Radiological study of the nuclear facility S3 of SPIRAL2

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and S3 team collaboration

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Plan

- GANIL and SPIRAL2 facility : the future of GANIL
- S3 facility
- Neutron production and modelling
- Radiological study results
- Conclusion

GANIL/SPIRAL2 facility

GANIL : common laboratory CEA/DRF & CNRS/IN2P3

Nuclear physics on exotic heavy ions

Nuclear reaction mechanisms

Nuclear structure

High knowledge and technical/scientific expertise about accelerators physics and engineering (cryogenics, high vacuum, ion sources, beam diagnostics...

Interdisciplinary research (materials irradiation...)

5 Cyclotrons

----- > 95 MeV/n

6 < Z < 92

SPIRAL2

Linear accelerator (p,d,α,Hi)

Spectrometer S3, Neutron source, Low energy ions

GANIL/SPIRAL2 facility

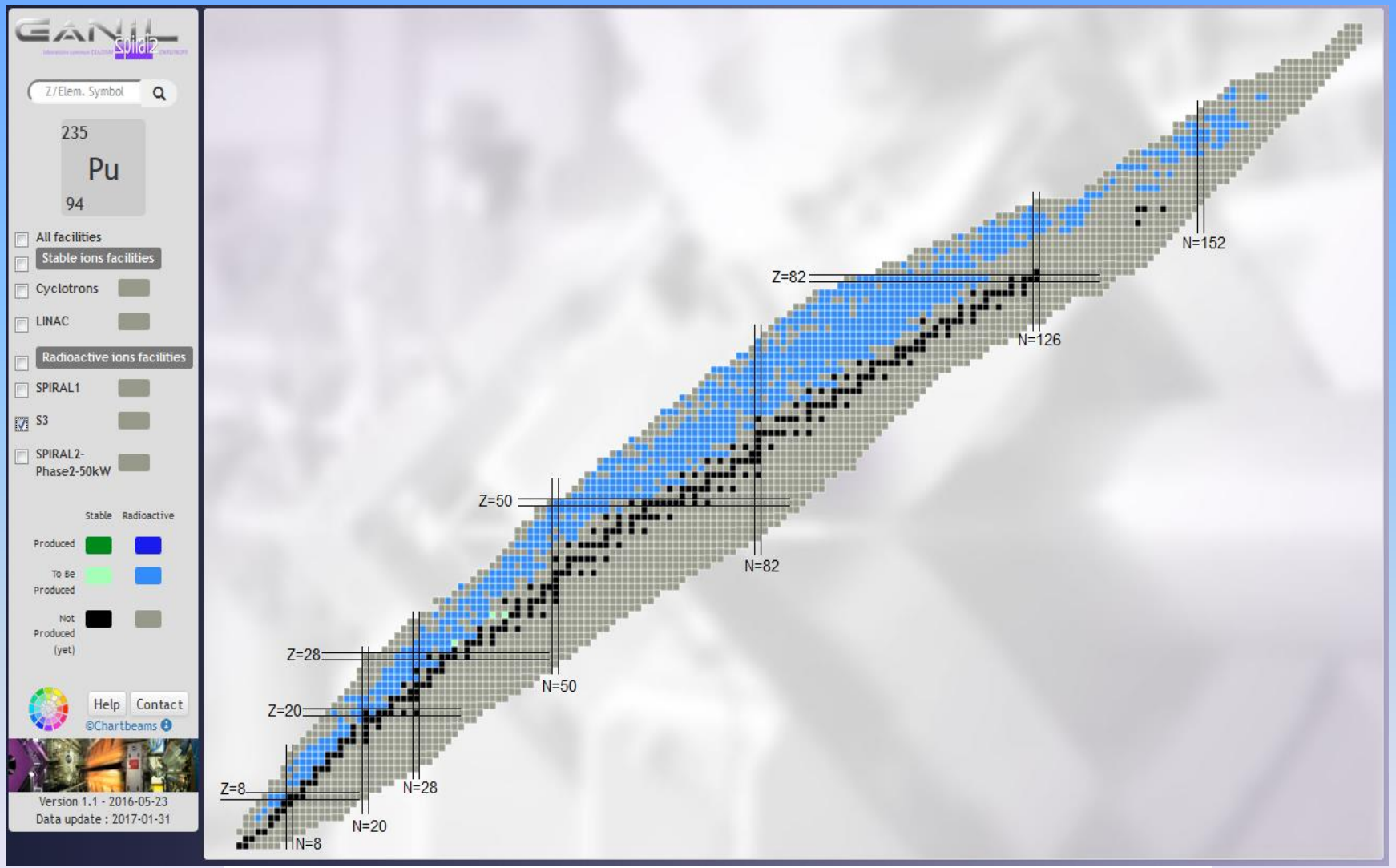
LINAC:
33MeV
40 MeV
14.5 AM

A/q=6 Inj

A/q=3
Up t

CIME cyclotron RIB at 1-20 AMeV (up to 10 AMeV for fiss.fragments)

