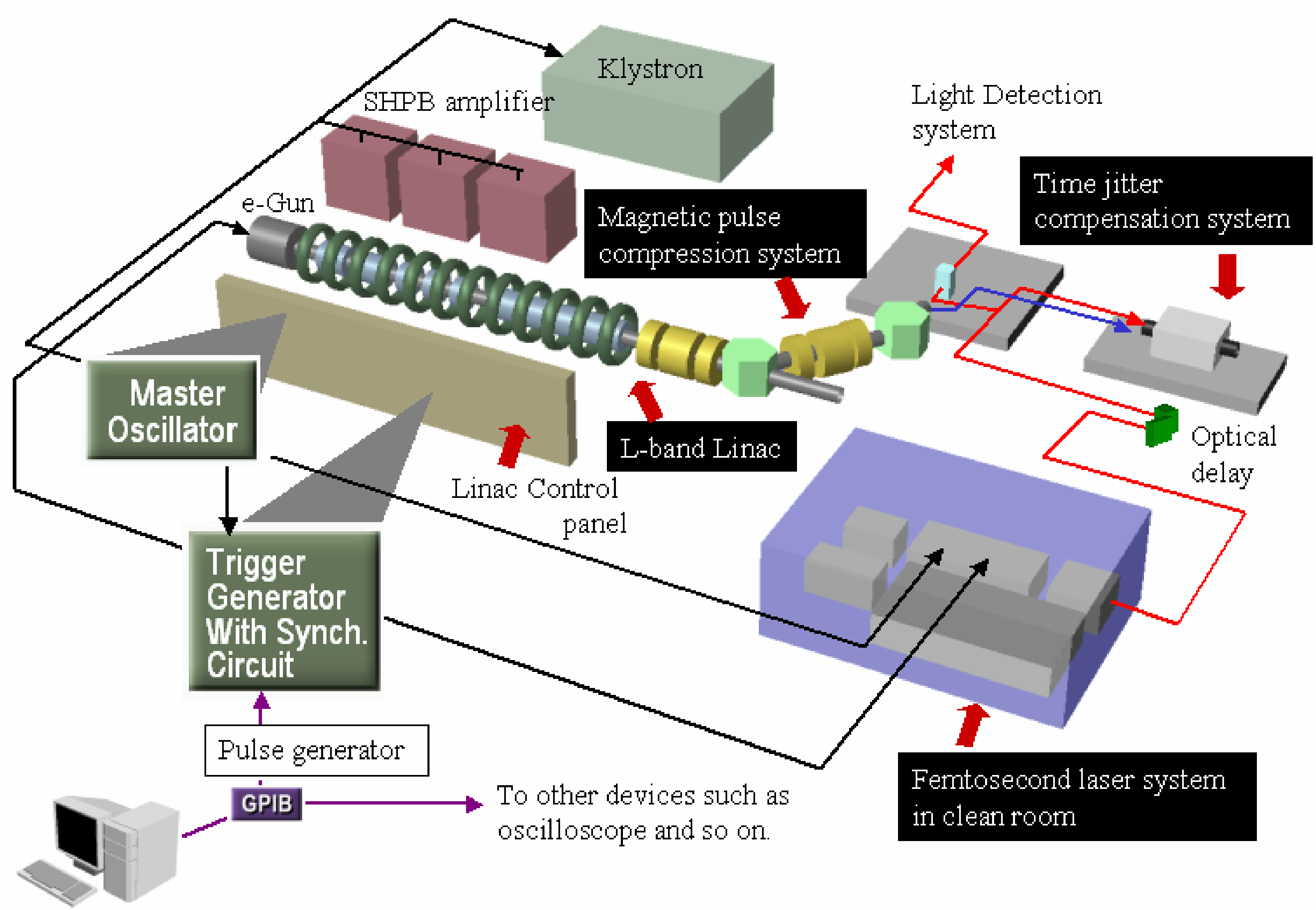
in Visual Basic

A kinetic trace in wide dynamic range can be measured on one pulse irradiation

