The 3rd African Conference on Fundamental and Applied Physics (ACP2023)

# Brief status of ICS X-rays source in Orsay ThomX

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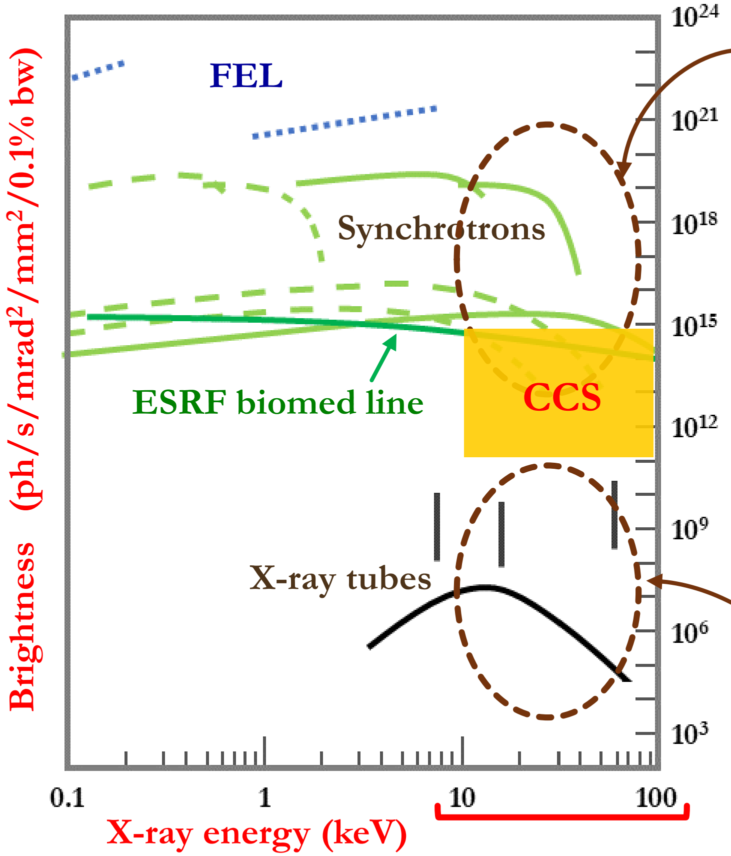
on behalf the ThomX collaboration

This presentation is a part of a more detailed presentation which will be made by the scientific manager of ThomX Marie Jacquet at the IMAGING 2023 conference on next September 28 in Varenna (Italy)

# X-rays production

Compton sources: WHY ?