GANIL/SPIRAL2 facility



http://u.ganil-spiral2.eu/chartbeams/

GANIL/SPIRAL2 facility

SPIRAL2

The quest for new nuclides

Nuclear masses measurement

Radioactivity of neutron/proton-rich nuclides

Shell structure far from stability
Single –particle levels far from stability

The synthesis of super-heavy elements

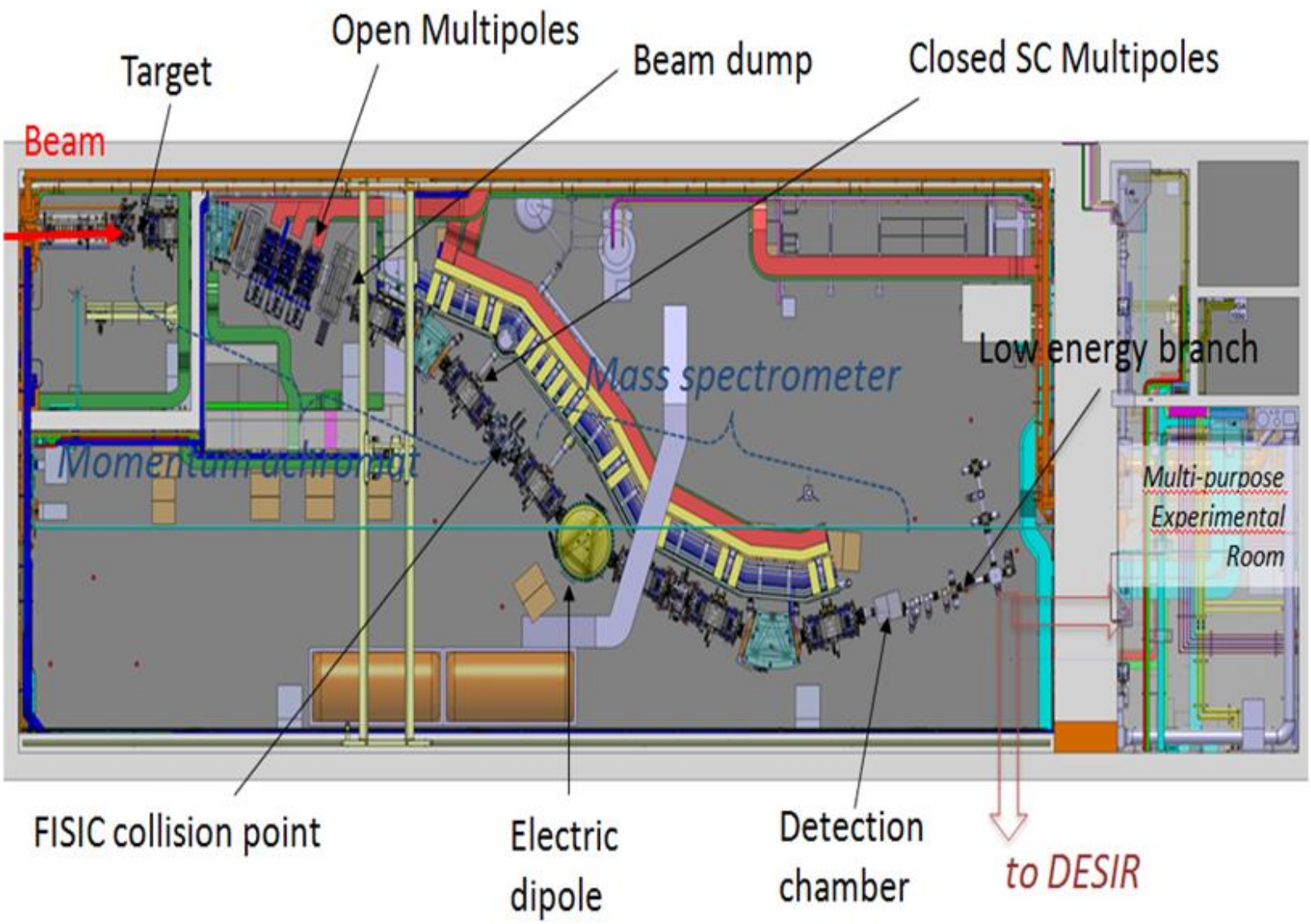
The elements and their origin

Fundamental interactions : searching for physics beyond the standard model

Neutron for Sciences ; Medical applications

Interdisciplinary research

S3 : The Super Separator Spectrometer for LINAC Beams



S3 : Objectives of the radiological study

1. Neutron enegy deposit on electronic components

2. Neutron energy deposit on superconductor elements

3. Neutron dose equivalent : neutron map on S3

Method : Monte Carlo simulations (PHITS, MCPN, …)

S3 : Nominal operation conditions

Reference beams of physics : 5 kW

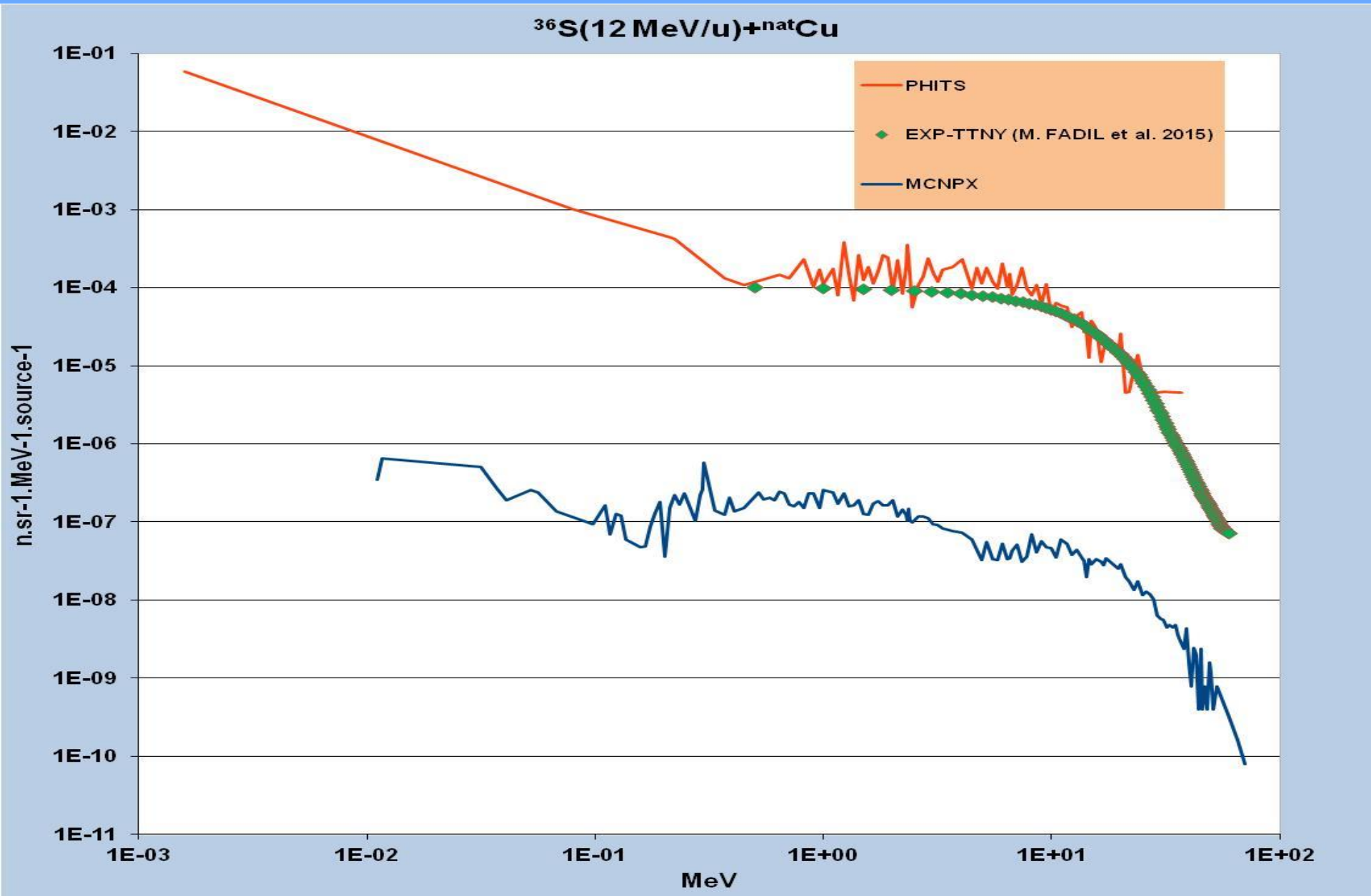
Ion beam	Energy (MeV/n)	Intensity (10^{14} pps)
12C	7	3.7
22Ne	5	2.8
48Ca	5	1.3
58Ni	5	1.1
58Ni	10	0.54
48Ca	10	0.65
20Ne	14	1.1
40Ar	14	0.56