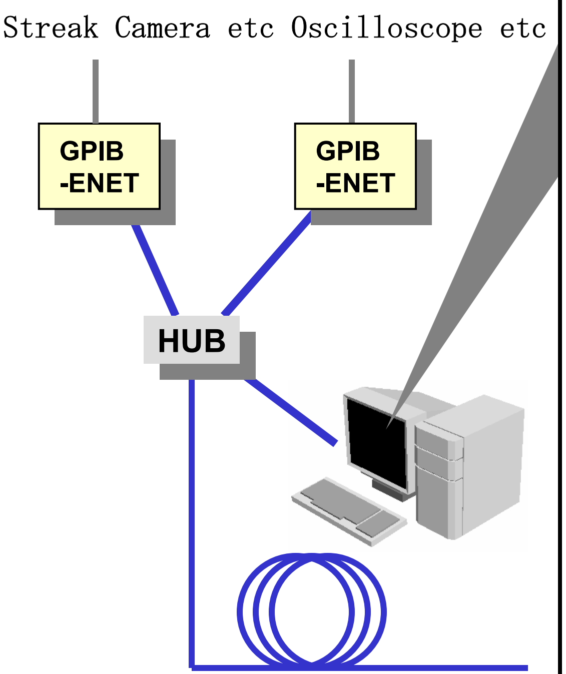


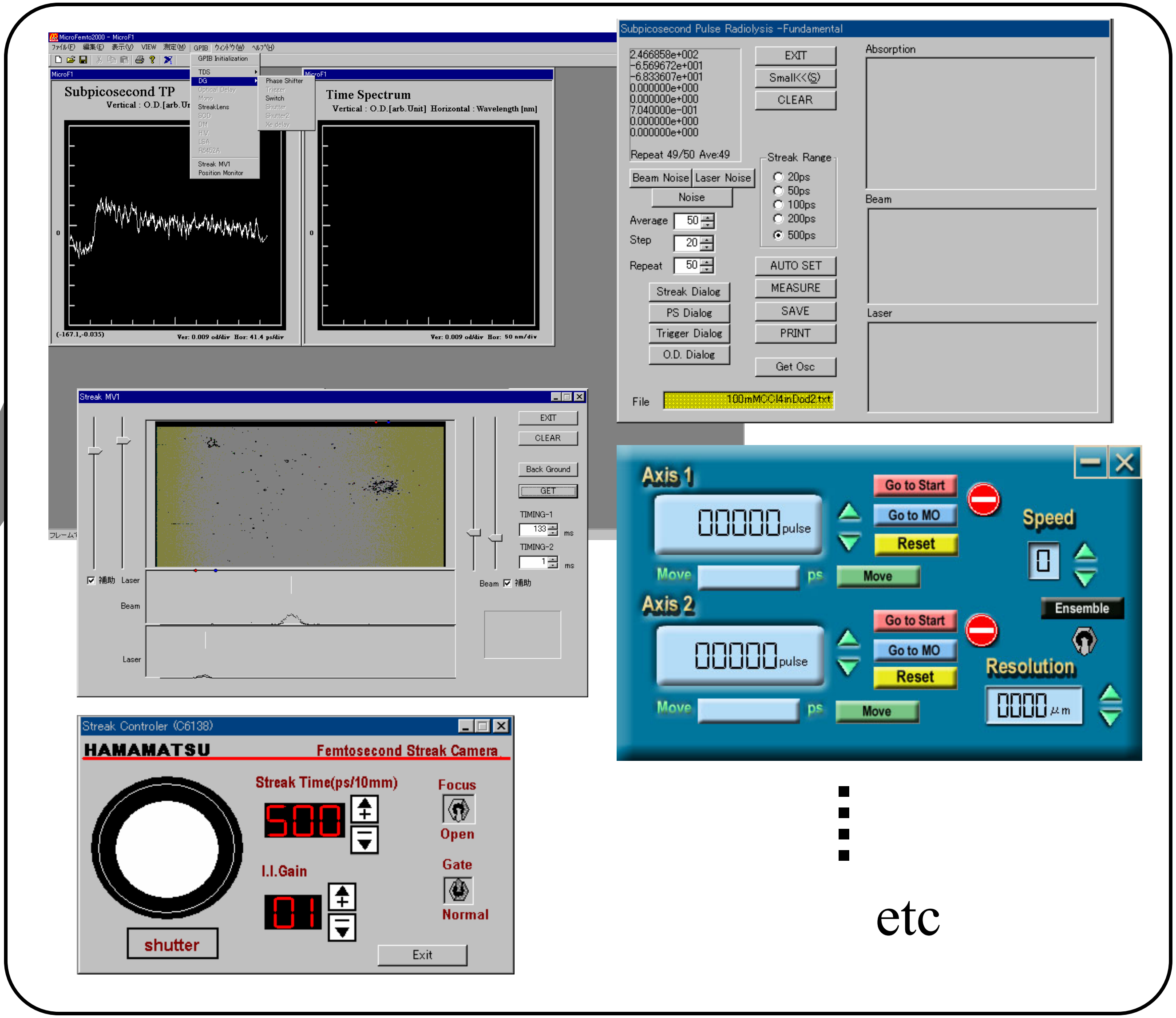
Stroboscopic pulse radiolysis

Highest time resolution 800 ± 50 fs
Monitoring wavelength 790 nm



