AGR-3/4 Fission Product Mass Balance and Ring Analysis

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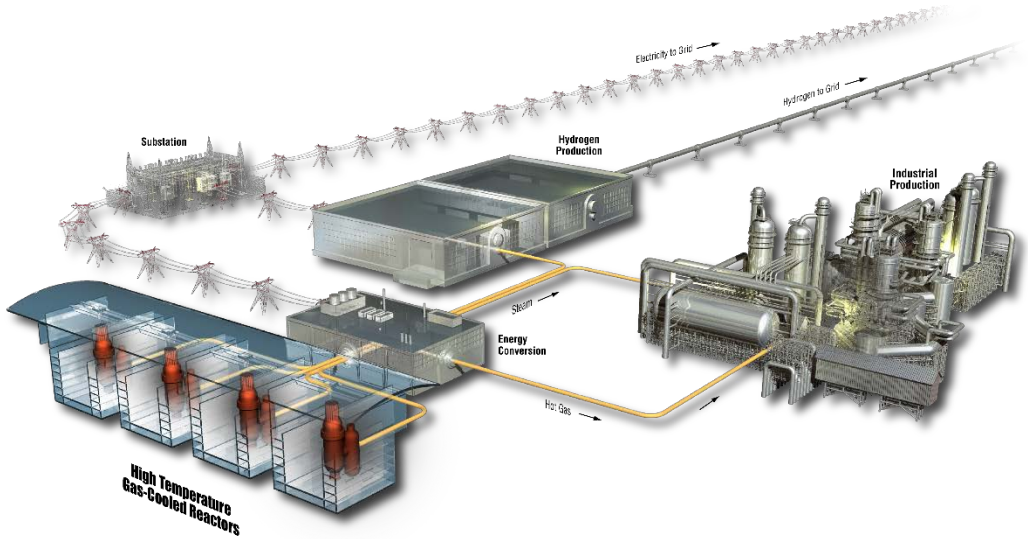

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Outline

- Introduction to AGR-3/4 experiment
- AGR-3/4 PIE activities status
- Ag-110m mass balance and distribution in capsule components
- Cs-134 mass balance and ring inventories versus temperature
- Eu-154 mass balance and ring inventories
- Comparison of modeling and measured ring inventories
- Precision gamma scanner (PGS) data update
- Summary and future work schedule

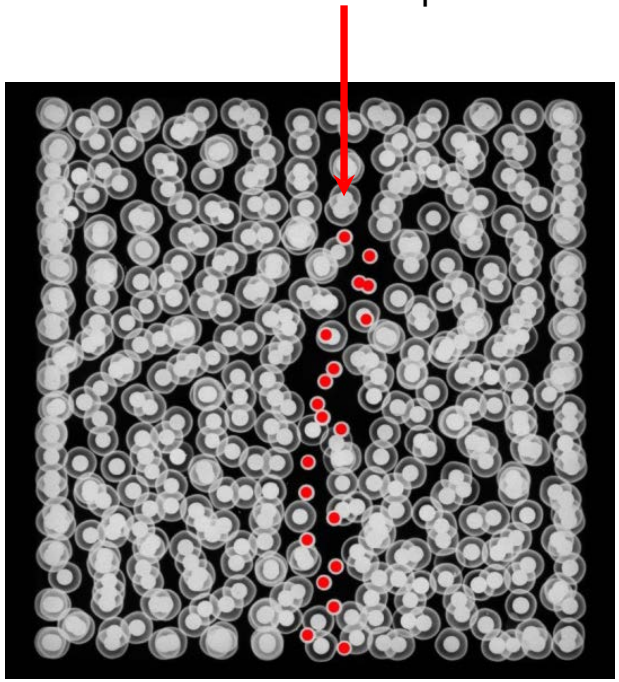
AGR-3/4 Experiment Goals

- Observe metallic fission product (e.g. Ag, Cs, Eu, and Sr) transport within graphitic matrix and nuclear grade graphites (IG-110 and PCEA)
- Measure fission product inventories and spatial distributions within fuel compacts and graphite
- Determine diffusion coefficients of metallic fission products within graphitic materials
- Goals fall under elements of the Technical Program Plan (PLN-3636)
  - #3. Fuel Post-Irradiation Examination and Safety Testing
  - #5. Fission Product Transport and Source Term

AGR-3/4 Compacts

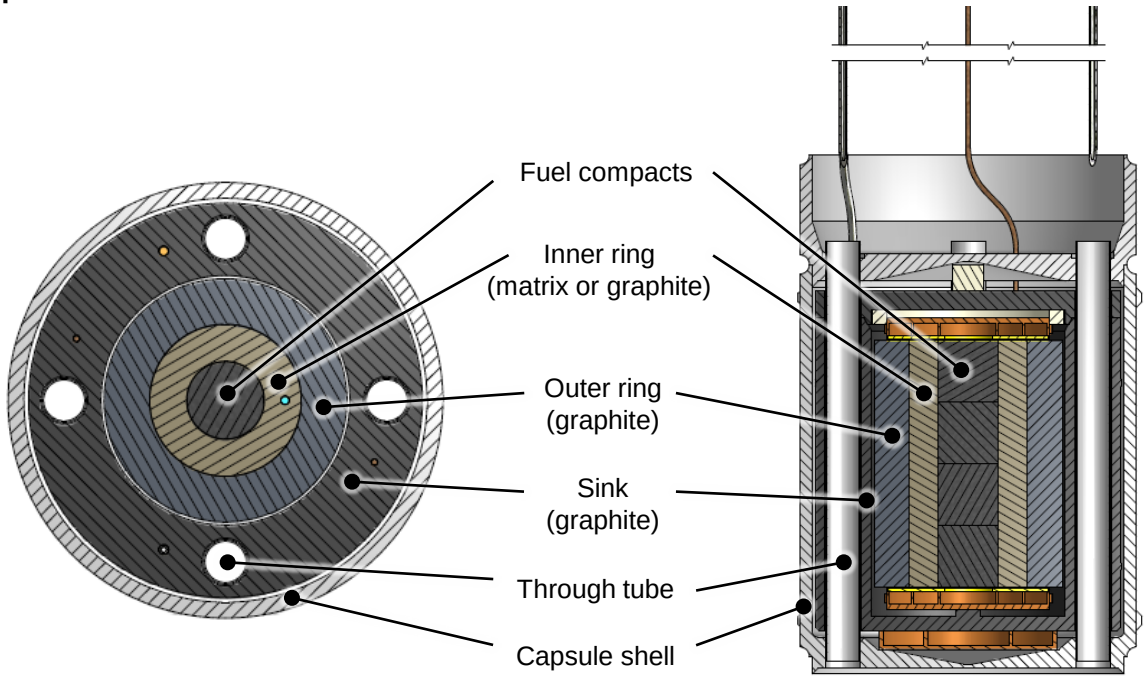
- Each compact is 0.5 in. tall, 0.5 in. diameter
- Approximately 1872 “driver” TRISO particles similar to AGR-1 Baseline fuel
- 20 designed-to-fail (DTF) particles coated only with 20µm thick pyrocarbon layer
- 4 compacts per capsule, 80 DTF particles per irradiation capsule
- DTF provide known source of fission products

X-ray showing 20 DTF particles in center of compact

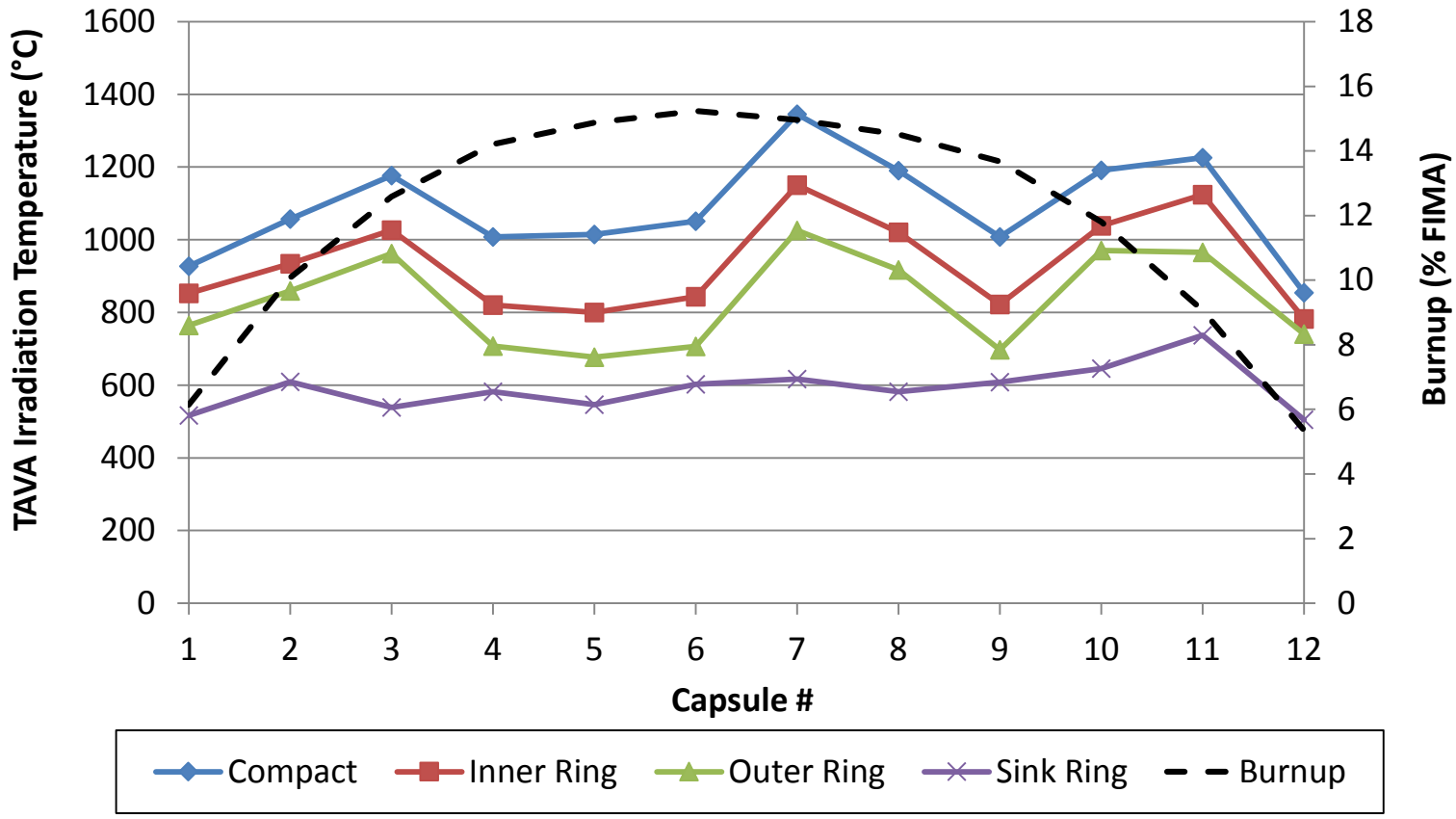


AGR-3/4 Irradiation Capsule

- Four compacts in center of “inner ring” (graphitic matrix, IG-110, or PCEA)
- Inner ring sits within “outer ring” (PCEA or IG-110)
- Outer ring held within cold “sink ring” (PCEA)
- Fission products may transport through components
- Standard capsules and sealed “fuel bodies” were used



