# R&D of Portable SNMs Detection System Based on Threshold Energy Neutron Analysis

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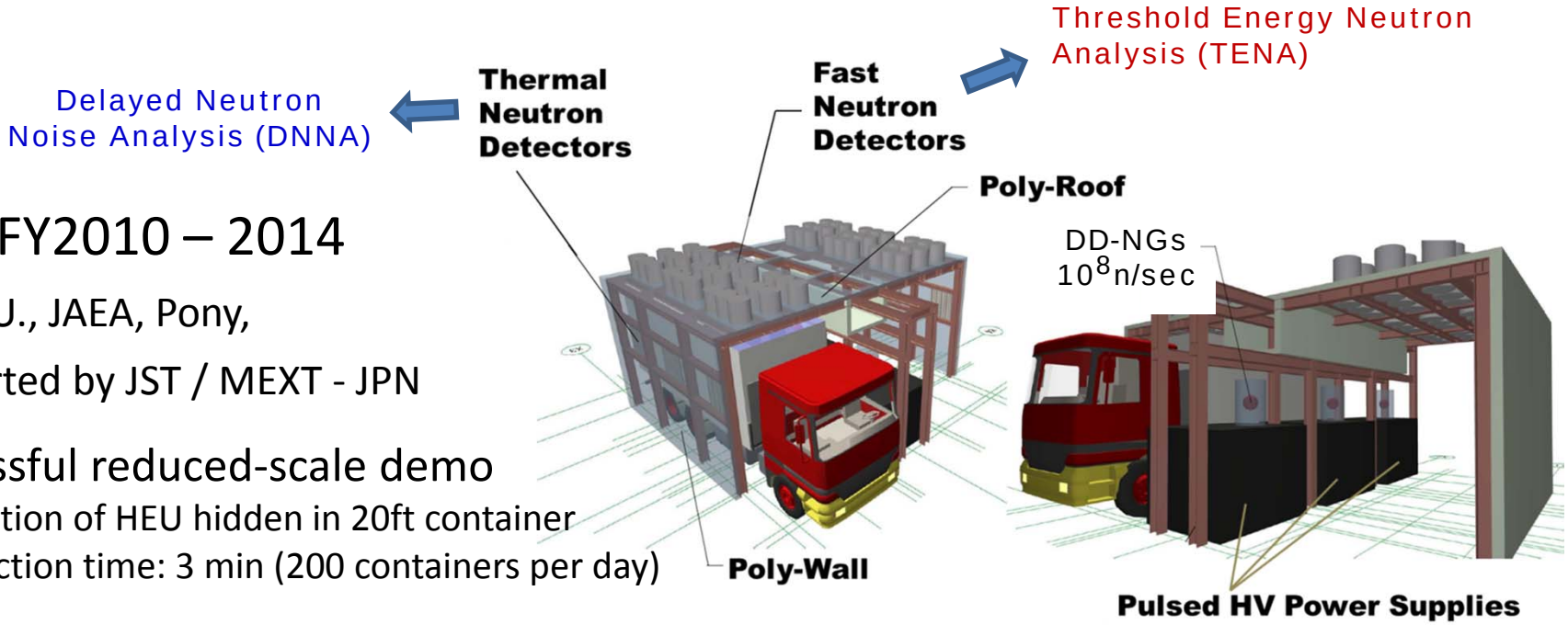
# R&Ds for combatting global nuclear terrorism



- Passive detection systems deployed in the marketplace are known to be inadequate in practice for identifying SNMs, especially U-235.
- Several active interrogation systems for deployment in seaports and airports have been proposed. Some of them can potentially be transportable, but hardly be portable.




