NCSP TECHNICAL PROGRAM REVIEW

IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Enhancing nuclear safety

« International intercomparison exercise for Nuclear Accident Dosimetry at the DAF using GODIVA-IV (IER148) – MCNP dosimetry calculations »

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NUCLEAR CRITICALITY SAFETY PROGRAM

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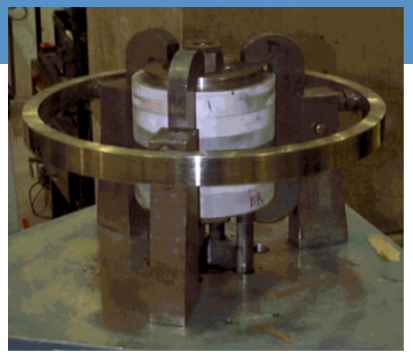
Background

- Main goal: Preservation and development of skills in order to limit the consequences of a Nuclear Criticality Accident
  - respond quickly and correctly to a “blue flash”
- DOE–IRSN experimental collaboration
  - participation to IER 147 in 2014 (Godiva-IV) (sending of IRSN dosimeters)
  - 2014 LLNL/AWE/IRSN comparison of criticality accident dosimetry using the CALIBAN and PROSPERO reactors (IM 2015 / ICNC 2015 common articles)
  - 2015: GODIVA-IV restart
  - 2016: IER 148 - International intercomparison exercise for Nuclear Accident Dosimetry at the DAF using GODIVA-IV

IER 148



- Assess radiation doses (physical dosimetry)
  - triage
  - medical handling of the victims

- IRSN objectives
  - to test the IRSN operational capabilities and skills to assess doses in case of a criticality accident
  - to improve data obtained during the 2013/2014 CALIBAN/PROSPERO experiments regarding the response of IRSN Criticality Accident Dosimeter
  - to test new development of IRSN CAD

- Acknowledgements

Dosimetry calculations of the IER 148

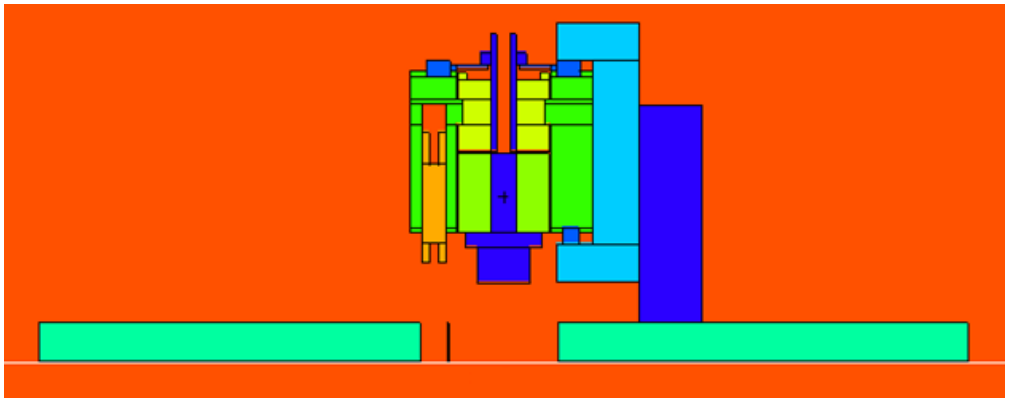
- Why these calculations ?
  - to know if we are able to do this kind of calculation…
  - to compare the calculation results with the experimental results
  - to support the analysis of the experimental results (sensitivity/uncertainty analysis)

- MCNP6.1 + SCALE6.1 package (ORIGEN) used to evaluate the following quantities around the core:
  - neutron flux and KERMA
  - gamma flux and dose (prompt and delayed)

- Preliminary results 

MCNP model

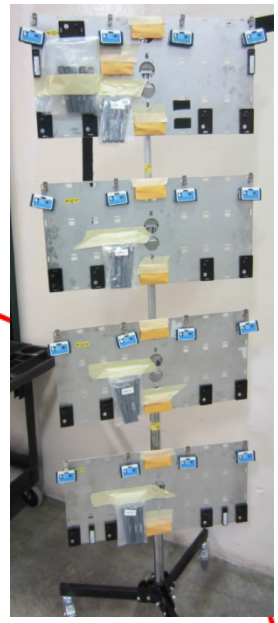
- GODIVA IV reactor: adapted from the OECD/ICSBEP benchmark simplified model
- Environment : concrete surroundings



