Conceptual design of the "Fast Processes" beamline at the SRF SKIF 4th generation synchrotron

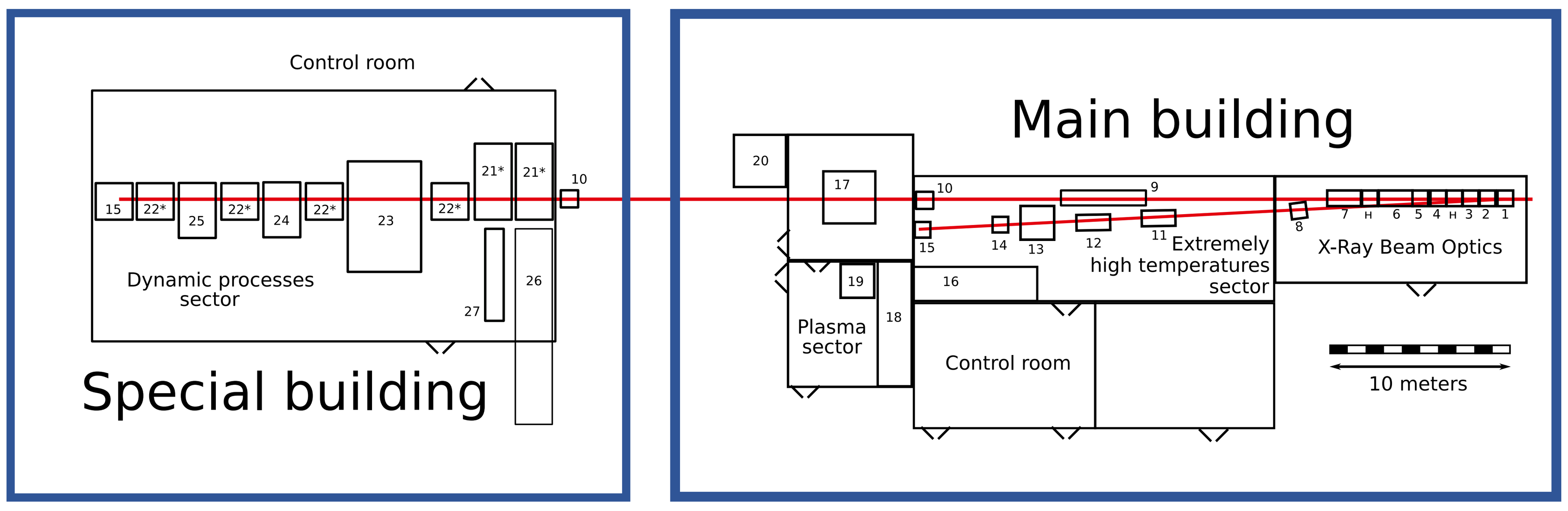
I.A. Rubtsov[1,2], K.A. Ten[1], E.R. Pruuel[1], A.O. Kashkarov[1], A.S. Arakcheev[3], B.P. Tolochko[4], A.I. Ancharov[4], Ya.V. Zubavichus[2], Ya.V. Rakshun[2,3]

[1] Lavrentyev Institute of Hydrodynamics SB RAS, Novosibirsk, Russia
[2] Boreskov Institute of Catalysis SB RAS, Novosibirsk, Russia
[3] Budker Institute of Nuclear Physics SB RAS, Novosibirsk, Russia
[4] Institute of Solid State Chemistry and Mechanochemistry SB RAS, Novosibirsk, Russia

General info

SRF SKIF (Shared Research Facility "Siberian circular photon source") is a 3 GeV, 4th generation national synchrotron photon source to be built in Novosibirsk scientific center (Russia). Commissioning of the beamline is scheduled for 2024.