## R&D FY2010 – 2014

Kyoto-U., JAEA, Pony,

Supported by JST / MEXT - JPN

Successful reduced-scale demo

- Detection of HEU hidden in 20ft container
- Inspection time: 3 min (200 containers per day)

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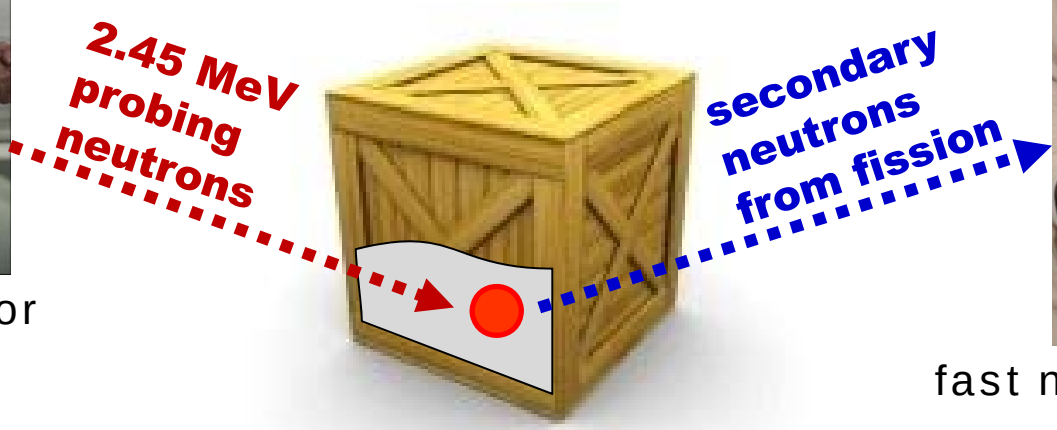
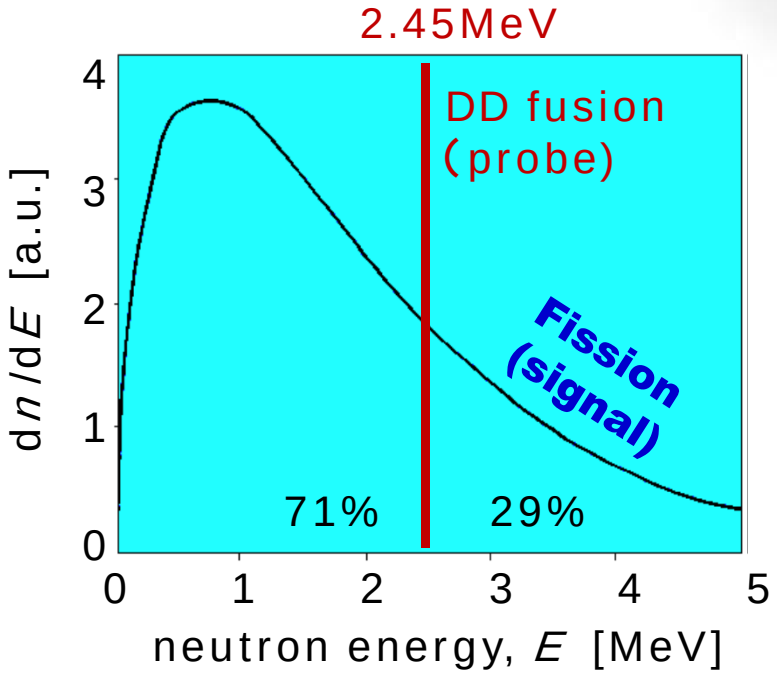
# Threshold Energy Neutron Analysis (TENA)



neutron generator
DD ~$10^8$n/sec




fast neutron detector




A significant portion (~30%) of fission neutrons is above DD neutron energy.

- Scattering makes the probing neutron energy lower than the threshold.
- No neutrons above the threshold (except cosmic-rays), unless fissile materials present.

Problems in using existing detectors:

- Pile-ups of neutrons below the threshold make false signals above the threshold.
- X-rays and neutron-inducing gamma-rays also make background signals.