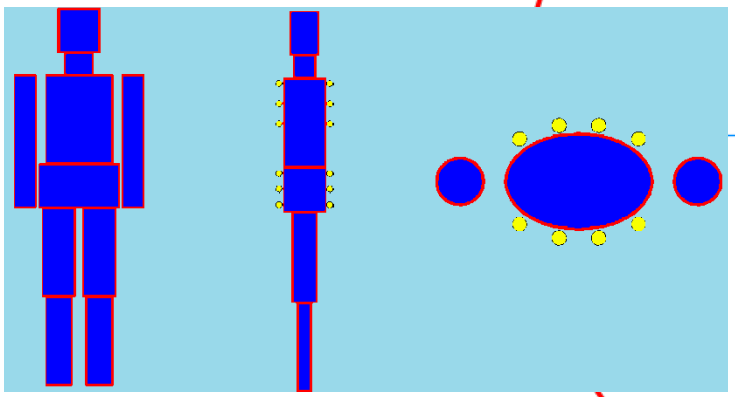
MCNP model

- Dosimeters on Trees and on BOMAB phantoms located around GODIVA-IV reactor
  - BOMAB phantoms without stand
  - no aluminum stand/plate for the Trees
  - air spheres (∅ 3 cm) for the dosimeters

Tree

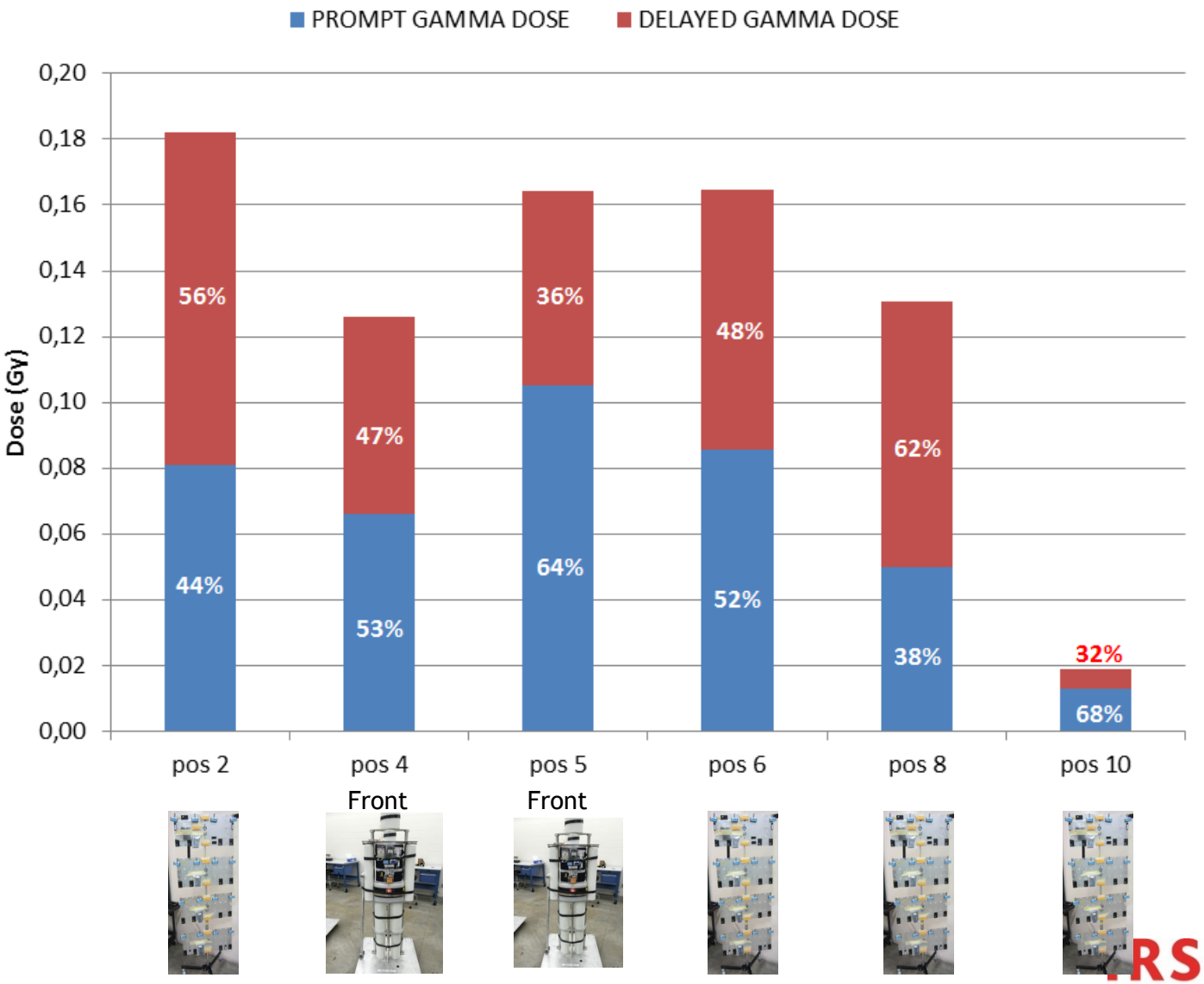


BOMAB

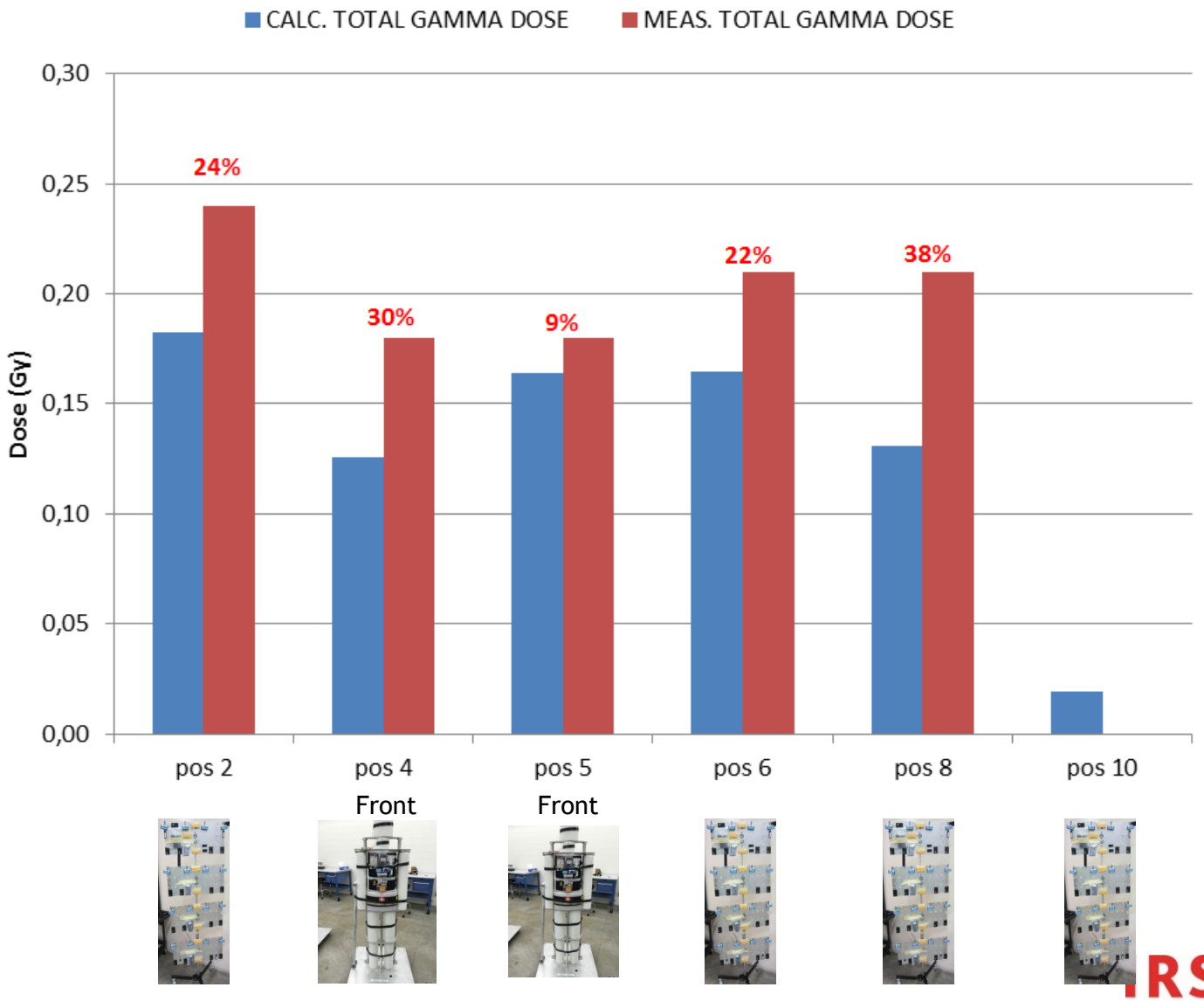


