

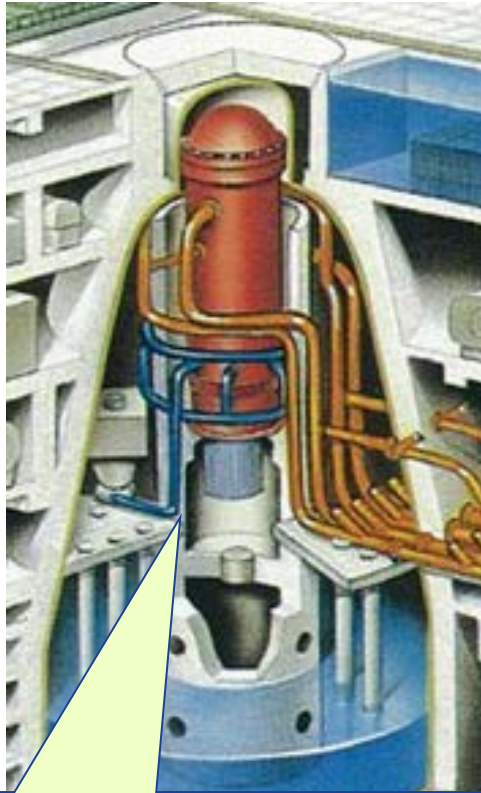
2014 North American ISOE ALARA Symposium

Development of On-Line Co-60 Monitoring System

Hirofumi Matsubara
Hitachi-GE Nuclear Energy, Ltd.

Jan. 14th 2014
Ft. Lauderdale, Florida

1. Background
 - a. Need for Co-60 monitoring
 - b. Development history
2. Monitoring system
 - a. Principal of coincidence method
 - b. System configuration
3. Performance demonstration
4. Summary



Source :
Co-60 contaminated
RRS piping

