Simulation of Bremsstrahlung Photon Yield at Turkish Accelerator and Radiation Laboratory at Ankara) TARLA

NİLGÜN DEMİR
Uludag University
Turkey

03-09 Oct.2010
1st Advanced course and Workshop on FLUKA

Outline

- **TAC project**
  - Component of TAC
  - (TARLA) Facility
  - What is the Bremsstrahlung
- **Simulations with FLUKA**
  - Simulating Tools and Parameters at the Bremsstrahlung Facility
  - Results
  - Future plans and conclusion

Turkish Accelerator Center
TAC

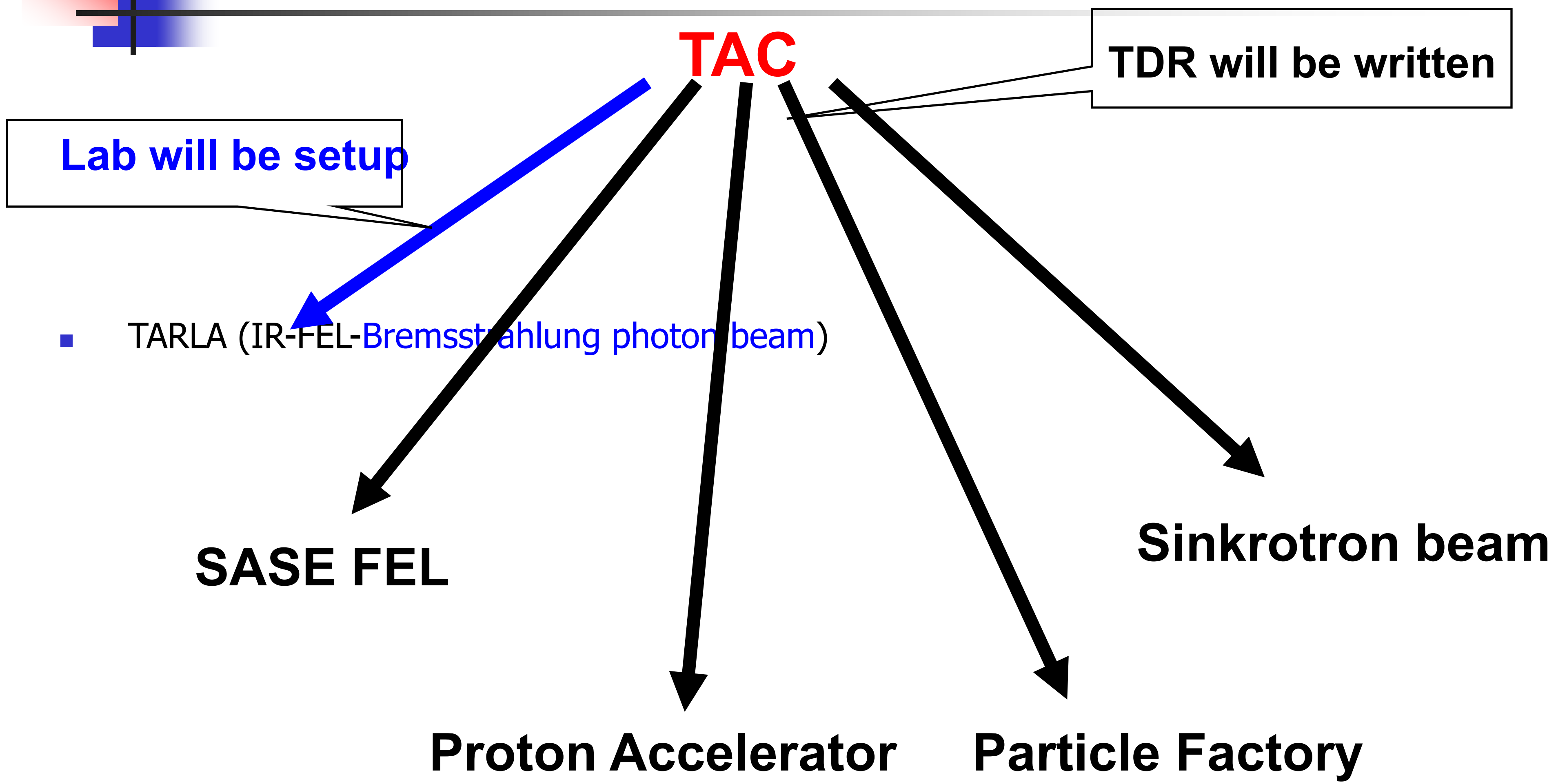
- First Proposed in 1997 (Feasibility was investigated)
- YUUP project started in 2006 (about 100 scientisit from 10 different University)

- TARLA (IR-FEL-Bremsstrahlung photon beam)

- (Turkish Accelerator and Radiation Laboratory at Ankara)

TAC PROJECT

- TARLA (IR-FEL-Bremsstrahlung photon beam)



TAC collaboration and project team

Ankara University (Coordinator)