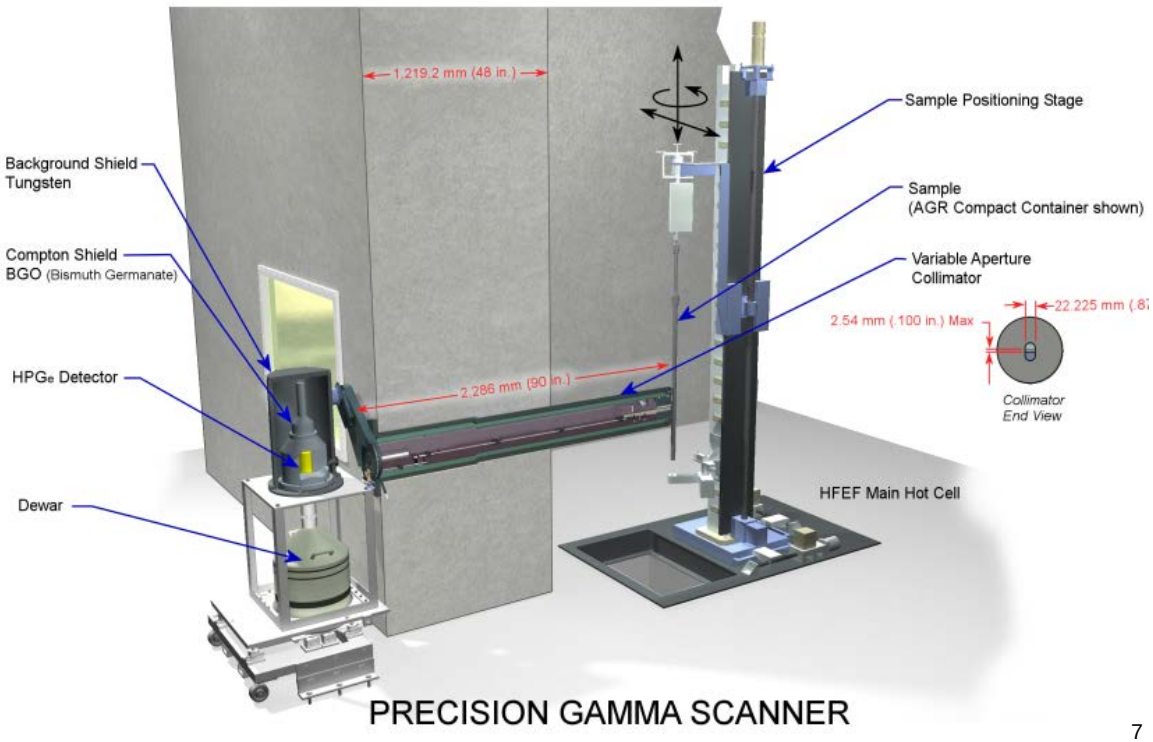
AGR-3/4 Experiment Irradiation Temperatures and Burnup



TAVA = time-averaged, volume-averaged
FIMA = fissions per initial metal atom

AGR-3/4 Fission Product Isotopes and Tools

- Gamma scanning primarily for Ag-110m, Cs-134/137, and Eu-154/155
- Precision gamma scanner (PGS) at Hot Fuels Examination Facility (HFEF)
  - Quantify fission product inventories in fuel compacts and graphite rings
  - Tomography (2D map) of fission product activity intensities at specific locations in graphite rings
- Other capsule component gamma-emitter inventories at Analytical Laboratory (AL)
  - Sink rings
  - Capsule spacers
  - Through-tubes
- Burn-leach, separation, and gas-proportional counting for Sr-90
- Fuel Accident Condition Simulator (FACS) furnace for high-temp safety testing of fuel compacts



Status of Mass Balance Activities

- Completed in FY17: all capsule through-tubes (not shown in table) have been leached and the leachate gamma-counted and analyzed for Sr-90.
- In FY17, all spacers have had short-count gamma (1 hr). Spacers with no measureable Ag-110m in short-count are being counted for 10 hrs

	PGS Axial Scans	PGS Tomographic Scans	Gamma at AL	Sr-90 Analysis
Capsule 1 Compacts	X			
IR-1	X			
OR-1	X			
Sink 1			X	X
Spacers			IP	
Capsule 2 Compacts (fuel body)				
IR-2				
OR-2				
Sink 2			X	IP
Spacers				
Capsule 3 Compacts	X			
IR-3	X	X		
OR-3	X	X		
Sink 3			X	X
Spacers			IP	
Capsule 4 Compacts (opened fuel body)	X			
IR-4	X	IP		
OR-4	X			
Sink 4			P	
Spacers			IP	
Capsule 5 Compacts	X			
IR-5	X	P		
OR-5	X			
Sink 5			X	P
Spacers			IP	
Capsule 6 Compacts (fuel body)				
IR-6				
OR-6				
Sink 6			X	P
Spacers				
Capsules 7-12 continued on next slide				

Completed in FY17
In-progress
Planned
X: complete and final data received
IP: in-progress
P: preliminary data received

Status of Mass Balance Activities (continued)

- Completed in FY17: all capsule through-tubes (not shown in table) have been leached and the leachate gamma-counted and analyzed for Sr-90
- In FY17, all spacers have had short-count gamma (1 hr). Spacers with no measureable Ag-110m in short-count are being counted for 10 hrs

	PGS Axial Scans	PGS Tomographic Scans	Gamma at AL	Sr-90 Analysis
Capsule 7 Compacts	X			
IR-7	X	X		
OR-7	X	P		
Sink 7			X	P
Spacers			IP	
Capsule 8 Compacts	X			
IR-8	X	X		
OR-8	X	X		
Sink 8			X	P
Spacers			IP	
Capsule 9 Compacts (fuel body)				
IR-9				
OR-9				
Sink 9			X	IP
Spacers				
Capsule 10 Compacts	X			
IR-10	X	X		
OR-10	X	middle, 8/21/17		
Sink 10			X	P
Spacers			IP	
Capsule 11 Compacts (fuel body)				
IR-11				
OR-11			P	
Sink 11			P	
Spacers				
Capsule 12 Compacts	X			
IR-12	X			
OR-12	X			
Sink 12			X	
Spacers			IP	

Completed in FY17
In-progress
Planned
X: complete and final data received
IP: in-progress
P: preliminary data received

Other AGR-3/4 PIE Activities Related to Fission Product Transport, FP Spatial Distributions, or Safety Testing

- Destructive analyses (discussed in next presentation) on select samples:
  - Compacts
    - Radial deconsolidation and particle analysis
    - High-temperature safety testing
    - Potential re-irradiation of as-irradiated compacts followed by safety testing
  - Inner and outer rings
    - Physical sampling (progressive machining to remove material in well-defined volumes)
    - Gamma and Sr-90 of material collected from physical sampling
    - Correlate results of physical sampling to PGS gamma tomography (2D activity maps)
- Safety testing compacts $1200°C \leq T \leq 1600°C$ in FACS furnace (may also heat rings)
- Analysis plan: “AGR-3/4 Phase 2 Post-Irradiation Examination Plan”, PLN-5382

Summary of AGR-3/4 Gamma-Emitting Fission Product Inventories

- Only inner and outer rings from fuel bodies have not been gamma scanned
- All sink rings have been gamma scanned
- 7 of 12 sinks have been through Sr-90 analysis

Capsule	Type	Ring Material			Inner Ring TAVA °C	Inner Ring Inventory (Capsule Fraction)				Outer Ring Inventory (Capsule Fraction)				Sink Ring Inventory (Capsule Fraction)			
		Inner	Outer	Sink		Ag-110m	Cs-134	Cs-137	Eu-154	Ag-110m	Cs-134	Cs-137	Eu-154	Ag-110m	Cs-134	Cs-137	Eu-154
1	Std	Matrix	PCEA	PCEA	853	<5.1E-2	4.9E-4	7.3E-4	8.9E-4	<5.2E-2	1.9E-5	1.0E-4	ND	2.9E-3	1.4E-5	1.1E-5	<2.1E-5
2	Fb	Matrix	PCEA	PCEA	934									< 2.8E-3	3.6E-4	9.7E-4	<6.6E-5
3	Std	PCEA	PCEA	PCEA	1026	3.9E-2	5.9E-4	7.7E-4	4.4E-3	1.4E-1	5.0E-4	5.9E-4	ND	4.8E-1	3.2E-3	3.4E-3	<1.3E-4
4	Fb	Matrix	PCEA	PCEA	820	6.8E-2	8.6E-3	8.4E-3	ND	1.99E-3	7.89E-4	7.38E-4	ND	2.8E-3	1.2E-4	5.6E-4	<5.4E-5
5	Std	Matrix	PCEA	PCEA	800	7.5E-4	7.7E-3	7.2E-3	ND	4.2E-4	7.2E-5	1.1E-4	ND	2.5E-3	2.1E-4	4.3E-4	<5.4E-5
6	Fb	Matrix	PCEA	PCEA	843									< 8.5E-4	2.9E-4	4.3E-4	<4.3E-5
7	Std	Matrix	PCEA	PCEA	1151	2.8E-4	6.2E-4	7.3E-4	3.0E-2	2.1E-2	9.7E-4	1.1E-3	ND	9.8E-1	3.6E-3	3.8E-3	<6.0E-5
8	Std	IG-110	IG-110	PCEA	1021	7.7E-2	7.1E-4	9.3E-4	8.0E-4	7.0E-1	3.4E-3	3.7E-3	ND	9.4E-2	2.5E-3	2.8E-3	<3.5E-5
9	Fb	Matrix	IG-110	PCEA	822									<3.5E-3	1.3E-4	4.5E-4	<1.8E-4
10	Std	PCEA	PCEA	PCEA	1038	9.1E-2	8.4E-4	1.0E-3	4.5E-4	4.0E-1	1.2E-3	1.3E-3	9.8E-5	2.3E-1	2.6E-3	2.9E-3	<7.6E-5
11	Fb	Matrix	PCEA	PCEA	1124									4.0E-2	2.4E-3	3.25E-3	<1.7E-4
12	Std	Matrix	PCEA	PCEA	782	<1.78E-1	2.7E-04	6.4E-04	ND	<1.95E-1	ND	1.5E-05	ND	<1.4E-2	1.0E-4	1.1E-3	<2.3E-4

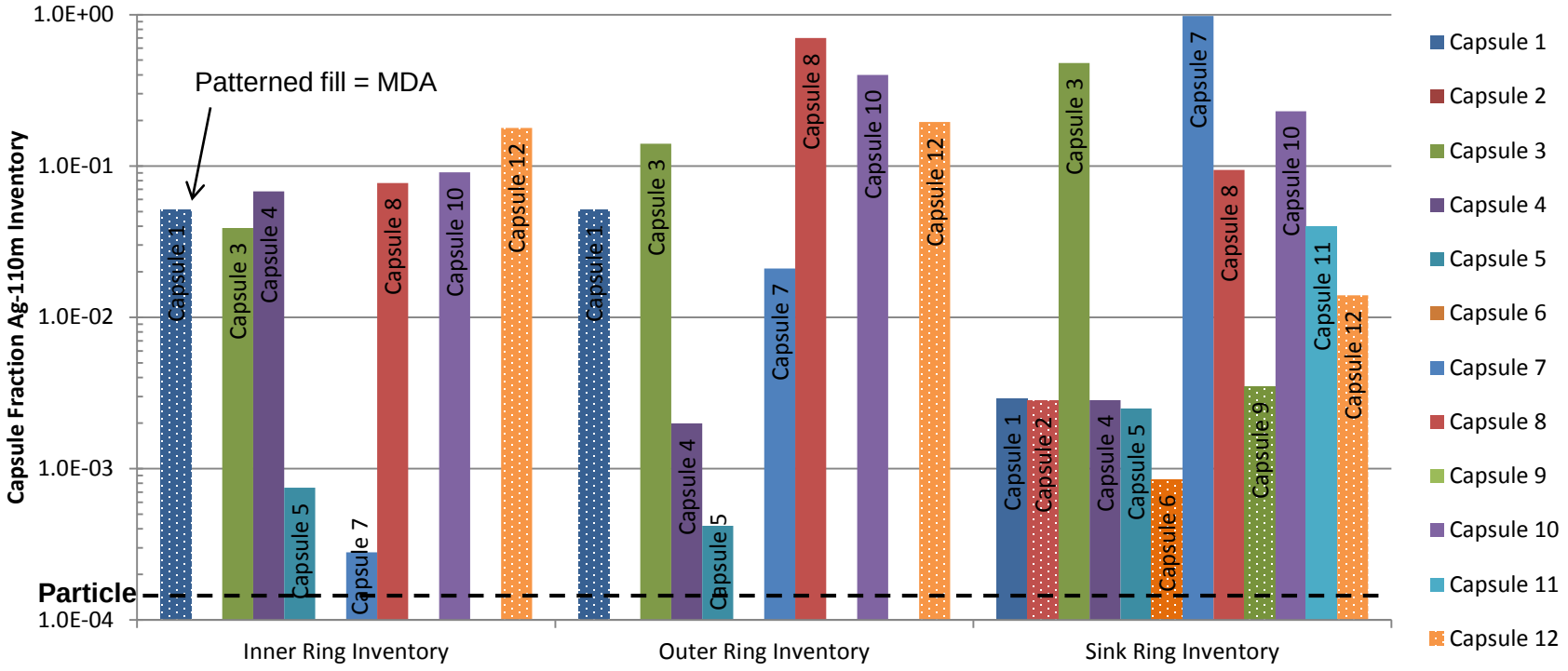
ND: not detected, minimum detectable activity has not been determined yet
One particle represents a capsule fraction of 1.3E-4