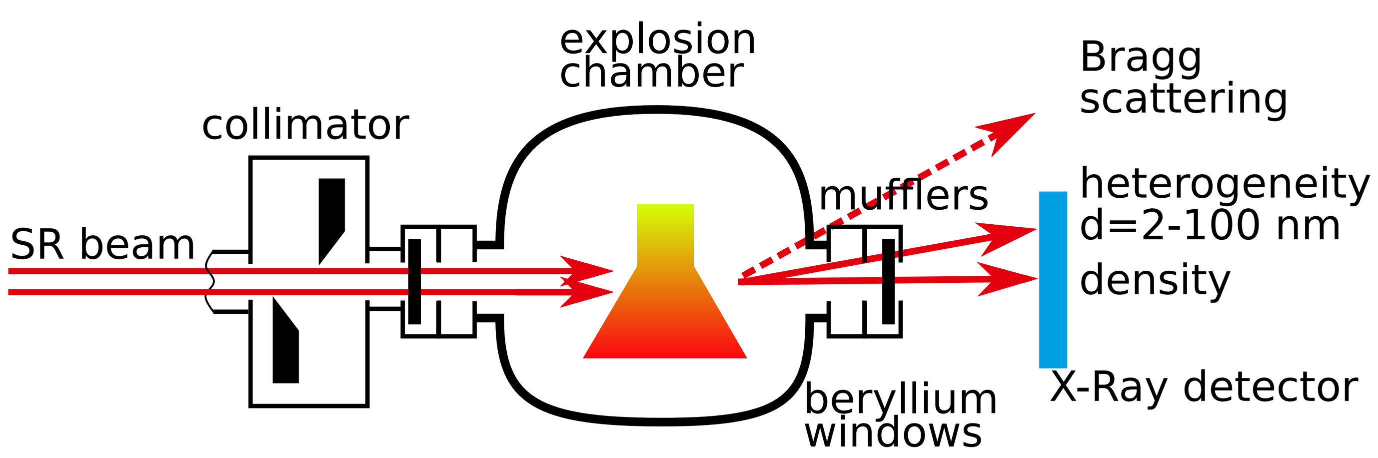
"Fast Processes" is one of six first priority beamlines that are planned for construction within this project. The beamline would include three independent sectors installed at a **wiggler source**, such as Dynamic processes, Plasma, and Extremely high temperatures. The beamline is designed to meet a wide range of research and technological challenges related to processes occurring at nano- and microsecond timescales. The current conceptual design of the beamline aims at a complex approach to structural studies of various objects relying on high-brightness synchrotron radiation beams.



General scheme of the Fast Processes beamline

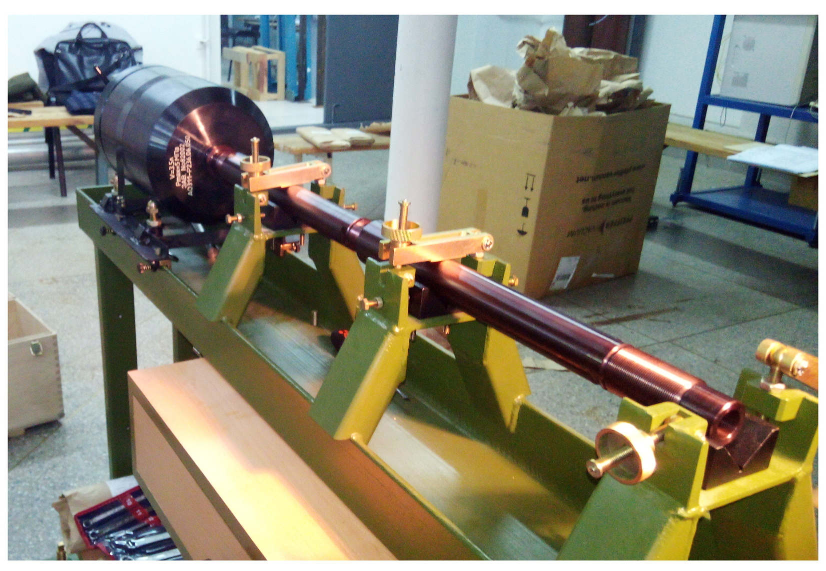
Dynamic processes sector

- **Dynamic behavior of materials and structural elements under shock loading.** The scope includes: the structure of the shock wave front, equations of state, phase transitions under compression, chemical reactions, high-rate deformations and fracture of materials, the dynamic formation of nanostructures.
- **Properties of high-energy materials.** Studying of dynamic characteristics (combustion, initiation and detonation) of industrially used and promising new high-energy materials (HEMs).