Dimensioning beam:
12C (15 MeV/n) at 45 kW

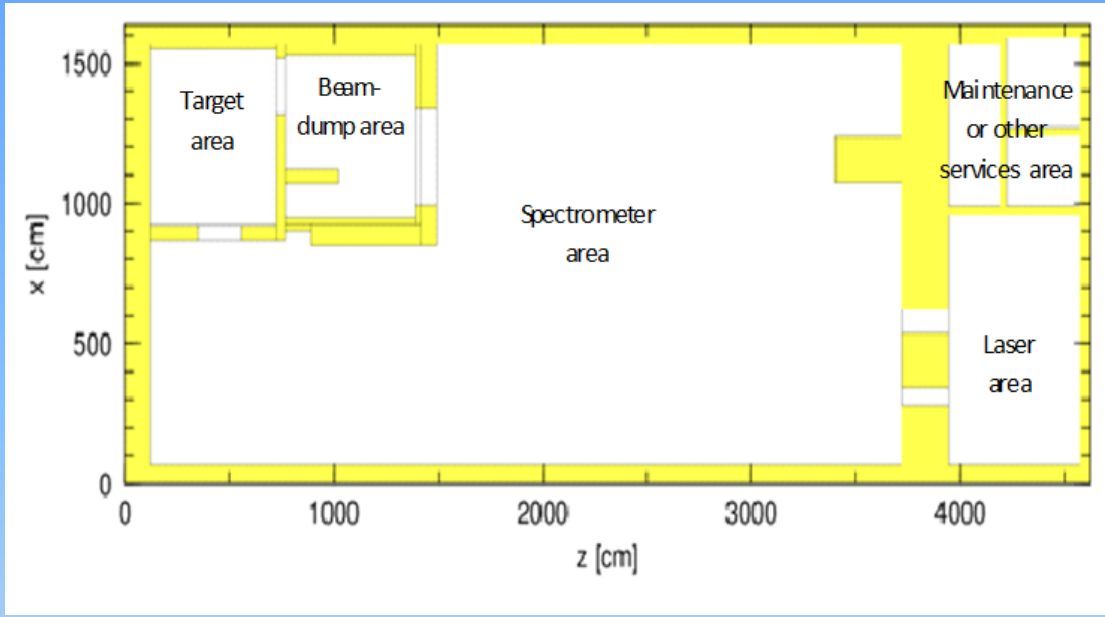
3. Neutron dose equivalent

1 & 2 . Neutron enegy deposit

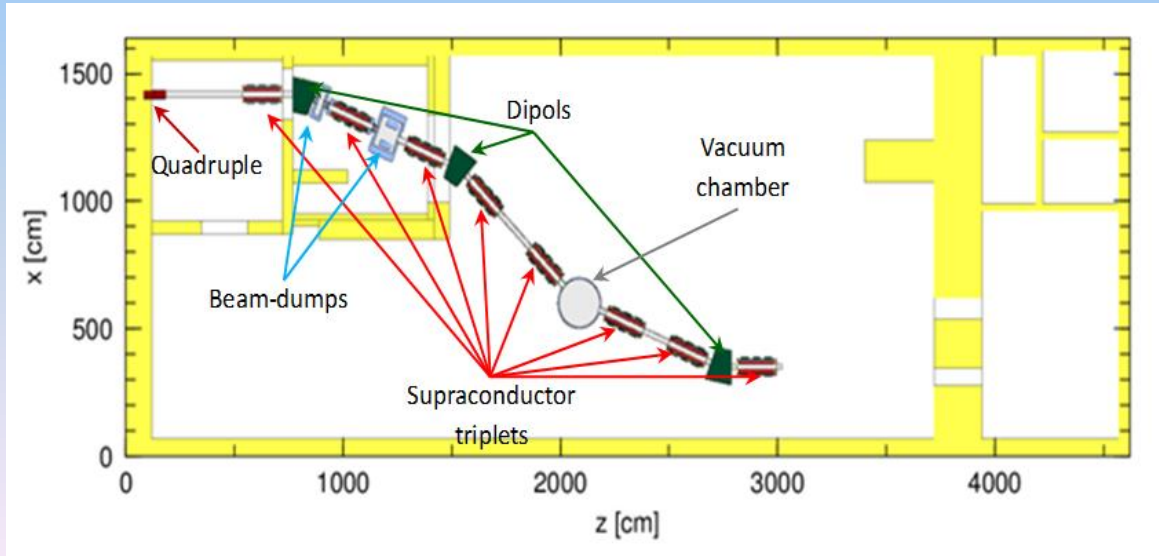
S3 : Choice of the transport code



S3 : building and equipements



Modelling code : PHITS2.88



S3 : building and equipments

