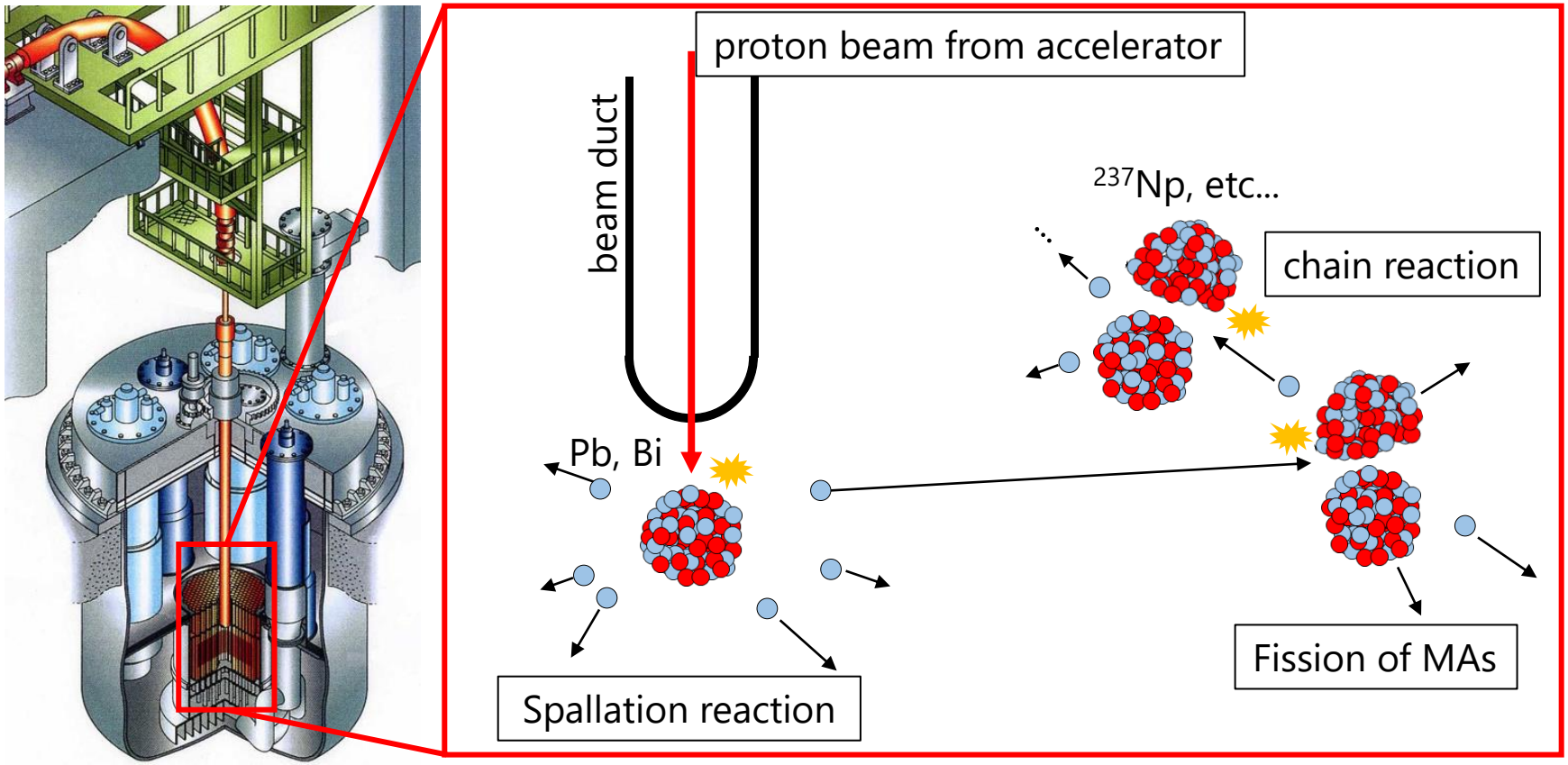
Experimental program of nuclear data for accelerator-driven nuclear transmutation system using FFAG accelerator
– First subprogram: spallation neutron measurement

JAEA *K. Nakano, H. Iwamoto, S. Meigo, K. Nishio, K. Hirose, Y. Iwamoto, F. Maekawa, H. Makii, K. Okabe, R. Orlandi, A. Oizumi, D. Satoh, F. Suzaki, K. Tsukada,
Kyoto Univ. Y. Ishi, Y. Kuriyama, T. Uesugi, H. Yashima

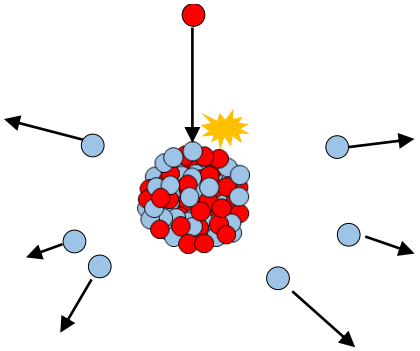
This work was supported by MEXT Innovative Nuclear Research and Development Program Grant Number 192201.