Gazi University

İstanbul University

Uludağ University

Dumlupınar University

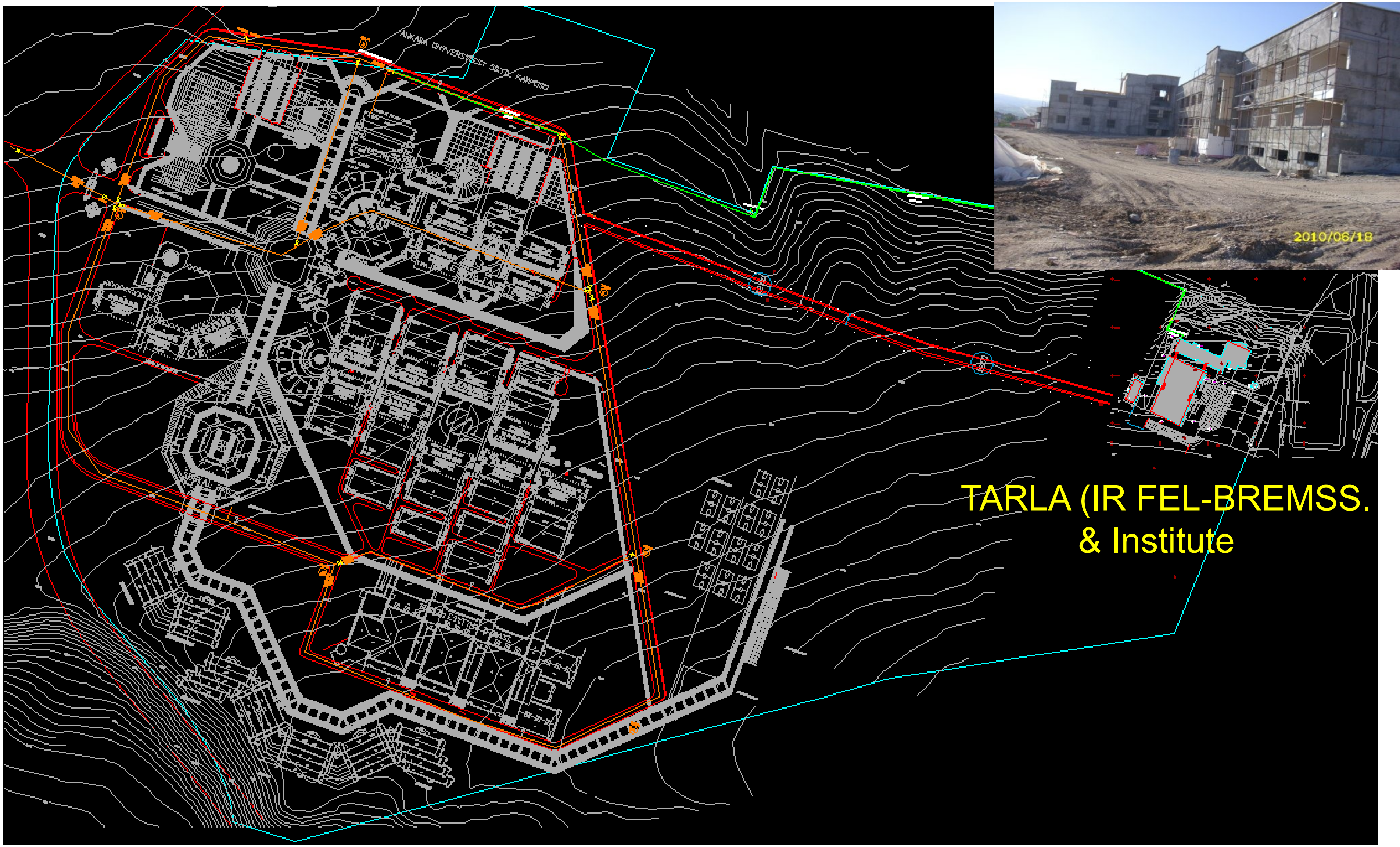
Boğaziçi University

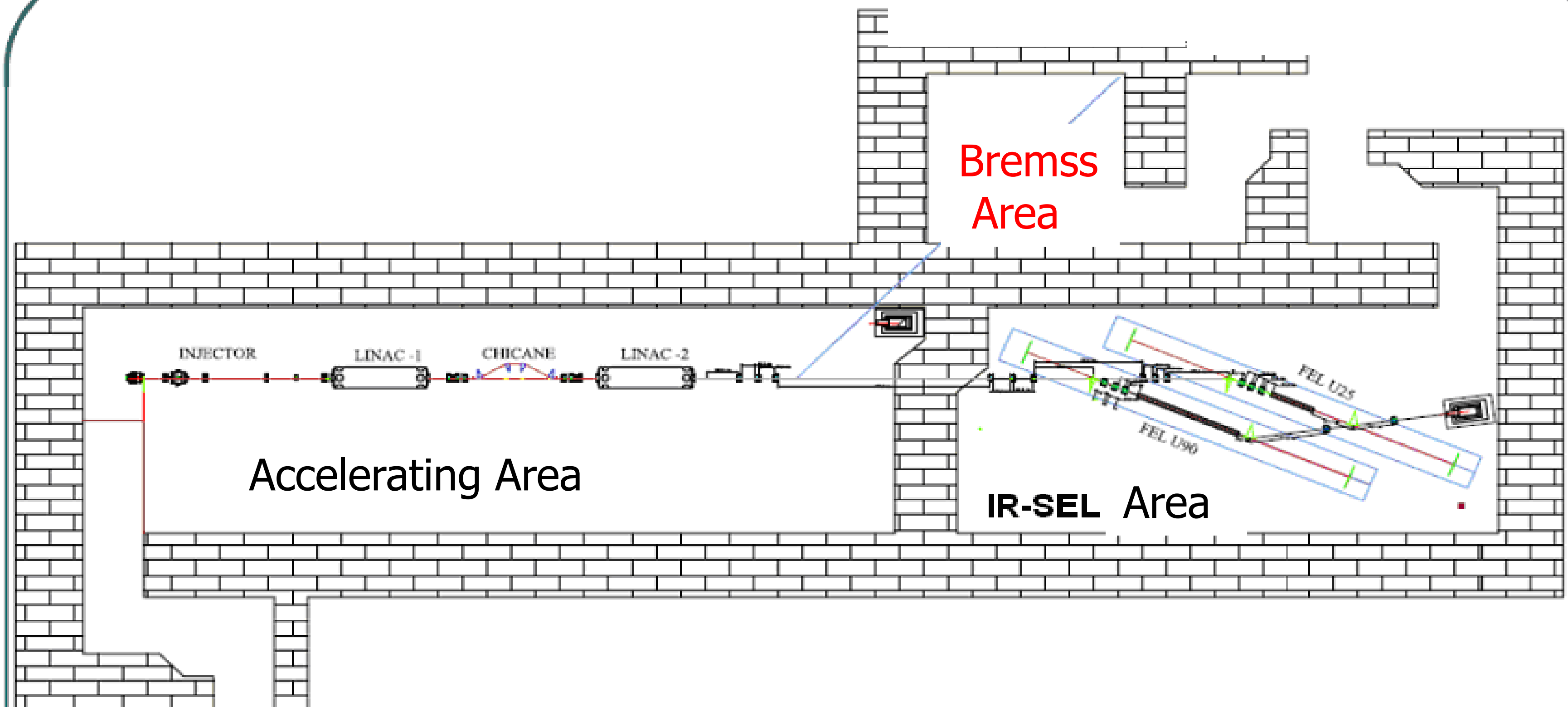
Doğuş University

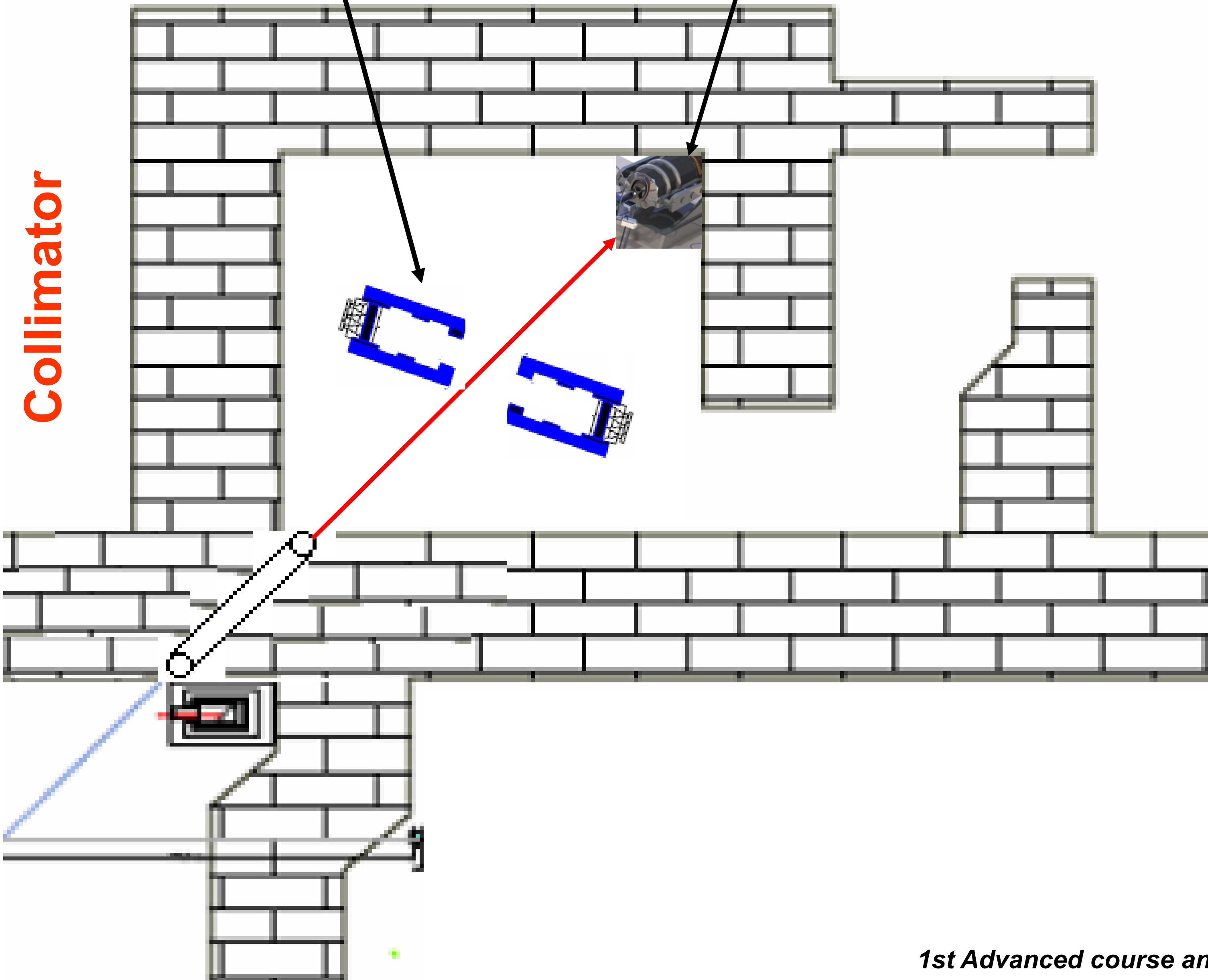