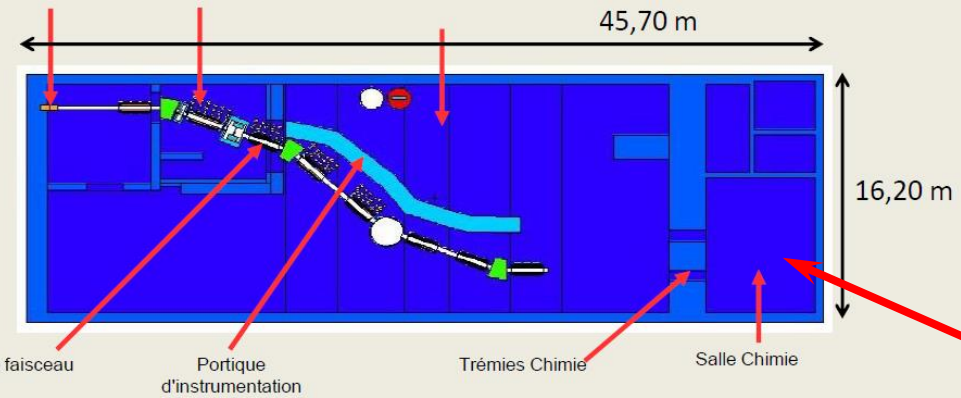
Target area

Beam dumps area

Spectrometer area

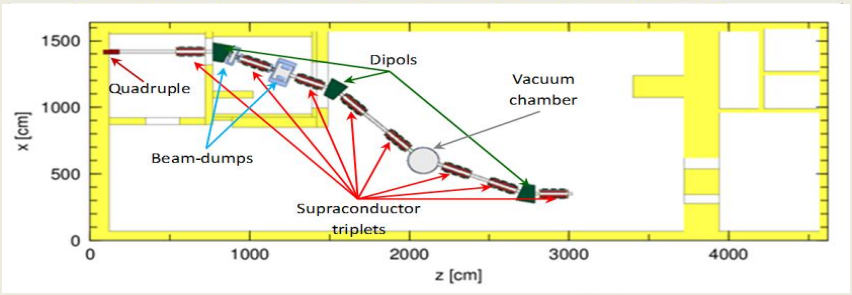
R-2

MCNP



Laser area -2

PHITS



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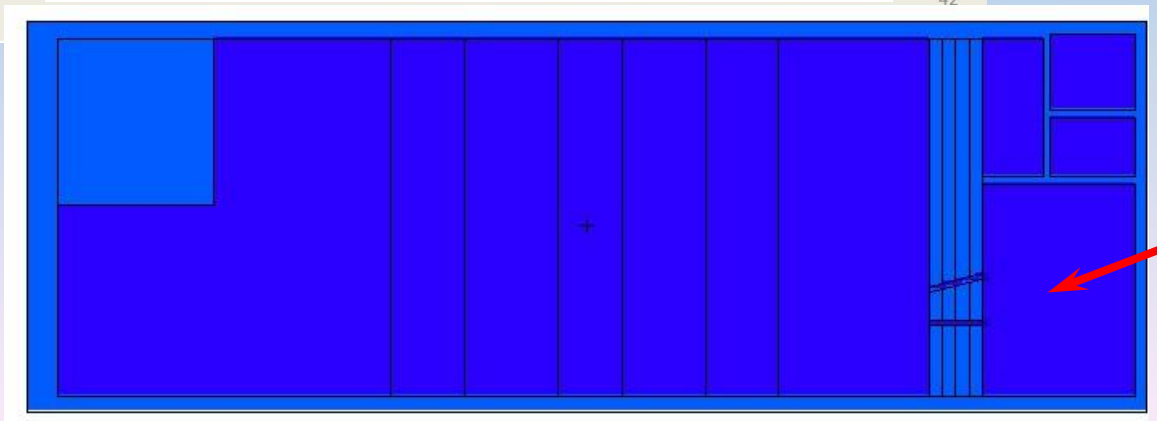
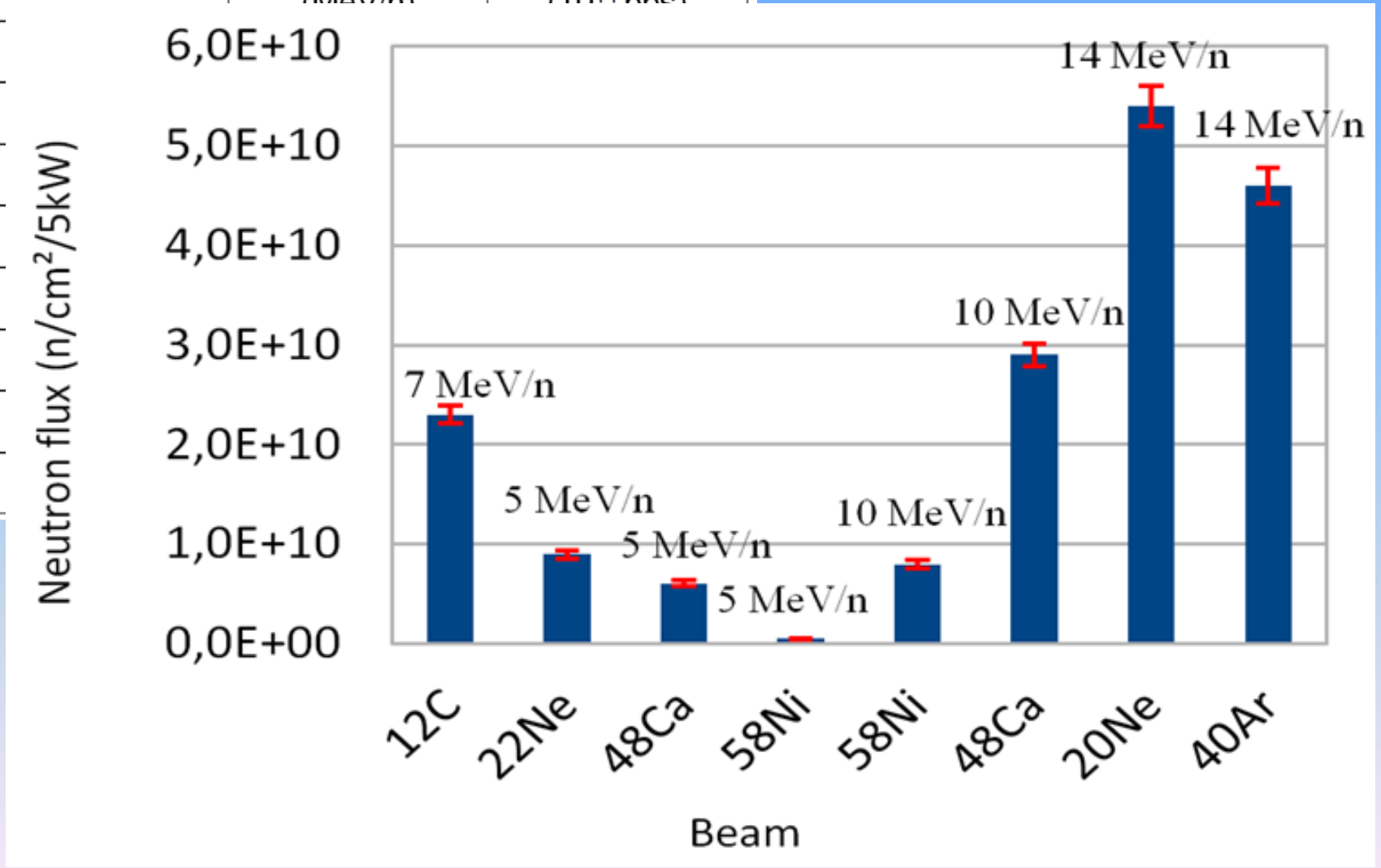
R-1