- Issue of High-Level radioactive Waste (HLW)
  - Minor Actinides (MAs) have high potential radiotoxicity:
    ^{241}Am ($T_{1/2} = 432$ y), ^{243}Am ($T_{1/2} = 7370$ y), ^{237}Np ($T_{1/2} = 2.14$ My)

- Accelerator-Driven System (ADS) is candidate of treatment of MAs
  - hybrid system combined with proton accelerator and subcritical core

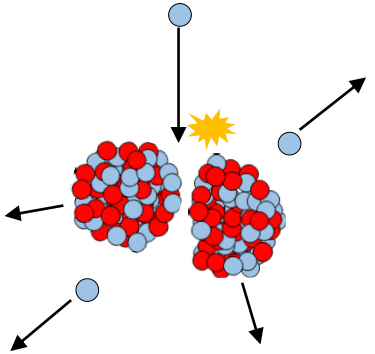


Spallation reaction



emission neutron:
- kinetic energy
- emission angle
- yield

High energy fission



emission neutron:
- kinetic energy
- emission angle
- yield

reaction product:
- isotopic yield

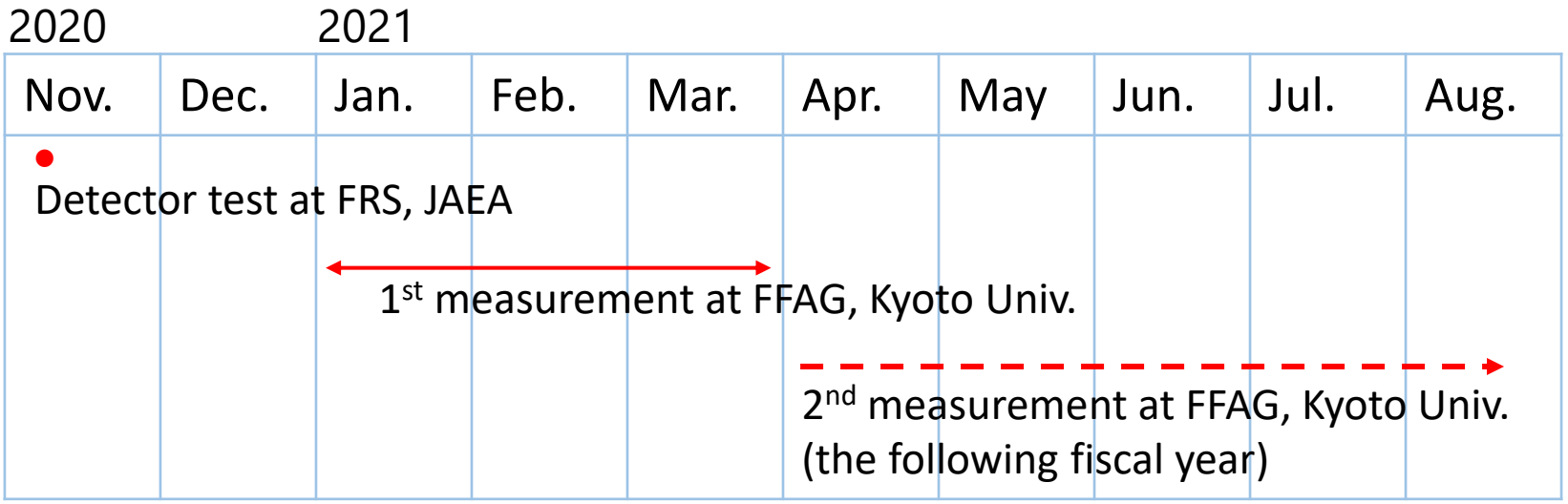
- design of beam window
- proton beam intensity
- burnup calculation
- shielding

- residual radioactivity
- impurity behavior

However...
- nuclear data below 100 MeV is inadequate.
- reproducibility of theoretical models in this region is not enough.

