CSR Workshop
Sep.24, 2007, UVSOR

Status of Coherent Radiation Beamline at KURRI-LINAC

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Outline

- Outline of KURRI-LINAC
- Specifications of the beamline

  (including coherence of CTR)
- Spectroscopic demonstrations

  on the beamline

Outline of KURRI-LINAC

It was constructed in 1964 for pulsed neutron source.
(Applied Radiation, USA)

RF: L-band (1.3GHz)
Energy: 40 MeV
Pulse width: 2ns～4μs (Multi-bunch operation)
Beam power: Max. 10kW (30MeV, 330μA)
Peak current: Max. 8A
Operation time: 2,700Hr (in 2006)

Research field (collaboration research program)

- Nuclear data with TOF
- Isotope production
- Electron irradiation
- Coherent radiation → since 1991
  10 weeks user-time/year

Linac-based coherent radiation

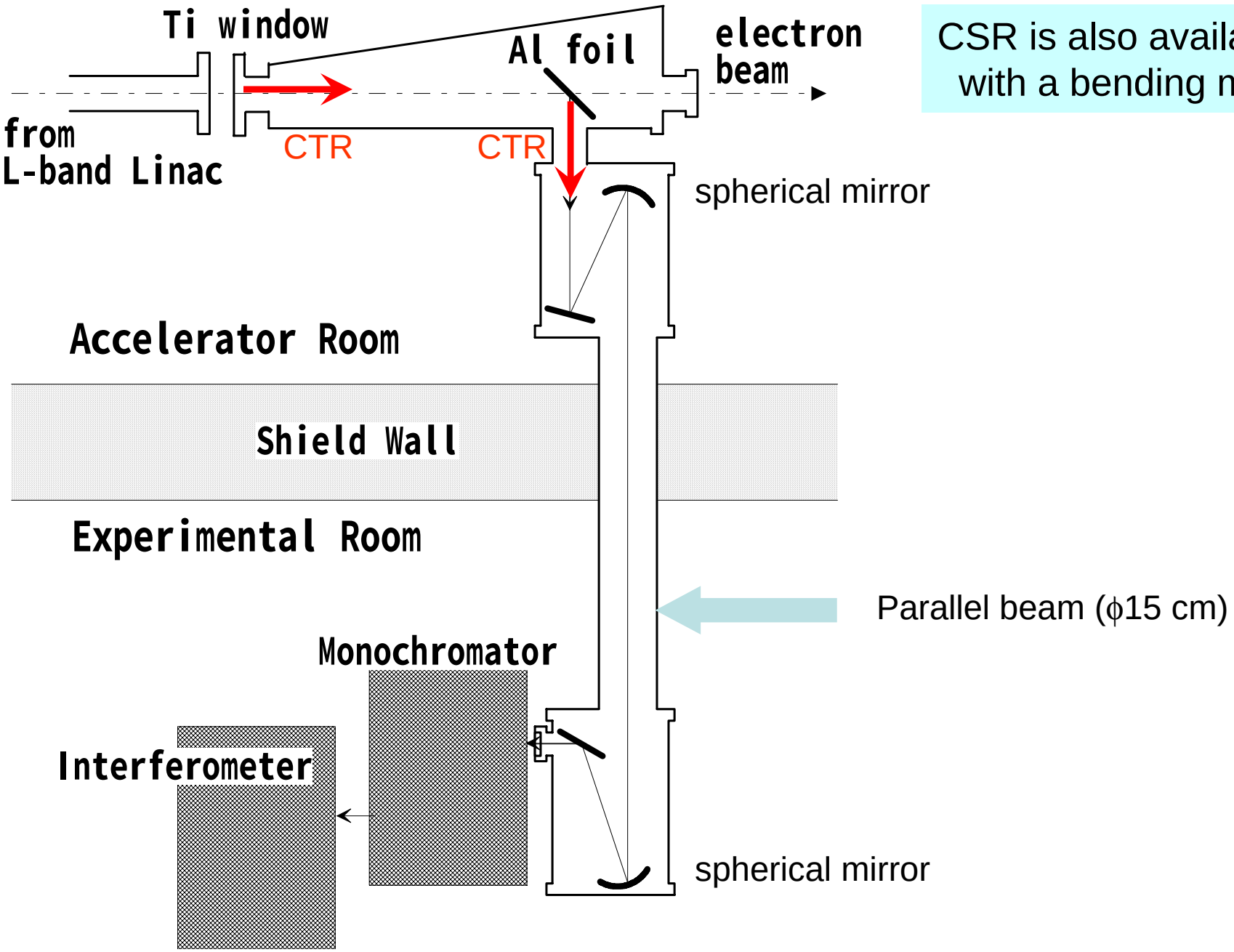
disadvantage

Single-user

advantages

- High peak-power
  (the high amount of charge in a bunch～several nC)
- Various types of coherent radiation are available.
  (synchrotron, transition, diffraction, Smith-Purcell, Cherenkov)
- Interaction between electron beam and medium is available.

Schematic diagram of the beamline



CSR is also available with a bending magnet.

Photograph around the emission point (Target Room)

Spectrometers and detectors

spectrometers
(home-made)

- Martin-Puplett type Interferometer (step scan) — broadband spectrum
- Grating type monochromator (Czerny-Turner type) — monochromatic light, high dynamic range

