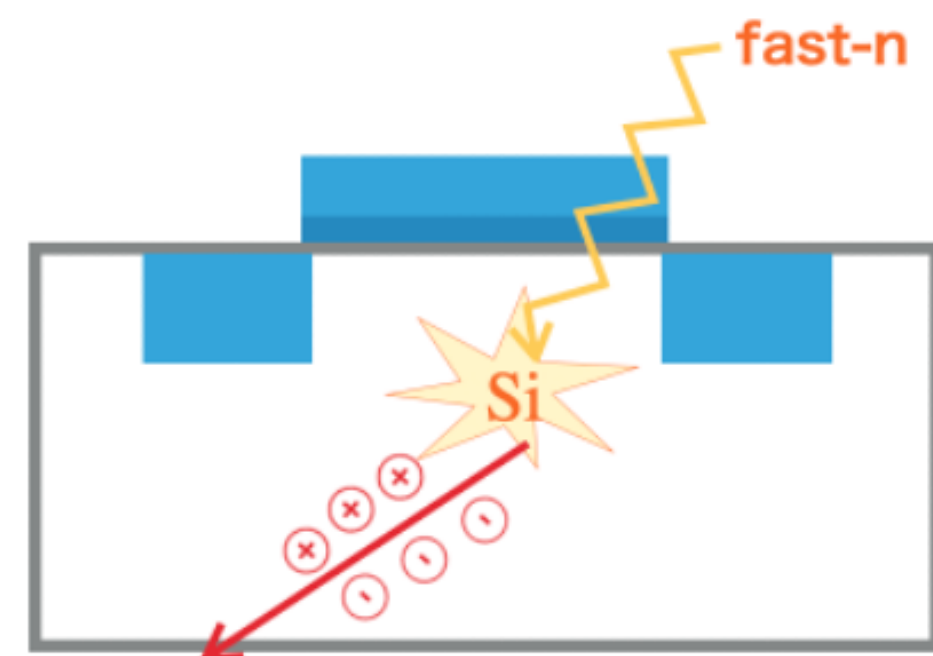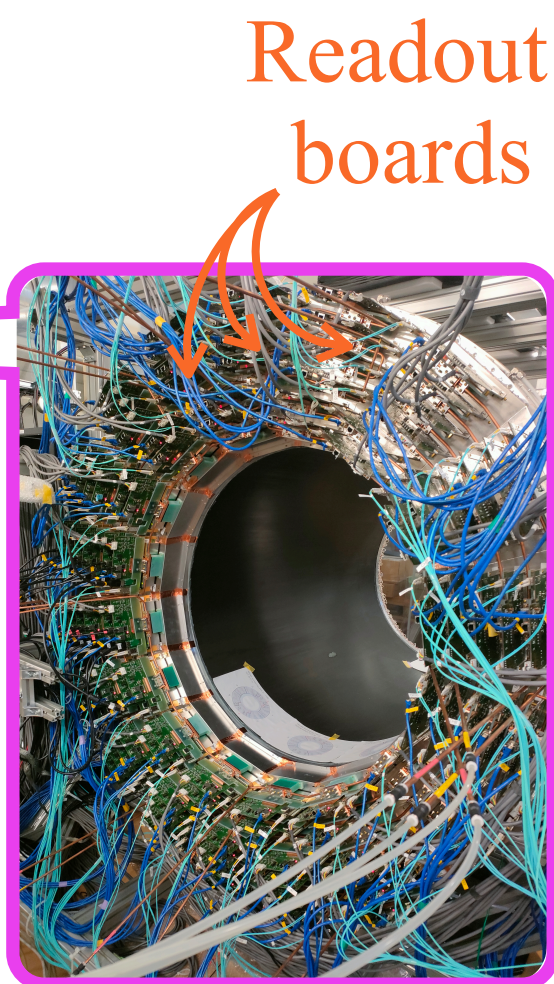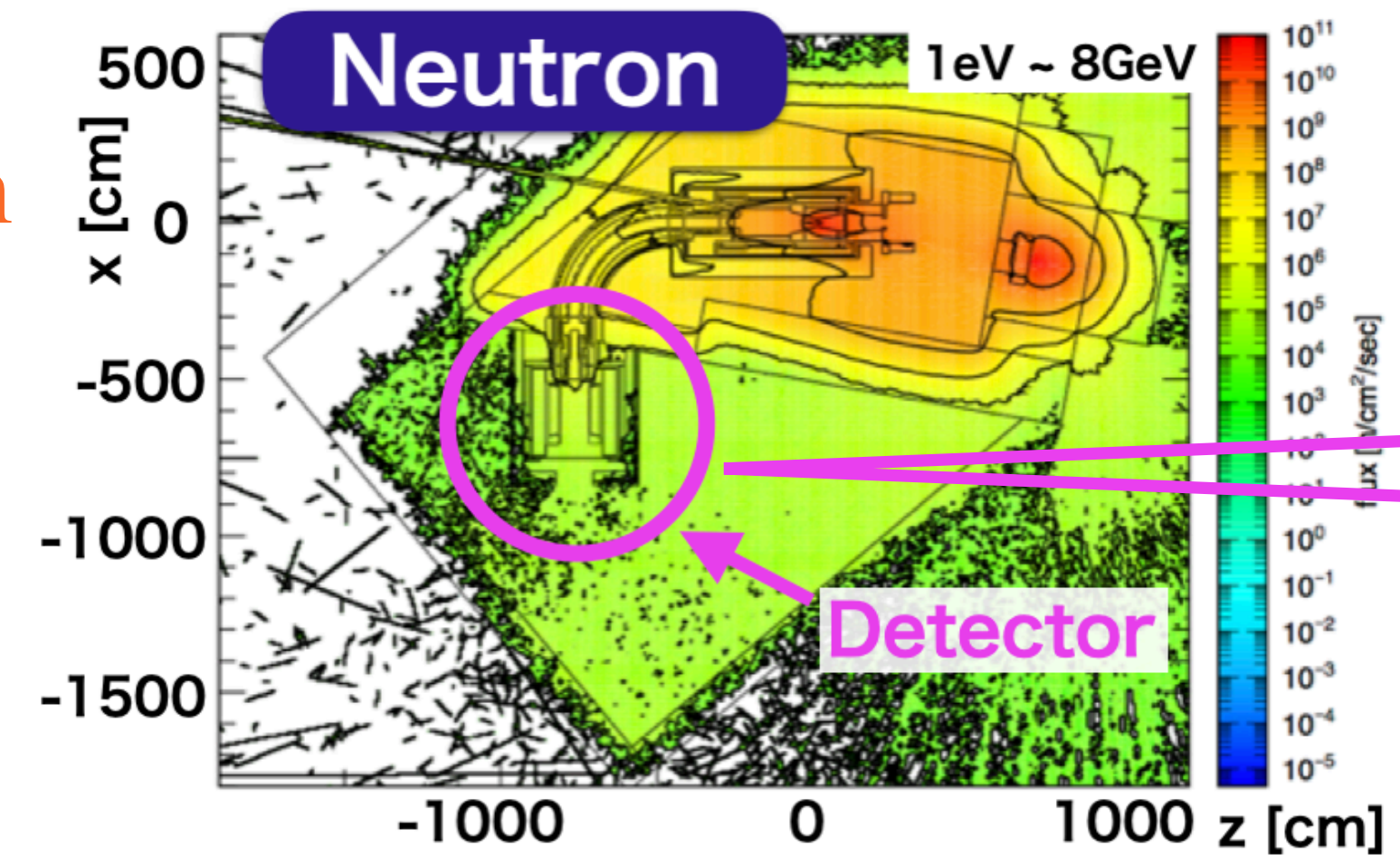# Thermal neutron induces Single-Event Upsets in the FPGA used in particle physics experiments

