



# **Panel Discussion 2: Strengthening the Nuclear Non-Proliferation Regime**

**The International Forum  
on Peaceful Use of Nuclear Energy,  
Nuclear Non-Proliferation & Nuclear Security  
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**Tetsuzo ODA  
Integrated Support Center for Nuclear Nonproliferation  
and Nuclear Security  
Japan Atomic Energy Agency**



# Promoting Safeguards Technologies Development for Nuclear Fuel Cycle in Japan

- **TASTEX (Tokai Advanced Safeguards Technique Exercise)**  
1978~1981 Development of Safeguards Techniques for Tokai Reprocessing Plant by Japan, US, France, IAEA  
The results were provided INFCE (International Fuel cycle Evaluation) and some tasks were continued under Japan Support program for IAEA.
- **HSP (HEXAPARTITE, Hex partite SG Project)**  
1980~1983 Development of safeguards approach for Centrifuge Enrichment Facility by Japan, US, Australia, Troika (UK, West Germany, Netherland), IAEA, EURTAOM  
HSP concluded the maximum enrichment could be achieved by LFUA (Limited Frequency Unannounced Access).
- **LASCAR (Large Scale Reprocessing Plant Safeguards)**  
1988~1992 Technical forum to discuss safeguards approach for large scale reprocessing plant by Japan, US, UK, France, Germany, Netherlands, Australia, IAEA, EURTAOM

Ningyo-toge  
U Enrichment



Tsuruga (Monju)  
FBR

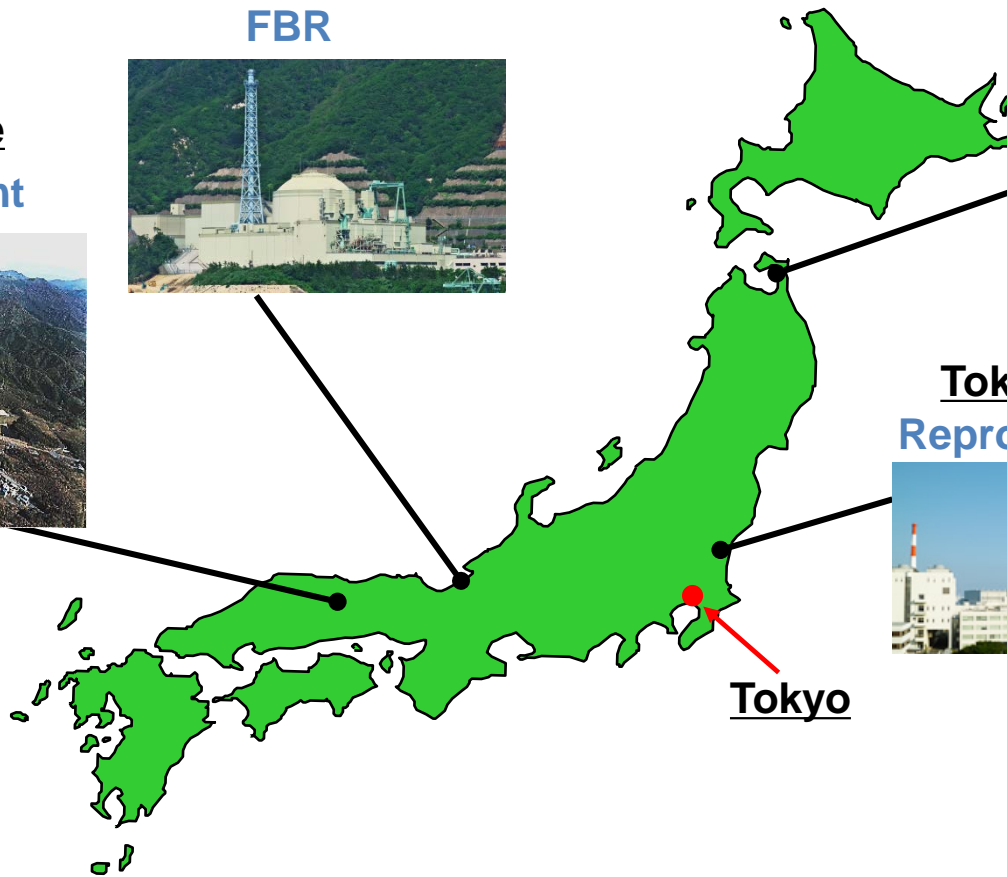


Rokkasho  
Commercial Plant  
(Enrichment, Reprocessing & MOX fabrication)