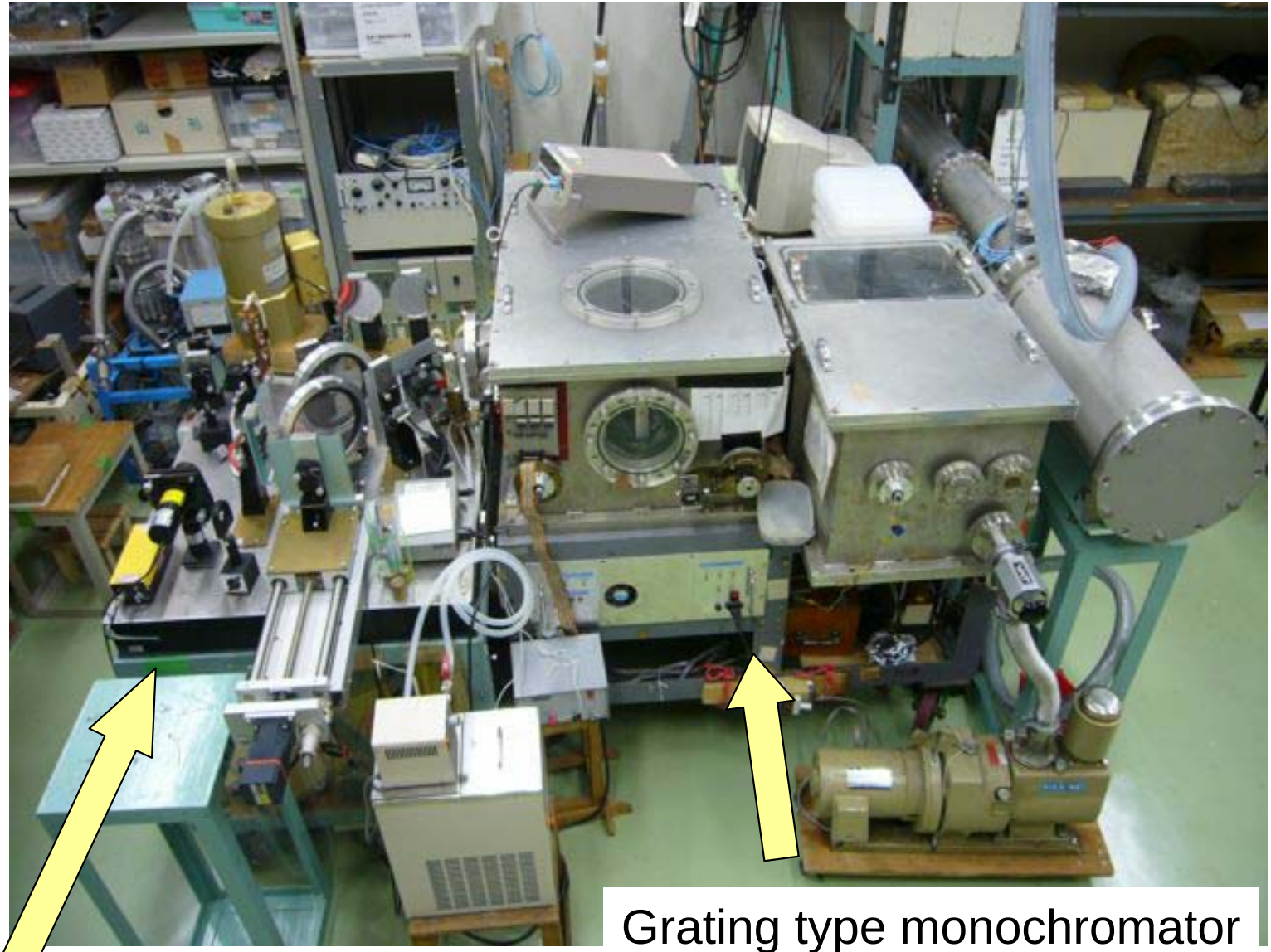
detectors

- Si bolometer (Liquid-helium-cooled) — high sensitivity, low noise, VBW1kHz
- InSb bolometer (Liquid-helium-cooled) — high sensitivity, low noise, VBW1MHz
- Diode detector — narrowband, fast detector VBW1GHz

signal acquisition

- Lock-in amplifier
- Fast gated integrator — for pulsed light source of small duty ratio

Photograph of spectrometer



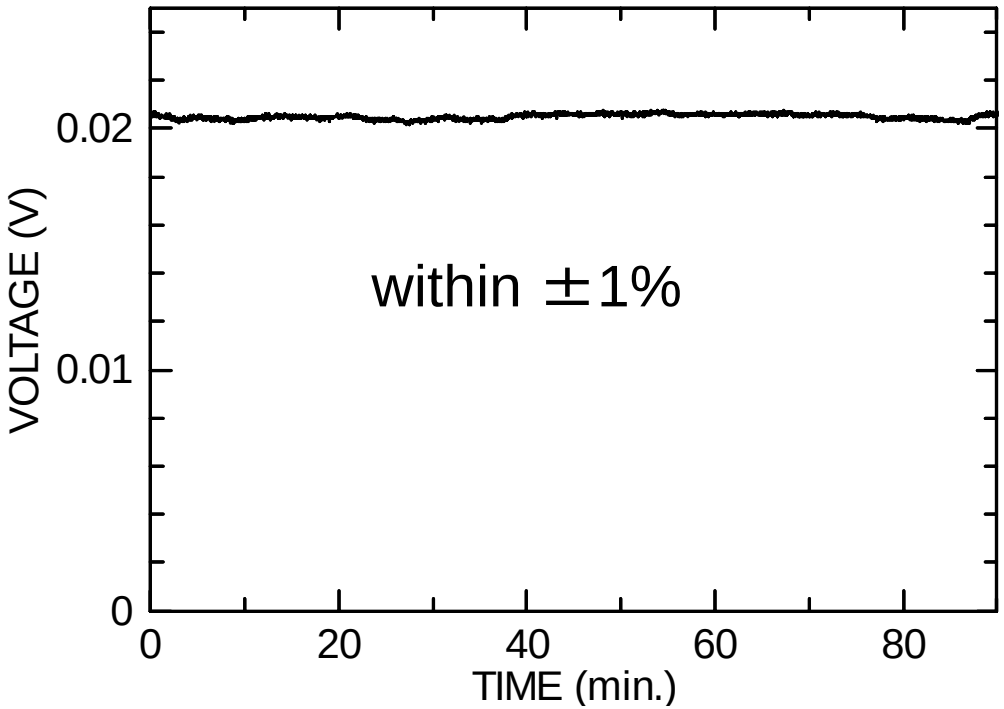
Martin-Puplett type interferometer

Grating type monochromator (Czerny-Turner type)

(The grating is replaced by a flat mirror under the interferometer mode.)

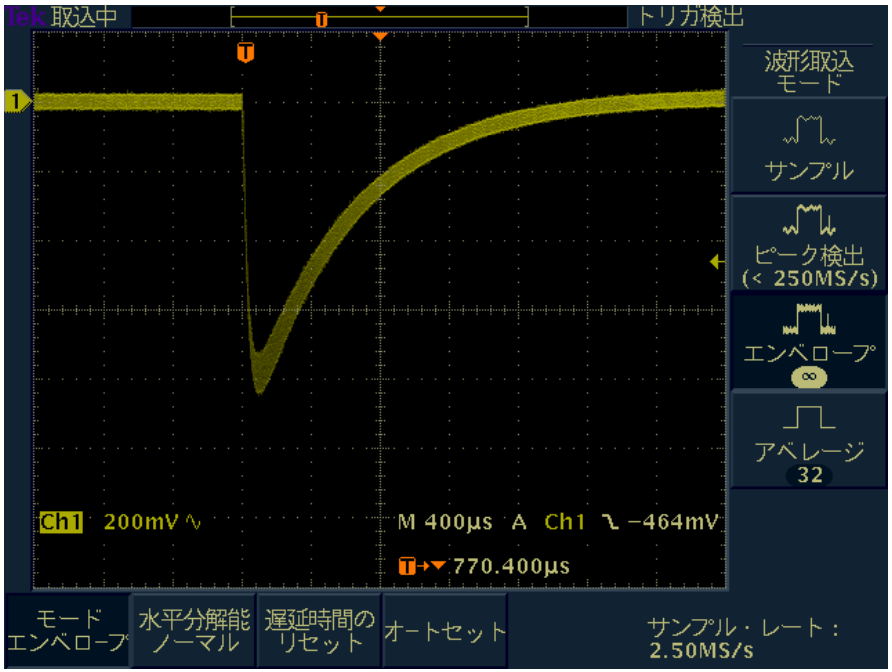
Stability of intensity

Long-time stability



Si bolometer on the interferogram
Lock-in Amplifier (Time const.:0.1s)