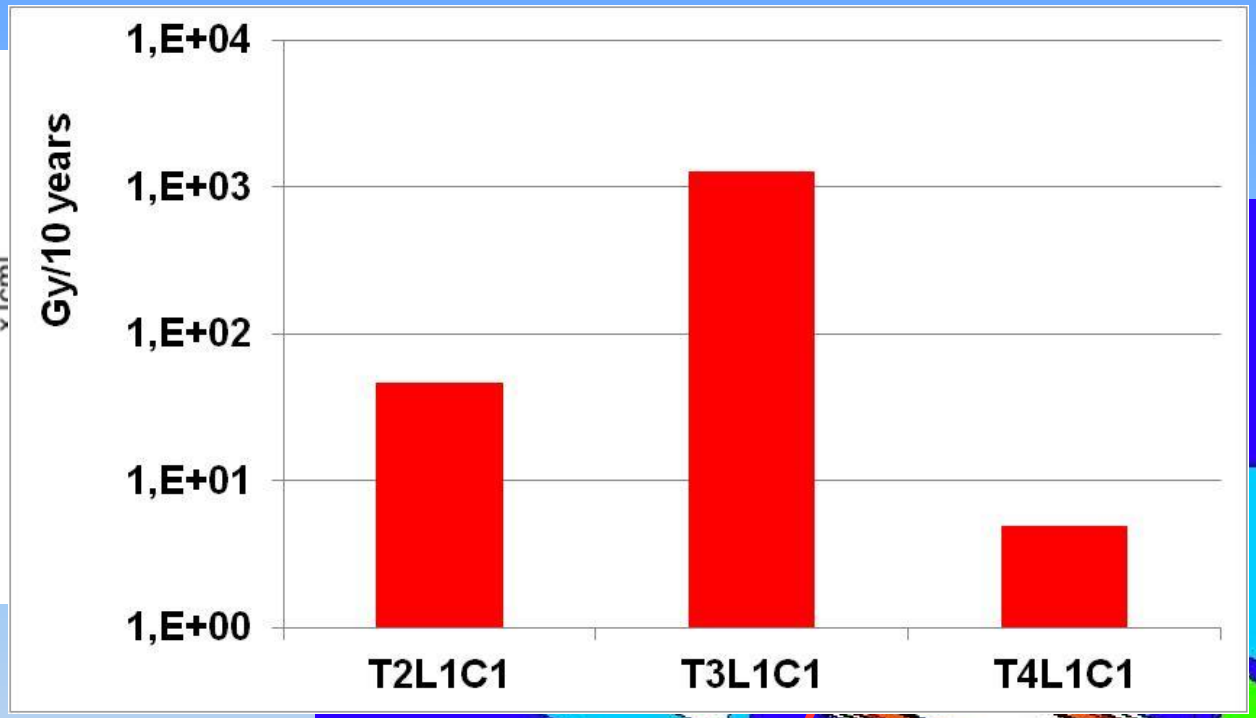
Laser area -1

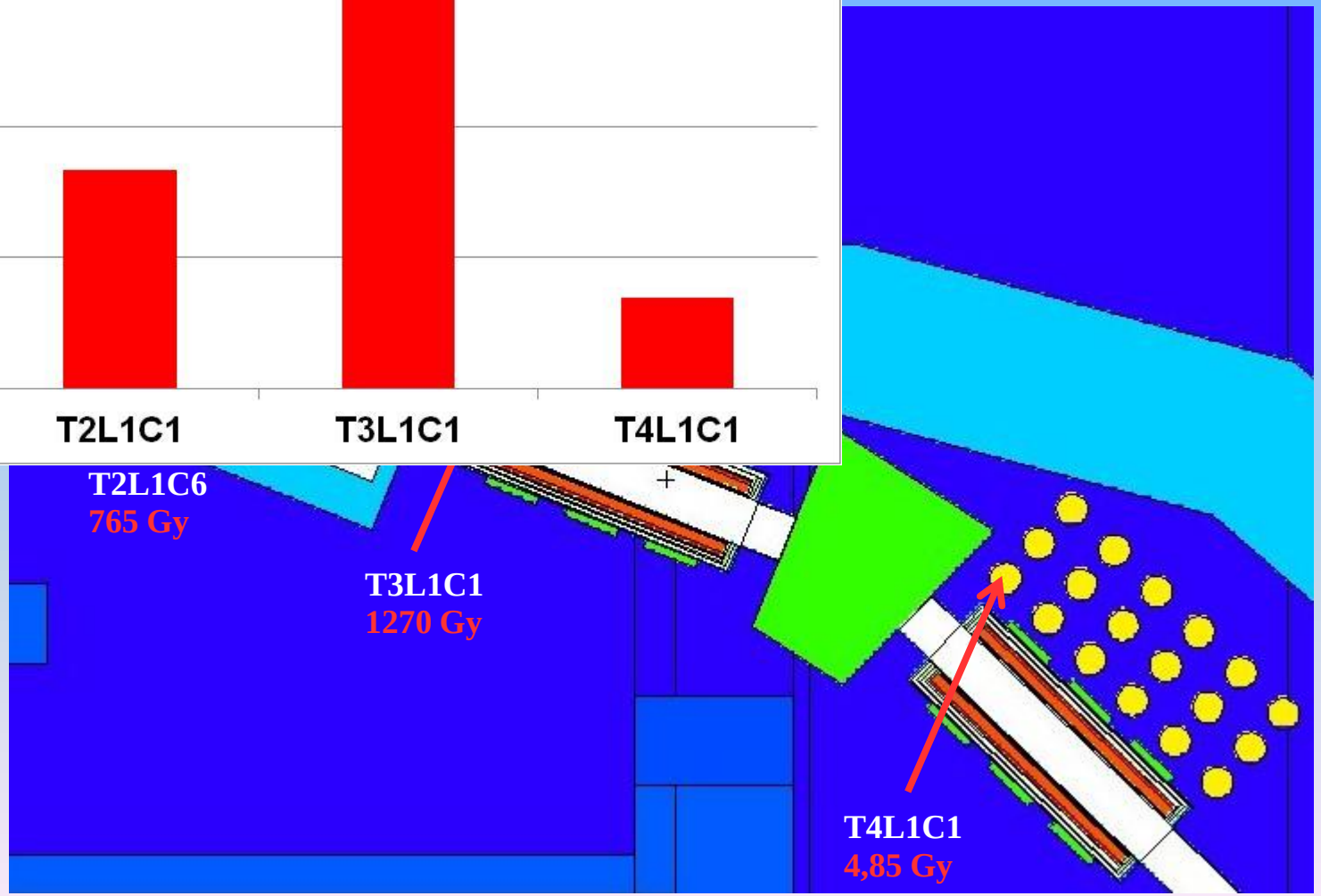
Neutron production : enveloppe beam

Ion beam	Energy (MeV/n)	Intensity (10^{14} pps)

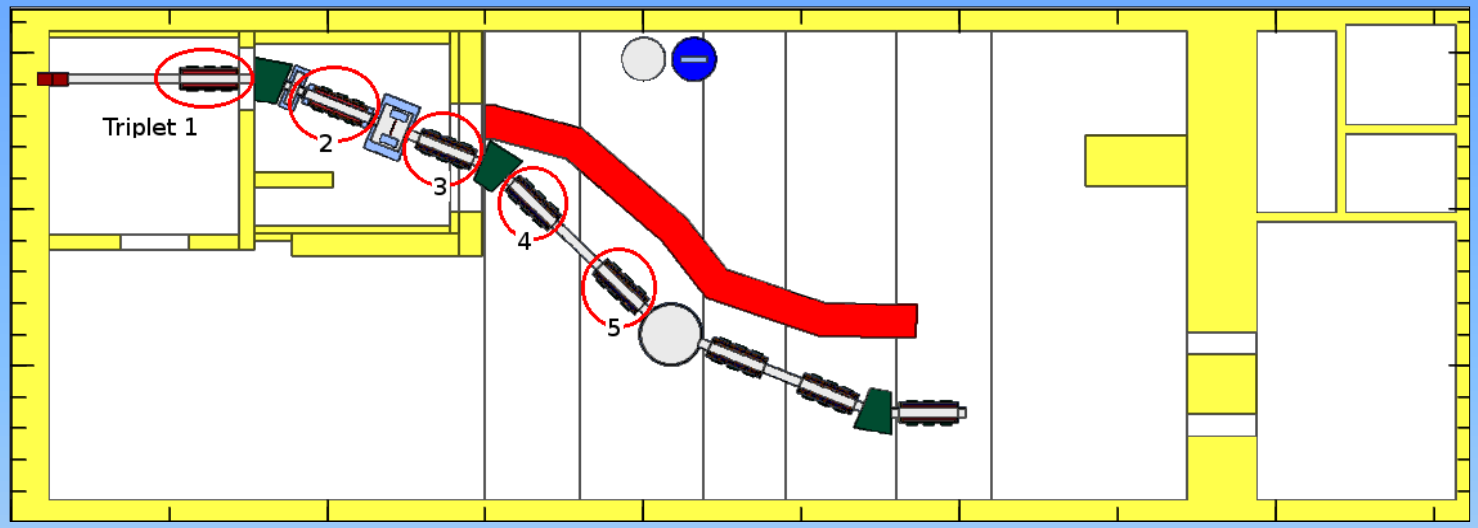


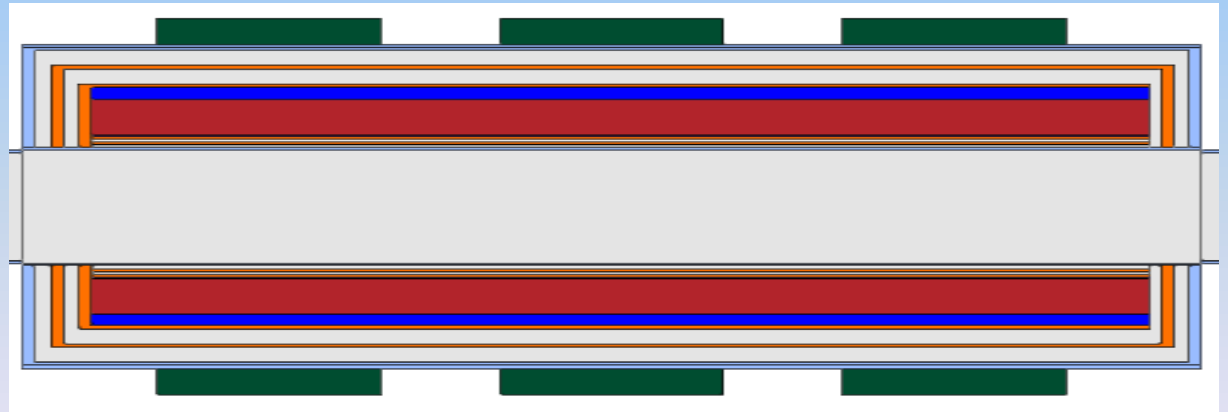
Neutron energy deposit for electronic components (20Ne (14 MeV/n) 5 kW)





