Change of Radiation Safety Control on Synchrotron Radiation User at Experimental Hall

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Introduction – Two Big Brothers and Three Tiny Sisters

Motivation – Korean Nuclear Safety Act

Change of PAL Safety Control on SR User

Base Facts – Operation Record
  - Dose level
  - Activity Using Radiation
  - Exemption Level

Current Status of Negotiating with Authority

Consensus and Questionnaire
Two Big Brothers

PAL-XFEL

PLS-II

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Radsynch9, NSRRC, Hsinchu
# PAL Chronology

## Ancient Era

<table>
<thead>
<tr>
<th>Event</th>
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<tr>
<td>Project started</td>
<td>Apr. 1 1988</td>
</tr>
<tr>
<td>Ground-breaking</td>
<td>Apr. 1 1991</td>
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<tr>
<td>2-GeV Linac commissioning</td>
<td>June 30 1994</td>
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<td>Storage ring commissioning</td>
<td>Dec. 24 1994</td>
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<tr>
<td>User’s service started</td>
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<tr>
<td>1(^{st}) PLS Upgrade Complete</td>
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<td>✓ Energy ramping to 2.5 GeV</td>
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<td>✓ 2.5-GeV injection</td>
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## Yesterday

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<td>3.0 GeV PLS-II Upgrade Complete</td>
<td>Dec. 2011</td>
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<td>Achievement of Goal (400 mA, Top-up)</td>
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## PAL XFEL (10GeV Linac & SASE Based 0.1 nm X-ray FEL)

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<td>Building Construction Completed</td>
<td>Jan 2015</td>
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<td>Commissioning Started</td>
<td>Apr. 14 2016</td>
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<td>First Lasing Achieved (0.5 nm)</td>
<td>Jun. 21 2016</td>
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<tr>
<td>0.1 nm Lasing Achieved</td>
<td>Mar. 16 2017</td>
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**Saturation Curve**

PAL-XFEL: 0.1 nm FEL 포화성능 달성

(2017. 3. 16)

PAL-XFEL: 1.5 nm

SX beamline

- **FEL intensity [W]**
- **Undulator magnetic length [m]**

**Graph Details:**
- Photon energy: 12.967 keV
- E-beam energy: 9.871 GeV
- Undulator K: 1.87
- Emittance: 0.55 mm-mrad
- Peak current: 3.0 kA

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Radsynch9, NSRRC, Hsinchu
PAL-XFEL (10 GeV, 240W, 0.1 nm HX, SX)
PLS-II (3 GeV, 400 mA, Top-up, 20 IDs)
Three Tiny Sisters

ITF
Test Linac
fs-THz linac
Injector Test Facility (140 MeV)
Test Linac (80 MeV, 1 kW)
fs-THz Beam (60 MeV, 10Hz, 0.1~3 THz)

Laser Room
- RF gun
- Accelerating Column
- Quadruple Magnet
- 266 nm, >250 uJ
- 1 kHz, > 2 ps
- Chicane electron bunch compressor

Experiment Room
- Tripler
- Oscillator
- 2.5 GW average power
- ~1.4 mJ
- ~1 cm diameter

Linac Room
- PSD
- Lead blocks
- Al foil
- THz radiation
- Test Linac
- ITF

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Radsynch9, NSRRC, Hsinchu
Radiation Safety Policy of PAL

- Radiation Control Policy based on Korean Regulation
  - Annual dose limit for radiation worker: 20 mSv/year
  - Annual dose limit for publics: 1 mSv/year
  - 6 mSv/yr for frequent visitors, 10 μSv during 1 hour for temporary visitors

- Shielding Criteria based on ALARA
  - 10 mSv/year on Surface (2000 h \( \Rightarrow \) 5 μSv/hour)
  - 1 mSv during 1 hour for accidental event
  - Area requirements (e.g. 0.4 mSv/week)

- Area Classification
  - Restricted Area: 0.25 mSv/y < Dose < 1 mSv/y
  - Generally-Controlled Area: 1 mSv/y < Dose < 20 mSv/y
    (A dosimeter is required)
  - Radiologically-Controlled Area: 20 mSv/y < Dose < 1 mSv/h
  - High Radiation Area: 1 mSv/h < Dose
    (No Access)
Area Classification when Beam On