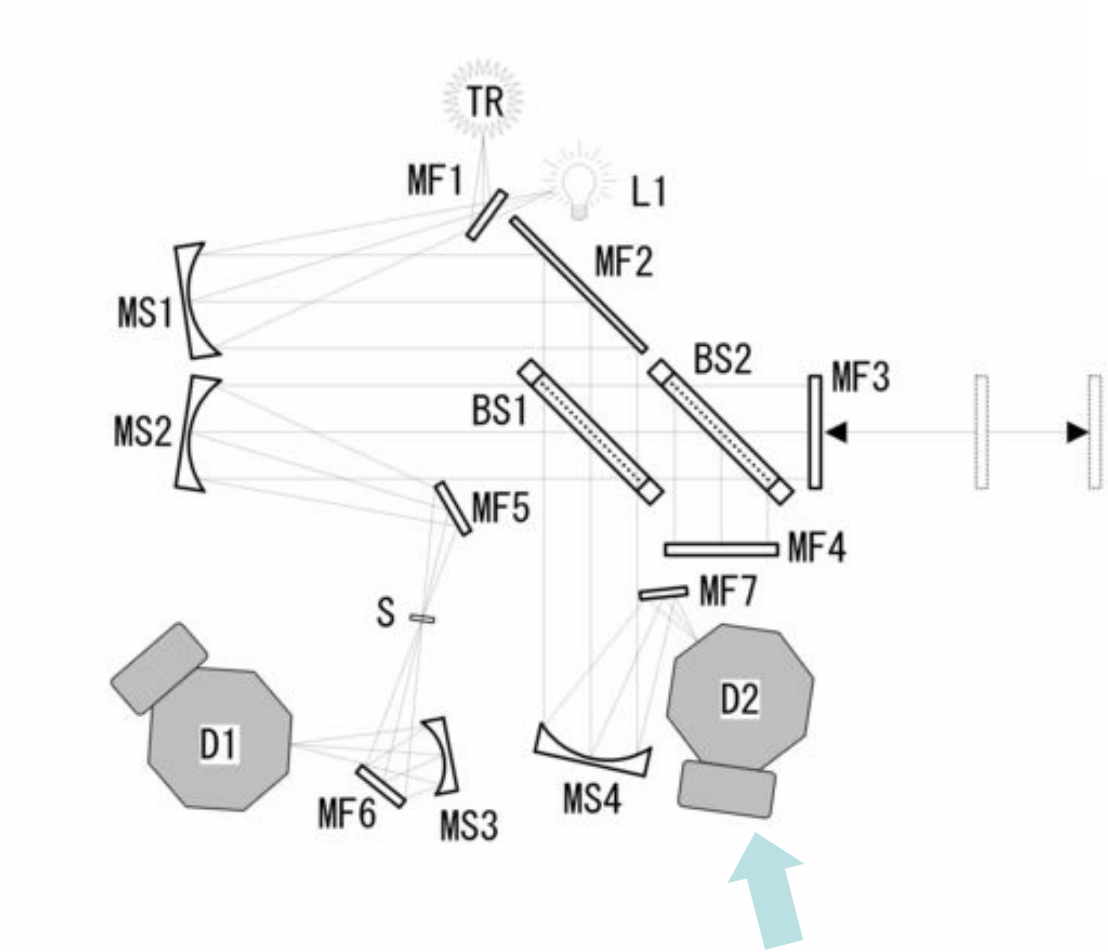
Pulse stability



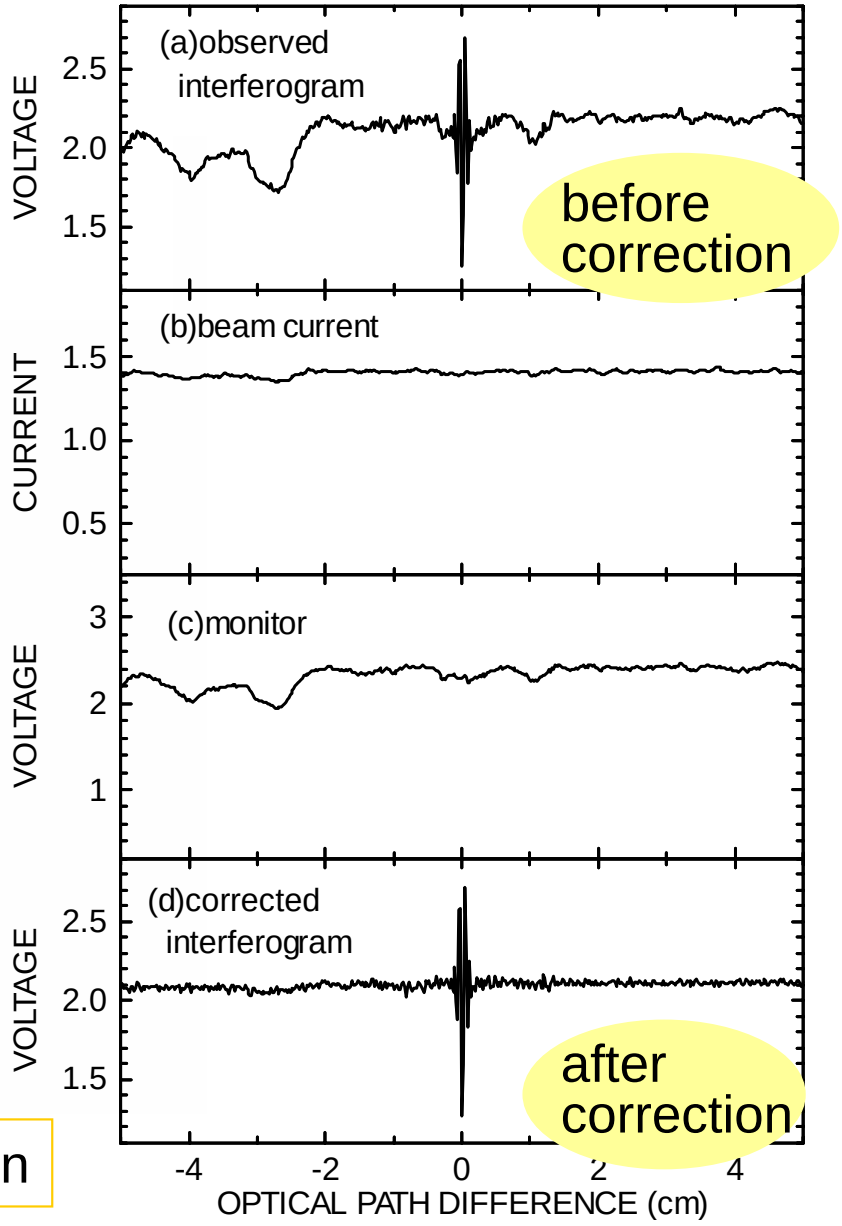
Si bolometer on the interferogram
Repetition rate: 46Hz
Oscilloscope: envelope mode

Correction of fluctuation

If the intensity fluctuates due to the trouble of the linac …..