BOMAB – MCNP model

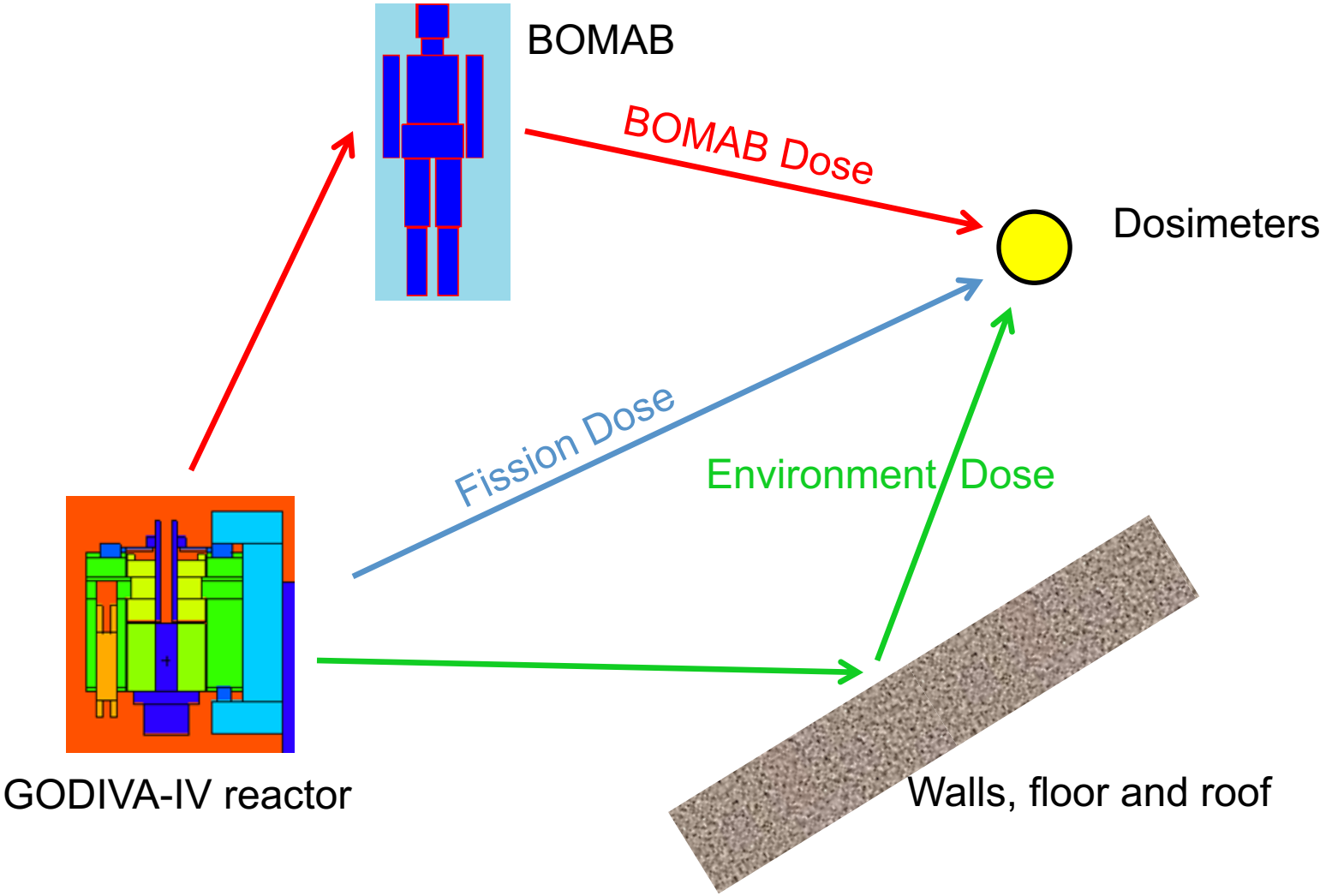
Example: pulse 1 (gamma)



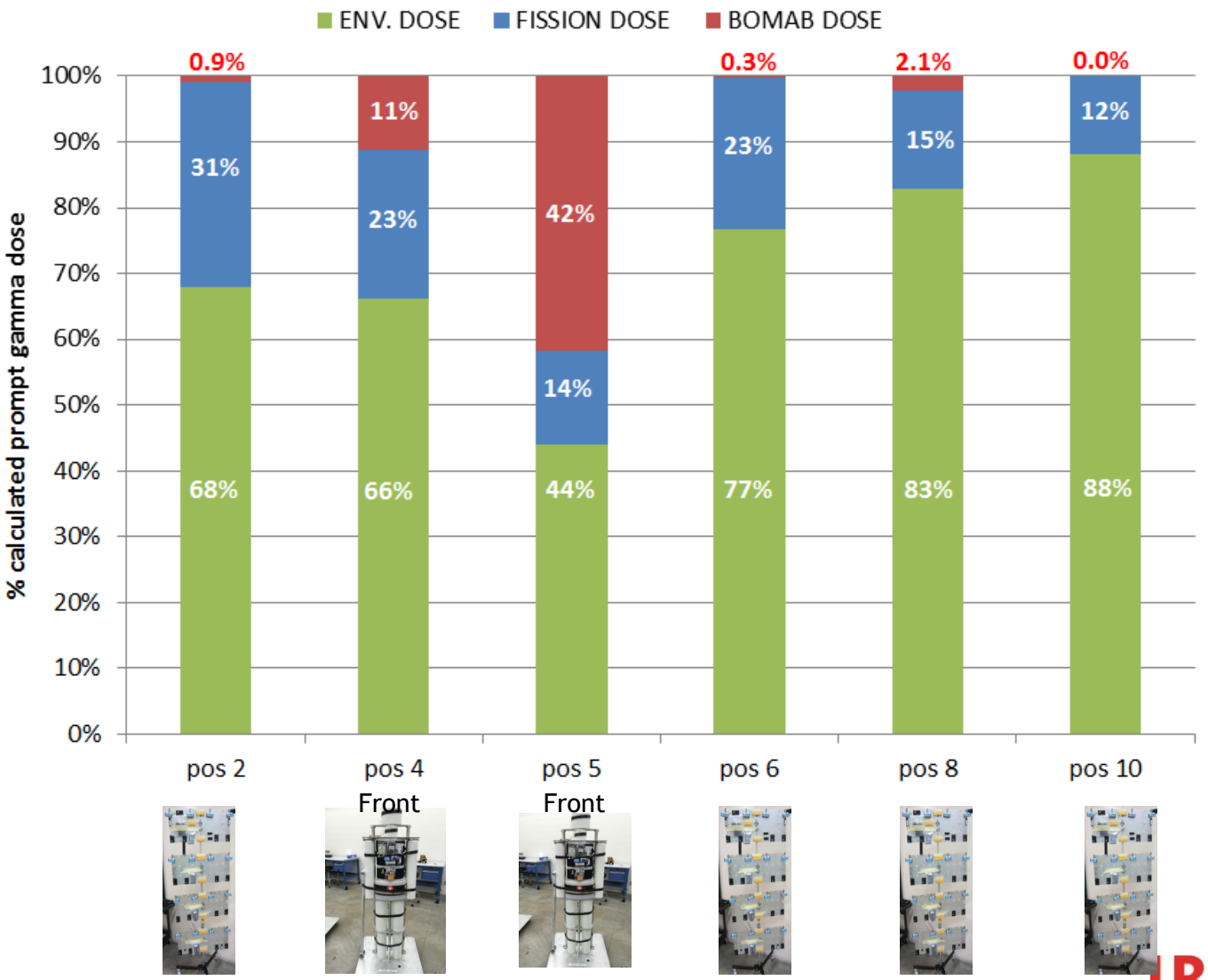
Example: pulse 1 (gamma)