Ag-110m Ring Inventory General Observations

- Significant radial transport out into the outer rings and sink rings occurred

NOTE: Patterned bars are minimum detectable activities (MDA)

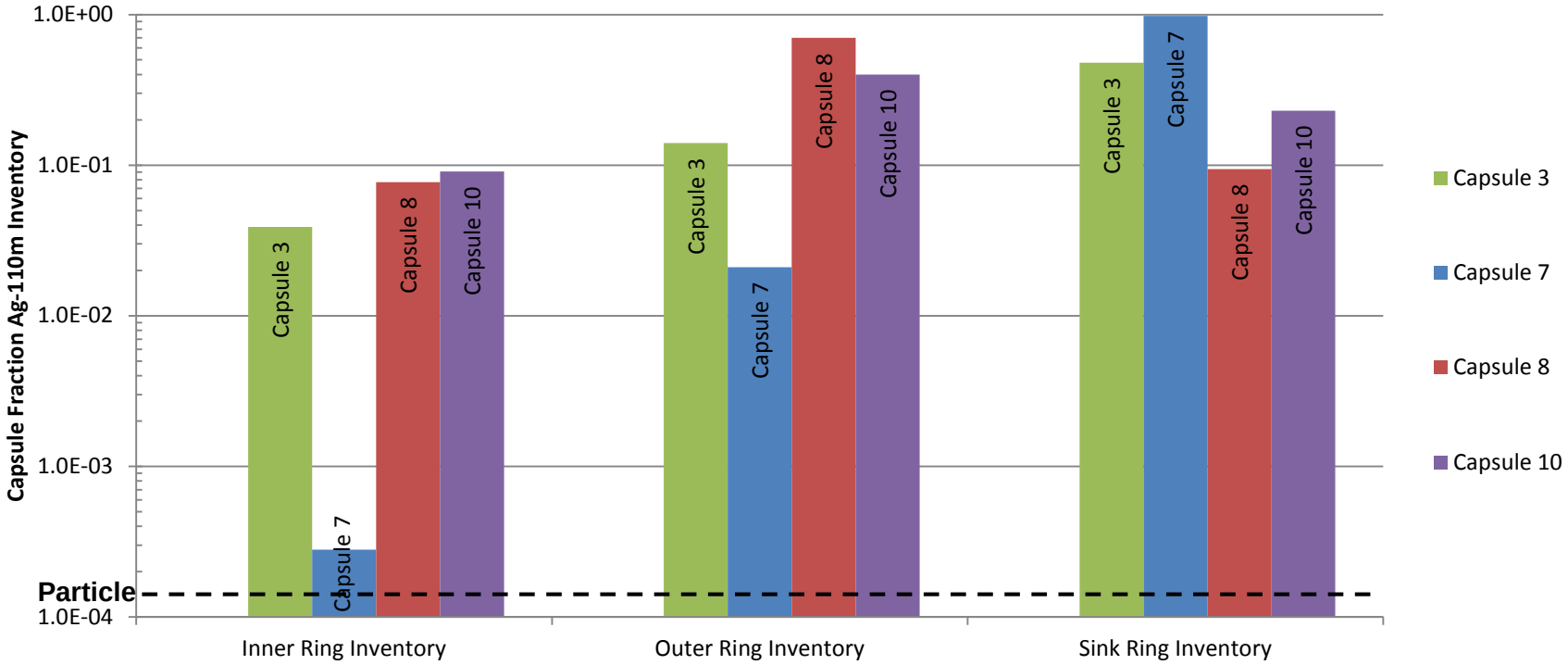
NOTE: Inner and outer rings not measured in fuel body capsules (2, 6, 9, and 11)



Ag-110m Ring Inventory General Observations (continued)

- Significant radial transport occurred
- Outer ring higher than inner for Capsules 3, 7, 8, 10 (hottest capsules)
- Sinks may be higher than inner and outer rings (i.e. capsules 3 and 7)

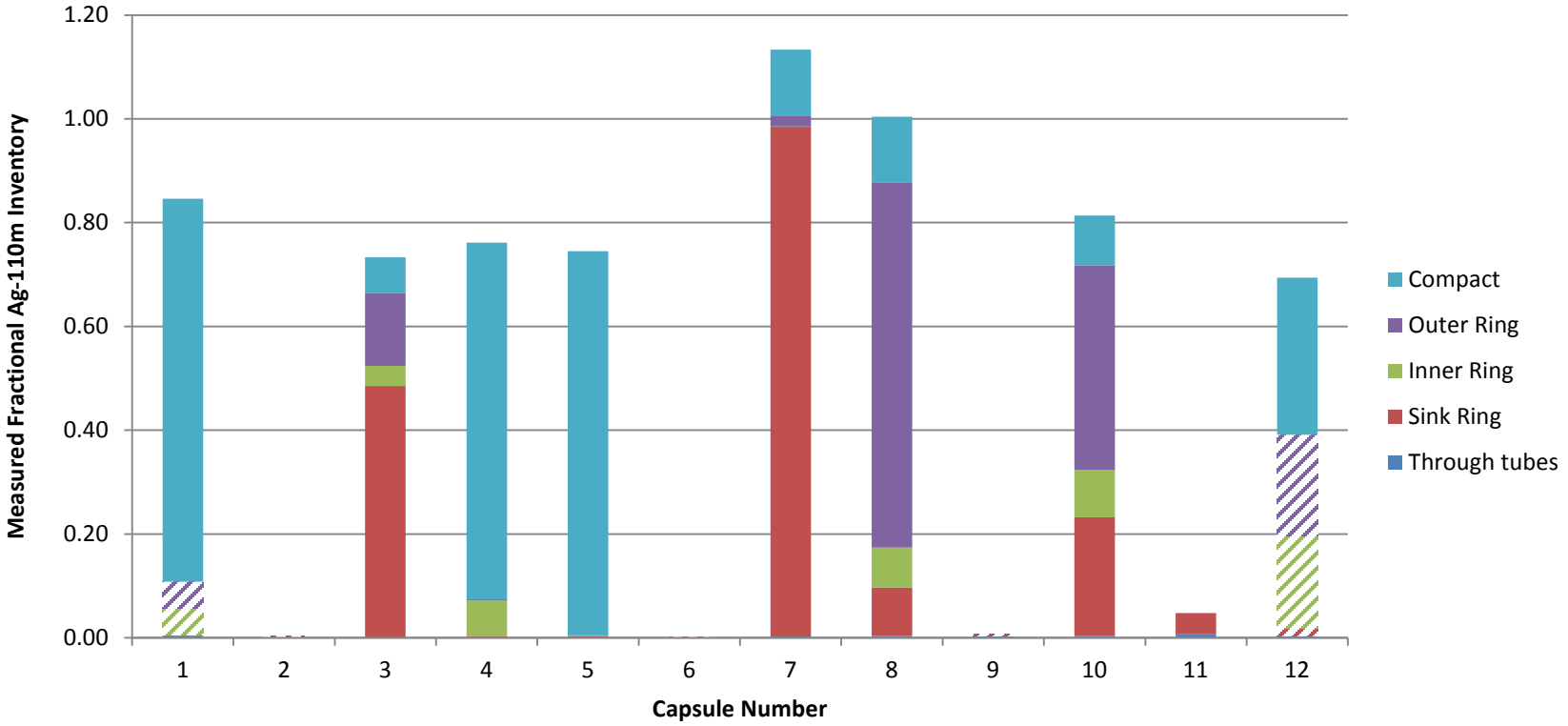
NOTE: Inner and outer rings not measured in fuel body capsules (2, 6, 9, and 11)



Ag-110m Distribution in Capsule Hardware

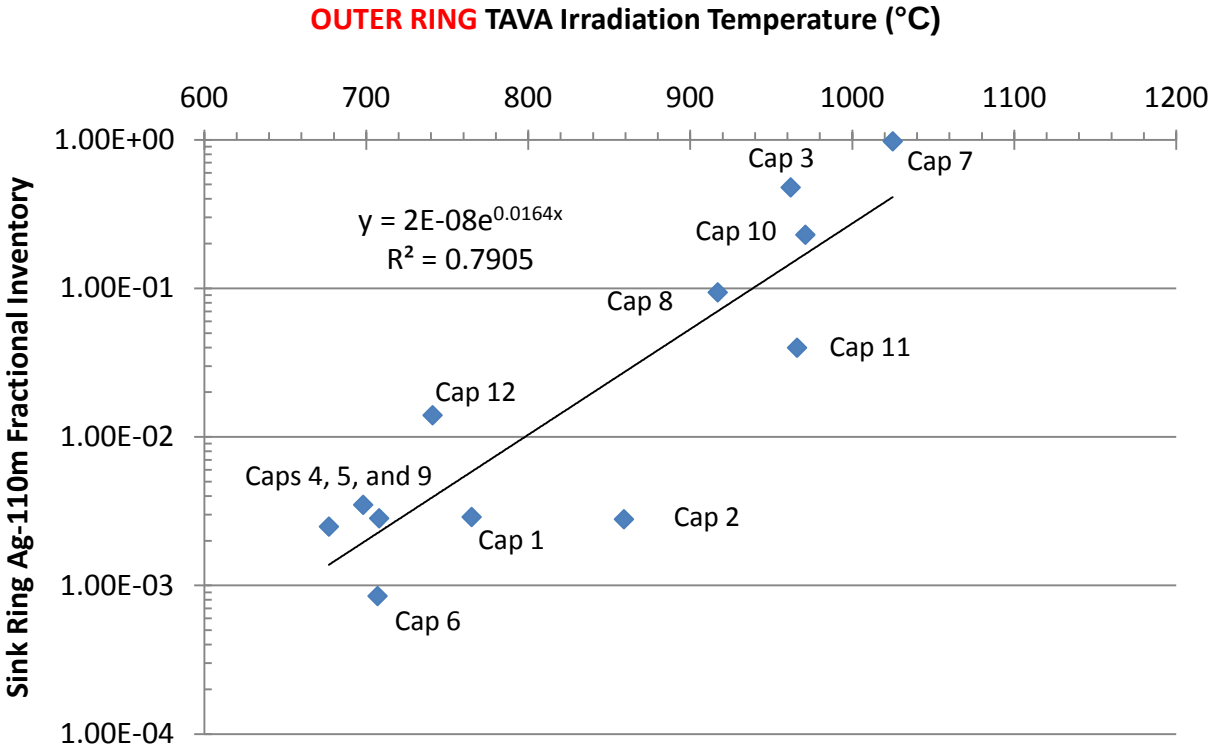
- Compact Ag-110m inventories generally decrease with increasing irradiation temperature
- Inner rings similar in 3 of the hottest 4 capsules
- Outer rings and sink rings have substantial inventory in hottest capsules (Capsules 3, 7, 8, 10, and 11; 1100 < Compact TAVA < 1400°C)

NOTES: Patterned bars are MDAs. Intact fuel body (i.e. 2, 6, 9, and 11) compacts and inner/outer rings not scanned. Capsule spacer analyses are in-progress.



