

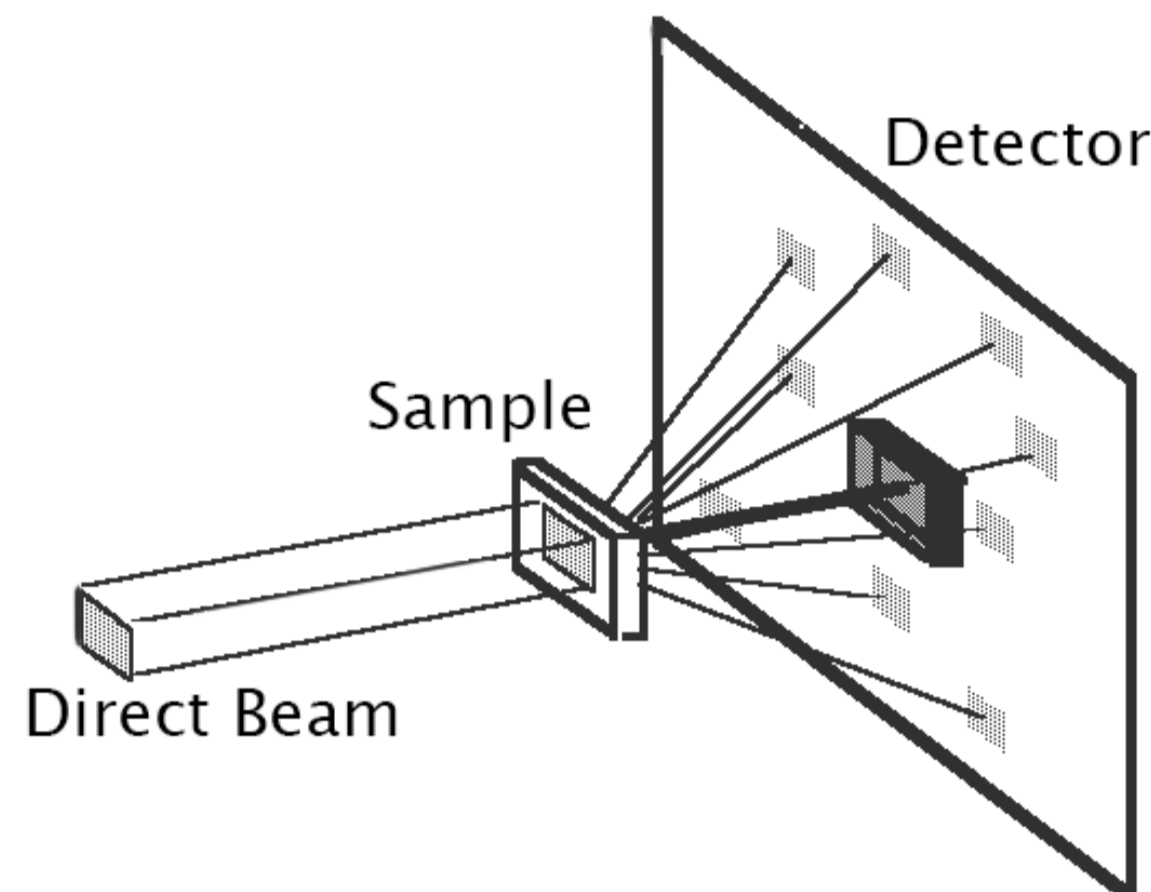
# Development of a Longitudinal Bunch Profile Monitor