Synchrotrons

High power, monochromaticity, coherence

Large facilities

Not very practical

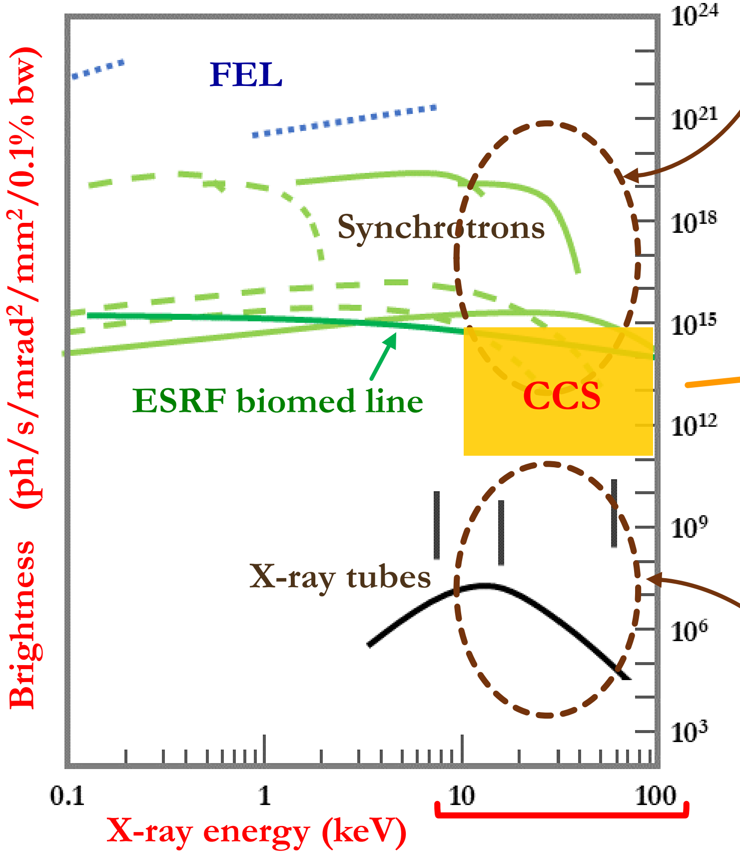
Limited access time

X-ray tubes

Lab-size sources

Lack of power, monochromaticity, coherence

## Compton sources: WHY ?




**Synchrotrons**

High power, monochromaticity, coherence

Large facilities
Not very practical
Limited access time

**COMPACT installations** (surface < 100 m²)

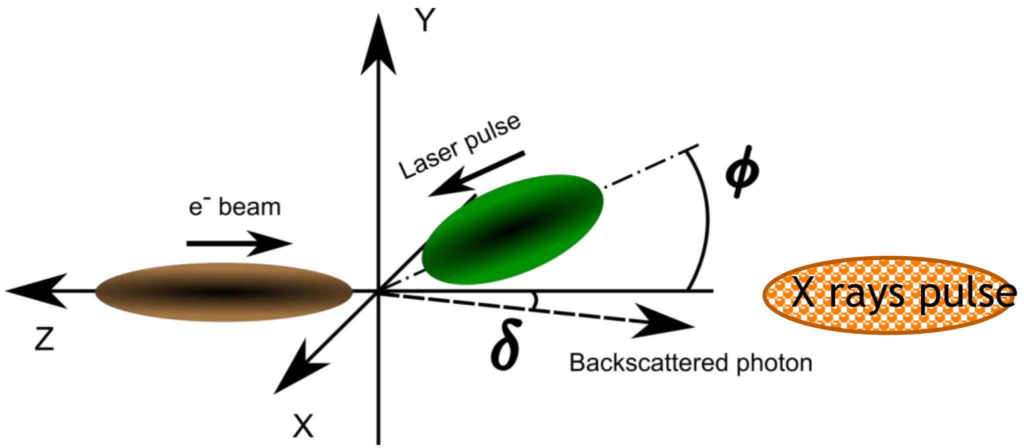
Some powerful analyzes currently realized at synchrotrons and requiring a high brightness beam could be developed in a lab-size environment (hospitals, labs, museums).

**X-ray tubes**

Lab-size sources

Lack of power, monochromaticity, coherence

# Just reminding the principle of ICS




$$E_x \simeq E_L \frac{4\gamma^2}{1+\gamma^2\delta^2+\frac{\phi^2}{4}}$$

<u>High flux</u> ($10^{12} – 10^{14}$ ph/sec)

