# Targets for Photonuclear Applications

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- **Photofission work at CEA**
  - # **Basic Physics and Applications;**
  - # **An example : The SPIRAL II photofission target**
  - # **Thermal Calculation: Radial & Full 3D**
- **First results on a RACE type target**

# Photofission Work at CEA

## ➢ Basic Nuclear Physics

Photonuclear reactions;
Prompt neutrons and gamma;
Fission products;
Delayed neutrons and gamma;
Implement database in transport codes;

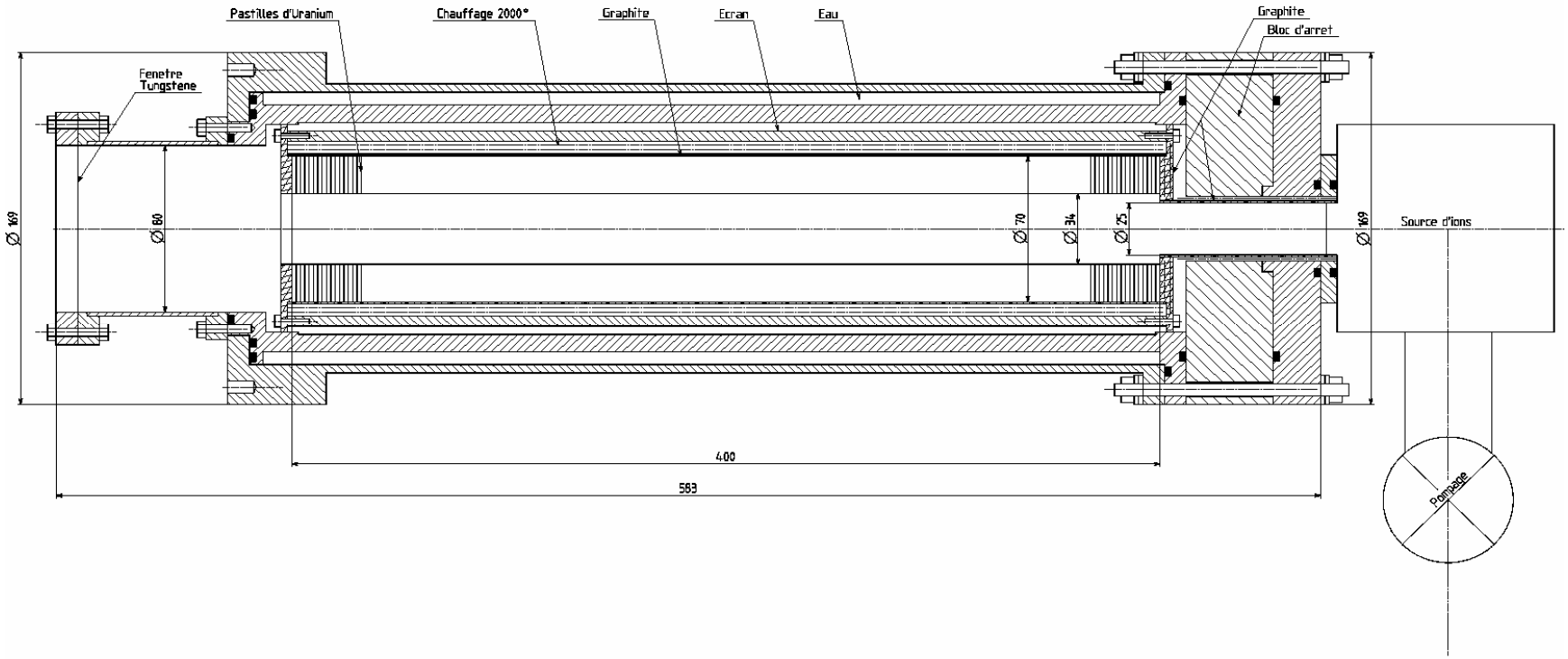
## ➢ Applications

Radioactive Isotopes Generation;
Non-Destructive Nuclear Waste Management;
Detection of Nuclear Matter;
“Mini-Irradiator”;
Beta Compensated Reactor;

# Design of a Photofission Target

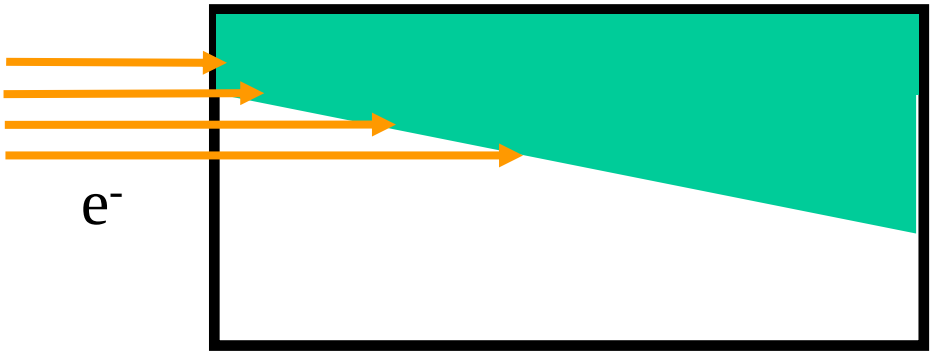
- **Nuclear Calculation**
  - Neutron Rate
  - Radiation
- **Radioprotection Calculation**
  - Radioactive Ion Production
  - Decay with time (disposal)
- **Thermal/Mechanical Calculation**
  - Beam impact
  - Working Temperature
  - Stress induced
- **Technology**
  - Target material
  - Heat removal
  - Assembly & Test

