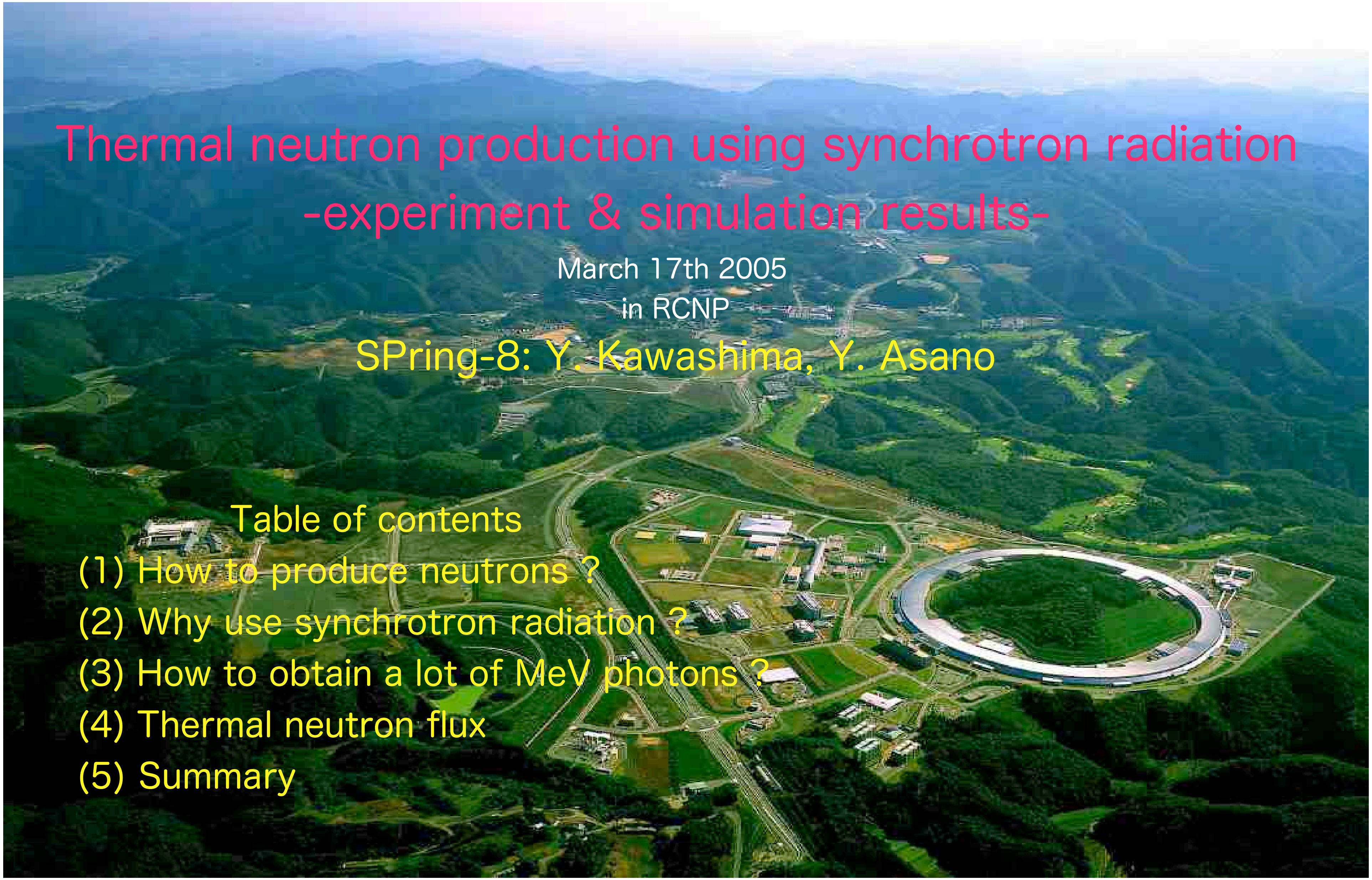

Thermal neutron production using synchrotron radiation -experiment & simulation results-

March 17th 2005
in RCNP

SPring-8: Y. Kawashima, Y. Asano

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(1) How to produce neutrons ?

