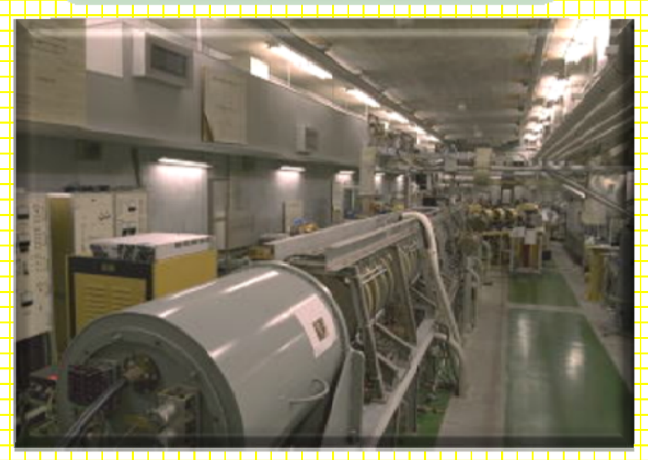
Research Laboratory for Quantum Beam Science

http://www.sanken.osaka-u.ac.jp/labs/rl/

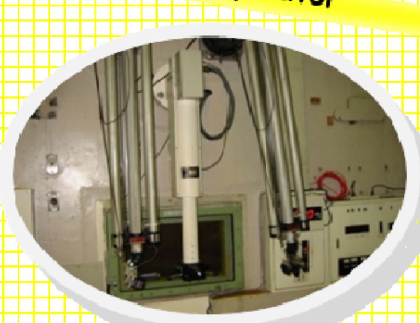
Joint research facility based on quantum beam science

