PMB ALCEN

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ELECTRON LINAC UPGRADE FOR THOMX PROJECT

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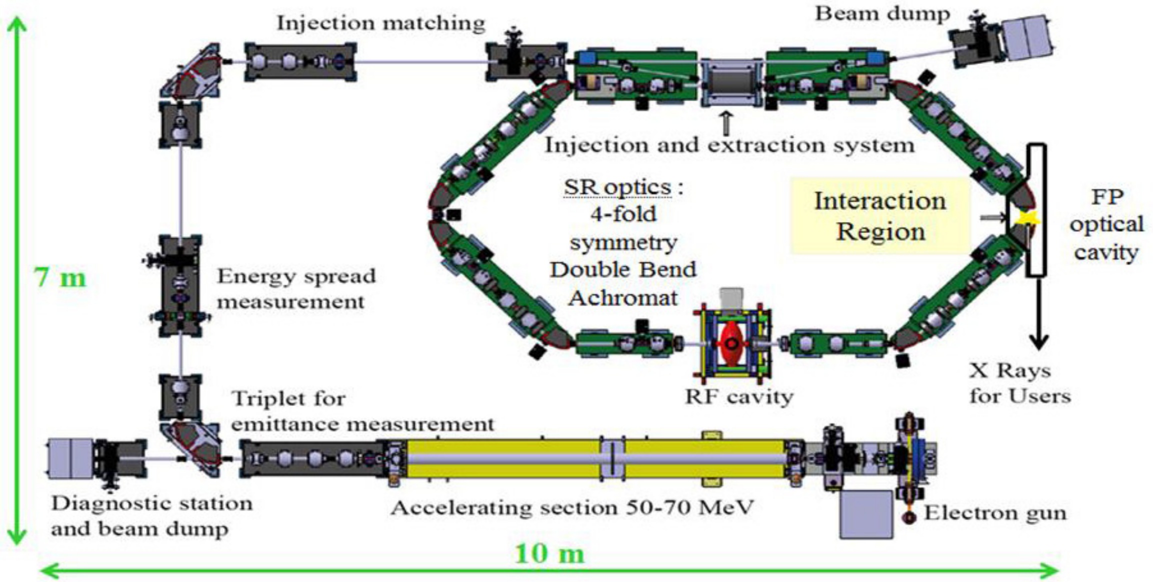
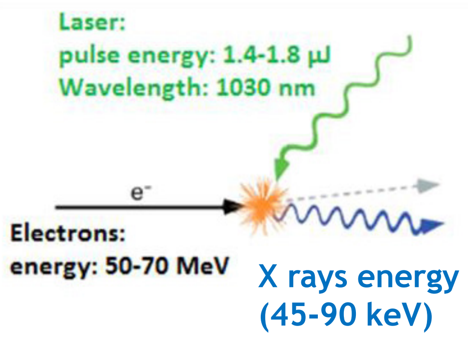
ThomX project





Compton backscattering principle

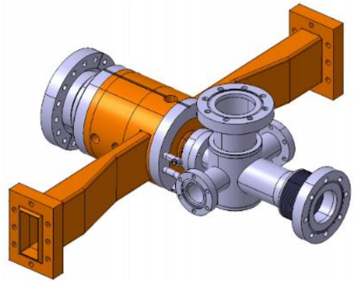
- French project led by LAL (budget: 12 M€, 10 M€ TTC facility & 2 M€ TTC operation).
- Compton backscattering compact hard X-rays (45-90 keV) source with high flux (10^{11}-10^{13} ph/s).
- Relatively low energy machine (50-70 MeV) which allows installation in hospitals or museums.
- A demonstrator was recently funded and it is under construction in the Orsay University campus.
- Application domains:
  - Cultural heritage: imaging, structural & chemical studies of artefacts,
  - Medical science: imaging, radiotherapy,

Industrialisation phase (Thales): ThomX demonstrator can be commercialised as an integrated product.

LINAC main specifications

- To fulfil the accelerator specifications, the LINAC has to be carefully designed, especially the photo-injector.