Fundamental idea was proposed by *D.A. Gryaznykh et al., Nucle. Inst. and Methods. A448 (2000) 106-108.*

Photoproduction reaction process:

$$^{9}Be\ (\gamma\ n)\ ^{8}Be$$

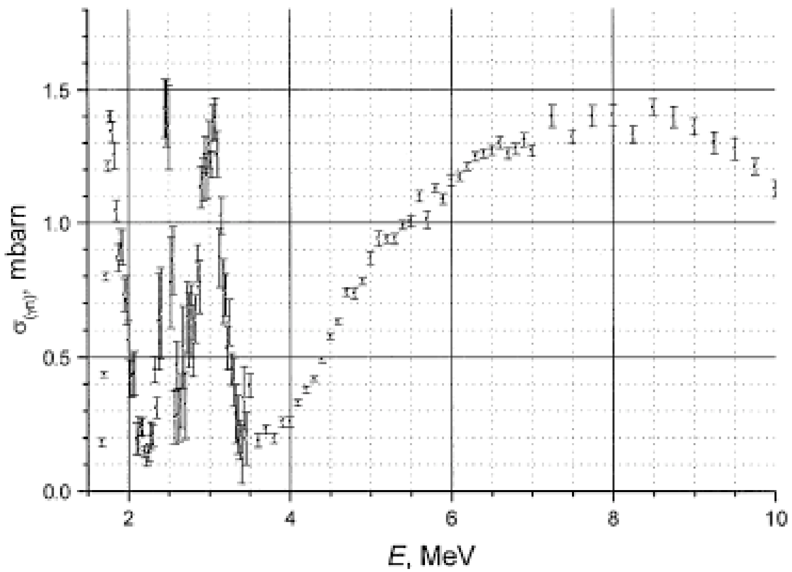


Fig. 1. Cross section of the $Be^9(\gamma n)Be^8$ reaction.

- Beryllium is chosen as its photoproduction cross section has three peaks in the reagion below 3 MeV.
- ^{9}Be finally decays into stable ^{4}He.

(2) Why use synchrotron radiation ?

the most important merits:

(1) MeV photon can be easily produced

(high availability of synchrotron radiation facilities)

