Physikalisch-Technische Bundesanstalt
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National Metrology Institute

RAD13-37

Eye lens dosimetry: does the direction of rotation (vertical or horizontal) play a role in type testing?

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PTB, Department “Radiation protection dosimetry” (FB 6.3)

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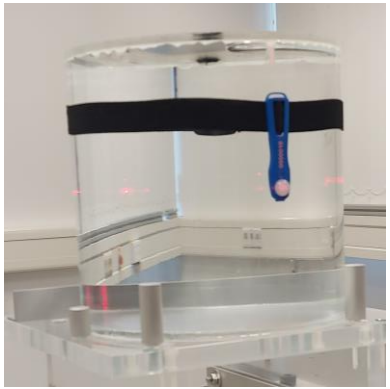
Introduction & motivation

Eye lens dosimetry using $H_p(3)$ dosemeter

Typical
eye lens dosemeter

https://awst.mirion.com/leistungen-produkte/teilkorperdosimetrie/augenlinsendosimeter/

usual type test geometry
(lateral radiation exposure)



Photograph: PTB, Khanbabaee

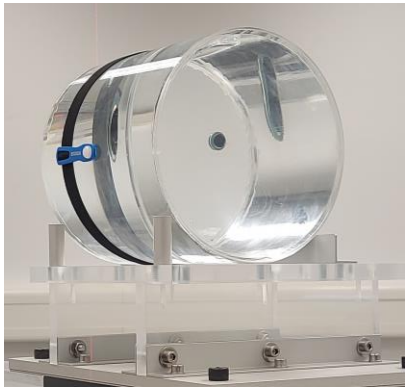
(radial rotation)

but

… typical real situation:
(oblique irradiation from bottom)

https://www.klinikum-lueneburg.de/diagnostische-und-interventionelle-radiologie/interventionelle-radiologie/

➔ Is additional type test geometry needed?
(obliqe radiation exposure)



Photograph: PTB, Khanbabaee

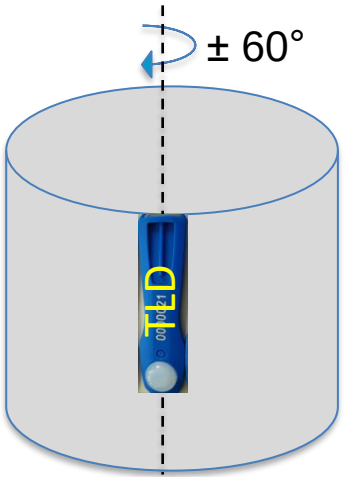
(polar rotation)

This motivated our study:

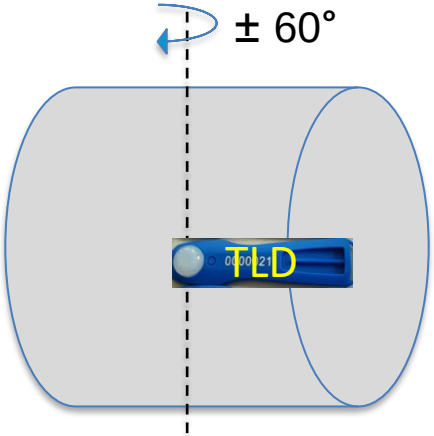
Dosemeter response: horizontal (polar) $\overset{?}{=}$ vertical (radial) rotation

Method

Irradiations with radiation qualities N-30 and N-100 at incidence angles: α = 0°, +60°, and -60°



vs.



Phantom in vertical geometry (radial rotation)

Phantom in horizontal geometry (polar rotation)

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TLD eye lens dosemeter

Luminescent materials can store a portion of the energy deposited by interactions with **ionizing radiation** and subsequently release this energy in the form of **thermoluminescence**, making them highly suitable for **radiation dosimetry** applications.