Prompt gamma-ray dose contributions – Pulse 1

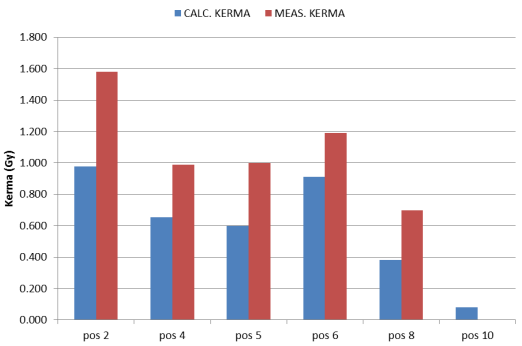


Prompt gamma-ray dose contributions – Pulse 1

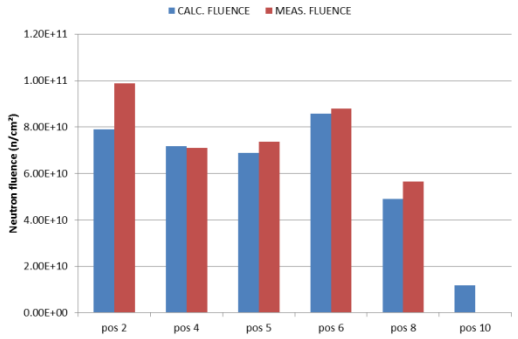


Example: pulse 1 (neutron)