Ag-110m Sink Ring Inventories vs Temperature

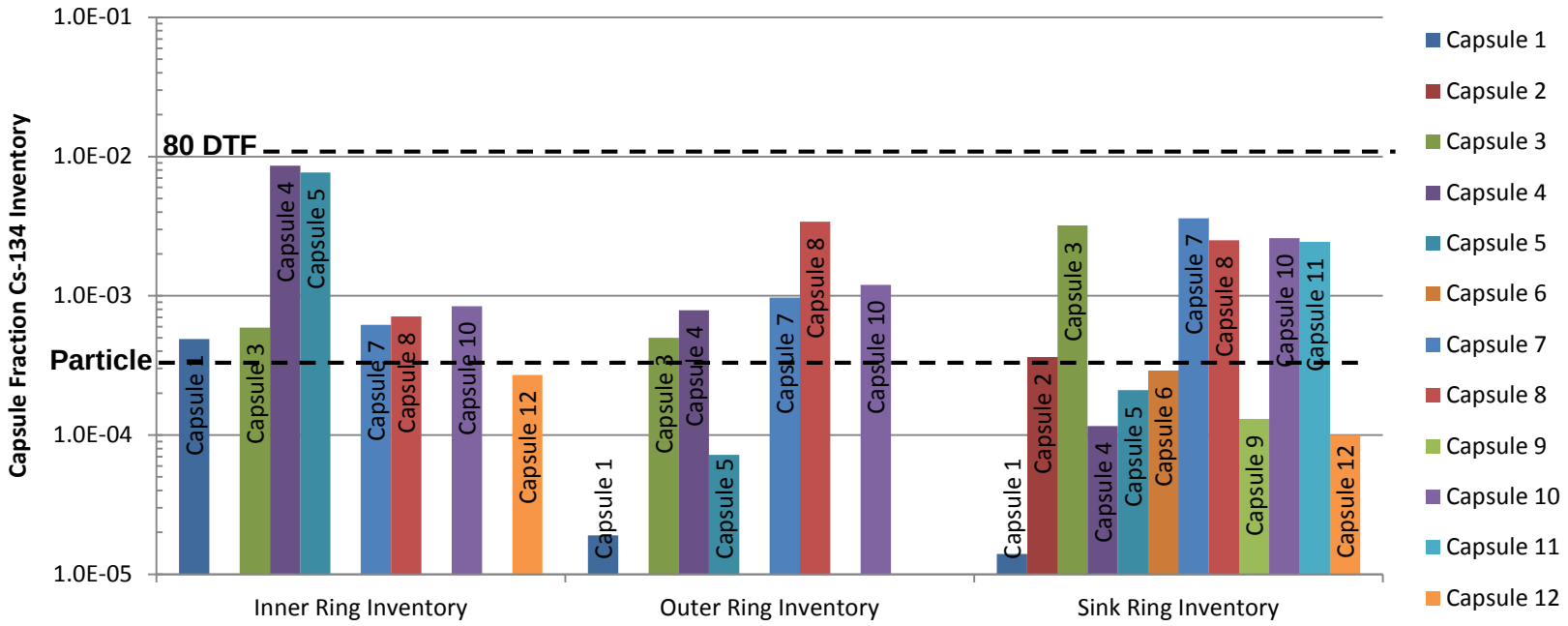
- Ag-110m inventories in all rings plotted vs temperature, clear temperature dependence only observed in sink ring
- Plotting sink ring Ag-110m inventory vs sink ring temperature produces random scatter
- Plotting versus outer ring irradiation temperature shows exponential dependence



Capsule	Type	Inner	Outer	Sink	% FIMA
1	Std	Matrix	PCEA	PCEA	6.14
2	FB	Matrix	PCEA	PCEA	10.07
3	Std	PCEA	PCEA	PCEA	12.58
4	FB	Matrix	PCEA	PCEA	14.21
5	Std	Matrix	PCEA	PCEA	14.87
6	FB	Matrix	PCEA	PCEA	15.24
7	Std	Matrix	PCEA	PCEA	14.96
8	Std	IG-110	IG-110	PCEA	14.51
9	FB	Matrix	IG-110	PCEA	13.67
10	Std	PCEA	PCEA	PCEA	11.80
11	FB	Matrix	PCEA	PCEA	9.06
12	Std	Matrix	PCEA	PCEA	5.35

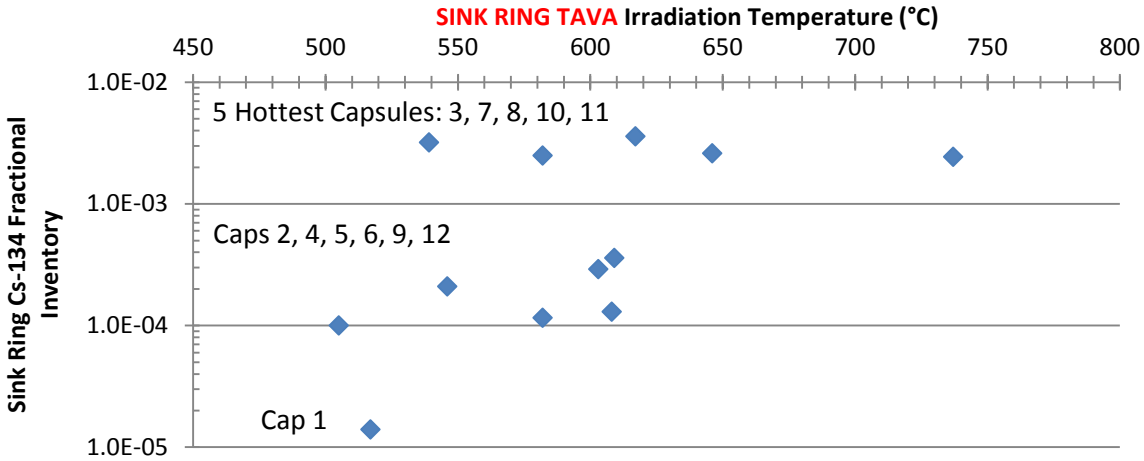
Cs-134 Ring Inventories General Observations

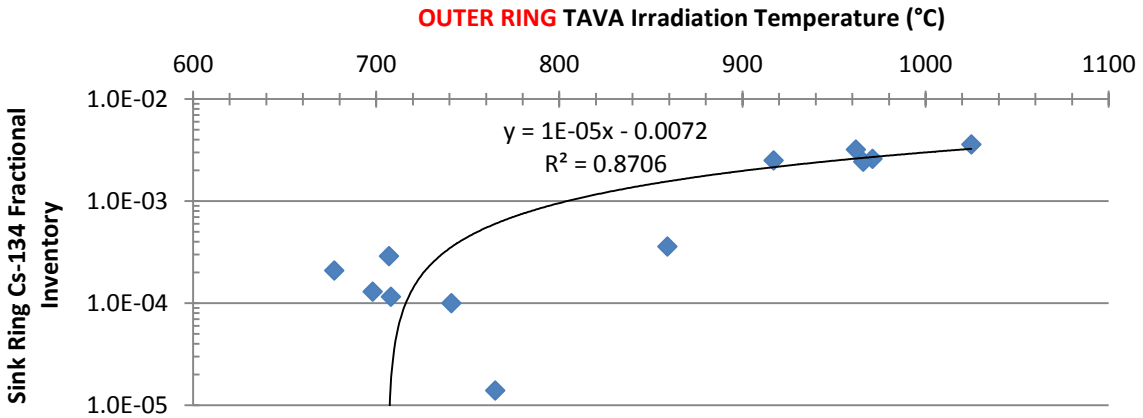
- Cs increases from inner ring to sink ring for hottest capsules (Capsules 7, 8, and 10)
- Cs decreases from inner ring to sink ring for cold capsules (e.g., Capsules 1 and 4)
- Inner rings 4 and 5 had most Cs despite lowest irradiation temperatures. Capsules 4 and 5 compacts were stuck in inner rings and were forcibly removed in PIE. (Increased inventories could be related to easier transport across gap between compacts and inner.)



Cs-134 Sink Ring Inventories vs Temperature

- No temperature dependency when plotted versus sink ring temperature, 3 bands of inventory apparent, most fuel bodies (except for Capsule 11) in middle band
- Linear dependency when plotted against outer ring temperature

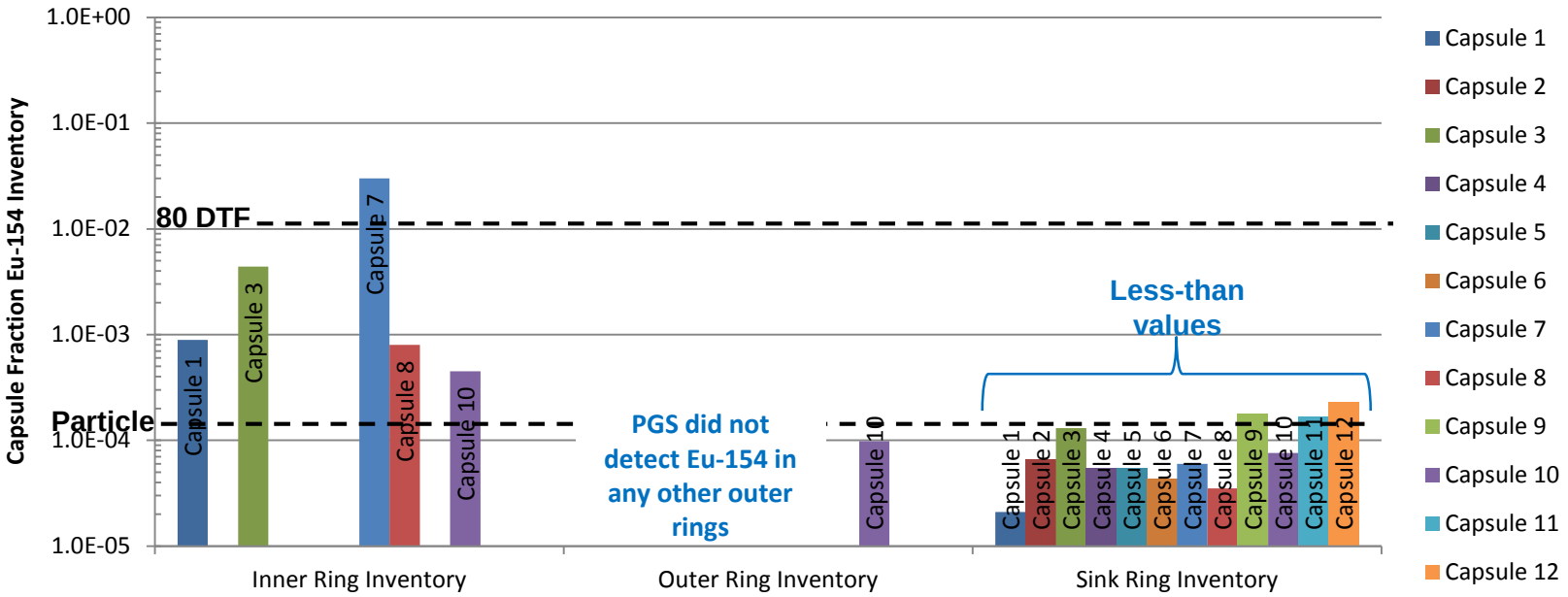




Capsule	Type	Inner	Outer	Sink	% FIMA
1	Std	Matrix	PCEA	PCEA	6.14
2	FB	Matrix	PCEA	PCEA	10.07
3	Std	PCEA	PCEA	PCEA	12.58
4	FB	Matrix	PCEA	PCEA	14.21
5	Std	Matrix	PCEA	PCEA	14.87
6	FB	Matrix	PCEA	PCEA	15.24
7	Std	Matrix	PCEA	PCEA	14.96
8	Std	IG-110	IG-110	PCEA	14.51
9	FB	Matrix	IG-110	PCEA	13.67
10	Std	PCEA	PCEA	PCEA	11.80
11	FB	Matrix	PCEA	PCEA	9.06
12	Std	Matrix	PCEA	PCEA	5.35

