Tampere University

In-situ H2 mechanical testing infrastructure development at Tampere University

Current status and next steps

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Topics today

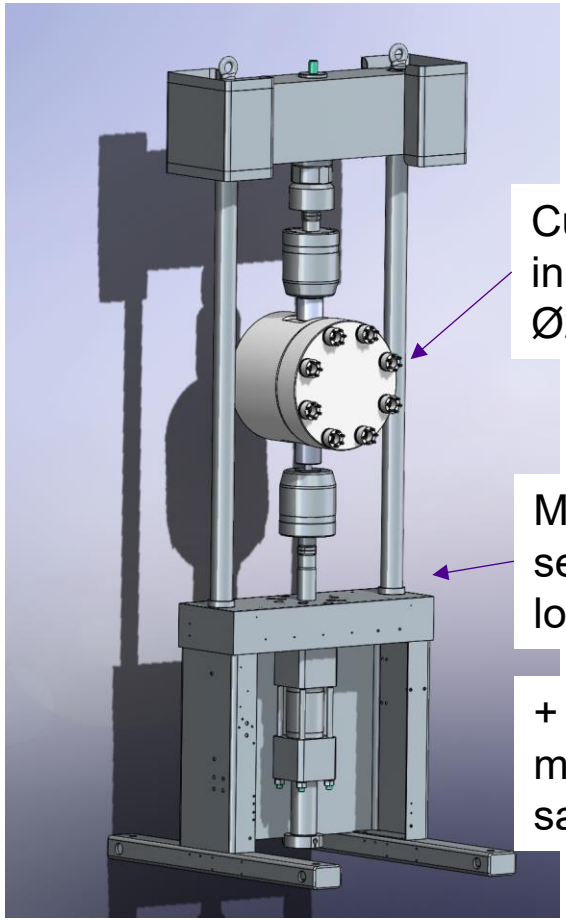
1. General description of the *H2-Mechanical testing machine (H2-MTM)* –project

2. Some technical aspects of the system

3. Outlook

In situ H_2-atmosphere mechanical testing

- Hydrogen has large detrimental effects on the mechanical properties of many materials
  → *Mechanical testing in high pressure hydrogen gas environment*
- Max. pressure 400 bar, max. temperature 220°C, loading range -10 … 50 kN
- Tensile testing, fracture toughness, fatigue testing, fretting
- External funding: RCF (FIRI), EAKR
- Scheduled commissioning: 2026

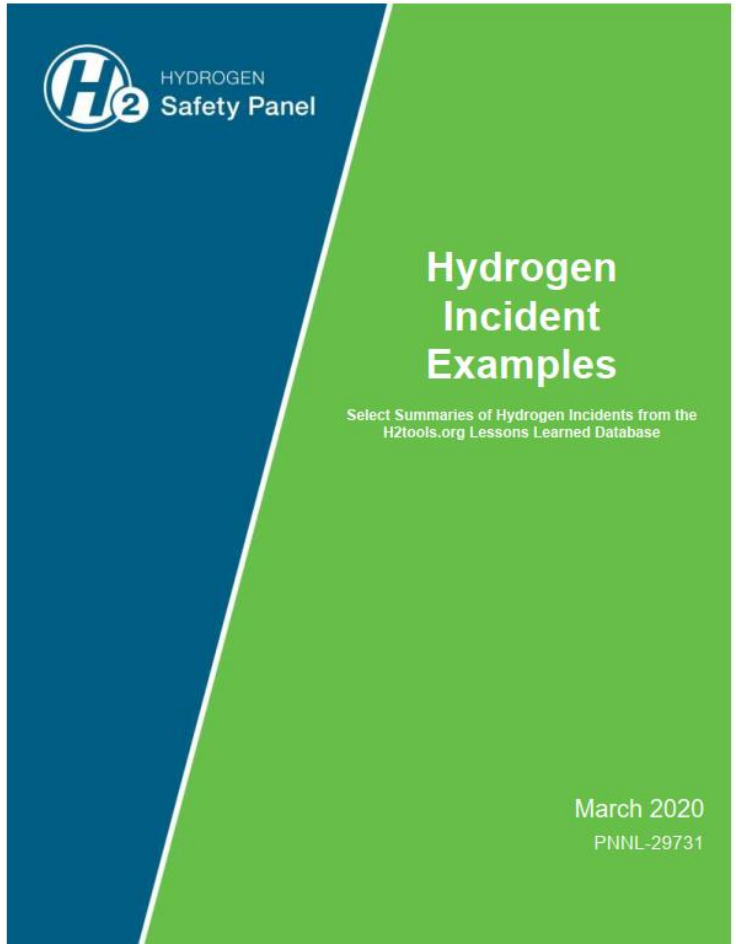


[Image courtesy of Antti Väinölä, Cormet Oy]