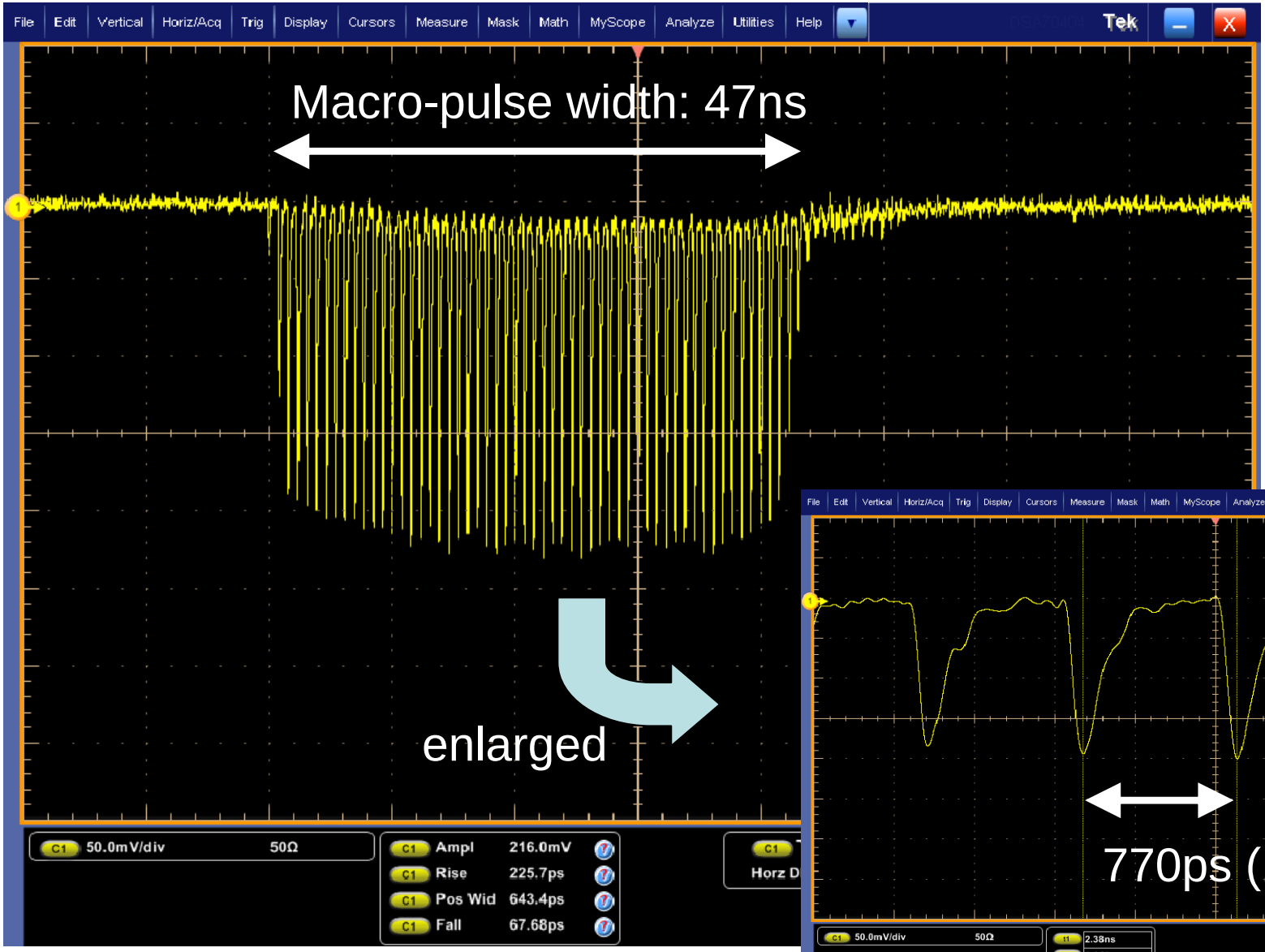


detector for monitoring fluctuation

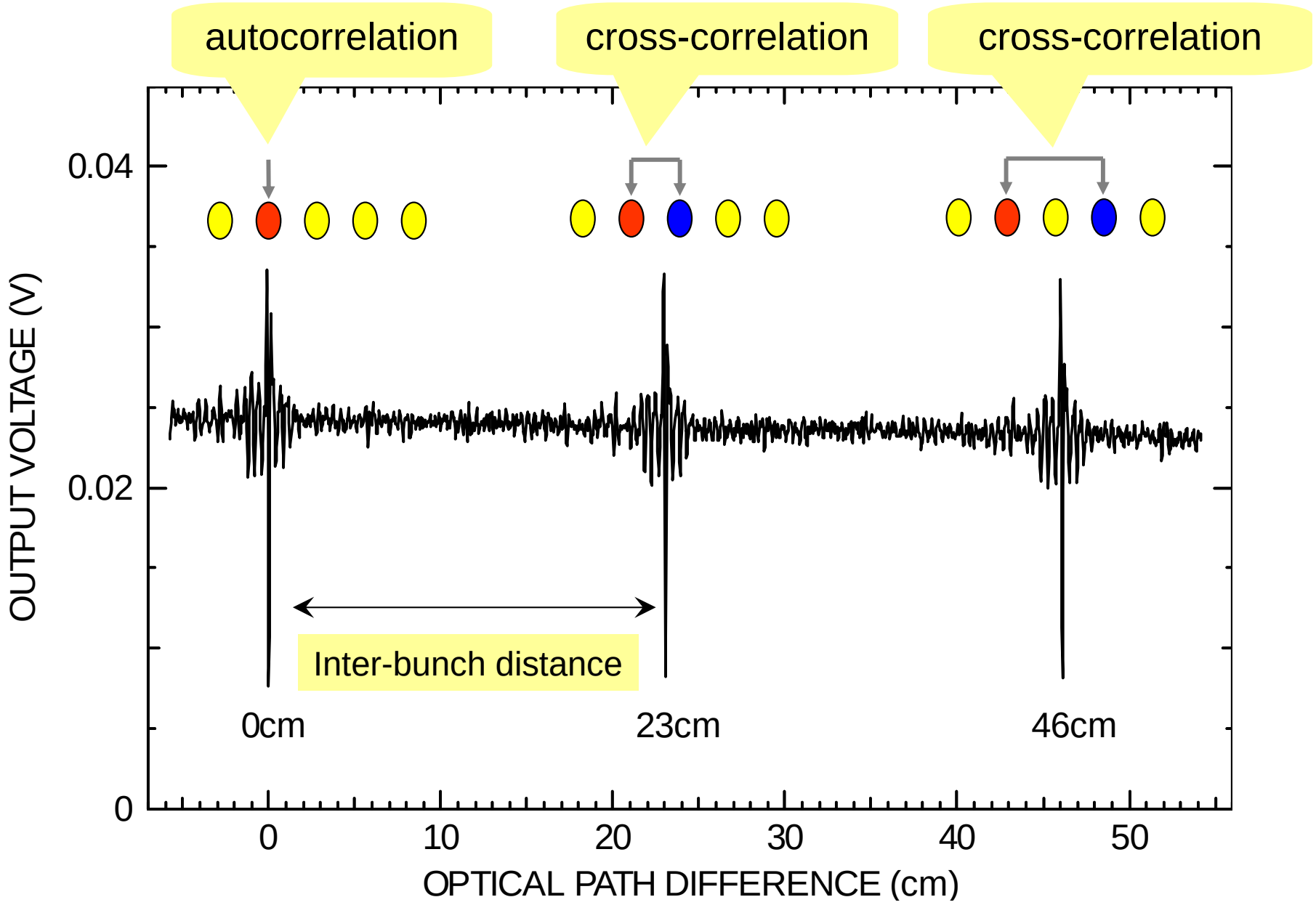


Temporal structure of CTR

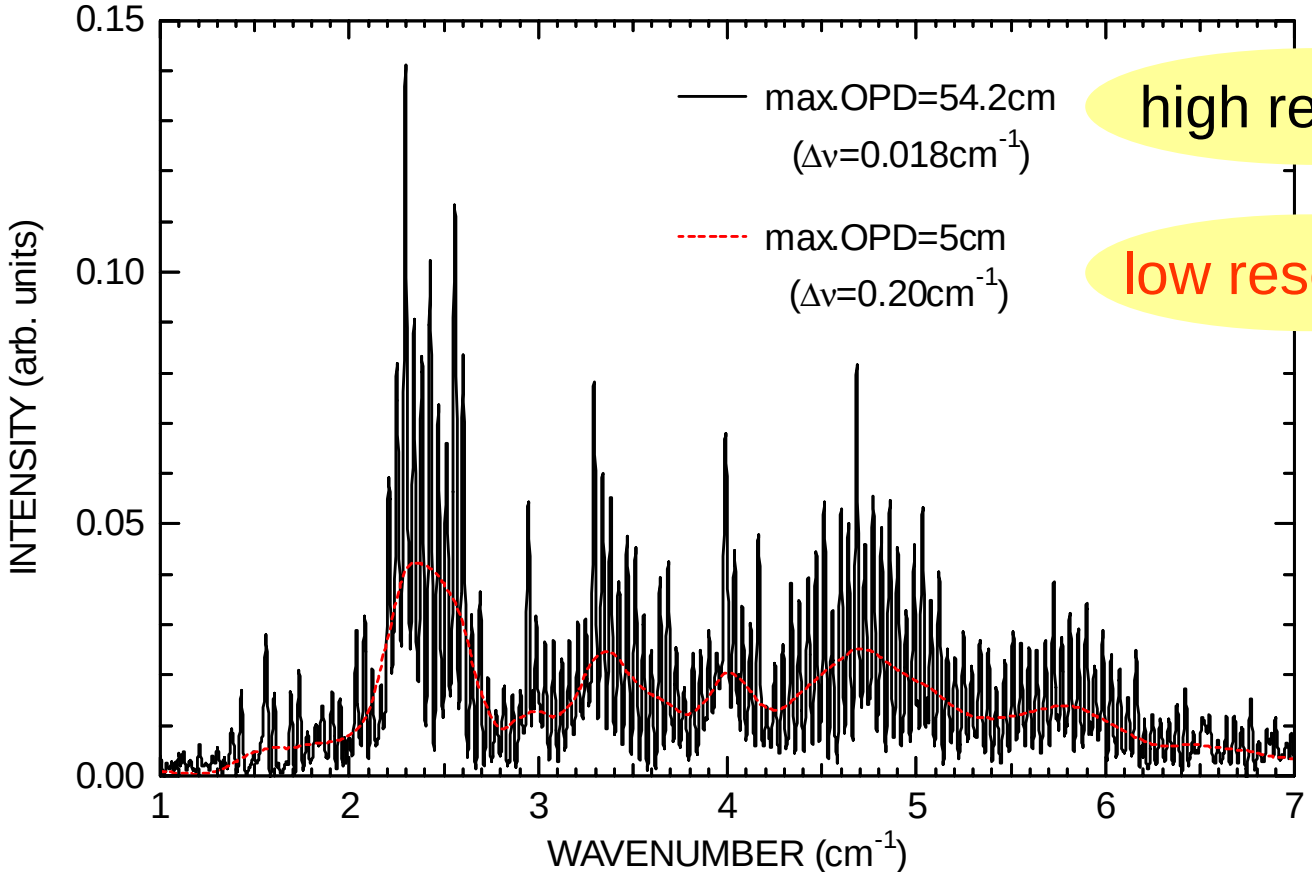
Diode detector
W-band
75-110GHz



Interferogram of large optical path difference



CTR form successive bunches



continuous spectrum: $\Delta\nu > f_{RF}/c(\mathrm{cm}^{-1})$ 0.043cm^{-1} for 1.3GHz

Demerit of multi-bunch

- Restriction on continuous spectrum
- Restriction on delay time in the time resolved measurement

→ The single bunch operation is needed.

