The Effect of Research Reactor Conversion on Reactor Productivity

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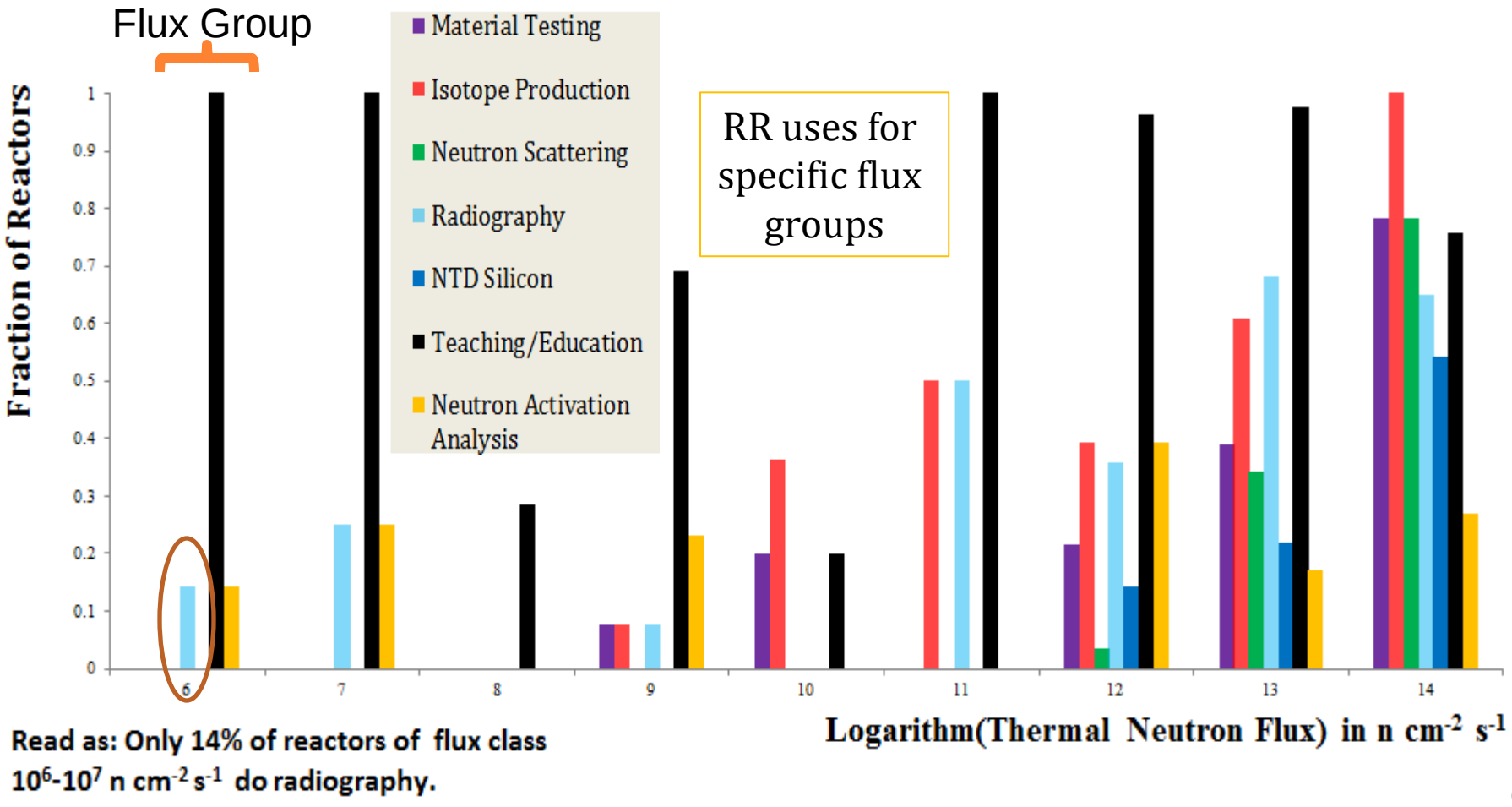
OUTLINE

- Motivations for this study
- Describe the present study
- Some results from 2010 study
- Impact of conversion on flux and on economics of fuel (INE study)