Some notes on H2-safety

- Based on literature, the main risks are:
  - Human errors, improper maintenance, faulted components, design flaws
  - Leaks are common, valves fail during use
  - High pressure leak self-ignites easily and can develop into a shock front
- Main safety system / fire fighting procedure is the closure of the H2 supply and effective ventilation to outside air

  → basis of our system design (automated safety systems)
- The system is subject to strict requirements of the Finnish pressure device legislation and ATEX-related legislation
- Only a few operators of the system (i.e. *users* have the research cases but *operators* operate the system)



https://h2tools.org/

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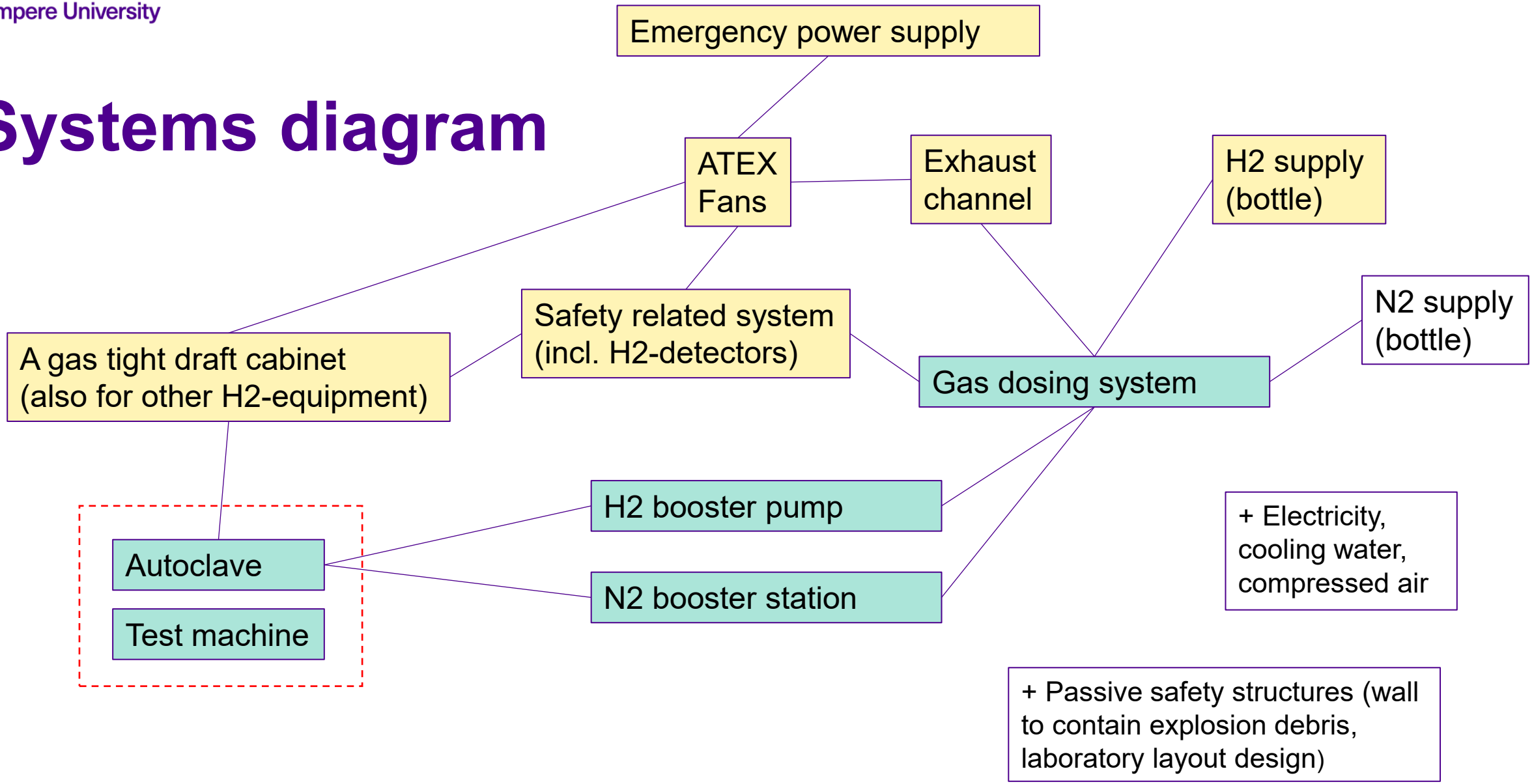
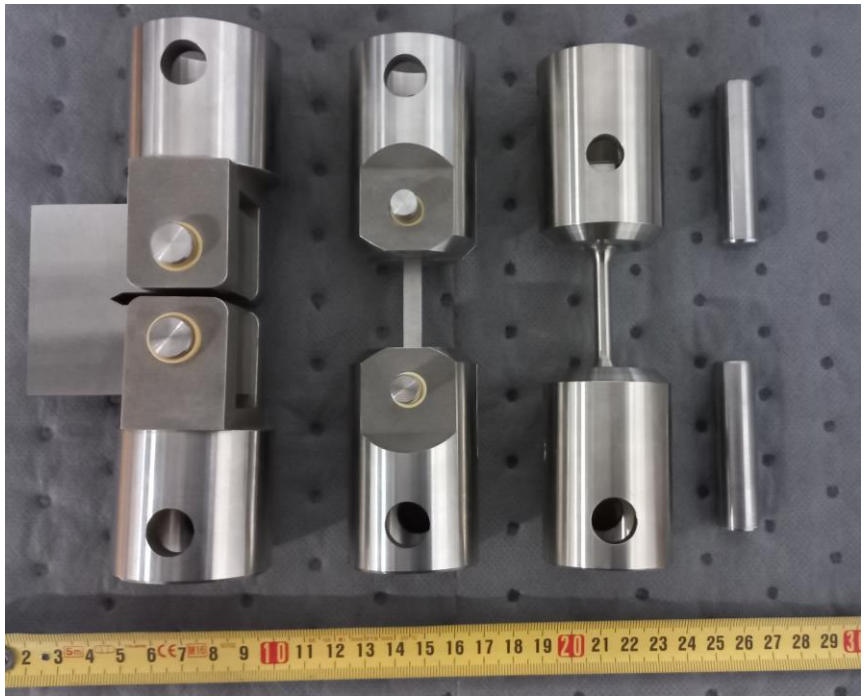
Systems diagram



