Source term after chemical decontamination and design modification

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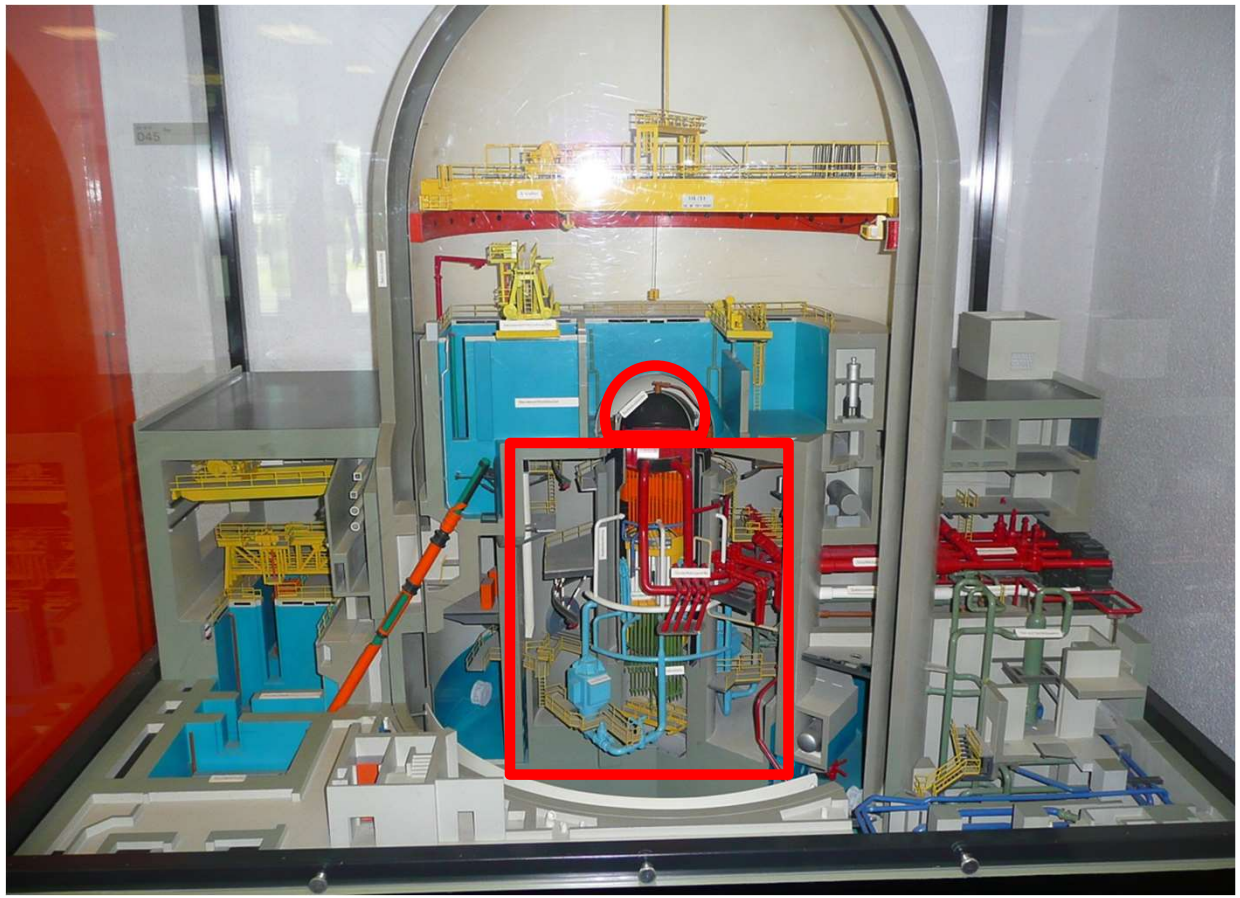
KKL Reactor Type

- Boiling Water Reactor BWR-6
- Mark-III Containment
- Output: 1260 MW
- Grid Connection: 1984



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Reactor Recirculation System