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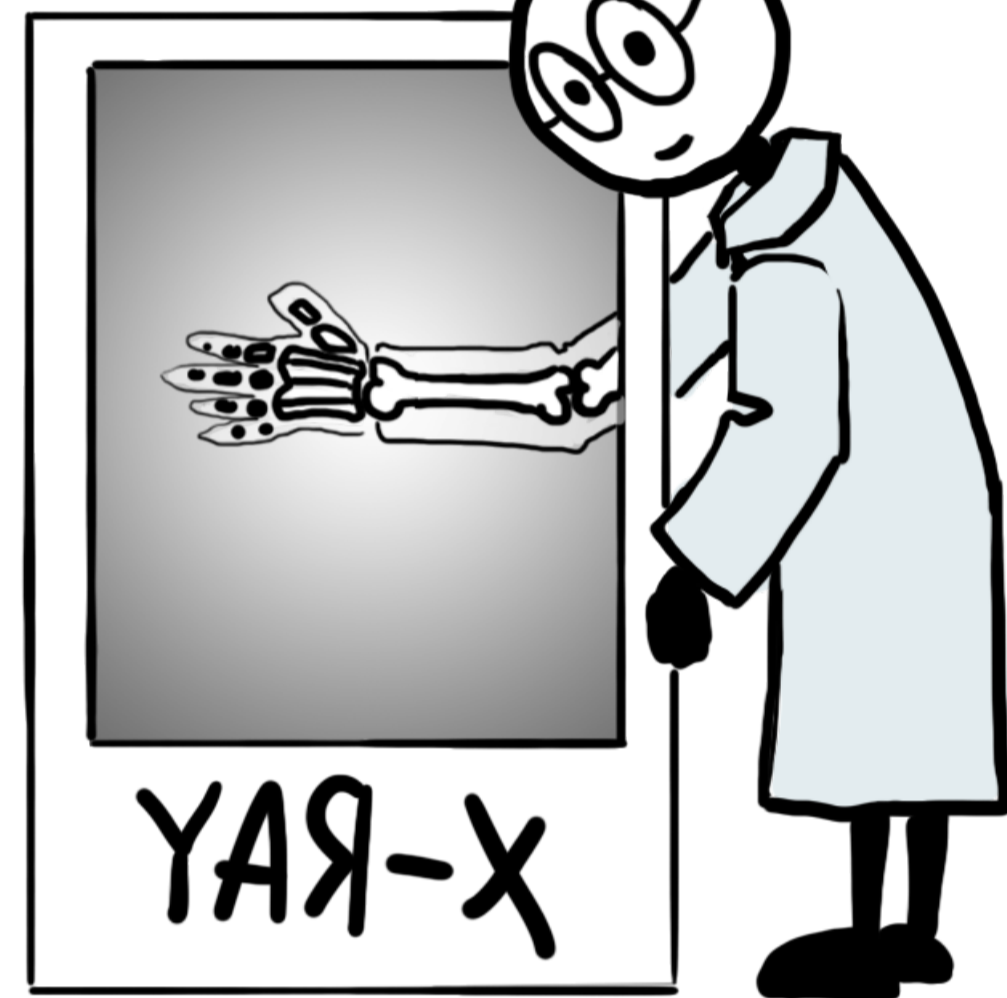
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## How to investigate the inner structure of materials?

