Molten Salt FP Release Tests in the GBI7 Experiment

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Grain Boundary Inventory 7 (GBI7) Experiment

- Last chance to use samples trace-reirradiated in NRU reactor
  - Trace-reirradiation technique was developed for GBI determination in UO_2
- Four different types of tests
  - GBI of MOX (similar to usual GBI of UO_2)
  - GBI of thoria (grinding; extension of previous work at Whiteshell Laboratories and elsewhere)
  - FP release from UO_2 under molten lead
  - FP release from molten salts
- Molten salt tests
  - 1000°C for about 4500 s – beyond design basis accident
  - Survey to determine whether FP release occurs
  - Inert, steam and air environments
  - preliminary results – data processing not complete

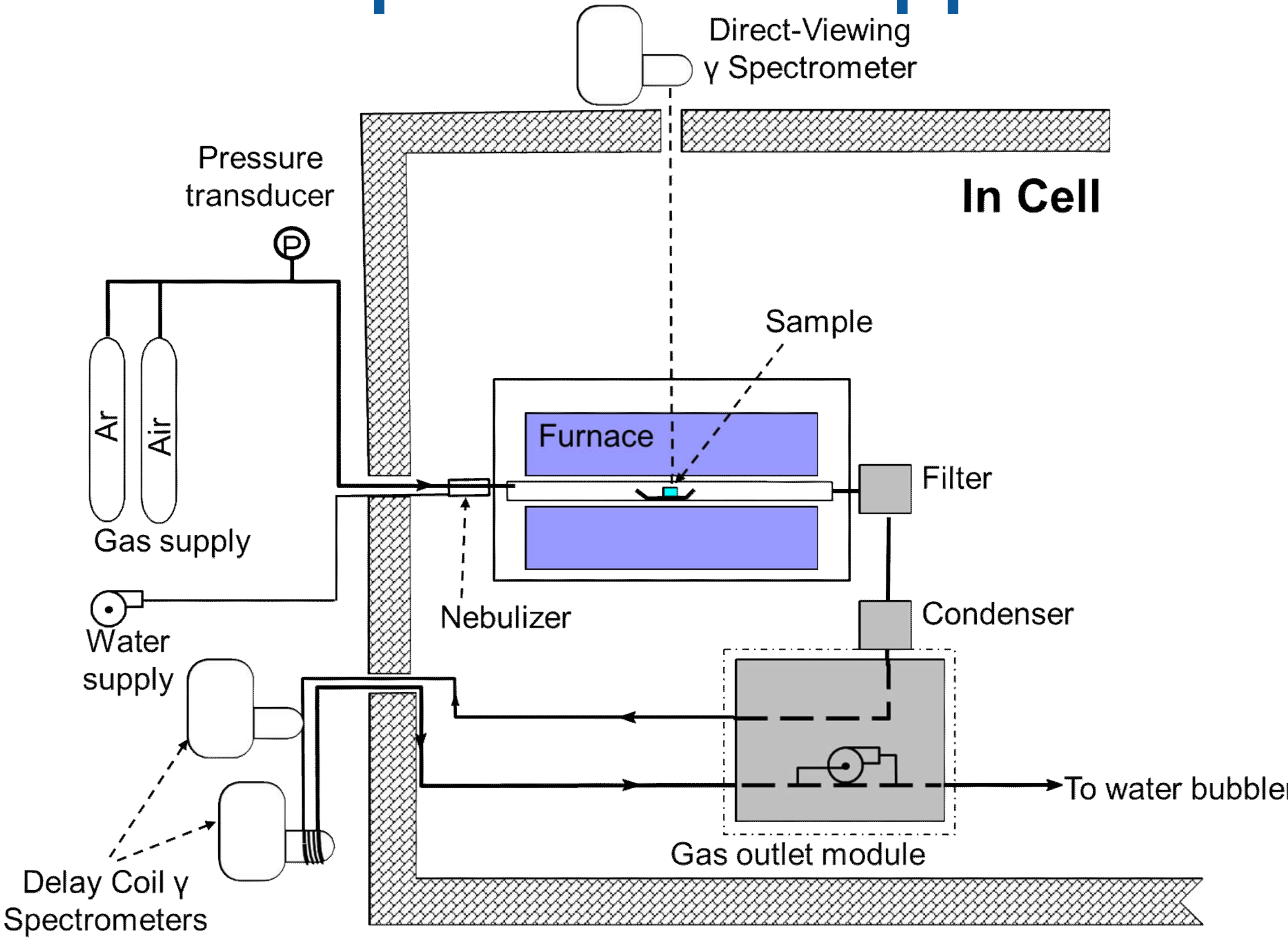
Molten Salt Preparation

- Trace-reirradiated UO_2 from NRU filler bundle
  - 38 kW peak linear power, 31 MWd/kgU burnup
  - Minimize segregation of noble metals into five-metal particles
- Grind to powder, mix with KHF_2 and NaF, add ~1% Zr
  - $UO_2 + 4\ KHF_2 \rightarrow 2\ H_2O + K_4UF_8$
  - Chvala studied reactor physics of 50.5%NaF – 21.5%KF – 28%UF_4
  - NaF lowers melting point
  - Zr consumes any excess F/HF from KHF_2, and will generate some "UF_3" in the mixture (desirable from reactor corrosion viewpoint)
- For some tests, substitute NaCl for NaF
  - Some fast reactor designs have chloride fuel salt separated from fluoride heat transfer salt
  - In order for significant FP release to occur, the fuel salt container must fail and the chloride and fluoride salts will mix

