Advanced Gas Reactor Fuels Program Review

AGR-3/4 PIE Planning

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Background

- Draft AGR-3/4 PIE Plan produced in March 2015
- TCT meeting held in March 2015 to discuss PIE objectives, scope, approach for processing data, and approach for selecting capsules for specific measurements
- Numerous changes to the proposed approach were discussed. The primary change was to include (**a**) measurements to examine in-pile integral fission product behavior (i.e., full examination of as-irradiated capsules), (**b**) heating tests of separate components (rings) to determine individual parameters of interest (diffusivities), and (**c**) tests to determine integral behavior of fission products at elevated temperatures (i.e., fuel body heating tests and post-test analysis).

General AGR-3/4 PIE Logic

Integral state after irradiation ~4 capsules

- γ scanning rings
- Sampling rings
- Compact destructive exams

Integral test heating fuel bodies ~3 fuel bodies

After heating tests:

- γ scanning rings
- Sampling rings
- Compact destructive exams

Integral effects data to compare to models

Separate effects or single effects tests and data

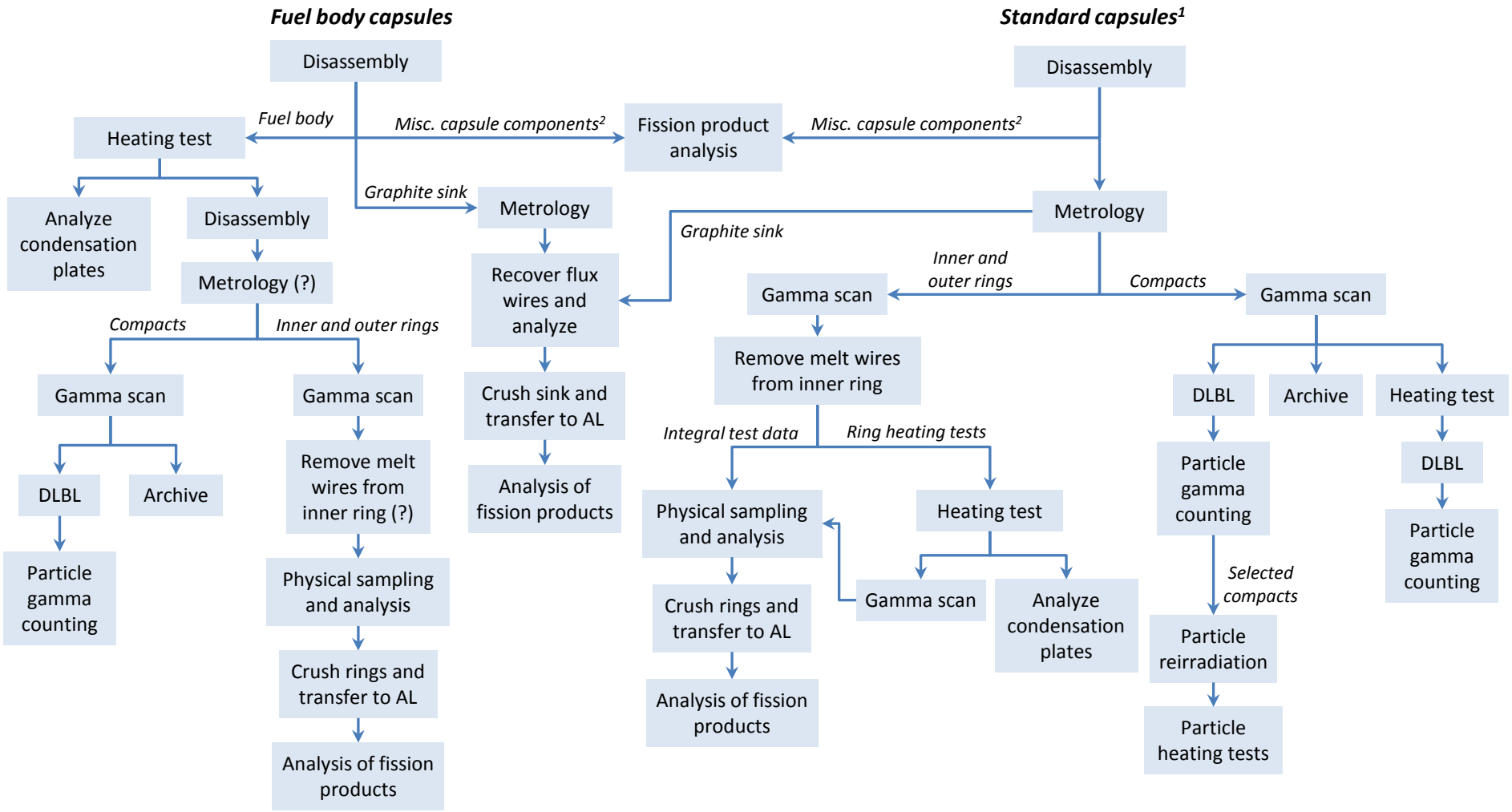
Heating tests on individual rings (graphite and matrix) ~4 temps ~8 samples