# An example : The SPIRAL II Photofission Target



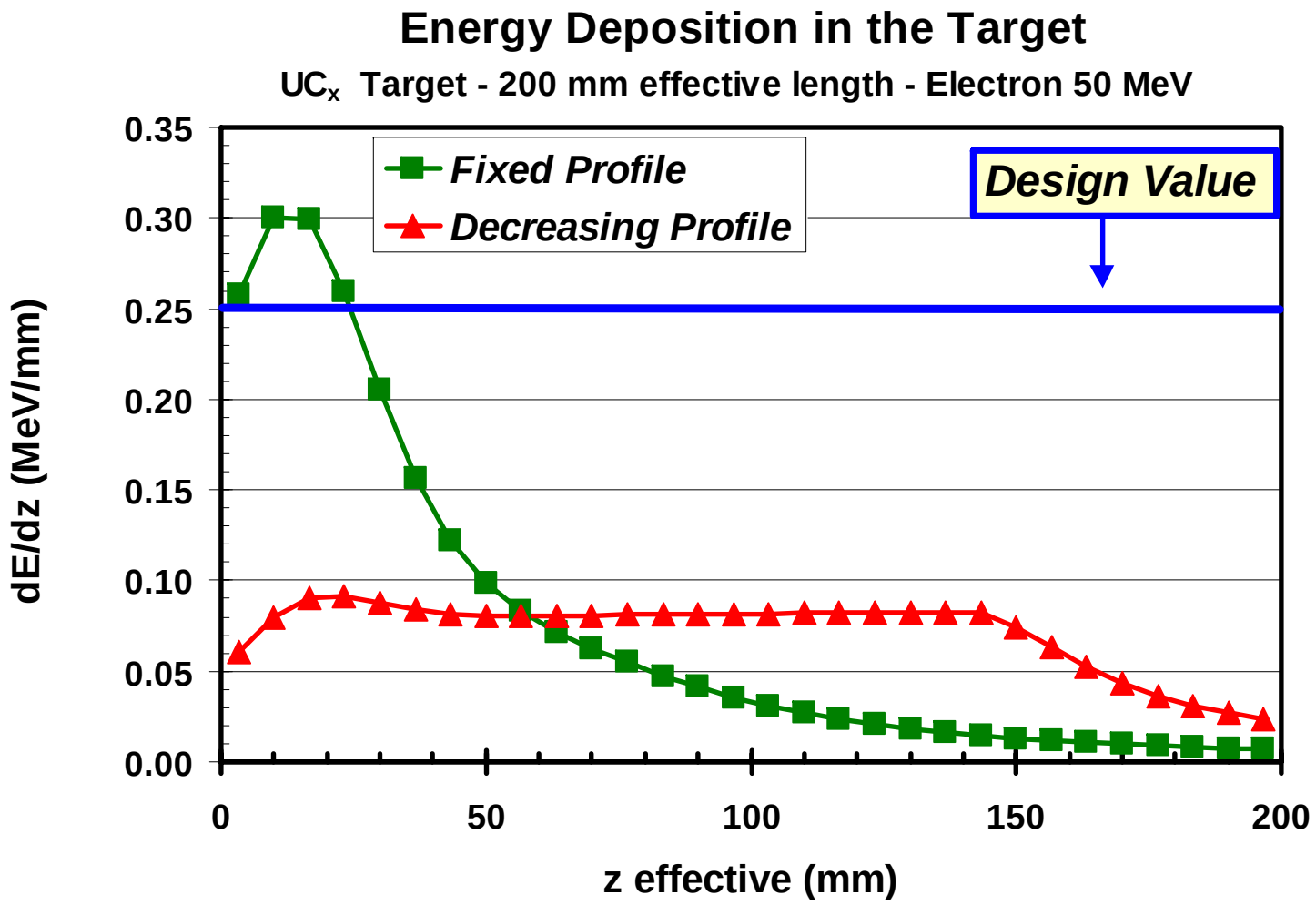
## Thermal : Deposited Heat


**Uniform Target**

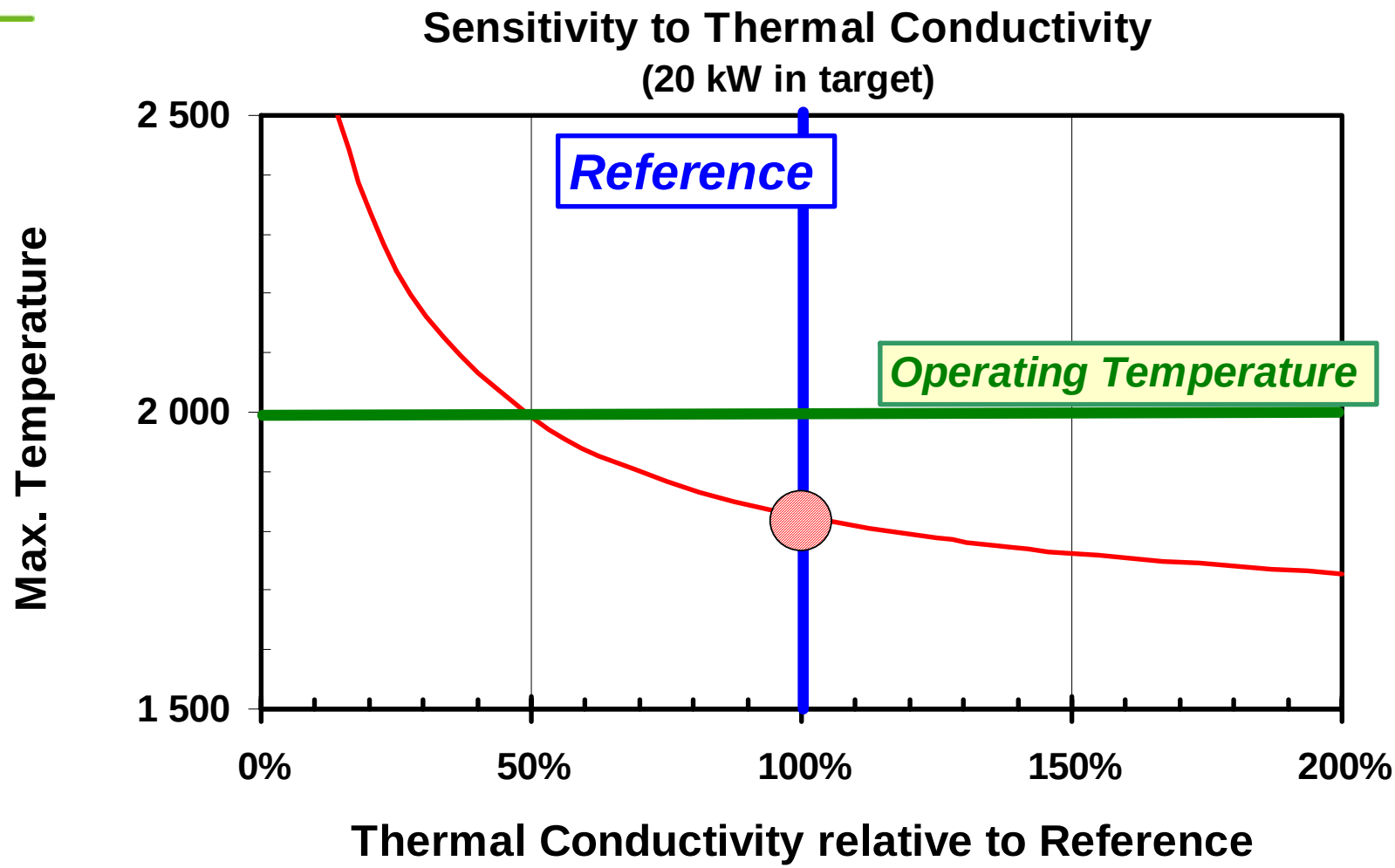



**Graded Target**

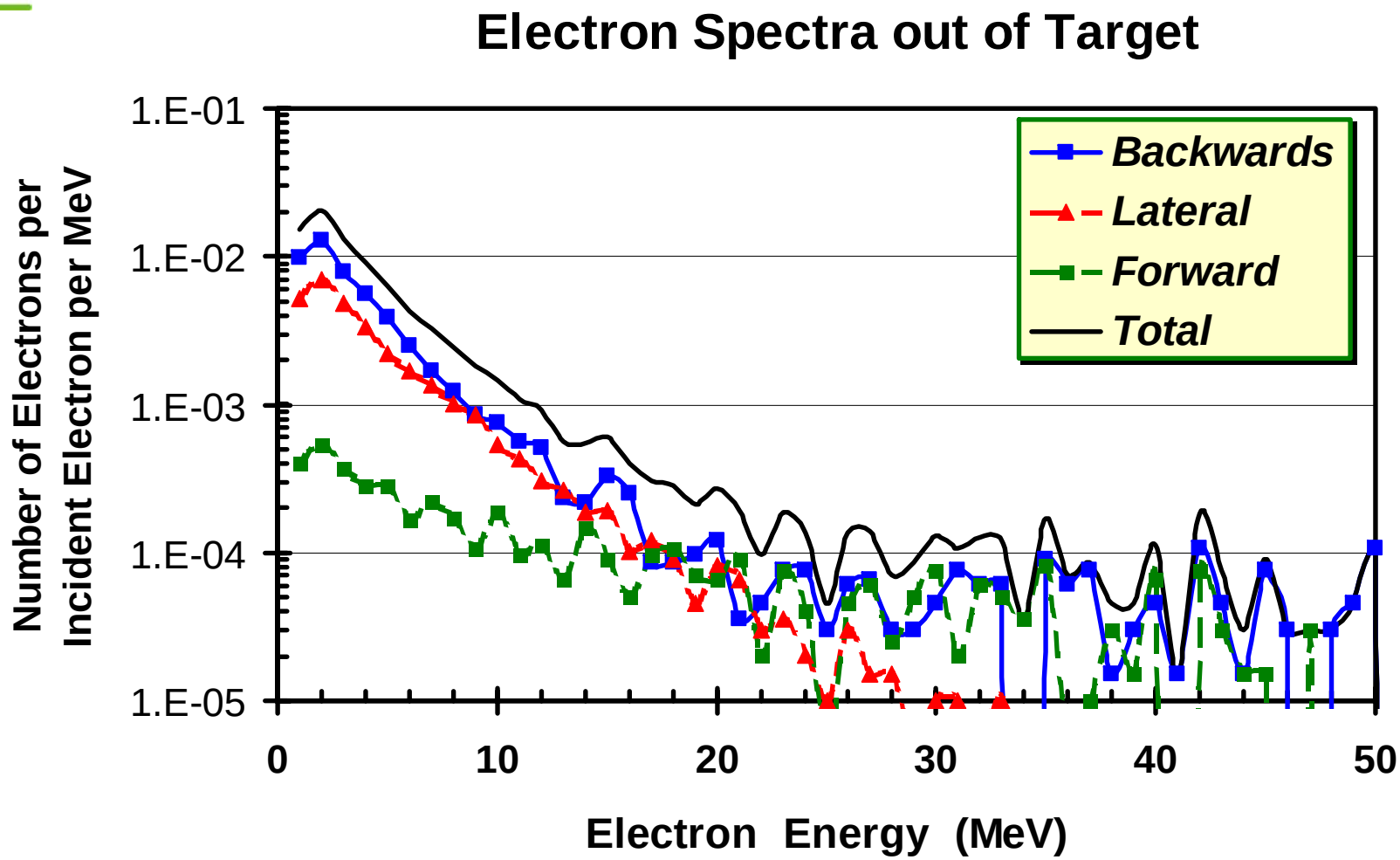
# Thermal Issue



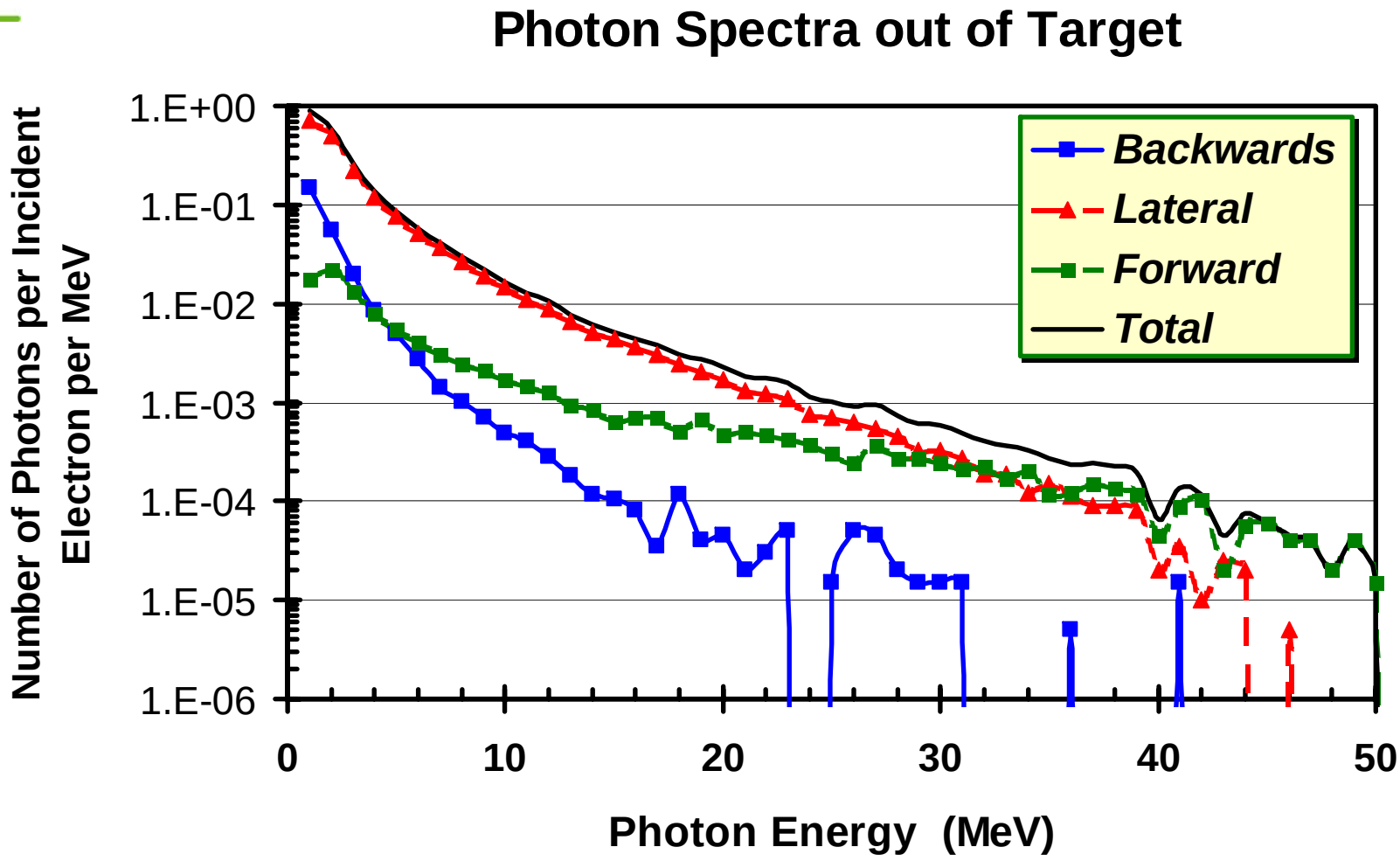
# Target Thermal Analysis



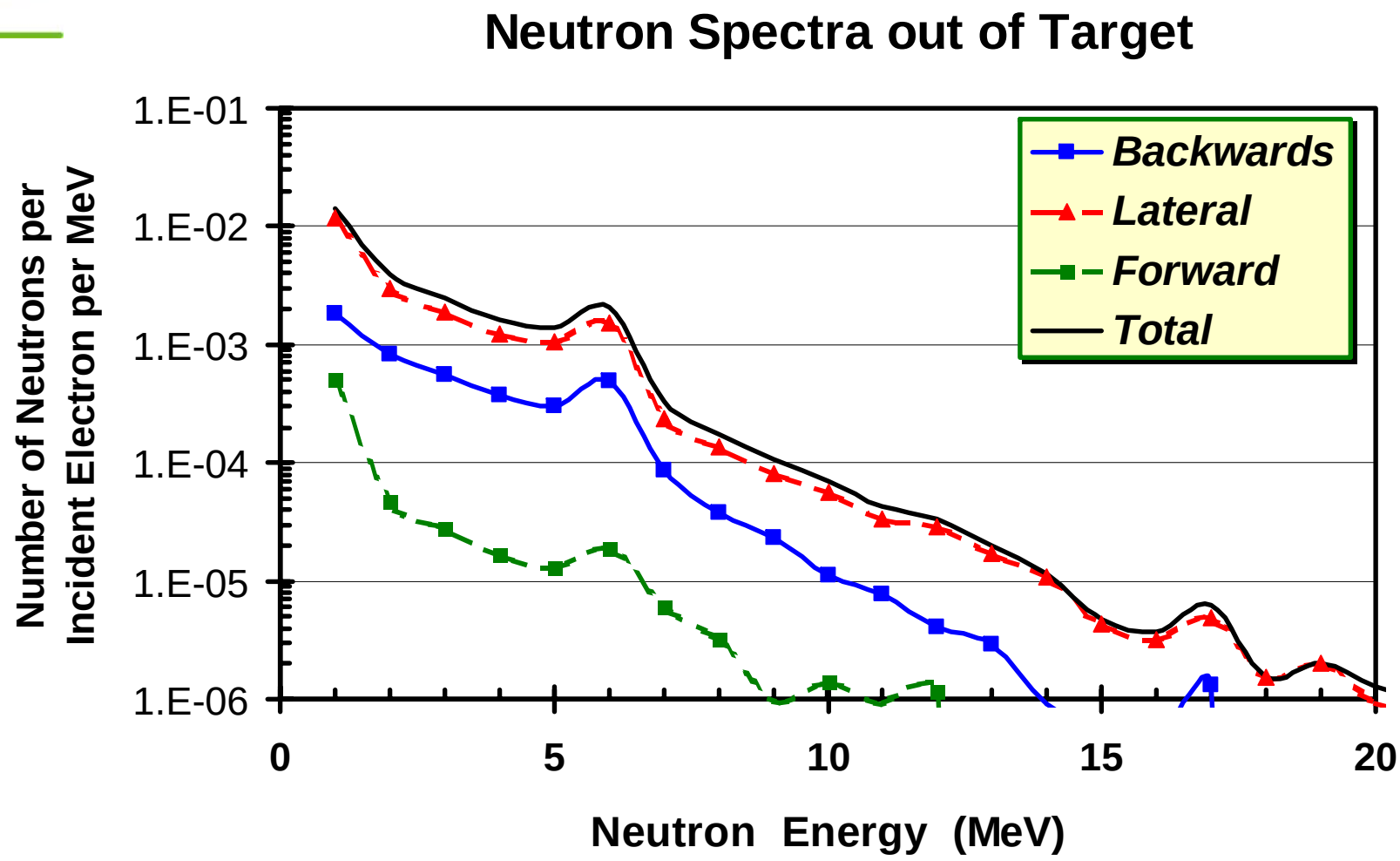
# Radiation


Electron Spectra out of Target
Number of Electrons per Incident Electron per MeV
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
