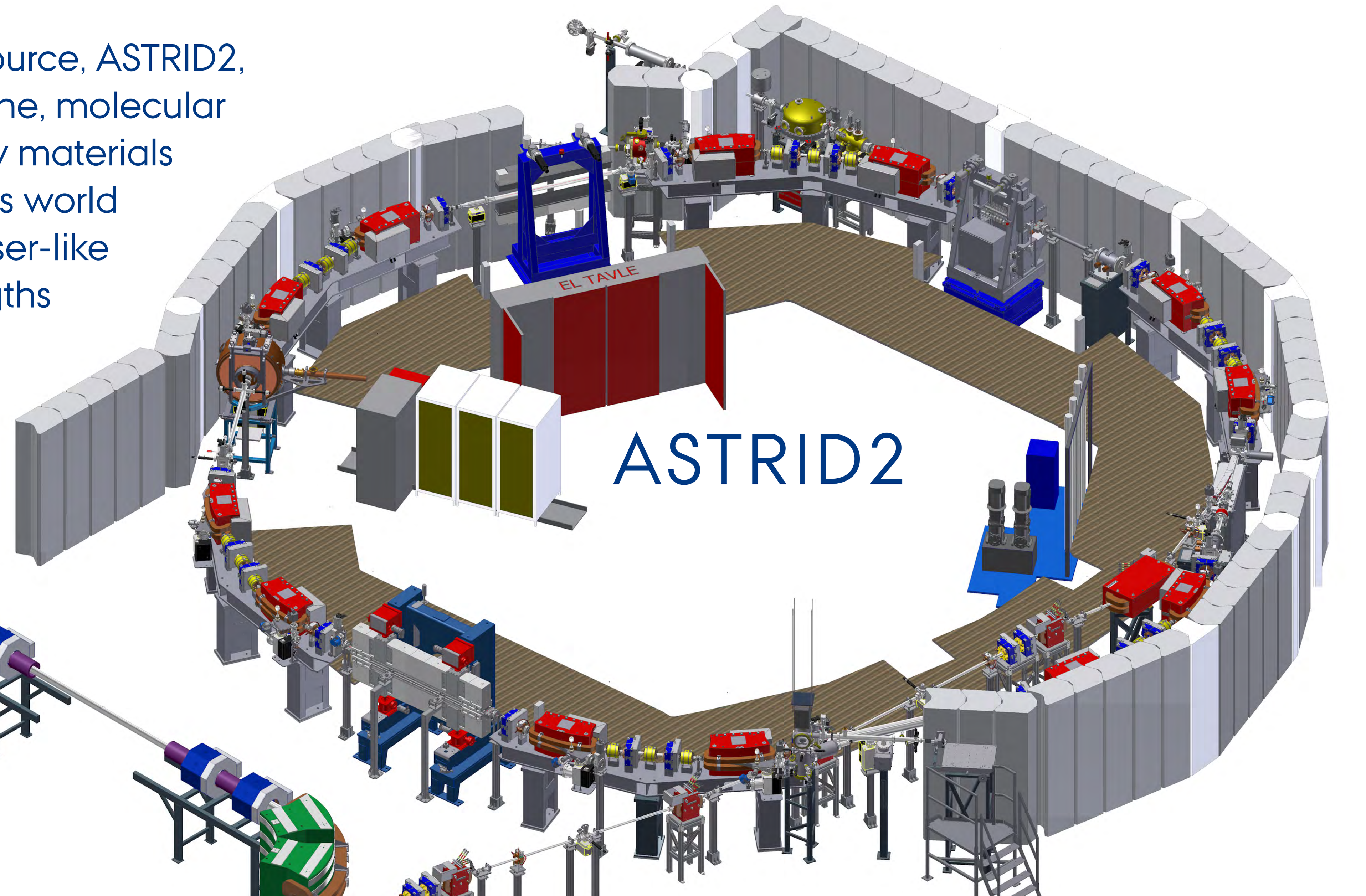
ASTRID2: the new Danish light source

AARHUS UNIVERSITY

The state-of-the art synchrotron light source, ASTRID2, will be used for research within medicine, molecular and cell biology, nanotechnology, new materials and atomic and molecular physics. This world class infrastructure will provide near laser-like beam quality, with tuneable wavelengths from the ultraviolet to the X-ray.



