Upcoming studies of runaway electrons at the COMPASS tokamak

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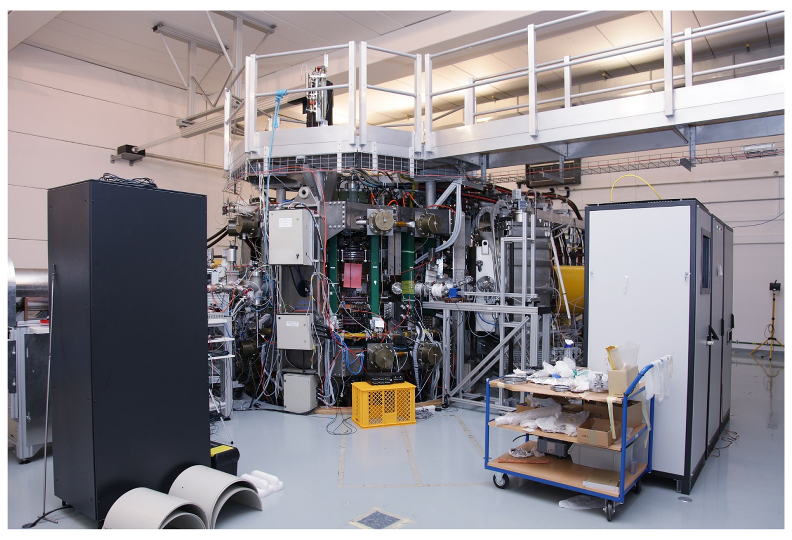
COMPASS tokamak



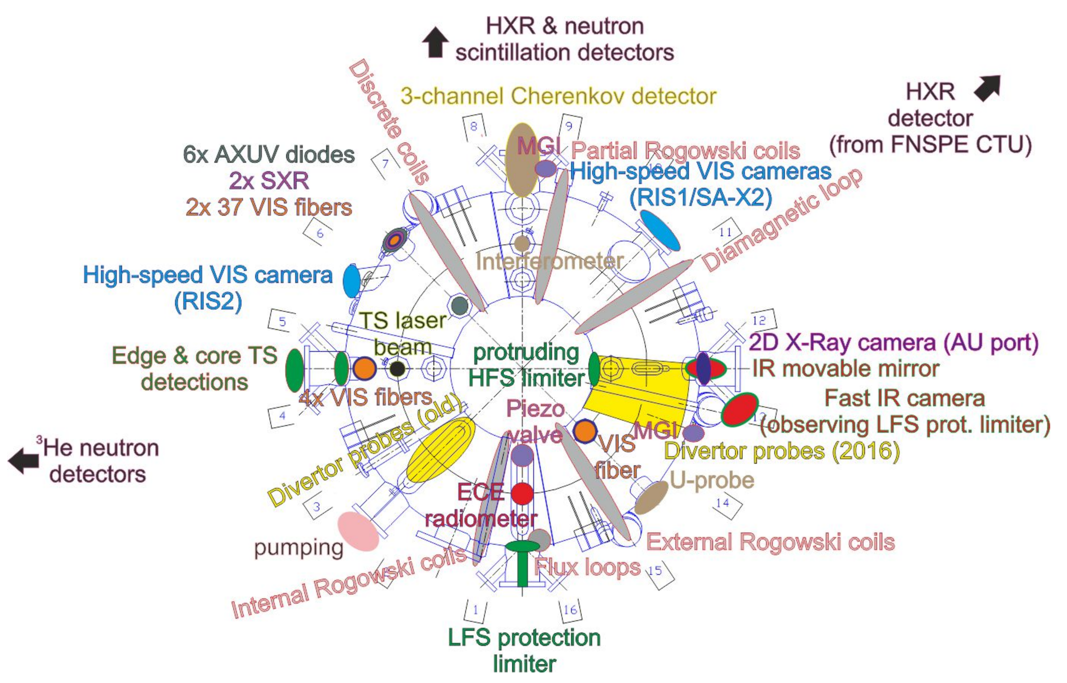
- the tokamak COMPASS is compact size tokamak located in Prague
- fields of research: H-mode physics, physics of plasma edge, plasma wall-interaction, physics of runaway electrons and disruptions etc.