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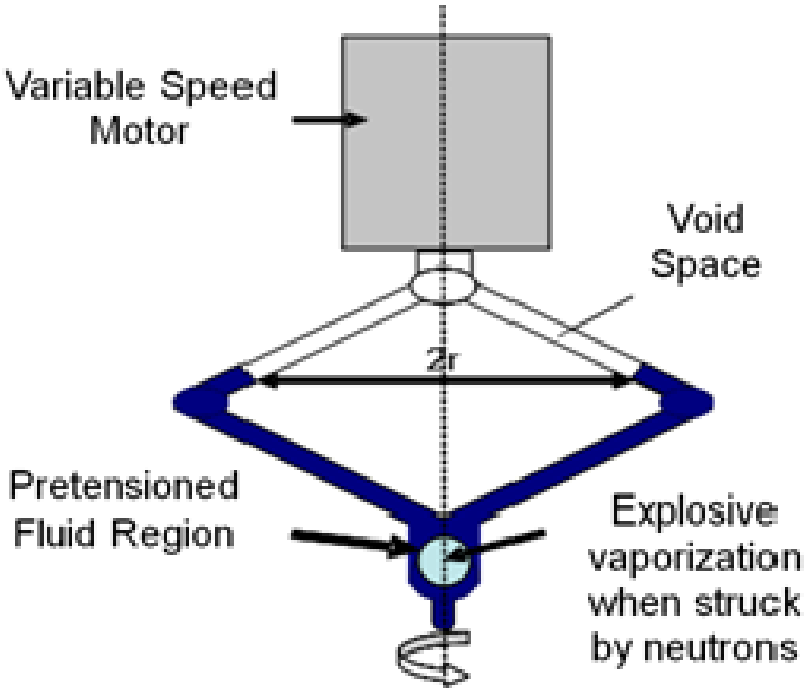
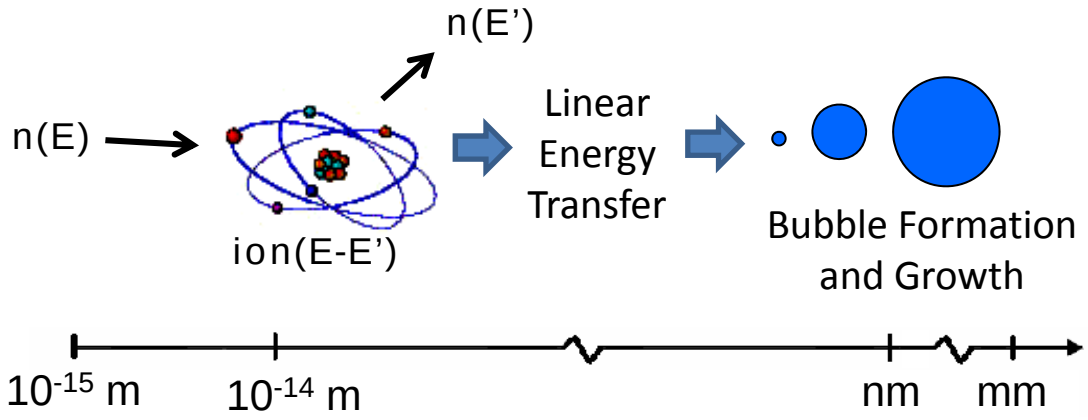
# Tensioned Metastable Fluid Detector (TMFD)



## Centrifugal TMFD

Developed by Prof. Taleyarkhan's group in Purdue U. See for example,
R.P. Taleyarkhan, et al., Nuclear Engineering and Design 238 (2008) 1820.




Induced tension on axis

$$p_{\mathrm{neg}} = \frac{1}{2}\rho r^2 \omega^2 - p_{\mathrm{amb}}$$

| | |
|---|---|
| $2r$ | meniscus diameter |
| $\rho$ | fluid density |
| $\omega$ | rotation speed |
| $p_{\mathrm{amb}}$ | ambient pressure |

Features necessary for a "portable" TENA system are,

- 100% blindness to X/gamma-rays,
- Blind to neutrons below a threshold energy,
- The threshold energy is tunable,

making rejection of the probing neutrons and background gamma-rays possible w/o shielding.