0
10
20
30
40
50
Electron Energy (MeV)
Backwards
Lateral
Forward
Total

# Radiation


Photon Spectra out of Target
Number of Photons per Incident Electron per MeV
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
0
10
20
30
40
50
Photon Energy (MeV)
Backwards
Lateral
Forward
Total

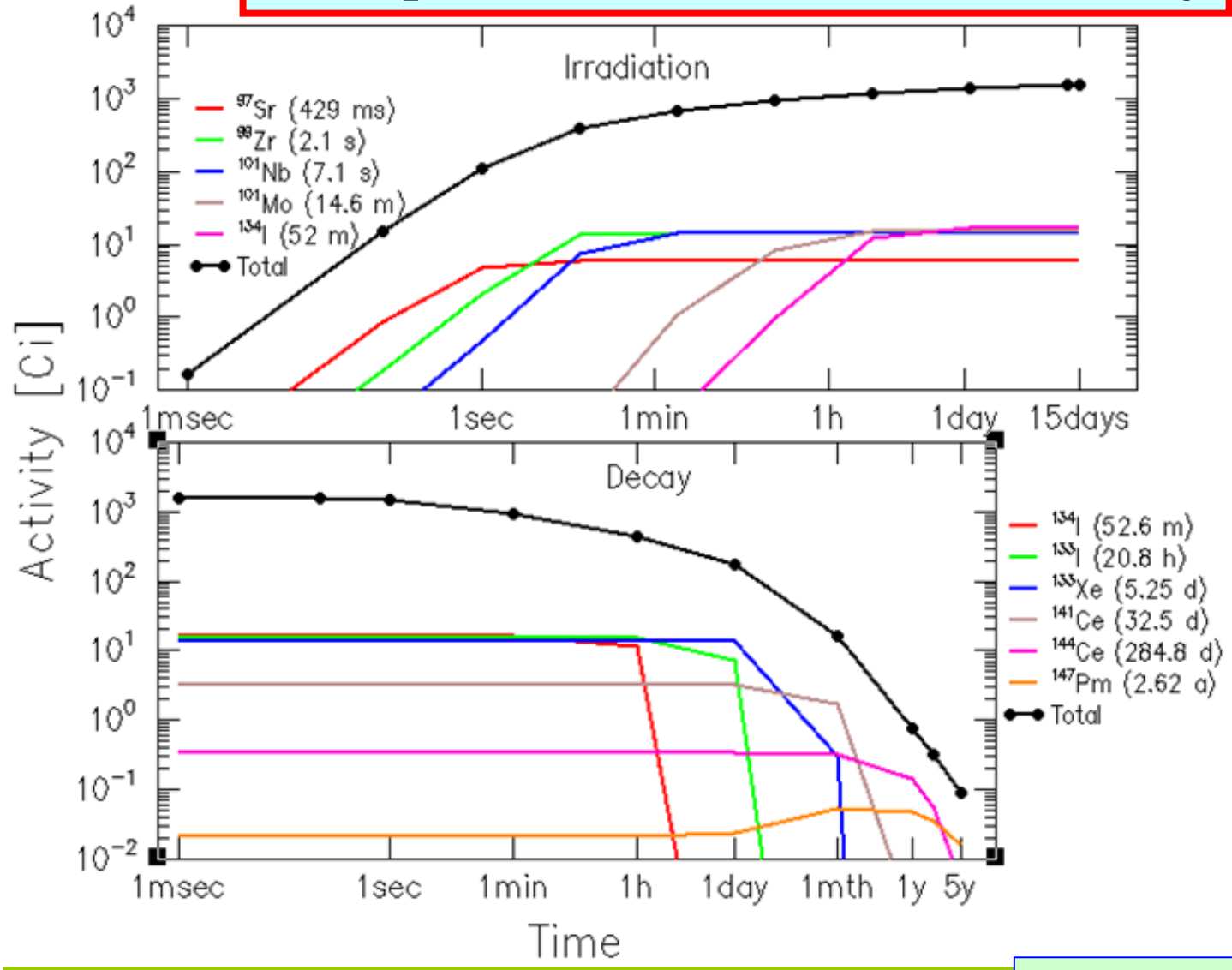
# Radiation


Neutron Spectra out of Target
Number of Neutrons per Incident Electron per MeV
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
0
5
10
15
20