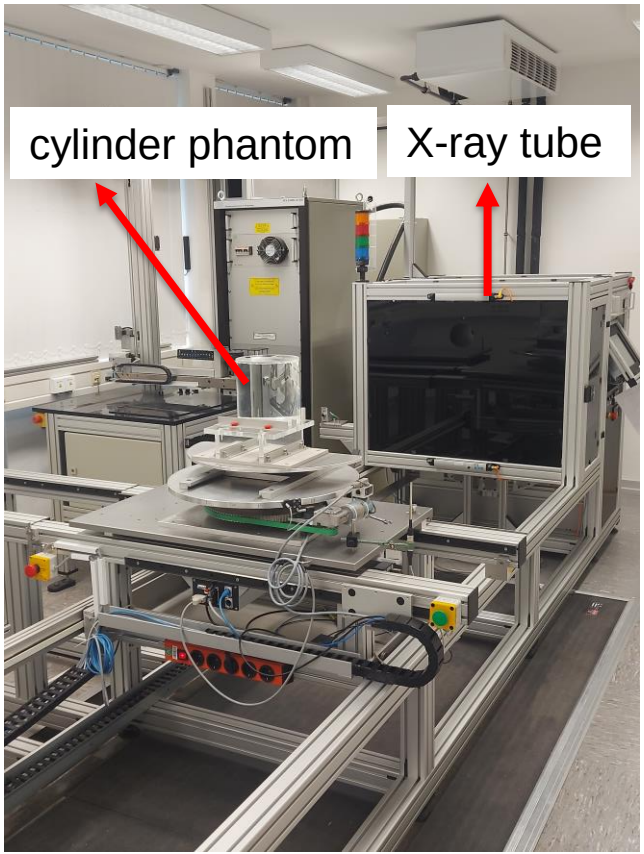
Specification: MCP-N TLDs (LiF:Mg,Cu,P)
Device: *Eye-D* (commercial eye lens dosimeter)
Geometry: 4.5 mm diameter, 0.9 mm thick
Dose range: ~1 (10) µSv to 10 (100) mSv
Photon energy dependence: 12 keV – 1.3 MeV

Front side of the badge

Back side of the badge

Contents

Measurement: X-ray irradiation of the TLDs

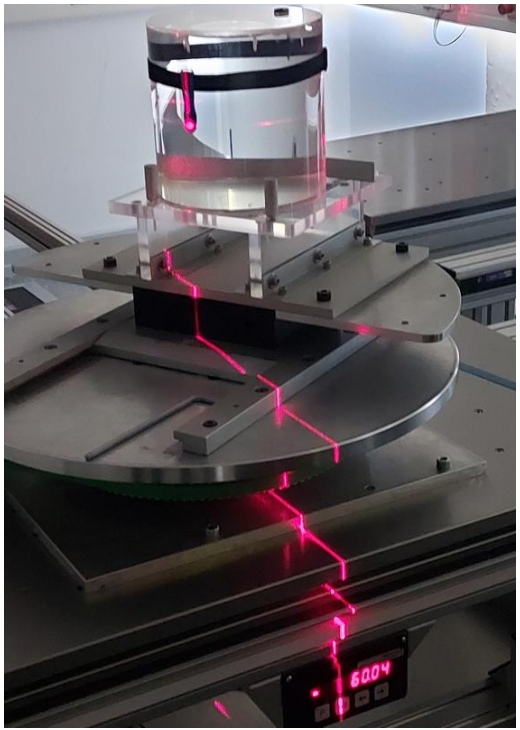


Irradiation facility for X-ray at PTB
https://www.ptb.de/cms/en/ptb/fachabteilungen/abt6/fb-63/information/irradiation-facilities.html

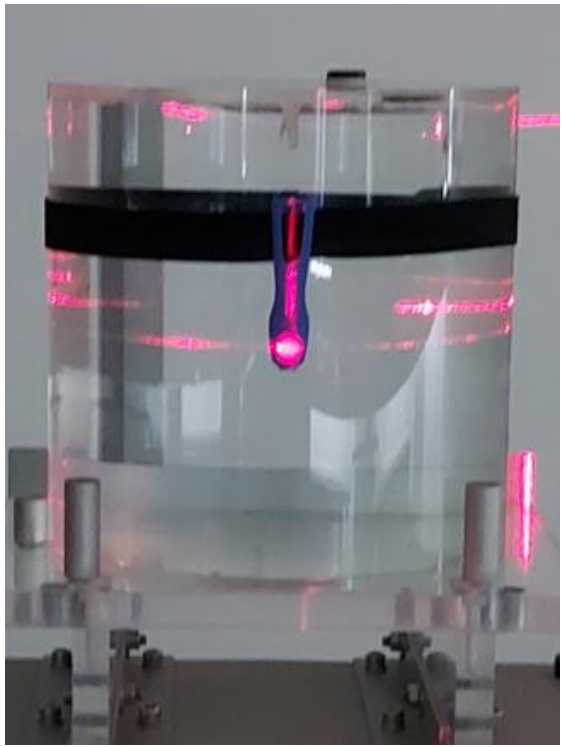
Applied radiation qualities N-30 and N-100 according to ISO 4037 at angles of α = 0°, +60°, and -60°.