Motivations for the Study

- Success of conversion means maintaining performance
- Important to test whether the RERTR Fundamental Principles of conversion are met
- Important to assess how reactor productivity has changed post-conversion
- Query research reactors that have converted whether their expectation are met

Wide Variety of Reactor Uses



Fraction of RR's in each flux group that use the reactor in specific ways. Ref. IAEA RRDB

Assessing Productivity Before/After Conversion

- Productivity defined differently for different applications and reactors
- Possible methods that could be used:

(1) Number of Publications (scientific output)
(2) Reactor Operator/Manager Survey

2010 Study

- Selected converted reactors 2003-2007
- Recent past – enough time to assess pubs after conv'n.

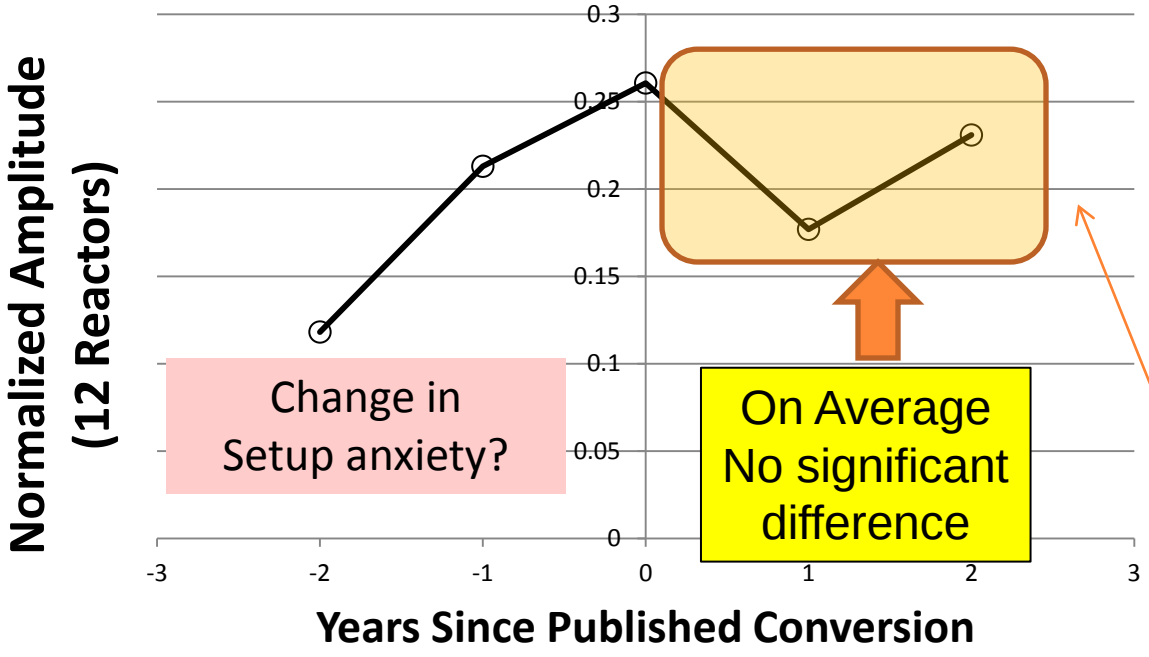
Different Research Reactor Uses

Reactor Log(Th. Flux)	Edu & Training	NAA	BCNT	N. Scatt	Radiography	Geochron	NTD	Isotope	Mat Test
14							X	X	X
14	X	X	X	X	X	X	X	X	
14	X	X			X			X	
14	X	X		X		X	X	X	
13		X			X	X		X	
13	X	X		X				X	
13	X	X		X	X			X	
13	X	X						X	
13	X	X				X	X	X	X
13	X	X			X			X	
13	X						X	X	
13	X	X	X		X			X	
9	X	X							

Number of Publications as Productivity Indicator

Number of Publications as a measure of Scientific Sustainability.

- Total Pubs – (Pubs about LEU conversion)
- Pubs as a function of time since conversion
- Assume ETDE adequate:



Each reactor treated equally
Number of papers each reactor produced is normalized and summed.