- Total release from rings during heating test
- Post-test analysis:
  - γ scanning rings
  - Sampling rings

Irradiated particle heating tests

Sorption isotherms out-of-pile

AGR-3/4 Capsule PIE



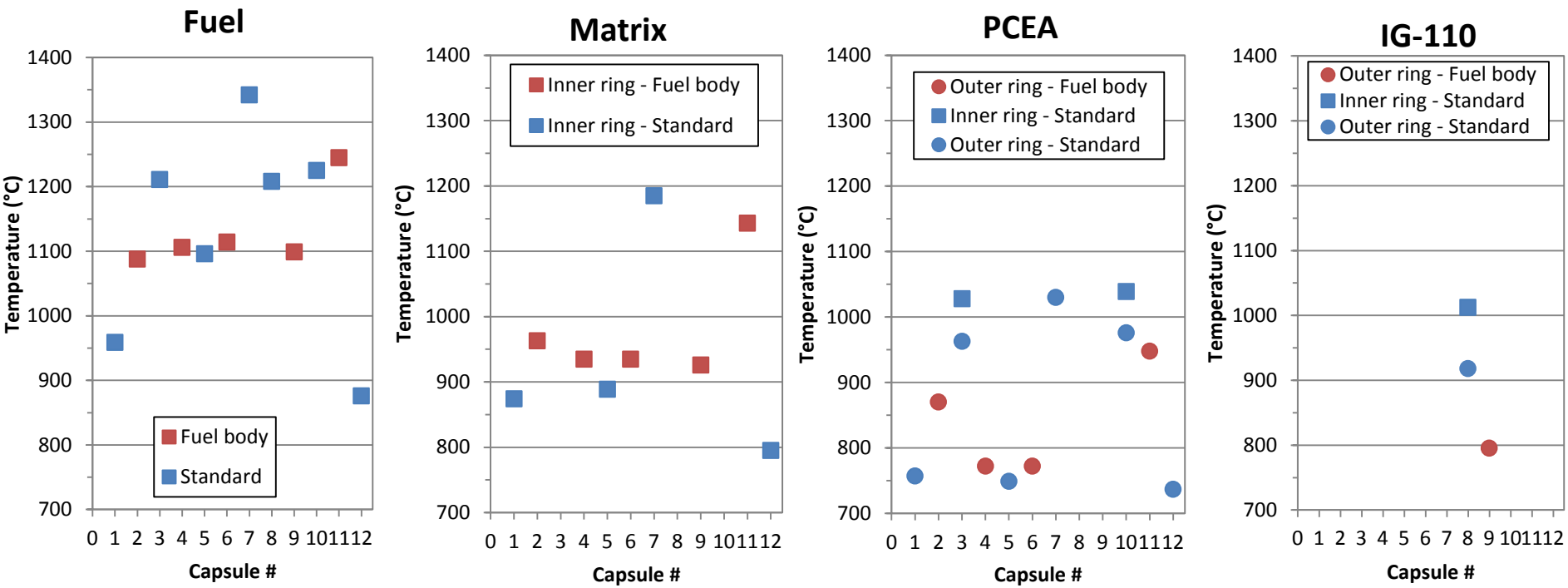
[1] *Note: Fuel body Capsule 4 will be treated as a standard capsule*
[2] *Spacers, through tubes, etc.*