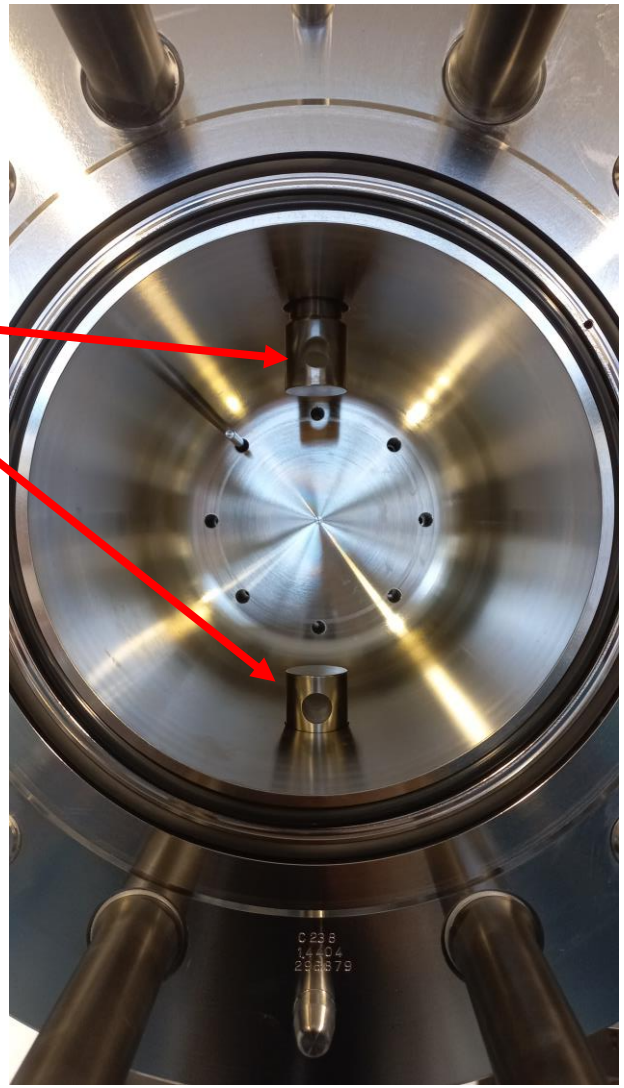
Specimen holders



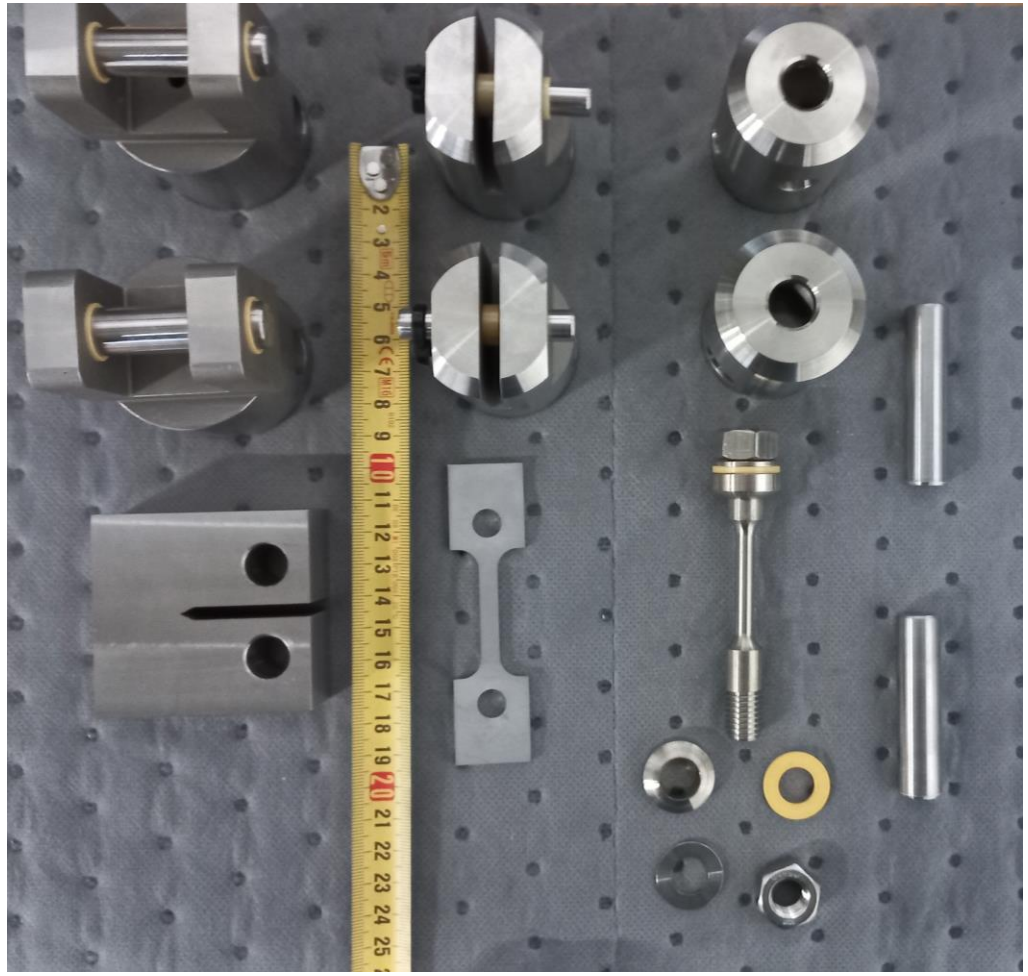
Left to right: CT (fracture toughness),
flat tensile specimen, round tensile specimen
+possibility to make in-house holders

Autoclave with the lid removed

Pull rods



Specimens



- Flat tensile specimen has been selected as the general starting point
- Coating on the specimen is possible in-house
- In-situ measurements: axial load and grip displacement
- Max. load 50 kN, max displacement ~10 mm
- In cyclic tests load ratio R~0 (compression limited to 10 kN)
- Fretting experiment design in progress

General H2-MTM-procurement plan and current status

- The loading system has been commissioned in the laboratory
- The supplier is constructing the gas management and safety systems
- Laboratory infrastructure is being built currently
- Tentative timetable:
  - Commissioning and first demonstration experiments by end of 2026
  - ”Full scale” research work availability from spring 2027 onwards

Interested?

- General questions, research topics, etc.:

  Prof. Mikko Hokka

- Technical aspects of the system:

  Dr. Matti Isakov

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