- Consistent underestimation of the kerma



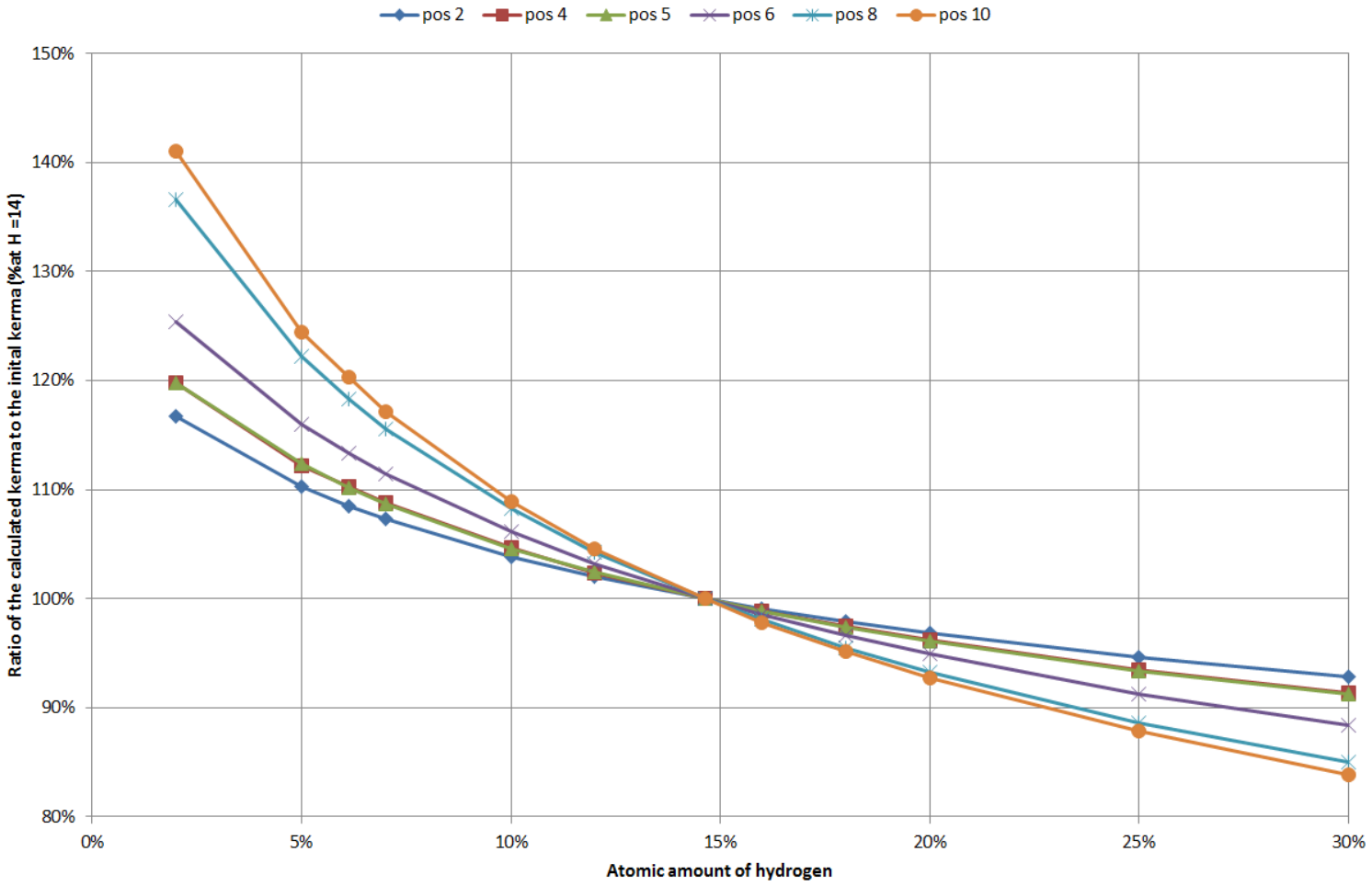
- Good agreement on the flux



- Strong contribution of the environment

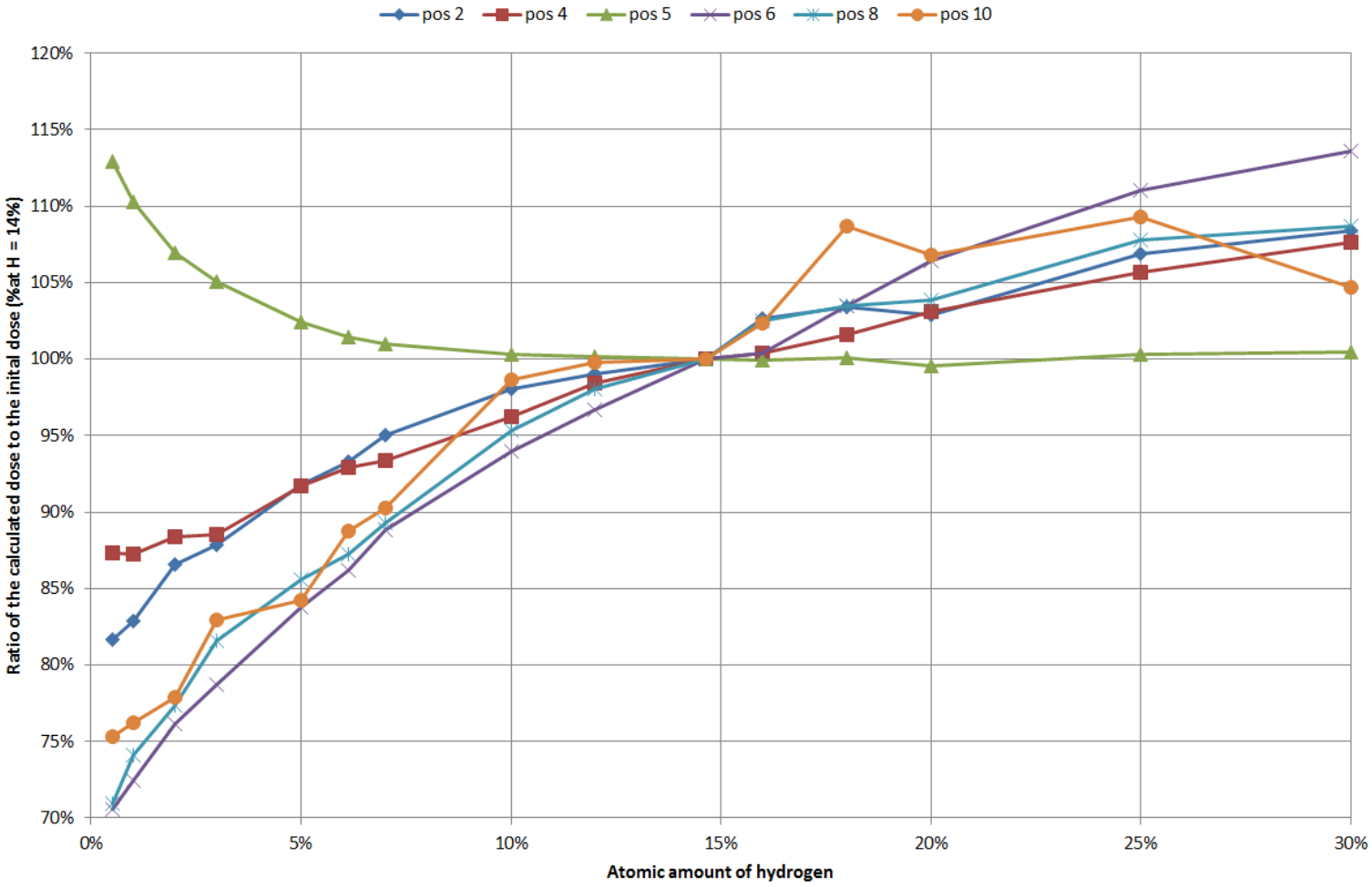
Sensitivity analysis on the composition of the concrete surroundings (hydrogen, general composition)