On-line Co-60 monitoring system can provide dose rate around RRS piping during BWR plant operation.

- (1) Optimization of zinc injection rate
- (2) Improvement of outage work planning

■ Conventional Monitoring Method

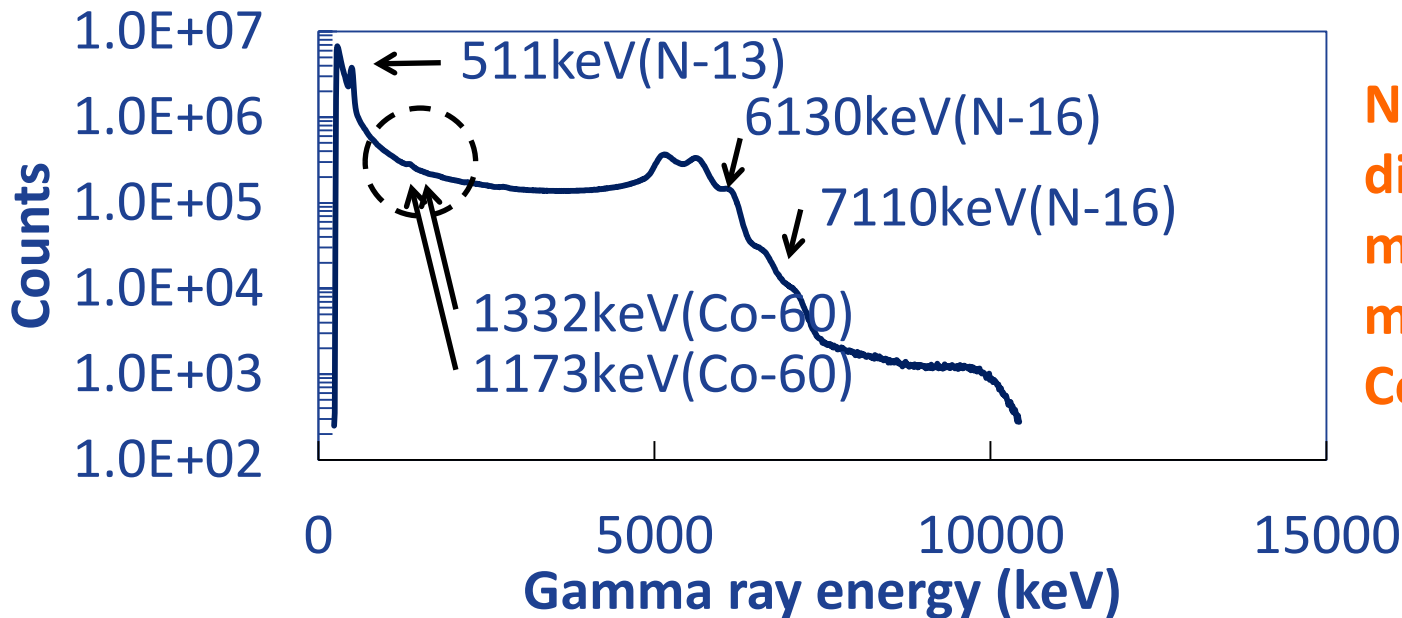
	Drywell	
	Inside	Outside (R/B, etc.)
Outage	<ul style="list-style-type: none"> • BRAC Measurements 	<ul style="list-style-type: none"> • Survey Meter • Area Monitor
Power Operation	<ul style="list-style-type: none"> • Nothing 	<ul style="list-style-type: none"> • Area Monitor