### Scheme of typical diffraction experiment



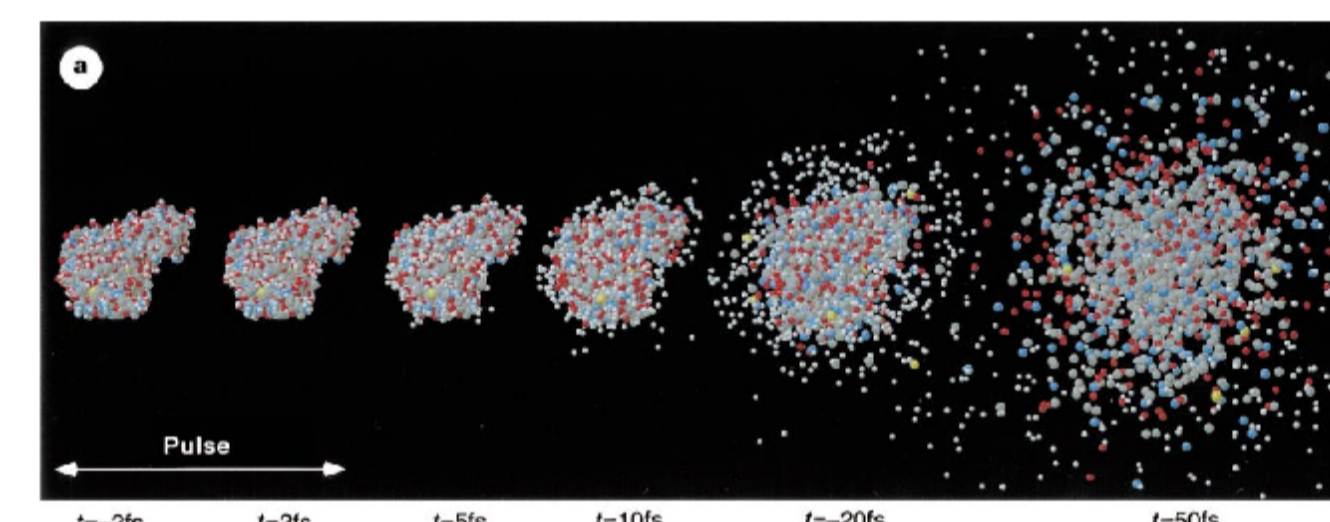
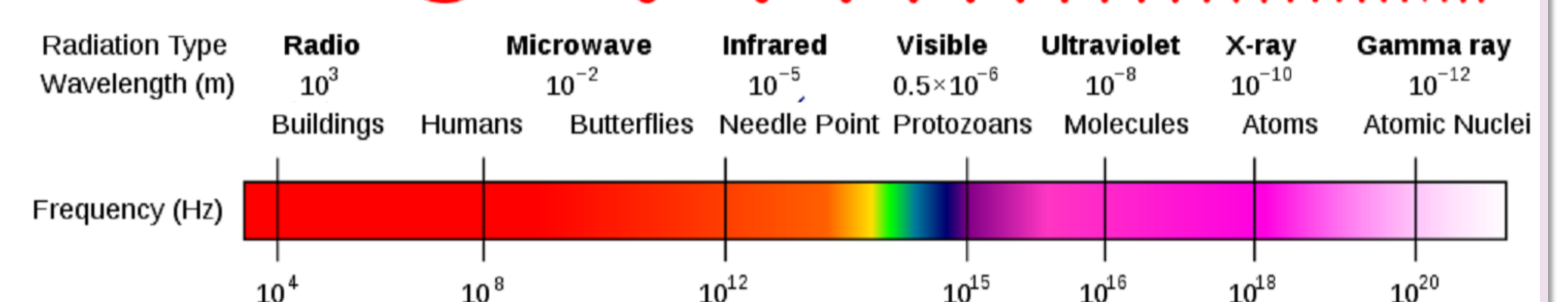
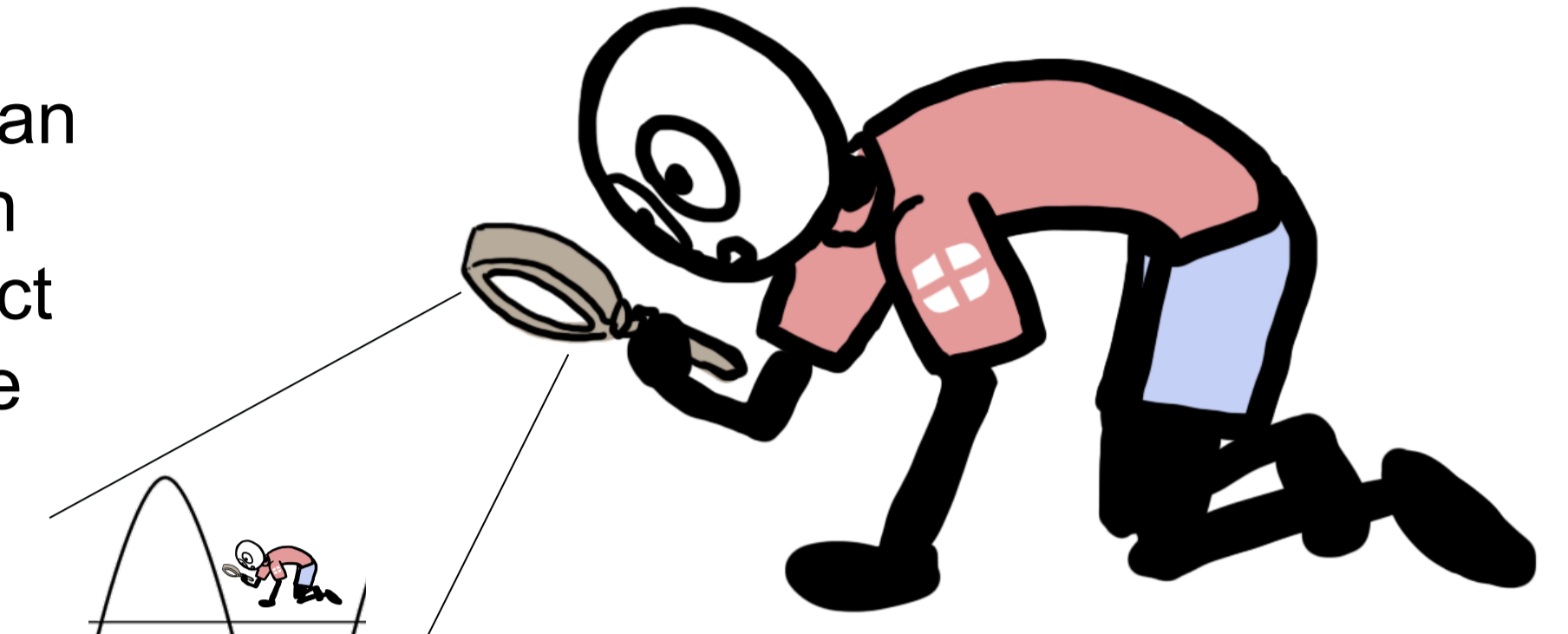
You can reveal the structure of the matter by performing a scattering experiments – light transmission through the material.