History

1928: Aarhus University founded.
1933: The first Physics Department opens at Aarhus University.
1938: First large accelerator is built, the "high voltage platform".
1974: Physics Department moves into the current buildings.
1991: Inauguration of the ASTRID accelerator.
2009-2013: ASTRID2 is built; inauguration in 2012.

ASTRID

Commissioned in 1991 as a storage ring uniquely for both ions and electrons, ASTRID has operated as a dedicated synchrotron light source since 2006.

The new facility will use ASTRID as a full energy injector for ASTRID2, topping up the current to create an unlimited beam lifetime for the ASTRID2 source.

Many of the beam lines currently on ASTRID will be transferred to the new ring with minor changes in order to take full advantage of the new brilliant light source. A brand new beam line for Atomic, Molecular and Optical physics has also been funded.

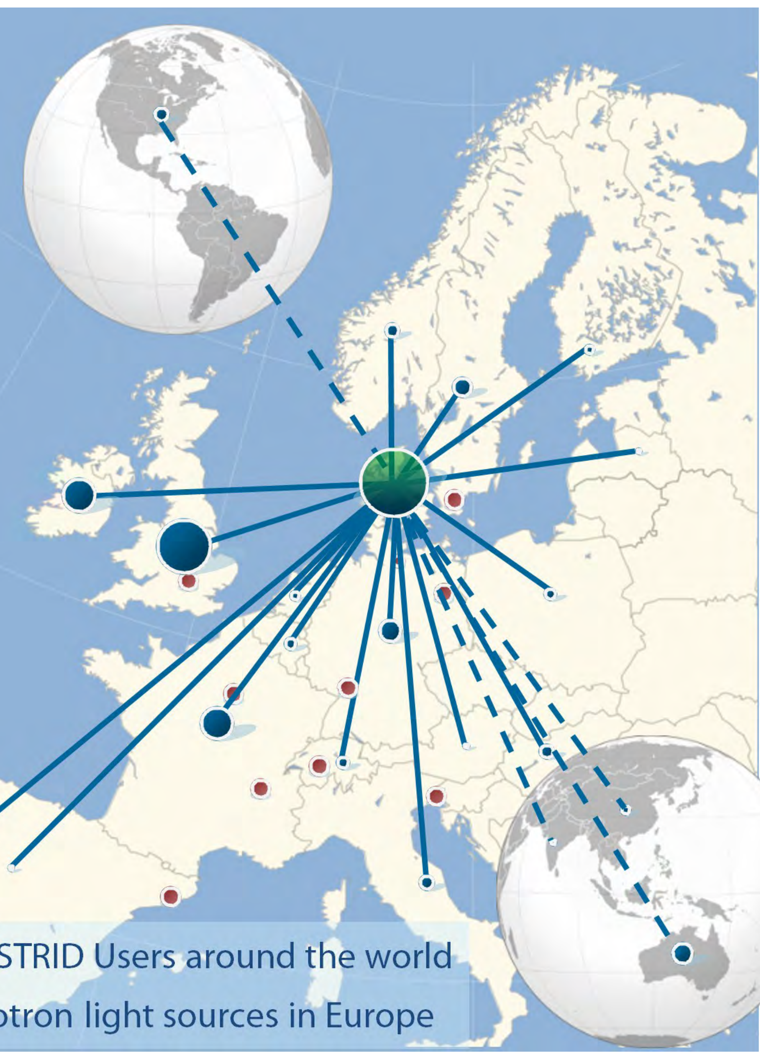
Funding

37 Mkr	The National Programme for Research Infrastructures, the Danish Agency for Science, Technology and Innovation.
~10 Mkr	The Lundbeck Foundation, The Carlsberg Foundation, The Danish Council for Independent Research | Natural Sciences.
12 Mkr	Financing from Aarhus University.
~20 Mkr	Building work, Aarhus University
~100 Mkr	The existing ASTRID accelerator.