R [m]	a [m]	I_p^{max} [kA]	B_T [T]
0.56	0.23	400	0.9-1.56

Runaway electrons

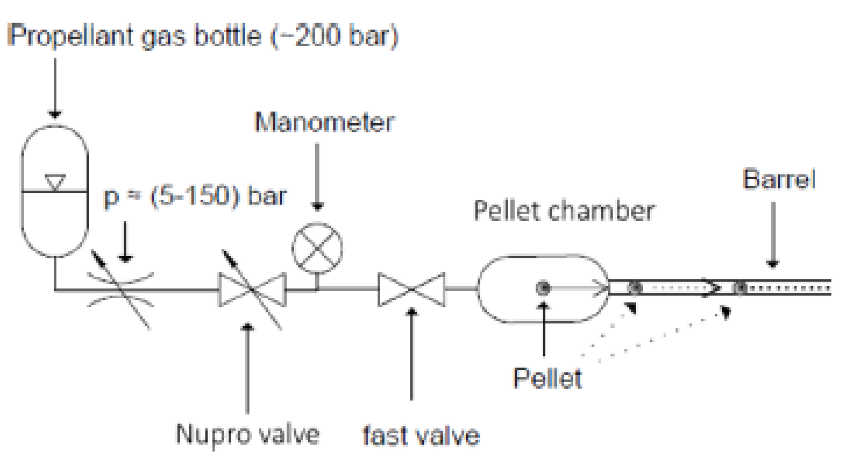
- runaway electrons (REs) are high energetic particles, which could cause damage by impact to the first wall of the tokamak → a threat to future fusion devices
- in tokamaks RE are created during low density discharges die to smaller friction force and during disruptions due to the high induced electrical field
- strong post-disruptive currents of RE are expected in ITER
- phenomenon of RE in not only matter of tokamak physics → lighting strikes

Overview of diagnostics

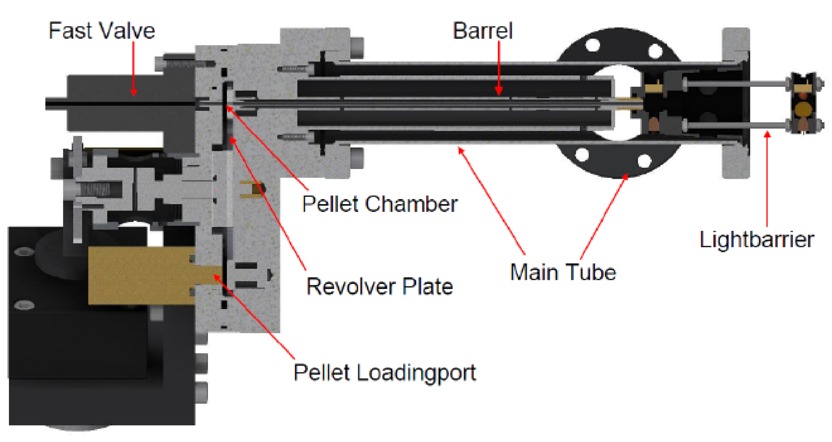


- useful diagnostics for RE studies: HXR scintillation detectors (NaI(Tl),YAP), neutron detectors, Cherenkov detector, V-ECE, fast cameras
- rich set of magnetic diagnsotics: three full poloidal rings of Mirnov coils, one ring of IPR
- high resolution Thomson scattering system

Room temperature solid state pellet injector (RTSPI)