➔ Laser power= 100 KW – 1 MW

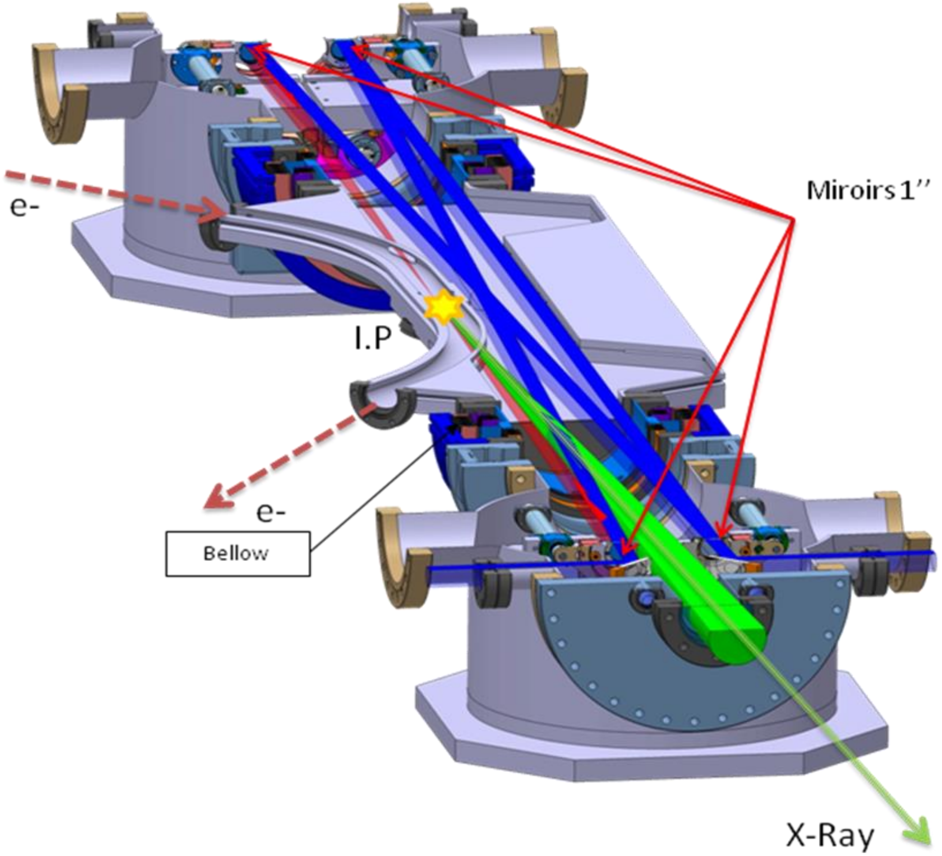
$E_e$ = 50 MeV

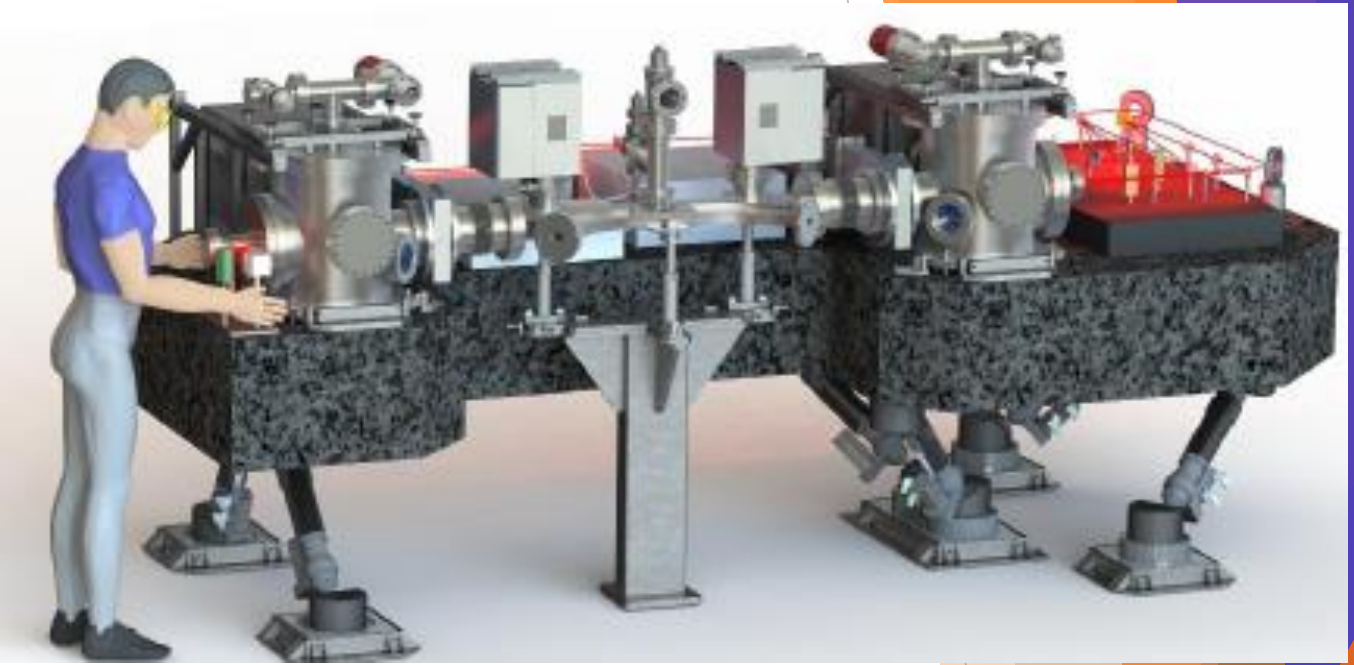
$E_L$ = 1 eV (1030 nm)

$E_x$ = 40 000 $E_L$

➔ Good control of Laser and Accelerator

# Optical Cavity scheme



7 tons to be adjusted at µm level

| Laser and FP cavity | |
| --- | --- |
| Laser wavelength | 1030 nm |
| Laser and FP cavity Frep | 36 MHz |
| Laser Power | 50 - 100 W |
| FP cavity finesse / gain | 30000 / 10000 |
| FP waist | 70 µm |