(2) lower radioactive wastes

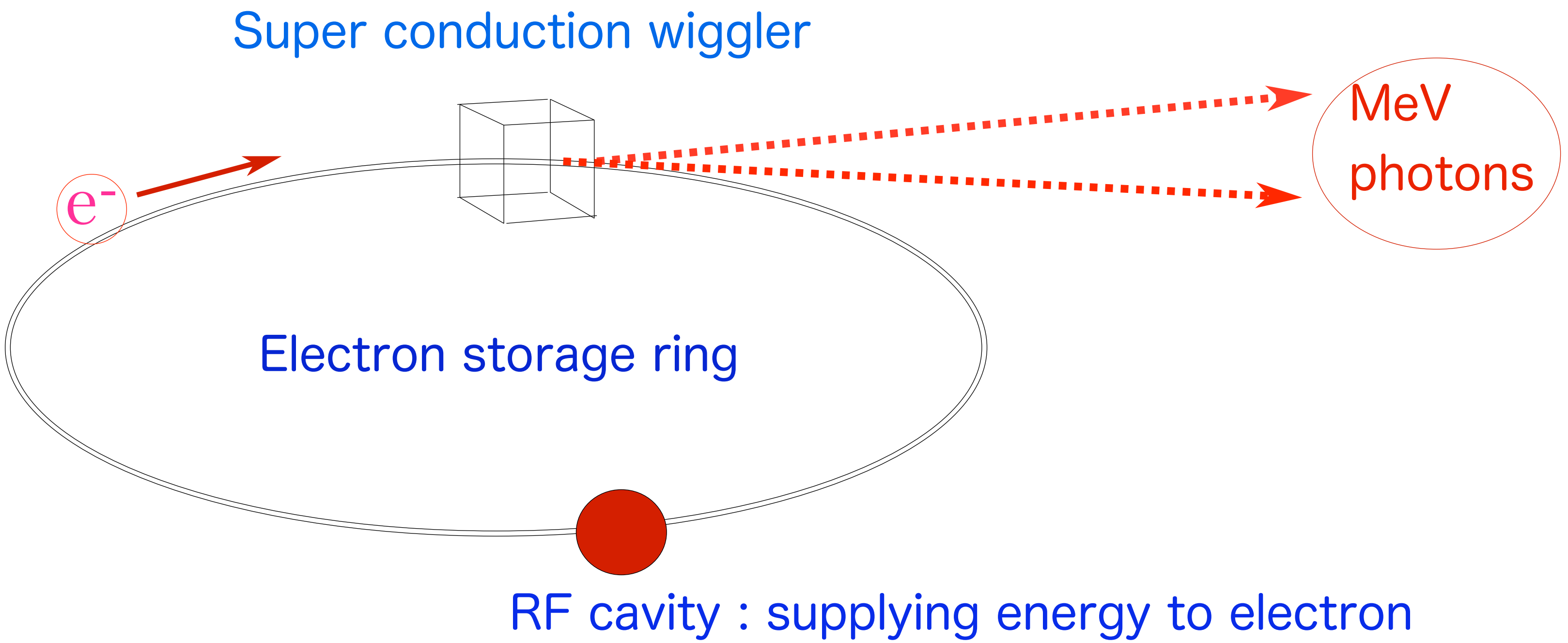
(3) easy operation and maintenance

demerit:

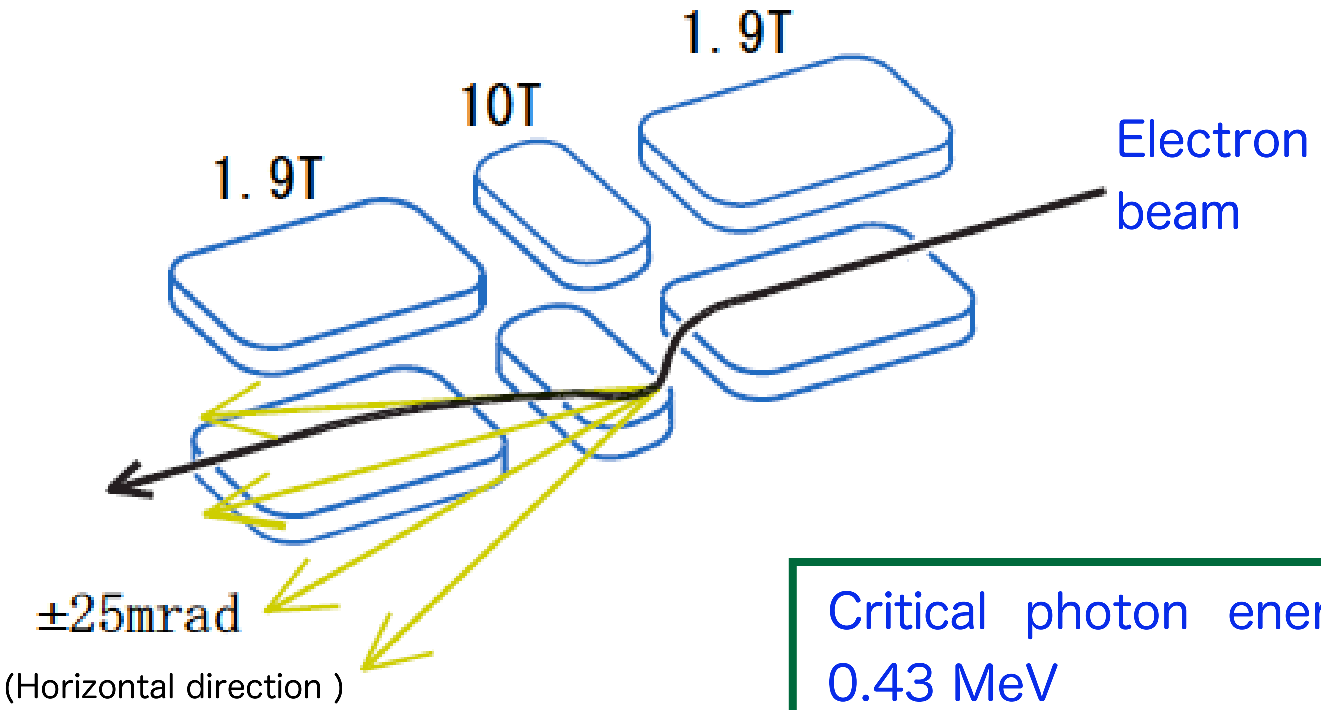
lower intensity comparing with hadron interaction process