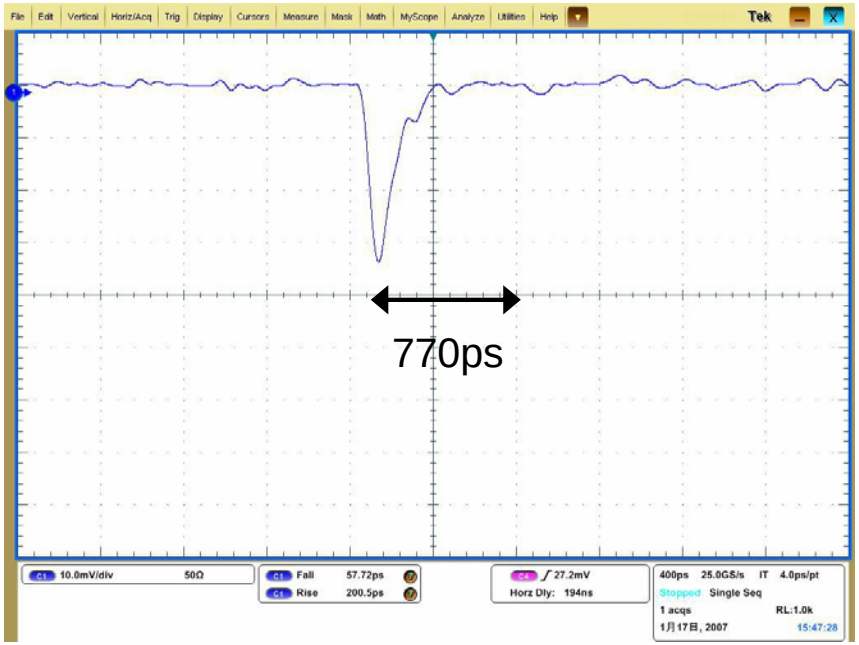
Generation of single bunch

~~Sub-harmonic pre-buncher~~

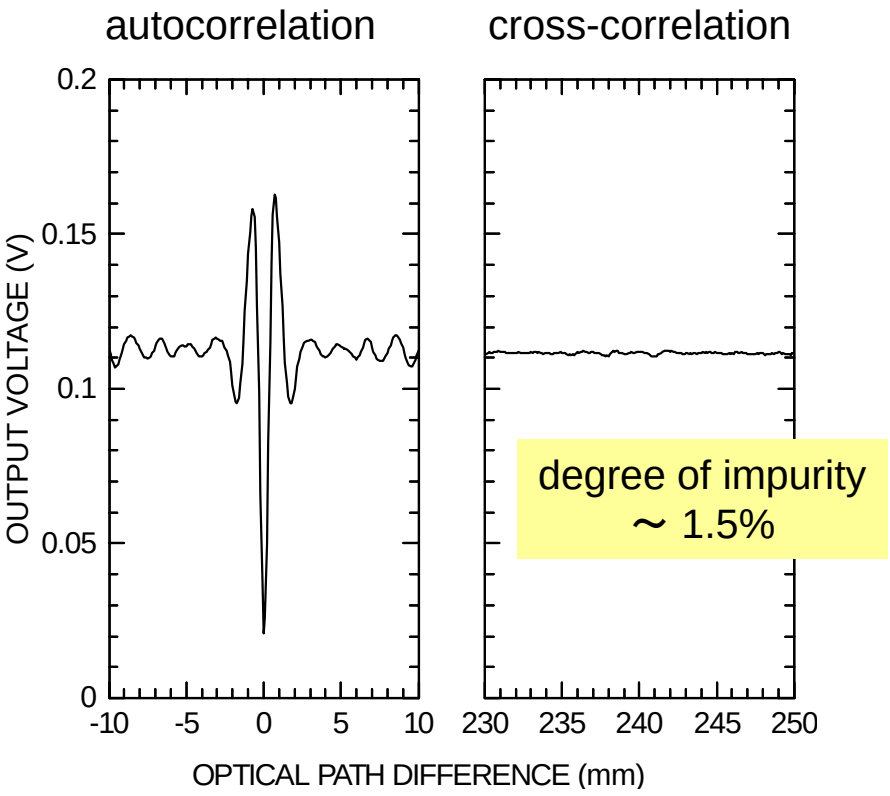
no space　　expensive

High-speed avalanche-type pulser

Development and
install on electron injector

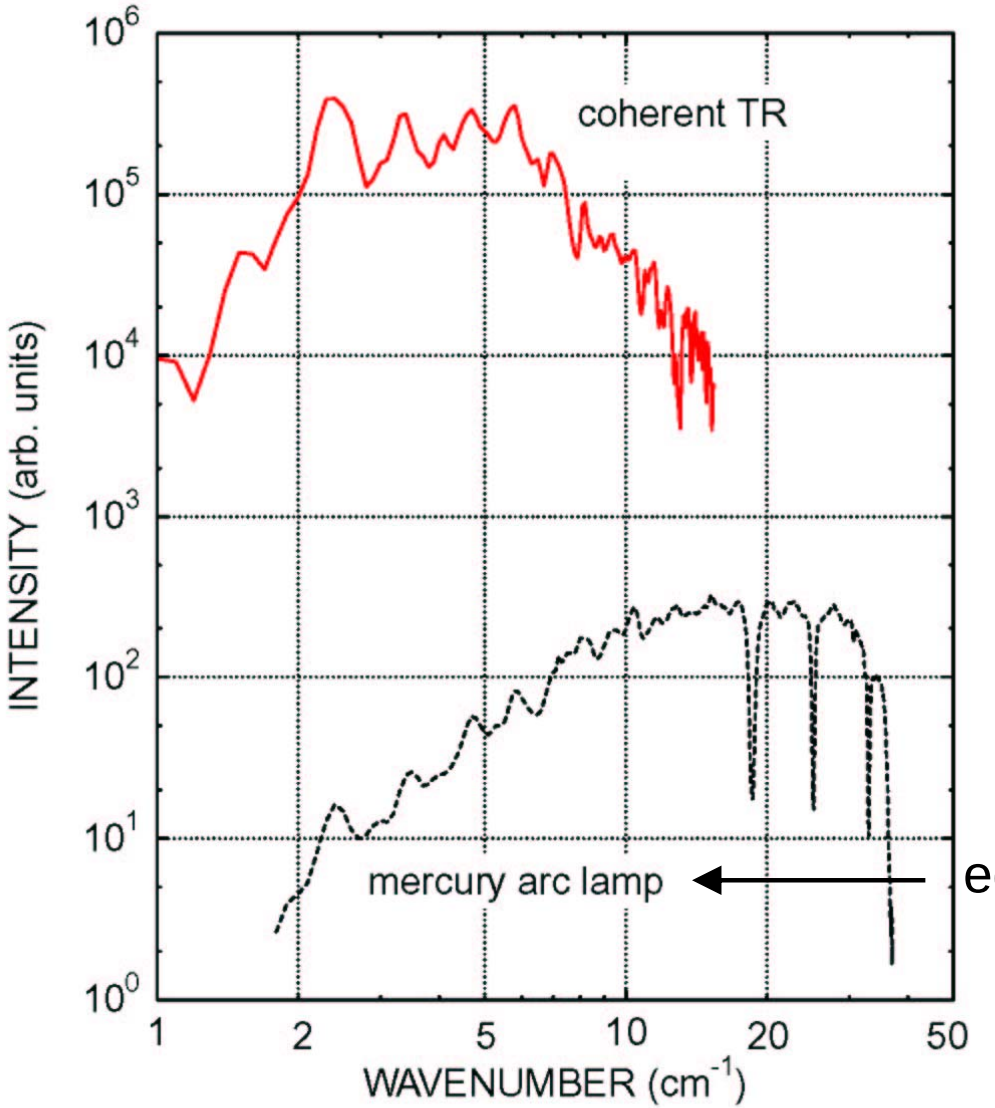


Waveform of CTR
（diode detector）



Interferogram of CTR
(Si bolometer)

Spectrum of CTR

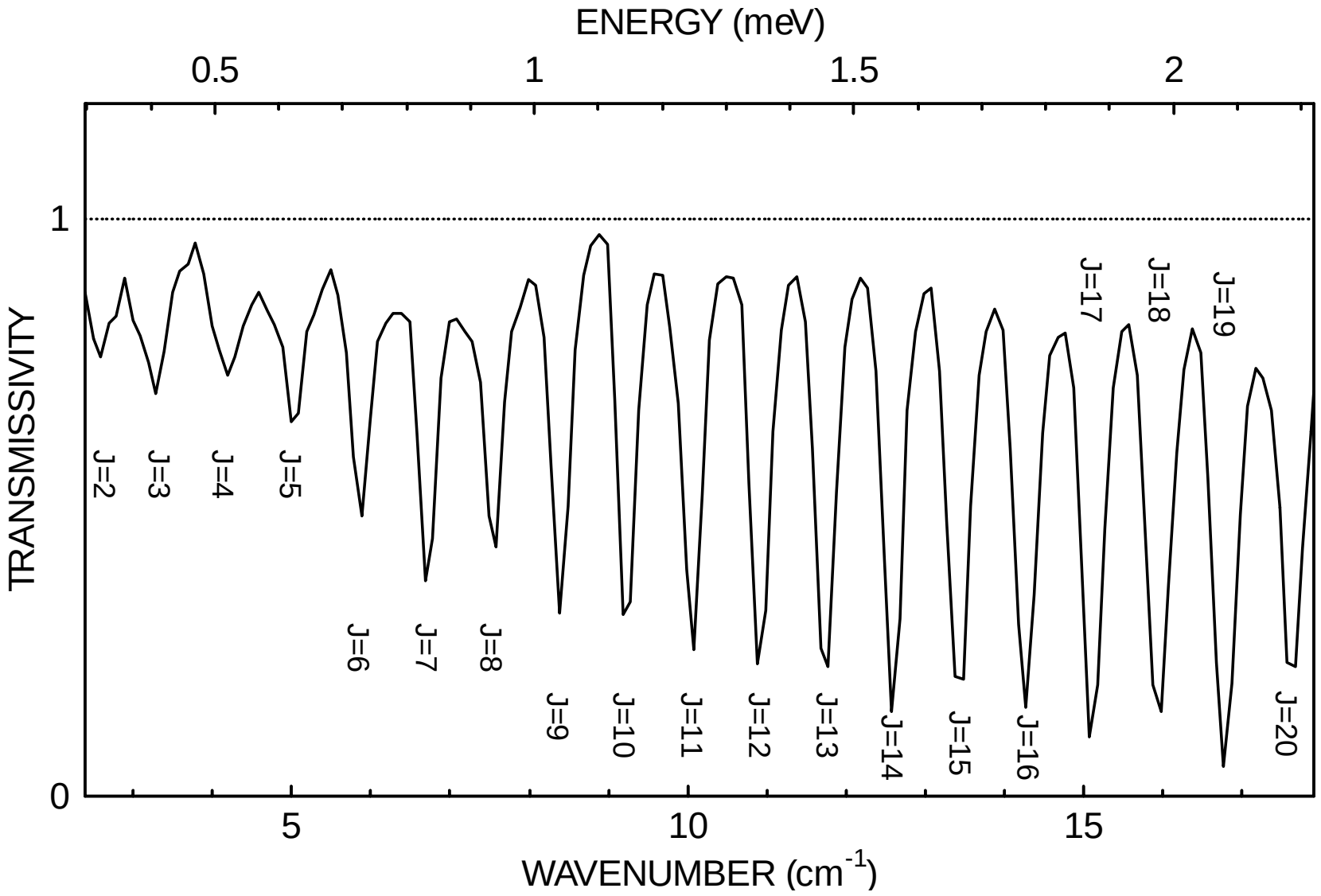


equipped on the interferometer
(100W; aperture ϕ10)

(acceptance angle: 70mrad)