Irradiated dose of $H_p(3)$ = 0.1 mSv

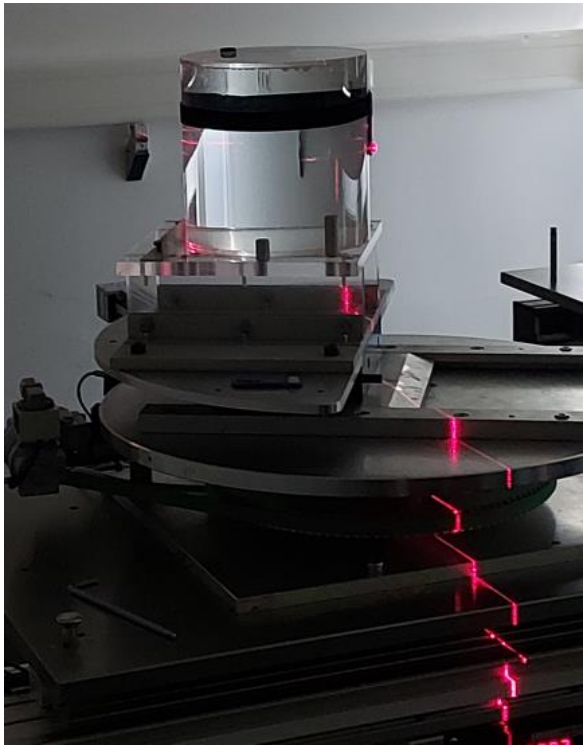
Measurement: Irradiation setup (radial)