(3) How to obtain a lot of MeV photons ?

Electron storage ring + super conducting wiggler



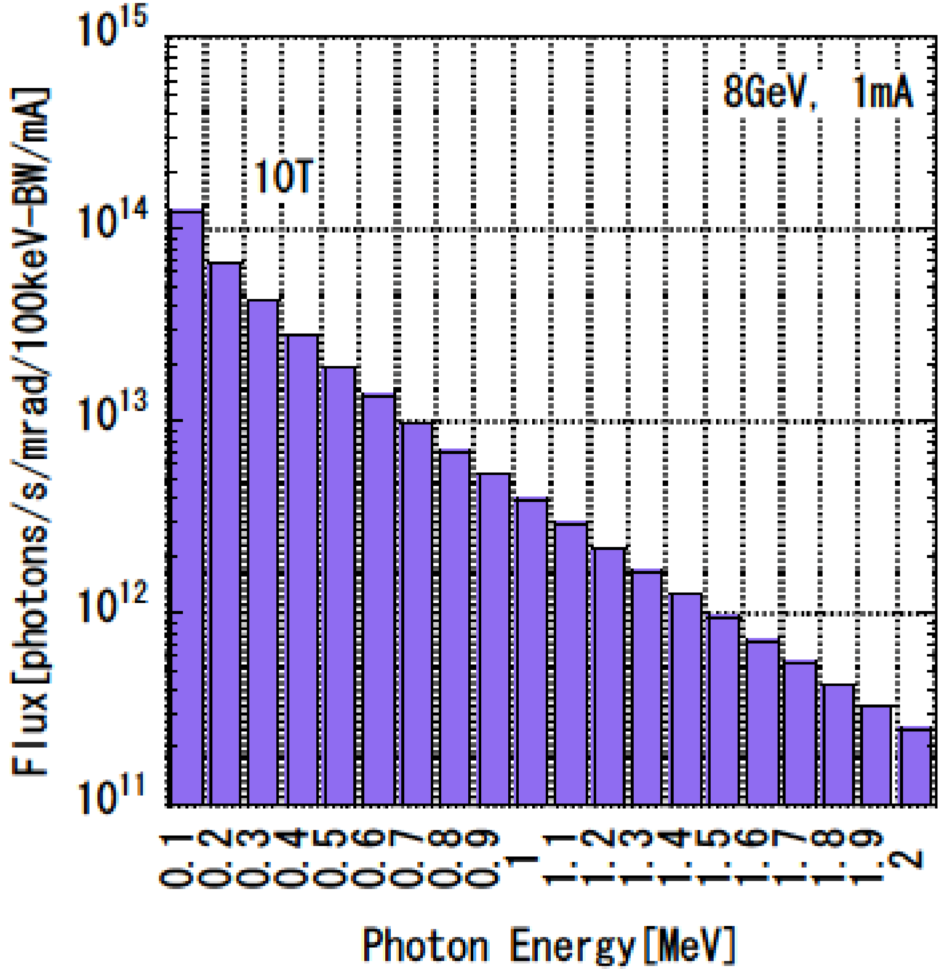
On a super conducting wiggler (SCW)