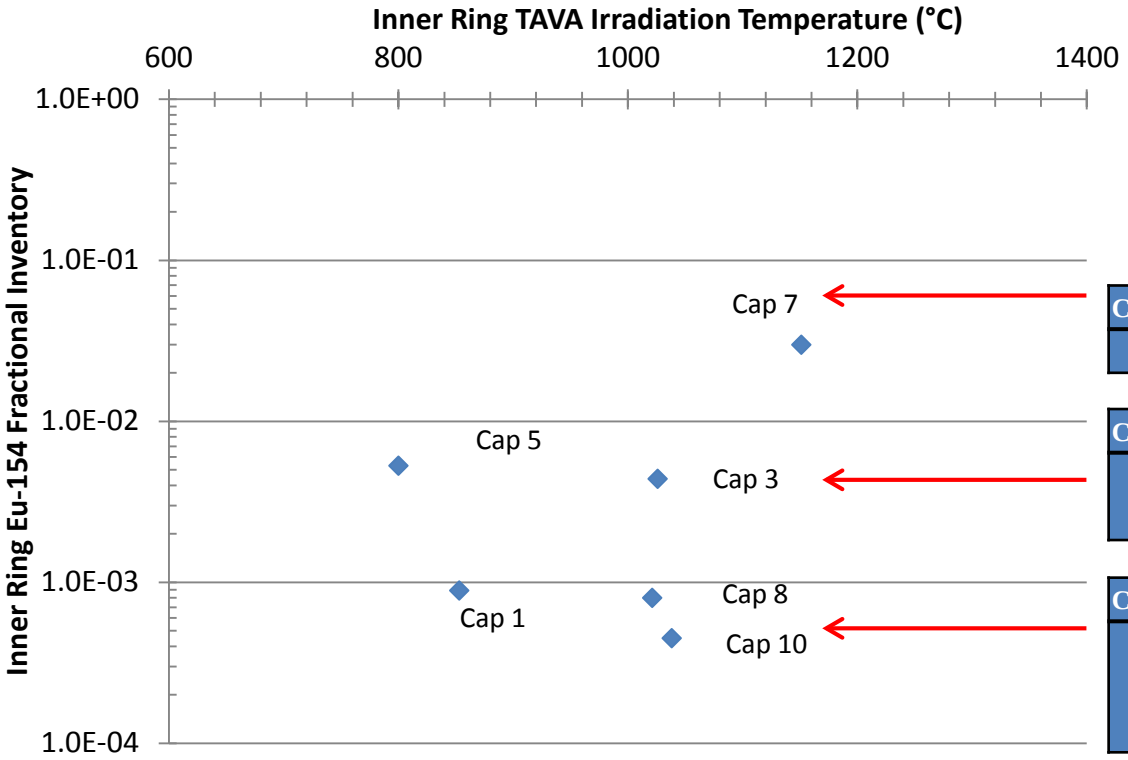
Eu-154 Ring Inventories

- Eu-154 measured primarily in inner rings
- Only outer ring with measured Eu-154 is OR-10



Eu-154 Inner Ring Inventories vs Temperature

- Shape of plot is same when plotted versus compact temperatures
- Three tiers of inventories
- IG-110 and PCEA inner rings had same inventories as Matrix rings but at higher temperatures



Capsule	Type	Inner	Outer	Sink	% FIMA
7	Std	Matrix	PCEA	PCEA	14.96

Capsule	Type	Inner	Outer	Sink	% FIMA
3	Std	PCEA	PCEA	PCEA	12.58
5	Std	Matrix	PCEA	PCEA	14.87

Capsule	Type	Inner	Outer	Sink	% FIMA
1	Std	Matrix	PCEA	PCEA	6.14
8	Std	IG-110	IG-110	PCEA	14.51
10	Std	PCEA	PCEA	PCEA	11.80

AGR-3/4 Fission Product Modeling

- AGR-3/4 data (both from gamma scanning and destructive analysis) is being used to inform fission product transport models
- 1D model developed to make pre-test predictions of fission product inventories and spatial distributions in AGR-3/4 test components
- FP transport is modeled based on temperature-dependent diffusion through the rings and ad/desorption across gaps between rings
- Major model inputs include:
  - Source term from ATR physics analysis and PARticle FUel ModEl (PARFUME) prediction of release from particles to compacts
  - Time and space-dependent temperature profiles based on detailed ABAQUS thermal analysis
  - Diffusion and sorption parameters from IAEA TECDOC-978
- AGR-3/4 will inform new estimates of diffusion coefficients

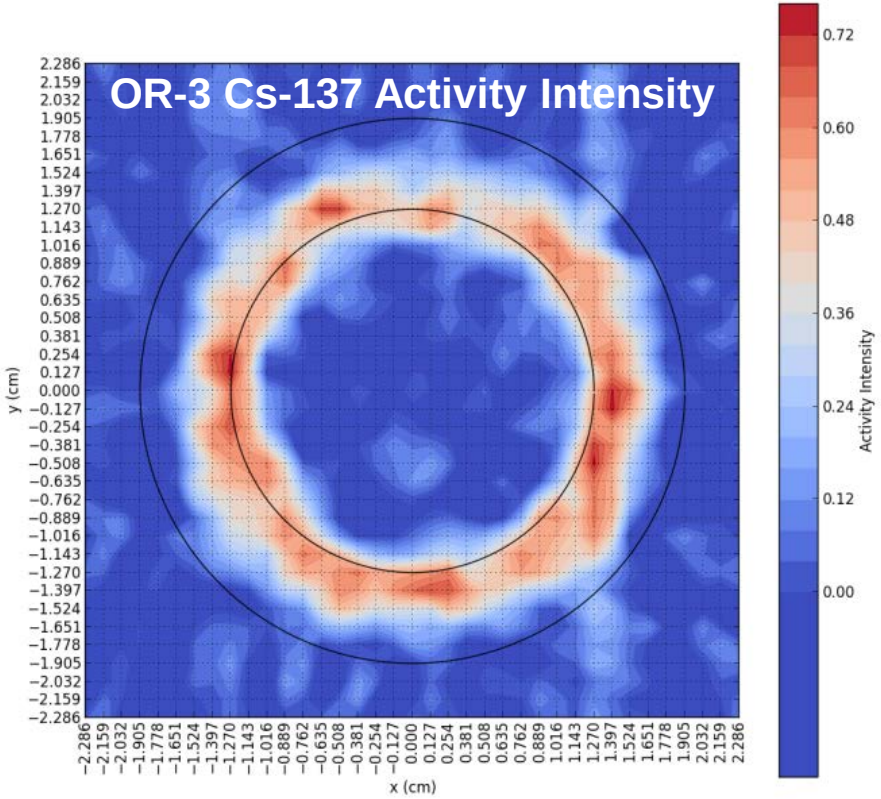
Comparison of ring measured and modeled inventories

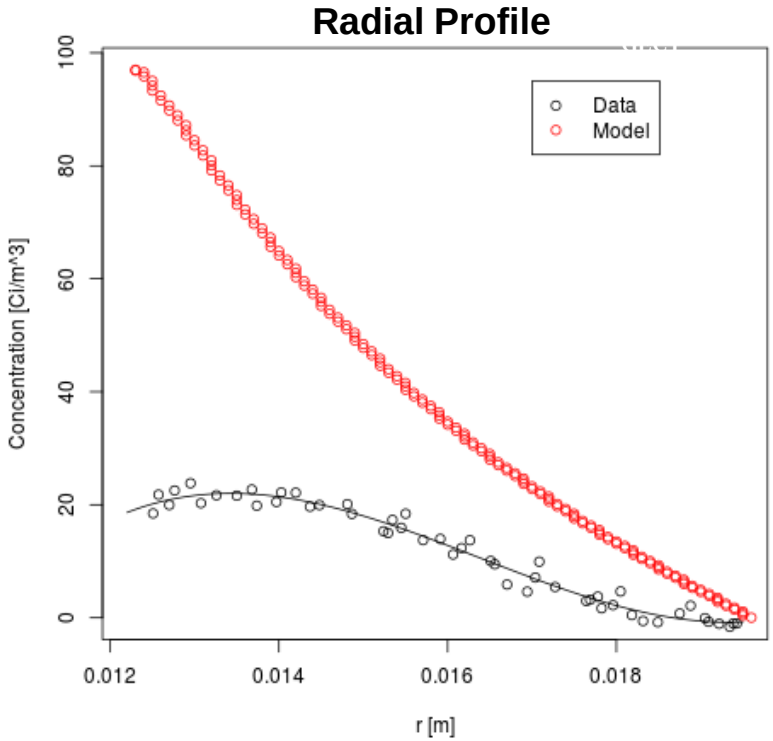
- Model objective is to predict measured values within +/- a factor of 10
  - RED TEXT = Model:Measured ratio outside of +/- factor of 10
- Inner and outer ring Ag and Cs predictions generally meet objective:
  - Hottest capsule (Capsule 7) could be improved for Ag and Cs
  - Coldest capsules (1, 5, and 12) could be improved for Ag
- Sink rings
  - Hottest capsule (3, 7, 8, 10, 11) sink ring predictions generally good for Ag and Cs
  - Ag-110m Model:Measured ratio could be improved for coldest capsules (1, 4, 5, 6, 9, 12)
  - Cs measured in sink rings higher than model prediction
  - Sr-90 measured in the sink rings is higher than predicted (likely due to gaseous precursor to Sr-90 not modeled)

Relative	Inner Ring, Model/Measured				Outer Ring, Model/Measured				Sink Ring, Model/Measured			
Capsule	Ag	Cs-134	Cs-137	Sr-90	Ag	Cs-134	Cs-137	Sr-90	Ag	Cs-134	Cs-137	Sr-90
1	#DIV/0!	9.97	6.74		#DIV/0!	9.40	1.70		0.00	0.00	0.00	0.00
2									>0.04	0.02	0.01	
3	0.60	4.64	3.54		0.18	3.99	3.33		0.73	0.35	0.18	0.00
4	0.41	1.20	1.23		0.13	0.10	0.11		0.00	0.00	0.00	
5	23.31	1.30	1.38		0.27	0.74	0.47		0.00	0.00	0.00	0.00
6									>1.6E-3	0.00	0.00	0.00
7	520.92	25.48	21.47		0.99	1.95	1.74		0.30	0.64	0.60	0.02
8	0.37	3.50	2.67		0.08	0.84	0.75		1.24	0.27	0.24	0.00
9									0.00	0.00	0.00	
10	0.34	3.53	2.92		0.10	2.16	1.87		0.46	0.40	0.35	0.00
11									2.71	0.00	0.00	
12	#DIV/0!	6.34	2.61		#DIV/0!	#DIV/0!	0.06		>3.0E-13	0.00	0.00	

