INTRODUCTION OF MCNP-CP CODE

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Ho Chi Minh City, 30-10-2020

OUTLINE

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- ✓ **Standard-MCNP**
- ✓ **Extend-MCNP**
- ✓ **Conclusion**

Standard-MCNP

- MCNP is a general-purpose **M**onte **C**arlo **N**-**P**article code

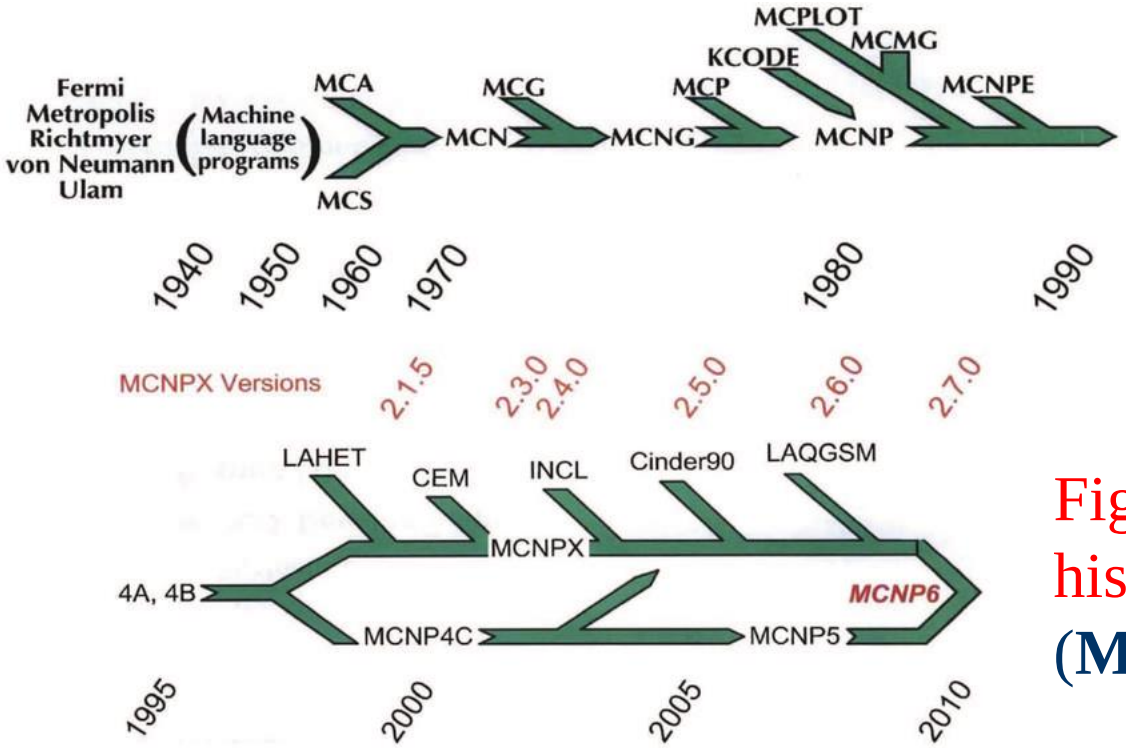

Figure 1: A schematic history of MCNP6 (**Mashnik et al., 2012**)

- Simulation tool for criticality, shielding, dosimetry, detector response, and many other applications.

- **37** different **particle types**.

Standard-MCNP (cont)

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Could it be simulated coincidence summing effect of multi-gamma transport of radionuclides?