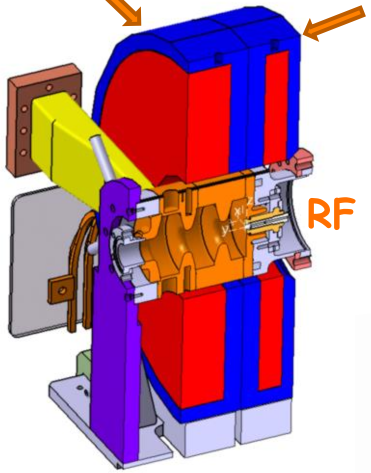
RF Gun designed & made at LAL



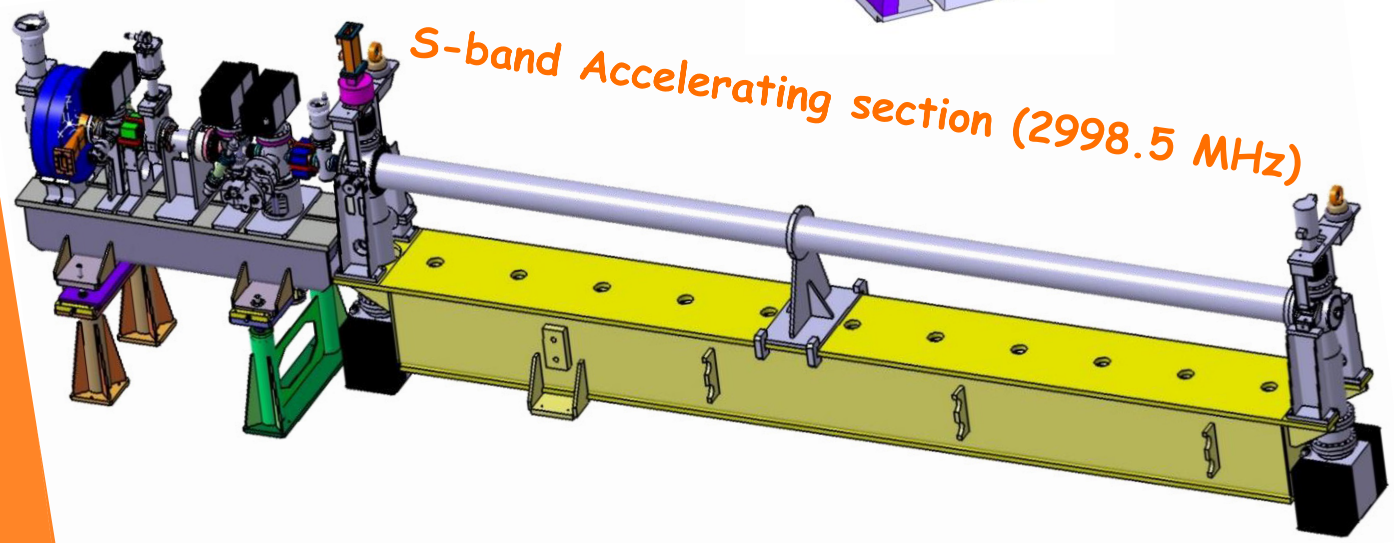
3D-RF Gun Catia drawing

THOMX brazed RF Gun

2.5 cells RF Gun



S-band RF Gun



RF Gun specifications

Laser wavelength	266 nm
Laser pulse duration & energy	100 μJ
Q – factor	15000
Shunt Impedance	50 MΩ/m

E_z = 80 MV/m (P_{in} = 6 MW, 3 μs) for Energy gain = 5 MeV

Nominal LINAC parameters:

- Energy: 50 MeV,
- Bunch charge: 1 nC,
- Repetition rate: 50 Hz,
- rms norm. emittance: $\varepsilon_N \sim 4\ \pi$ mm mrad
- rms energy spread: < 1%
- rms bunch length: < 5 ps

LAL-PMB collaboration on high gradient S-band structure research

- The collaboration agreement between PMB and LAL has been established from October, 1st, 2014 to September, 30th, 2018.

Commissioning phase: LIL structure
LEP Injector Linear structure (LIL)

- Total length: 4.5 m (135 cells),
- Travelling wave section (TW),
- Quasi-constant gradient structure,
- Phase advance per cell: $2\pi/3$-mode,
- Average acc. field: 14 MV/m @ 12 MW,
- Filling time ~ 1.35 μs,