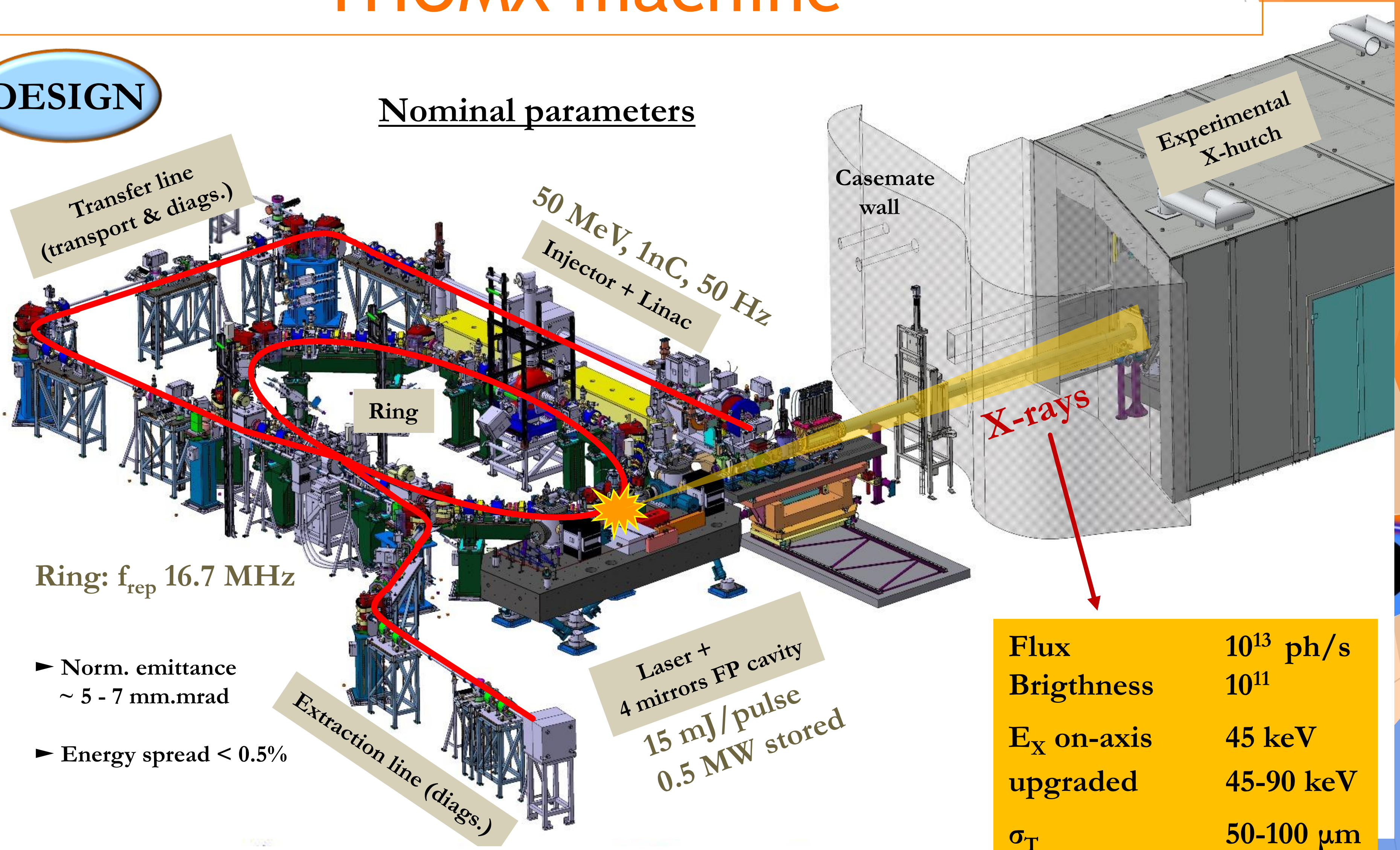


ThomX

# THOMX machine

ThomX DESIGN

## Nominal parameters

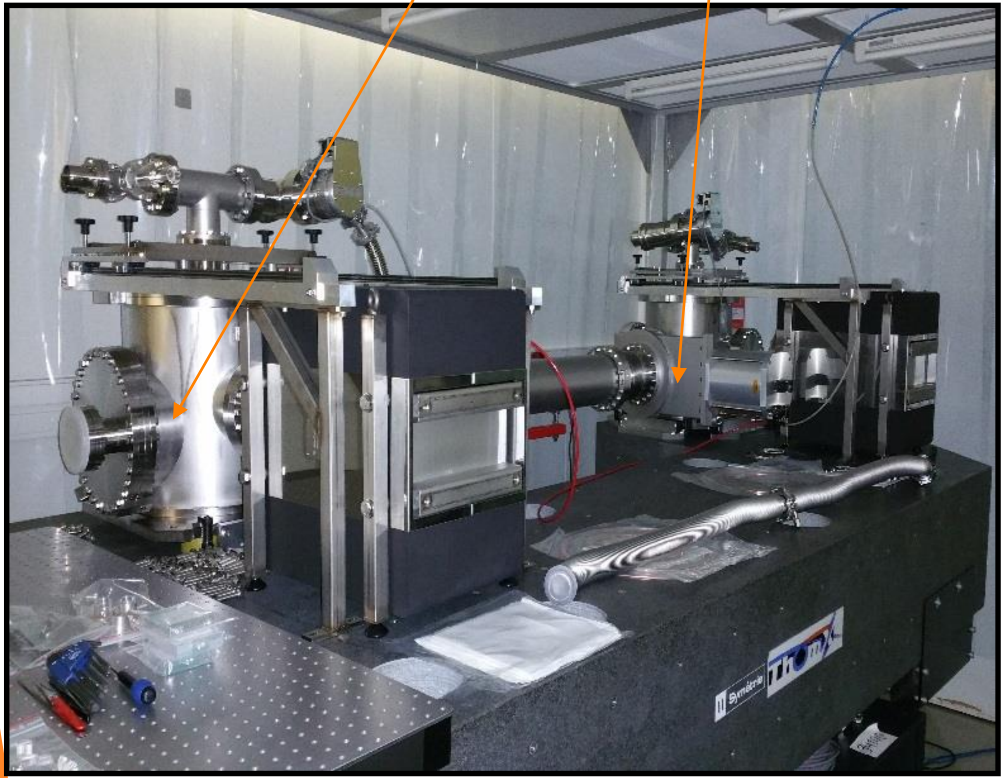



- Norm. emittance ~ 5 - 7 mm.mrad
- Energy spread < 0.5%

| | |
|---|---|
| Flux | $10^{13}$ ph/s |
| Brigthness | $10^{11}$ |
| $E_X$ on-axis | 45 keV |
| upgraded | 45-90 keV |
| $\sigma_T$ | 50-100 µm |