International Research

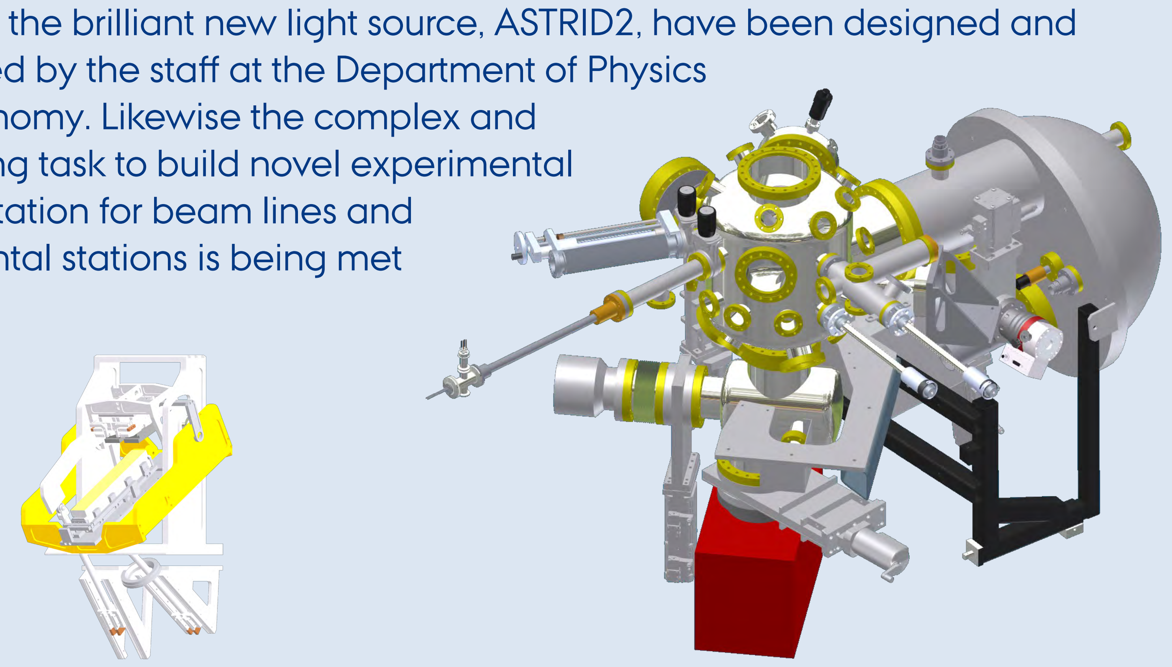
Synchrotron radiation is one of the best tools of today for investigating and understanding nature at the microscopic level. The brilliance of the light from ASTRID2 will allow new science to be performed in which we can, for example, examine drug action, probe new means of fabricating electronics and examine the properties of exotic metals, nanowires and biological molecules.

The facility serves a wide community of scientists from both Denmark and internationally, acting as a powerful catalyst for EU and worldwide collaboration.