Neutron energy deposit : Heat on superconductor elements (20Ne (14 MeV/n) 5 kW)





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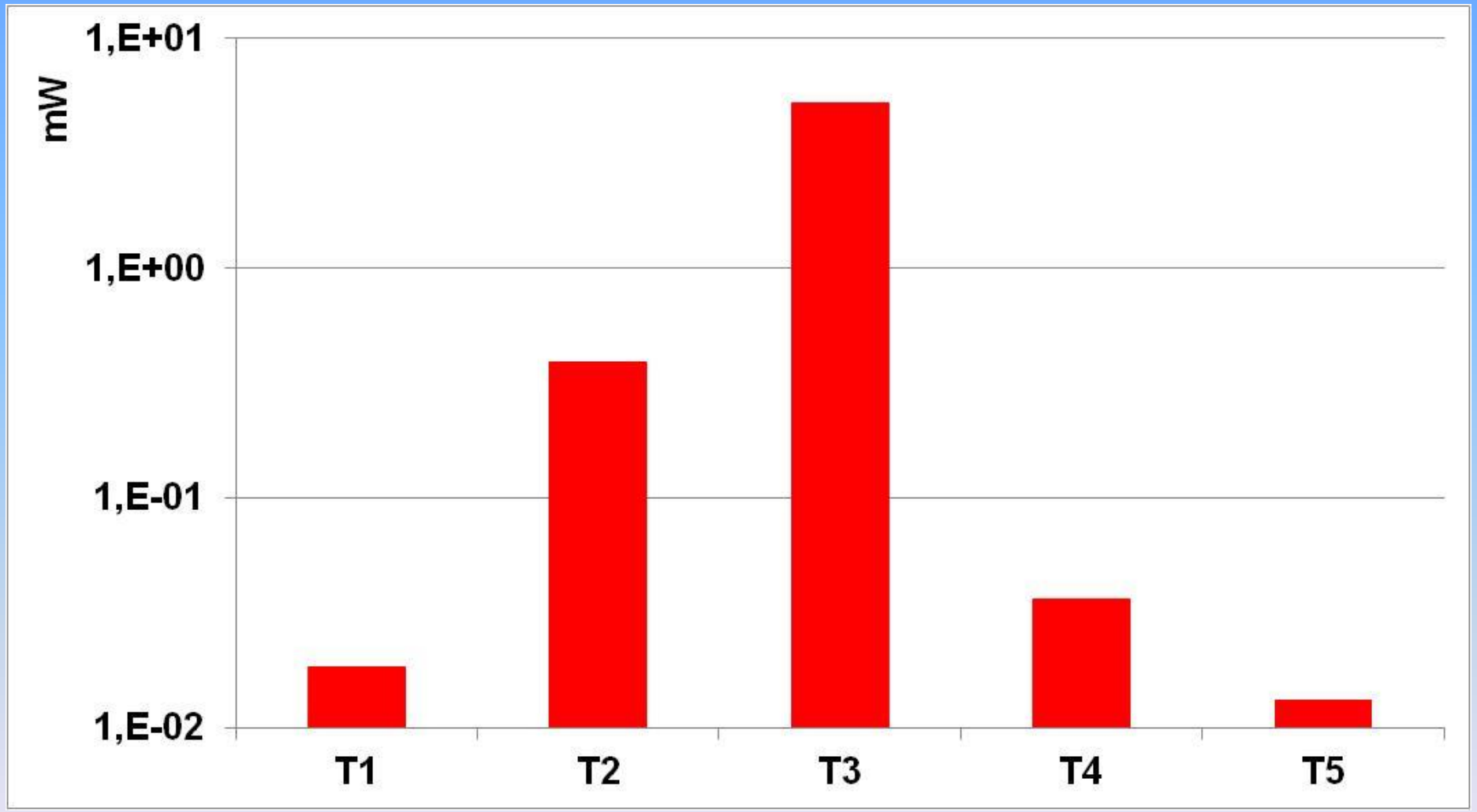
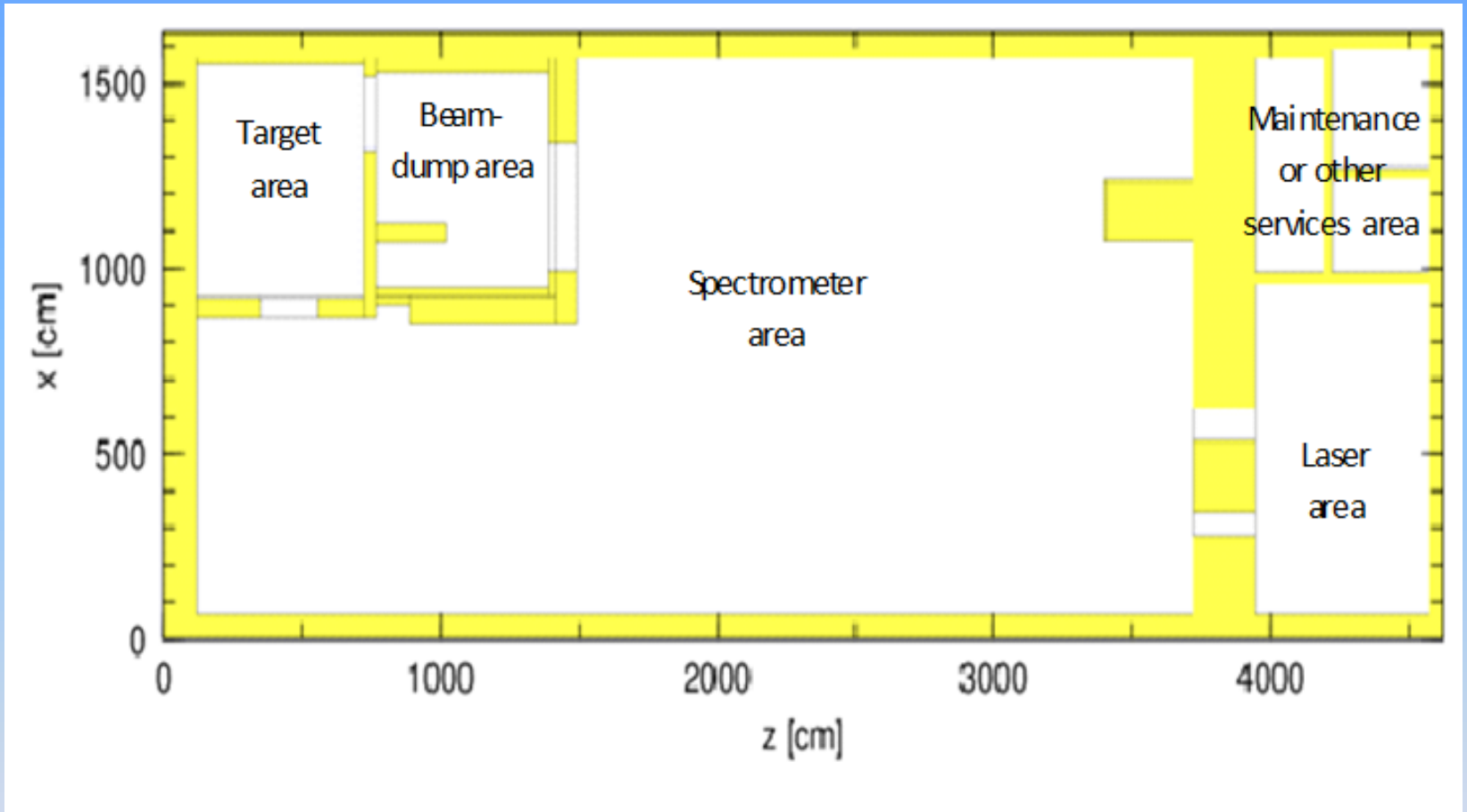