Erciyes University

Süleyman Demirel University

Niğde University


2010/06/18
TARLA (IR FEL-BREMSS.
& Institute

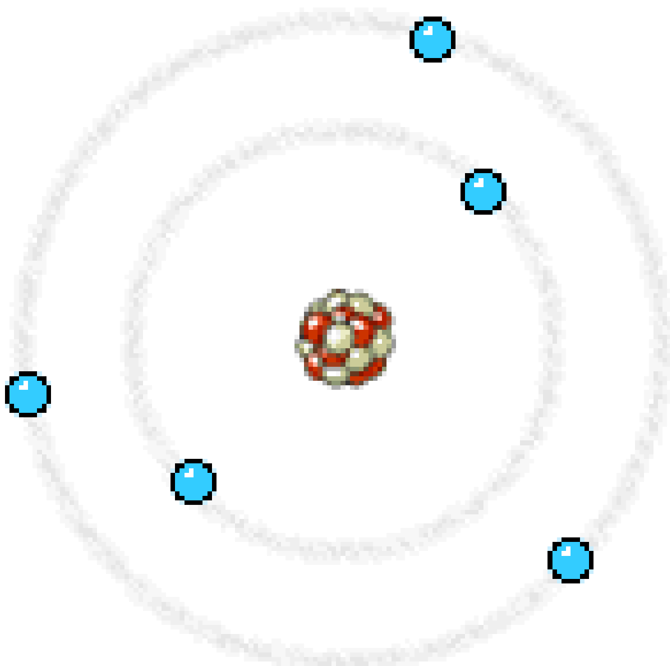

Bremss Area
INJECTOR
LINAC -1
CHICANE
LINAC -2
FEL U25
FEL U90
Accelerating Area
IR-SEL Area