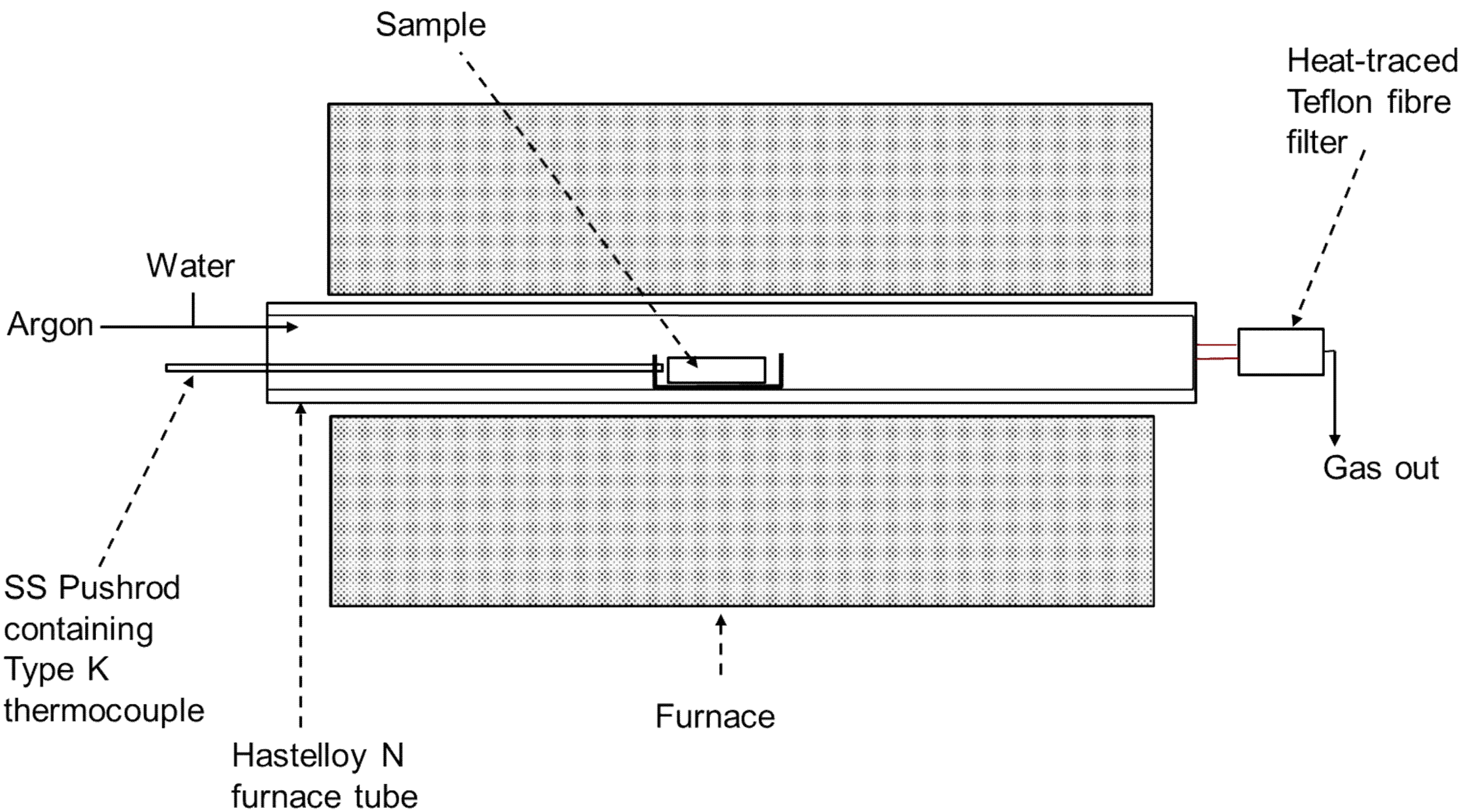
Molten Salt Test Technique

- Heat to ~400-500°C to cause reaction
  - Noble gases release during reaction – indicator for completeness of reaction
  - Minimal releases of other FP at this temperature
- Heat molten sample to 1000°C for about 4500 s
  - Observe using gamma spectrometry
  - Post-test analysis using SEM of cooled mixture