Neutron dose equivalent : 45 kW of 12C (15 MeV/n)

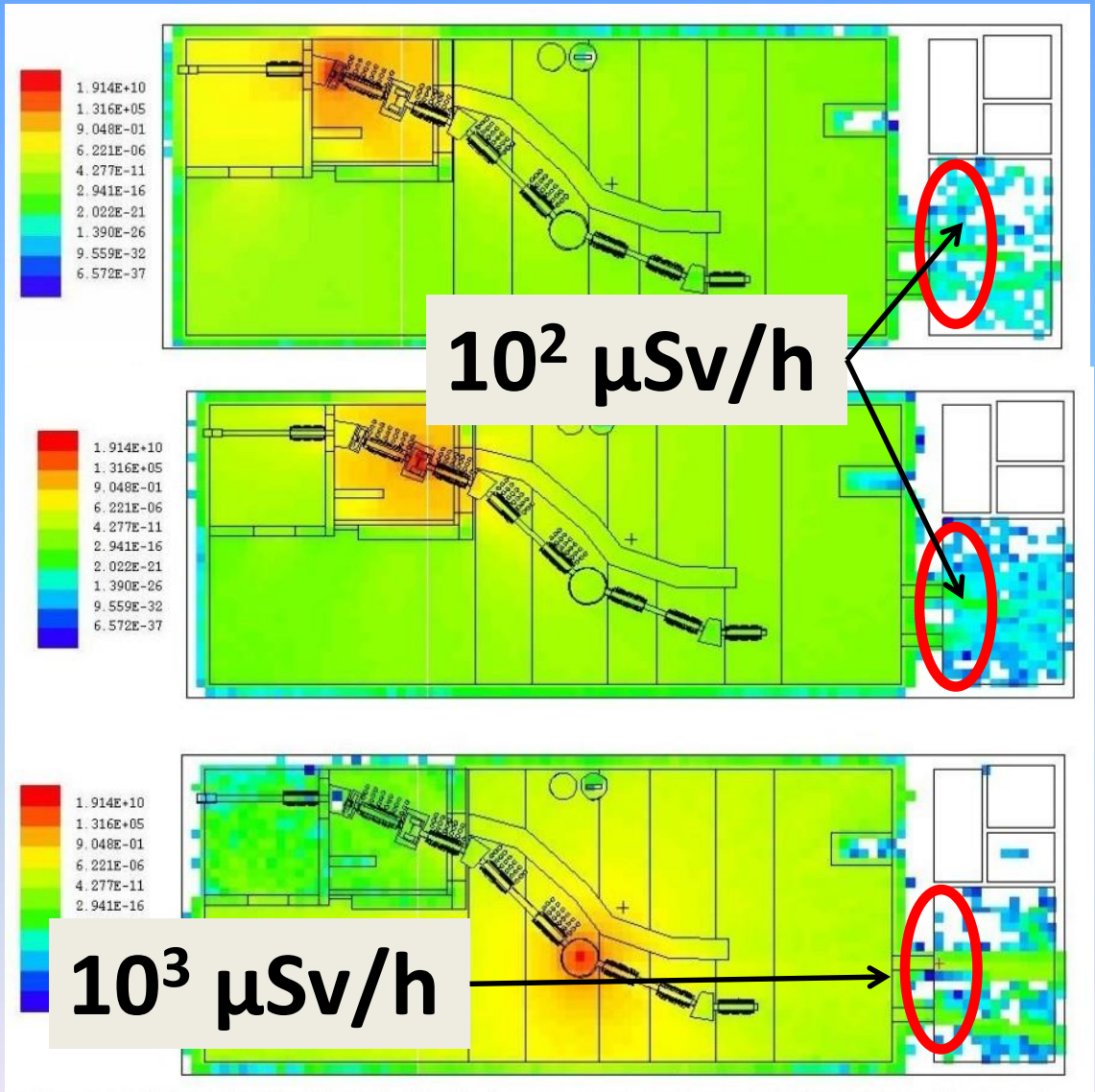


Neutron dose equivalent : 45 kW of 12C (15 MeV/n)

1st beam-dump : 45 kW

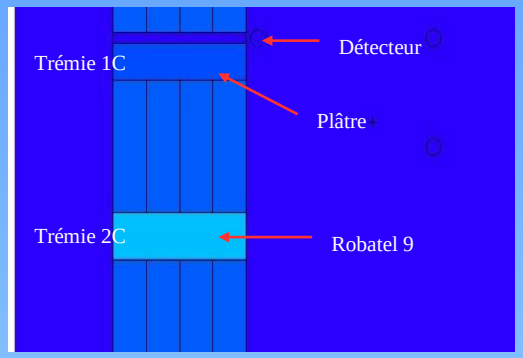
2nd beam-dump : 45 kW

VC : 100 W

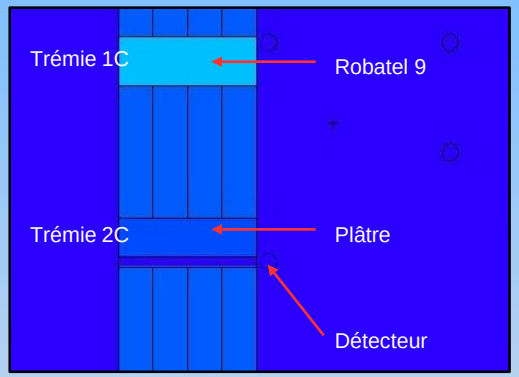


Neutron dose equivalent : 45 kW of 12C (15 MeV/n)