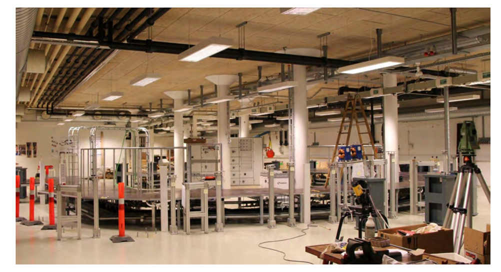


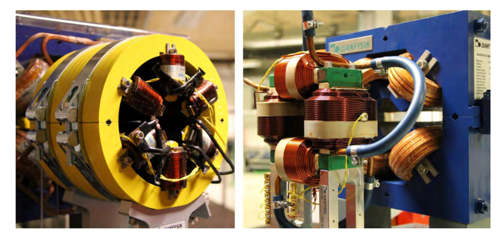
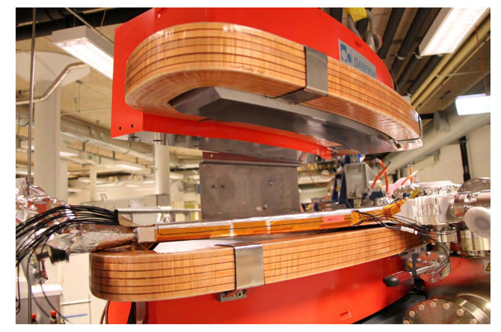
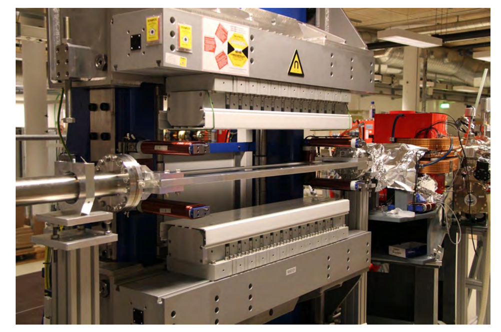
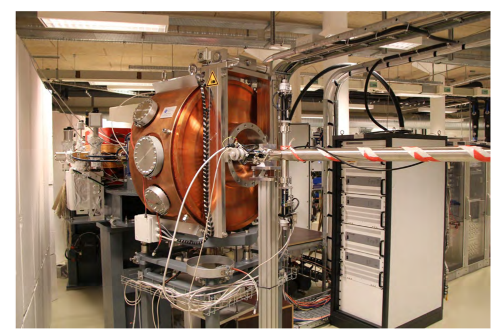
Design Technology

The long-standing accelerator expertise at Aarhus University has meant that all aspects of the brilliant new light source, ASTRID2, have been designed and constructed by the staff at the Department of Physics and Astronomy. Likewise the complex and challenging task to build novel experimental instrumentation for beam lines and experimental stations is being met locally.

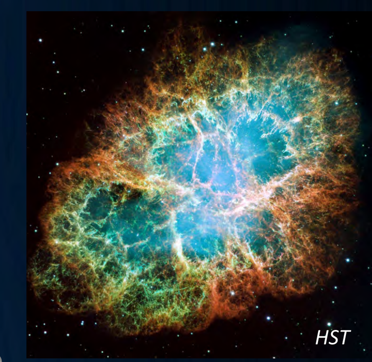


Development of the ASTRID2 machine is based on technological innovations and forms a solid basis for Denmark's knowledge and knowhow in advanced accelerators, especially relevant for particle beam cancer therapy.

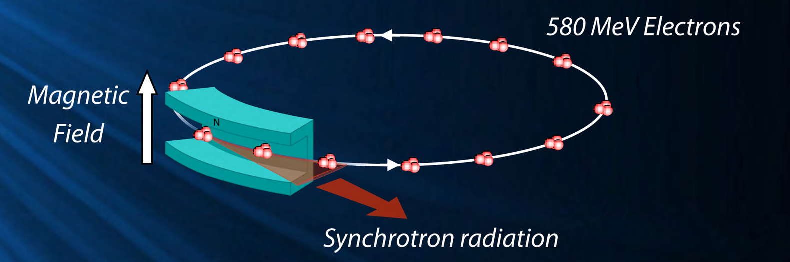

Synchrotron Radiation

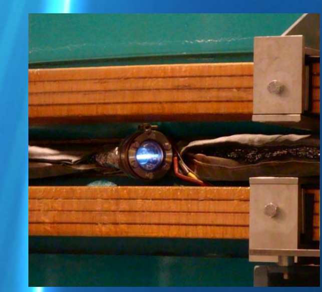


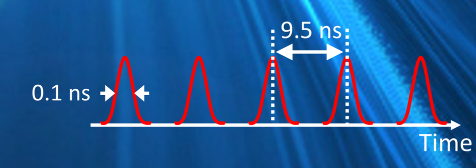
Synchrotron radiation is the name given to the electromagnetic radiation which is emitted by relativistic electrons being deflected by a magnetic field.

Synchrotron radiation occurs naturally in space where relativistic electrons spiral through magnetic fields, an example of this can be seen in the Crab Nebula (picture to the right).

Synchrotron radiation can also be produced artificially using a synchrotron storage ring such as ASTRID2. When electrons in the ring are accelerated to speeds close to that of light, radiation is emitted within a narrow cone in the direction of motion.