Capsule 3 Outer Ring Tomography with PGS

- Cs-137 in Middle of OR-03
- 0.05” steps, 17 angles
- 16.8 days of scanning

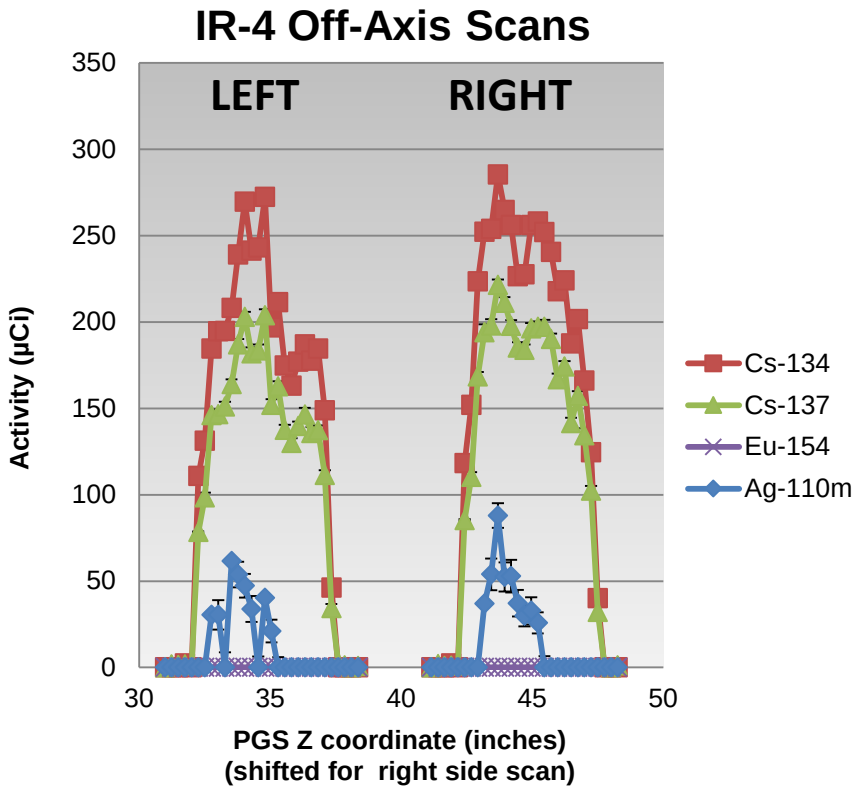


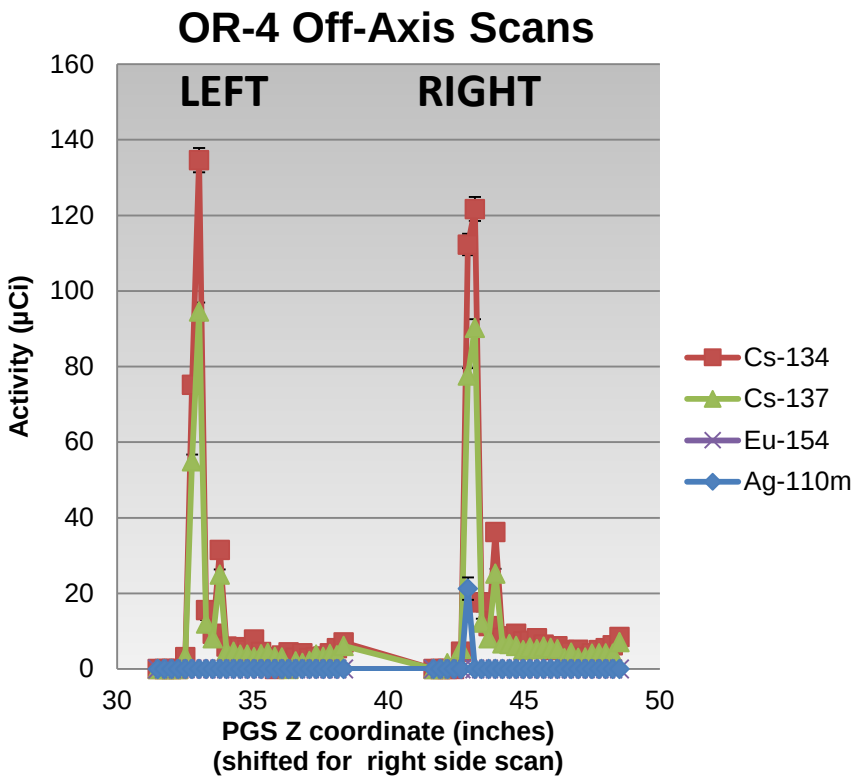


AGR-34-OR-03_M-SHL-Cs-137

Capsule 4 Inner and Outer Ring PGS Axial Scans

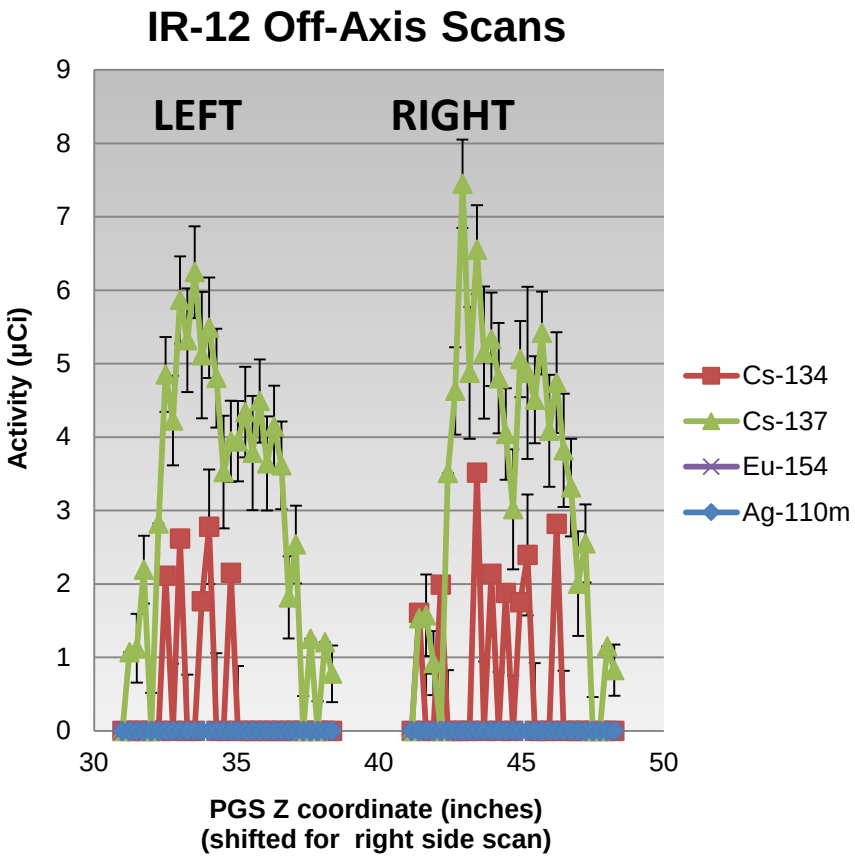
- IR-4 Cs and Ag activities peak in axial middle of ring
- Began tomography of middle of IR-04 on July 5, 2017
- Rings with activity peaked at ends: IR-7/8, OR-3/7/8/10 (all other rings peaked in middle)
  - Cause of middle versus end peaking is unknown
  - IR-10 had Cs peak in the middle but Ag peak at ends

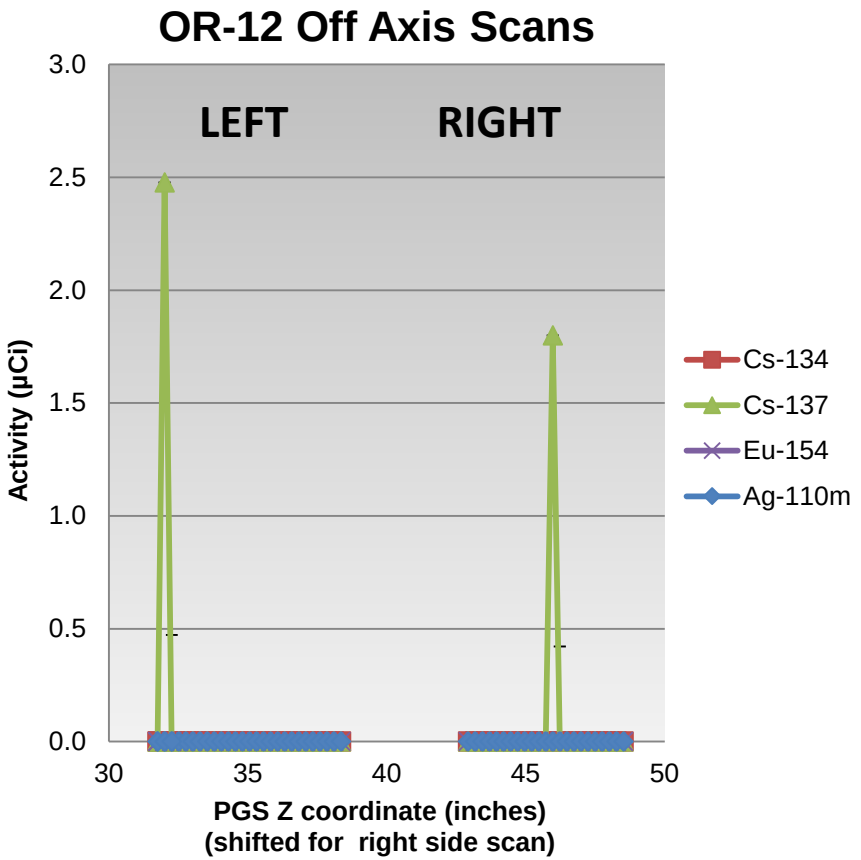




Capsule 12 Inner and Outer Ring PGS Axial Scans

- IR-12 Cs activities peak in axial middle of ring
- Tomography not planned on Capsule 12 rings





Summary of Completed Work

- Completed gamma inventory analysis on all compacts, rings, and through-tubes
- Completed Sr-90 analysis on all through-tubes and 7 of 12 sink rings
- Completed short gamma scans on all irradiation capsule spacers
- Completed 8 of planned 10 PGS tomographic scans (2D fission product maps) of inner and outer rings
- Completed comparisons of all measured inner, outer, and sink ring inventories to model predictions

Planned Work

- Complete safety test of one AGR-3/4 compact in the Fuel Accident Condition Simulator furnace before end of FY17
- Recent and planned PGS tomographic scans:

Ring	Axial Location	Start of Scans	Status
OR-07	Middle	May 15, 2017	Complete
IR-05	Middle	June 5, 2017	Complete
IR-04	**Middle**	**July 5, 2017**	**In-progress**
OR-10	**Middle**	**August 21, 2017**	**Planned**

- Continue to compare tomography radial profiles to model-predicted radial profiles
- Compare tomography profiles to profiles from physical ring sampling (discussed in next presentation)
- Complete analyses (gamma and Sr-90) of AGR-3/4 irradiation capsule spacers
- Complete Sr-90 analysis of sink rings
- In FY18, prepare milestone report on capsule fission product inventories

Questions and Discussion

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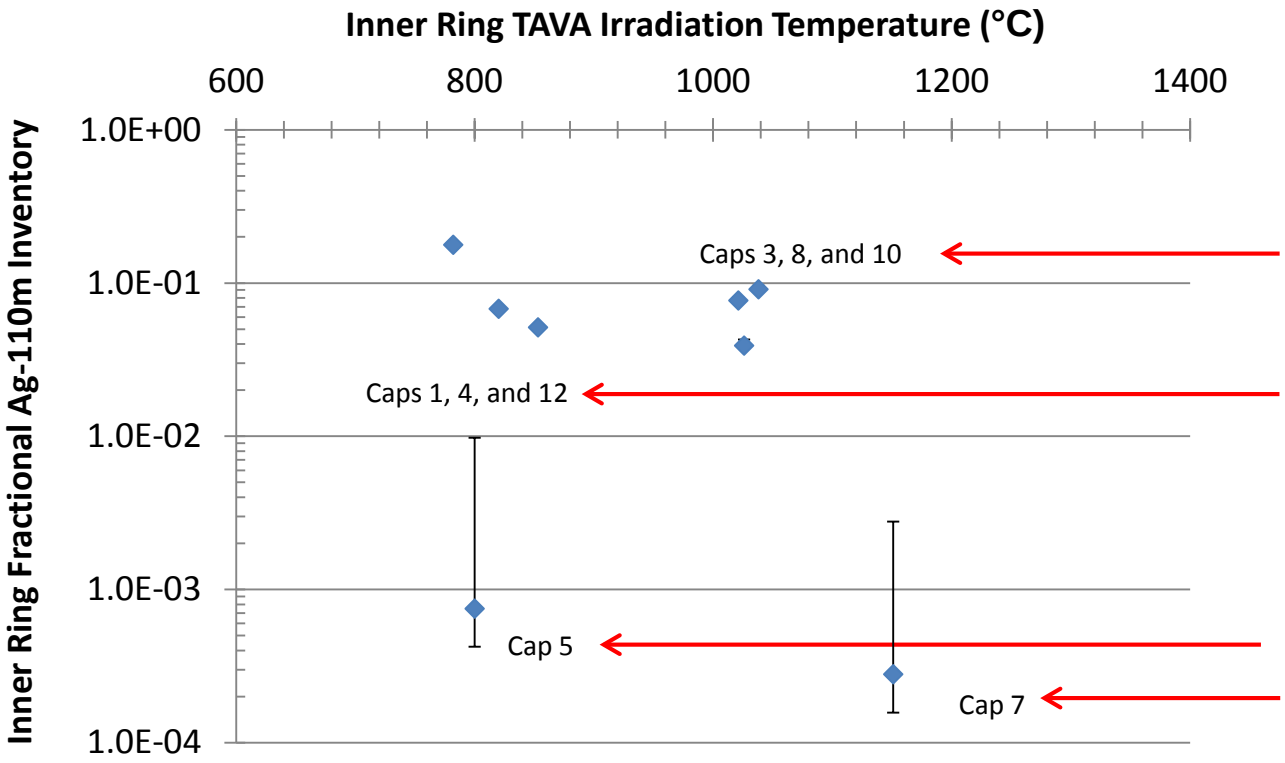
Ag-110m Inner Ring Inventories vs Temperature

- Capsules 3, 8, and 10 inner rings (PCEA and IG-110) had similar inventories to Capsules 1, 4, and 12 inner rings (Matrix), but at higher irradiation temperatures (~200°C higher)
- Capsule 5 had similar irradiation temperature to 1, 4, and 12, similar burnup to 4 (fuel body) and same ring material, but much less inner ring Ag-110m inventory