# Optical cavity and Accelerator

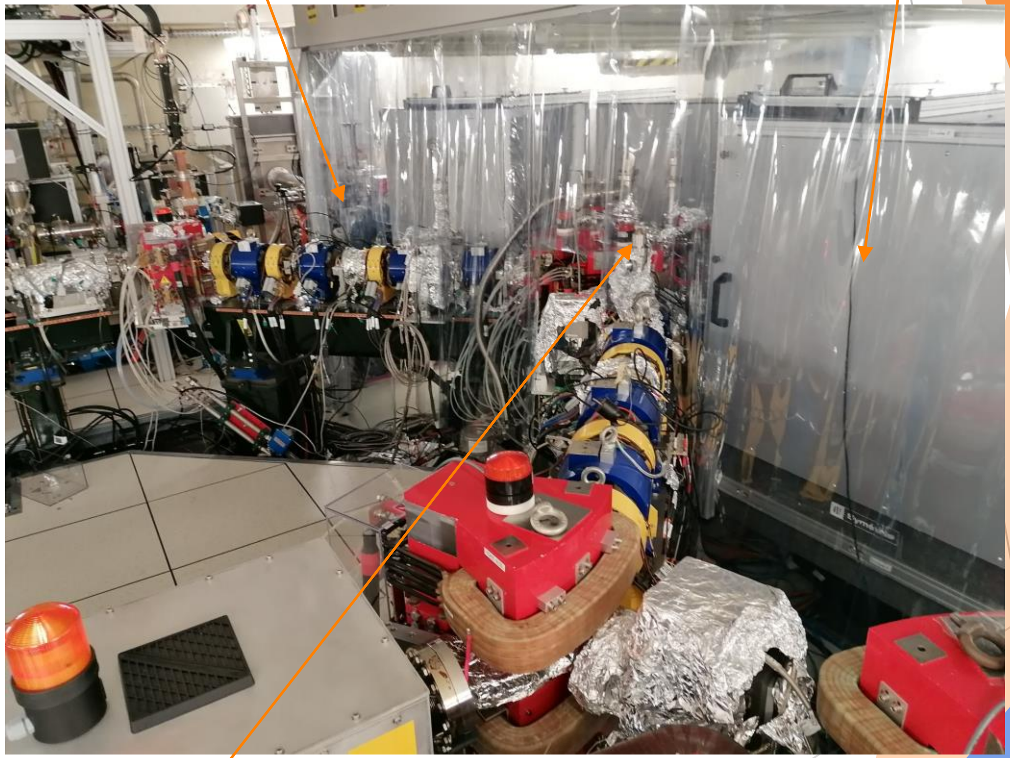
Mirrors vaccum chambers



Measured parameters
Finesse of 30000 -> gain of 10000
200KW stable power

X-rays beam