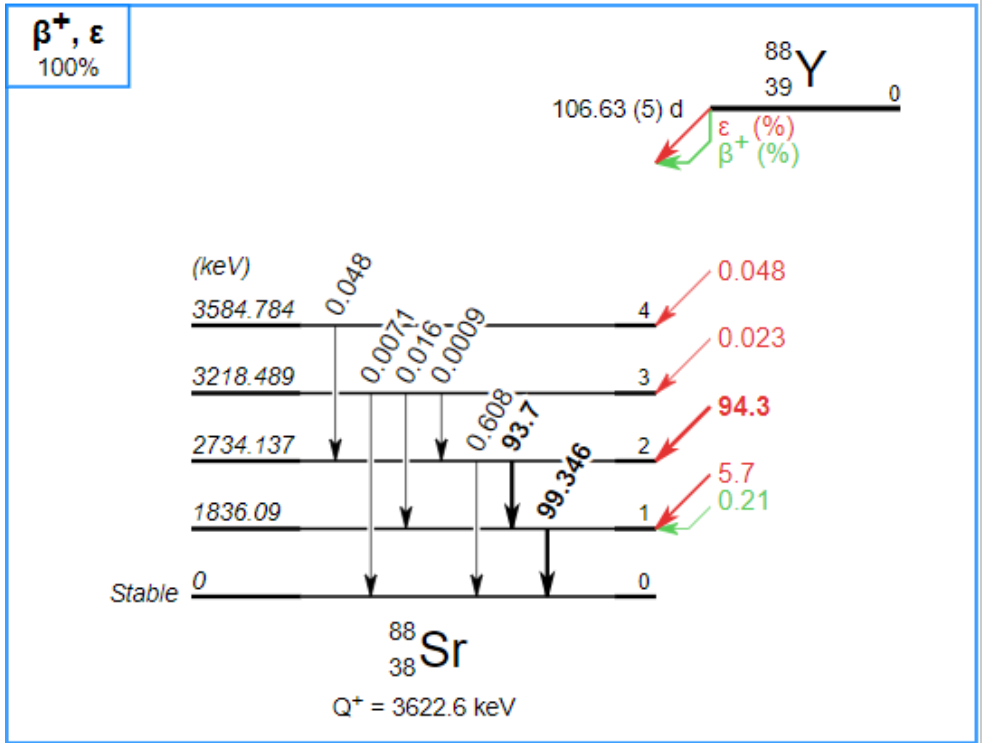

Figure 2: Decay scheme of Y-88
(Source from http://www.nucleide.org/Laraweb/index.php)

Extend-MCNP

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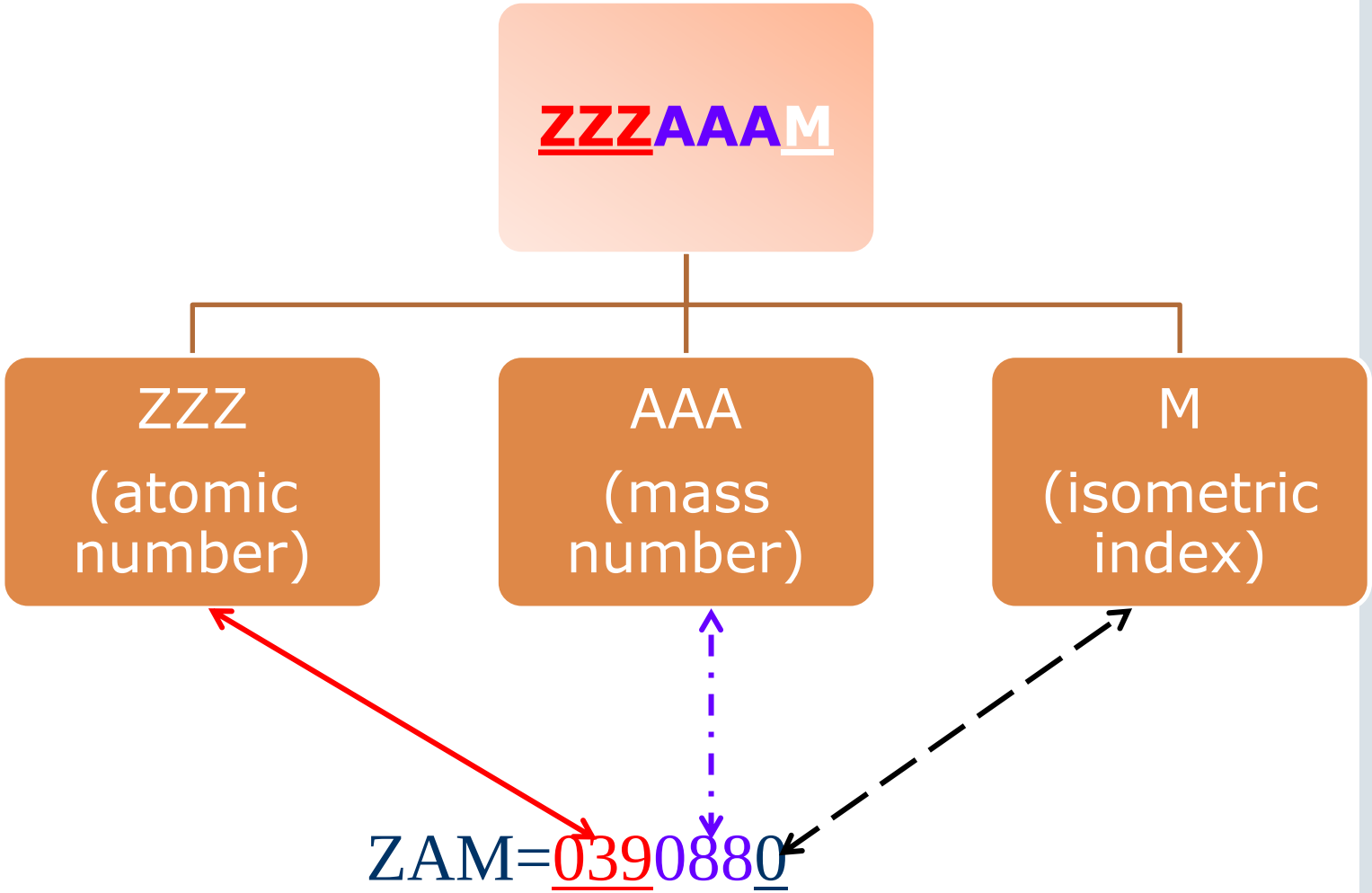
- A patch was developed to **upgrade standard MCNP (Berlizov., 2012)**
- Source of **c**orrelated nuclear **p**articles (**MCNP-CP**)
- **Radioactive decay** of a specified radionuclide
- Data file **ENSDF**
- **Gamma-gamma angular correlations**
- **Only Windows platform**