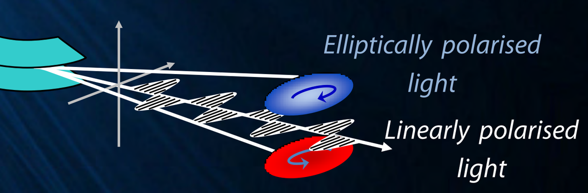


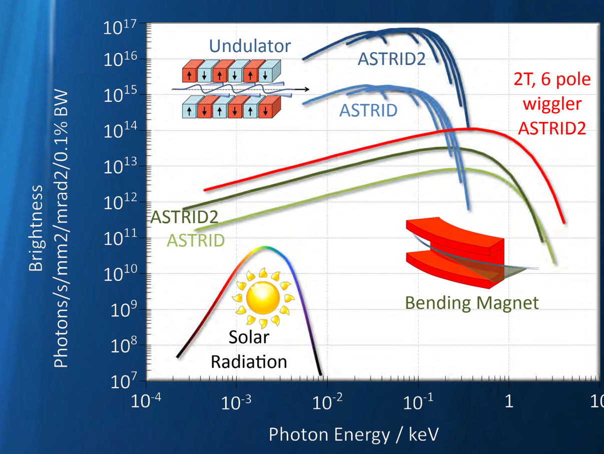




There are 16 bunches of electrons in ASTRID2. The light from one bunch of electrons appears as a flash of radiation with only 9.5 ns between each flash of light, so fast that to the human eye the light emitted appears to be constant.

The polarisation of the radiation emitted from a bending magnet is linear in the plane of the electron orbit. Above and below the plane the radiation is elliptically polarised. The degree of polarisation is dependent on both the viewing angle and the wavelength of the radiation.





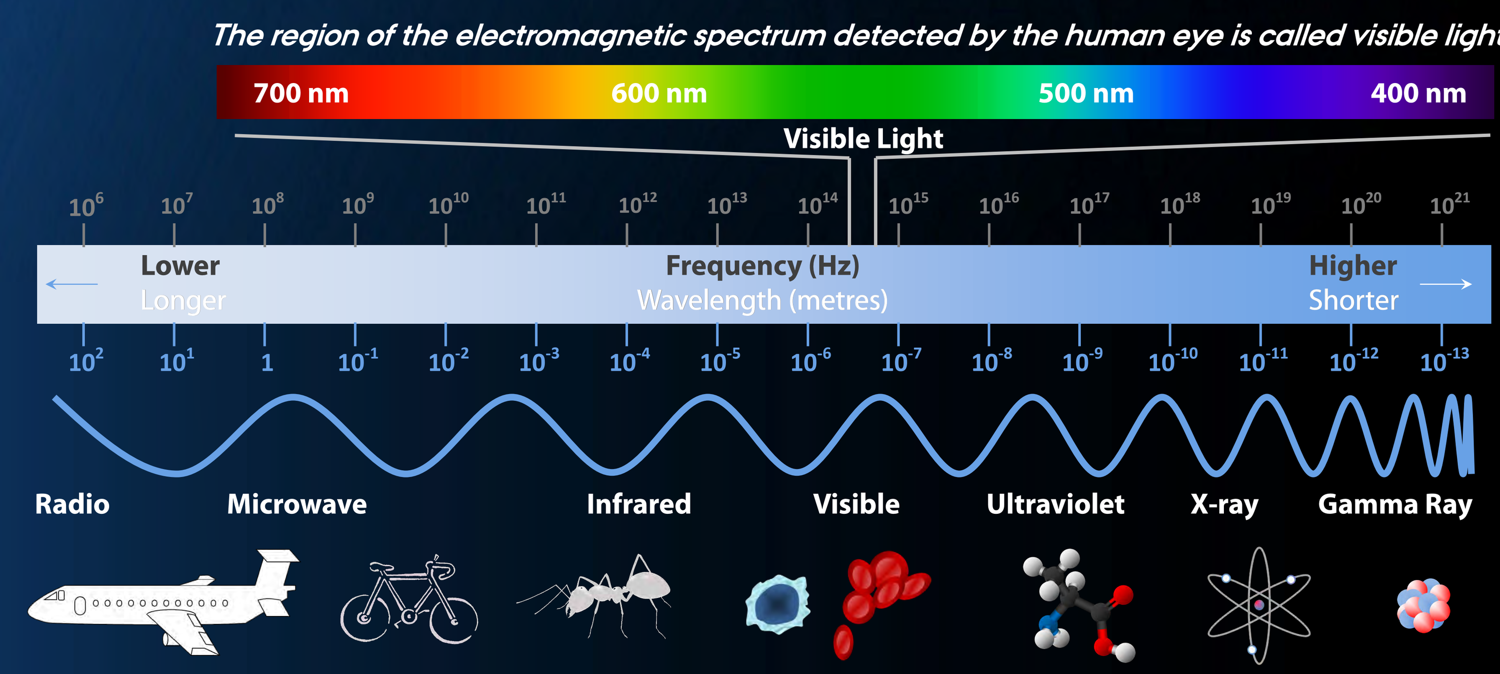
Brightness of synchrotron radiation from ASTRID2