Incidence angle α = -60°

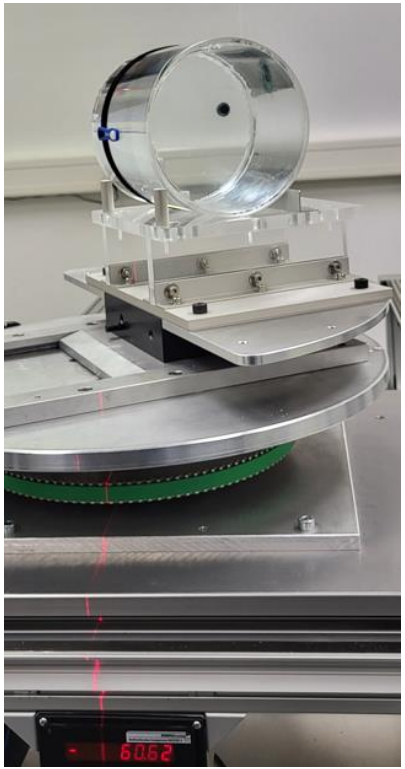


Incidence angle α = 0°

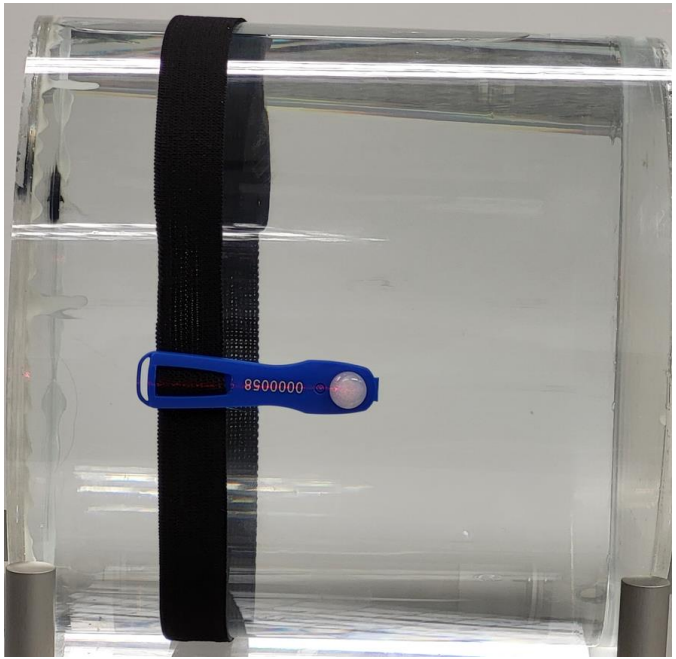


Incidence angle α = +60°

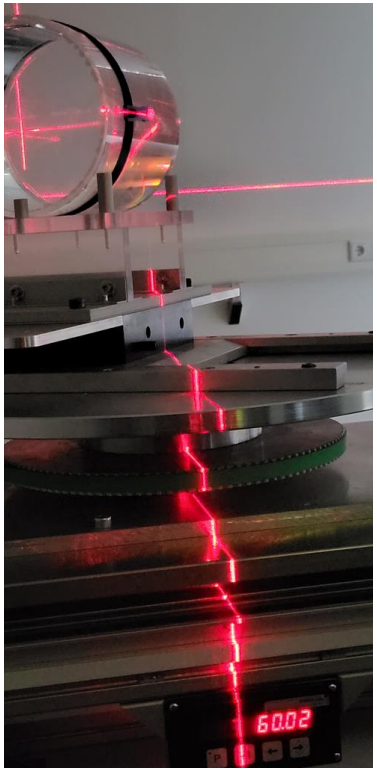
Measurement: Irradiation setup (polar)