Neutron Energy (MeV)
Backwards
Lateral
Forward
Total

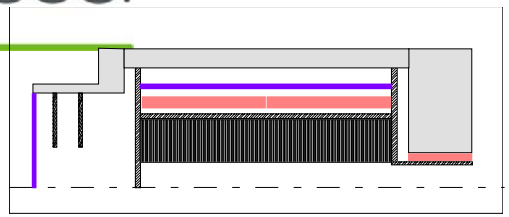
# Energy Balance

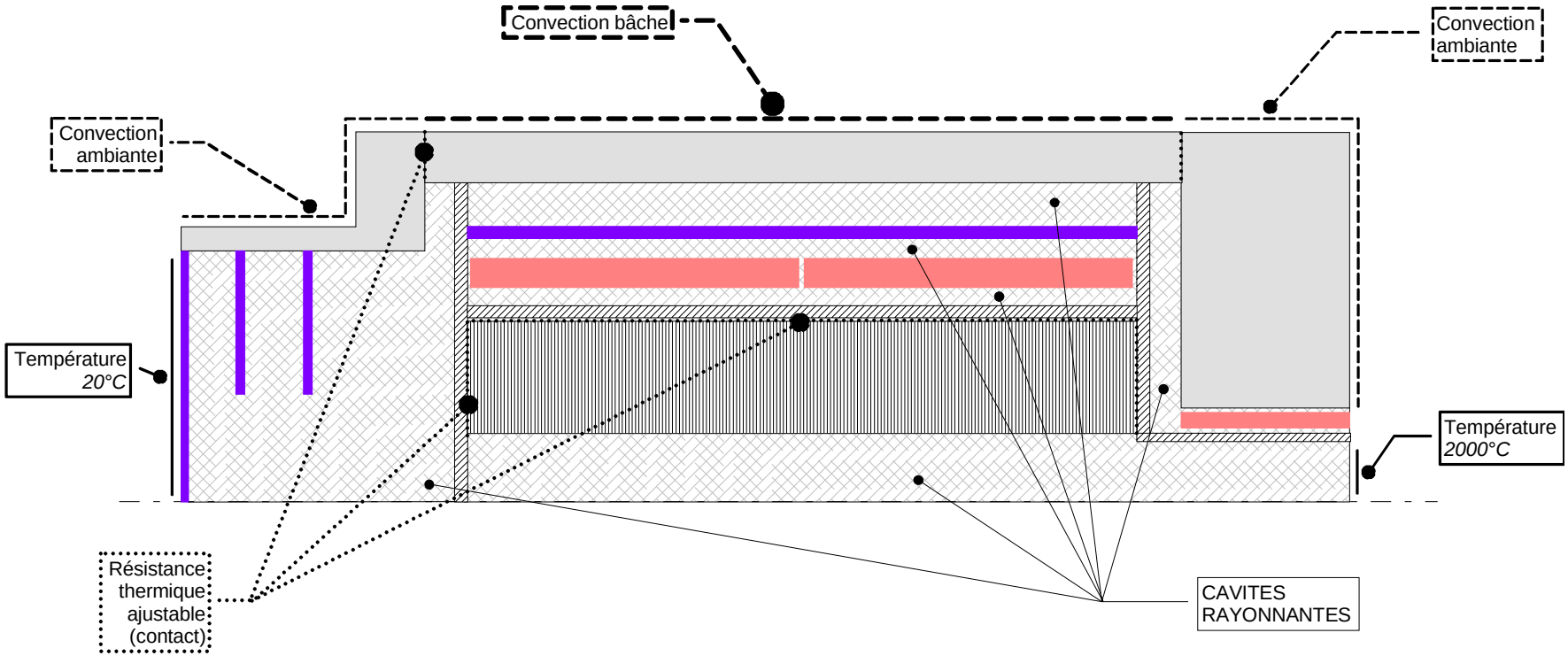
| ENERGETIC BALANCE (in MeV) | | | |
|---|---|---|---|
| | | | |
| INPUT | Electron | 50.00 | |
| | Fission | 0.72 | |
| | Total | | 50.72 |
| | | | |
| LOSS | Target | 23.94 | |
| | Structure | 19.12 | |
| | Dump | 2.05 | |
| | Total | | 45.11 |
| | | | |
| OUTPUT | Gamma | 5.22 | |
| | Electron | 0.39 | |
| | Neutron | 0.05 | |
| | Total | | 5.66 |