On-line Co-60 monitoring system provides feedback of dose rate changes caused by water chemistry conditions.

- Goal of the study is to improve the understanding of the effects from:
 - SCRAMs
 - OLNC injections
 - Co-60 transients
(i.e. from fretting/wear of Stellite™ components)
 - Hydrogen trips
 - Changes in zinc levels

Environment inside drywell

	Measurement nuclide Co-60	Interference nuclide N-16
Existing location	RRS piping	Reactor water
Gamma ray energy	1173, 1332keV	6129, 7110keV
Dose rate	10~1000 mR/h (Pipe surface dose rate)	5000 mR/h (Atmosphere)

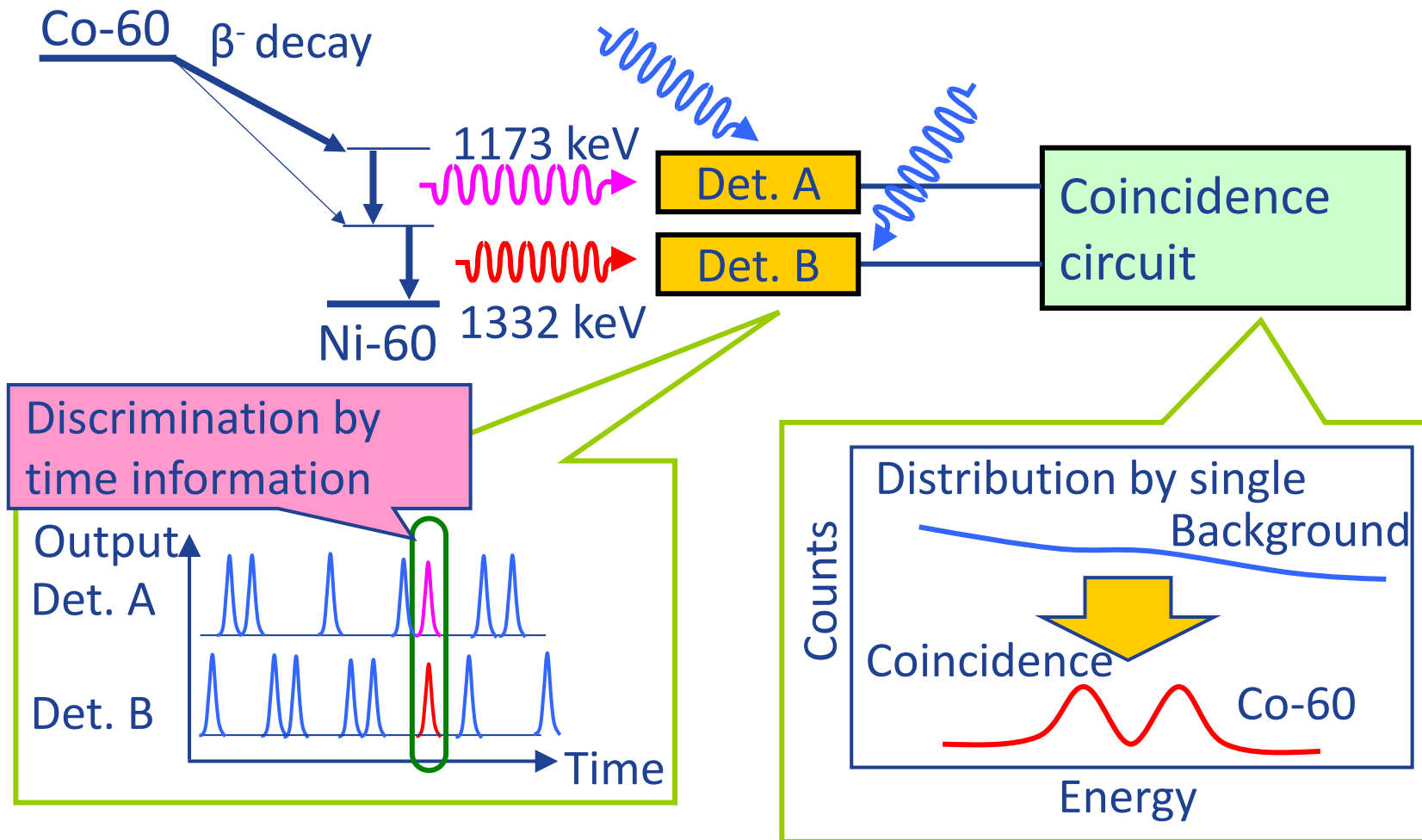


N-16 Compton distribution makes measurement of Co-60 difficult

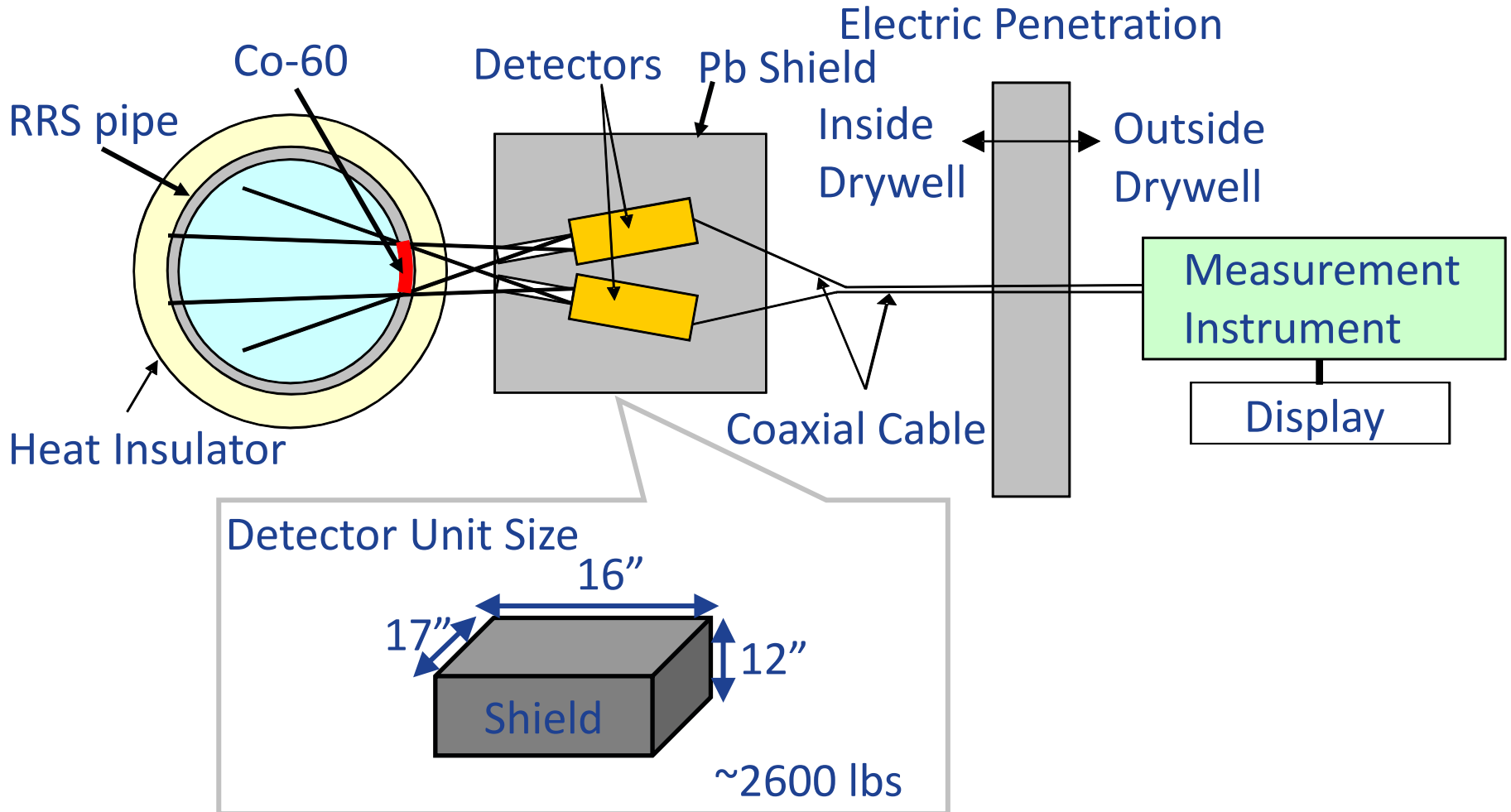
Principles of Coincidence Method



Discrimination of Co-60 from the background radiation is accomplished by coincidental signals from two detectors.



Detect cascade gamma-ray from Co-60 using two detectors in coincidence method.