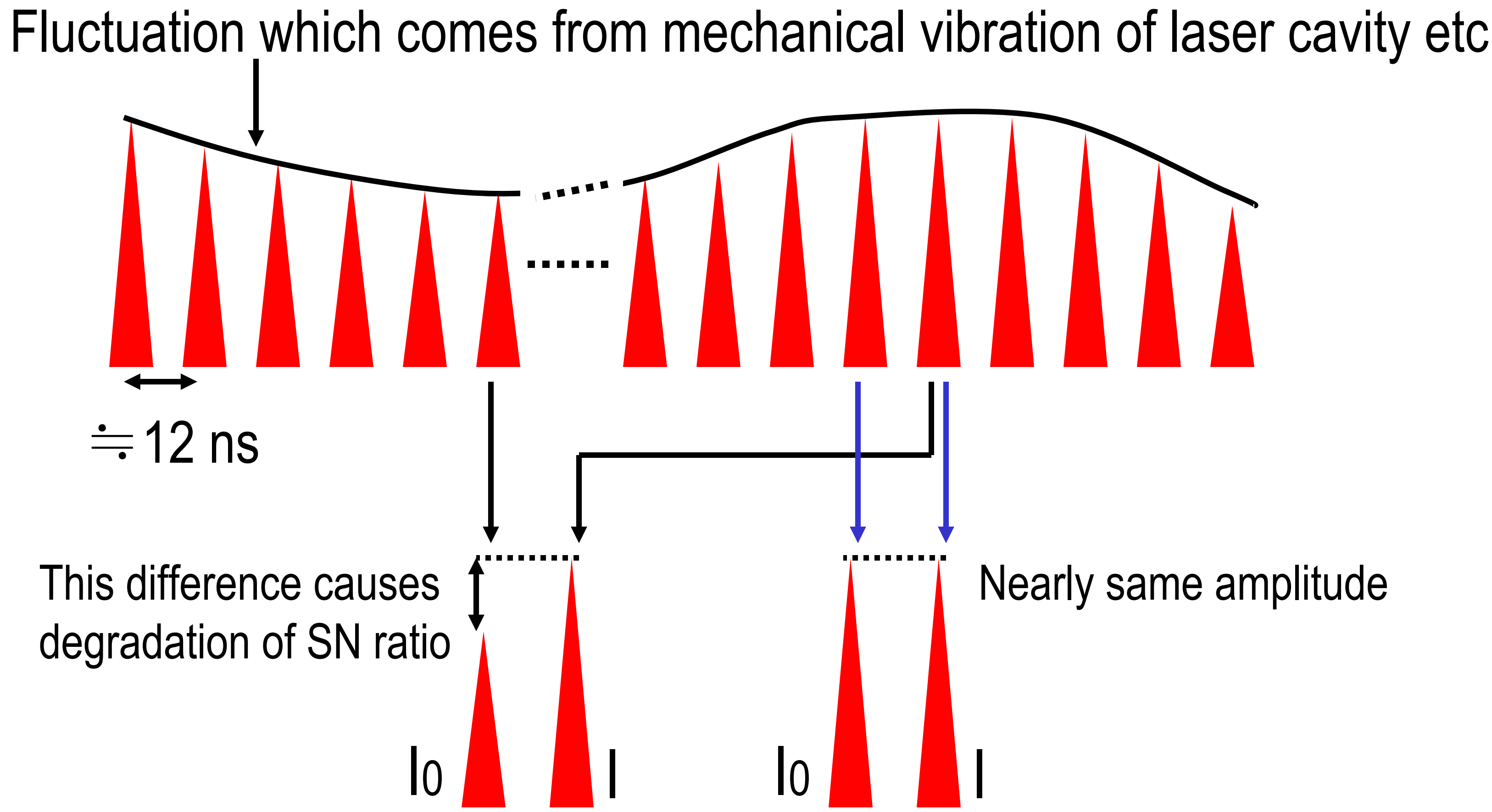
Stroboscopic pulse radiolysis





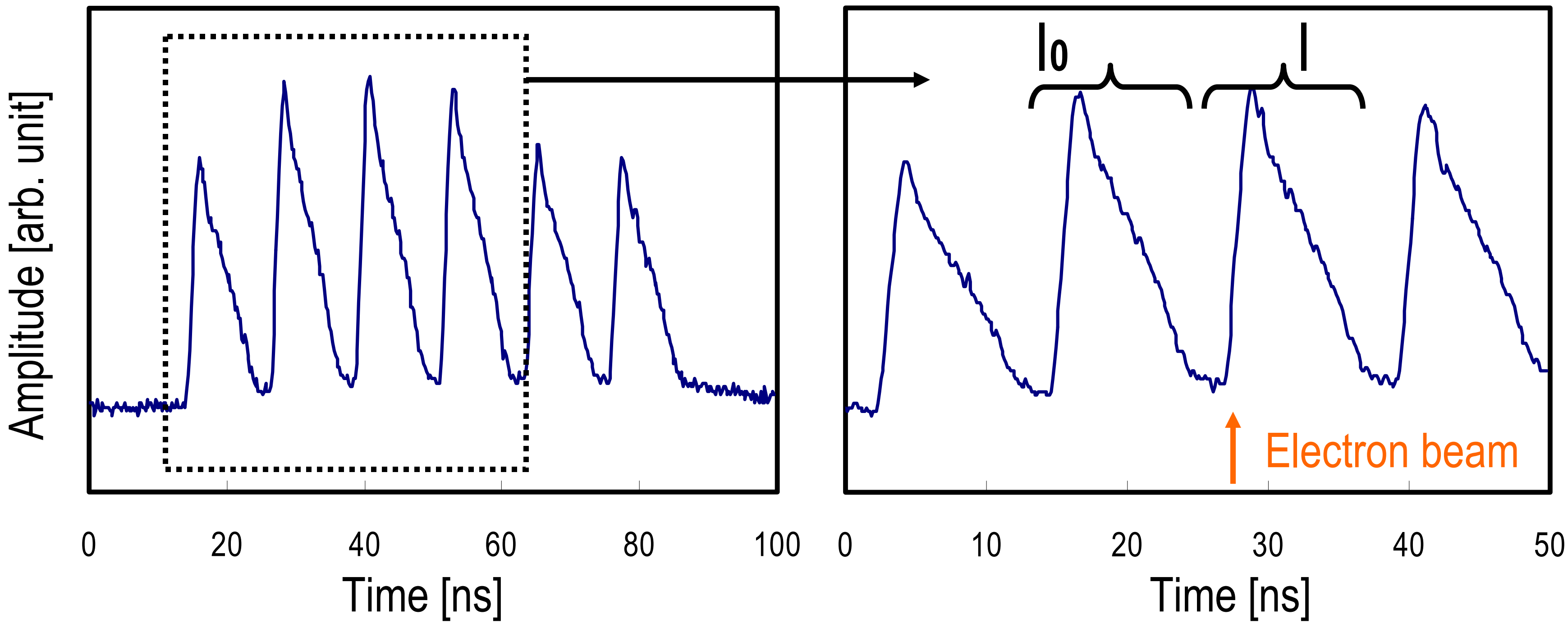
in Visual C++