JNFL HP: <http://www.jnfl.co.jp/business-cycle/recycle/>

Tokai  
Reprocessing MOX fabrication



Tokyo



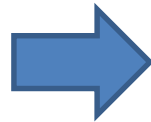
# SG technologies development at JAEA

- Advanced Safeguards Technology Developments
  - Safeguards Technologies for the future nuclear fuel-cycle
    - Improved tools & techniques for Pu/MA(minor actinide) fuels
    - More effective, short-time, and accurate/precise for verification
    - Safeguards by Design
- Proliferation Resistance and Evaluation Methodology
- Measurement Technologies
  - NDA for Pu in spent-fuel
  - Alternative Sample Assay System(ASAS) for MOX
- Nuclear Transparency for Nonproliferation
- Safeguards Applications at Fukushima Daiichi NPPs

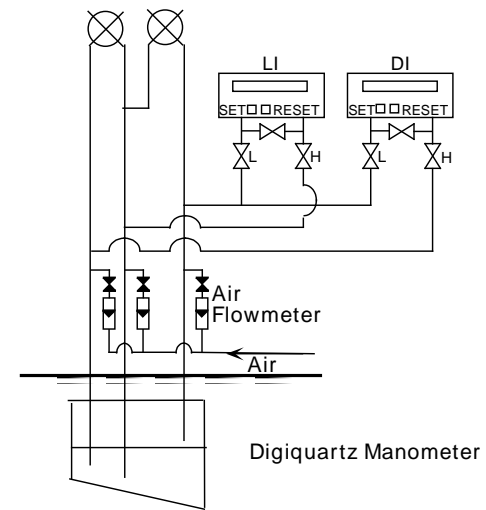
## 1. More accurate Volume measurement



Water manometer



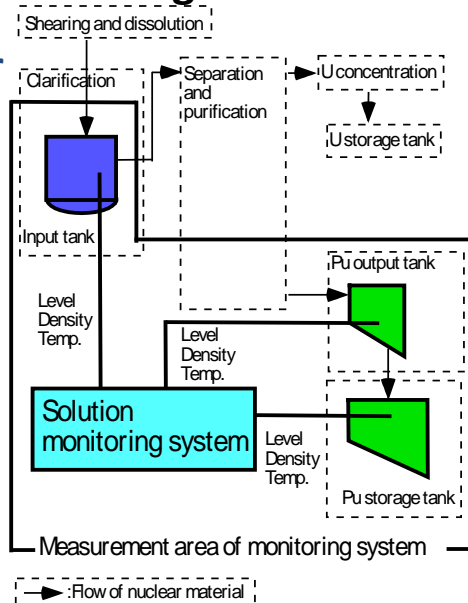
Digiquartz manometer



Volume measurement system by air flow

## 2. Solution Monitoring

### Solution monitor



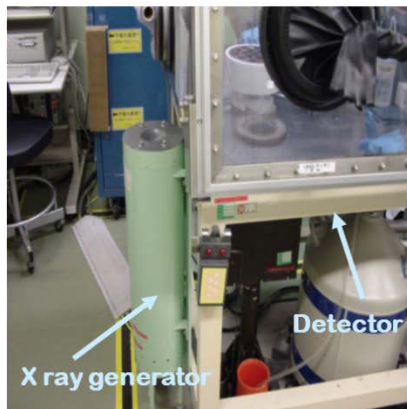
Sealed box including data collection computer



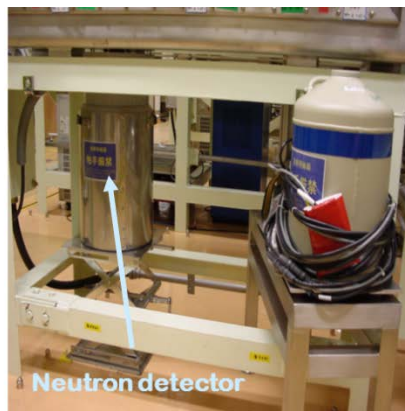
Sealed box including transformer of pressure to electric signal



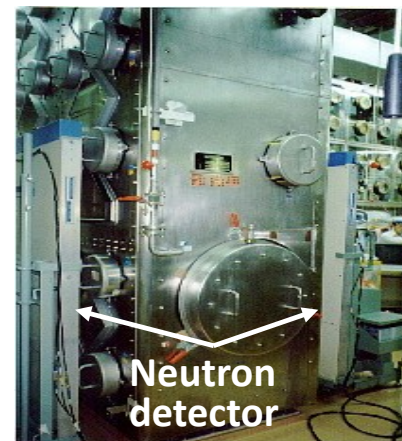
## 3. Nondestructive Assay



K-edge densitometer  
for Pu solution



Inventory sample counter for  
Pu solution and MOX powder



Measurement system of hold-up  
in glove box for MOX

## 4. Measurement of small amount in waste



Vitrified Waste Canister Counter



Measurement system of waste drum



# JAEA NDA Development Programs subsidized by MEXT(1/2)

(conducted between JFY2011-2014)