- Purpose:
  To contribute to improve the prediction power of nuclear models,
  - measure neutron production Double-Differential cross sections (DDXs)
  - measure Thick-Target Neutron Yields (TTNYs)

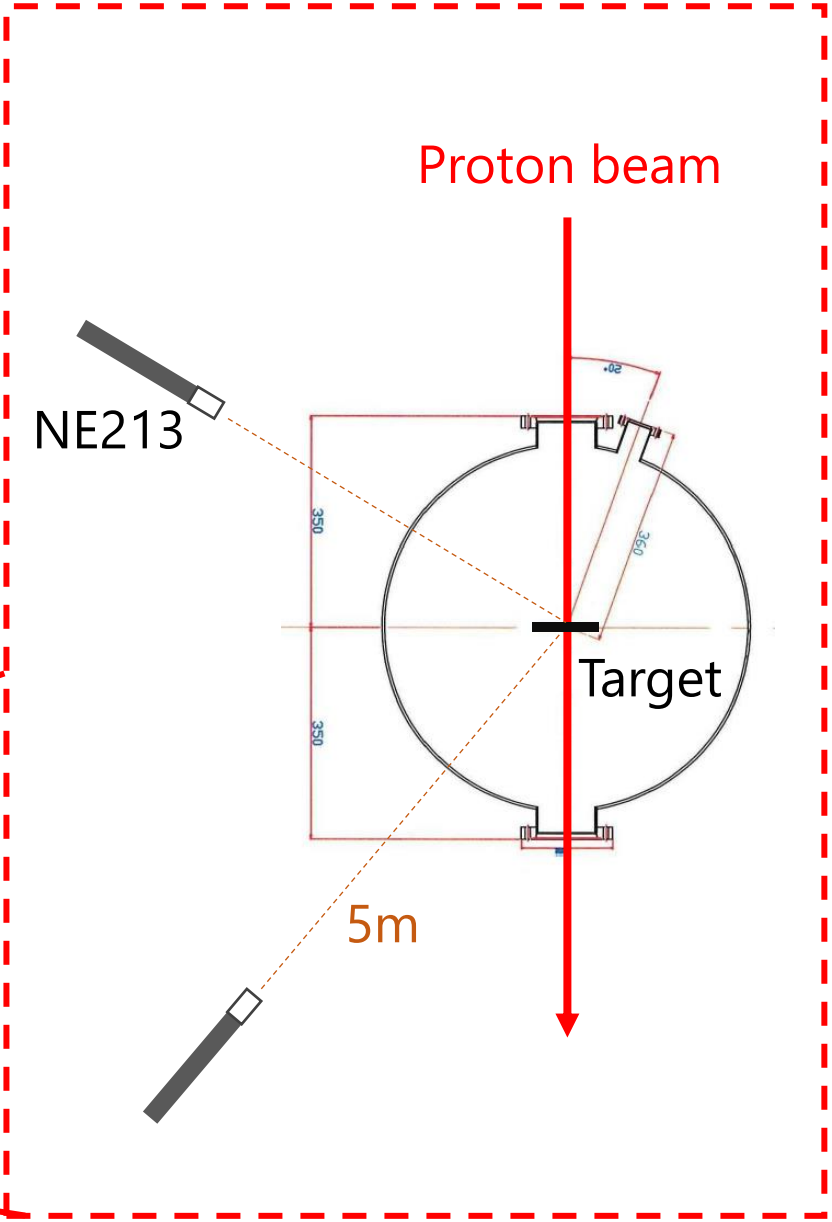
  by protons at several tens of MeV on Pb, Bi, and Fe.
  - measure neutron energy spectrum down to several hundreds of keV.



In this poster,
experimental plan at FFAG and results of detector test at FRS is presented.

DDX and TTNY will be measured.

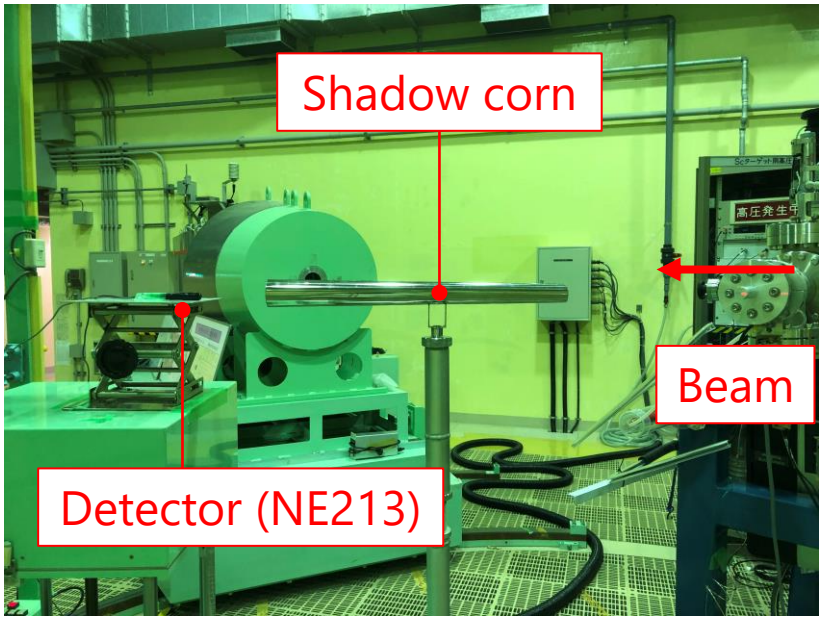
Facility	FFAG Facility, Kyoto Univ.
Beam	Proton @ ~100 MeV
Current	0.1 nA for TTNY, 1 nA for DDX
Target	TTNY: Fe, Pb (30 mm^t), Bi (35 mm^t) DDX: Fe, Pb, Bi (2 mm^t)
Detector	- Liq. scintillator, NE213 (8mmΦ × 20mmL) - ^{237}Np fission chamber