Chihiro Yamada

We would like to use

higher intensity, higher luminosity, and higher energy beam

→ **radiation damages** 😢

e.g.) COMET experiment. (muon rare decay search)
Neutron doses around readout board ~ 10^{12} $n_{1-MeVeq}/cm^2$

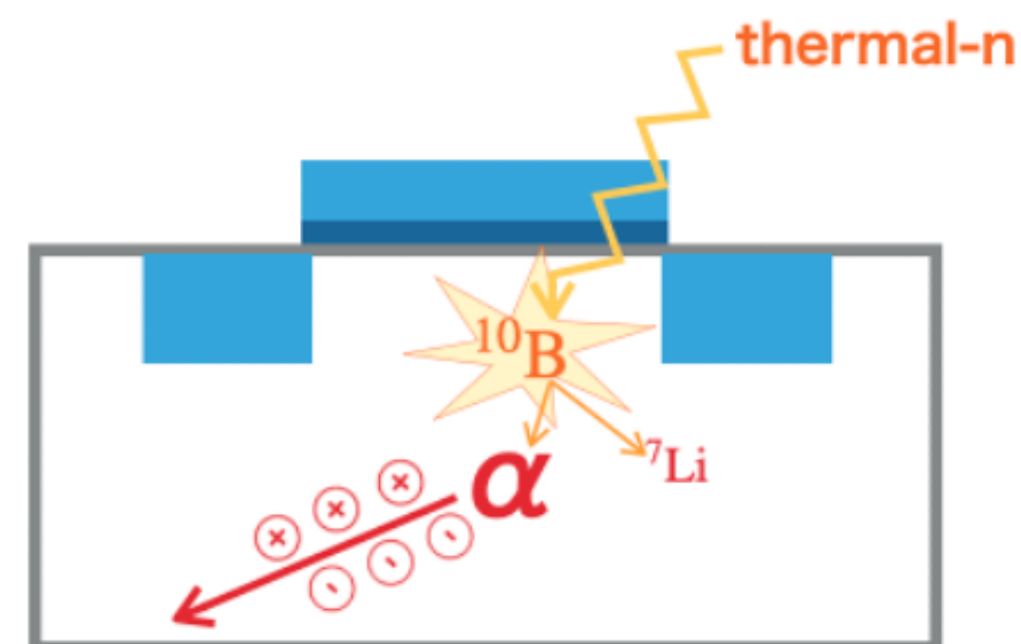< Neutrons effects on semi-conductor device >

Fast neutrons

| emit Ion particle by nuclear reaction with Si |

Thermal neutrons

| emit α particle by capture reaction with ^{10}B |

→ induce electron-hole pairs

→ Change the logic state (**Single-Event Upset:SEU**)