Development of basic technologies of advanced NDA of NM for nuclear safeguards and security	
(1)	Measurement test of the PNAR-NDA system for Fugen SFAs (JFY2011-2013)(JAEA/USDOE collaboration)
(2)	Basic development of NRF-NDA technologies using LCS gamma-rays (JFY2011-2014) (using HIGS of Duke University) (JAEA/USDOE collaboration for simulation codes) <span style="float: right;">(Security)</span>
(3)	Development of neutron detector alternative to $^3\text{He}$ using $\text{ZnS/B}_2\text{O}_3$ ceramic scintillator (JFY2011-2014)
(4)	NRD using NRTA and NRCA (JFY2012- 2014) (JAEA/JRC-IRMM collaboration)

PNAR :Passive Neutron Albedo Reactivity

NRF :Nuclear Resonance Fluorescence

LCS :Laser Compton Scattering

NRD :Neutron Resonance Densitometry

NRTA :Neutron Resonance Transmission  
Analysis

NRCA :Neutron Resonance Capture Analysis



# JAEA NDA Development Programs subsidized by MEXT(2/2)

(conducting for next 3-5 years)

Development of the following NDA technologies  
for nuclear safeguards and security

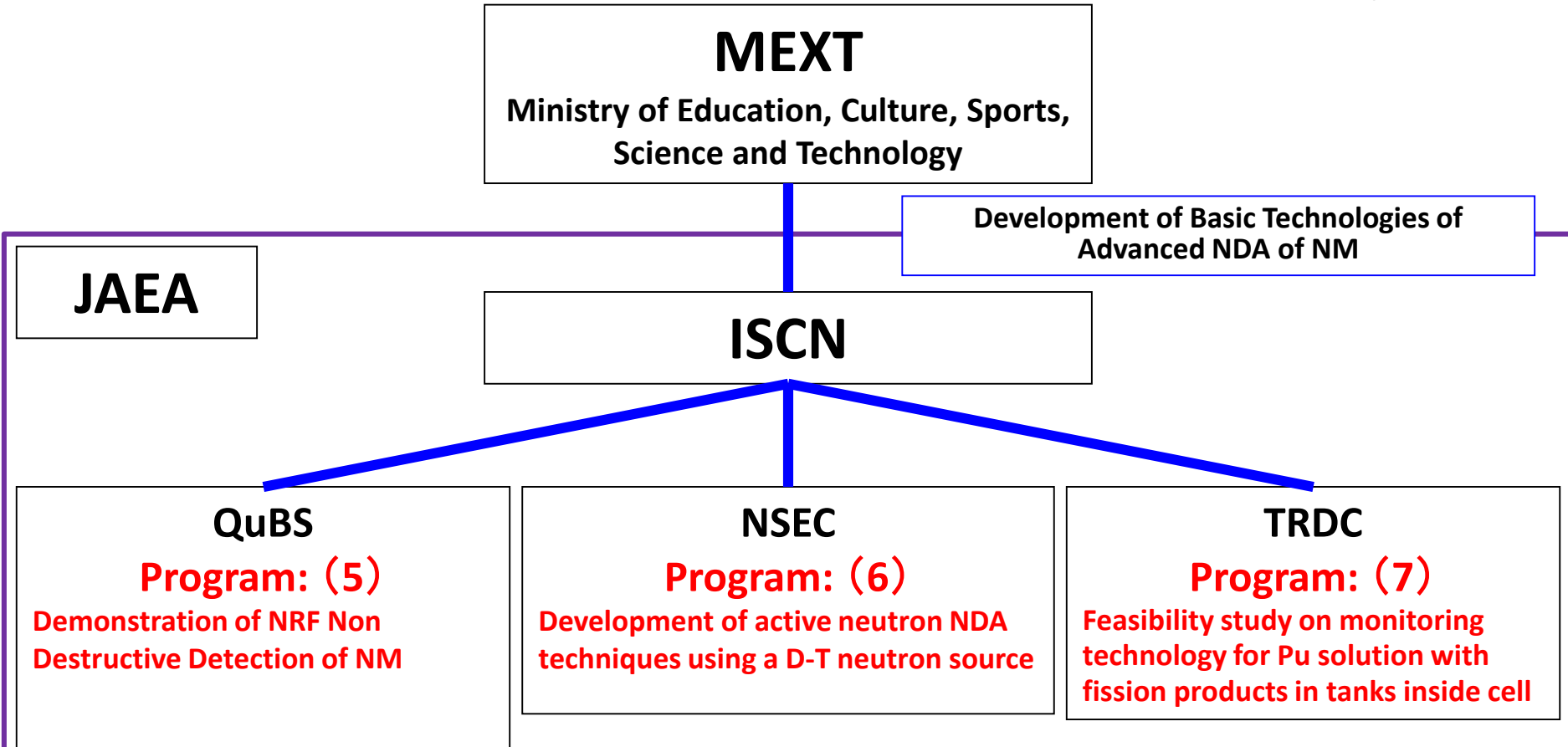
(5)	Demonstration of NRF Non Destructive Detection of NM (JFY2015-2019) (using HlgS of Duke University) (Security)
(6)	Development of active neutron NDA techniques using a D-T neutron source (JFY2015-2017) (JAEA/JRC collaboration)
(7)	Feasibility study on monitoring technology for Pu solution with fission products in tanks inside cell (JFY2015-2017) (to be JAEA/USDOE collaboration)