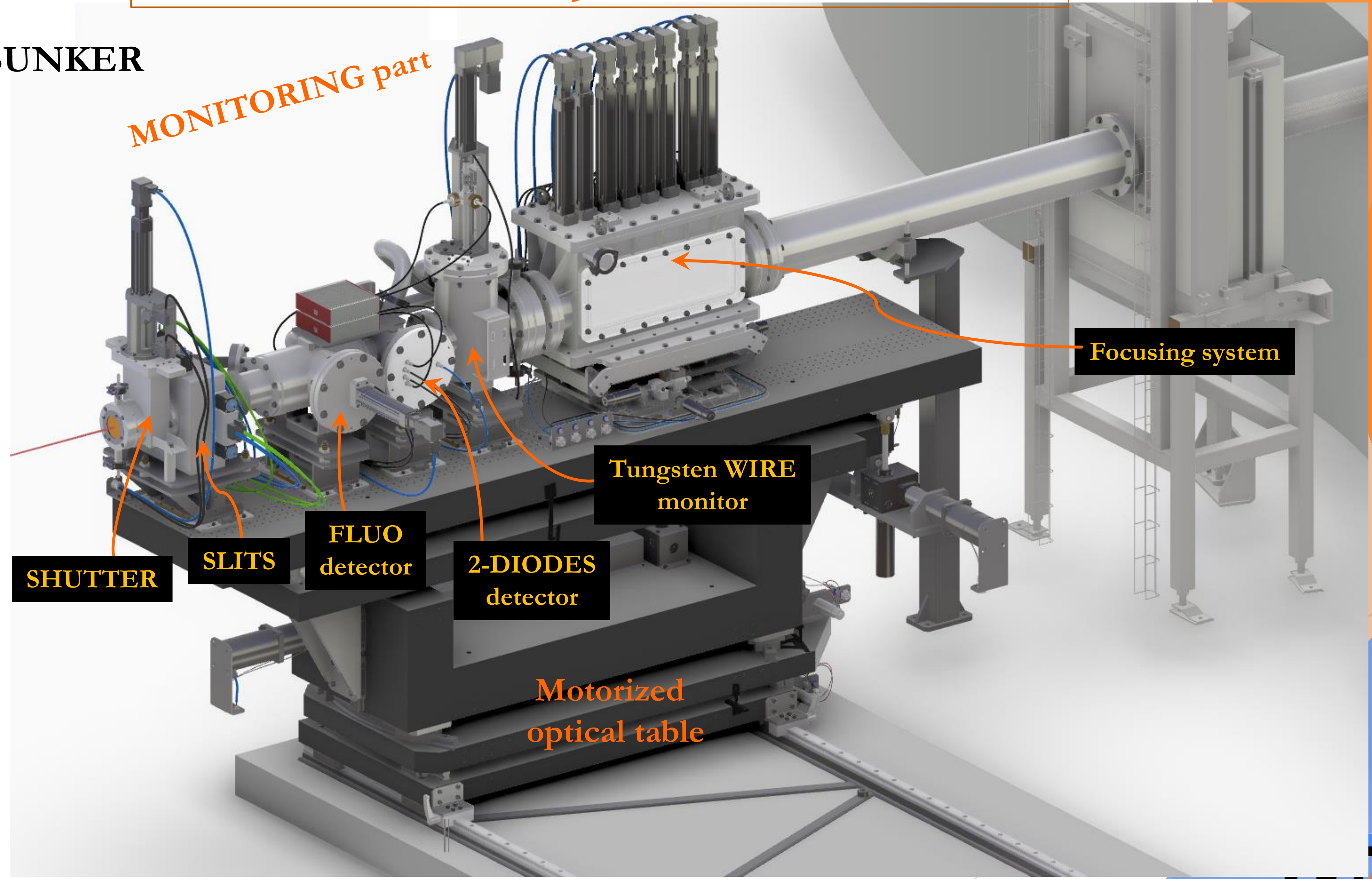
Complete Laser Cavity system



Interaction point

# X-rays line

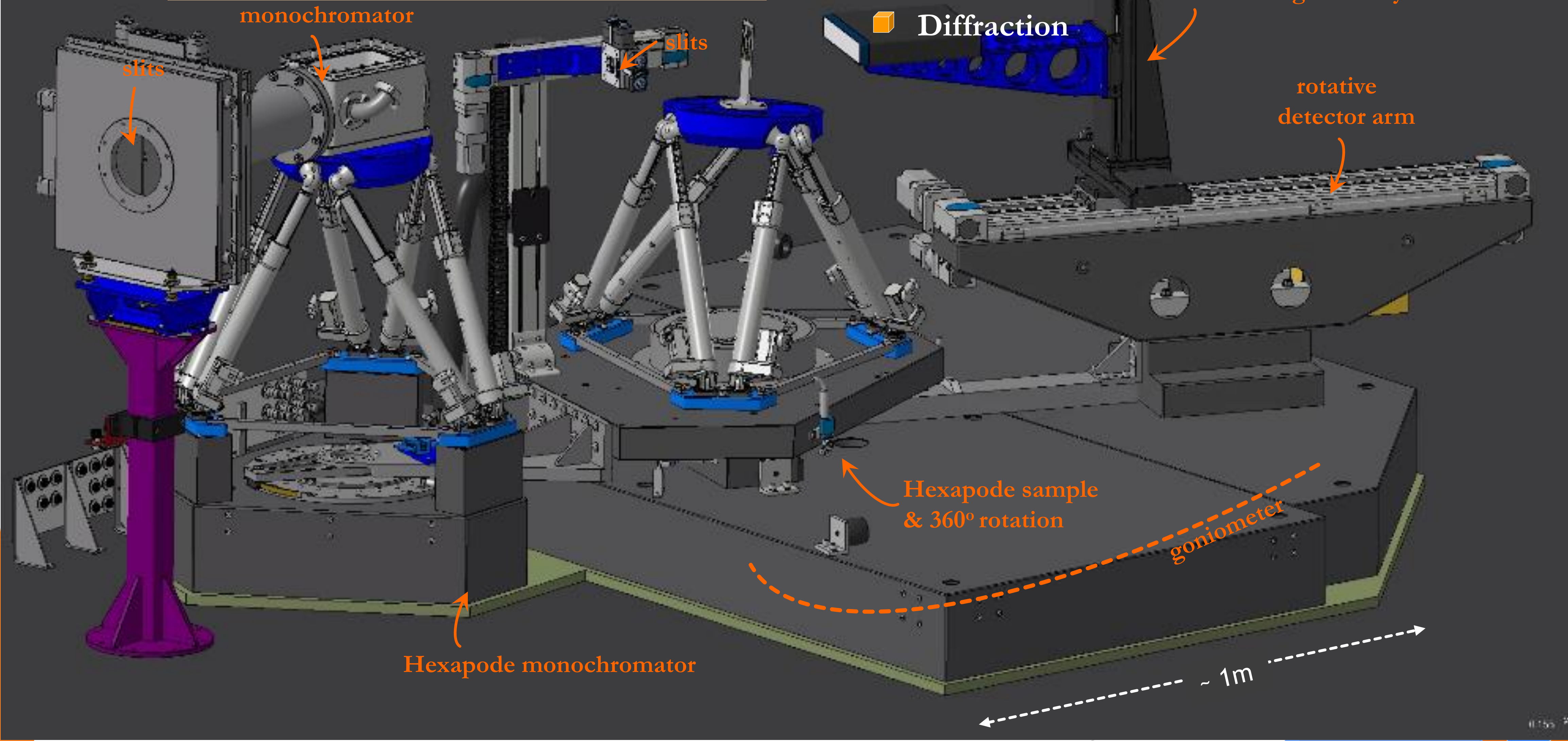
**Inside BUNKER**



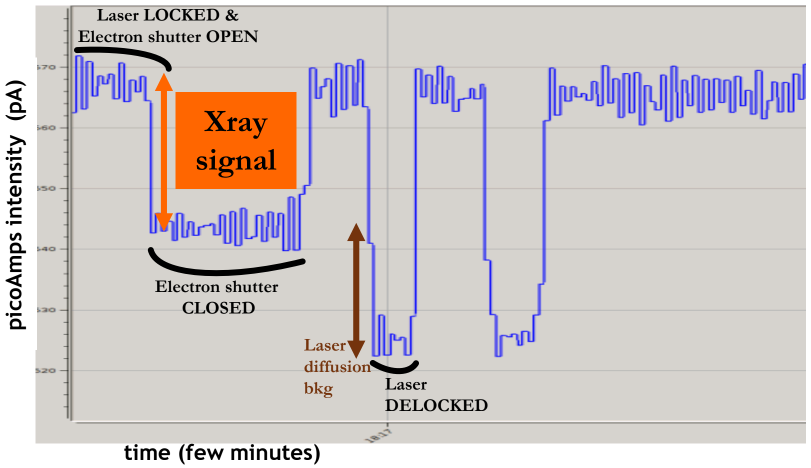
# X-rays experimental hutch

→ Design a modulable equipment in order to be able to explore/qualify the main analysis techniques

- Standard imaging
- Phase contrast imaging
- Tomography
- Fluo spectro
- Diffraction