# Radioprotection : Induced Radioactivity

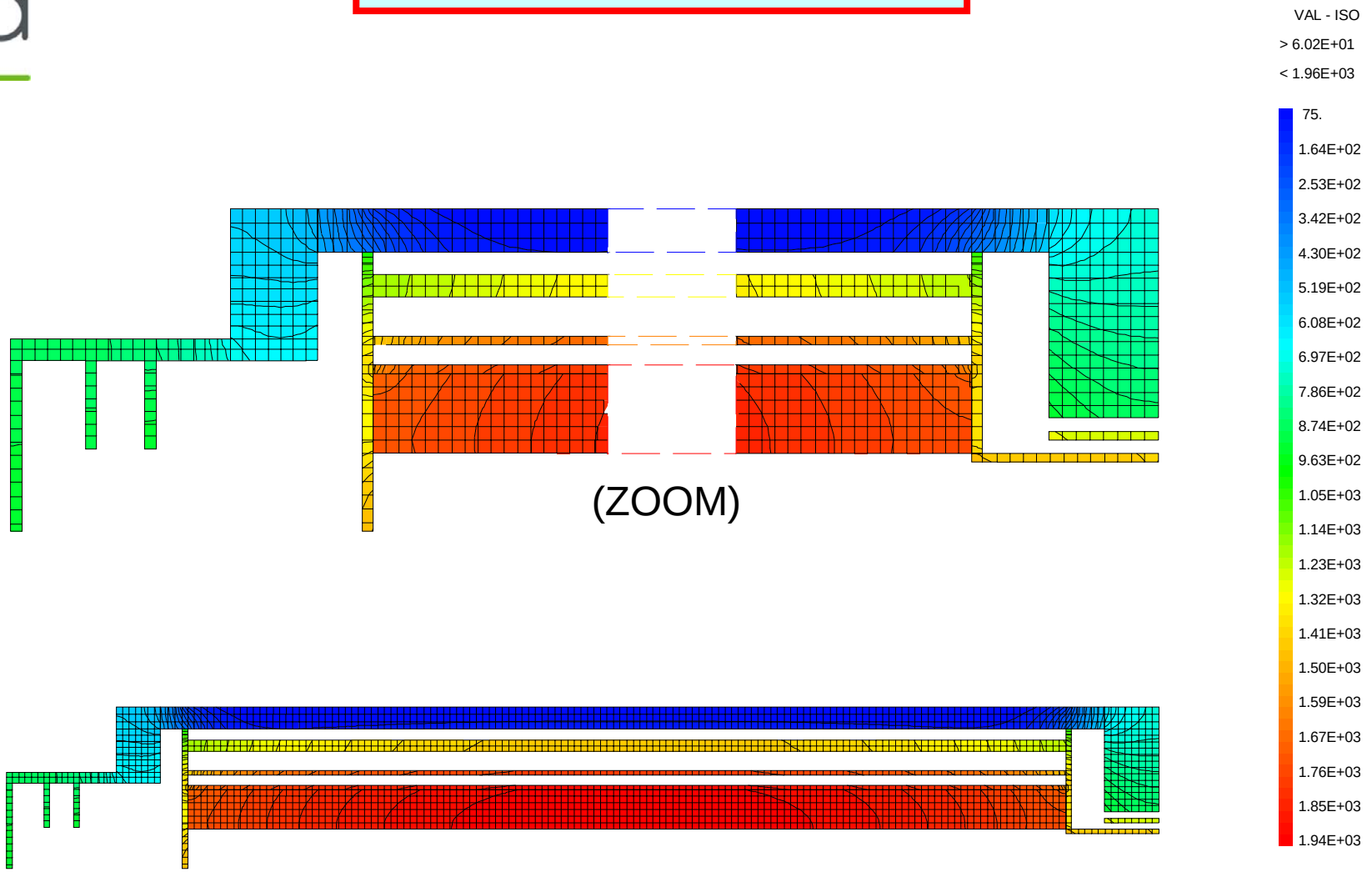


# Target Thermal Analysis



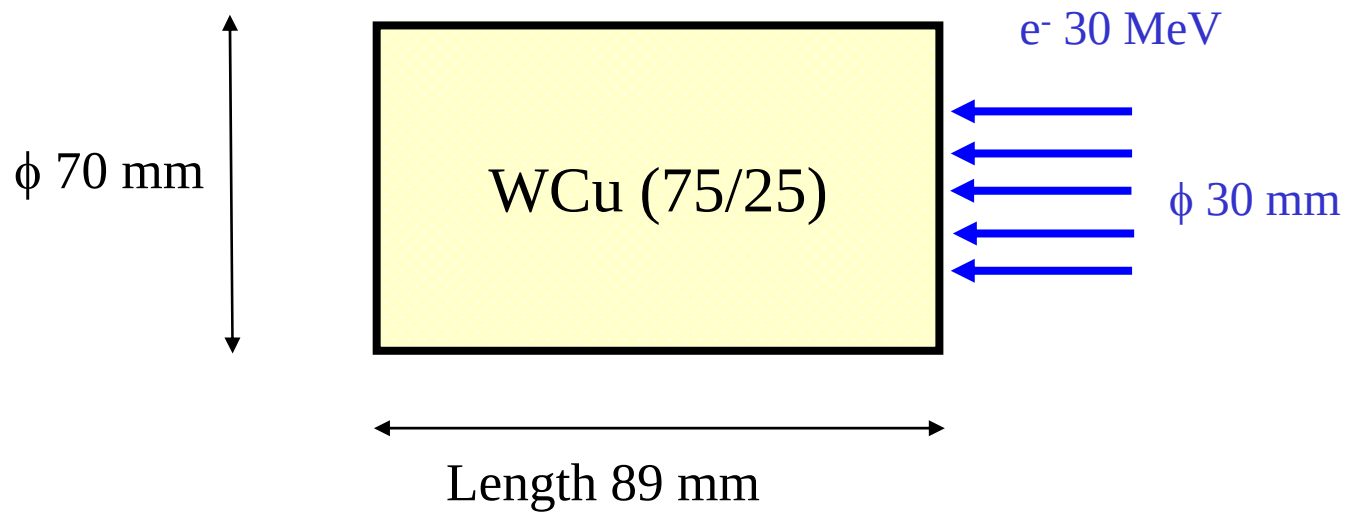


# Target Thermal Analysis



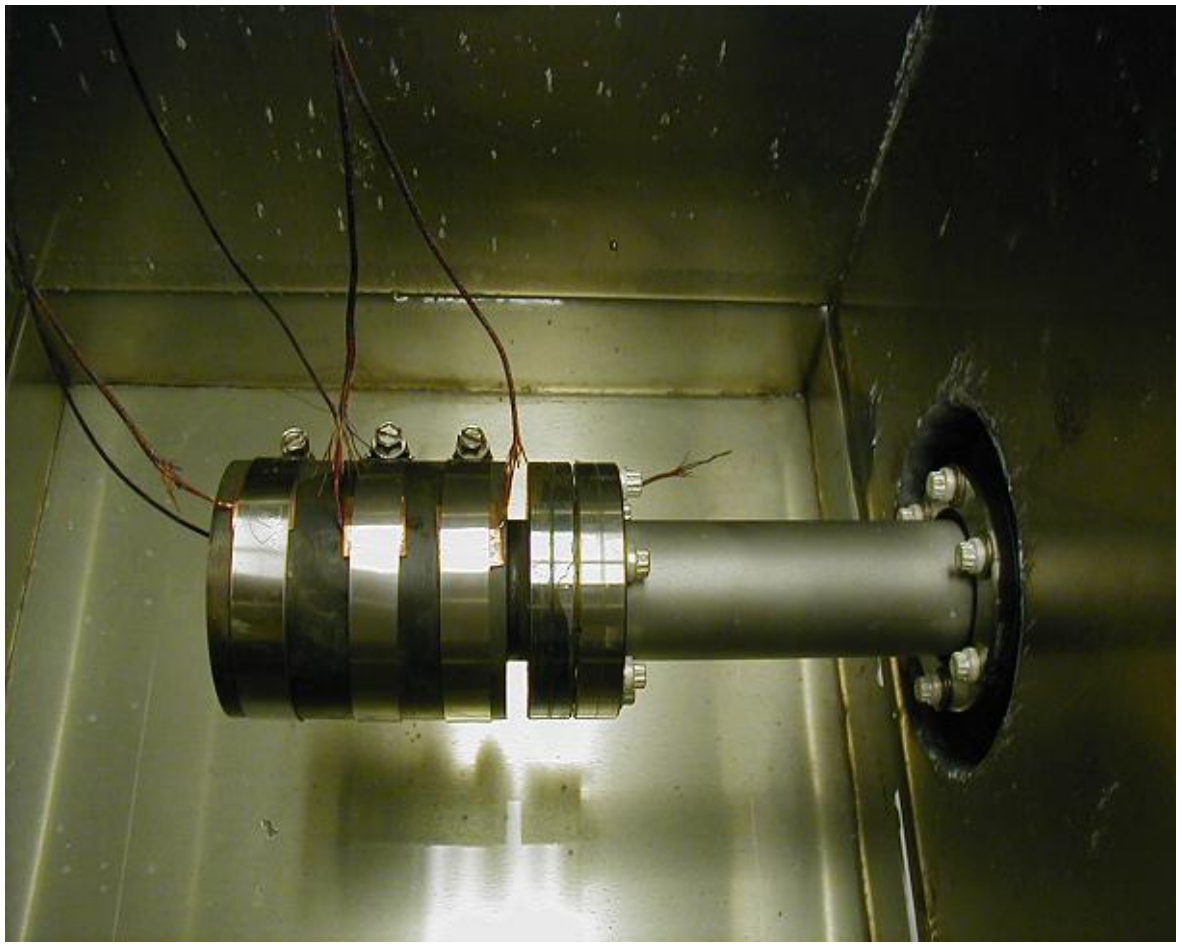