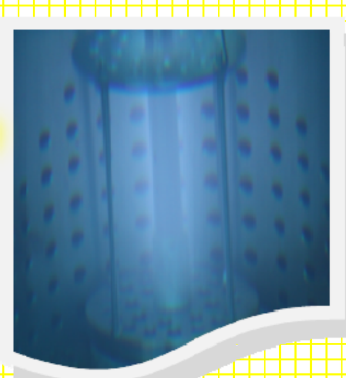
Co60γ-ray irradiation facility

L-band electron Linac

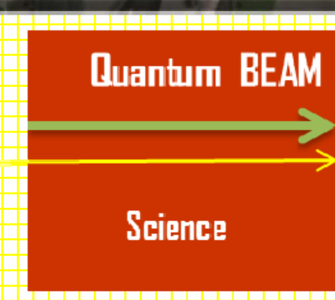


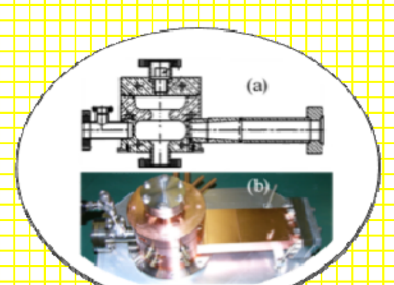
manipulator





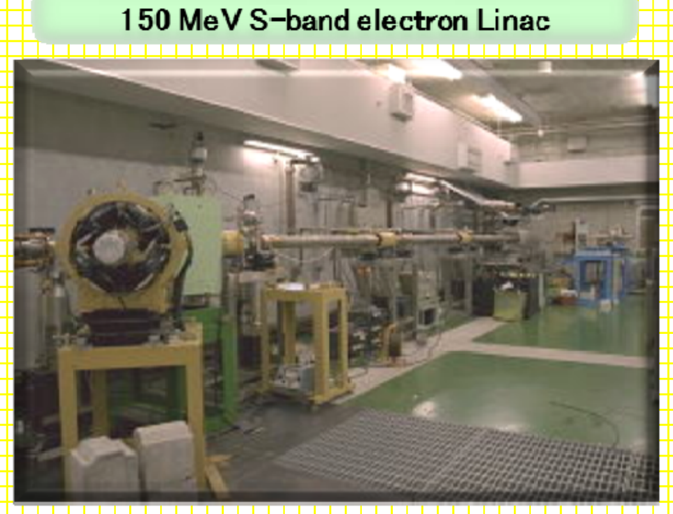
Cherenkov from Co60γ-ray



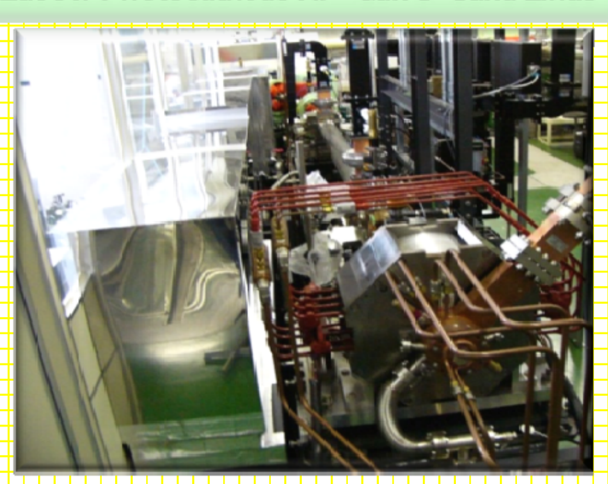


Emitter of RF-Gun

150 MeV S-band electron Linac



Lasoer Photocathode RF-Gun S-band Linac

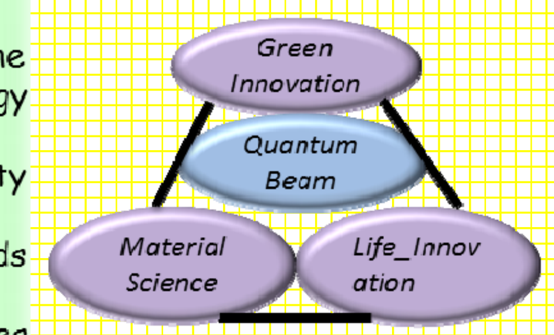


OUTLINE

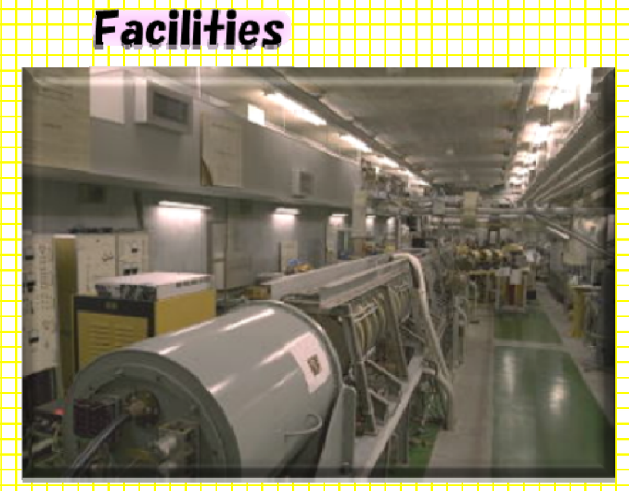
The Research Laboratory for Quantum Beam Science (RLQBS) was established in 2009 as a successor of Radiation Laboratory. All the facilities such as L-band linac and ^{60}Co γ-ray irradiation facility were taken over. These are opened to users in Osaka University and also the members of Network Joint Research Center for Materials and Devices, which was developped in 2010. Based on quantum beam science, frontier beam science relating to environmental material science, new energy sources and advanced medical technology as well as fundamental beam science are promoted with concurrent members. The management including operation, maintenance and the safety control of radiation related facilities are also conducted with the aid of concurrent members.

<Research Topics>

① Application of quantum beam science to the fields of environmental science, new energy technology and advanced medical technology.
② Management, operation, maintenance and safety control of the facilities.
③ Research and development of analyzing methods of materials using quantum beams.
④ Radiation induced reactions in organic molecules and photocatalytic semiconductors.