Technical configuration

- 2 pumps
- 2 loops
- 2 flow control valves

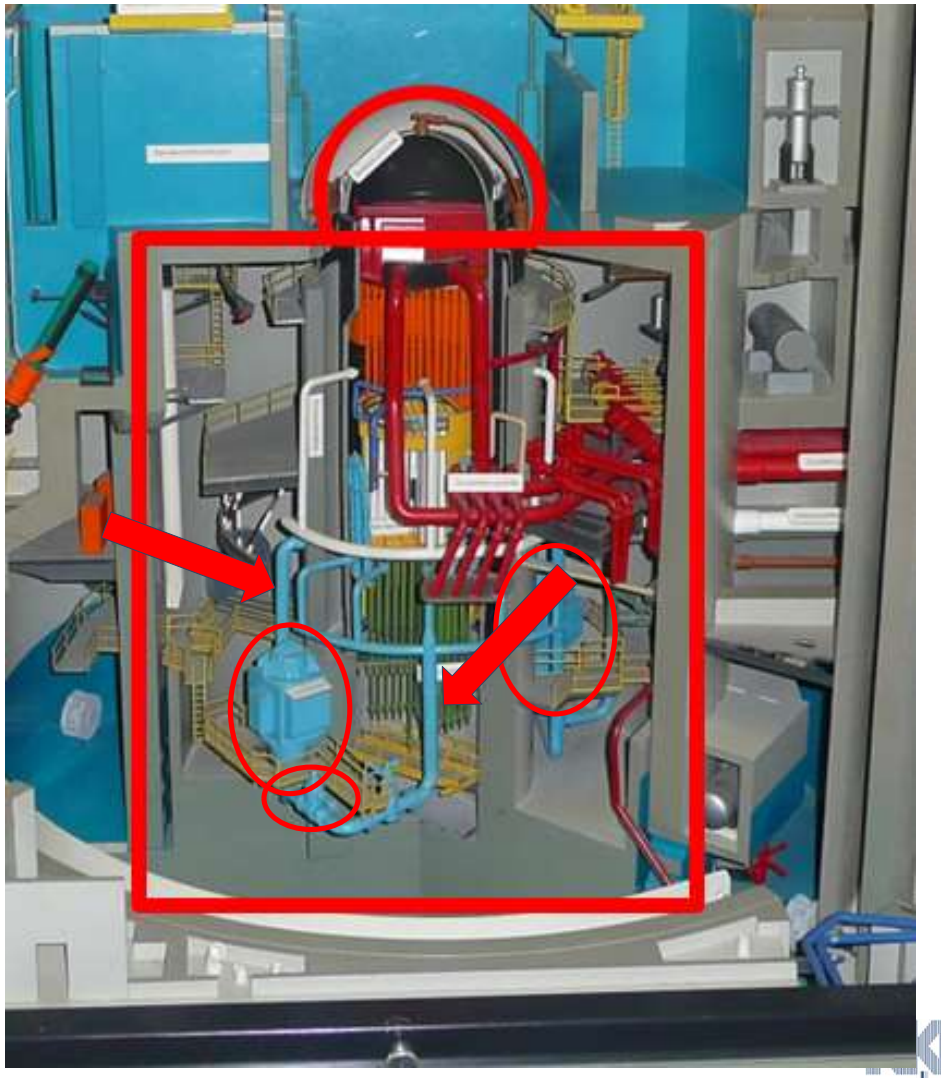
Radiological factor

- Major contributor (≈75%) for Drywell radiation levels
- Dose rates showed increasing trend since HWC/OLNC
- ≈10 % of elemental cobalt input into reactor

Considering:
- Contact surfaces of water and components
- Corrosion and erosion rates
- Cobalt content of the materials

System health (Status 2012)

- Erosion of RRS pump journals
- Repeated repairs in 2004 and in 2012
- Pumps reached end of life
- Ultrasonic testing showed indications in RRS pipe welds



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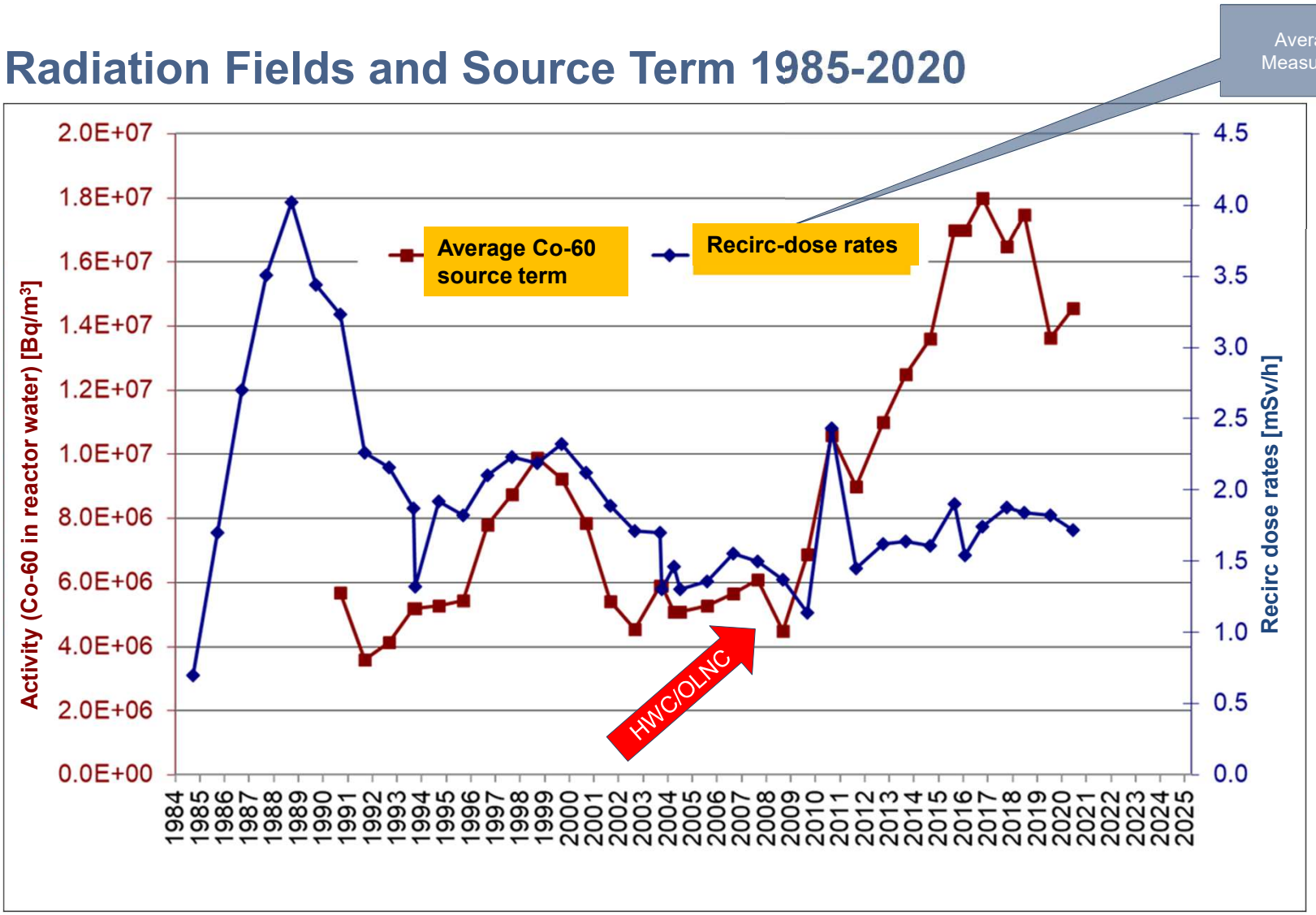
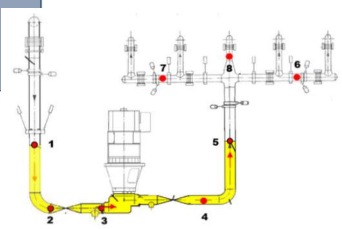
Radiation Fields and Source Term 1985-2020