Pure rotational spectrum of N_2O gas

T.Takahashi et al. Rev.Sci.Instrum., 69(1998)3770



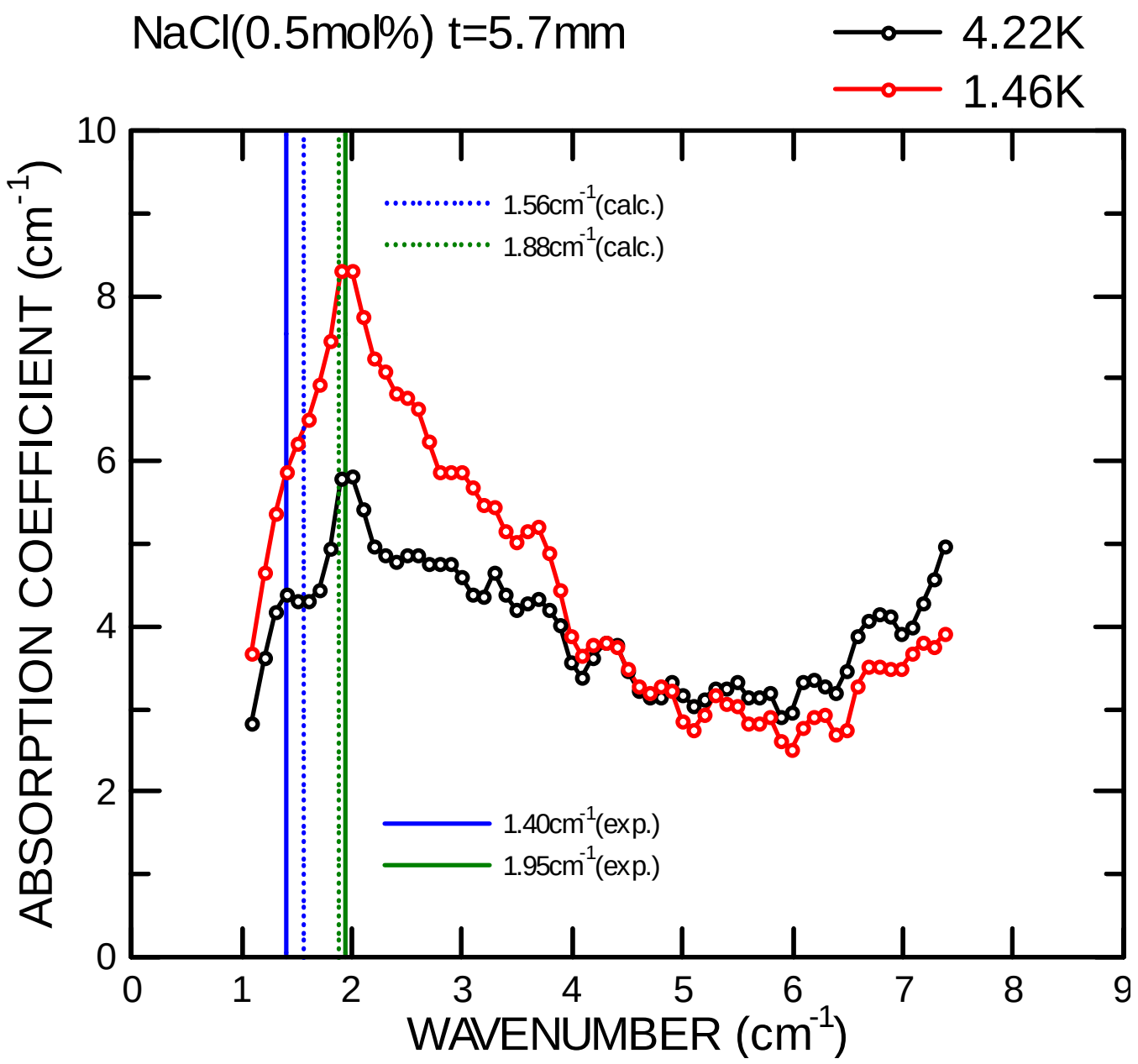
Resolution: 0.2cm^{-1}

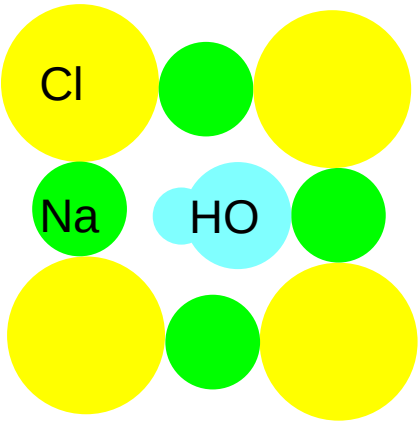
Optical path length in N_2O: 9.3m

Pressure: 2×10^4 Pa

Absorption spectrum of OH^- ion in NaCl

(collaboration research with Tohoku Univ.)





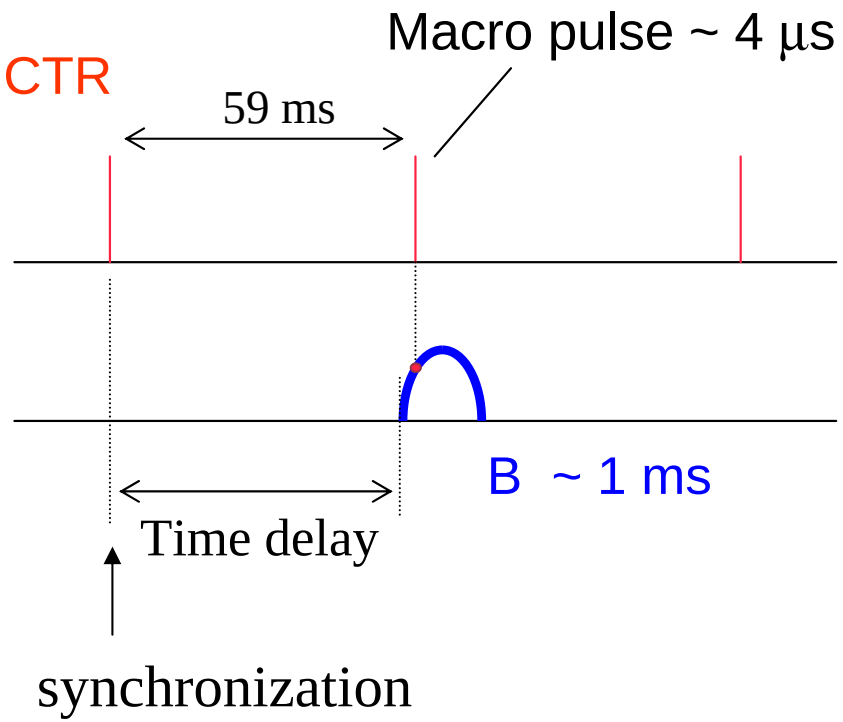
Light-pipe type Cryostat (1.4K～4.2K)

MM-wave magneto-spectroscopy

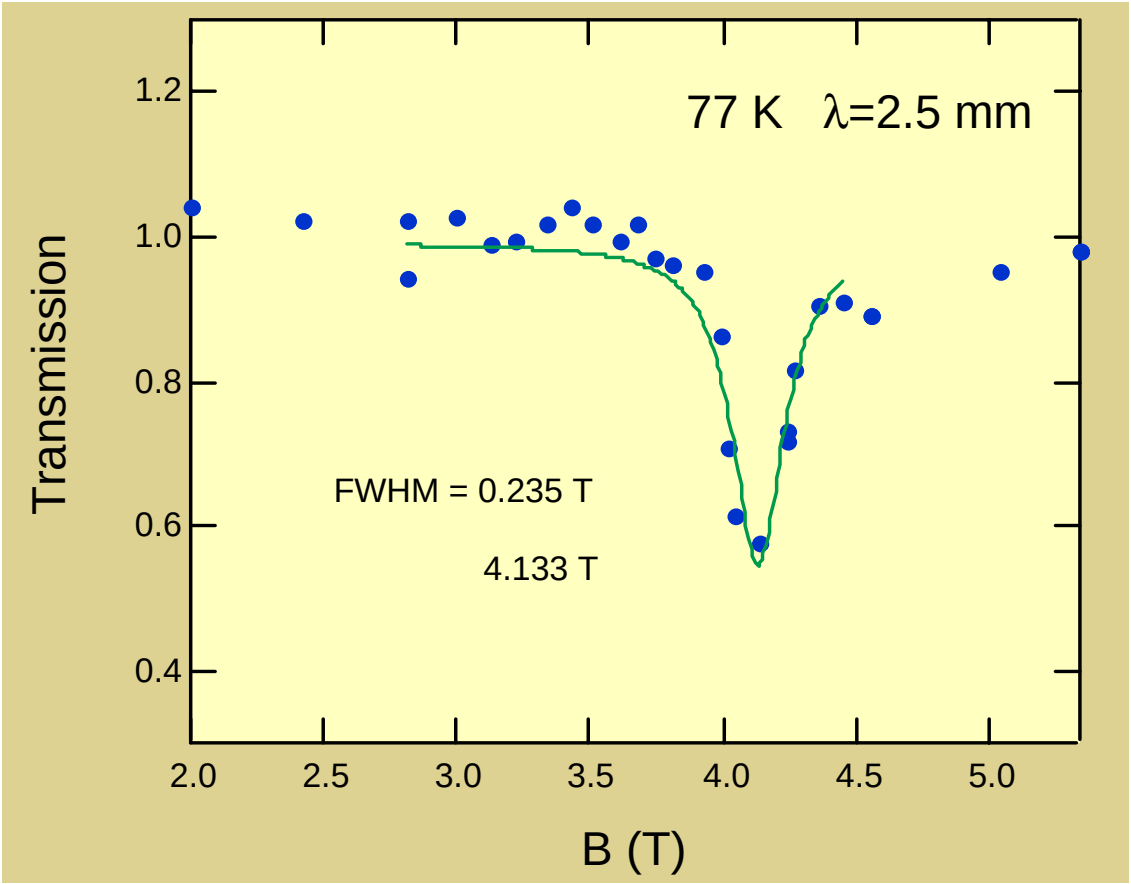
(collaboration research with Okayama Univ.)