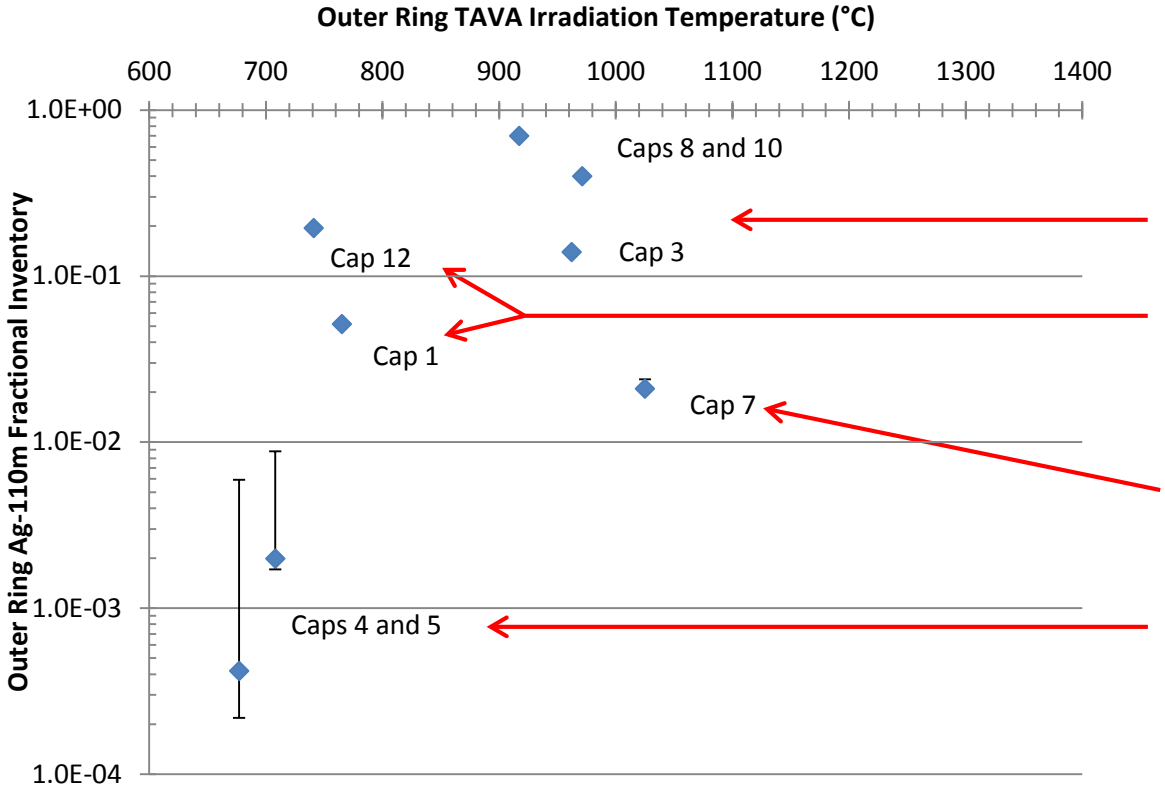
Capsule	Inner	Outer	Sink	%FIMA
3	PCEA	PCEA	PCEA	12.6
8	IG-110	IG-110	PCEA	14.5
10	PCEA	PCEA	PCEA	11.8

Capsule	Inner	Outer	Sink	%FIMA
1	Matrix	PCEA	PCEA	6.14
4	Matrix	PCEA	PCEA	14.2
12	Matrix	PCEA	PCEA	5.35

Capsule	Inner	Outer	Sink	%FIMA
5	Matrix	PCEA	PCEA	14.87
7	Matrix	PCEA	PCEA	14.96

Ag-110m Outer Ring Inventories vs Temperature

- Ag-110m inventory in the outer rings increases up to about 1000°C
- Beyond 1000°C, outer ring inventory goes down, but sink ring inventory goes up
- Shape of plot similar when plotted versus Outer Ring, Compact, Inner Ring, or Sink Ring temps



Capsule	Inner	Outer	Sink	%FIMA
3	PCEA	PCEA	PCEA	12.6
8	IG-110	IG-110	PCEA	14.5
10	PCEA	PCEA	PCEA	11.8

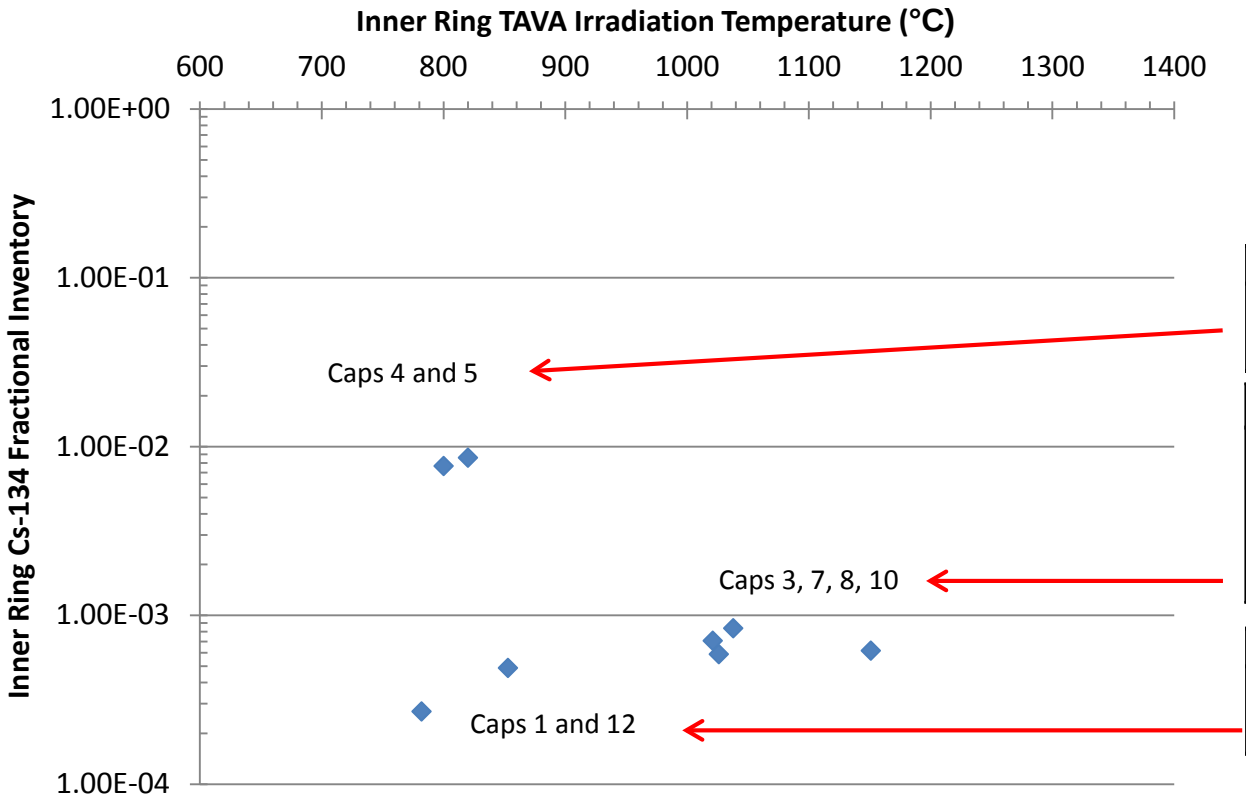
Capsule	Inner	Outer	Sink	%FIMA
1	Matrix	PCEA	PCEA	6.14
12	Matrix	PCEA	PCEA	5.35

Capsule	Inner	Outer	Sink	%FIMA
7	Matrix	PCEA	PCEA	14.96

Capsule	Inner	Outer	Sink	%FIMA
4	Matrix	PCEA	PCEA	14.2
5	Matrix	PCEA	PCEA	14.87

Cs-134 Inner Ring Inventories vs Temperature

- Except for Capsules 4 and 5 inner rings, Cs inventories between 2E-4 and 9E-4
- Shape of plot is similar when plotted versus compact temperature



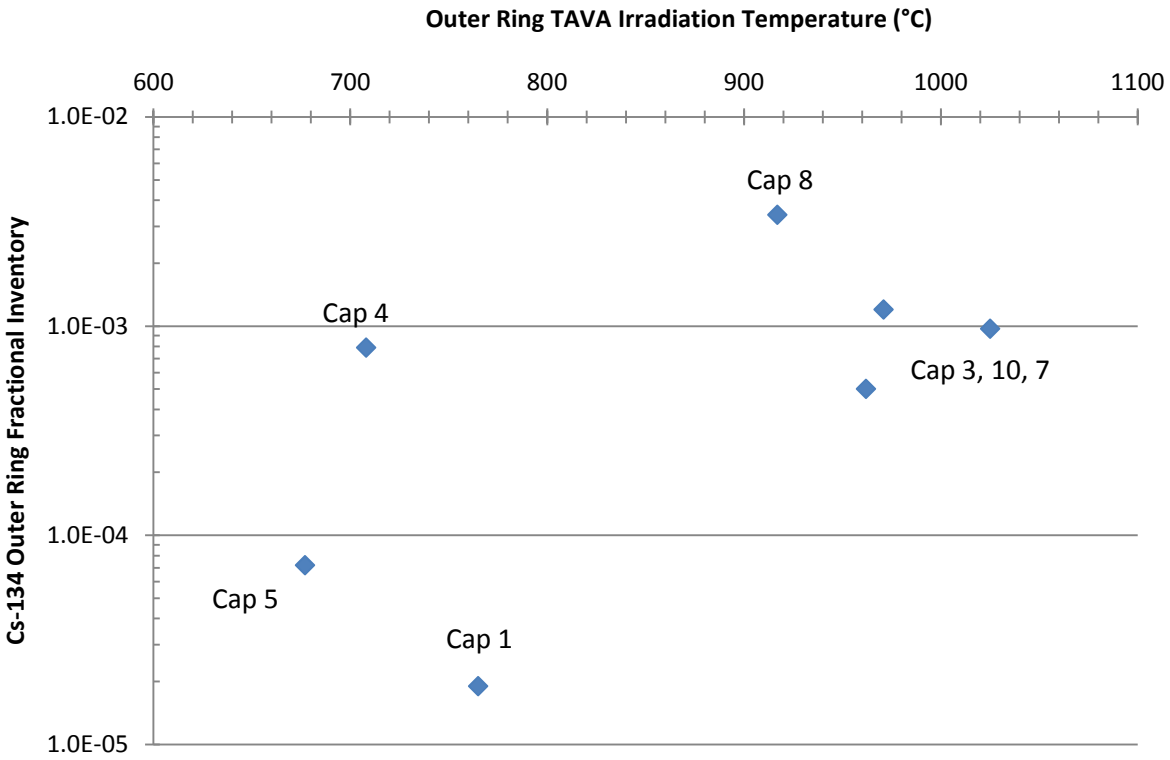
Capsule	Inner	Outer	Sink	%FIMA
4	Matrix	PCEA	PCEA	14.2
5	Matrix	PCEA	PCEA	14.87

Capsule	Inner	Outer	Sink	% FIMA
3	PCEA	PCEA	PCEA	12.58
7	Matrix	PCEA	PCEA	14.96
8	IG-110	IG-110	PCEA	14.51
10	PCEA	PCEA	PCEA	11.80

Capsule	Inner	Outer	Sink	%FIMA
1	Matrix	PCEA	PCEA	6.14
12	Matrix	PCEA	PCEA	5.35

Cs-134 Outer Ring Inventories vs Temperature

- No apparent correlation to material or temperature
- Shape of plot is similar when plotted versus compact or inner ring temperature