Incidence angle α = -60°



Incidence angle α = 0°



Incidence angle α = +60°

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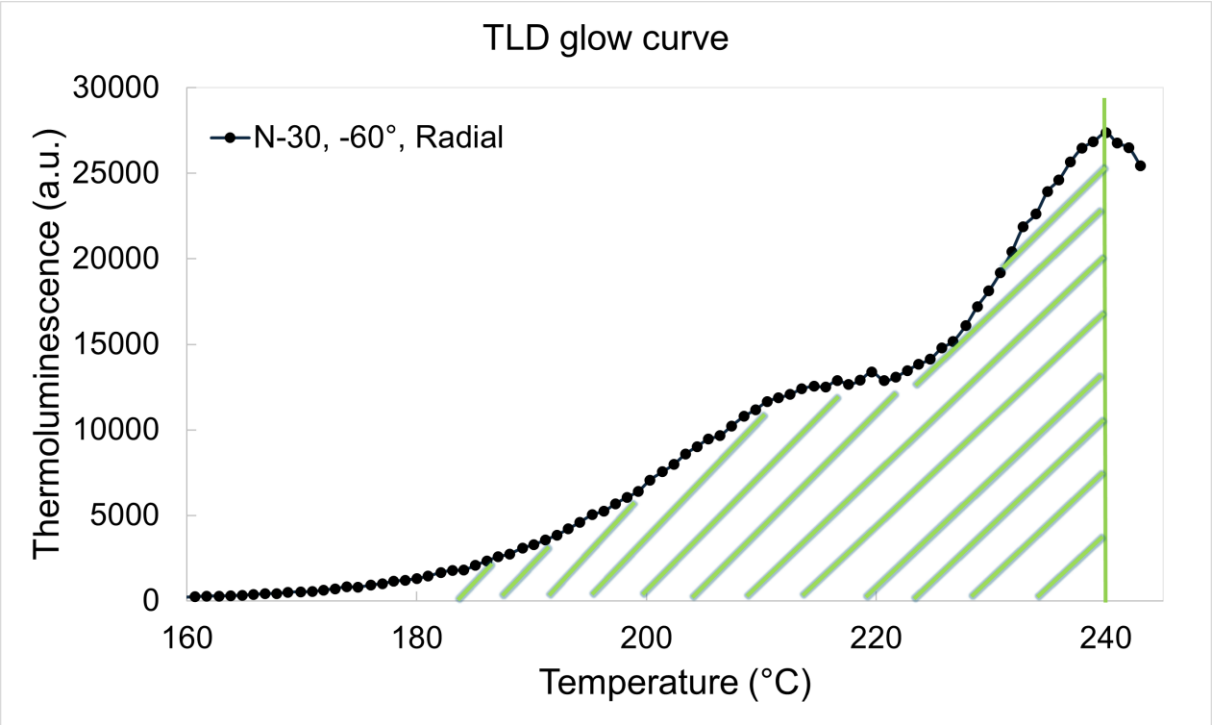
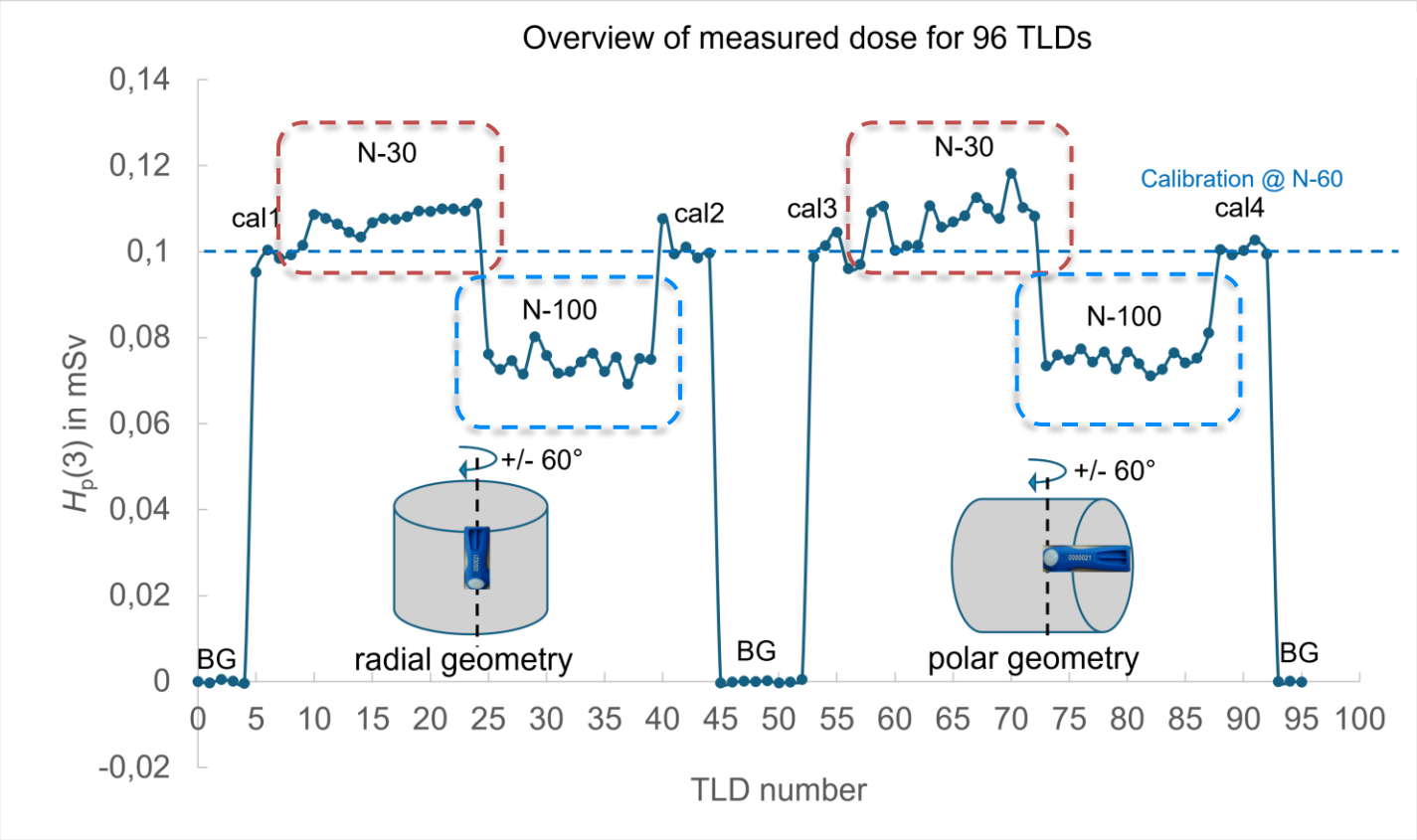
Results: TL spectra from RISØ TL-Reader



Dose:

The area under the glow curve corresponds to the irradiation dose absorbed by the TLD

Results: Dosimetric evaluation-Overview



A total of 96 TLDs were measured:

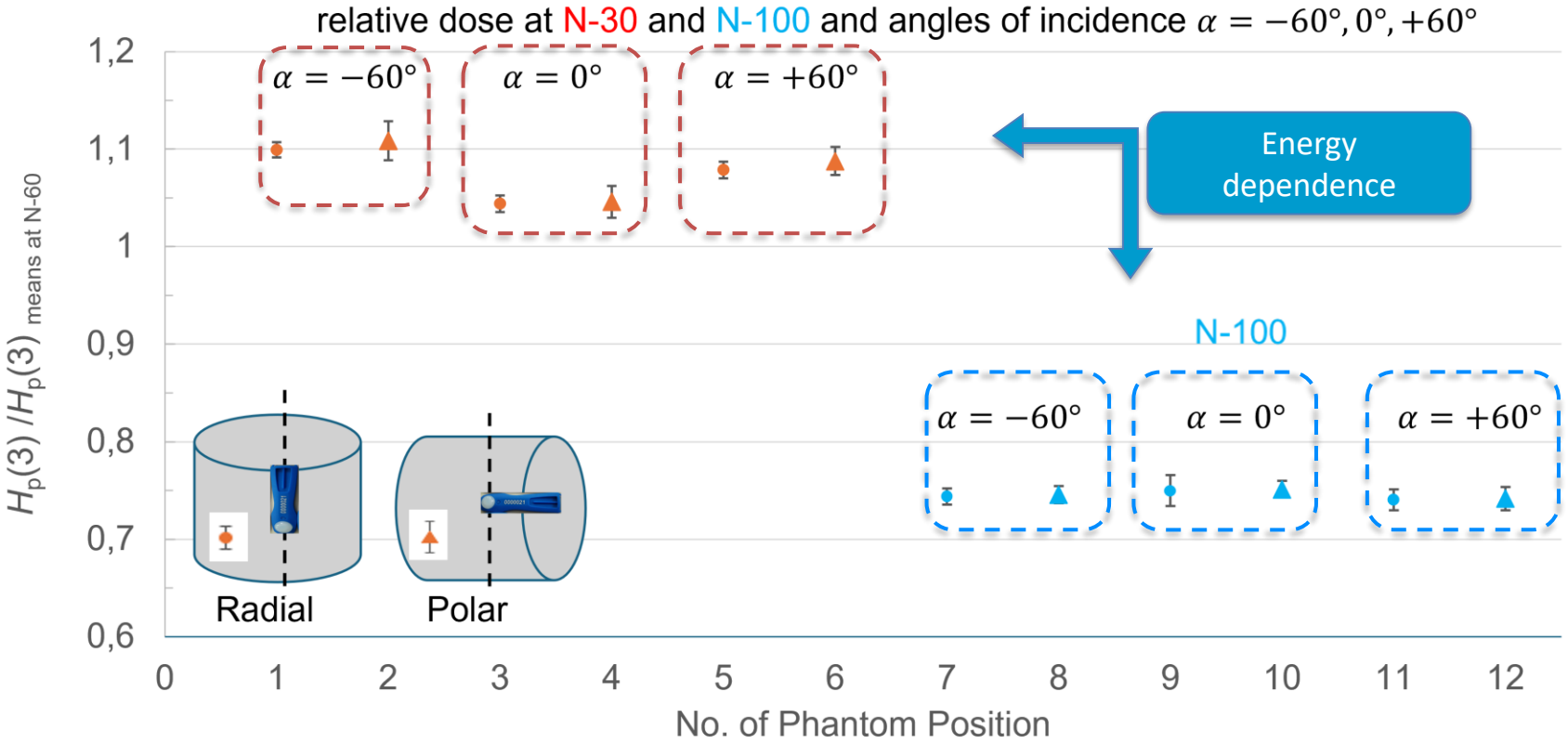
→Calibration: 20 TLDs

→Background (BG): 16 TLDs

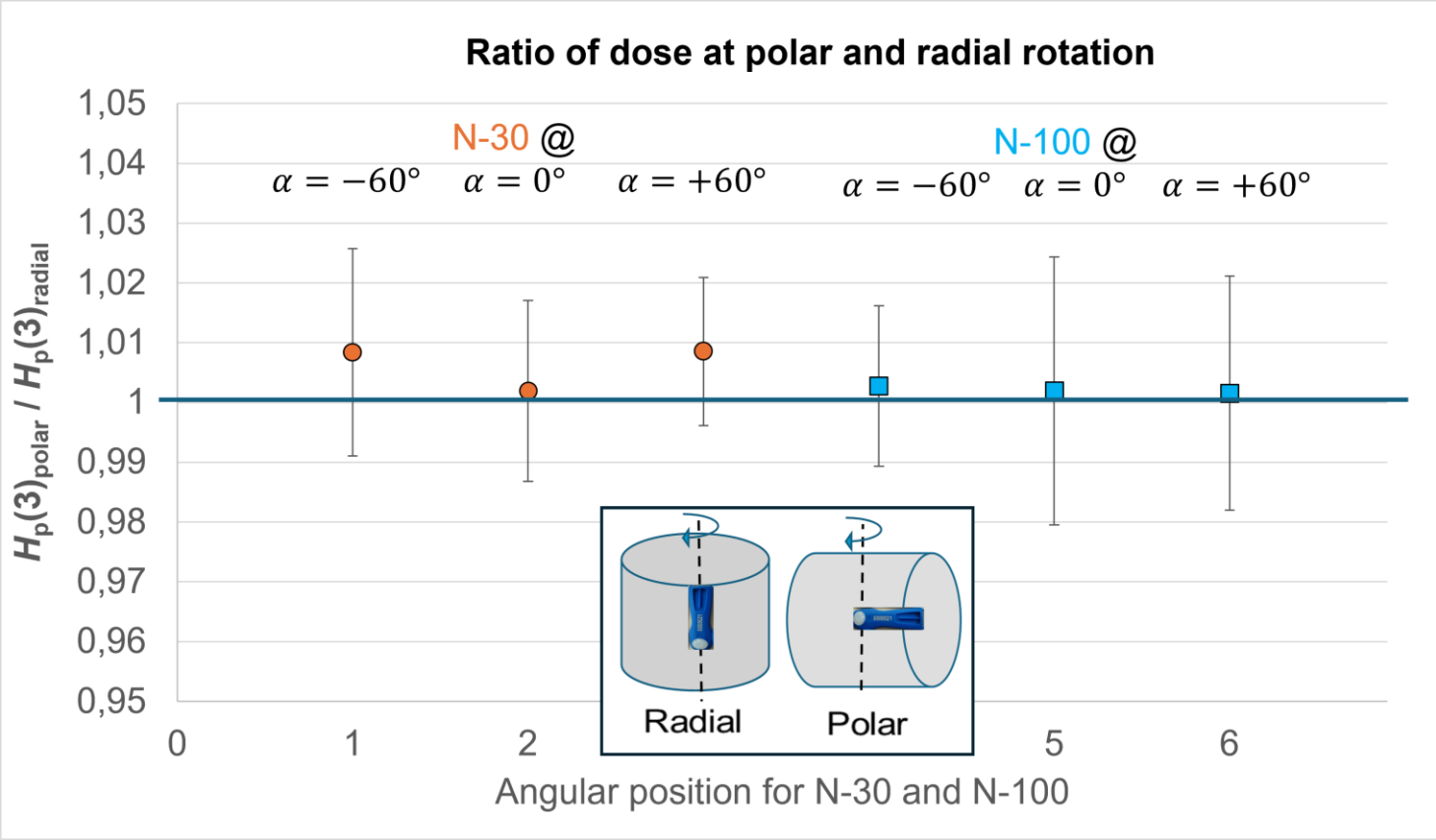
→irradiated@ N-30: 30 TLDs,

→irradiated@ N-100: 30 TLDs

Results: Normalized dose @ N-30 and N-100



Results: Relative dose (polar / radial)



Relative dose within ±1%, below ±2% combined uncertainty.

No significant difference for both N-30 and N-100 (@ α = 0°, ±60°)

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This motivated our study:

Dosemeter response: horizontal (polar) $\overset{?}{=}$ vertical (radial) rotation

- ✓ No significant differences were observed in dosemeter response between horizontal and vertical (radial and polar) orientations at exposure angles of 0° and ±60°.
- ✓ The recorded relative dose remained within ±1%, well below the combined uncertainty of ±2%.
- ✓ Therefore, type tests of rotationally symmetric eye lens dosemeters can be performed in the typical vertical phantom orientation.

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NOTE

Eye lens dosimetry: does the direction of rotation (vertical or horizontal) play a role in type testing?

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Thank you for your attention!

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