The European X-Ray Free-Electron Laser facility (European XFEL) is one of first ESFRI projects under implementation. Construction started in January 2009. From end of 2016 on, European XFEL will generate intense, ultrashort and coherent X-ray flashes of unique properties for scientific applications. Researchers from all over the world will use this international facility to investigate nanometer-scale structures, fast processes, and extreme states, taking 3D images of viruses or proteins, and filming chemical reactions. The fundamental research will benefit applications in energy research and new materials and life sciences.

**Accelerator technology**

Construct high brightness superconducting electron accelerator for the production of high brightness X-ray radiation. Industry produced accelerator components must yield high performance at reasonable cost.

- **CRISP input**: Develop cavity inspection techniques allowing to analyse industry produced accelerator cavities in case of insufficient performance.
- **CRISP input**: Improve production yield of superconducting cavities, recover performance and produce benefit to future accelerator projects.

**Detector technology**

New requirements to speed, dynamic range, radiation hardness asked for new detectors

- 3 developments: LPD, AGIPD, DSSC
- dynamical gain & single phot. sensitivity
- store images on chip; delayed readout
- high integral data rate of 10GB/s per detector

- **CRISP input**: cooling technologies to remove energy
- beyond: technology limitations call already for improvements

**Facts**

- 3.4 km long facility from the DESY site in Hamburg to Schenefeld in Schleswig-Holstein
- 1.7 km long 17.5 GeV superconducting linear accelerator generating 27 000 flashes/sec
- Peak brilliance 10⁸ times higher than that of most advanced synchrotron sources
- Construction cost: 1.15 B€ (2005 price level)
- Preparation project Pre-XFEL: 5 M€ (EC)

**Experiments**

Exp. stations integrate various types of ancillary instrumentation

- X-ray delivery & optics
- 2D detectors, diagnostics
- sample delivery systems
- optical laser systems

- Large challenges to new developments
- **CRISP input**: How to employ optical lasers at MHz rates and how to best utilize industry developments

**Data acquisition & processing**

Flexible architecture for data handling

- Multiple layers and slice architecture
- Insertion of new technology
- Scaling & partitioning ability
- Data reduction schemes

- Technologies: TCA crates (PICMG MTCA.4, ATCA); ext. FPGA usage (Xilinx); 10 Gbps UDP & TCP protocols; 1 Gbps low latency feedback; high performance compute and GPU clusters
- **CRISP input**: common timing IF; early frame real-time VETO; FPGA & imaging framework; high speed data recording & access