- Source Term increase: +140% (since 2008)
- Dose Rate increase: +60% (since 2010)

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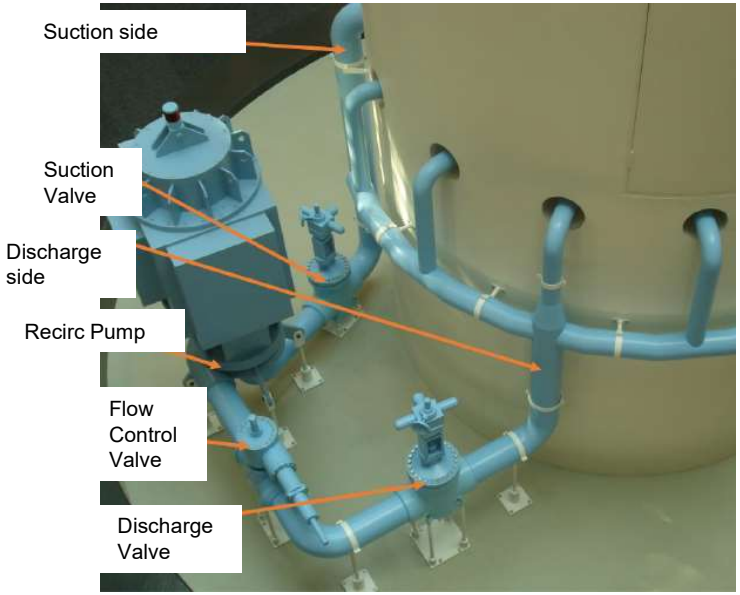
Replacement of RRS
Project scope

System	Replace	Remove	ALARA / Source Term Benefits
Pumps and Motors	x		• **Adjustable speed drives→** • No need for Flow Control Valve

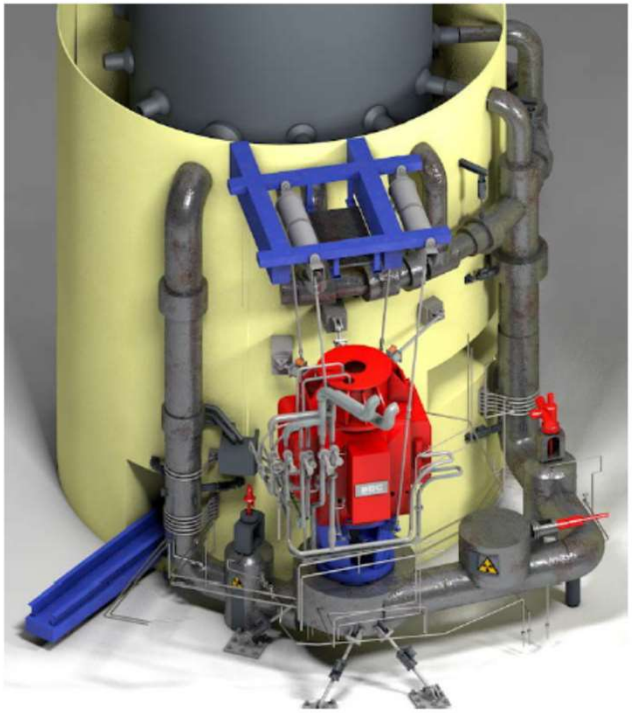
Pipes and valves	x		• **Reduced number of welds→**
			  • Reduced amount of In Service Inspections
			• **Electropolishing→**
			  • less deposition of CRUD on surfaces