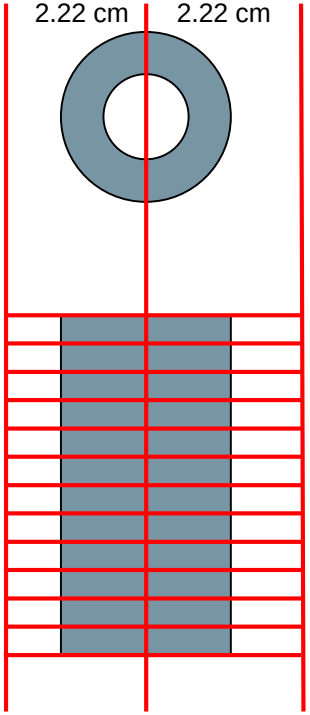


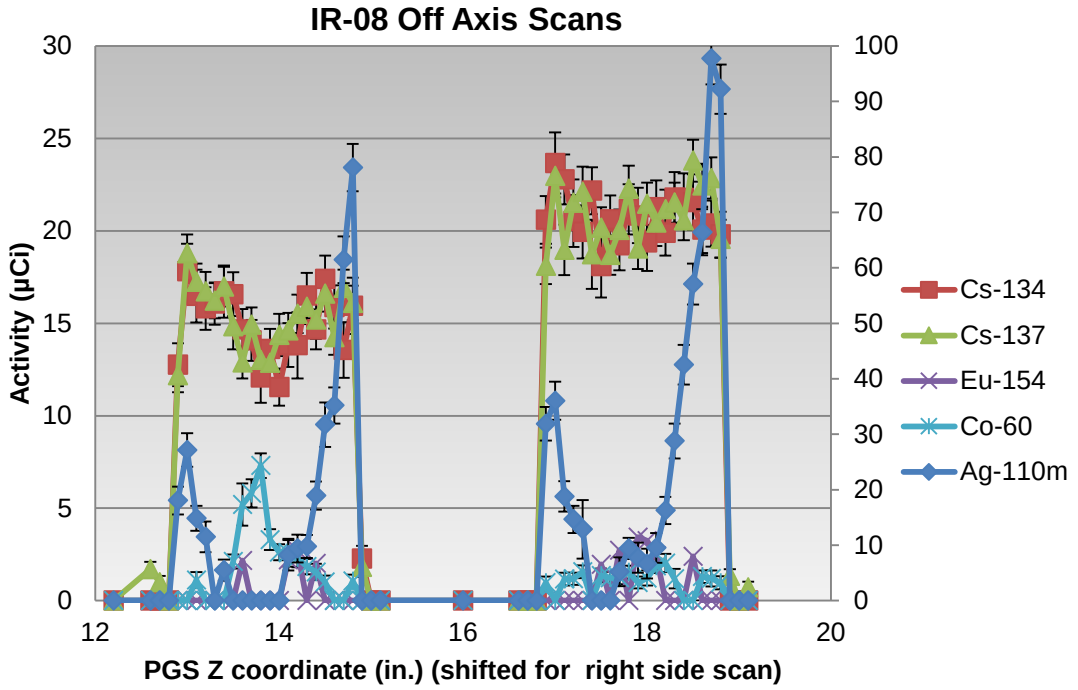
Capsule	Type	Inner	Outer	Sink	% FIMA
1	Std	Matrix	PCEA	PCEA	6.14
2	FB	Matrix	PCEA	PCEA	10.07
3	Std	PCEA	PCEA	PCEA	12.58
4	FB	Matrix	PCEA	PCEA	14.21
5	Std	Matrix	PCEA	PCEA	14.87
6	FB	Matrix	PCEA	PCEA	15.24
7	Std	Matrix	PCEA	PCEA	14.96
8	Std	IG-110	IG-110	PCEA	14.51
9	FB	Matrix	IG-110	PCEA	13.67
10	Std	PCEA	PCEA	PCEA	11.80
11	FB	Matrix	PCEA	PCEA	9.06
12	Std	Matrix	PCEA	PCEA	5.35

Definition of the Off-axis Scans

- Off-axis scans are two or more vertical scans of an item that identifies the height of fission products in an item and can be used to estimate the fission product inventory in an item

- These scans are presented as the left side of an item followed by the right side of an item shifted on the horizontal axis





AGR-3/4 Inner, Outer, and Sink Ring Inventory Summary

Capsule	Type	Material			Inner Ring Inventory (Capsule Fraction)				Outer Ring Inventory (Capsule Fraction)				Sink Ring Inventory (Capsule Fraction)				Total Ring Inventory (Capsule Fraction)			
		Inner	Outer	Sink	Ag-110m	Cs-134	Cs-137	Eu-154	Ag-110m	Cs-134	Cs-137	Eu-154	Ag-110m	Cs-134	Cs-137	Eu-154	Ag-110m	Cs-134	Cs-137	Eu-154
1	Std	Matrix	PCEA	PCEA	<5.13E-2	4.90E-04	7.30E-04	8.90E-04	<5.15E-2	1.90E-05	1.00E-04	0.00E+00	2.90E-03	1.40E-05	1.10E-05	<2.1E-5	2.90E-03	5.20E-04	8.40E-04	<9.1E-4
2	FB	Matrix	PCEA	PCEA									**< 2.8E-3**	**3.60E-04**	**9.7E-4**	**<6.6E-5**				
3	Std	PCEA	PCEA	PCEA	3.90E-02	5.90E-04	7.70E-04	4.40E-03	1.40E-01	5.00E-04	5.90E-04	0.00E+00	4.80E-01	3.20E-03	3.40E-03	<1.3E-4	6.60E-01	4.30E-03	4.70E-03	<4.6E-3
4	FB	Matrix	PCEA	PCEA					**1.99E-3**	**7.89E-4**	**7.38E-4**	**0.00E+00**	**2.8E-03**	**1.2E-04**	**5.6E-04**	**<5.4E-05**				
5	Std	Matrix	PCEA	PCEA	7.50E-04	7.70E-03	7.20E-03	5.30E-03	4.20E-04	7.20E-05	1.10E-04	0.00E+00	2.50E-03	2.10E-04	4.30E-04	<5.4E-5	3.70E-03	8.00E-03	7.80E-03	<5.3E-3
6	FB	Matrix	PCEA	PCEA									**< 8.5E-4**	**2.90E-04**	**4.3E-4**	**<4.3E-5**				
7	Std	Matrix	PCEA	PCEA	2.80E-04	6.20E-04	7.30E-04	3.00E-02	2.10E-02	9.70E-04	1.10E-03	0.00E+00	9.80E-01	3.60E-03	3.80E-03	<6.0E-5	1.00E+00	5.20E-03	5.60E-03	<3.0E-2
8	Std	IG-110	IG-110	PCEA	7.70E-02	7.10E-04	9.30E-04	8.00E-04	7.00E-01	3.40E-03	3.70E-03	0.00E+00	9.40E-02	2.50E-03	2.80E-03	<3.5E-5	8.70E-01	6.60E-03	7.40E-03	<8.4E-4
9	FB	Matrix	IG-110	PCEA									**<3.5E-3**	**1.30E-04**	**4.50E-04**	**<1.8E-4**				
10	Std	PCEA	PCEA	PCEA	9.10E-02	8.40E-04	1.00E-03	4.50E-04	4.00E-01	1.20E-03	1.30E-03	9.80E-05	2.30E-01	2.60E-03	2.90E-03	<7.6E-5	7.10E-01	4.60E-03	5.30E-03	<6.2E-4
11	FB	Matrix	PCEA	PCEA									**4.0E-02**	**2.4E-03**	**3.2E-03**	**<1.7E-04**				
12	Std	Matrix	PCEA	PCEA	**<1.78E-1**	**2.70E-4**	**6.40E-4**	**ND**	**<1.95E-1**	**ND**	**1.5E-5**	**ND**	**<1.4E-2**	**1.0E-4**	**1.1E-3**	**<2.3E-4**				

BOLD: new since December 2016

AGR-3/4 Inner Ring Inventory Summary

Capsule	Type	Material			TAVA	TA Min	TA Peak	Inner Ring Inventory (Capsule Fraction)			
		Inner	Outer	Sink	°C	°C	°C	Ag-110m	Cs-134	Cs-137	Eu-154
1	Std	Matrix	PCEA	PCEA	853	782	889	<5.13E-2	4.90E-04	7.30E-04	8.90E-04
2	FB	Matrix	PCEA	PCEA	934	864	977				
3	Std	PCEA	PCEA	PCEA	1026	984	1050	3.90E-02	5.90E-04	7.70E-04	4.40E-03
4	FB	Matrix	PCEA	PCEA	820	736	882	**6.80E-2**	**8.6E-3**	**8.4E-3**	**ND**
5	Std	Matrix	PCEA	PCEA	800	732	858	7.50E-04	7.70E-03	7.20E-03	5.30E-03
6	FB	Matrix	PCEA	PCEA	843	747	912				
7	Std	Matrix	PCEA	PCEA	1151	1084	1203	2.80E-04	6.20E-04	7.30E-04	3.00E-02
8	Std	IG-110	IG-110	PCEA	1021	984	1048	7.70E-02	7.10E-04	9.30E-04	8.00E-04
9	FB	Matrix	IG-110	PCEA	822	743	884				
10	Std	PCEA	PCEA	PCEA	1038	1014	1055	9.10E-02	8.40E-04	1.00E-03	4.50E-04
11	FB	Matrix	PCEA	PCEA	1124	1046	1166				
12	Std	Matrix	PCEA	PCEA	782	754	802	**1.78E-1**	**2.70E-4**	**6.4E-4**	**ND**

BOLD: new since December 2016

AGR-3/4 Outer Ring Inventory Summary

Capsule	Type	Material			TAVA	TA Min	TA Peak	Outer Ring Inventory (Capsule Fraction)			
		Inner	Outer	Sink	°C	°C	°C	Ag-110m	Cs-134	Cs-137	Eu-154
1	Std	Matrix	PCEA	PCEA	765	750	785	<5.15E-2	1.90E-05	1.00E-04	ND
2	FB	Matrix	PCEA	PCEA	859	834	875				
3	Std	PCEA	PCEA	PCEA	962	945	976	1.40E-01	5.00E-04	5.90E-04	ND
4	FB	Matrix	PCEA	PCEA	708	688	727	**1.99E-3**	**7.89E-4**	**7.38E-4**	**ND**
5	Std	Matrix	PCEA	PCEA	677	661	706	4.20E-04	7.20E-05	1.10E-04	ND
6	FB	Matrix	PCEA	PCEA	707	688	728				
7	Std	Matrix	PCEA	PCEA	1025	1014	1045	2.10E-02	9.70E-04	1.10E-03	ND
8	Std	IG-110	IG-110	PCEA	917	904	945	7.00E-01	3.40E-03	3.70E-03	ND
9	FB	Matrix	IG-110	PCEA	698	671	721				
10	Std	PCEA	PCEA	PCEA	971	962	986	4.00E-01	1.20E-03	1.30E-03	9.80E-05
11	FB	Matrix	PCEA	PCEA	966	951	975				
12	Std	Matrix	PCEA	PCEA	741	735	748	**<1.95E-1**	**ND**	**1.5E-5**	**ND**

BOLD: new since December 2016

AGR-3/4 Sink Ring Inventory Summary

Capsule	Type	Material			TAVA	TA Min	TA Peak	Sink Ring Inventory (Capsule Fraction)			
		Inner	Outer	Sink	°C	°C	°C	Ag-110m	Cs-134	Cs-137	Eu-154
1	Std	Matrix	PCEA	PCEA	517	486	534	2.90E-03	1.40E-05	1.10E-05	<2.1E-5
2	FB	Matrix	PCEA	PCEA	609	571	635	**< 2.8E-3**	**3.60E-04**	**9.7E-4**	**<6.6E-5**
3	Std	PCEA	PCEA	PCEA	539	504	569	4.80E-01	3.20E-03	3.40E-03	<1.3E-4
4	FB	Matrix	PCEA	PCEA	582	538	620	**2.8E-03**	**1.2E-04**	**5.6E-04**	**<5.4E-05**
5	Std	Matrix	PCEA	PCEA	546	501	589	2.50E-03	2.10E-04	4.30E-04	<5.4E-5
6	FB	Matrix	PCEA	PCEA	603	558	643	**< 8.5E-4**	**2.90E-04**	**4.3E-4**	**<4.3E-5**
7	Std	Matrix	PCEA	PCEA	617	573	659	9.80E-01	3.60E-03	3.80E-03	<6.0E-5
8	Std	IG-110	IG-110	PCEA	582	528	636	9.40E-02	2.50E-03	2.80E-03	<3.5E-5
9	FB	Matrix	IG-110	PCEA	608	558	652	**<3.5E-3**	**1.30E-04**	**4.50E-04**	**<1.8E-4**
10	Std	PCEA	PCEA	PCEA	646	609	678	2.30E-01	2.60E-03	2.90E-03	<7.6E-5
11	FB	Matrix	PCEA	PCEA	737	704	758	**4.0E-02**	**2.4E-03**	**3.2E-03**	**<1.7E-04**
12	Std	Matrix	PCEA	PCEA	505	483	519	**<1.4E-2**	**1.0E-4**	**1.1E-3**	**<2.3E-4**

BOLD: new since December 2016