Energy Technology Data XCh

$$\sum_{j=1}^{12}\left[\frac{N_{pubs}\,(year\ 2, reactor\ j)}{Tot\ Pubs\ Reactor\ j}\right]$$

Difficult to measure the productivity for specific uses

Survey of Reactor Operators/ Managers as Productivity Indicator

Productivity Indicator: Questionnaire

- Sent survey to operators (2003-2007) (first in line for complaints) - 50% resp.
- Questions written in the affirmative on a *Likert* (5) scale

3) The sensitivity and/or applicability of *NAA (Neutron Activation Analysis)* has improved after reactor conversion (please place X in the table below where it is most appropriate).

Strongly Agree (100% True) ←				(50% True)		→ Strongly Disagree (100% False)		
4	3	2	1	0	1	2	3	4
					x			

If possible, please explain your reasons for choosing above and whether the change after conversion is caused by reactor conversion or other external factors.

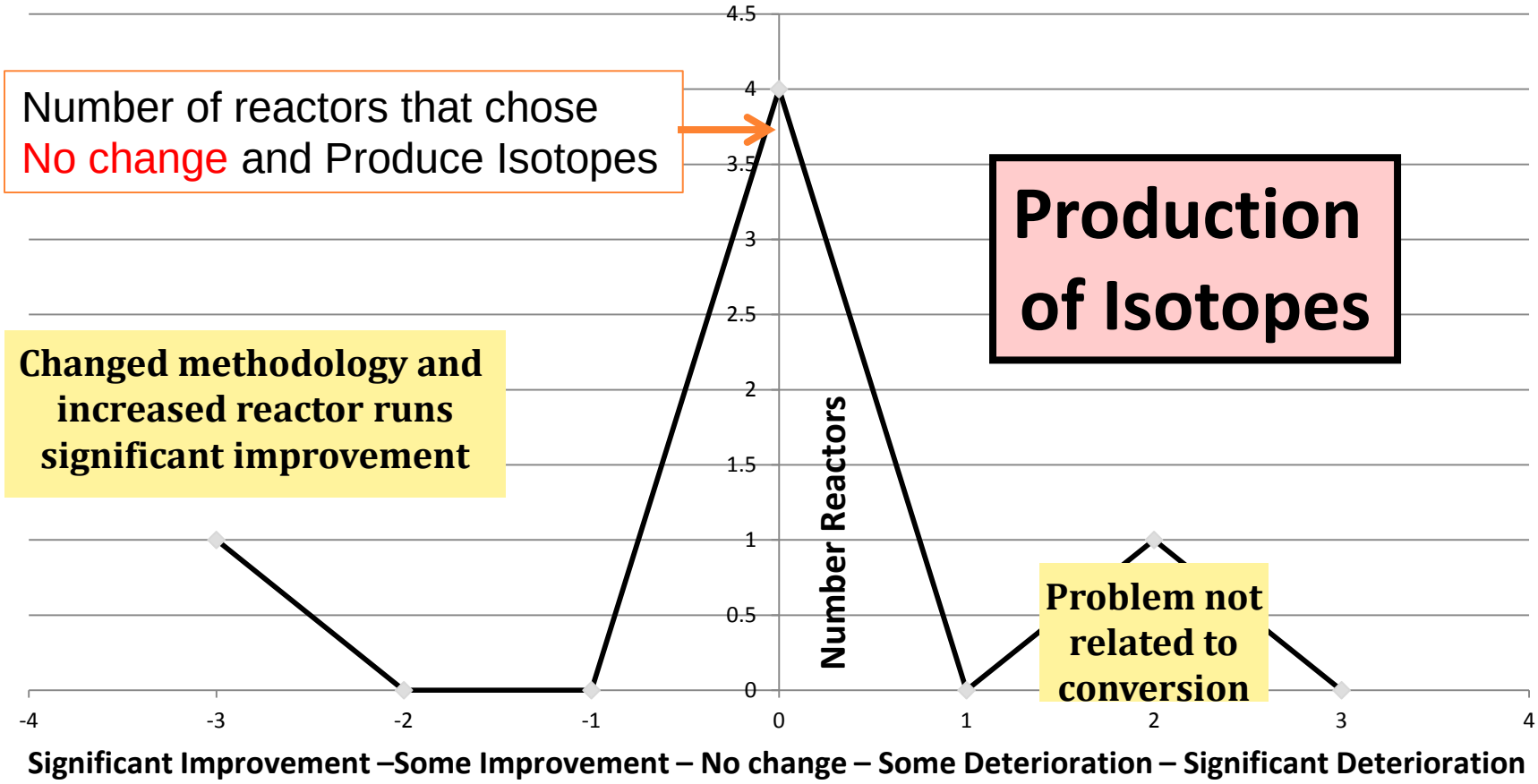
The change was hardly noticeable. A much larger improvement was obtained after the core conversion by using more sensitive neutron detectors on the samples.