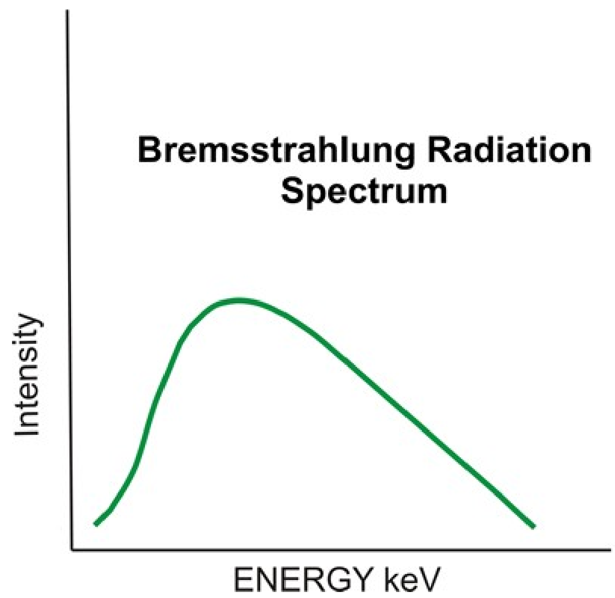
Size

6X20 m^2

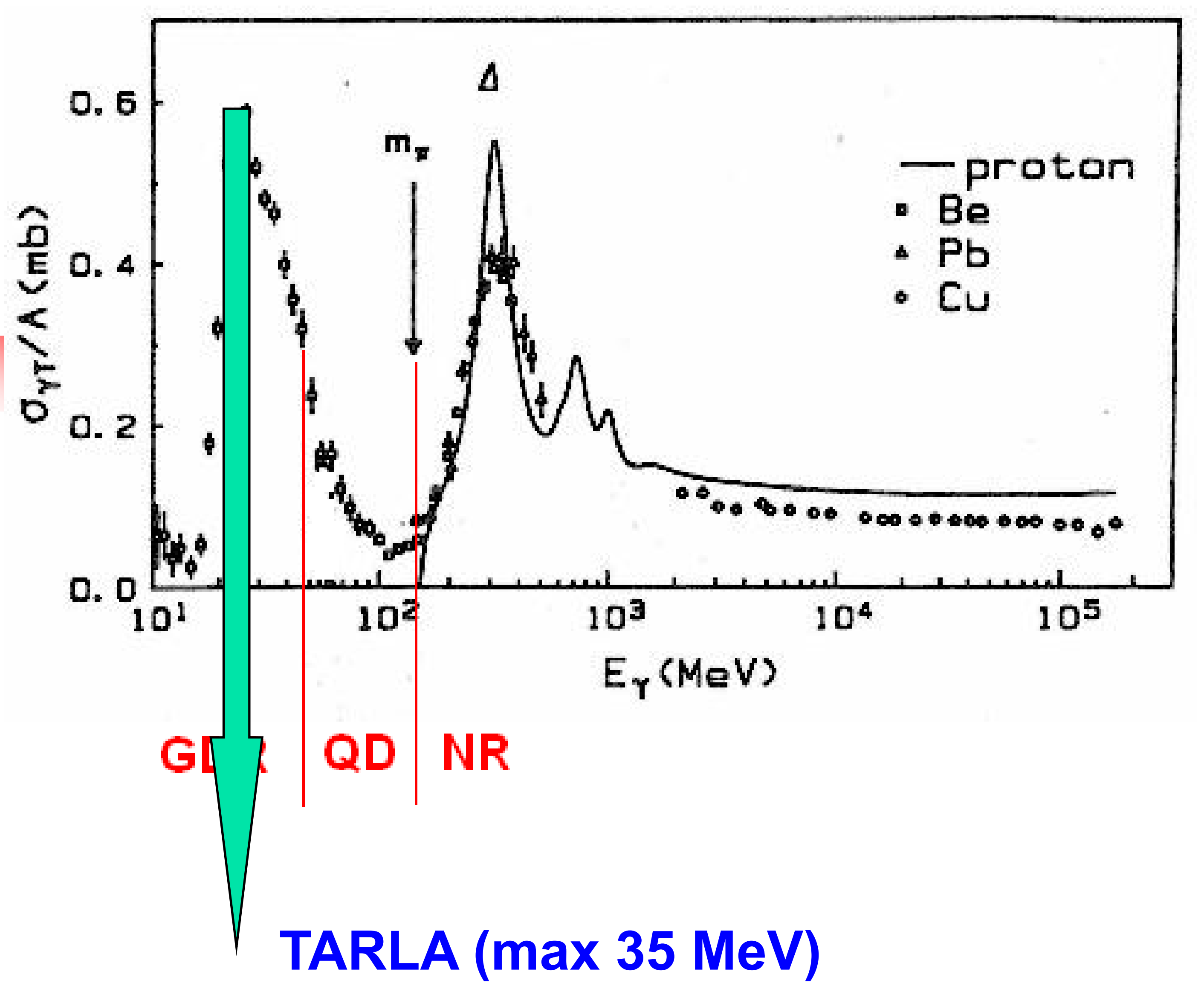
What is the Bremsstrahlung



- Bremsstrahlung process $E_\gamma = E_0 - E_r$
- $E\gamma$ can be created in the range between 0.1% - 0.9% of Eo