# First Results on a simple Target

**Geometry : Plain cylindrical target**

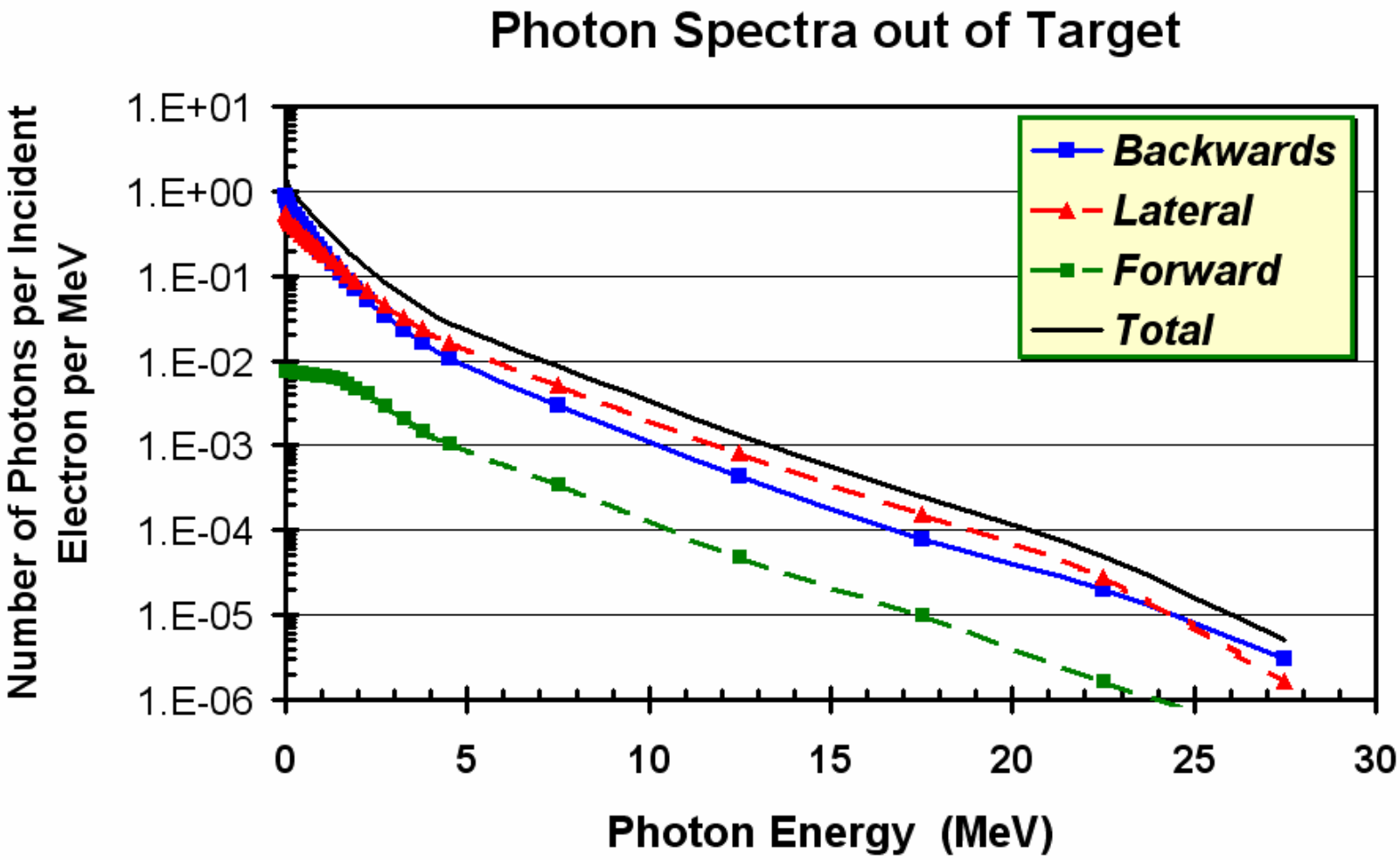


# The first RACE Target

**Actual target (from ISU) :**



## First Results on