GBI7 Experimental Apparatus



GBI7 Experimental Apparatus



Tests

Test Name	Salt Type	Environment
MS1	UF_4-KF-NaF-1%Zr	Ar, 0.25 mmol/s
MS2	UF_4-KF-NaF-1%Zr	62% steam, 0.75 mmol/s
MS3	UF_4-KF-NaCl-1%Zr	69% steam, 0.67 mmol/s
MS4	UF_4-KF-NaCl-1%Zr	Ar, 0.25 mmol/s
MS5	UF_4-KF-NaF-1%Zr	air, 0.25 mmol/s
MS7	ThF_4-KF-NaF-1%Zr	Ar, 0.25 mmol/s

Preliminary results

- Fission product release at 1000°C
  - ~30% release of Cs isotopes
  - Comparable release of I-131
  - Much less I-131 release from chloride-fluoride salt than from fluoride-only salt
  - Release of Ru, particularly in oxidizing environment
- Fuel Behaviour
  - Inert-environment tests showed salt layer in bottom of boat
  - Oxidizing-environment tests showed salt "climbing over the walls" of the boat
  - Strong wetting of oxidized metal surface caused some salt to leave the boat

Future plans

- Molten salt samples will be examined
  - Completeness of reaction with UO_2
  - Oxidation state
  - FP segregation
- Future tests
  - Wetting behaviour in oxidizing environment
  - FP release at lower temperatures (NOC and transient)
- Establish trace-reirradiation capabilities with another reactor
  - Shorter time between irradiation and test to examine behaviour of other FP (e.g., Te, Mo)

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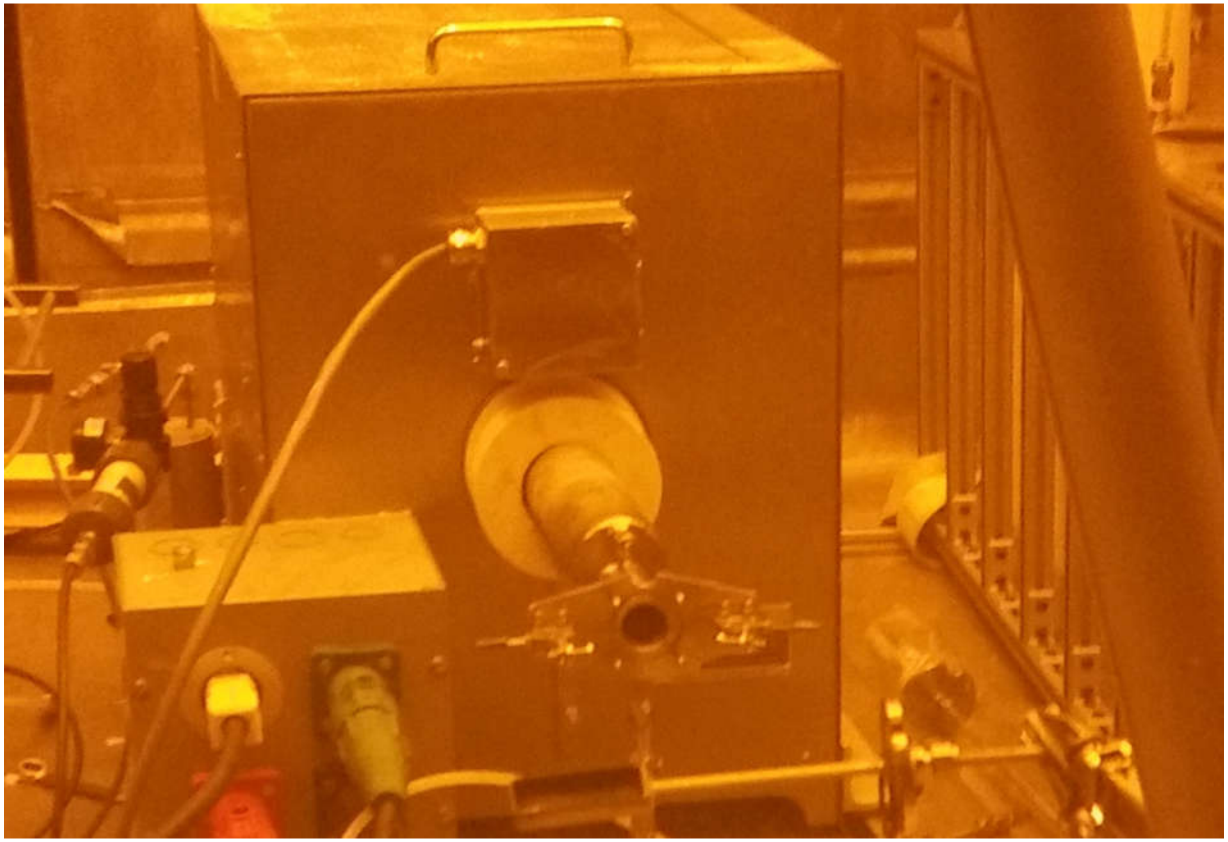

Thank you. Merci.

Questions?

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