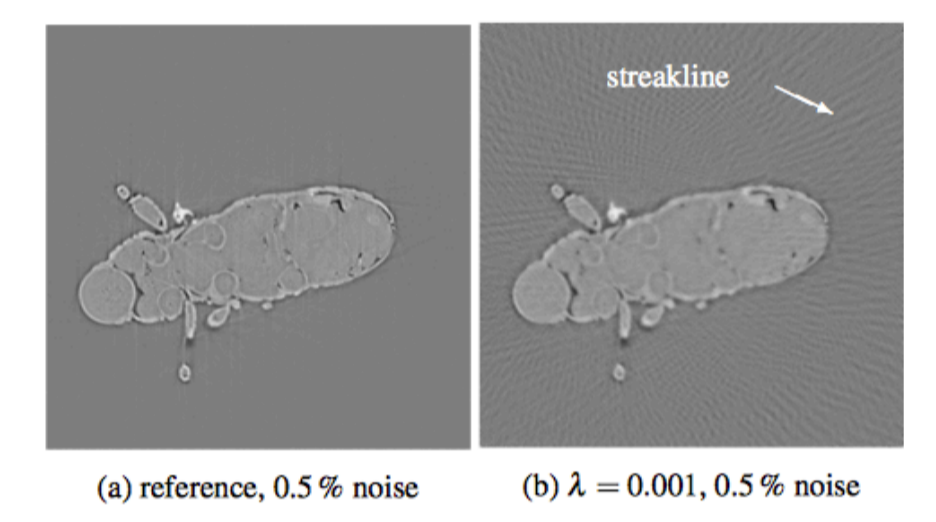
1895: Discovery of X-rays by W.C.Röntgen

## How small could be the structure that I want to measure?

The minimum size of an object is wavelength dependent. The object linear size should be larger than  $\lambda/2$



Explosion of Biomolecule [1]



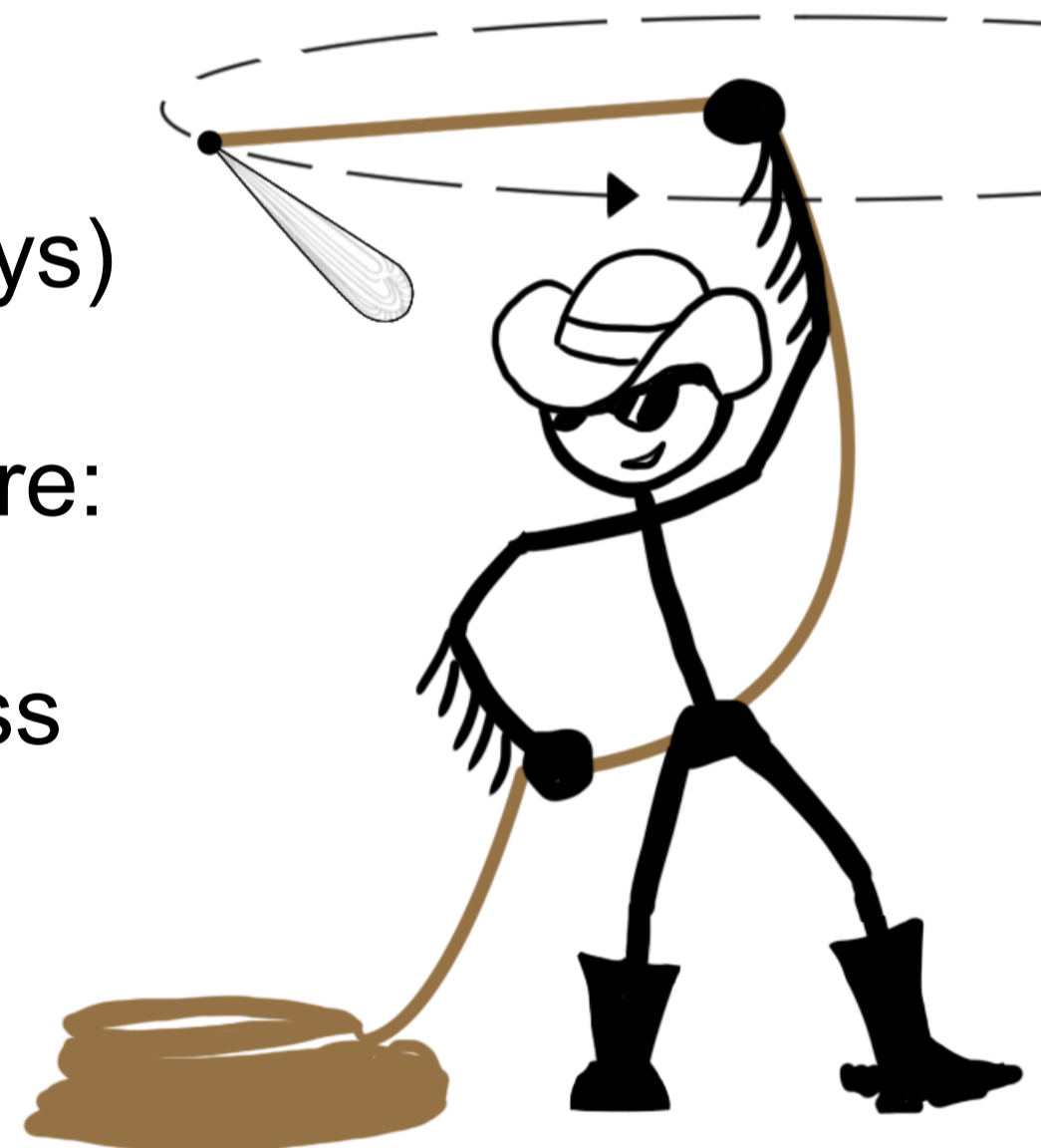
A biological screw in a beetles leg [2]