a RACE type target



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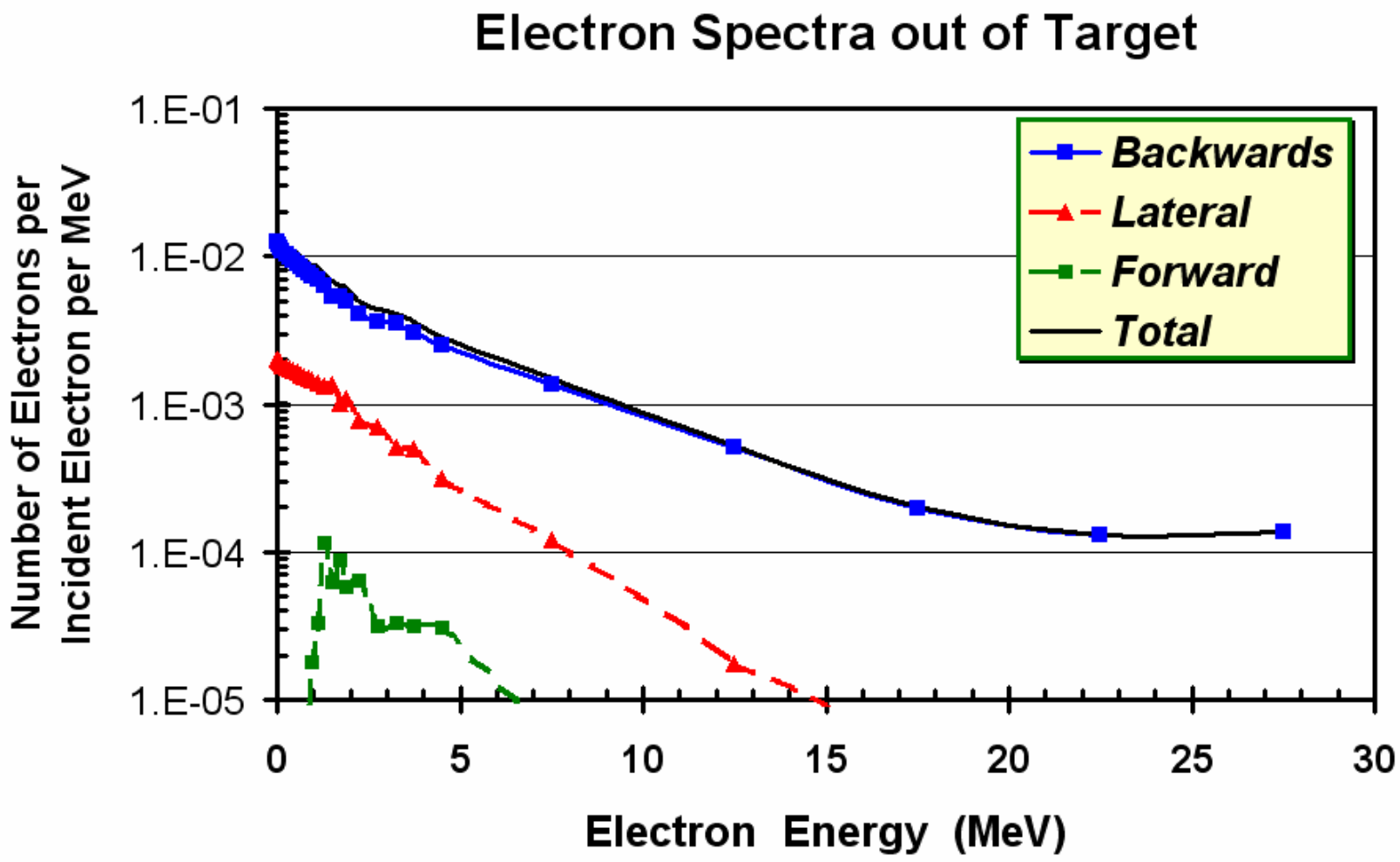

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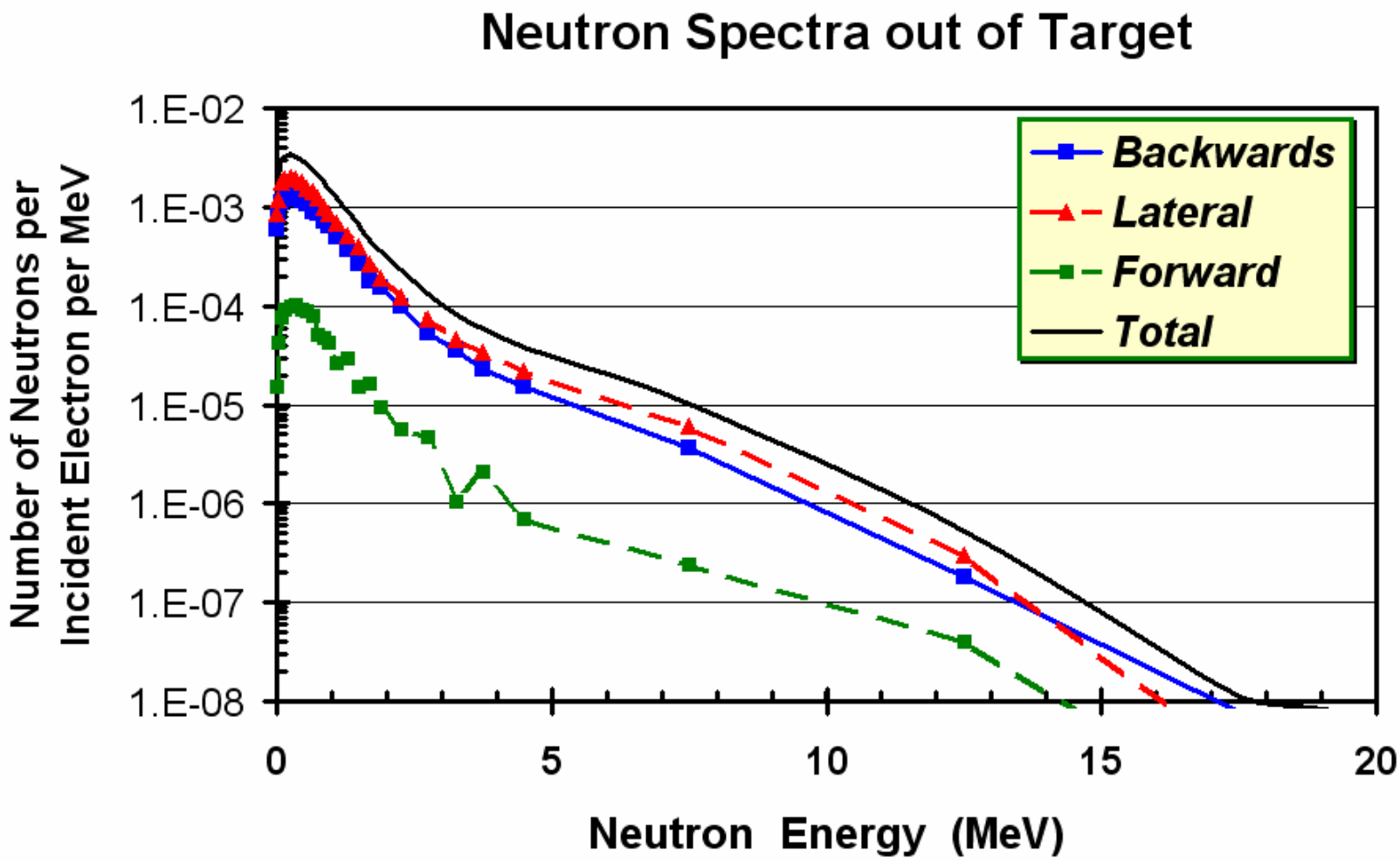