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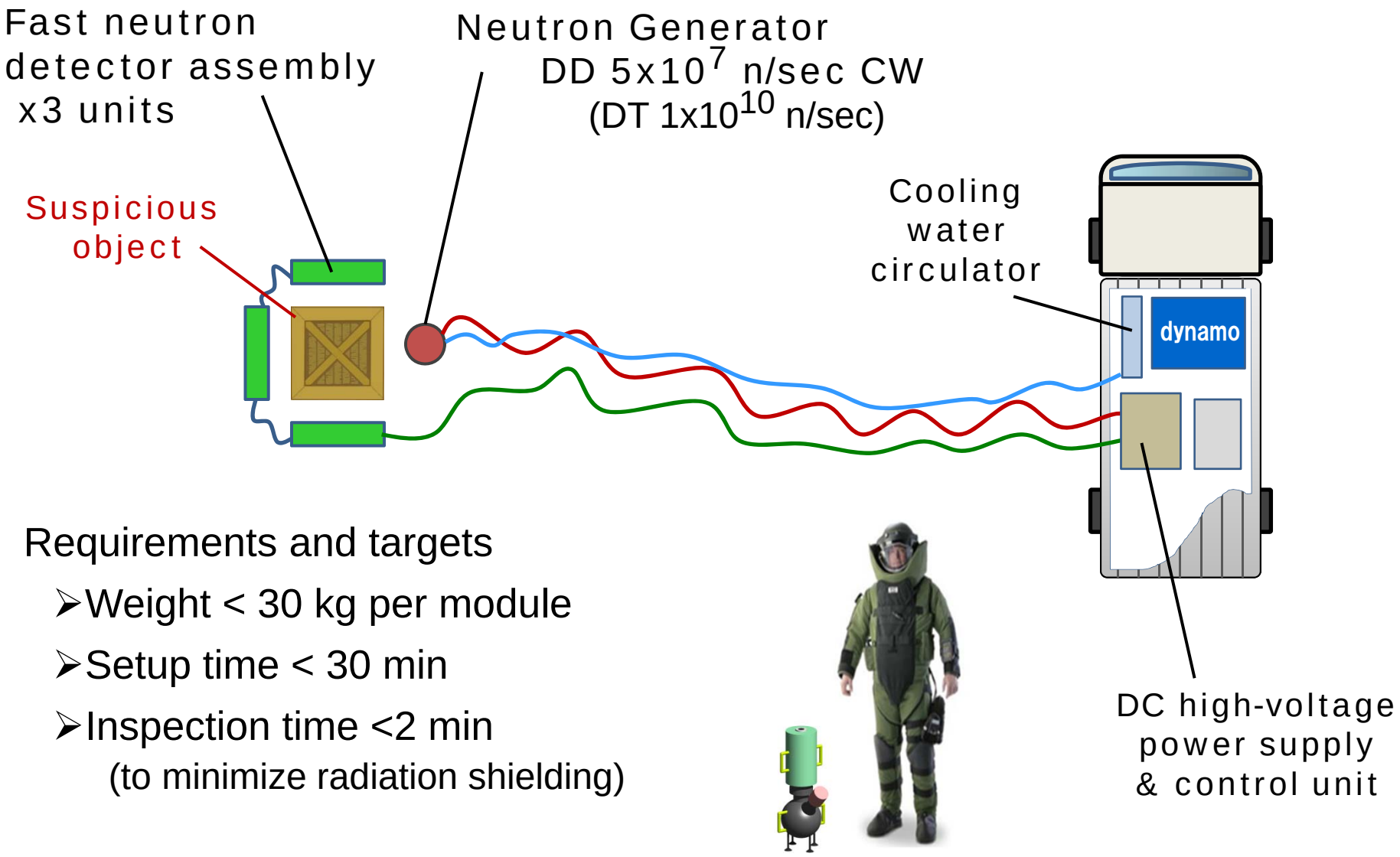
# The world's first portable SNMs detection system






Requirements and targets

- Weight < 30 kg per module
- Setup time < 30 min
- Inspection time <2 min
  (to minimize radiation shielding)

# R&D schedule



2015 R&D started under support of NEDO, JPN.

2016 Successful proof-of-principle experiments using ~10g HEU, prototype TMFDs, and a DD neutron generator.

R&D of detector assembly and portable DD neutron generator under way.

2017 Integral experiments for developing and vetting a fieldable prototype system.

2018 Put the system onto Japanese market.

2020 Tokyo Olympic and Paralympic Games

"CBRNe" Threats

Portable, transportable and stationary gate devices have been deployed in the marketplace in response to all hazard threats except "N" threat.