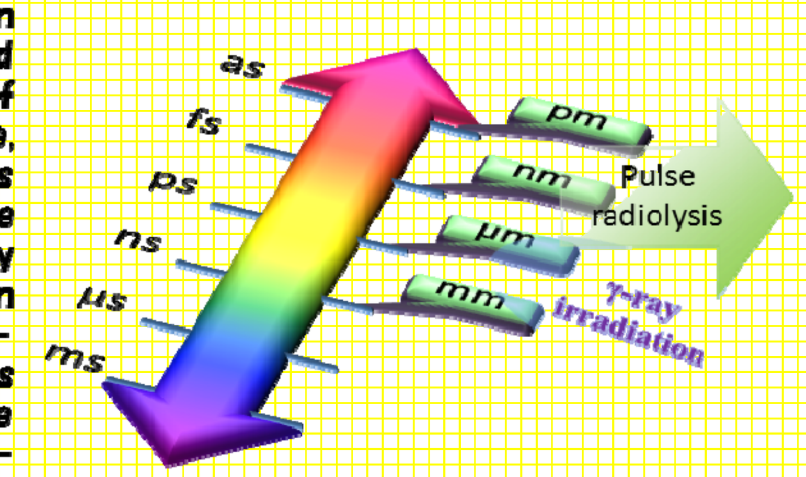


Facilities

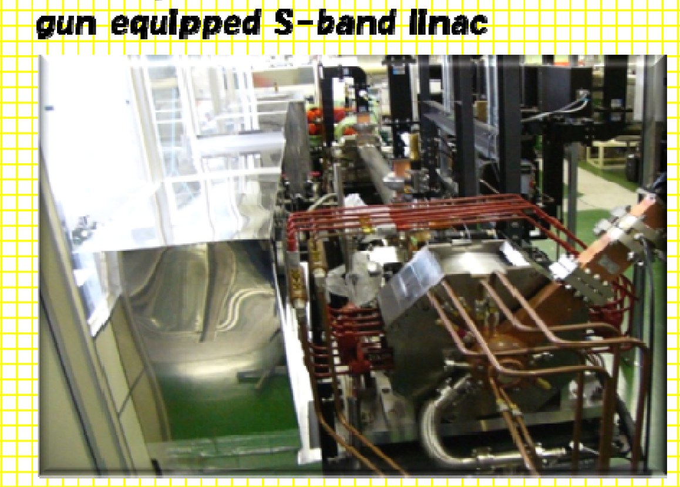


The L-band linac was constructed in 1978 to genere an intense singly bunched electron beam with pulse width of 20 picosecond. Acceleration power is supplied by 30 MW L-band klystron. After the improvement of bunching system and the gun cathode, the charge per single bunch was increased up to 91 nC. Such the intense electron beam has been mainly used to study transient phenomena in the range from nanosecond to sub-picosecond with a pulse radiolysis system, and also used as a tool of free electron laser (FEL) to produce far-infrared light.

This linac was improved in 2003 for the purpose of getting high stability and reproducibility as well as easy operation. The linac is composed of a thermionic electron gun, three sub-harmonic pre-bunchers, pre-buncher, buncher and 3 m long accelerating tube, and is operated with four modes: transient, steady, single-bunch and multi bunch modes. Electrons injected from the gun are usually accelerated up to around 25 MeV. An available pulse width is now from less than 1 ps in single mode operation to several ns in transient mode operation.



Laser-photocathode RF electron gun equipped S-band linac

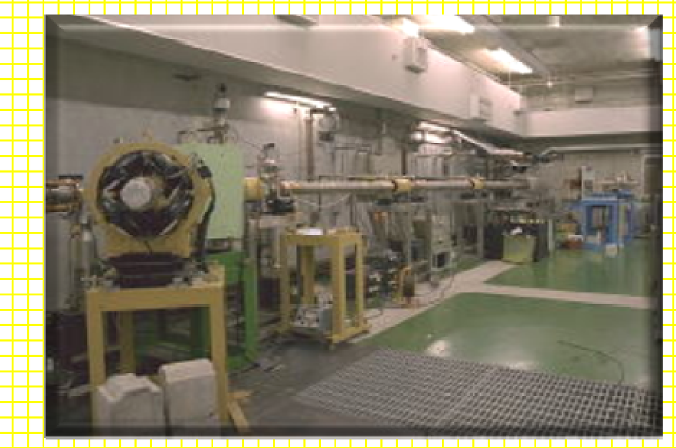


The laser-photocathode RF electron linear accelerator, which was constructed in 2003, can generate a low-emittance and ultrashort electron beam. The linac consists of a 1.6-cell S-band laser photocathode RF electron gun, a 2-m-long traveling-wave linac, and a magnetic bunch compressor. Picosecond electron beams are generated in the RF gun using a Nd:YLF picosecond laser. The electron beams are accelerated in the linac for optimal energy-phase correlation. Finally, the electron beams of ~30 MeV compressed into femtoseconds by the magnetic bunch compressor for femtosecond pulse radiolysis. Utilization of the compressor realized an ultrashort single electron beam of 98 fs. The combination of the femtosecond electron beam and a femtosecond laser achieved a time resolution of 240 fs in pulse radiolysis successfully.