Flow Control Valves		x	• **Reduced Co-59 input into reactor**

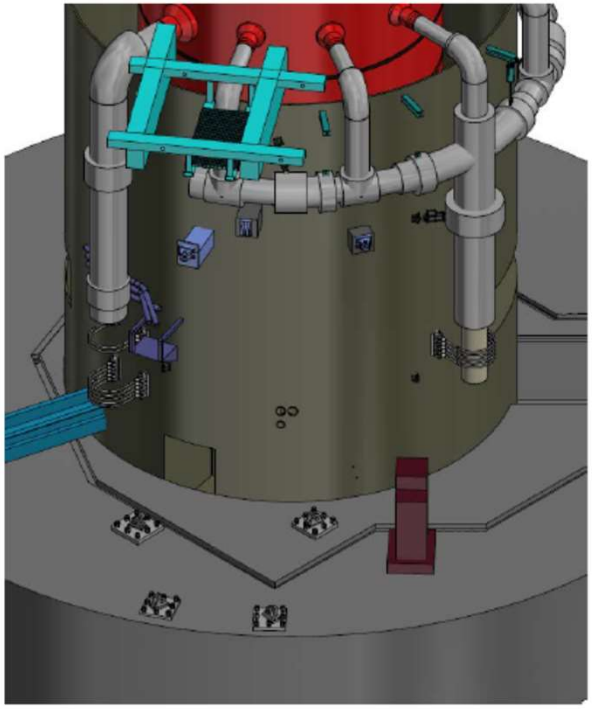


Outage 2021

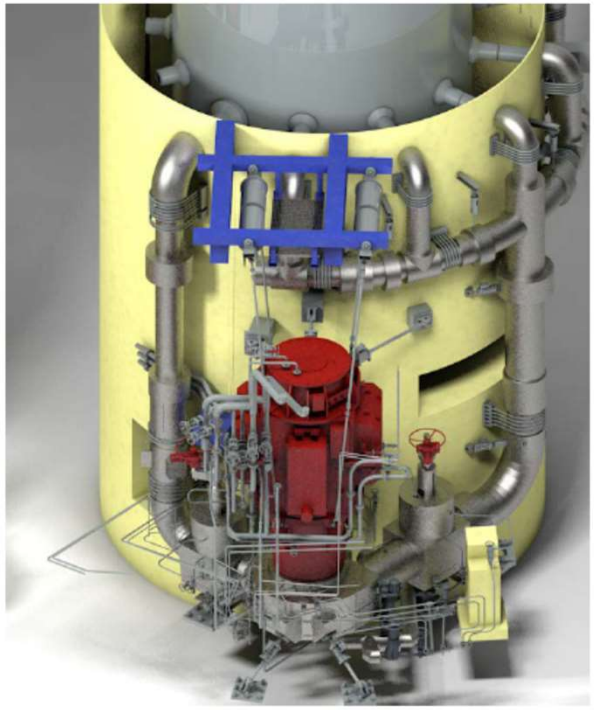
Before



During



After



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Outage 2021

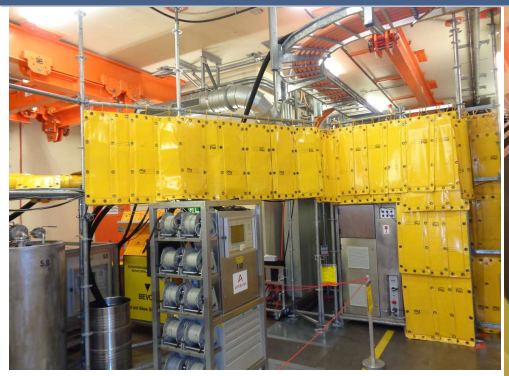
Optimization:

Chemical Decontamination

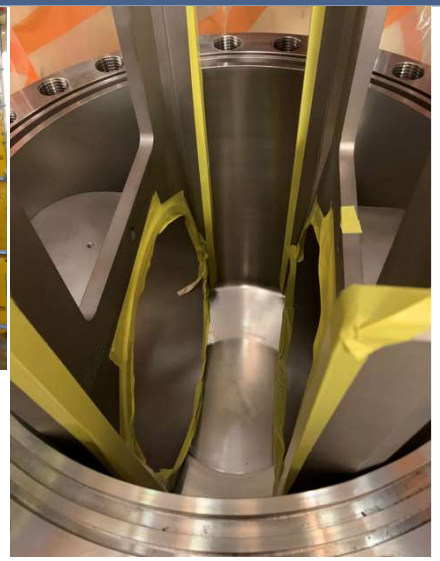
- 3-cycle UV-CORD®
- +High pressure blazing

Shielding

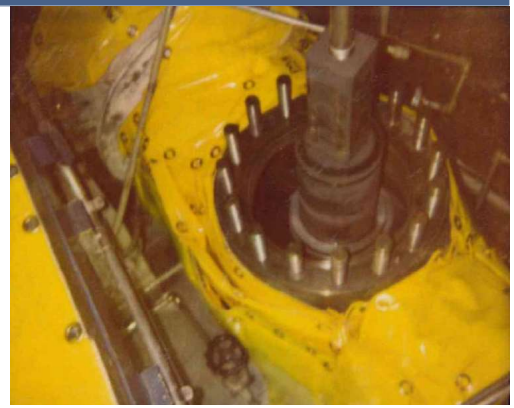
- 27 t →Drywell
- 21 t →Decon system (Aux Building)



Electropolishing of new components



Elimination of flow control valve



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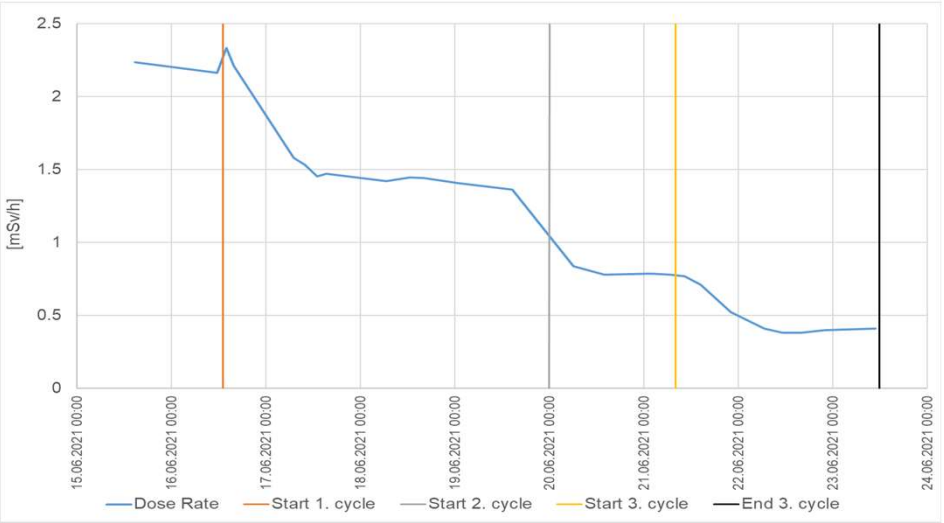
Outage 2021

- CORD-UV® process applied
- Total core was offloaded

- Decon loop connected to jet pumps and RWCU-valve

- Decon factor 17 achieved (average), vertical piping showed much better removal of contamination than horizontal piping
- Duration 8 days, 3 decon-cycles applied