Impact of hydrogen in the concrete for neutrons calculations (Pulse 1)



Variation up to 41% from the initial calculation

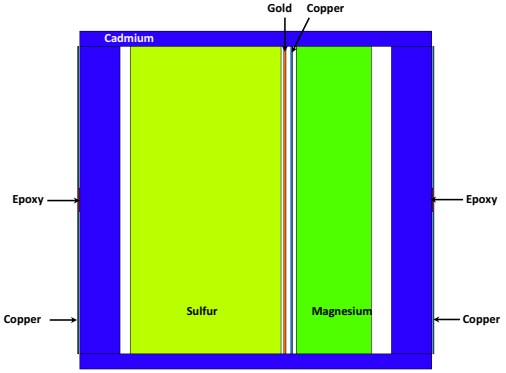
Impact of hydrogen in the concrete for prompt gamma-ray calculations (Pulse 1)



Variation up to 30% from the initial calculation

Additional studies

- Consistency of results between various pulses
- Comparison of energy spectra (correction factor, etc.)
- Simulation of the IRSN dosimeters and SNAC2
- …



Perspectives

- IER 148
  - Update the results with the final IER 148 results/additional data
  - Complete calculations with the pertinent additional studies
  - Use other codes and methods to calculate prompt and delayed doses
  - Provide to NCSP the IRSN report

- Ready (and happy!) to participate to the next IER (GODIVA IV, FLATTOP, etc.) in 2017+
  - IER 434, 407, 406, 321, 253, **252**, 175, 147

- Simulations are useful to understand and analyze the experiment results
- Simulations may be helpful to design/optimize criticality accident experiments
- Simulations will be used in case of a real criticality accident

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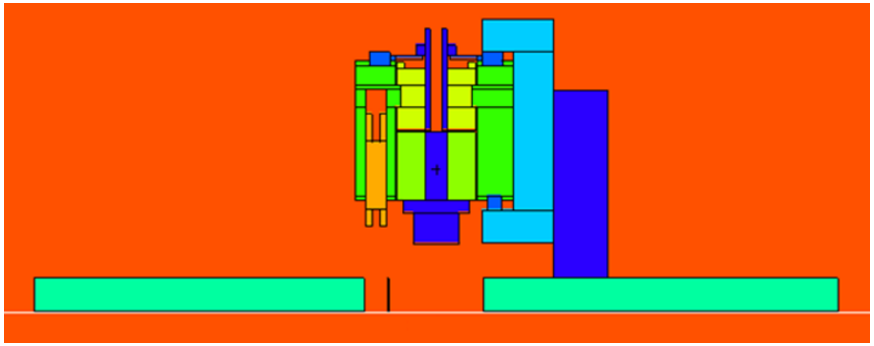
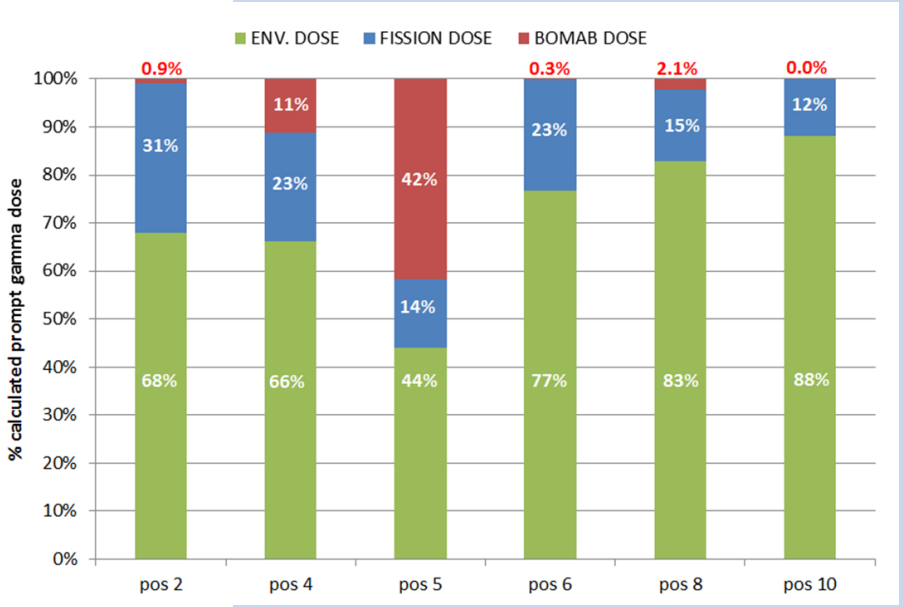