## Synchrotron radiation concept

- When charged particles are accelerated radially (for example in a bending magnet) - synchrotron radiation emitted.

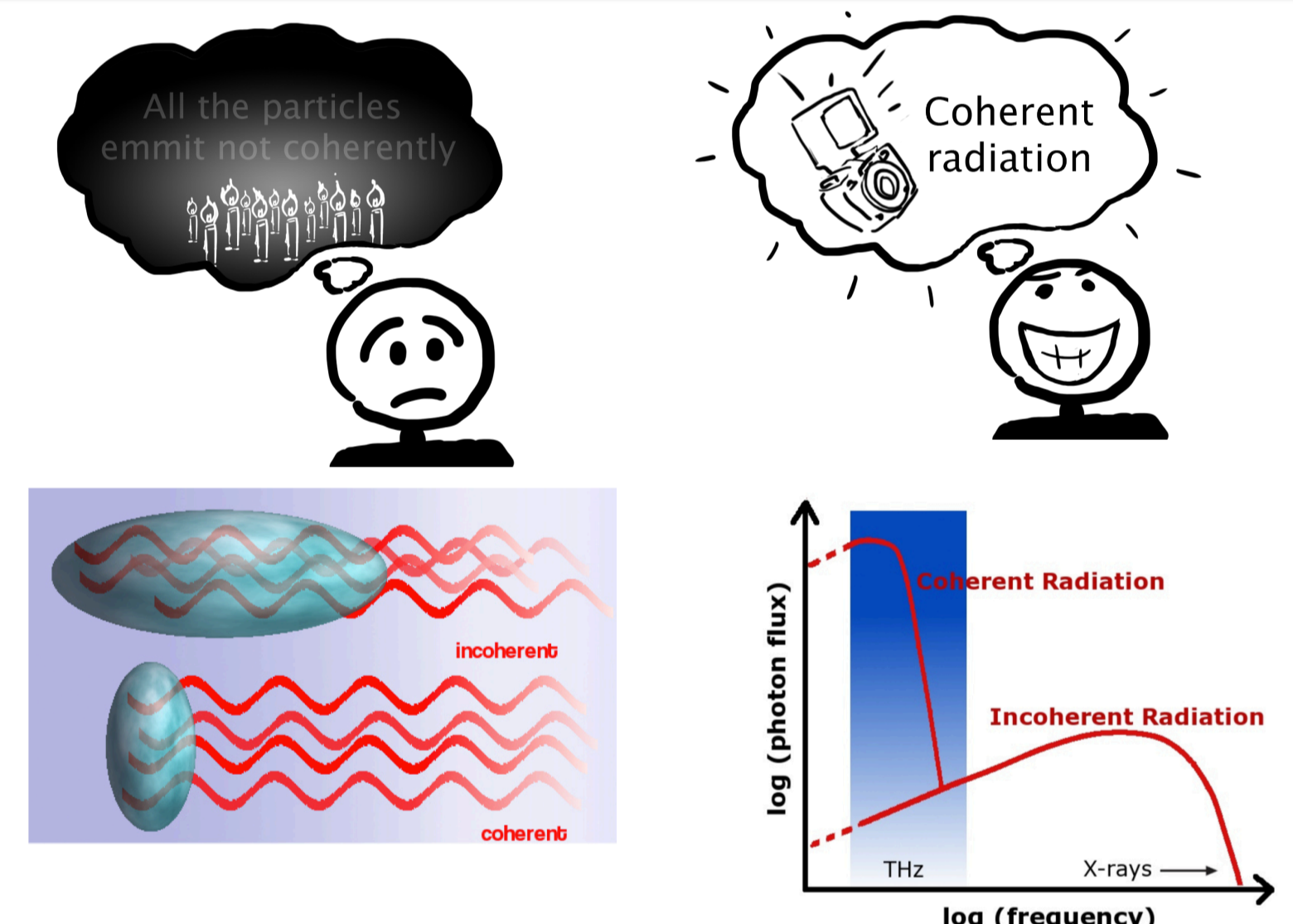
### Properties of synchrotron radiation:

