Implementation of a Compton source for X-rays in the ELSA facility

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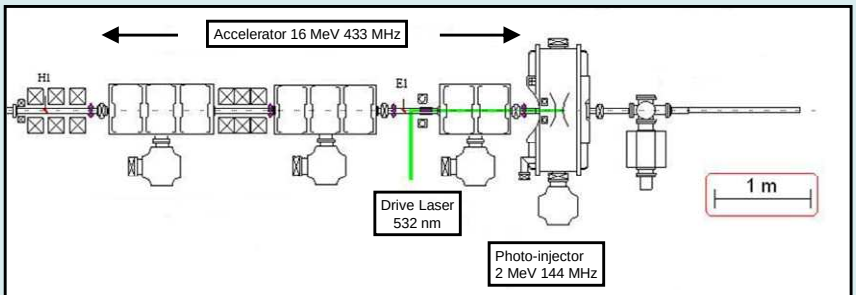
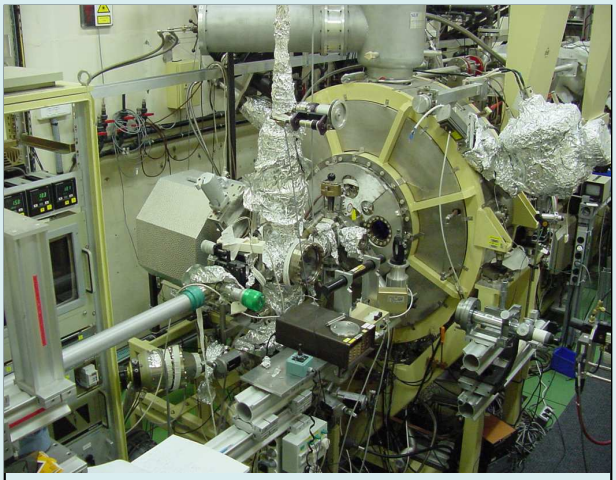
A study of a Compton source for X-rays in the ELSA facility is in line with the RADIOTHOMX project (*Thales Communication, Colombes, France*). The goal of this project is to develop a compact device to deliver an intense flux of monochromatic X-rays for medical applications. Thanks to its low emittance (~3 µm normalized r.m.s) and high current electron beam, the 18 MeV electron linear accelerator ELSA (*CEA/DAM, Bruyères-le-Châtel, France*) is a good candidate to study Compton interaction. ELSA includes a 2 MeV, 144 MHz photo-injector and accelerates up to 15 nC micro-pulses. A derivative of the 532 nm drive laser beam will be amplified to impact the picosecond electron bunches.

1-ELSA facility

- Linear electron accelerator from 1 to 18 MeV
- A 144 MHz photo-injector: the trains of electron bunches are accelerated up to 2 MeV with macro-pulses from 20 to 150 µs
- Three 433 MHz accelerating cavities powered by a unique klystron

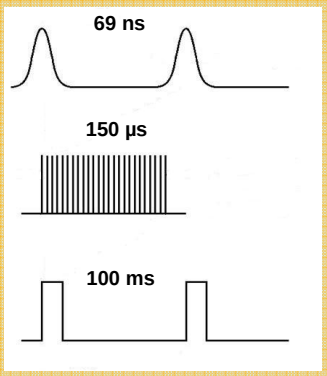


Accelerating part of ELSA



ELSA photo-injector

2-Temporal structure of the electron beam



Micro-pulse: ~30 ps
Bunch spacing: ~69 ns, 18 MeV, < 15 nC

Macro-pulse: ~150 µs
< 2000 micro-pulses

Macro-pulse repetition rate: < 10 Hz

3-Characteristics of the laser beam

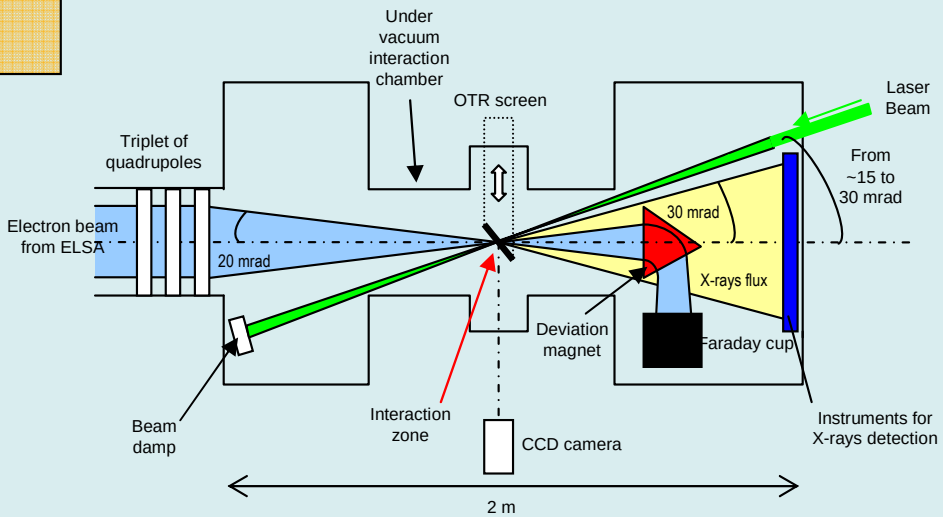
- 72 MHz oscillator
- Nd:YAG cristal pumped by a flash lamp
- Macro-pulses: 1J @ 532 nm

With these features, ELSA and its drive laser could provide Compton X-rays from the interaction between 2000 electron micro-pulses, 2nC, 18 MeV, 30 ps and 2000 photon pulses, 8.5 mJ, 30ps.

4- First design of the interaction chamber

An angle of 30 mrad between electron beam and laser beam seems necessary to recover all the X-ray flux. This angle corresponds to the half-angle of the radiation cone for a 18 MeV electron beam.

With ELSA characteristics, it could be possible to reduce the interaction diameter under 100 µm.



At this time of the project, we can say that the flexibility of the accelerator ELSA will let us study in detail the Compton interaction and optimize the parameters of the accelerator and the laser to get the best yield of X-rays. The first experiments of a Compton X-rays source in ELSA will occur during 2009.

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