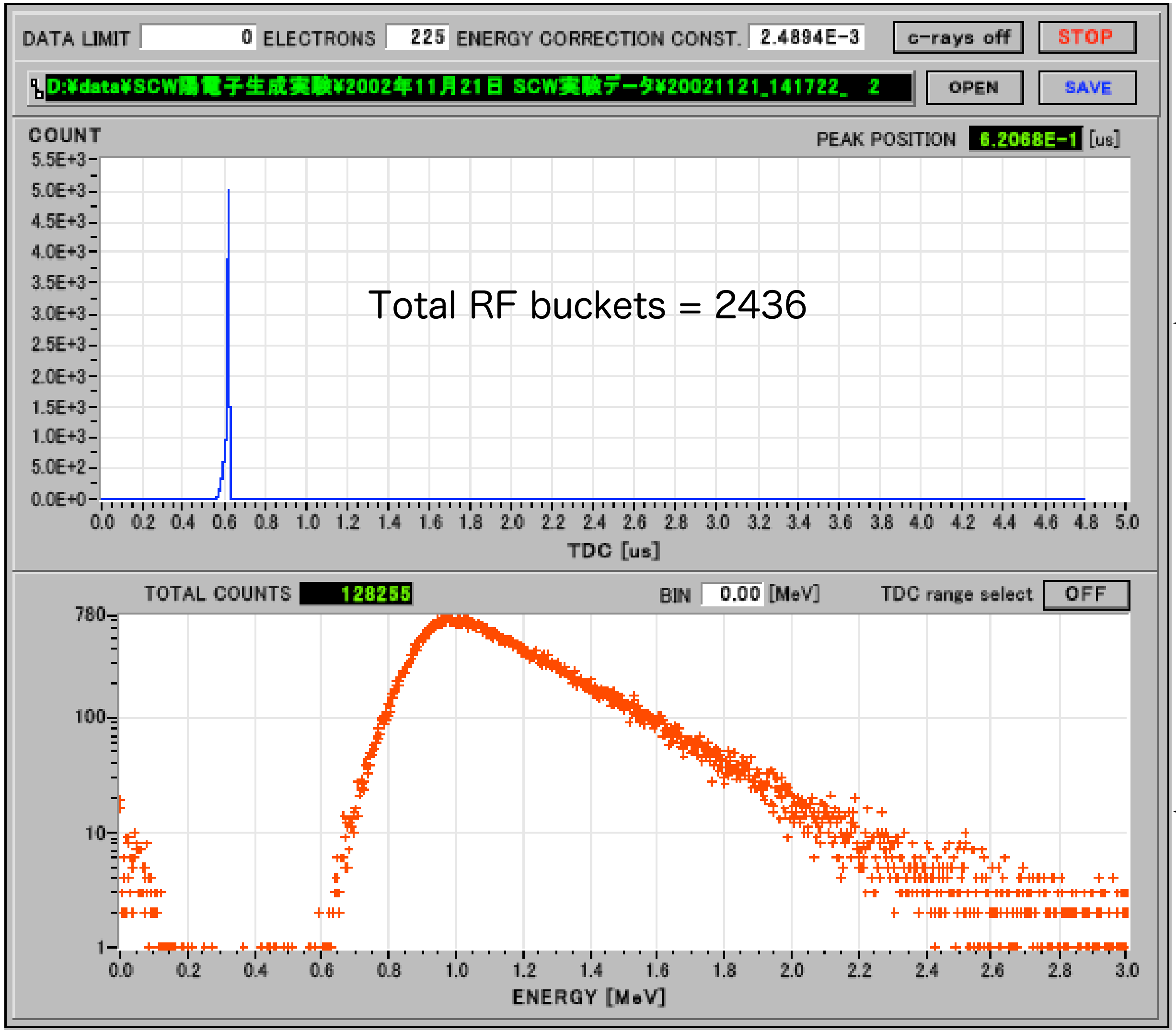
±0.07 mrad
(Vertical direction)