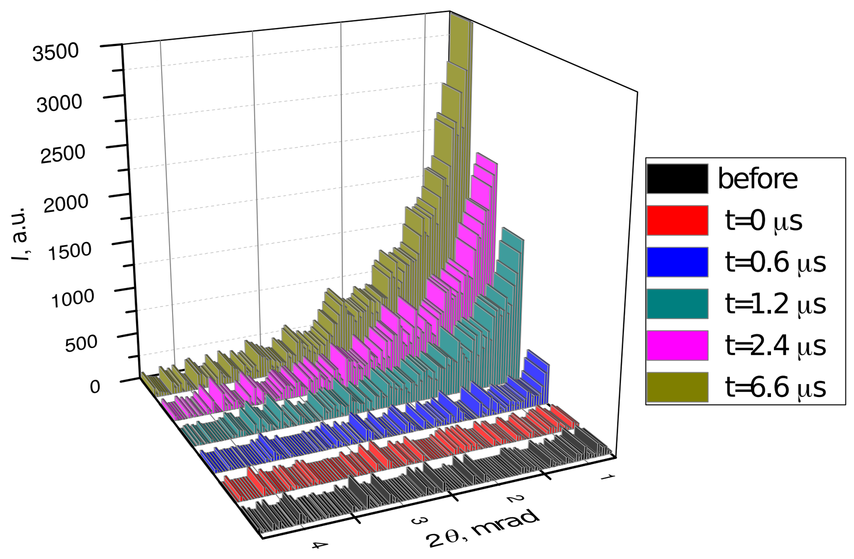


General scheme of the experiments

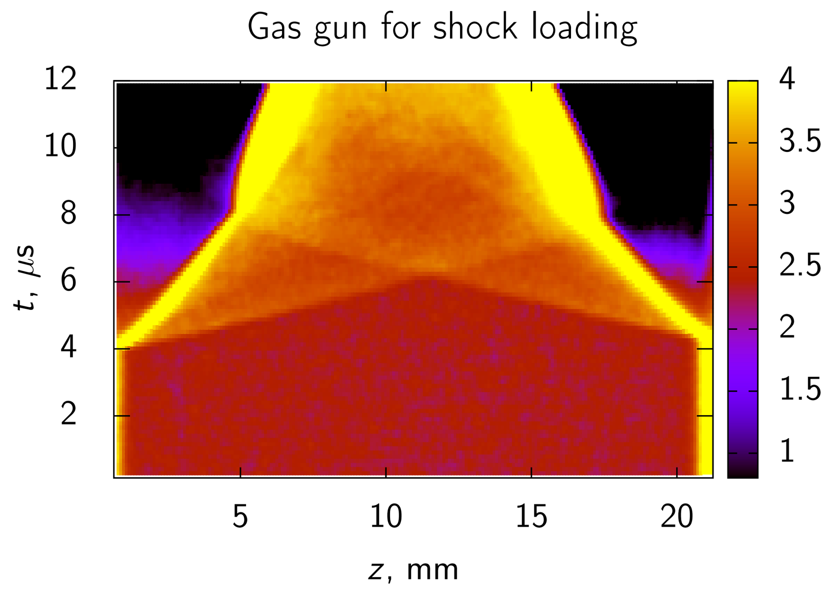
Explosion chamber for 2 kg of HEMs



Gas gun for shock loading



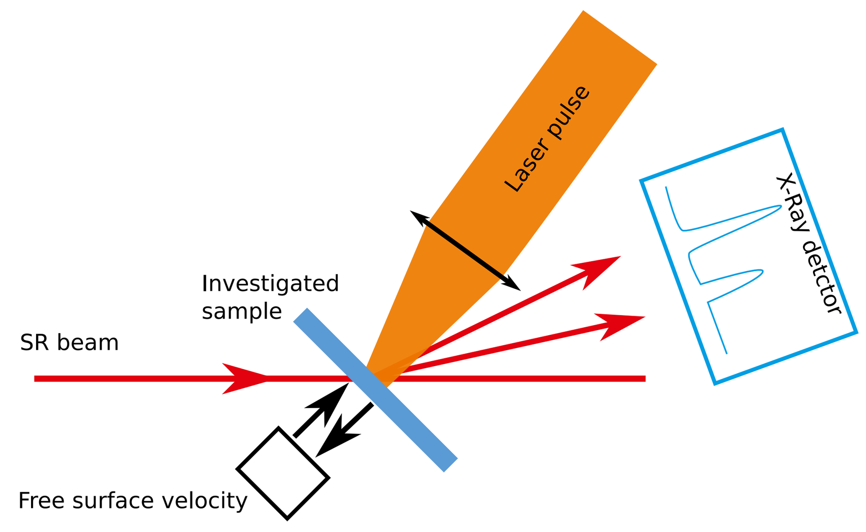
SAXS during TNT/RDX detonation



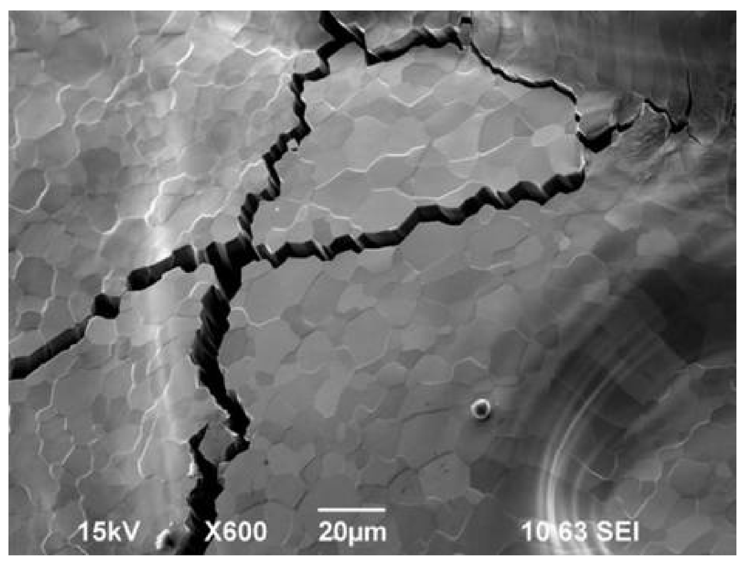
X-Ray imaging of shock loading

Plasma sector

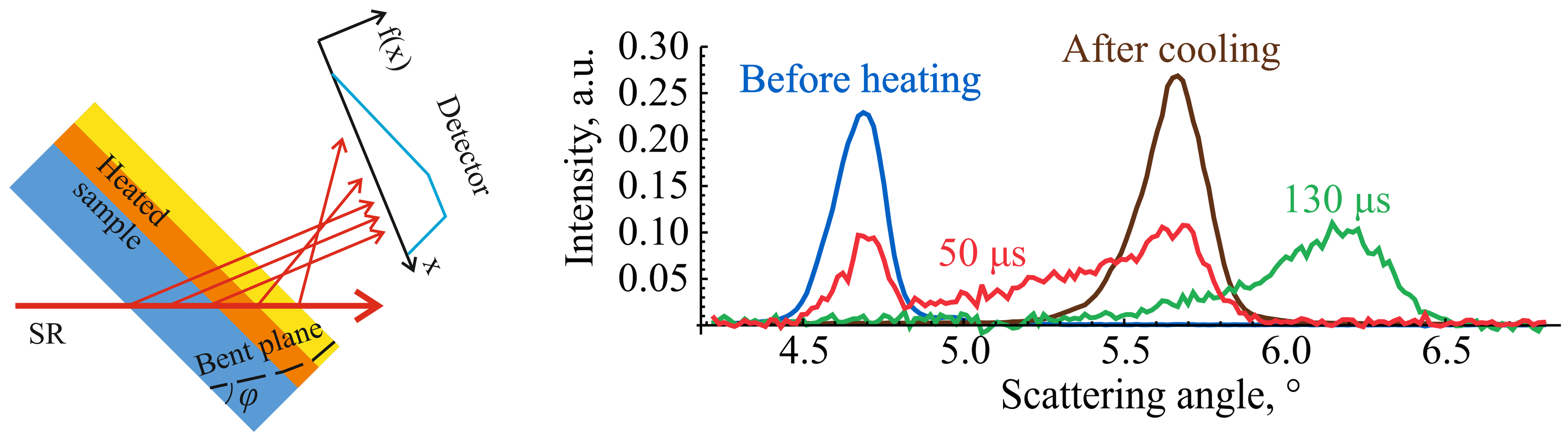
- **Investigation of the impact of high-power pulsed heating and plasma on materials simulating a fusion reactor.** The behavior of the material structure under the influence of pulsed heat load, deformation of the material at significant temperature gradients, the influence of plasma on the material.
- **Study of the impact of pulsed laser radiation (terawatt) on the substance.** Generation of super-strong (hundreds of GPa) shock waves. Equation of state under these conditions.