Upgrade ⇒

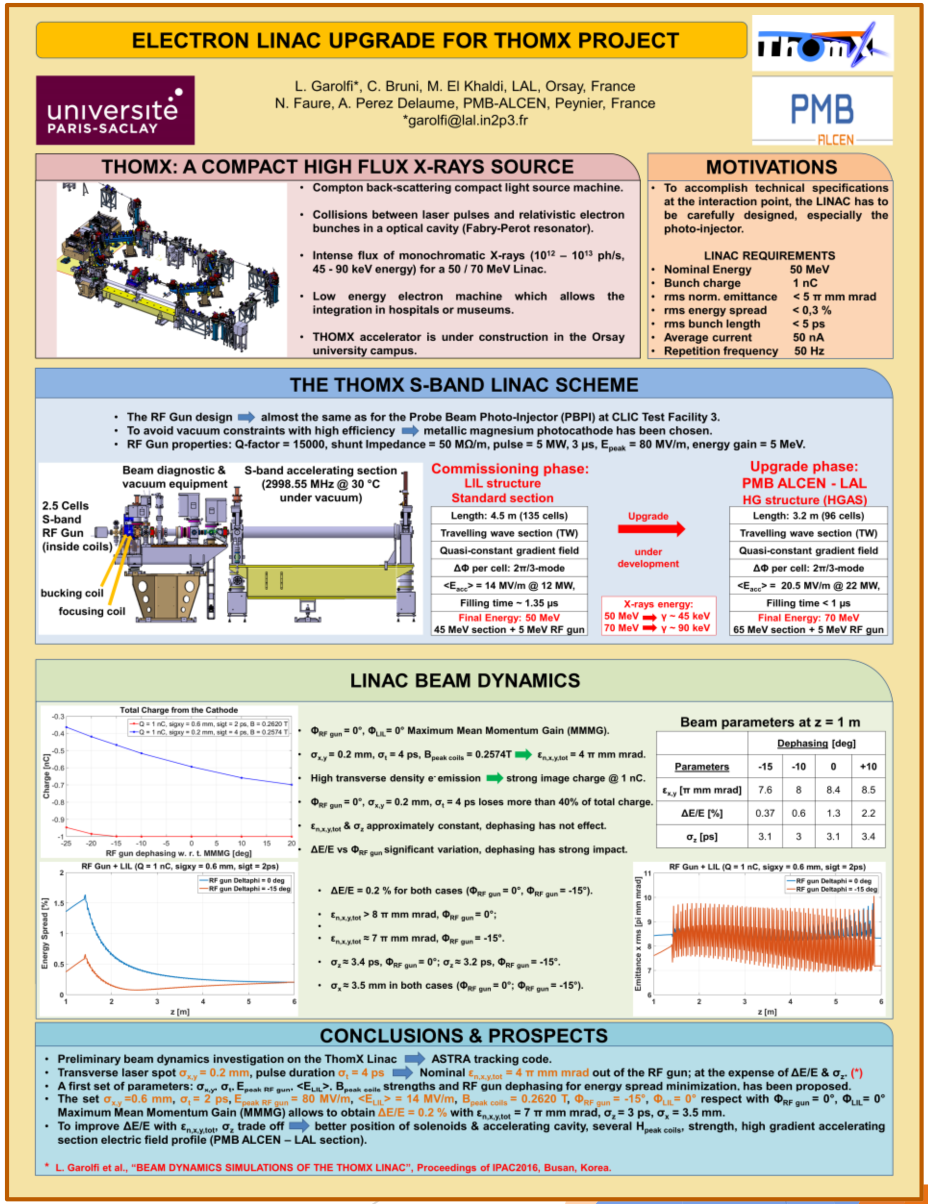
Upgrade phase: PMB-LAL
High gradient & compact structure (HGAS)

- Total length: 3.2 m (96 cells),
- Travelling wave section (TW),
- Quasi-constant gradient structure,
- Phase advance per cell: $2\pi/3$-mode,
- Average acc. field: 20.5 MV/m @ 22 MW,
- Filling time ≤ 1 μs,

Direct impact on X-rays energy:
50 MeV ⇒ γ ~ 45 keV
70 MeV ⇒ γ ~ 90 keV

ELECTRON LINAC UPGRADE FOR THOMX PROJECT

- Beam dynamics simulations have been performed using ASTRA code:
  - A method to determine the best magnetic field strength which compensates the transverse emittance has been considered.
  - A scan over different parameters, such as transverse laser spot size, pulse duration, RF dephasing of the RF gun and accelerating section with respect to $\Phi_{RF} = 0$ Maximum Mean Momentum Gain (MMMG) has been carried out for energy spread minimisation.
  - A preliminary set of parameters able to achieve an energy spread of $\Delta E/E = 0.2$ %, with a reasonable rms transverse emittance has been proposed.



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Thank you for your attention