➡ We investigated SEUs to FPGA caused by thermal neutrons

Thermal neutron induces Single-Event Upsets in the FPGA used in particle physics experiments
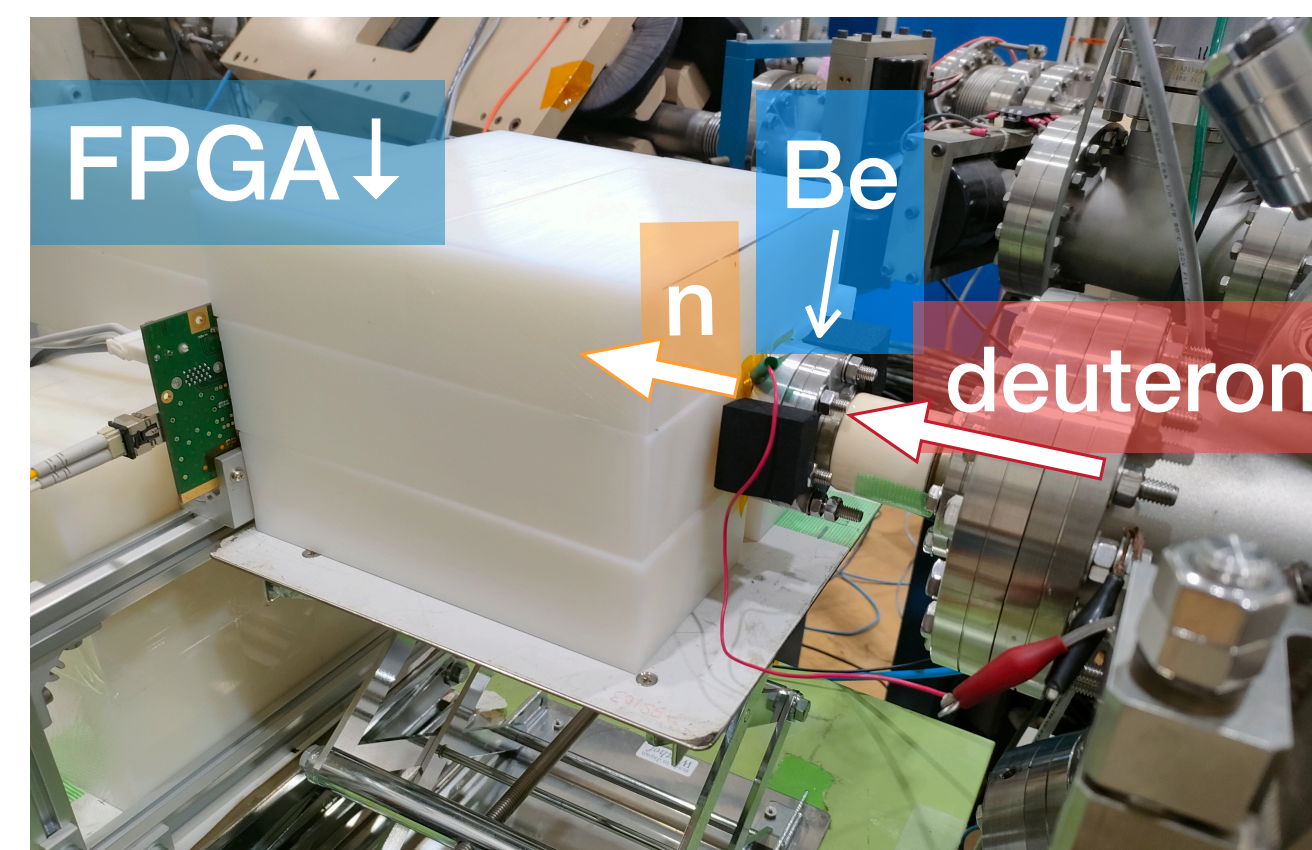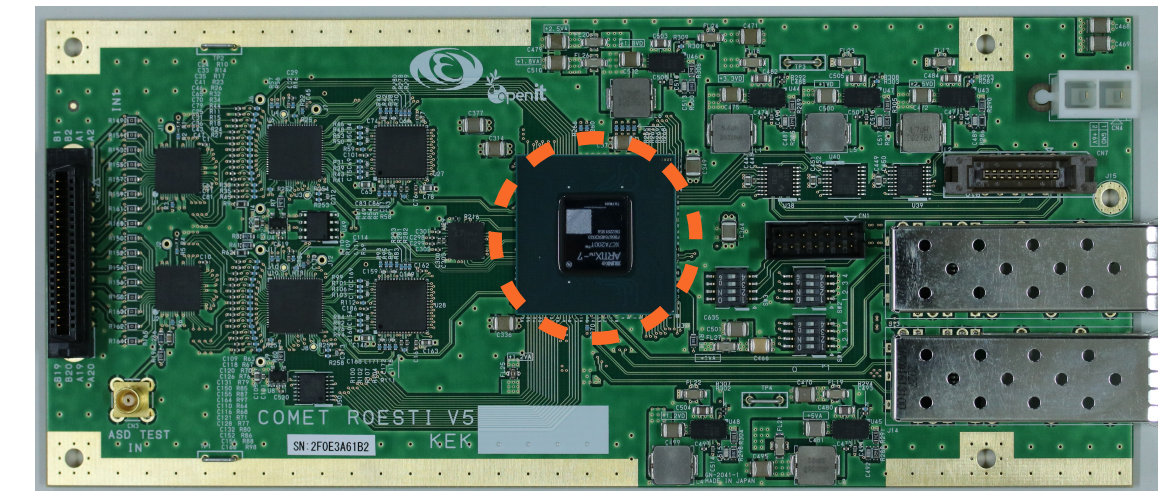
Chihiro Yamada

< Measurement > Tandem accelerato

FPGA : Artix-7 (28-nm CMOS process, AM

✦Put some blocks (PE or PE $+^{10}$B) around th

to degrade or reflect fast neutrons,

✦Irradiated <u>FPGA</u> and detected SEUs

✦Irradiated <u>CR39 (solid-state track detector)</u>

to measured fast and thermal neutron doses

FPGA↓　　Be

deuteron

< Result>

It was found that SEUs occurred due to thermal neutrons.

SEU count increased in propotion to the beam charge →

My poster compares the results of several setups
to show that we have observed SEUs induced by thermal neutrons!

SEU count vs beam charge in setup A

SEU count

120

100

80

60

40

20

0

0　　1000　2000　3000　4000　5000
d Beam Charge [C]