The main advantages of synchrotron radiation from a storage ring over radiation from conventional sources are:

⇒ The spectrum of light is continuous from the infrared region to soft X-rays.
⇒ A high level of polarisation of the light (linear or elliptical).
⇒ The brightness is many orders of magnitude times higher than conventional sources.
⇒ The beam has a time structure.

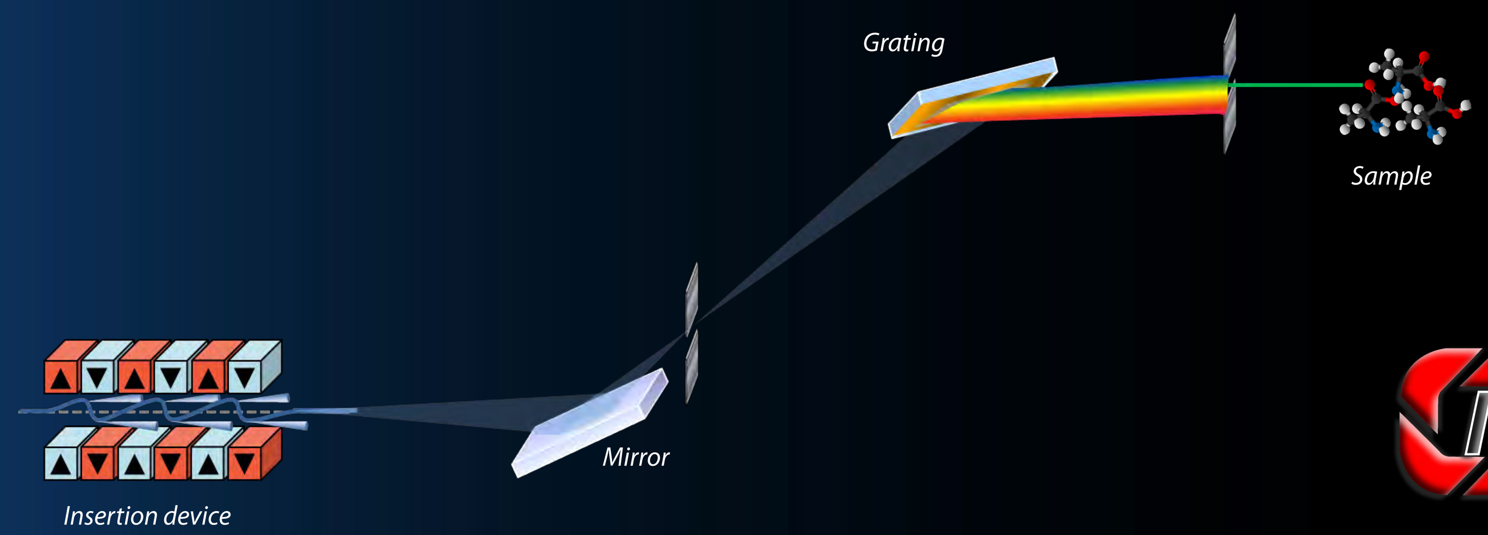
The Electromagnetic Spectrum

The electromagnetic spectrum is the entire range of wavelengths (or frequencies) of electromagnetic radiation, from the longest radio waves used, for example, to detect aircraft, to gamma rays which are used in positron emission tomography (PET) and cancer radiation therapy. Visible light is only a small part of the spectrum.



Beam lines

The instrumentation required to guide photons from the synchrotron storage ring to an experimental end station is called a *beam line*. Typically consisting of mirrors and a grating so that a specific energy of photons can be selected, a beam line focuses the light onto or through a sample under investigation.



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