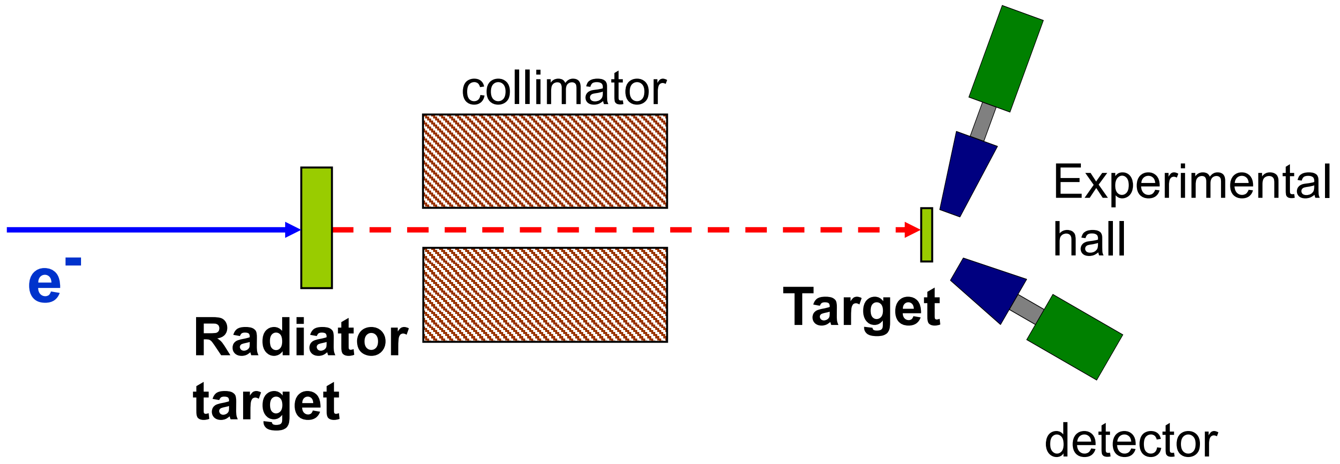
photonuclear reaction



Simulating Tools and Parameters at the Bremsstrahlung Facility

The main steps to obtain bremsstrahlung photon beam are ;

- Creation of the beam (bremsstrahlung process)
- Transport of the beam into experimental hall
- Particle detection system
- Dump of the recoil electron beam and also photon beam



The schematic view of the main steps

Simulating Tools and Parameters at the Bremsstrahlung Facility

1. Definition of the radiation source:

Option BEAM, is used to define the particle type and momentum (or energy).
Option BEAMPOS is used to define the particle starting point and direction

For TAC Bremsstrahlung Facility;

Particle type: Electron beam
Energy : 20 + 20 MeV=40 MeV

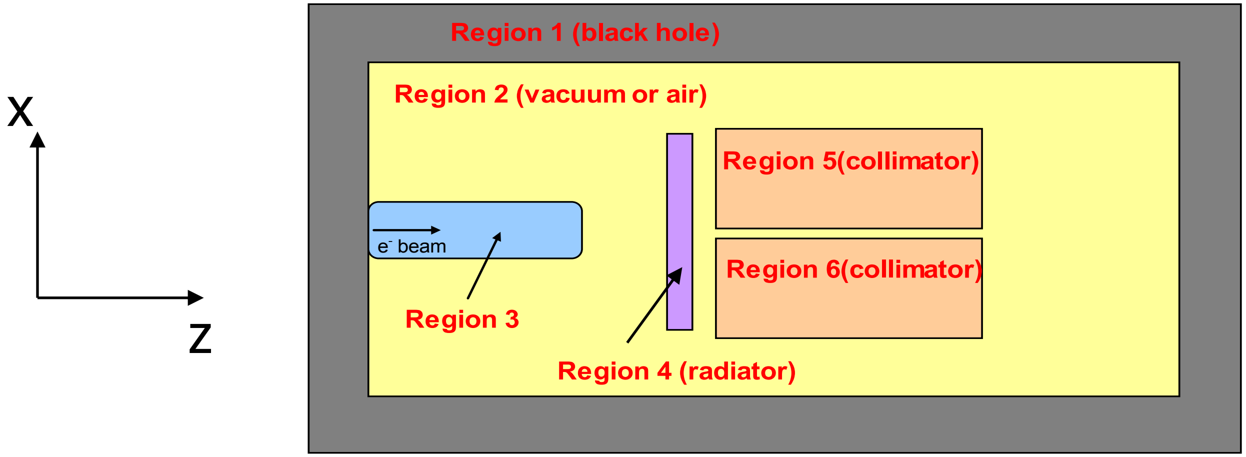
Simulating Tools and Parameters at the Bremsstrahlung Facility

2. Description of the geometry:

The Combinatorial Geometry used by Fluka is based on two important concepts:

bodies and regions

- bodies: are closed solid bodies (spheres, parallelepipeds, etc.)
- regions: are sorrounded bodies



Sketch of the geometry set-up of the bremsstrahlung production

Simulating Tools and Parameters at the Bremsstrahlung Facility

3. Definition of the Radiator material:

Radiator : (Al, Cu, Nb or diamond etc.) thin foil.
The typical thickness ranges from $3x10^{-4}$ to 10^{-3} times the radiation length X_o