AGR-3/4 Capsule Data

Capsule	Type	Inner ring	Outer ring	Burnup (%FIMA)	Fast fluence (x 10^{25} n/m^2)	Temperature			EOL # failed particles
						Fuel	Inner ring	Outer ring	
12	Standard	Matrix	PCEA	5.4	1.501	876	795	737	40
11	Fuel body	Matrix	PCEA	9.1	2.871	1245	1143	948	69
10	Standard	PCEA	PCEA	11.8	3.941	1225	1039	976	47
9	Fuel body	Matrix	IG-110	13.7	4.652	1099	926	795	90
8	Standard	IG-110	IG-110	14.5	5.08	1208	1012	918	78
7	Standard	Matrix	PCEA	15.0	5.269	1342	1185	1030	52
6	Fuel body	Matrix	PCEA	15.2	5.312	1114	935	772	47
5	Standard	Matrix	PCEA	14.9	5.193	1096	889	749	54
4	Fuel body	Matrix	PCEA	14.2	4.846	1106	935	772	76
3	Standard	PCEA	PCEA	12.6	4.216	1211	1028	963	96
2	Fuel body	Matrix	PCEA	10.1	3.208	1088	963	870	91
1	Standard	Matrix	PCEA	6.1	1.761	959	874	757	41

- Burnup and fluence are capsule-average values
- Fuel temperatures are time-average, volume average
- Ring temperatures are at the inner surface, axial mid-height, SW position

Fuel body and standard capsule temperature comparisons



- Comparisons do not consider burnup, fast fluence, temperature history, gap size differences, etc.
- Variation in burnup and fluence across test train is ~3X and 4.5X, respectively

AGR-3/4 Capsules

Capsule	Type	Inner ring	Outer ring	Remarks
12	Standard	Matrix	PCEA	**Lowest predicted inventory of Ag and Cs in inner ring and very low concentration in outer ring**; **little or no Sr predicted in either ring**
10	Standard	PCEA	PCEA	Graphite inner ring; best chance at Sr data in graphite
8	Standard	IG-110	IG-110	Graphite inner ring; best chance at Sr data in graphite
7	Standard	Matrix	PCEA	Highest temperature capsule; highest Sr predicted in both rings
5	Standard	Matrix	PCEA	**Little or no Sr predicted in either ring**
4	Fuel body	Matrix	PCEA	Fuel body treated as standard capsule; **likely to have little or no Sr in either ring**
3	Standard	PCEA	PCEA	Graphite inner ring
1	Standard	Matrix	PCEA	**Little or no Sr predicted in either ring**
Fuel body heating tests				
11	Fuel body	Matrix	PCEA	Very steep predicted Sr gradient in inner ring; **little or no Sr predicted in outer ring**
9	Fuel body	Matrix	IG-110	**Little or no Sr predicted in either ring**
6	Fuel body	Matrix	PCEA	**Little or no Sr predicted in either ring**
2	Fuel body	Matrix	PCEA	**Little or no Sr predicted in either ring**

- 8 standard capsules available; to accomplish goals, will need to use ~all of them

AGR-3/4 PIE Planning: General Considerations

- Computational modeling of fission product transport in rings is in progress to help with appropriate ring selection for (a) as-irradiated examination and (b) ring heating tests
- Considerations for selecting capsules/rings for integral effects measurements or ring heating tests:
  - Predicted fission product concentration and distribution in the ring (very different for Ag/Cs vs. Sr). Still needs to be verified by early gamma scanning data on first several rings.
  - Ring material (graphite inner rings provide better opportunity for Sr data)
- Fission product transport modeling results needed to determine optimal fuel body and ring heating times and temperatures

Proposed Initial Capsule Priorities for Gamma Scanning

1. Capsule 3
   - Standard capsule
   - Relatively high inner and outer ring temperature
2. Capsule 4
   - Fuel body capsule (treated as standard)
   - Demonstration of fuel body disassembly
   - Intermediate temperatures (lower than Capsule 3), but matches numerous other capsules

⇨ Modeling results will be used to draft an updated PIE Plan with preliminary capsule assignments

Questions?

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