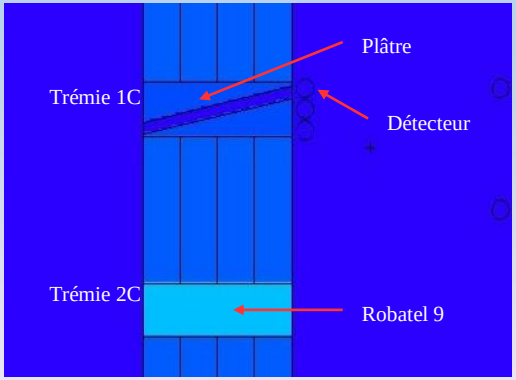
Present configuration



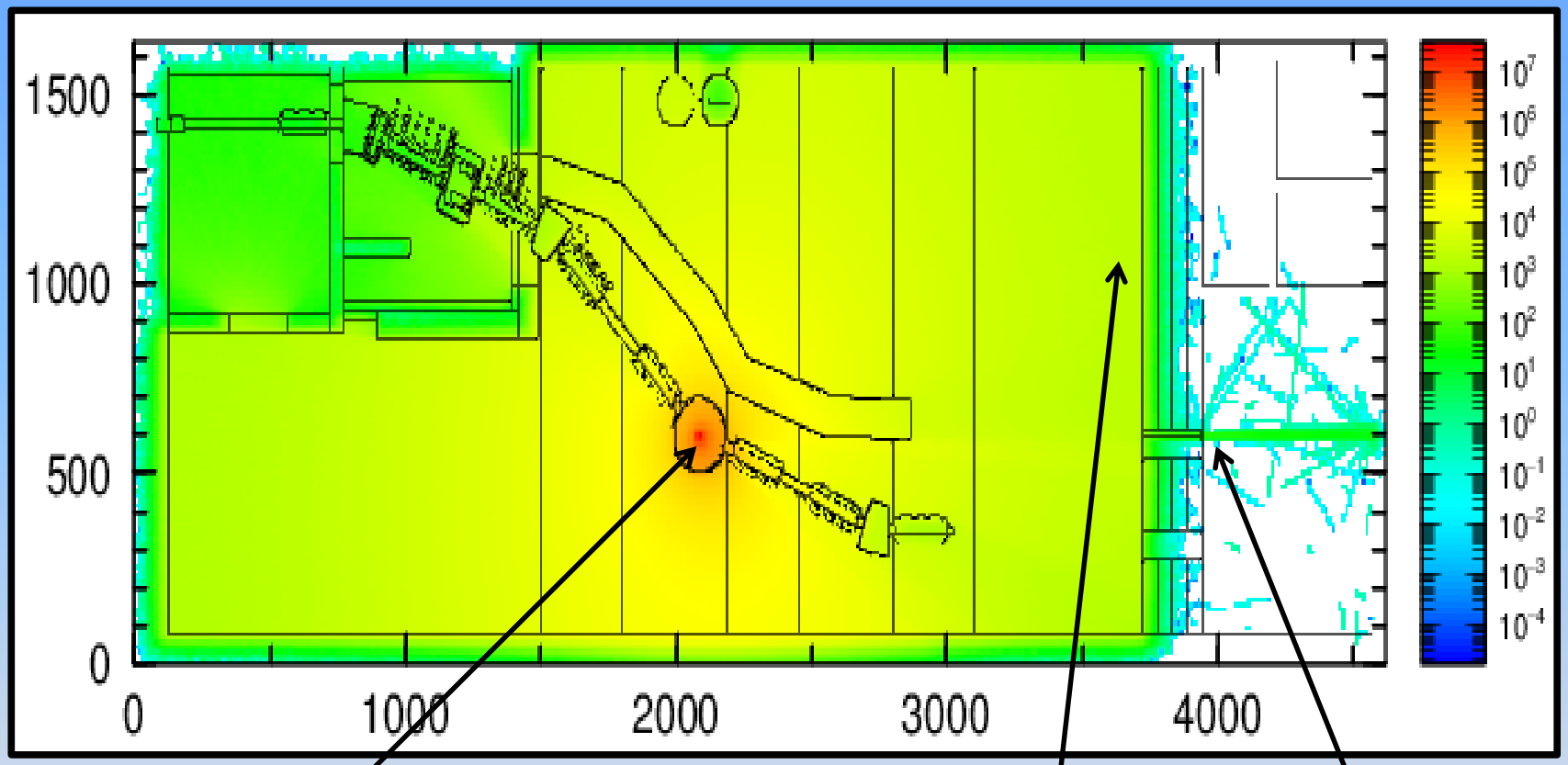
1st configuration



2nd configuration



Neutron dose equivalent : 45 kW of 12C (15 MeV/n)

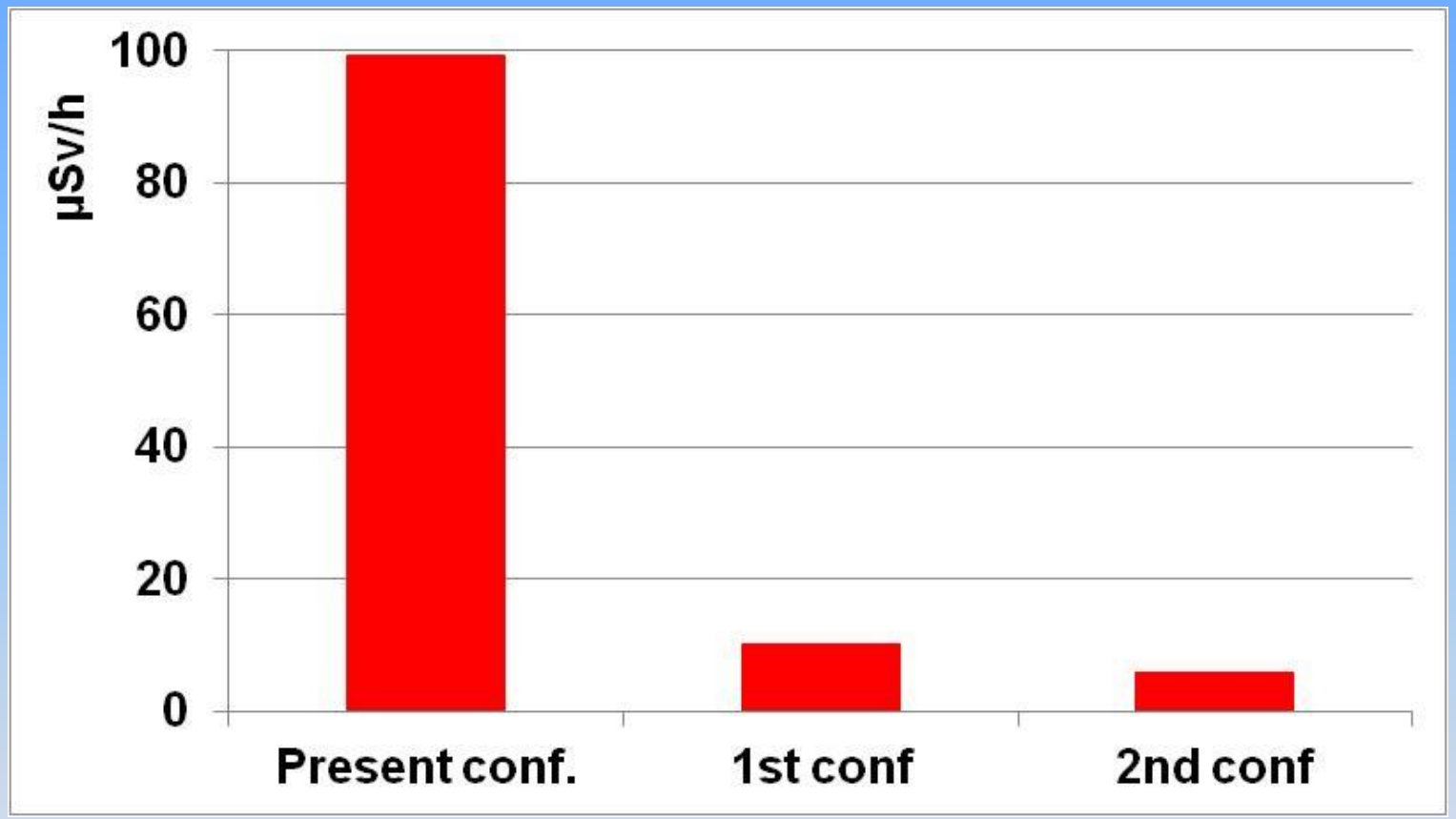


10^7 µSv/h

10^4 µSv/h

10^2 µSv/h

Neutron dose equivalent : 45 kW of 12C (15 MeV/n)



Conclusion

- **20Ne (14 MeV/n) : enveloppe beam for secondary particles, especially neutrons**
- **PHITS : more adapted to S3 nuclear reactions simulations**
- **Few arrangements still needed in S3 building (Laser aeras)**
- **Environment very hostile for electronic components**