Y.H.Matsuda et al. Physica B 346-347(2004)519

Repetition rate: 17 Hz



Electron spin resonance of Mn ions in $RbMn_{0.3}Mg_{0.7}F_3$

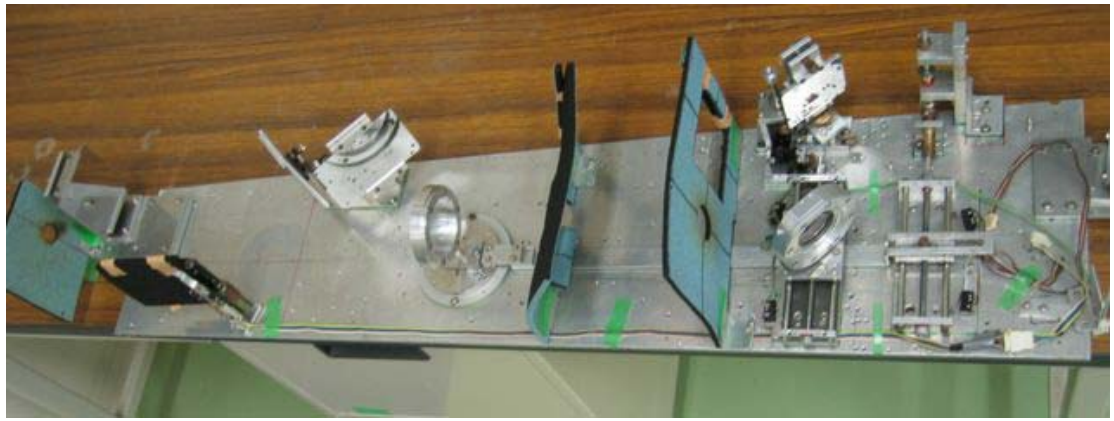


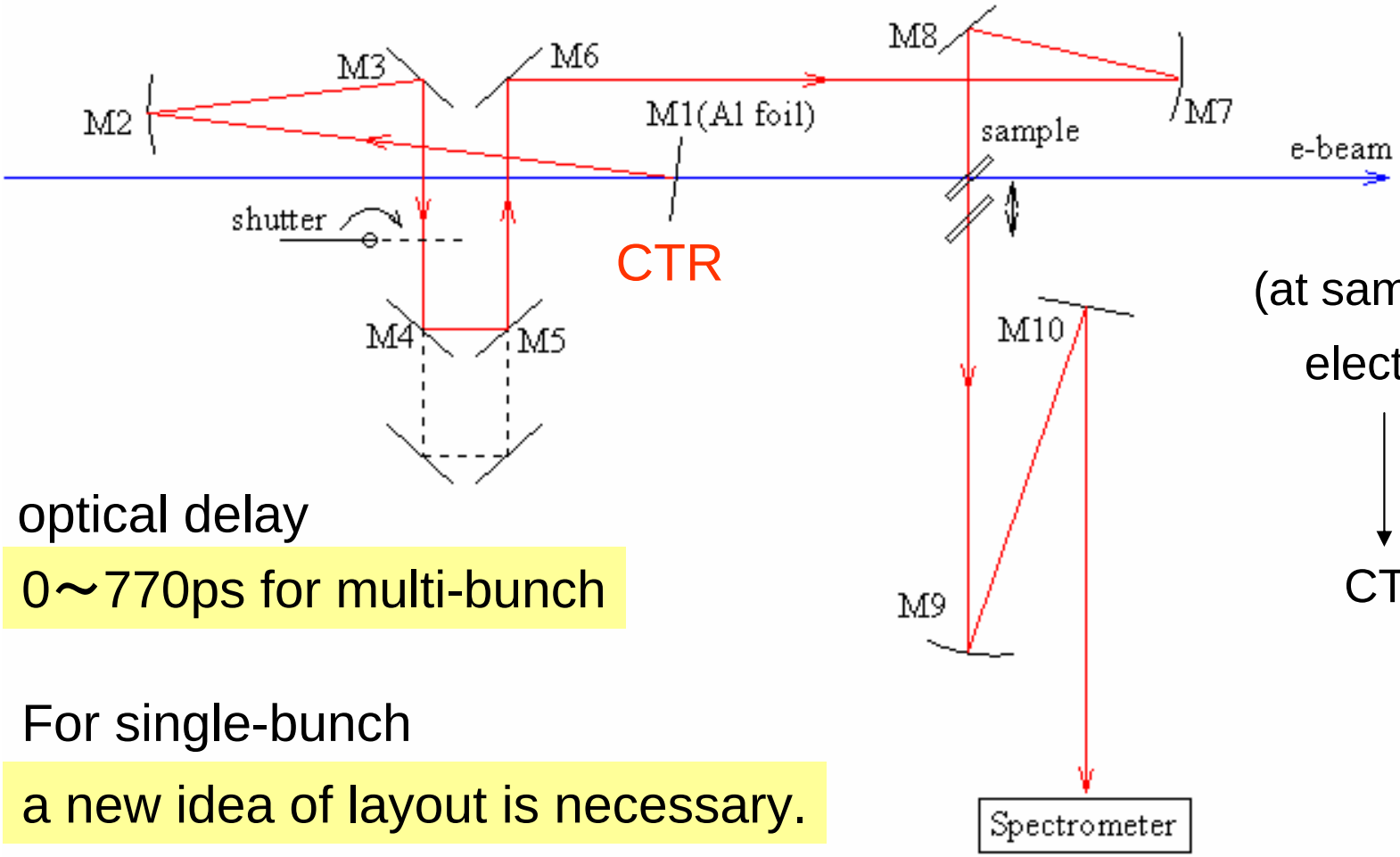
Portable pulsed magnet

Capacitor bank: 533 × 658 × 1234mm^3 Max. 20T

Coil: outer diameter: 20-30mm, length: 10-30mm, bore size: 3-6mm

MM-wave Pulseradiolysis





(at sample position)

electron beam

$10L_b$

(7.7ns)

CTR

optical delay

0～770ps for multi-bunch

For single-bunch

a new idea of layout is necessary.

Summary

- *KURRI-LINAC has been upgraded for coherent radiation.*

  stabilization, generation of single-bunch beam

- *Several spectroscopic researches has been demonstrated.*

Researches in progress

- Optical conductivity of superionic conductors
  (collaboration research with Tohoku Gakuin Univ.)

- Optical properties of water
  and polymeric materials under γ-ray irradiation
  (collaboration research with Osaka Prefecture Univ.)

- Development of pulseradilysis system