Typical Research Fields in Radiation Chemistry

- Study on quantum beam induced ultra-fast transient phenomena
- Study on damaging proccss on DNA
- Study on damaging or redox proccsses on resist by driving radiation
- Study on charge transfer process in materials

150 MeV S-band linac



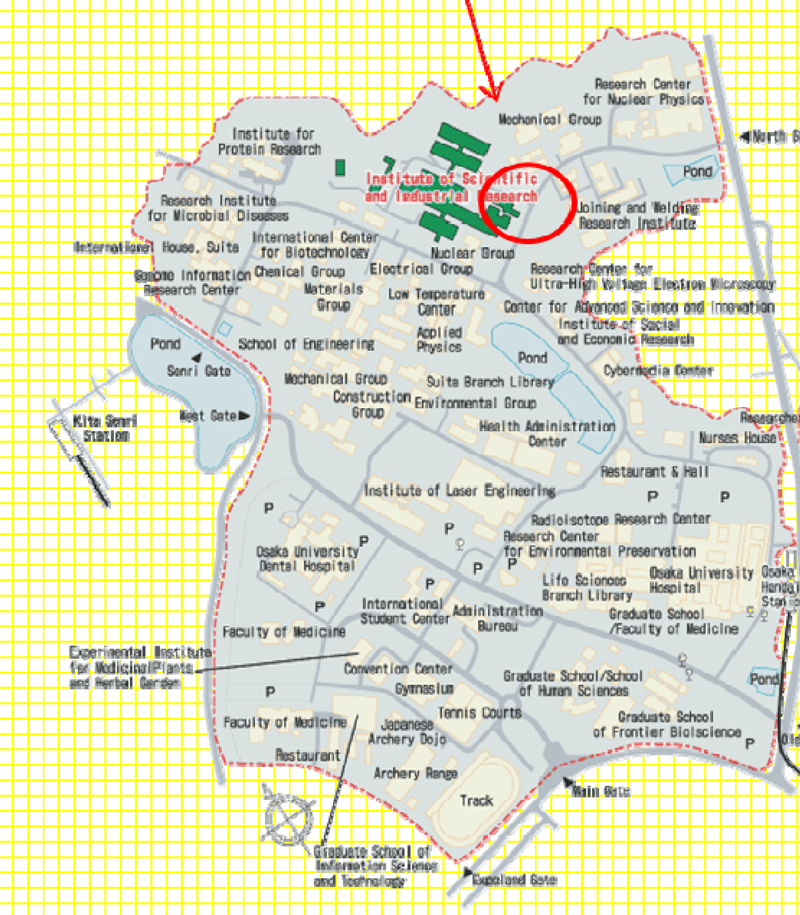
The 150 MeV S-band linac was developed in 1990. This linac consisting of three acceleration tubes and a thermionic gun, can accelerate electron bunch up to 100 MeV with the current of 0.25 A in a representative operation. The bunch length is two microseconds and its repetition is less than 30 Hz. This linac has been dominantly used to produce positron beam.