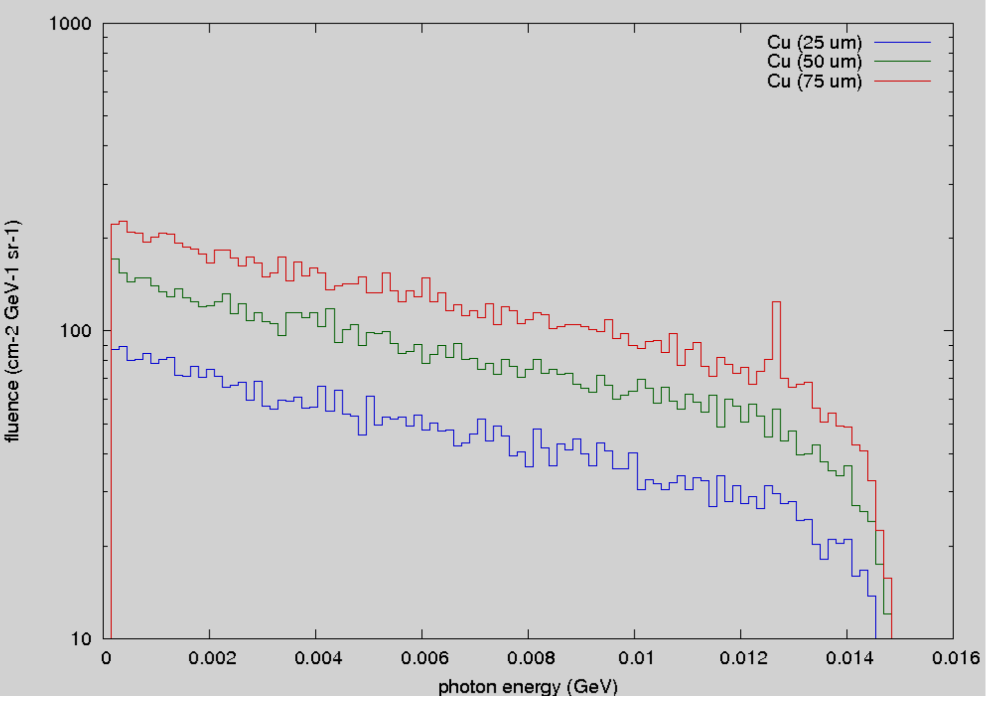
<u>In Radiator design</u>

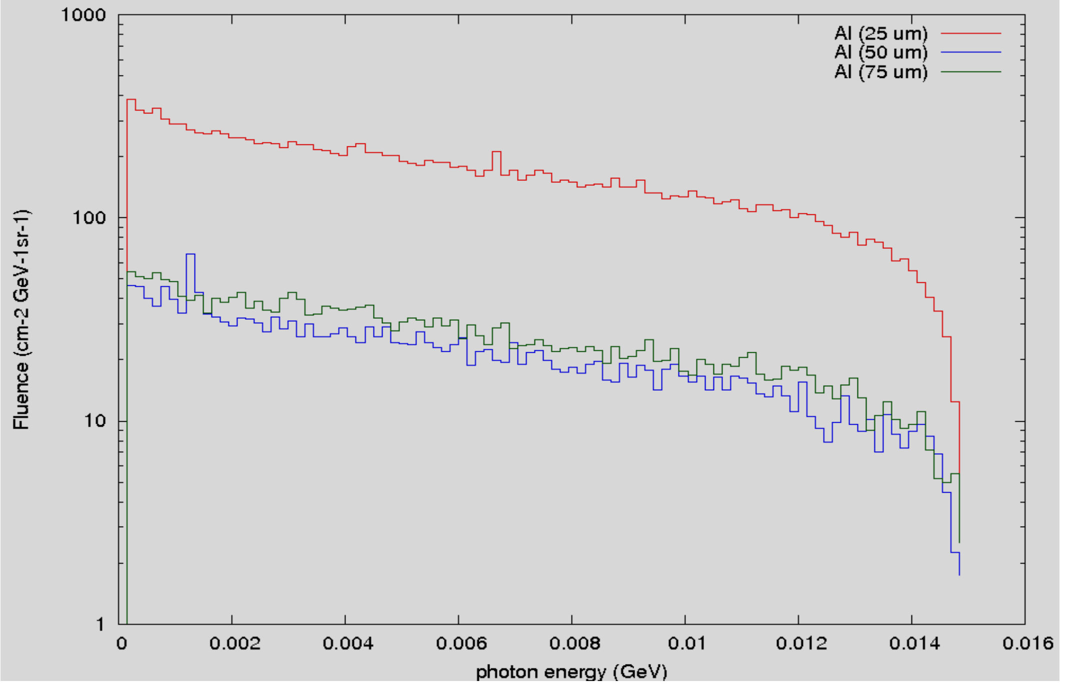
Max photon intensity
Minimize angular distribution of electron in radiator material
Optimum temperature distribution
should be considered