Improvement of S/N ratio

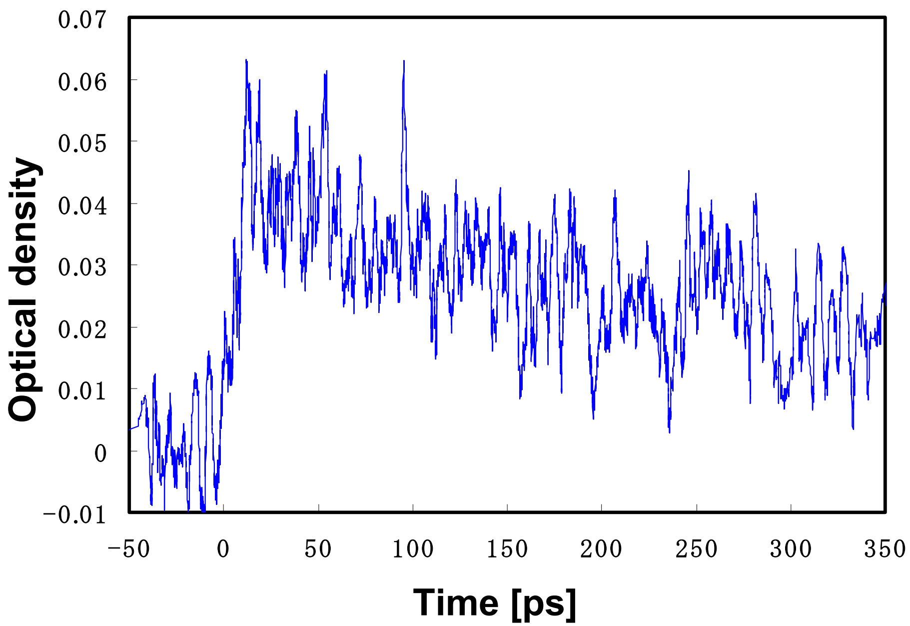


D.M.Bartels et al., *J.Phys.Chem. A*, 104, 1686 (2001)

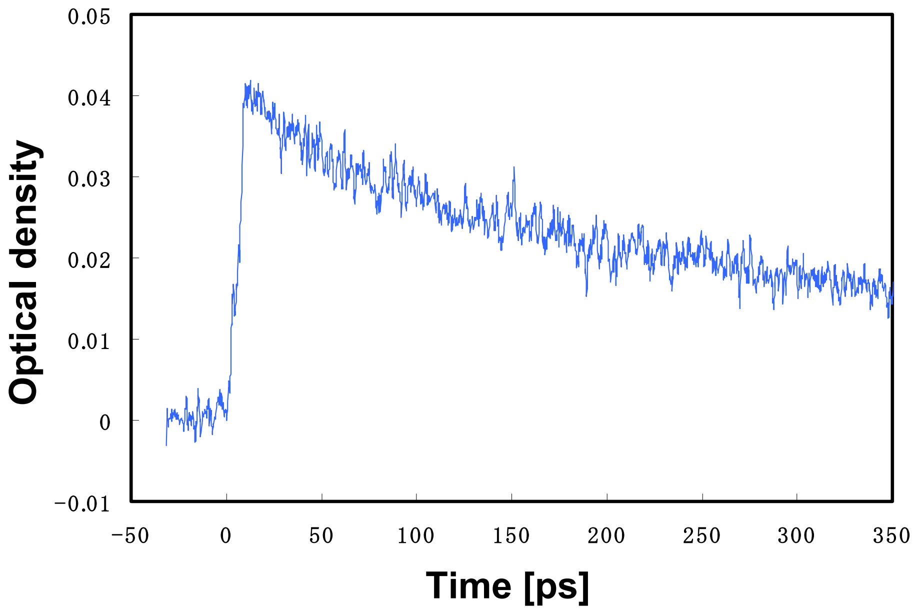
Improvement of S/N ratio



Improvement of S/N ratio



Before improvement



After improvement

T.Kozawa et al., *Jpn. J. Appl. Phys.*, 41, 4208 (2002)