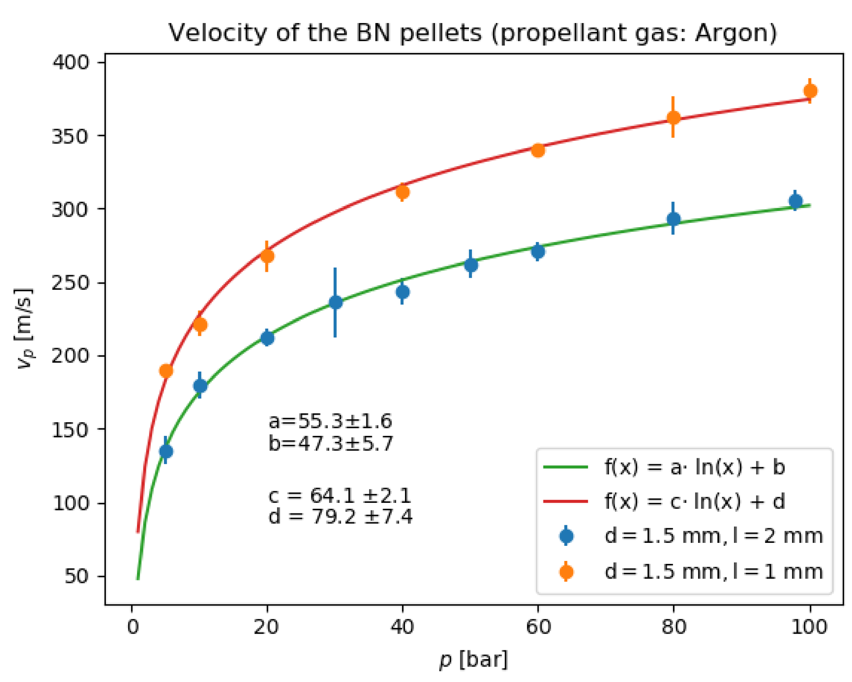


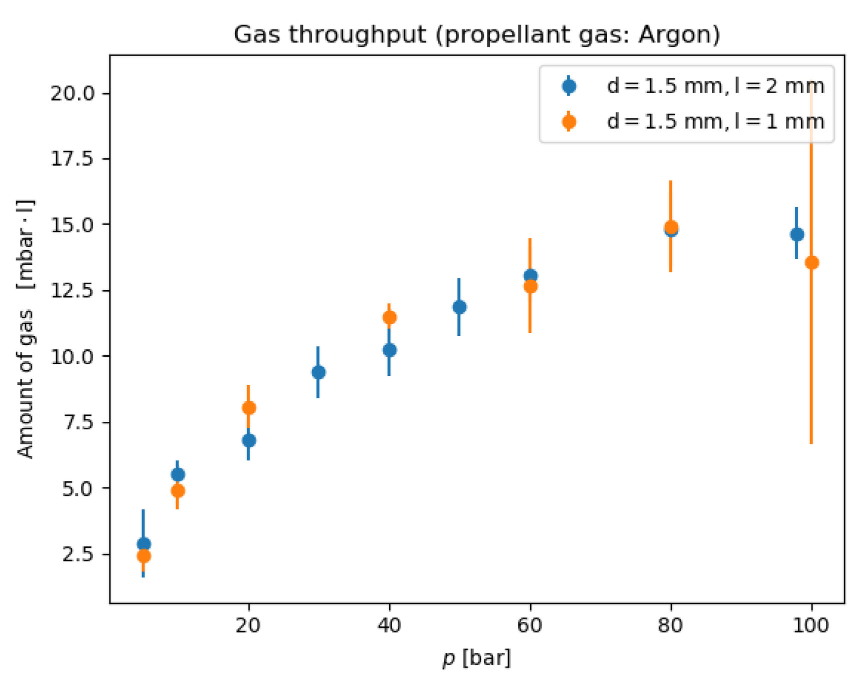
- designed for ASDEX Upgrade
- capable of launching solid pellets at room temperature by a pressurised gas pulse
- pellets dimensions: up 2 mm in height and up 1.5 mm in diameter



- compatible pellet materials: carbon, steel, tungsten
- maximum repetition rate: 2 Hz
- maximum operation pressure: 150 bar

Characterisation of RTSPI





- maximum attainable velocities with Argon ≈ 400 m/s (small pellets)
- ability of firing smaller pellets than holes in magazine was verified
- gas throughput need to be reduced → design of system of expansion vessels ($V \approx 300$ l)
- scattering angle of pellets ≈ 1°