Storage Ring

No of Synchrotron Radiation User of PAL
~5000 per year

SR user was classified as Frequent Visitor

High Radiation Area
Radiologically Controlled Area
Generally Controlled Area
“Experimental Hall”
Classification of Person in Korean Nuclear Safety Act

- Radiation Worker (100 mSv/5yr)
- General Public (1 mSv/yr)
- Frequent Visitor (6 mSv/yr)

Persons who access to RC area for works such as cleaning and maintenance, but except of radiation worker
Motivations: Change of Nuclear Safety Act

- Several Accidents at NDT companies
- No rigor of regulation for persons who visit at RC area

To Enhance Nuclear Act and Implementation

- Safety training system for radiation worker was enhanced and changed to parallel mode (NDT & non-NDT)
- Strict application of Frequent Visitor category with new THREE requirements
New Requirements for Frequent Visitor

- Medical Check is obligation, which was only to Radiation Worker
- To wear dosimeter and to report exposure record to Government
- Extended safety training every year

New PAL Policy:
SR User is classified as the general public

How to apply it to SR users?
Check Base Facts

- Experimental Hall at PAL is not RC area, but Generally-Controlled Area

- Radiation Level at Exp. Hall and Exposure Record of SR Users are sufficiently low.
Radiation Monitoring Record

- Area Monitoring System (SR + Beamline)
- Area Monitoring using Passive Dosimeter (OSNL)
- To check integrated dose (gamma + neutron) at every quarter
Annual Dose at Beamline Monitors

Beamline Monitoring (160101~161231)

With Background Dose

- Gamma
- Neutron
- Total

Annual Dose (μSv)

BEAM RMS No
SR Monitoring (160101~161231)

No 1, 2 – Injection Area
No 7, 8, 9, 10, 12 - Infield

With Background Dose

Annual Dose in Storage Ring Building
SR Annual Dose (150101~151130)

With Background Dose

Annual Dose (μSv)

- Gamma
- Neutron
- Total

SR Annual Dose in Storage Ring Building

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SR 2 daily dose (150101~151130)

- Gamma
- Neutron
- Total

Date (Month/Date):
- 01/01
- 04/08
- 07/04
- 10/04

Daily Dose (μSv)
SR 12 Daily Dose (150101~151130)

- Gamma
- Neutron
- Total

Date (Month/Date):
01/01
04/03
07/04
10/04
## Annual Dose by Passive Dosimeters

### N-DDE + Neutron = 0.5 mSv 이상

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<tr>
<th>위치</th>
<th>1 분기 2015. 01. 16 ~ 2015. 04. 20</th>
<th>2 분기 2015. 04. 01 ~ 2015. 07. 14</th>
<th>3 분기 2015. 07. 14 ~ 2015. 10. 16</th>
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### Fact Check: Exposure Record of SR User

Using OSLD (with $^{6}$Li)

#### 2015

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#### 2016

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0.1 mSv: Report limit
SR Users work at low dose area, experimental hall, for their exp. period and their exposure dose records are much lower than the dose limits of general publics.

- SR User = General Publics
  with dosimeter and short training

But SR Users handle the safety/hutch shutter to allow SR into exp. hutch.

- Activity to use radiation and related things
  (Authority issue)

- SR User is a radiation worker.
Exemption Conditions (NSSC Notices)

- Radiation below 5 keV is not controlled by nuclear safety act.
- For licensed X-ray device with well-shielded housing, if maximum applied HV is lower than 50 kV and a dose rate does not exceed 1 uSv/h at 10 cm from any surface, it is not controlled by nuclear safety act.
Other Countries and Other SR facilities

- No rigorous control except of Japan
  (SR User is a radiation worker in Japan)

Then, Three Questions?

1. Is SR user a radiation worker or general public?

2. Is it the activity with radiation harmful to others (exposure) to handle the shutter?

3. Is SR beam included in exempted device?
Fundamentally the regulation strength should be based on the danger level, RISK.

We need your helps to make some Consensus from SR safety community (Radsynch).
Facility Name/Beam Energy/Stored Beam Current/Operation Mode

1. Is the experimental hall of your facility classified to the radiation control area or not?
   - If yes, what is the reason?
   - If no, which zone category is applied to there?

2. Is the SR user classified to a radiation worker or the general public, or the other?
   - What is the base policy for such a classification?

3. Does the SR user wear the dosimeter at the experimental hall?

4. Do you get extra operation permit to use SR beamline?

5. Is a radiation worker required to have any medical check every year?
Thank you for your attention!