General scheme of the experiments



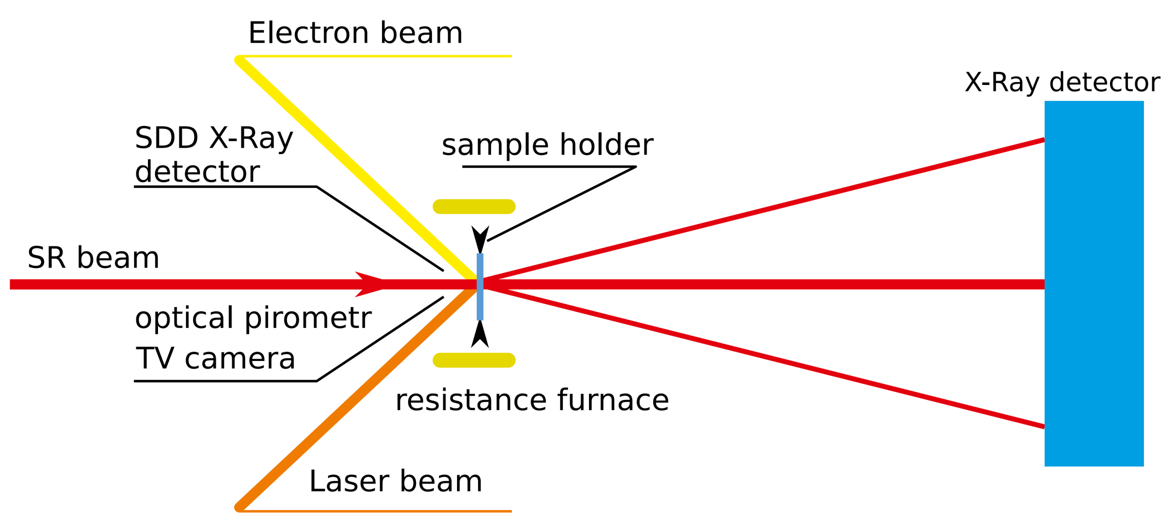
Crack in tungsten after pulsed plasma load



Principle scheme of the experiment (left), and dynamics of the 110 diffraction peak of 100 single-crystal tungsten during pulsed heat load (right).

Extremely high temperatures sector

- **Materials science problems (annealing, recrystallization, texturing) at high temperatures.** Studies of the structure of substances at high temperatures.
- **High-temperature synthesis of refractory materials (oxides, borides, carbides) under e-beam and laser irradiation (real-time monitoring).** Production of refractory composite materials for parts of hypersonic aircrafts, spacecrafts, and nuclear reactors.



General scheme of the experiments

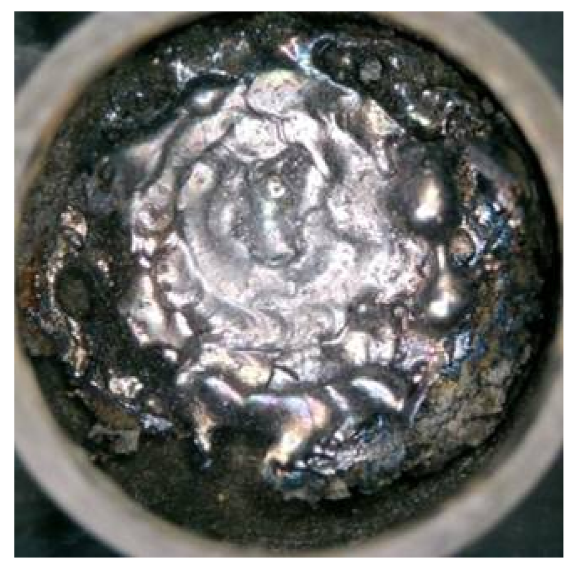


Image of the surface of fused carbide

Research techniques:

- High-speed radiography and tomography (X-Ray Imaging), time resolution to 1 ps;
- Time-resolved small angle X-Ray Scattering, time resolution to 10 ns;
- Time-resolved X-Ray Diffraction, time resolution to 100 ns.

Main types of detectors:

- DIMEX detector - BINP SB RAS
- Nanogate cameras - Nanoscan Ltd.
- Streak camera - Hamamatsu Photonics, PGPI RAS
- PILATUS3 X CdTe 2M detector - Dectris Ltd.