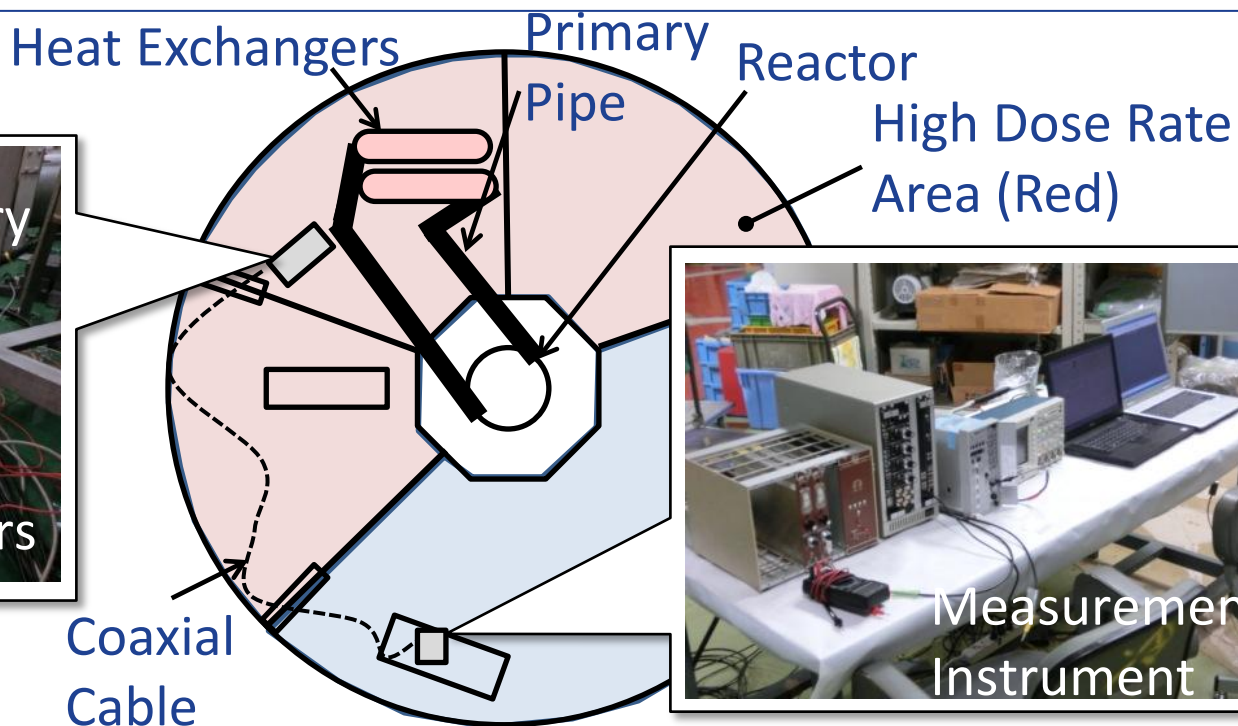
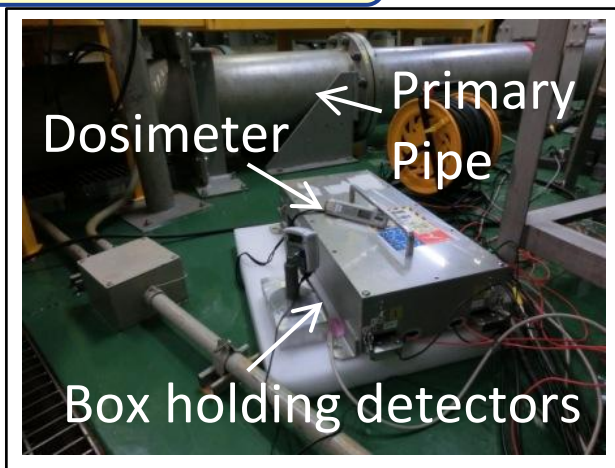
2nd Demonstration in Research Reactor ✘