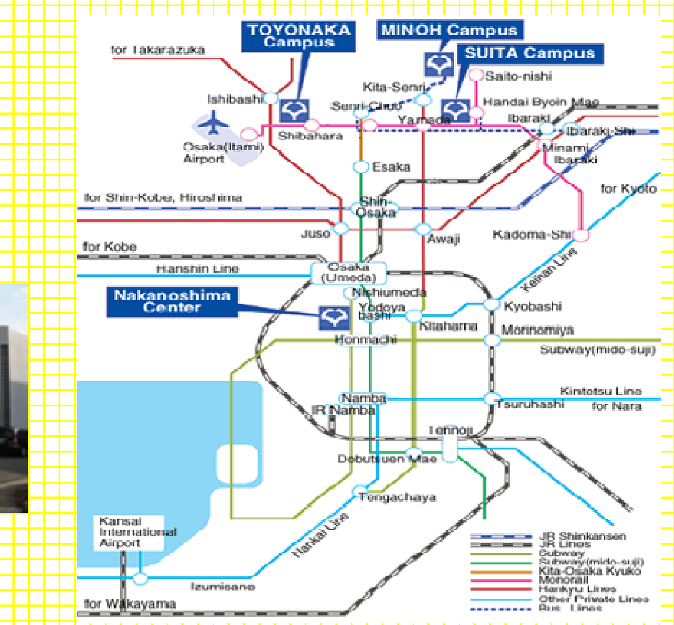
Cobalt-60γ-ray irradiation facility

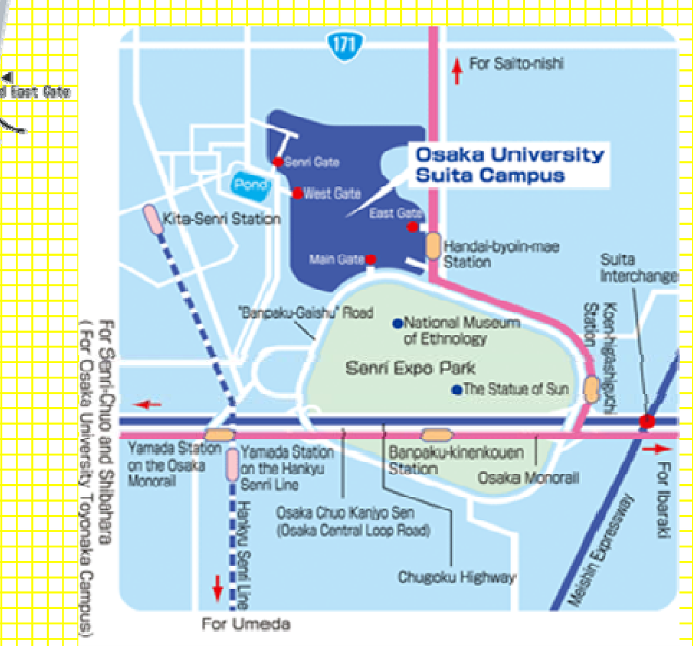
The Co-60 γ-ray irradiation facility has been equipped with 3 Co-60 γ-ray sources with their activity ranging from 7 TBq, 76 TBq and 303 TBq at Apr.1st in 2012. Two radiation shielded irradiation caves are available. To date, the present facility has been used in the fields such as irradiation effects on materials and tissues, radiation induced polymerization, radiation damages on materials, radiation hazard on biological system and so on.

Suita Campus

Research Laboratory for Quantum Beam Science







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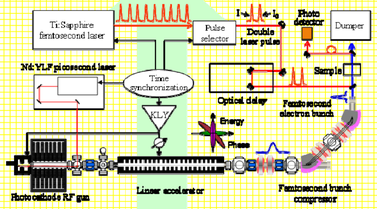
Green Innovation

Promotion for Joint-Research Use and for Industorial use!

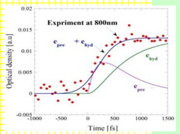
Material science

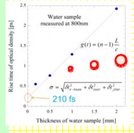
Semiconductor device | Catalyst chemistry | DNA chemistry | Life Science | Environmental technology | Fuel cell

Frontier of ultrafast reaction in radiation chemistry



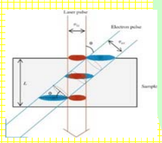
Femtosecond pulse radiolysis using photocathode RF gun linac.

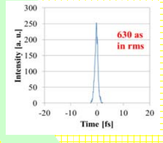




World record!

First observation of solvation process and realization of 240 fs time resolution in pulse radiolysis.



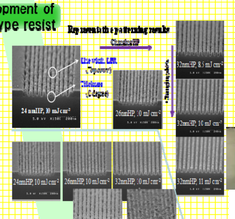


For improvement of the time resolution…

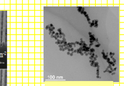
- Equivalent velocity spectroscopy (EVS)
- Sub-femtosecond electron beam
- Double-decker pulse radiolysis …

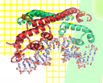
Development of fs/as pulse radiolysis for comprehensive understandings of ultrafast radiation-induced phenomena.