Thus
Material type
Material thickness
are important parameter to be considered

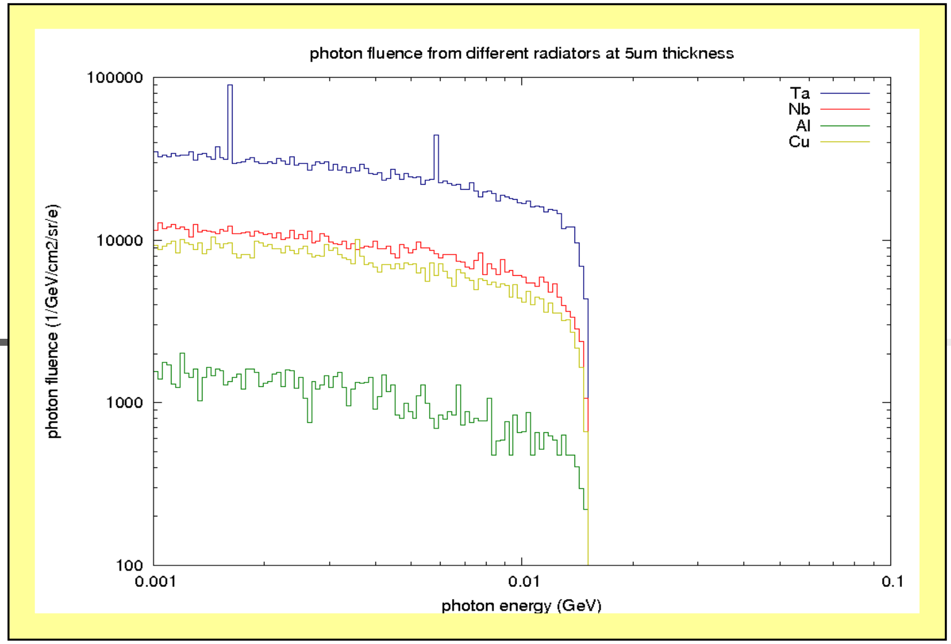
Results

Primary electron : 10^6
Energy : 15 MeV

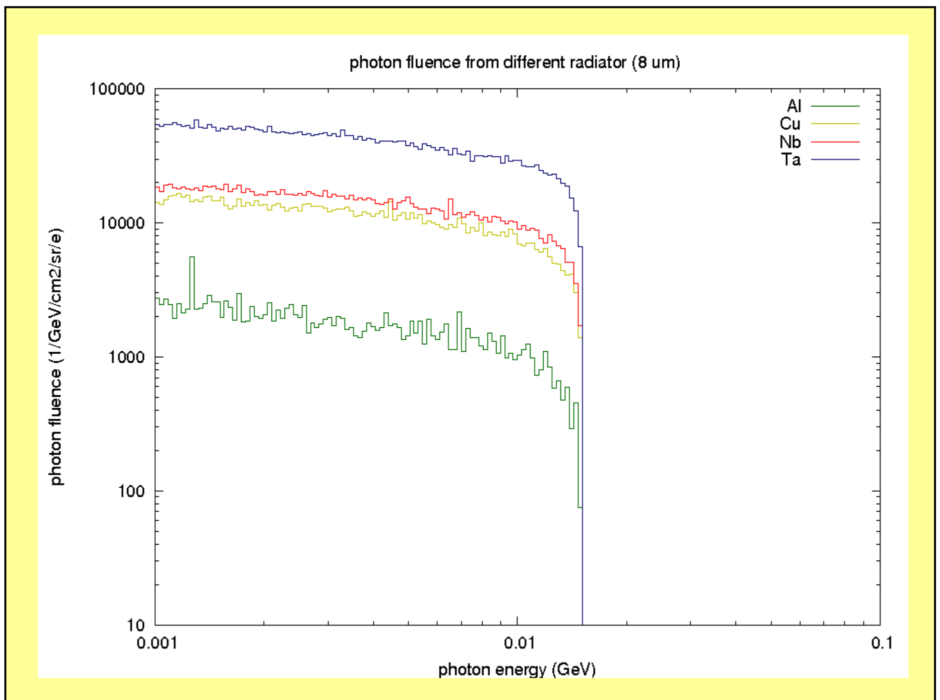


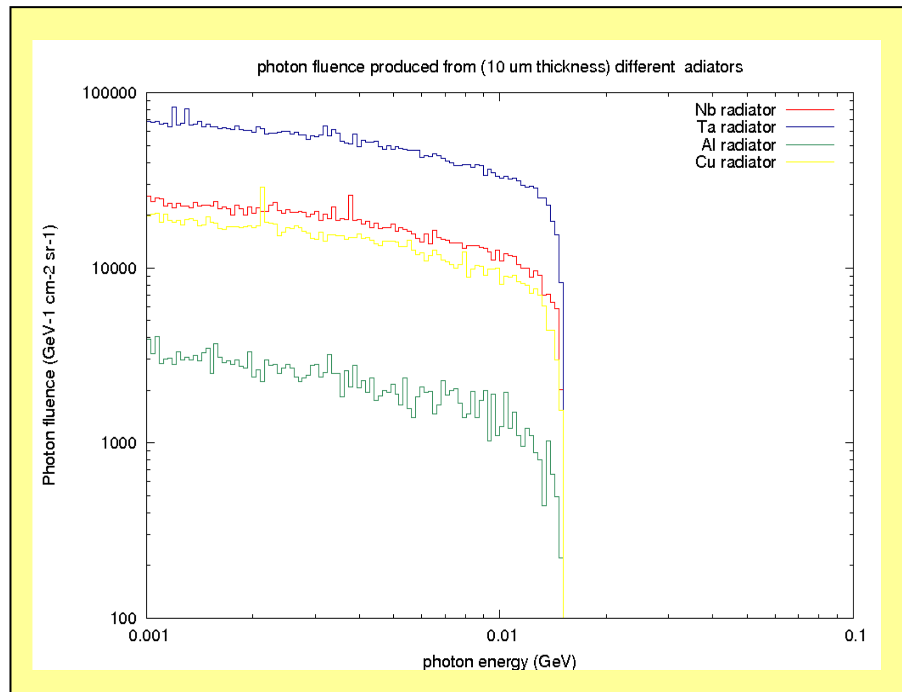


The bremsstrahlung photon fluence are calculated for four different radiator material (Cu, Al, Nb,Ta) using with FLUKA code.