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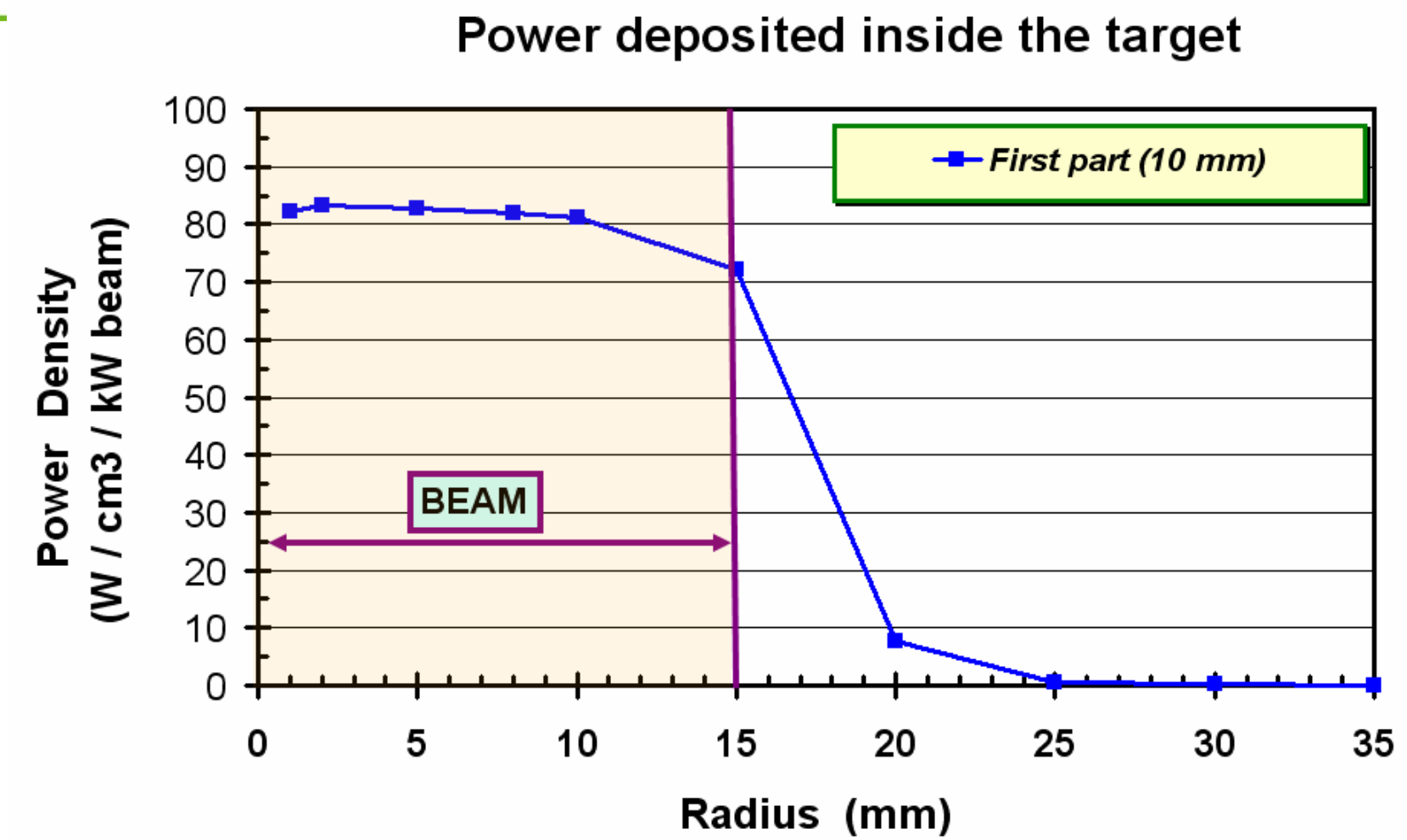

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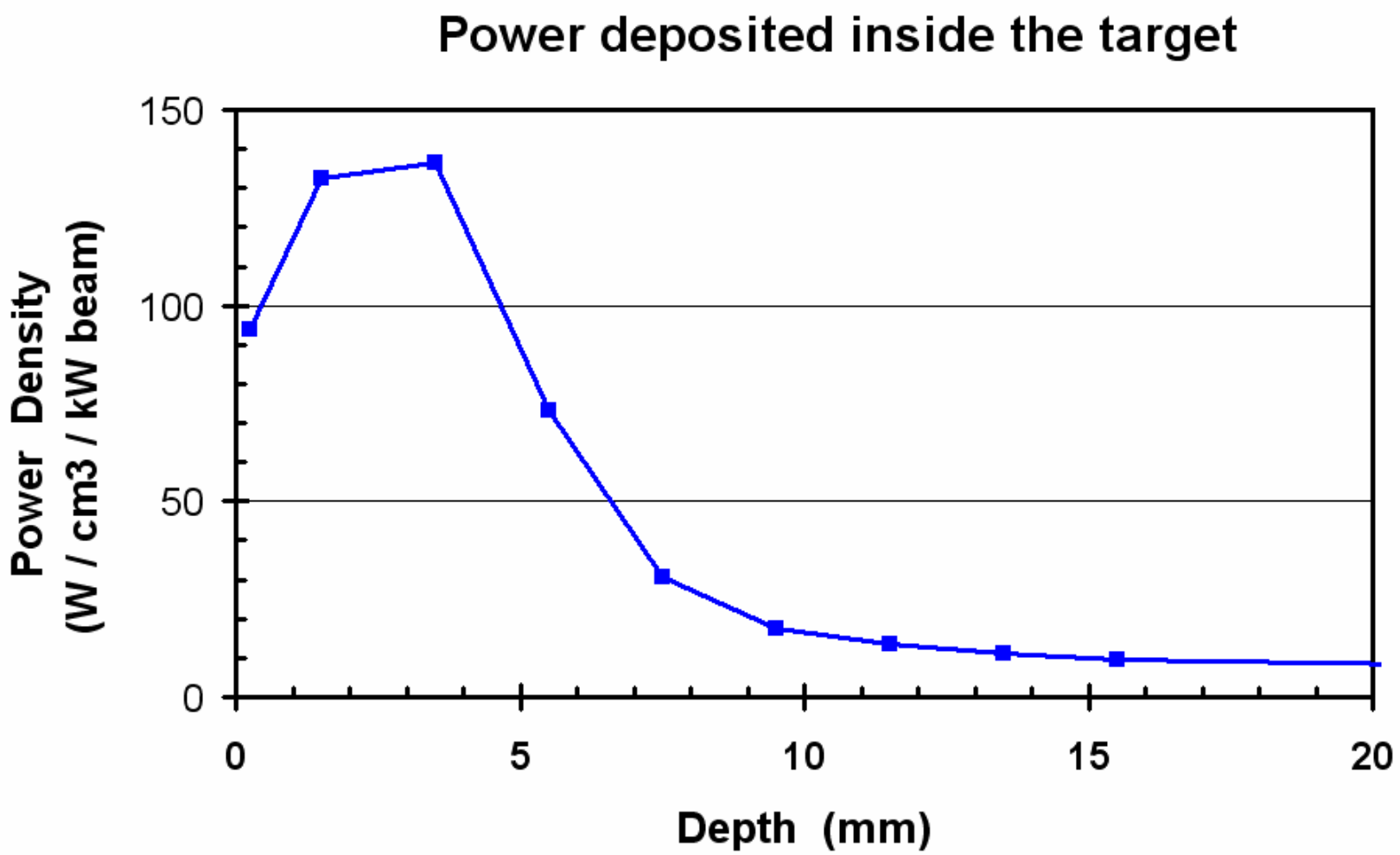

# CONCLUSIONS

**Existing simulation tools at CEA well adapted to photonuclear reactions**

- Neutronics Code
- Radiation from target (electrons, photons, neutrons)
- Energy and Power Loss
- Thermal calculation

**Use as an input for thermo-mechanical calculations (Cécile KRAKOWIAK)**

**Improvements can be proposed in the frame of the EUROTRANS/ECATS**

- Optimization of the WCu target geometry;
- Optimization of other targets (e.g. U)
- Neutronics, thermal, radioprotection, experimental contribution