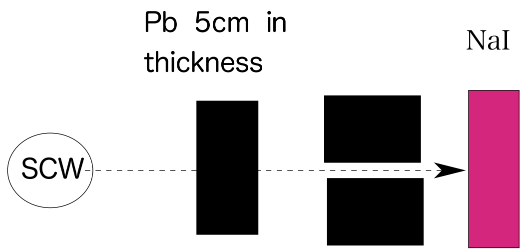
Critical photon energy :
0.43 MeV
for E=8GeV, B=10T

MeV photon flux from a super conduction wiggler (calculation)



MeV-photon spectrum obtained at SPring-8





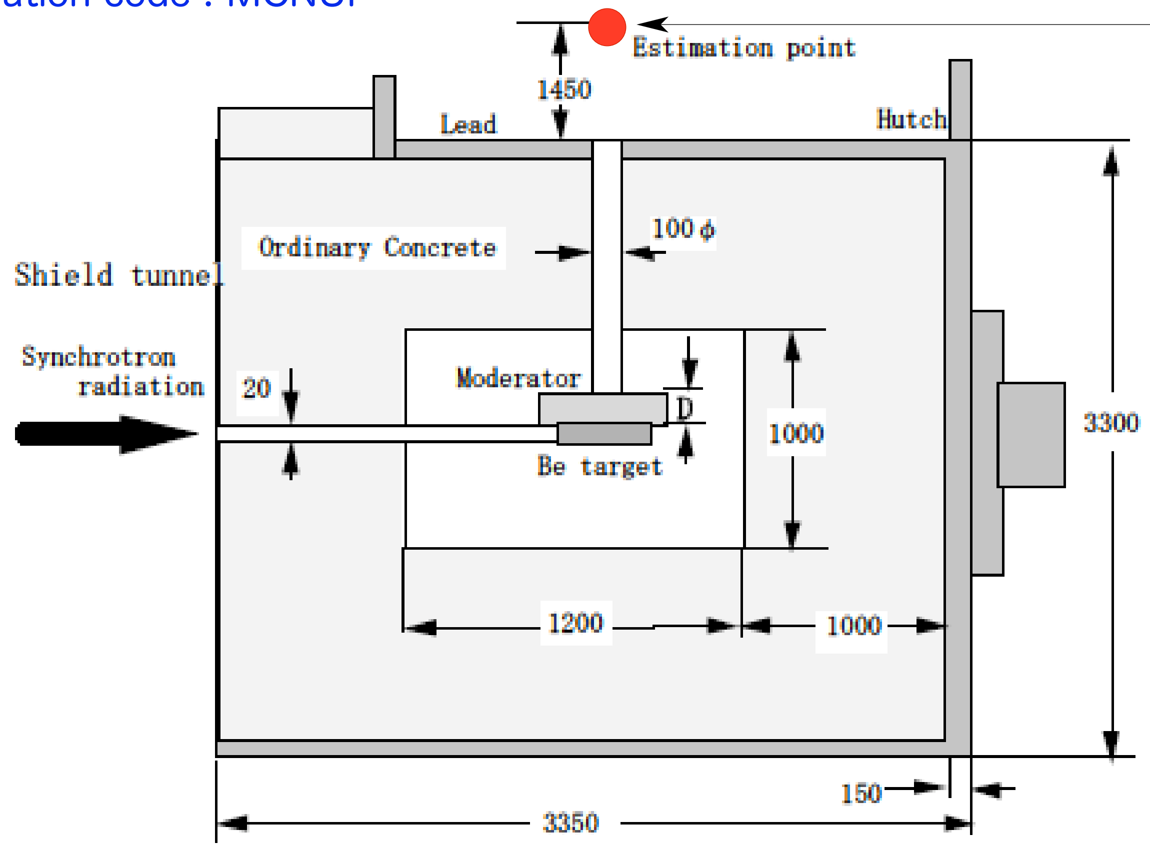
TDC data
4.8 μ s/ turn
only one RF bucket filled with beam