Conditions

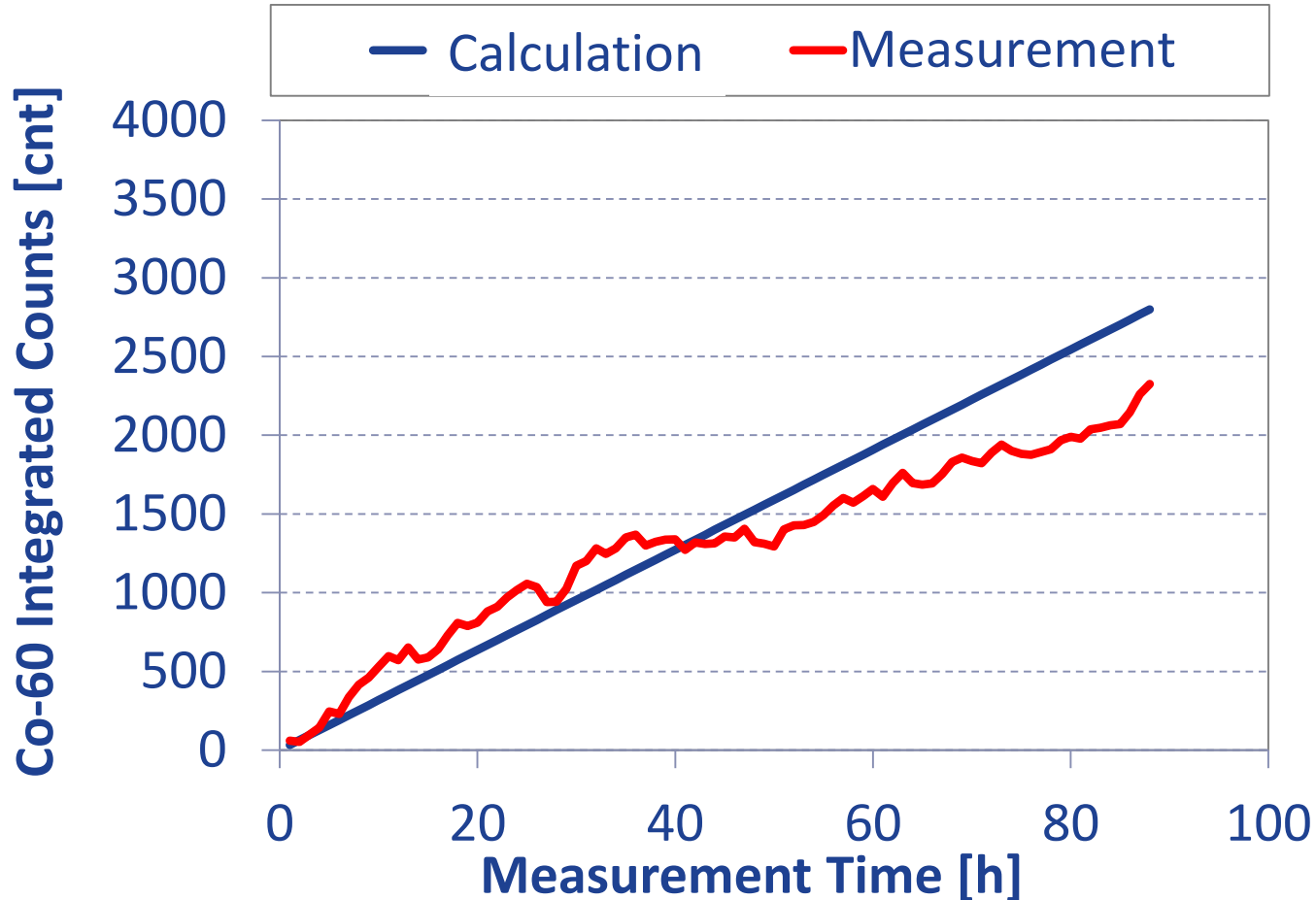
✘ Kyoto University Research Reactor (KUR)

Parameter	Conditions	Remarks
Background dose rate	480 mR/h	Dose rate inside Pb shield was simulated
Interference nuclide	N-16	-
Measured nuclide	Co-60	Contaminated RRS piping was simulated using checking source