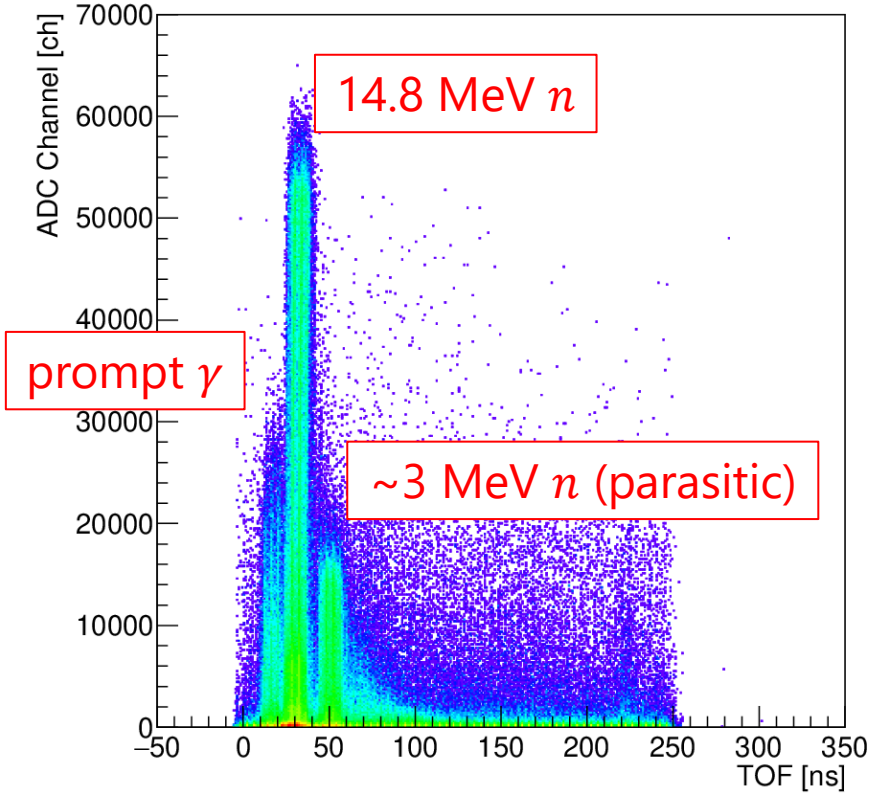


Detector test at Facility of Radiation Standard (FRS), JAEA

In advance of the experiment at FFAG,
detector test was conducted to check the response
and detection efficiency at FRS, JAEA.