# Preliminar results

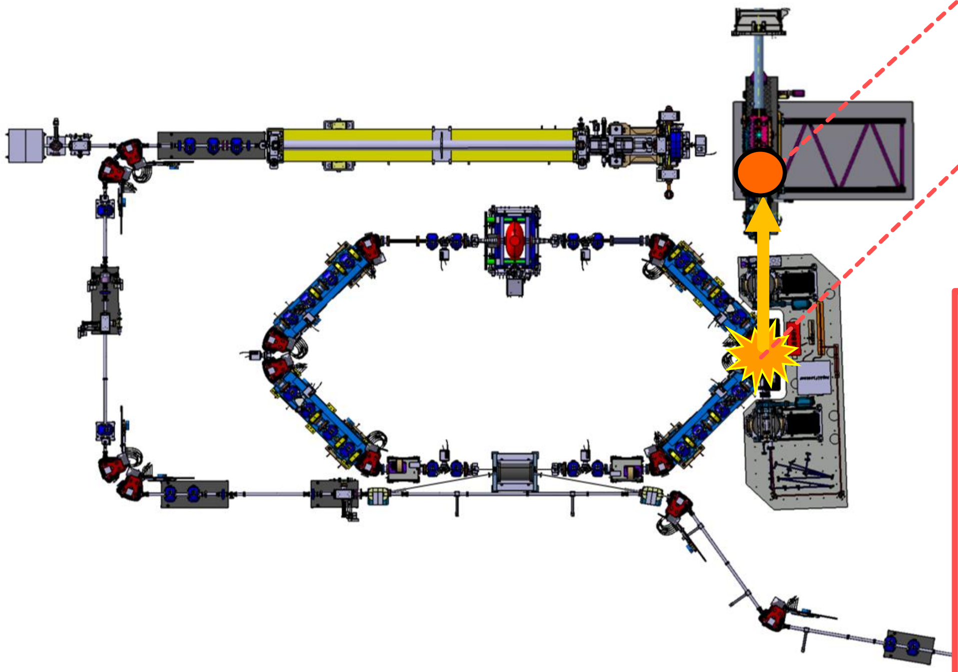



PicoAmps signal vs time

FLUO detector

First X-rays in bunker !
June 23, 2023
(desynchro mode)

Summer 2023



X-ray flux measurement with fluo screen
(ESRF calib in 2016)

Measured = $5.8\ 10^{6}$ ph/s (with bunker pdiode)

Expected ~ $4\text{-}10\ 10^{6}$ ph/s (uncertainty storage e-)

Near futur:

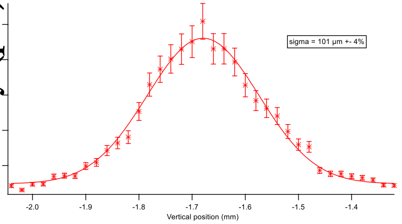
with 100 kW laser CFP + synchronisation e-/laser

→ Expected $10^{10}$ - $10^{11}$ ph/s

Summer 2023: 1st X-rays measurements

## Measurement (in bunker) of the transverse electron bunch size at IP

picoAmps intensity (pA)



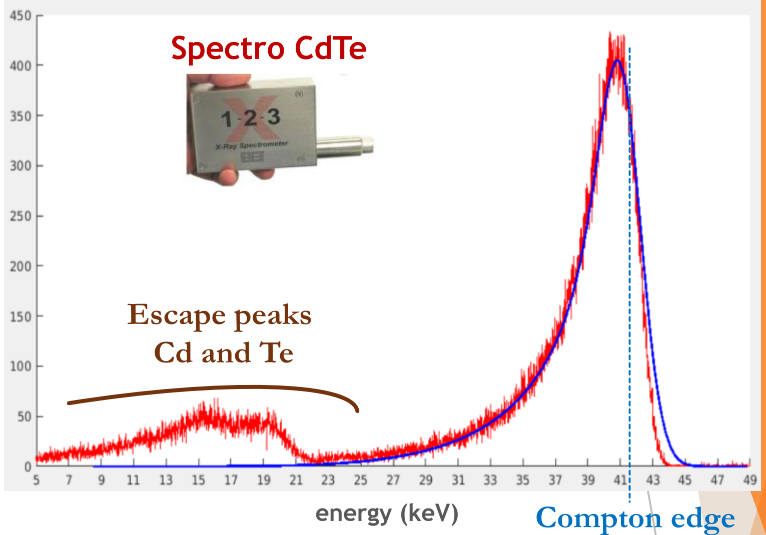

$\sigma \sim 100\ \mu m$

FPC table vertical position (mm)

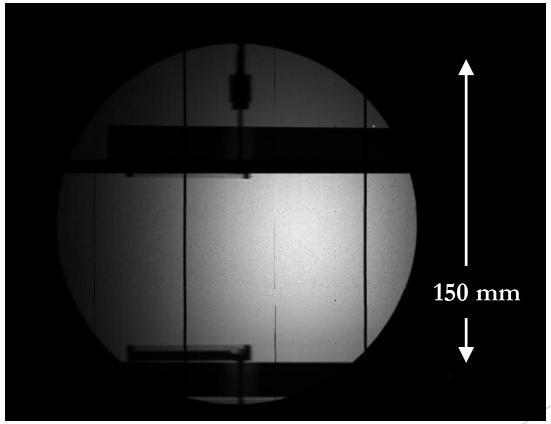
$\sigma_{laser} = 60\ \mu m$ (measured before)

➔ $\sigma_{e-} \sim 80\ \mu m$

## First X-ray spectra in X-hutch




## First X beam image in X-hutch




Pixel Camera CdTe

# THANKS FOR YOUR ATTENTION

# Next steps

**Plans**

Once (soon) e- and laser will be synchronized

→ X beam CHARACTERIZATION

→ 1st demonstration EXPERIMENTS TO QUALIFY the source

- spatial resolution
- spectral resolution
- sensitivity
- contrast
- acquisition times

…

in the various ANALYSIS TECHNIQUES

- Standard imaging
- Phase contrast imaging
- Tomography
- Fluo spectro
- Diffraction

…