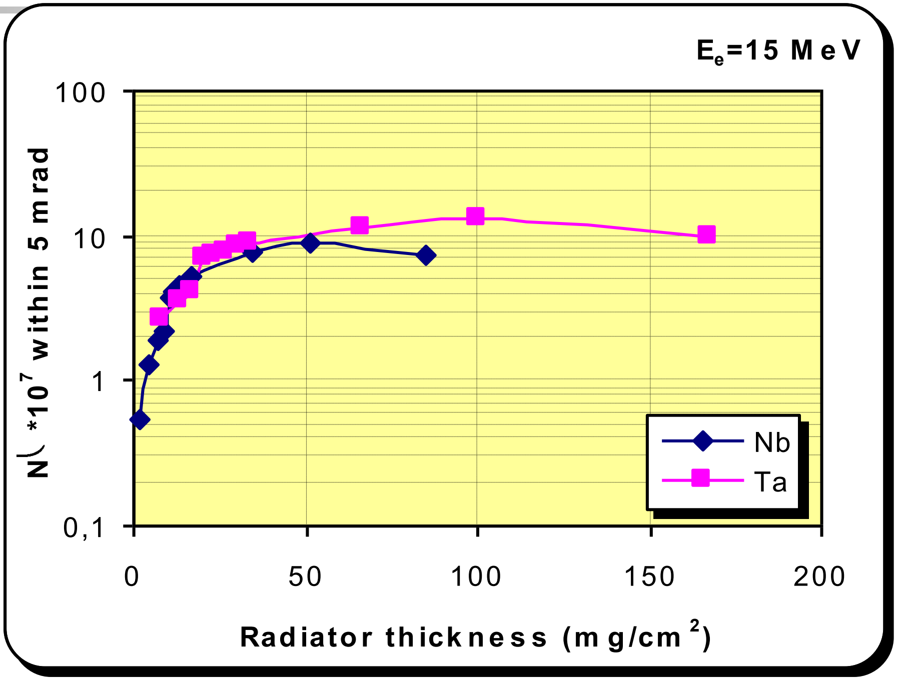
max. photon fluence
Ta radiator





Results

The photon flux with in 5 mrad,increases with the radiator thickness, but saturates for thicknesses greater than about 50 mg/cm^2.
In thick radiators more photons are produced but a growing part of them those not pass the 5 mrad opening angle of the collimator.



In order to keep the small angle scattering low we use thin radiators with thicknesses corresponding to about 2x10^{-4} – 1x10^{-3} radiation lenghts.

Results

Another important point:

The thermal features of the radiator materials. Because the radiator be exposed to high radiation ıt's temperature increases.

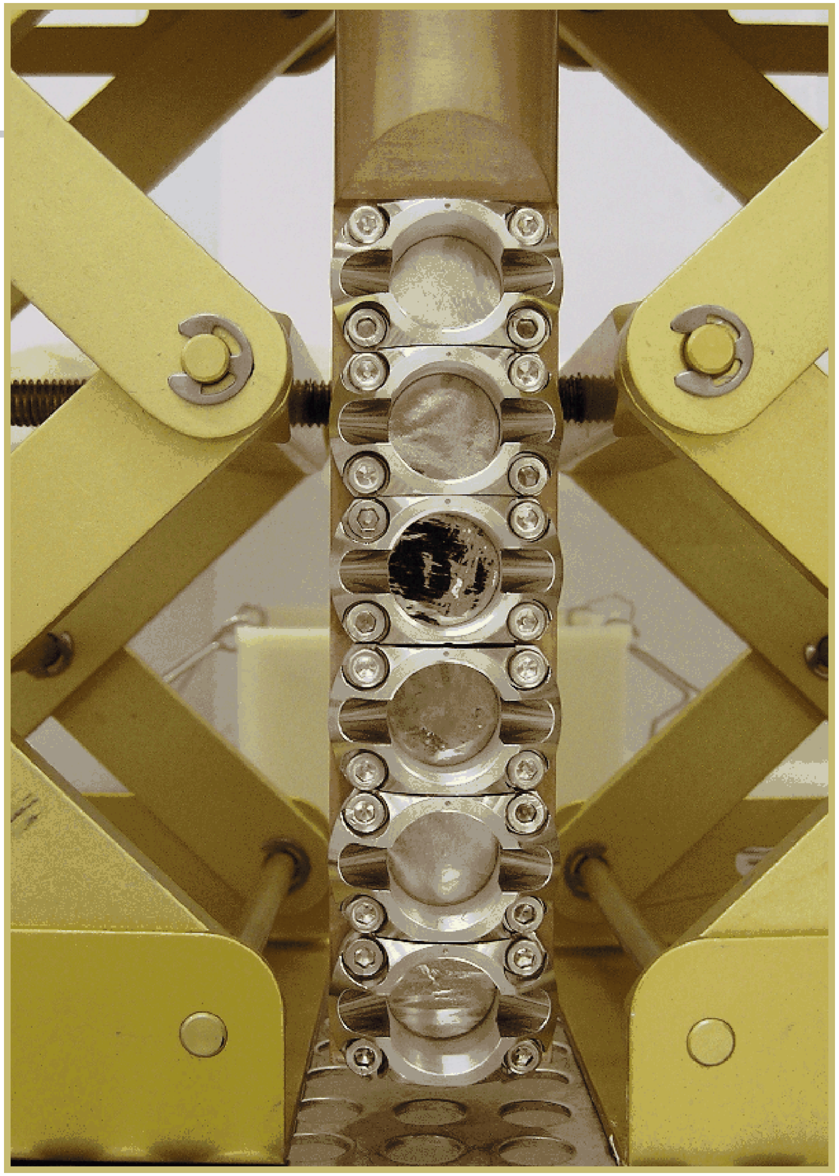
Material	X_0 (g/cm^2) radiation lengh	Melting point(^{0}K)
Ta	6.828	3290
Nb	10.16	2750
Al	24.26	933.47
Cu	13.16	1357

High melting point should be choosen.

High intensity, high melting point → **Ta and Nb**

ELBE→ Radiator

- ELBE Radiator (Niobium)
  - Thickness → 1.7, 2.6, 3.4, 4.3, 6.0, and 10.6 mg/cm^2,
  - 16 mm diameter
  - 2450 ^oC melding temperature
  - About 12 MeV e-beam → 600 μA → 1200 ^oC
  - And other materials
- Ours will be most similar with ELBE's design



Future Plan

- The design of collimator
- Photon beam dump

} FLUKA simulation

2^{nd} half of 2012	First beam
1^{st} half of 2012	Setup of devices
2^{nd} half of 2011	Production/ordering of equipment
1^{st} half of 2011	Design and technical details

TEŞEKKÜR EDERİM

means

THANK YOU