- Broad Spectrum (microwaves to X-rays)
- Pulsed Time Structure: down to tens of picoseconds (process on the same time scale)



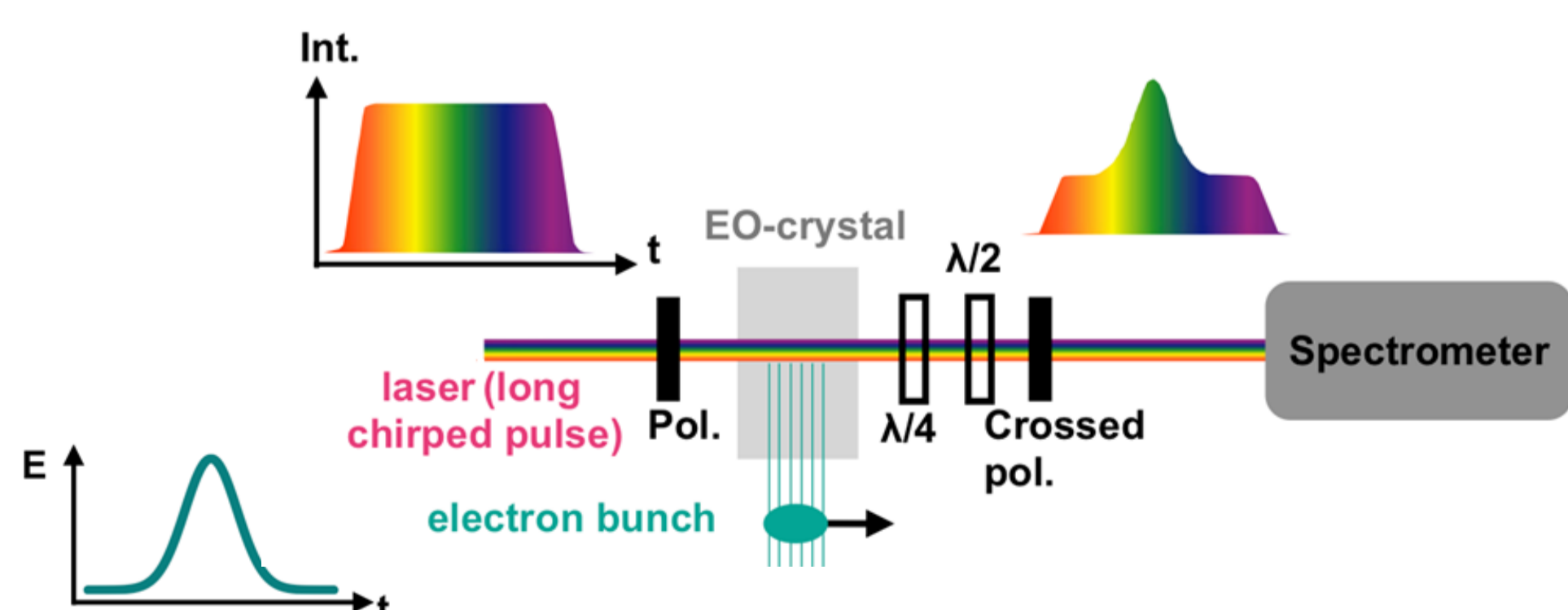
## Generation of coherent radiation

- High Flux: high intensity photon beam
- High Brilliance: highly collimated photon beam generated by a small divergence and small size source (spatial coherence)



In order to study the generated radiation, the charge distribution in a bunch must be monitored!