Configuration

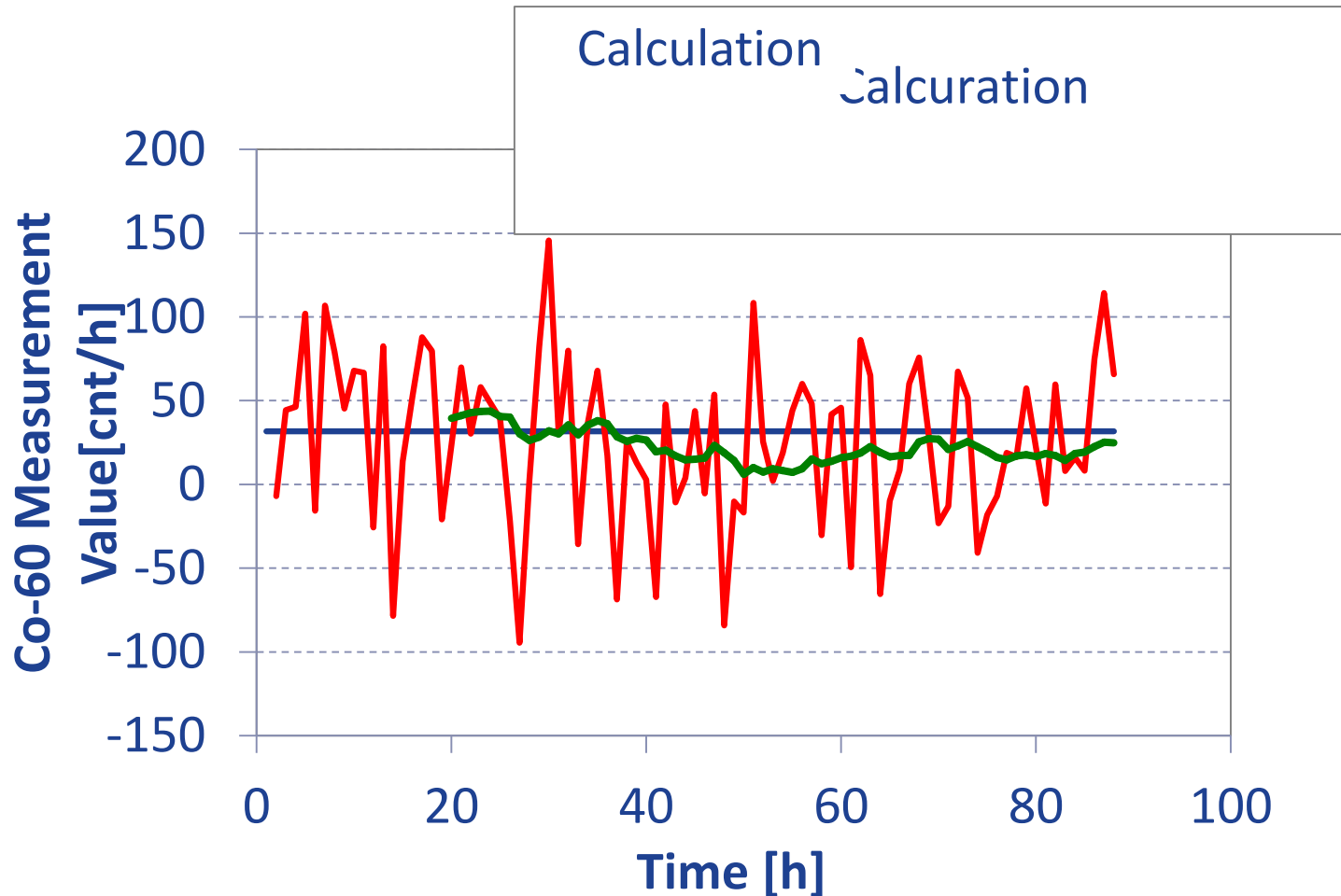


Confirmed this system can discriminate Co-60 radiation.





Moving average of 20 measurements meets desired $\pm 30\%$ of accuracy.