Experimental plans

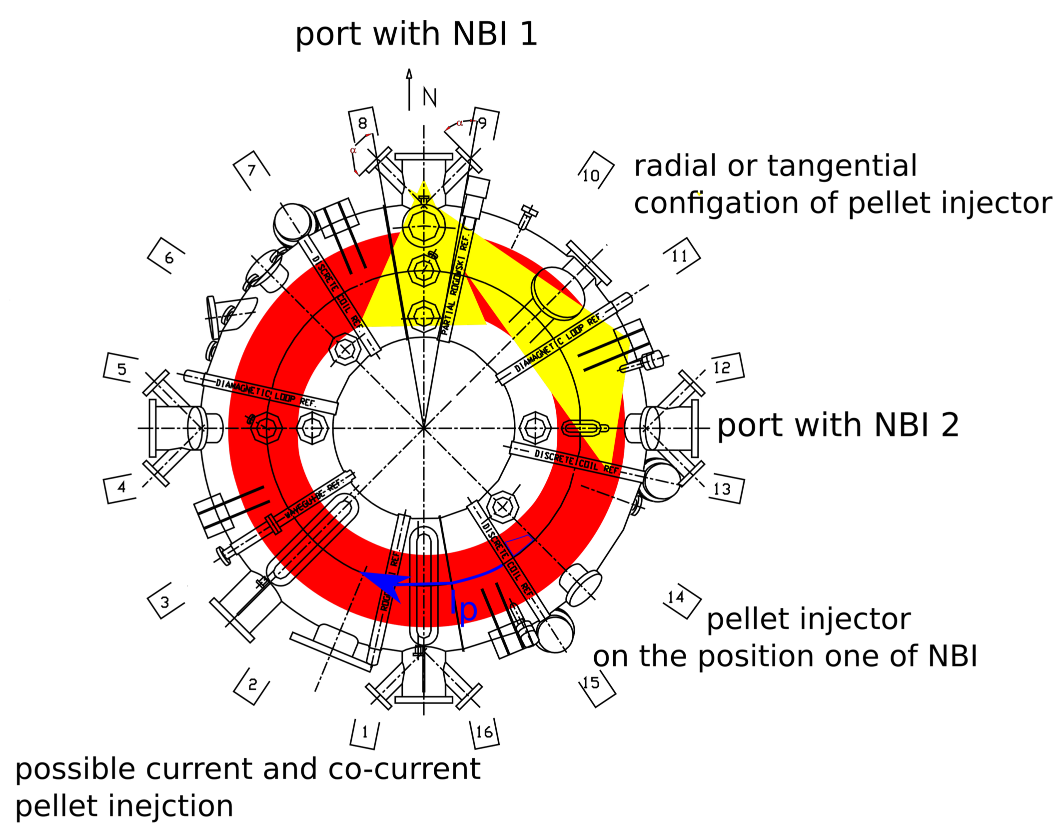
Aim of the experiments

- study of interaction of runaway electrons with solid state materials
- exploration of possible mitigation strategies
- developing of new scenario of generation of runaway electrons beam
- new diagnostic method for investigation of runaway electrons

Realisation of experiments

- pellet injector will be borrow from tokamak ASDEX Upgrade
- delivery of pellets to the plasma volume by solid state injector at room temperatures
- considered propellant gases: Ar, He

Experimental setup



Pellets

- cylindrical shape, considered dimensions: 1.5 mm in diameter, 1 and 2 mm in height
- considered materials: carbon, boron nitrate, powders of metals (W,Fe, . . .)

Possible plasma scenario

1. **Mitigation of RE beams**
   - generation of runaway electrons by puff of killer gas (Argon, Neon, . . .) - TCV-like scenario or MGI in ramp up current phase → possible mitigation by pellet injection
2. **Generation of RE beams**
   - injection of the pellet → colling of the plasma → possible generation of runaway electrons
   - afterwards attemps of mitigation of runaway elecetons by MGI

Possible modelling of experiments

Ablation of pellets

- modelling of ablation of pellets in ohmic plasma → deposition of pellet material, cooling of the plasma → generation of runaway electrons, comparison with experiment

Enhanced ablation of pellets

- modelling of ablation of pellets with presence of fast particles (RE,NBI ions), possibility of estimation of distribution function of fast particles → comparison with LUKE, CODE

References

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