Fluctuation of Beam Position

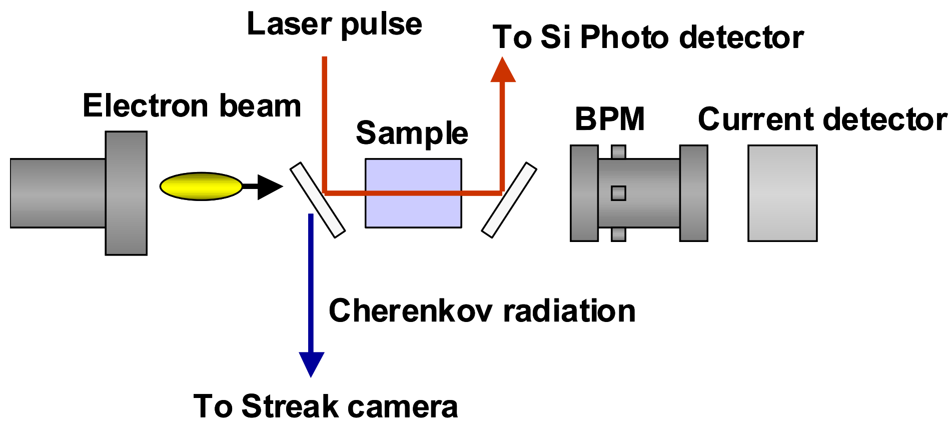
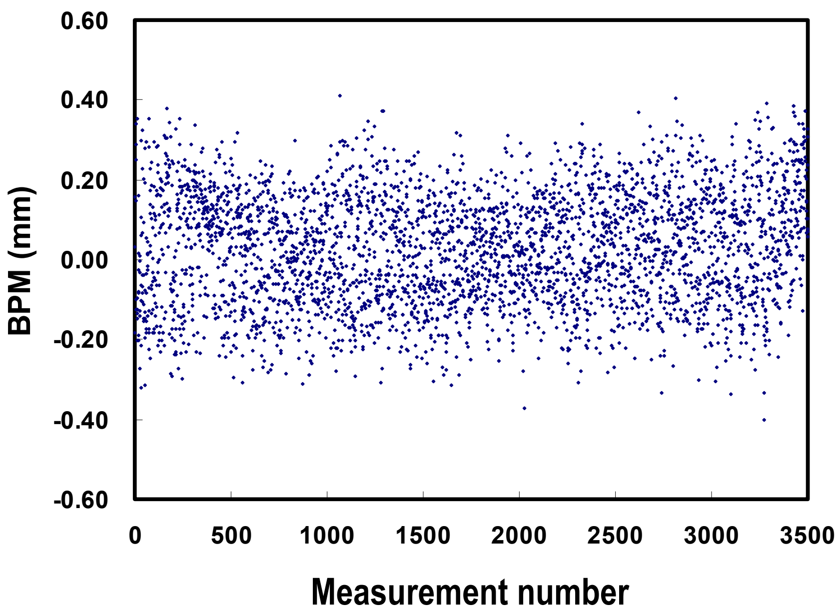
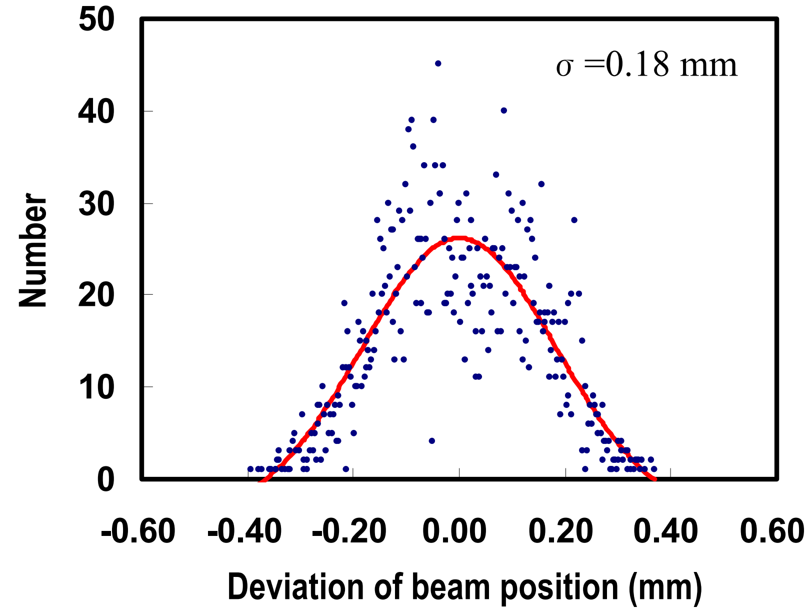