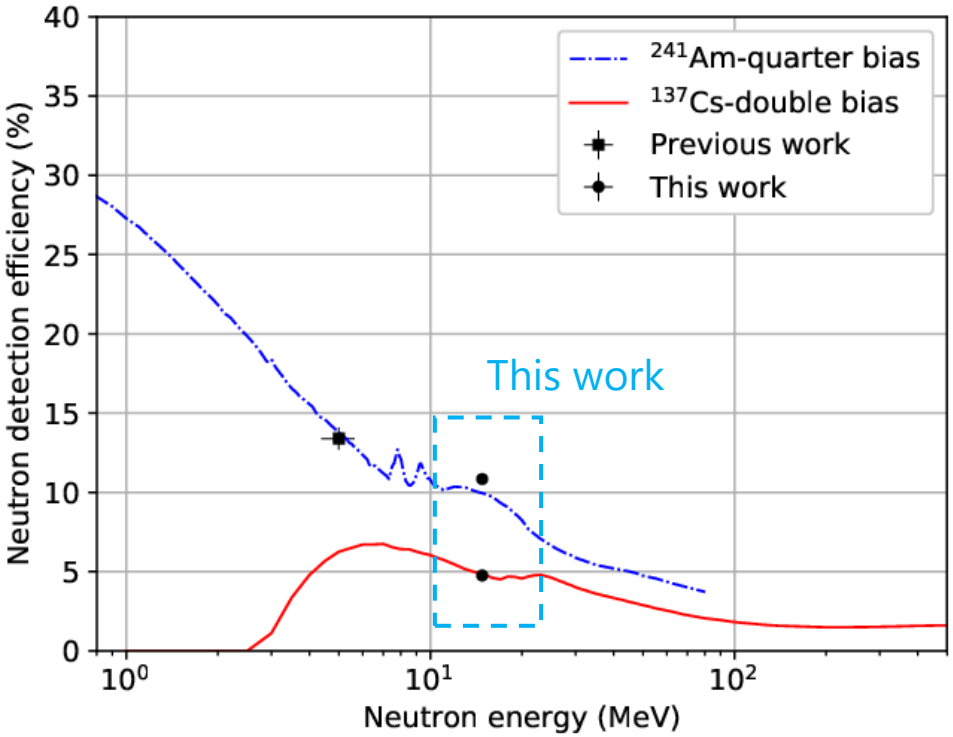
Facility	FRS, JAEA
Beam	neutron at 14.8 MeV (from $d-t$ reaction)
Detector	- Liq. scintillator, NE213 (8mmΦ × 20mmL) - ^{237}Np fission chamber

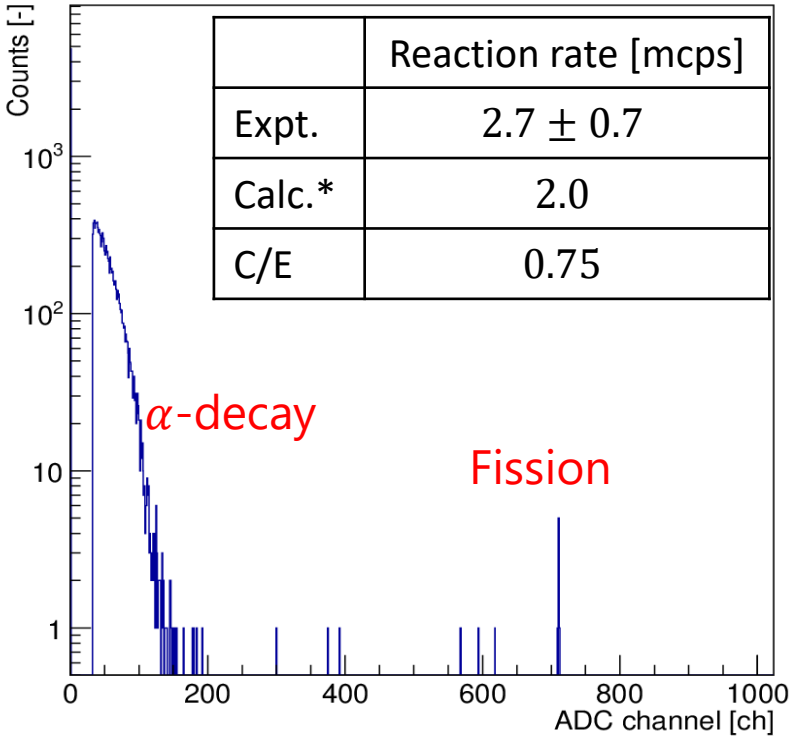




TOF vs charge histogram for NE213

Results of FRS experiment





	Reaction rate [mcps]
Expt.	2.7 ± 0.7
Calc.*	2.0
C/E	0.75

Left: detection efficiency of NE213
Right: ADC spectrum of ^{237}Np fission chamber

- The calculations almost reproduce the obtained data.
- However, further detector test and further analysis are needed to investigate the cause of the difference.

* calculated from activity of ^{237}Np (31.3 kBq)

Summary

- New experimental campaign has been launched to obtain neutron production Double-Differential cross sections (DDXs) and Thick-Target Neutron Yields (TTNYs) necessary for development of Accelerator-Driven System (ADS).

- We plan to conduct the measurements of DDXs and TTNYs at FFAG facility at Kyoto University.

- In advance of the measurements,
  - detection efficiencies of NE213 and reaction rate of ^{237}Np fission chamber was checked with 14.8 MeV neutron at FRS.
    → They agree with the calculations, but further studies are needed.

- Next year, the experiments will be conducted.