Should this information remain anonymous? Please place X where appropriate.	YES	NO
		x

Each questionnaire specific to reactor uses.

Sent to reactor managers

Example: Isotope Production After Conversion



Most of the reactors surveyed showed no significant change in isotope productivity, NAA, and other uses

Another Productivity Indicator: Questionnaire

-Number of students before/after
-Number of technical staff before/after
-Education/Training -

Phone Interview: process "pretty awesome" for education of nuclear engineers.
-40 people involved with 2 PhD's produced
-Mostly supervised students doing the work

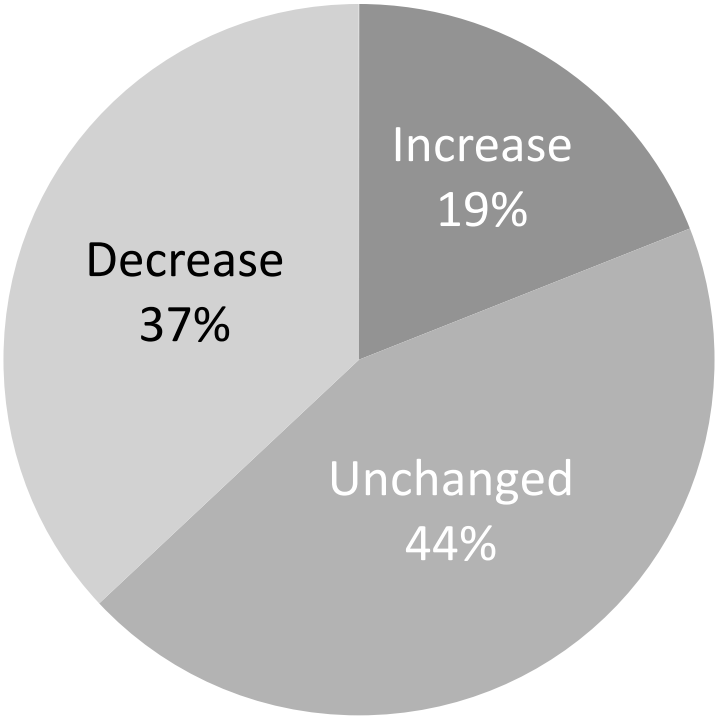
- Statistics are very low -
-Reactors low flux-

Conversion Impact on Flux Density and Economics

Work by: Kevin Alldred and Nigel Mote
International Nuclear Enterprise Group, LLC
Presented at RRFM 2008

Conversion Impact Flux Density

- Survey conducted by INE Group
- Only 37% of RR operators observed a significant *"flux penalty"*



Change in Neutron Flux Density Following Conversion.

Kevin Alldred and Nigel Mote
International Nuclear Enterprise Group, LLC
Presented at RRFM 2008

Further Findings: Economic Issues

- Some reactor operators reported increases in LEU fuel acquisition and fabrication costs.
  - -Claimed: Increased consumption with LEU fuels -> increase in spent fuel costs.
- True cost of SF management masked by the Foreign RR SNF Acceptance Program (removal of US-origin HEU fresh and SNF)
- If program ends could become a disincentive for conversion since “step” cost increase.

LINK: Spent Fuel Acceptance – GTRI Conversion

Kevin Alldred and Nigel Mote
International Nuclear Enterprise Group, LLC
Presented at RRFM 2008

Summary

- Reactor use does not seem to be adversely affected (low flux primarily)
- Reactor flux density “penalty” appears manageable for many reactors (INE study)
- Future: Expand survey to increase statistics.