## Scheme of the EO measurement

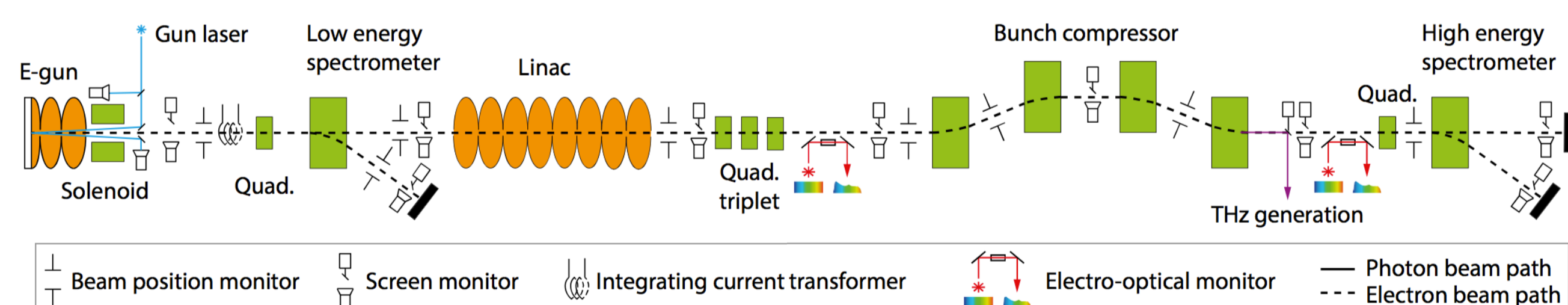


EO crystal examines the Coulomb field of an electron bunch at a specified distance from the electron beam.

## REFERENCES

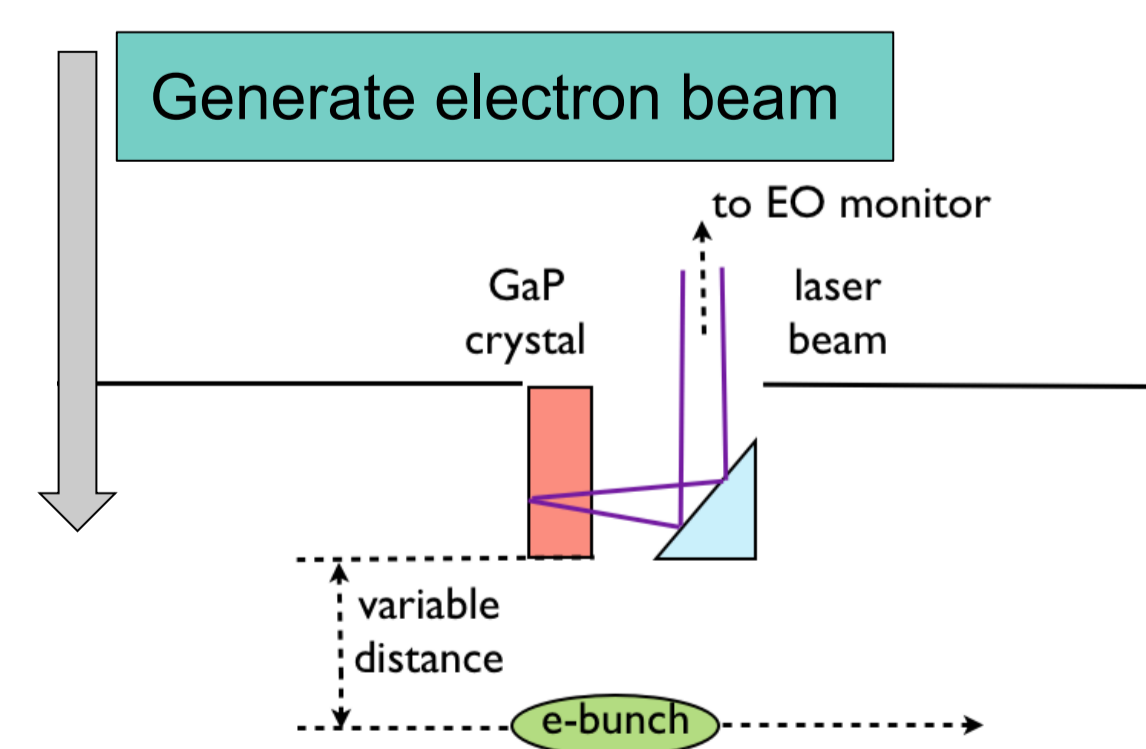
- [1] R. Neutze *et al.*, *Nature* 406, 752-757 (17 August 2000);
- [2] T. van de Kamp *et al.*, *A biological screw in a beetle's leg*, *Science* 333: 52 (2011);
- [3] M. Nasse *et al.*, *Rev.Sci.Instrum.*84, 022705, (2013).
- [4] M. Nasse *et al.*, TUPWA042, IPAC 2015.