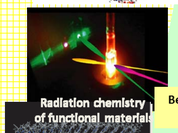
Development of new type resist



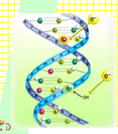
Nano particle produciton





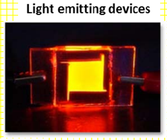


DNA damage



Study on DNA damage based on vibrational spectroscopy

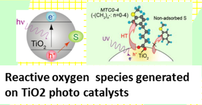
Light emitting devices



Nano materials and bioscience based on multidisciplinary spectroscopic methods

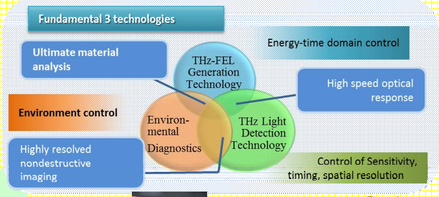
New spectrum system (RAMAN)

Beam-induced molecular chemistry based on radiation chemistry



Reactive oxygen species generated on TiO2 photo catalysts

Scientific and technological innovation based on next generation THz light



Production scheme of FEL light

Undulator for Free Electron Lazer

Development of A New Evaluation System of Polymer Electrolyte Membrane for Fuel Cell (PEMFC)

What is detected by positron ?

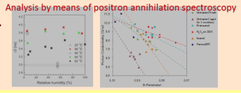
Defects
Interface
Precipitated materials
Free volumes in polymer
Porosity
Structural change
etc.

Polymer Electrolyte Membrane (PEM)

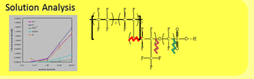
Exposure to selectively produced radicals

Evaluation

Analysis by means of positron annihilation spectroscopy



Solution Analysis

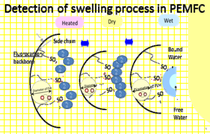


Other techniques such as ESR, FT-IR, etc.

Comparison → New Evaluation System

Evaluation of used PEM

Detection of swelling process in PEMFC



Positron annihilation spectroscopy

Pulse radiolysis

L-band Linac Electron Linac

Development of Secondary Beams

- THz Light
- EUV Light
- Slow Positron Beam

RF-Gun Equipped S-Band Linac L-Band Linac 150MeVS-Bnad Linac
Cobalt-60 γ-ray Source

RF-gun equipped S-band Electron Linac

150MeV S-band Electron Linac

Cooperative Laboratories

Department of Advanced Nanofabrication
http://www.sanken.osaka-u.ac.jp/jp/organization/nnc/nnc_index.html

Department of Accelerator Science
http://www.sanken.osaka-u.ac.jp/jp/organization/sec/sec_index.html

Department of Molecular Excitation Chemistry
http://www.sanken.osaka-u.ac.jp/jp/organization/thi/thi_index.html

Department of Beam Material Science
http://www.sanken.osaka-u.ac.jp/en/organization/sec/sec_07.html

Beam Application Frontier Research Laboratory
http://www.sanken.osaka-u.ac.jp/jp/organization/srp/srp_03_01.html

HISTORY

3/1957	Regulations for Organizing Committee of Radiation Laboratory was made.
4/1957	HOT LAB. was placed as facility of Osaka University.
5/1958	Regulations for facility of Radiation Laboratory was made.
3/1959	Adiation Laboratory was built in the Sakai pref. of ISIR.
4/1964	Radiation Laboratory has belonged to ISIR by National law.
4/1965	A rRight administration for β-tron has moved to here from school of science.
3/1968	The facility has moved from Sakai pref. to Suita pref. by the Osaka Univ. collaboration plan.
4/ 1975	Ultrashort electron bunch and the laser light has placed.
1/1978	Linac building has completed.
3/ 1978	The Ultra short electron bunch and the laser light has been started running.
12/1983	Joint-use of the Ultrashort electron bunch and the laser light has started.
12/1989	150 MeV S-band Linac has developed and started running.
12/1999	Future plan for the Radiation Laboratory has placed.
3/2002	The Radiation Laboratory was closed.
4/2002	The Radiation Laboratory in the Nano Science and New Technology center of ISIR has started.
4/2009	The Research Laboratory for Quantum Beam Science has established.