ADC data
photon spectrum obtained by NaI detector

(4) Thermal neutron flux

● An apparatus for thermal neutron production

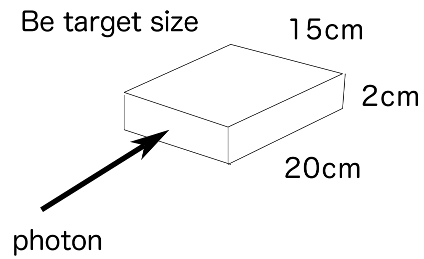
Simulation code : MCNUP



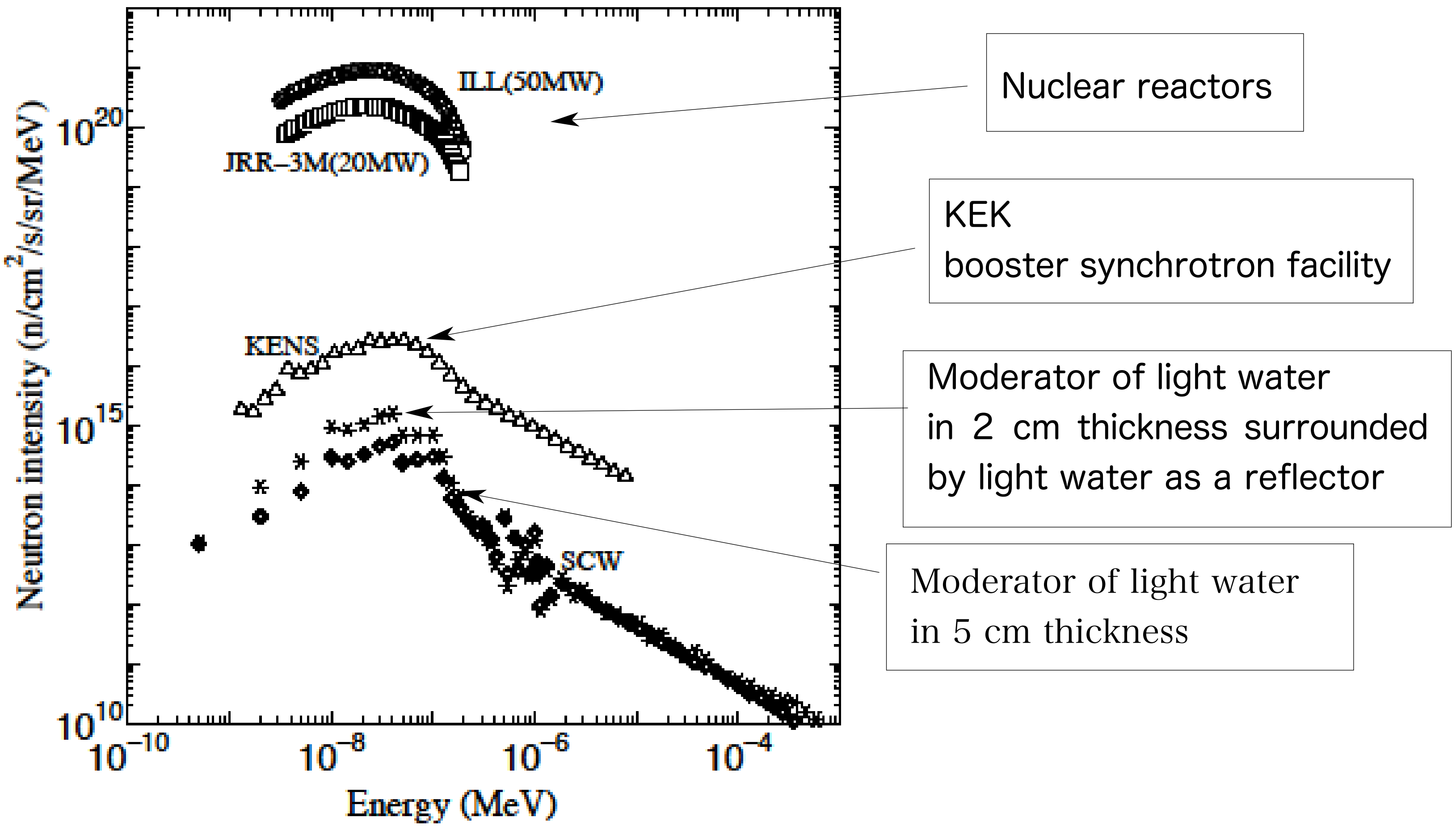
UNIT: mm

Neutron flux:
1.0 x10^5 cm^{-2} s^{-1}

Conditions for simulation
(1) beam energy: 8 GeV
(2) stored current 100mA
(3) aperture : ±0.5mrad.



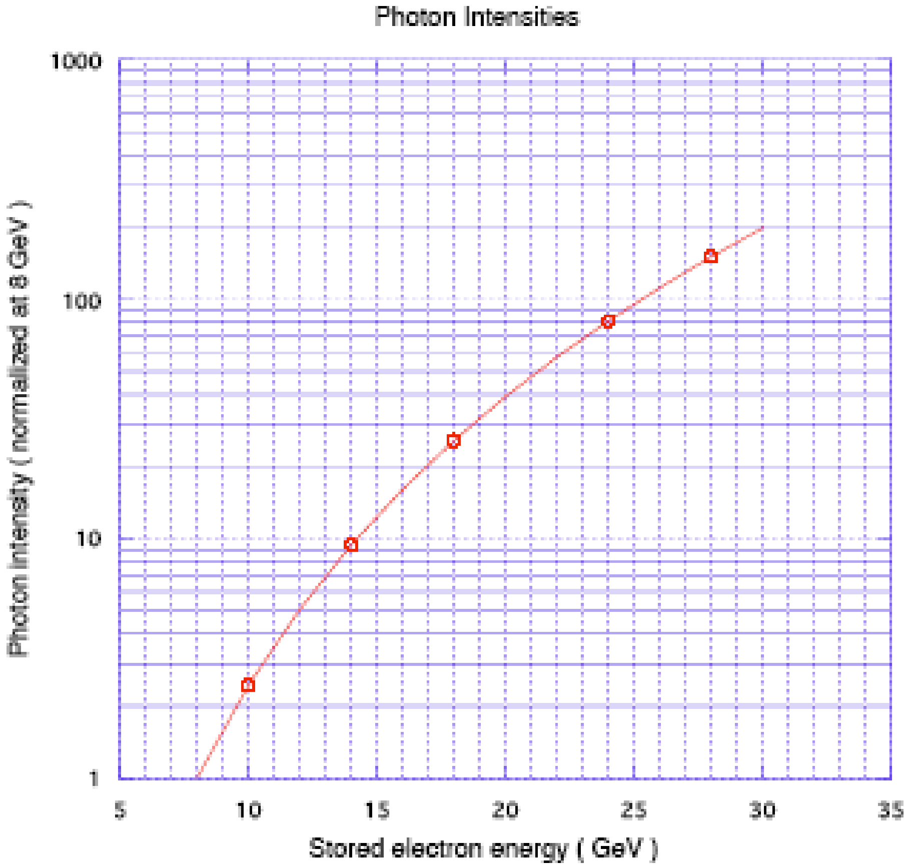
Obtained neutron spectrum and comparison with other facilities



Is it possible to increase neutron flux ?

Yes

- increase stored current $\propto I$ (I: stored current)linearly increasing
- increase magnetic field of SCW $\propto B$ linearly increasing
- increase stored electron energy $\propto E_e^4$ (E_e : electron energy)



(5) Summary

(i) photoproduction reaction process

merit: easy operation and low radioactive waste

(ii) electron storage rings with the energy of up to 8 GeV are available in the world

Collider machines:

- HERA (DESY)
- PEP-II (SLAC)
- AR and KEKB (KEK)

Synchrotron radiation machines:

- SPring-8

(iii) low neutron flux, however, the methods to increase the neutron flux exists