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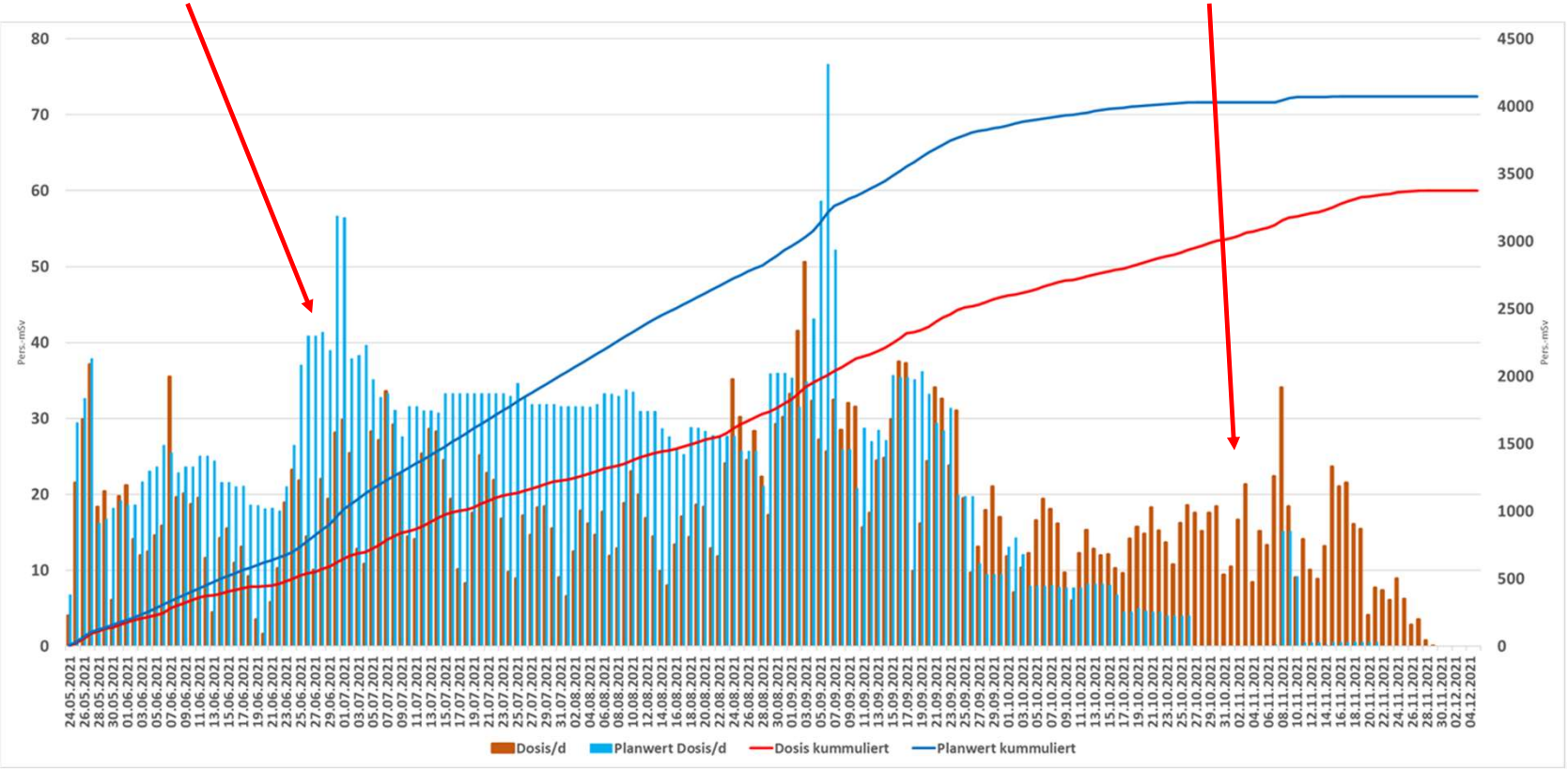
Outage 2021

CRE 2021 (all outage work)

Decon effect better than anticipated

Delay/Outage extension



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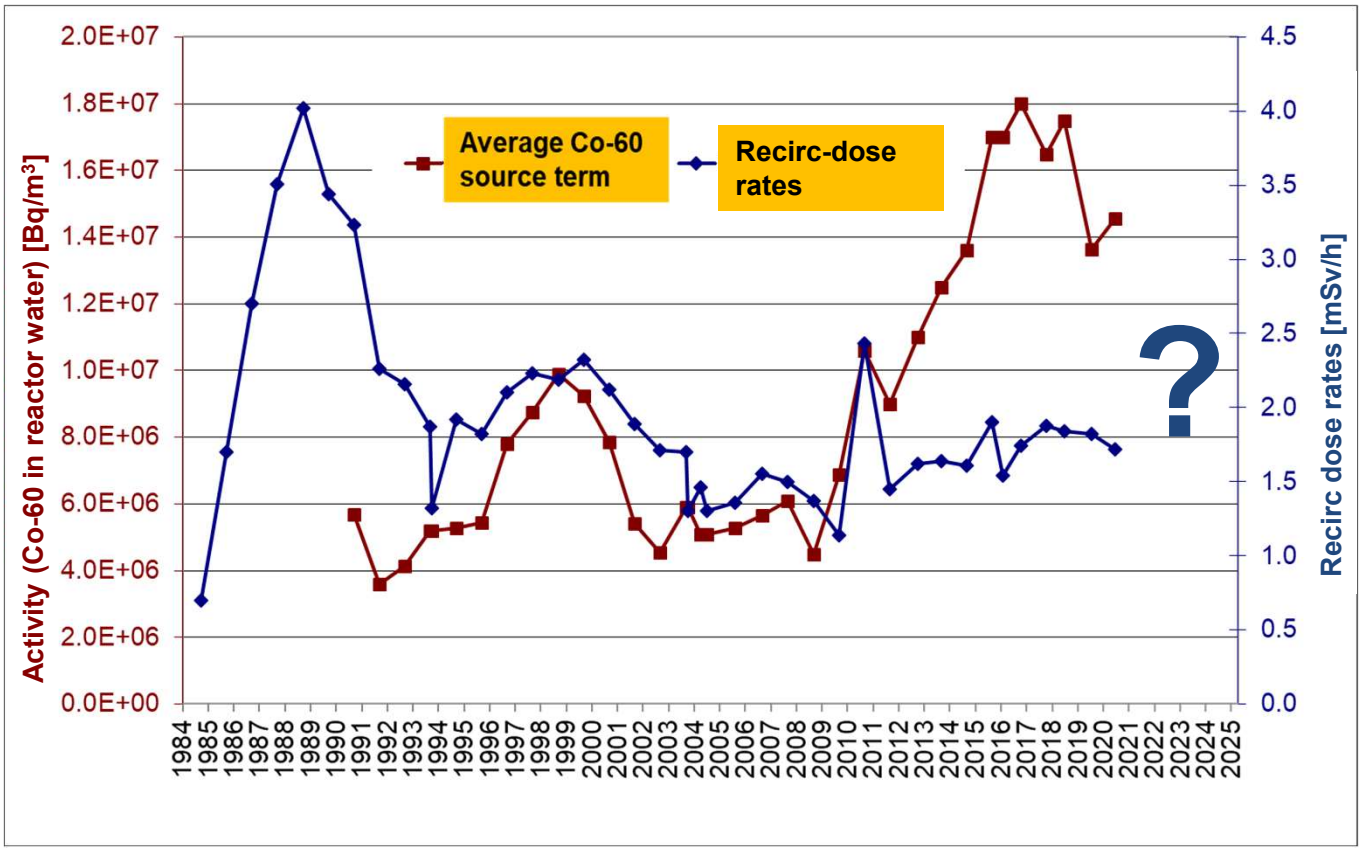
Radiation Fields (Drywell)