Diagram of BPM calibration experiment

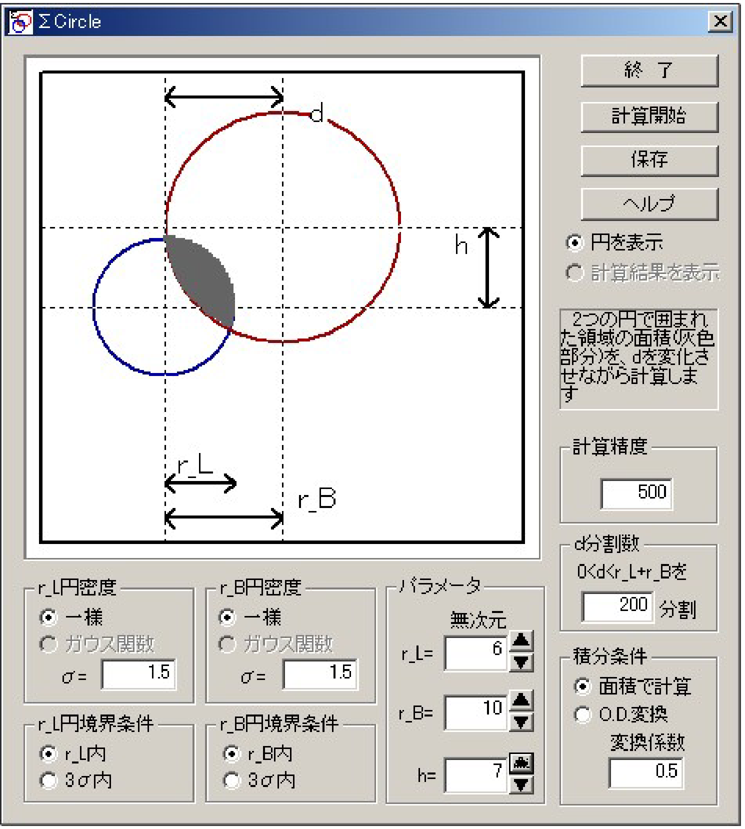


Beam position calculated by pickup voltage and a_1=8.52



Deviation of beam position and Gauss fitting

Calc. about effect of beam position on O.D.



<Algorism of BPM calibration>

$$[Optical\ \ Density]_i = \log \frac{I_0^i}{I^i}$$

$$I_0^i = \sum_{n=0, f_l(x_n, y_n) \le 0}^{mesh\_num} g_L(x_n, y_n)$$

$$I^i = \sum_{n=0, f_l(x_n, y_n) \le 0, f_B(x_n, y_n) > 0}^{mesh\_num} g_L(x_n, y_n) + \sum_{n=0, f_l(x_n, y_n) \le 0, f_B(x_n, y_n) \le 0}^{mesh\_num} g_L(x_n, y_n) \times \exp\left\{-\alpha\ g_B(x_n, y_n)\right\}$$

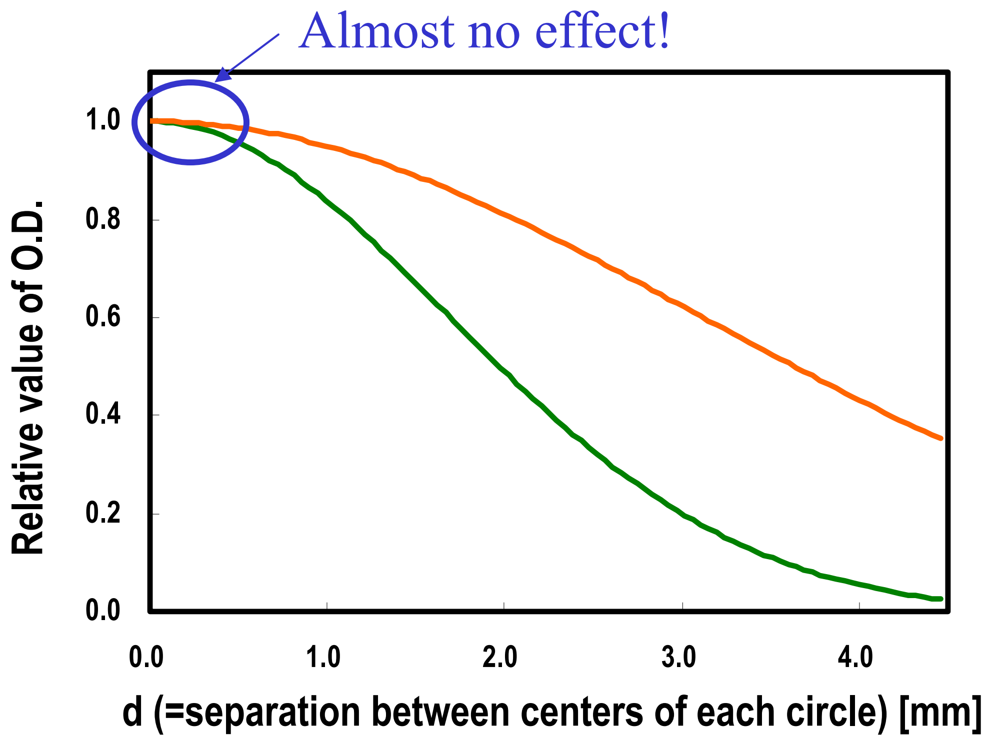
$$g_L(x_n, y_n) = \frac{1}{\sigma_L \sqrt{2\pi}} \exp\left(-\frac{x_n^2 + y_n^2}{2\sigma_L^2}\right) \qquad \text{(Gauss Function)}$$