## FLUTE Layout & Diagnostics Overview [4]



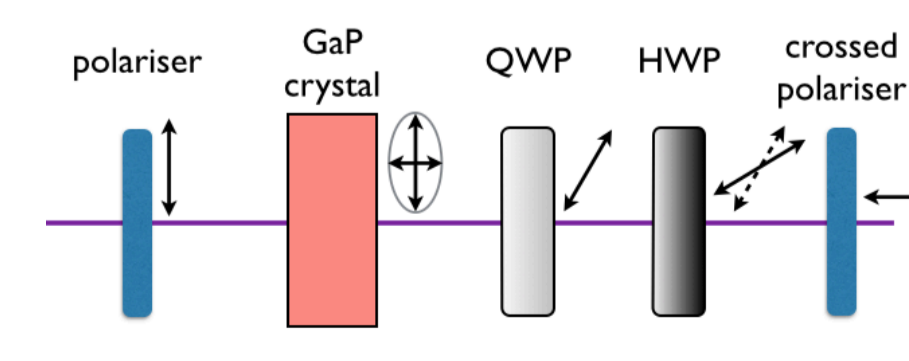
## FLUTE key parameters

Final electron energy	~41 MeV
Electron bunch charge	1–3000 pC
Electron bunch length	~1–300 fs
Pulse repetition rate	10 Hz
Energy / THz pulse	up to ~3 mJ
Power / THz pulse	up to ~5 GW



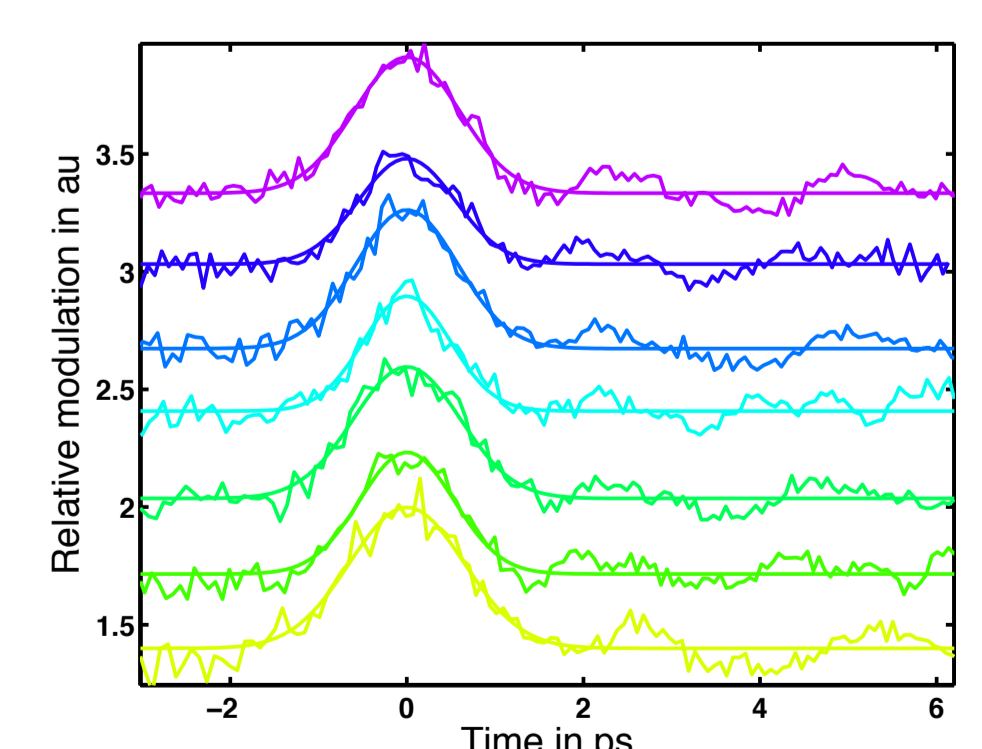
In-vacuum setup

Modulate the field of e-bunch on a laser beam



Nearly crossed polarizer detection scheme

Analyze the modulation on a laser beam



Example of EO measurements (made @PSI SwissFEL ITF)

Find the correlation between the bunch shape and radiation properties