Thank you for your attention !!!



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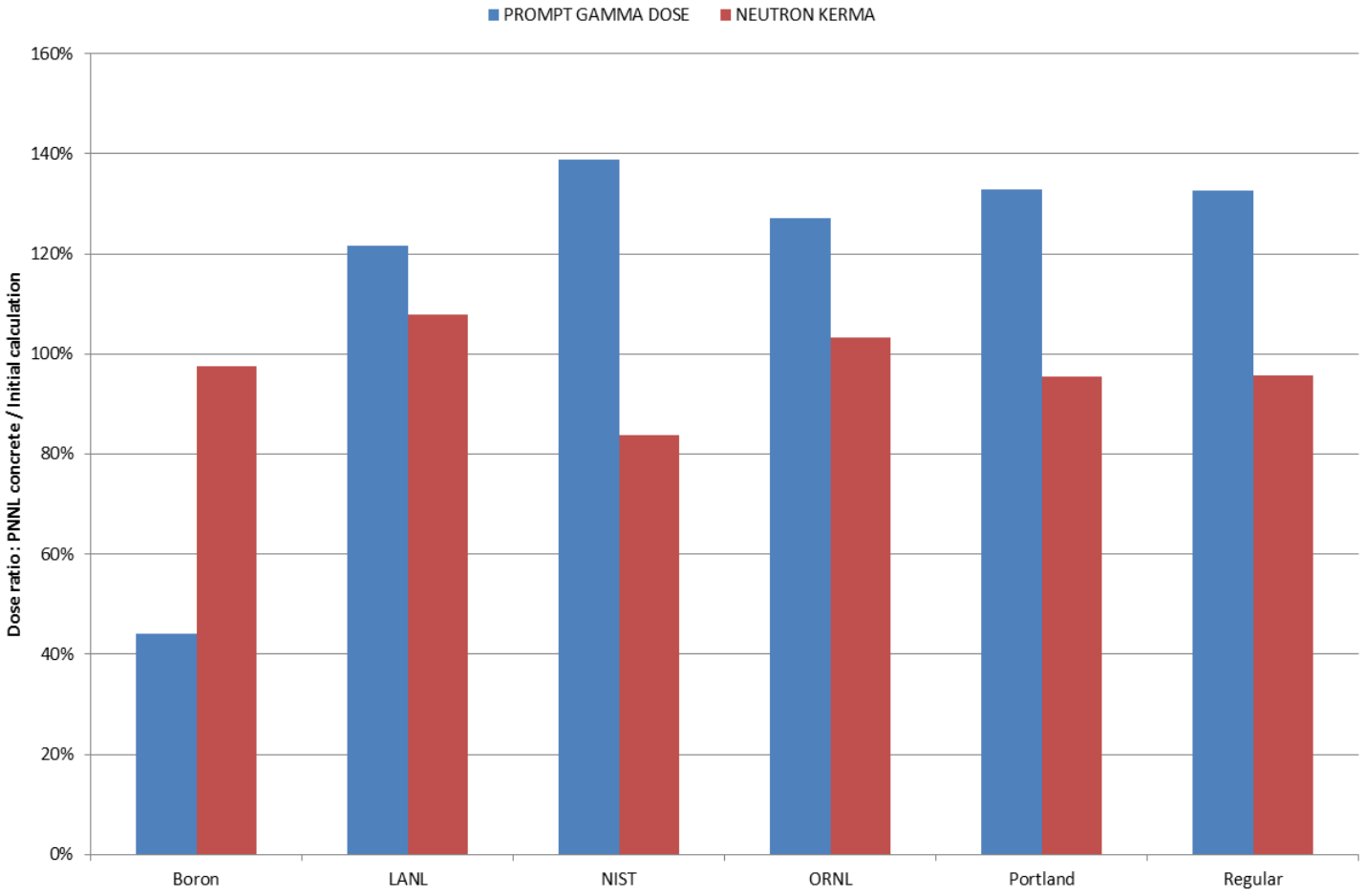
Impact of the concrete on prompt gamma dose and neutron Kerma (Pulse 1)



Various concretes from the PNNL Compendium (PNNL-15870-Rev1) → strong impact on prompt gamma-ray dose