Extend-MCNP (cont)

- SDEF General Source Card Extension



Extend-MCNP (cont)

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- CPS Correlated Particle Source settings card

Form: CPS DCPGT IAS IGA IKX ILX IPO IBT ICE IAE IGG IIS

DCPGT	= the correlated particle grouping time in shakes.
IAS	= analog simulation mode switch.
IGA	= decay gamma-ray emission flag.
IKX	= KX-ray emission flag.
ILX	= LX-ray emission flag.
IPO	= positron emission flag.
IBT	= beta-particles emission flag.
ICE	= conversion electrons emission flag.
IAE	= Auger electrons emission flag.
IGG	= gamma-gamma angular correlation flag.
IIS	= isomeric level(s) decay radiation suppression flag.

```
C ********** BLOCK 3: DATA **********
MODE P E
imp:p 1 7r 0
imp:e 1 7r 0
SDEF CEL=6 ZAM=D1 PAR=2 POS=0 0 7.7 AXS= 0 0 1
SI1 L 0390880
SP1 D 1.0
c CPS -1
```

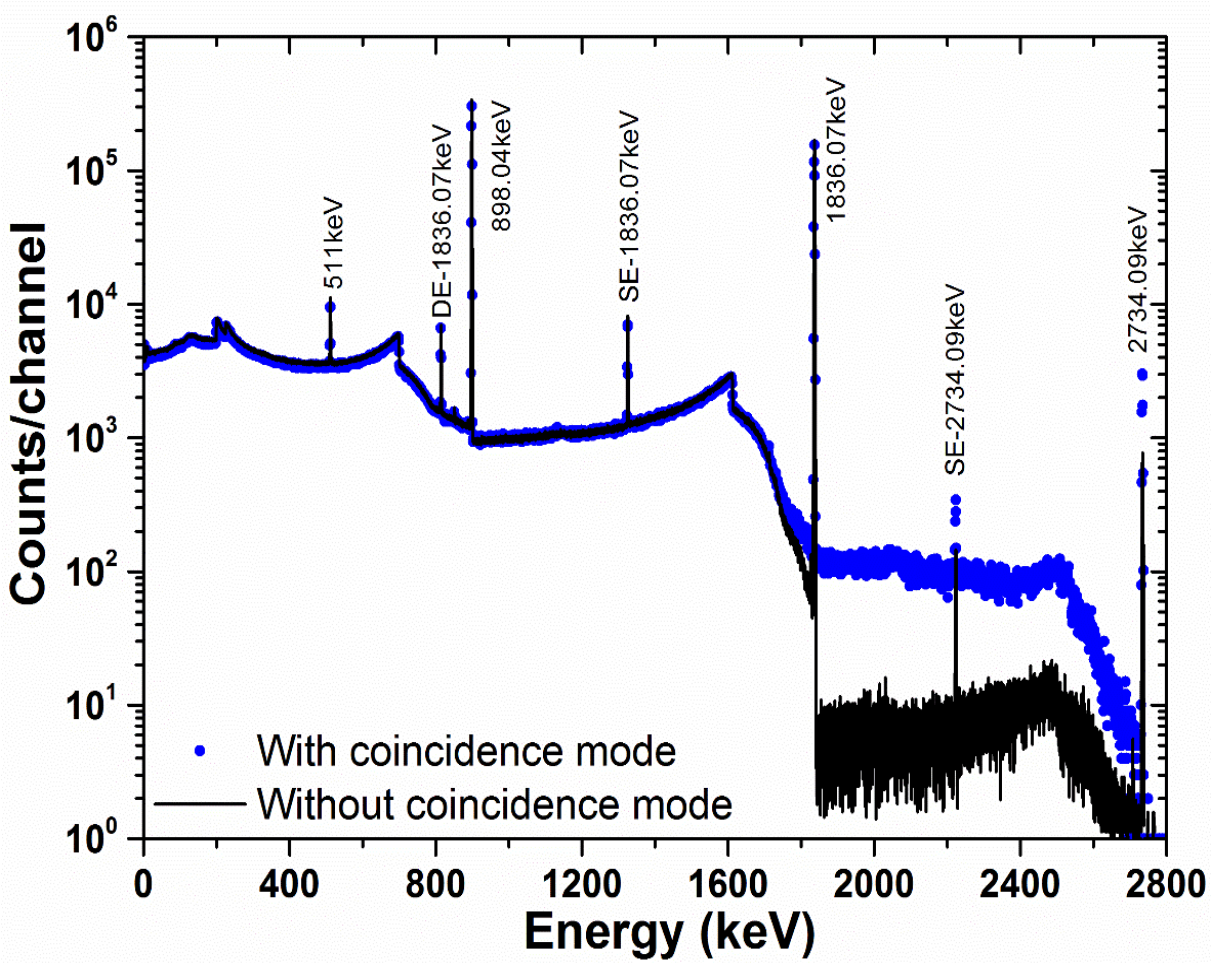
With coincidence mode

```
C ********** BLOCK 3: DATA **********
MODE P E
imp:p 1 7r 0
imp:e 1 7r 0
SDEF CEL=6 ZAM=D1 PAR=2 POS=0 0 7.7 AXS= 0 0 1
SI1 L 0390880
SP1 D 1.0
CPS -1
```

Without coincidence mode

Conclusion

The coincidence summing factor (CSF) is a ratio of FEP efficiencies



$$CSF = \frac{\varepsilon_{Wo}(E)}{\varepsilon_{W}(E)}$$

Figure 3: The simulated spectra are with (**blue point**) and without (**black line**) coincidence summing mode for Y-88.

References

1.Mashnik, S.G., et al., 2012, Current status of MCNP6 as a simulation tool useful for space and accelerator applications, AIP Conference Proceedings 1560(1).

2. Berlizov, A., 2012. A correlated particle source extension of a general purpose Monte Carlo N-particle transport code, MCNP-CP Upgrade Patch Version 3.2. Institute for Nuclear Research National Academy of Sciences of Ukraine

3. Pelowitz, D.B., (Ed). 2013. MCNP6™ user's manual, Version 1.0. Los Alamos National Laboratory report LA-CP-13-00634, Rev 0

4. Goorley, T., et al., 2016, Features of MCNP6, Annals of Nuclear Energy, 87(2), 772-783.