What was the outcome?

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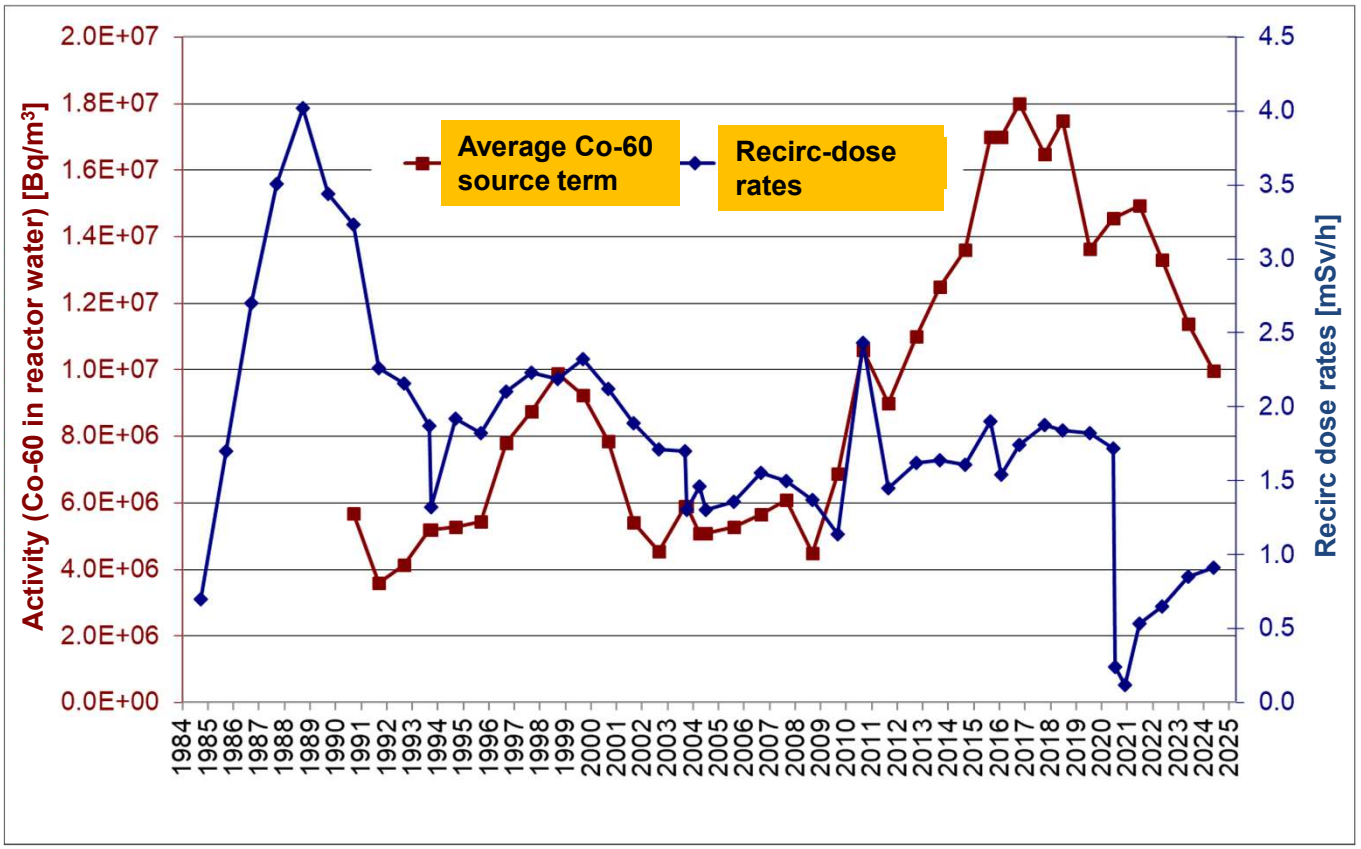
Radiation Fields (Drywell)



2021-2025:

- Source Term: -32%
- Radiation field: -50%

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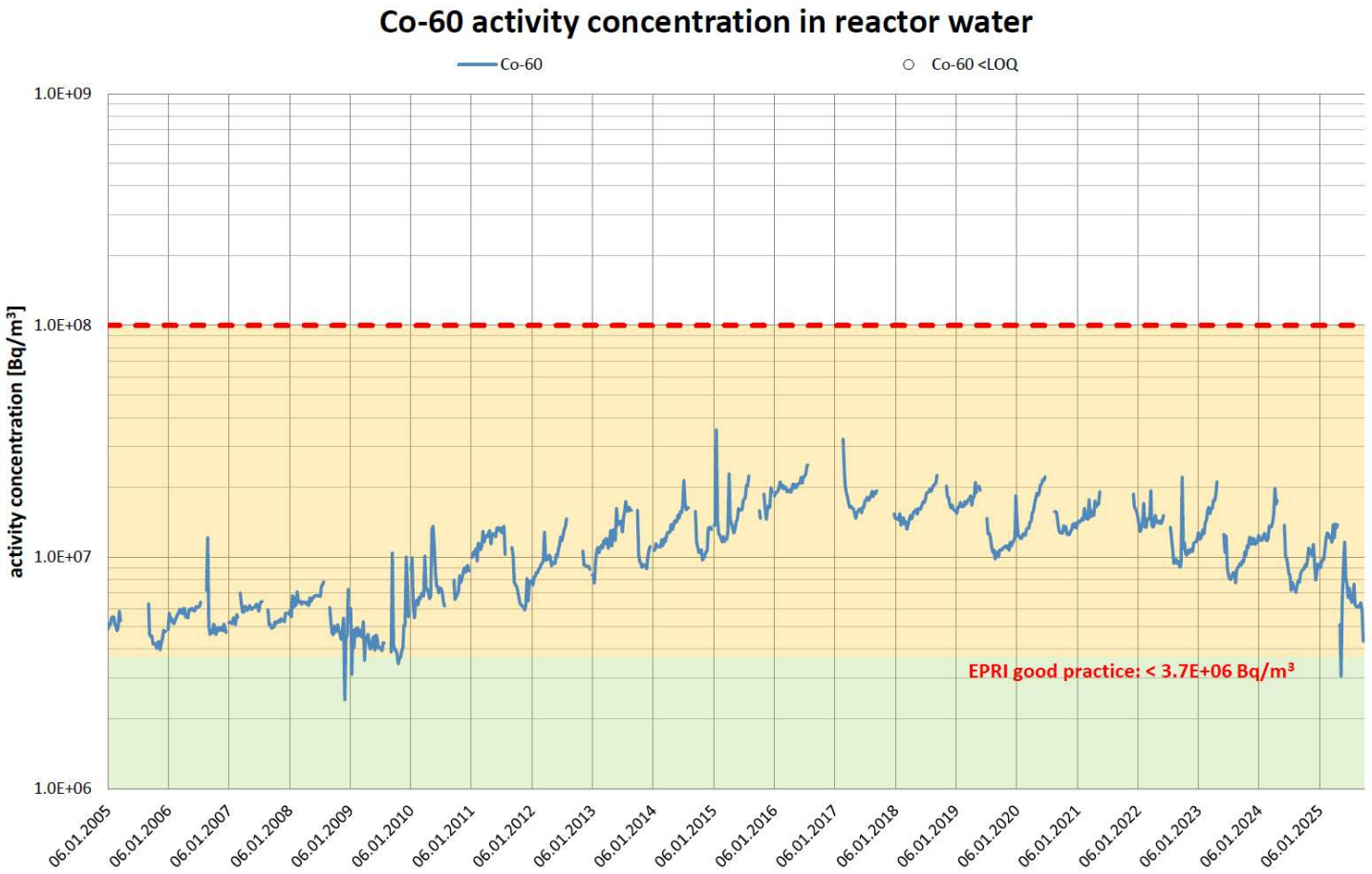
Source Term



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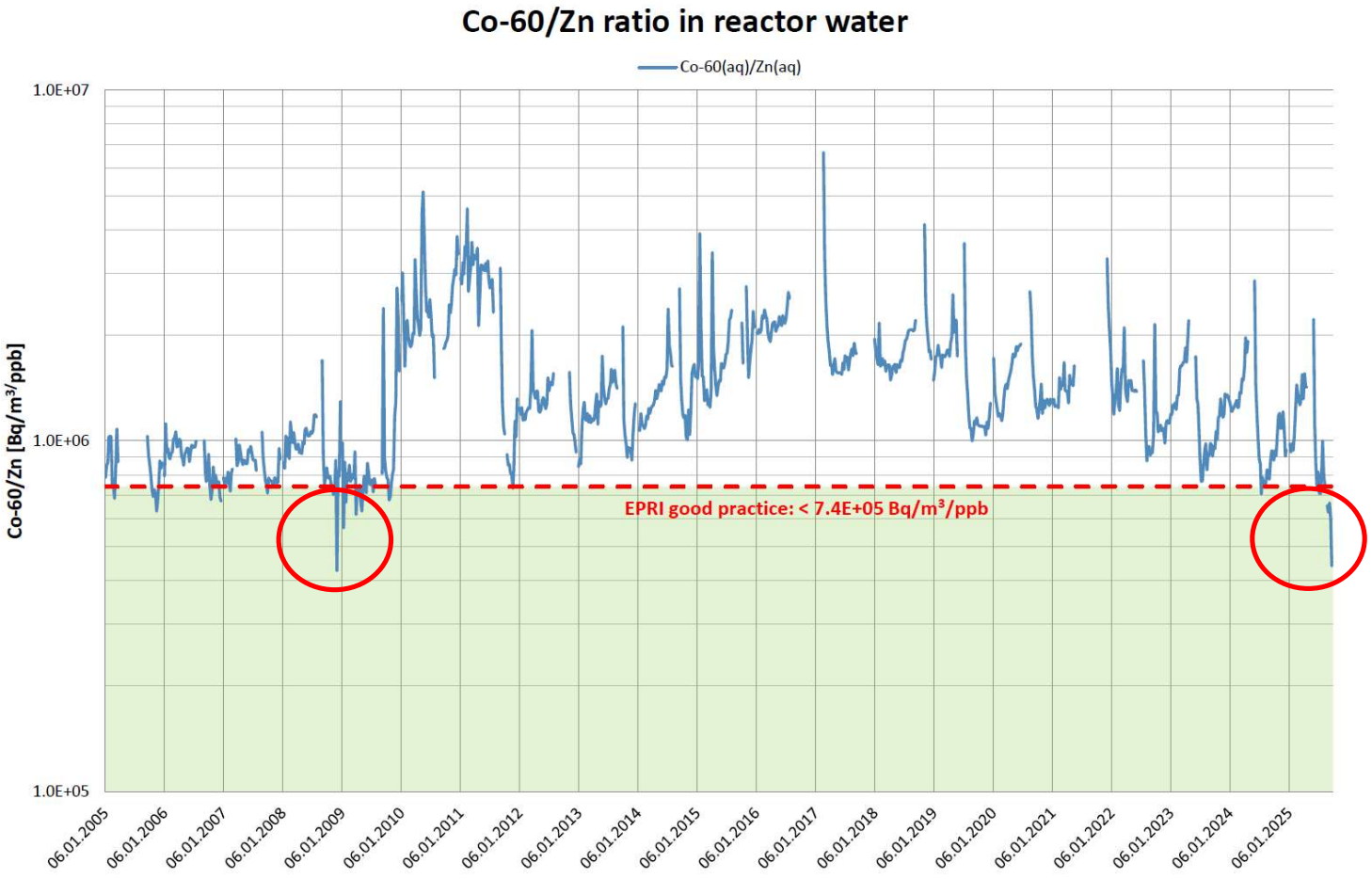
Source Term