# An Organization Diagram of JAEA NDA R&D Programs subsidized by MEXT

(As of February 2016)



QuBS: Quantum Beam Science Center    NSEC: Nuclear Science and Engineering Center  
TRDC: Tokai Reprocessing Technology Development Center



# Future Needs to Improve Safeguards and Nuclear Nonproliferation Technologies in Nuclear Fuel Cycle

- Advanced measurement/monitoring systems
  - Unattended/Real-Time System for Large-scale facilities
  - Improvement of quality measurement / analysis systems
- Advanced containment system (New seal system)
  - Remote verification, Safeguards by Design, ...
  - Cost-effectiveness
- New surveillance system
  - Assurance of integrity during CA
- Proliferation Resistant Fuel Cycle Technologies
  - SBD for the new technology and/or new type facility
- Development of accountancy/safeguards concept and measurement technologies for Fukushima Daiichi NPPs



# Framework of International Cooperation for Safeguards Technology Development

- **JASPAS (Japan Support Program for the Agency)**  
1981-- State Level Support Program for IAEA SG Technology  
SG System/Approach, Measurement Technique, C/S,  
Training, Cost Free Expert
- **JAEA/DOE SG Cooperation Agreement**  
1988-- Cooperation for SG technology development between  
JAEA/DOE (Currently, under the MEXT-DOE arrangement)
- **Cooperation with EC/JRC**  
1990-- Cooperation between JAERI and EURATOM  
2011-- Amendment and expansion of cooperation area  
Human resource development and technology development  
for nuclear nonproliferation, nuclear security and safeguards



# R&D cooperation with the US/DOE in nuclear non-proliferation



- ✓ Started in 1988 under the arrangement between JAEA-USDOE/NNSA in the field of non-proliferation, safeguards and nuclear security(Currently, under the MEXT-DOE arrangement)
- ✓ More than 130 technical projects were successfully completed and 11 projects are ongoing.
- ✓ Annual review meeting(PCG: Permanent Coordinating Group) .

## Ongoing projects (as of May 2015)

- Pu and U Standard Materials( PFDC)
- U Age Dating Measurements(ISCN)
- Advanced Technology for Ningyo Enrichment Monitoring(NEP)
- Advanced Nondestructive Assay Systems for Plutonium Solutions(TRP)
- Advanced Holdup Measurement Techniques at PCDF
- Safeguards Application at Fukushima-Daiichi Nuclear Power Station (ISCN)
- Human capital development for coulometric measurement(TRP)
- Training development and coordination in the area of Nuclear nonproliferation including safeguards(ISCN)
- Single Chip Shift Register(PFDC)
- Boron based neutron detector(PCDF)

PFDC : Plutonium Fuel Development Center  
 NEP : Ningyo Enrichment Plant  
 ISCN : Integrated Support Center for Nuclear Nonproliferation and Nuclear Security  
 TRP : Tokai Reprocessing Plant  
 PCDF : Plutonium Conversion Development Facility



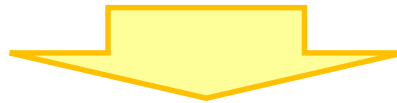
Group photo of 27<sup>th</sup> U.S.-Japan PCG meeting (March 2015). It was successfully done.



NDA systems developed under the cooperation

# Conclusion

- **JAEA has long history of development of SG technologies in close cooperation with IAEA, USDOE, EC/JRC through other international cooperative programs.**
- **JAEA has made proactive efforts for a long period, aiming at promoting peaceful use of nuclear energy with more effective and efficient safeguards.**



- ◆ **The efforts contributed to the reducing PDI of inspection, the design and operation of the commercial plants.**
- ◆ **The experiences are the very important precedents for the IAEA to promote the safeguards implementation in other states that strive to have peaceful use of nuclear fuel cycle.**
- ◆ **The evolution of technologies has benefited both the State/Operator and the IAEA.**