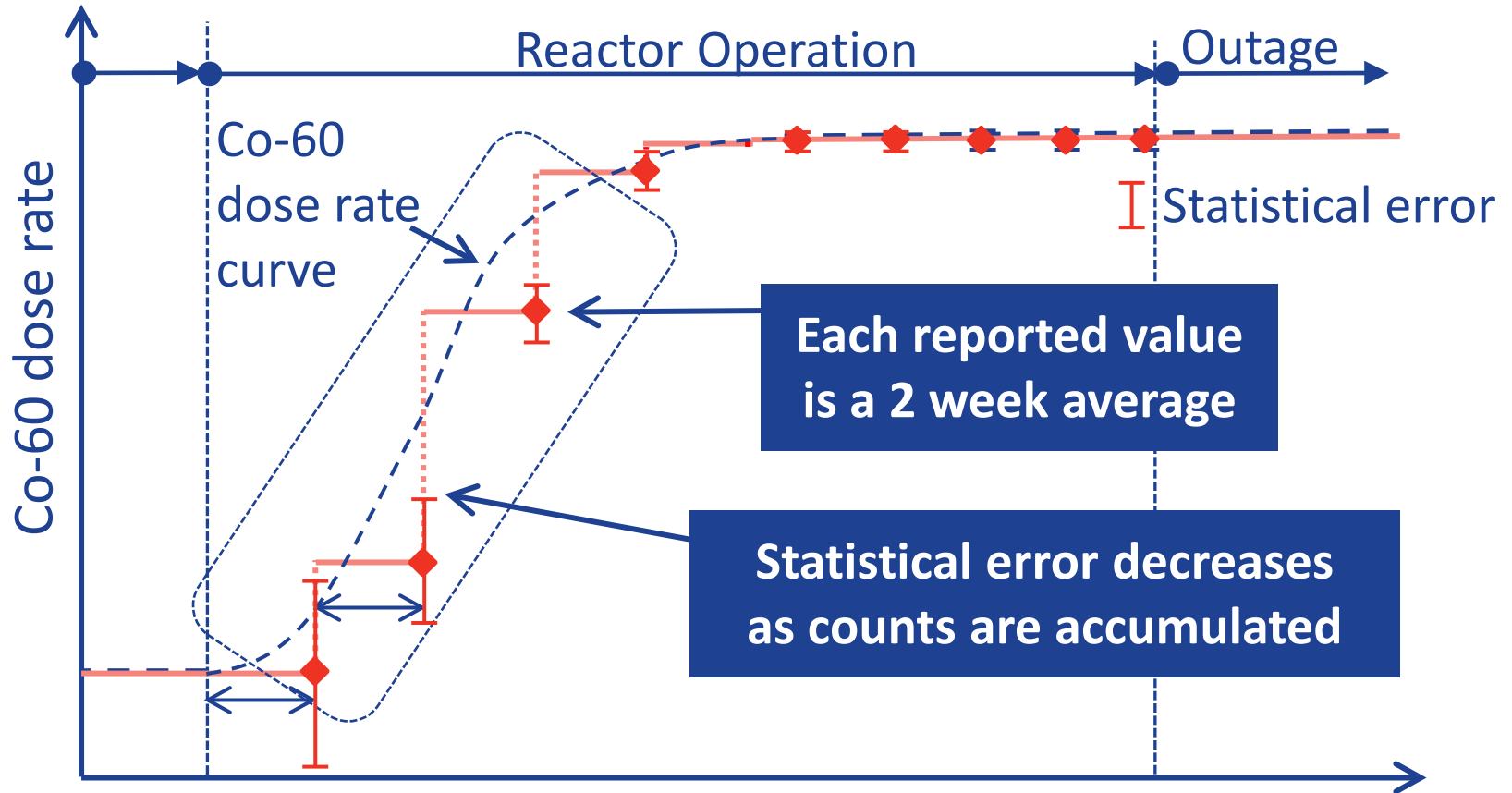


- Based on the results from the research reactor and the expected conditions inside a BWR drywell, the lower limit of detectability (LLD) was evaluated for a measuring period of 2 weeks.
- Measuring period is determined by the trade-off between detection limit and accuracy.
- An initial baseline period is required to establish the desired LLD and accuracy; this baseline period will depend on plant specific conditions.

Parameter	Desired Performance
Measuring Period	2 weeks
Lower Limit of Detectability	0.5 $\mu\text{Ci}/\text{cm}^2$
Measuring Accuracy	< $\pm 30\%$

Depiction of Co-60 Dose Rate

The system continuously displays data during reactor operation.





We have developed the on-line Co-60 monitoring system.

- The system can detect Co-60, using two detectors and the coincidence method of Co-60 cascade gamma-rays under N-16 background.
- The system was evaluated at the research reactor.
⇒ The increase in coincidence counts with the detection of Co-60 was confirmed.



Thank you for your attention