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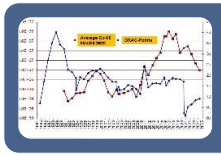
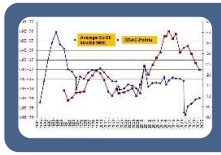
Conclusion

1,27 TBq (34,3 Ci) gamma-emitters removed



Recontamination RRS after 4 cycles @50% compared to 2021



Recirc dose rates nearly as low as after 1st cycle

Co-60 activity in RW 1st time in 15 years below EPRI good practice

Co-60/Zn ratio in RW 1st time in 15 years below EPRI good practice

Saved collective dose* [Pers.-mSv / (p-rem)]:
2021: 3000 / (300)
2022: 300 / (30)
2023: 150 / (15)
2024: 70 / (7)
2025: 70 / (7)

KKL capitalizes on Chemical Decon, Electropolishing and Elimination of flow control valve

*estimated numbers based on dose rates and stay times

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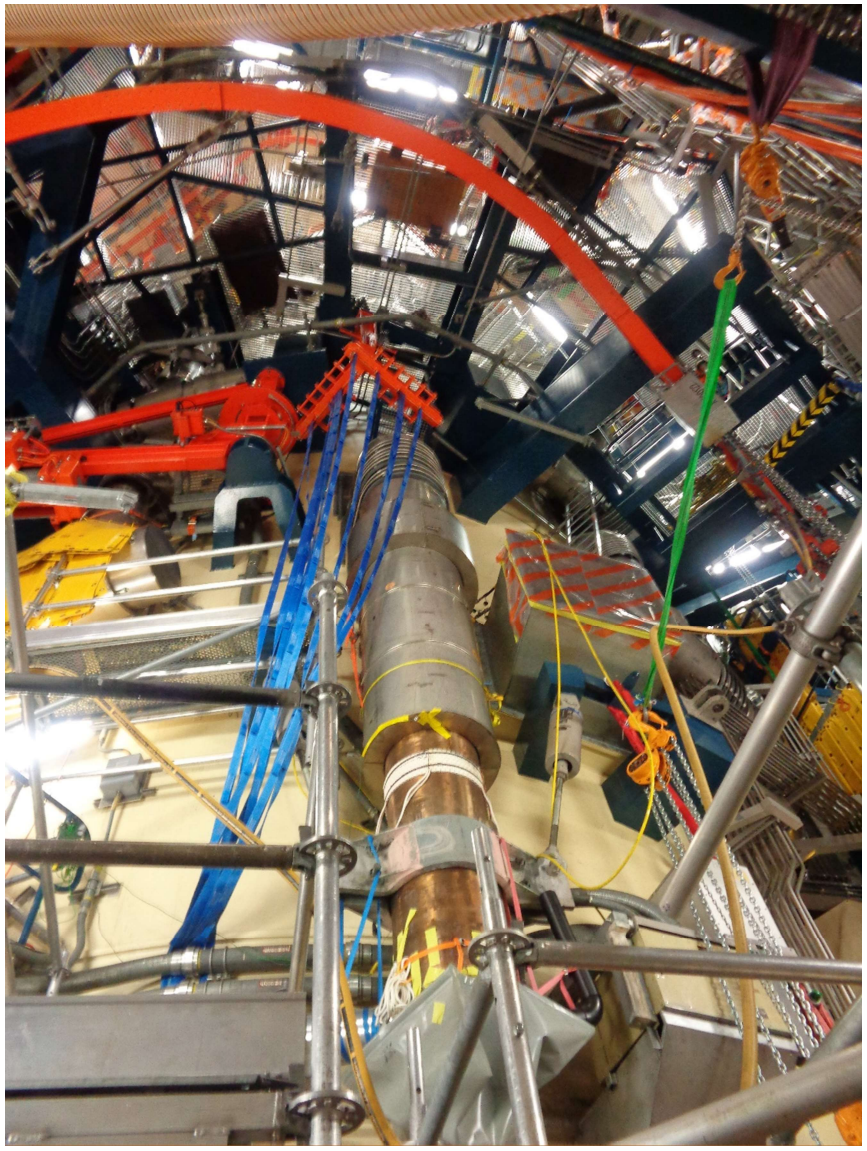
Thank you for your attention

René Hoffmeister,

RP Manager



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