$$g_B(x_n, y_n) = \frac{1}{\sigma_B \sqrt{2\pi}} \exp\left(-\frac{(x_n - d_i)^2 + (y_n - h)^2}{2\sigma_B^2}\right) \qquad \text{(Gauss Function)}$$

Calculation result of BPM

Simulation parameter

	σ L (mm)	σ B (mm)	h (mm)	σ L boundary condition	σ B boundary condition
Parameter1	1.5	1.5	0.0	radius 1.5 mm	radius 3σ mm
Parameter2	1.5	3.0	0.0	radius 1.5 mm	radius 3σ mm



d v.s. Relative value of O.D.
parameter1, parameter2

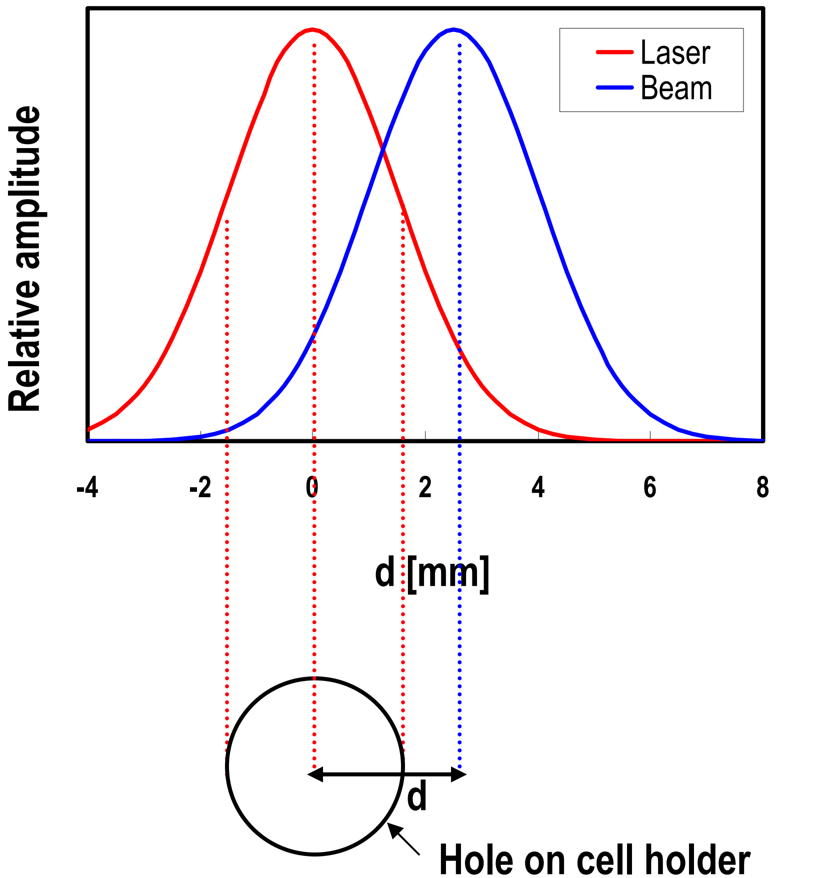


Image of position correlation between laser and beam

Additional Summary

- L-band linac was renewed and the renewal was completed in May 2004.
- It will become a powerful tool for establishing bases of nanotechnology.
- The nanosecond & picosecond pulse radiolysis have been developed.
- The available wavelength of these system will expand and cover the range from UV to IR.