



Crystal Characterization

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CalVision General Meeting

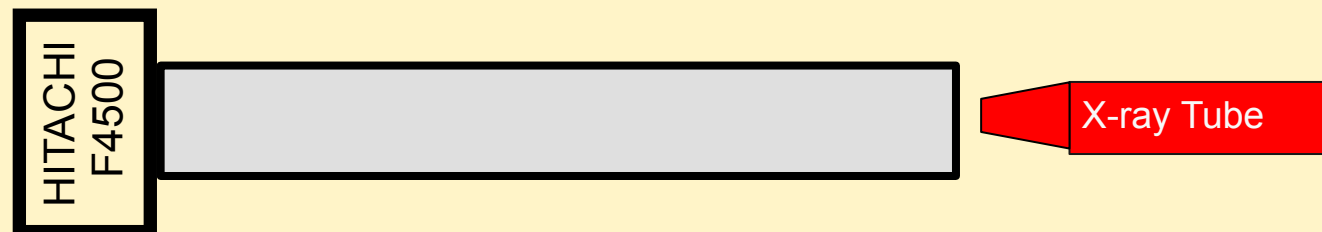
Twenty BGO Crystals ($22 \times 22 \times 160 \text{ mm}^3$)



- ❑ The 20 Caltech BGO of $22 \times 22 \times 160 \text{ mm}^3$ crystals were delivered to Caltech on Jan. 13, 2025.
- ❑ Each crystal was marked a number (1-20) at one corner with a diamond tipped scribe.
- ❑ Measurements at room temperature:
 - X-ray excited luminescence (XEL),
 - Longitudinal/Transverse transmittance (LT/TT),
 - Light Output (LO) & Decay Time(τ), Light Response Uniformity (LRU), and Light Yield (LY) with Emission Weighted Quantum Efficiency (EWQE) taken out.

Measurement Setup

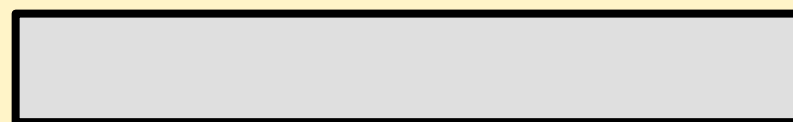
X-ray excited luminescence



XEL spectrum measured for each sample
With no wrapping and air gap coupling

Transmittance

HITACHI 3210



LT and TT (at crystal center) spectra
measured for each sample

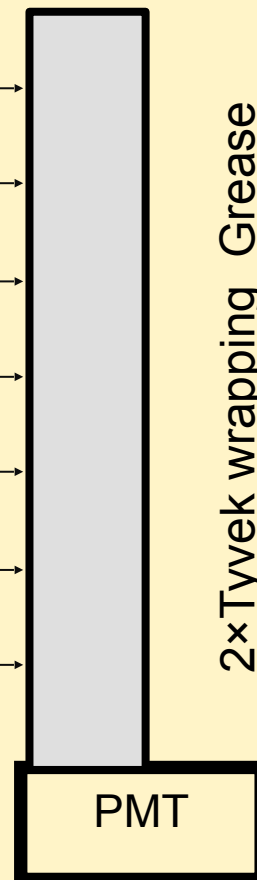
Integrating
sphere

PMT

Na-22
position

G
F
E
D
C
B
A

2xTyvek wrapping Grease
Coupling to PMT

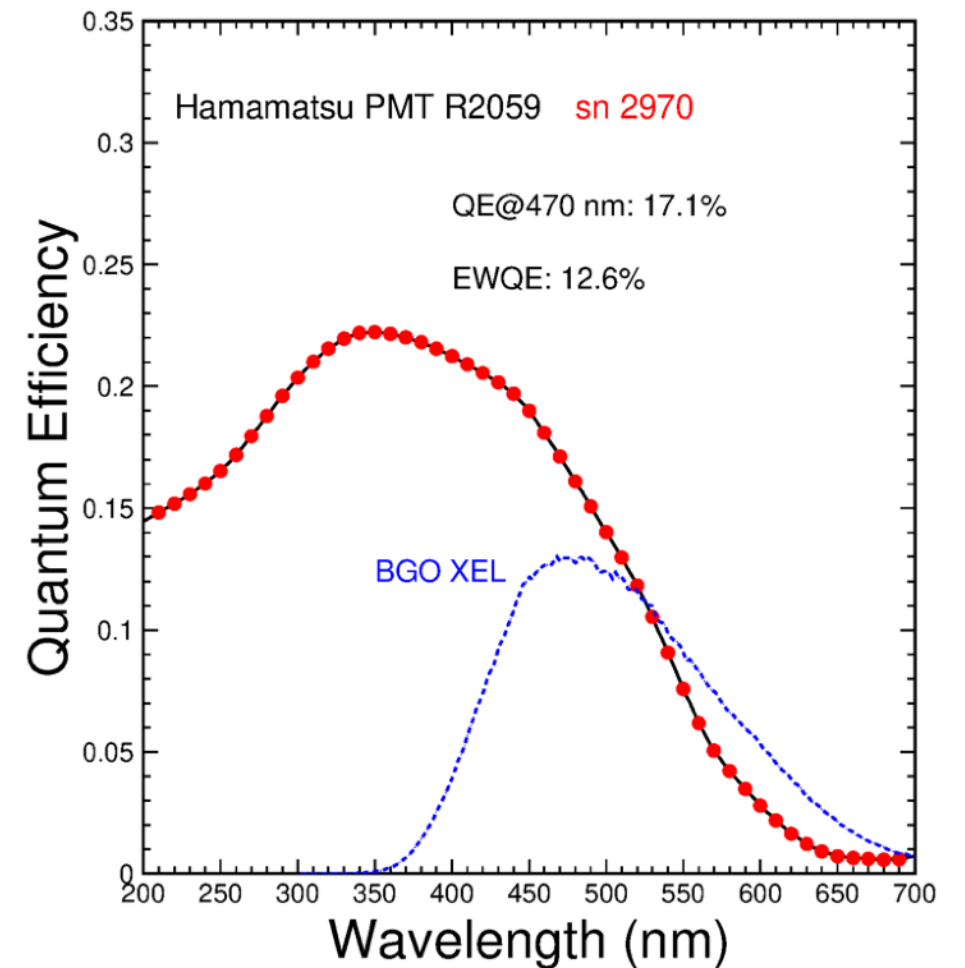
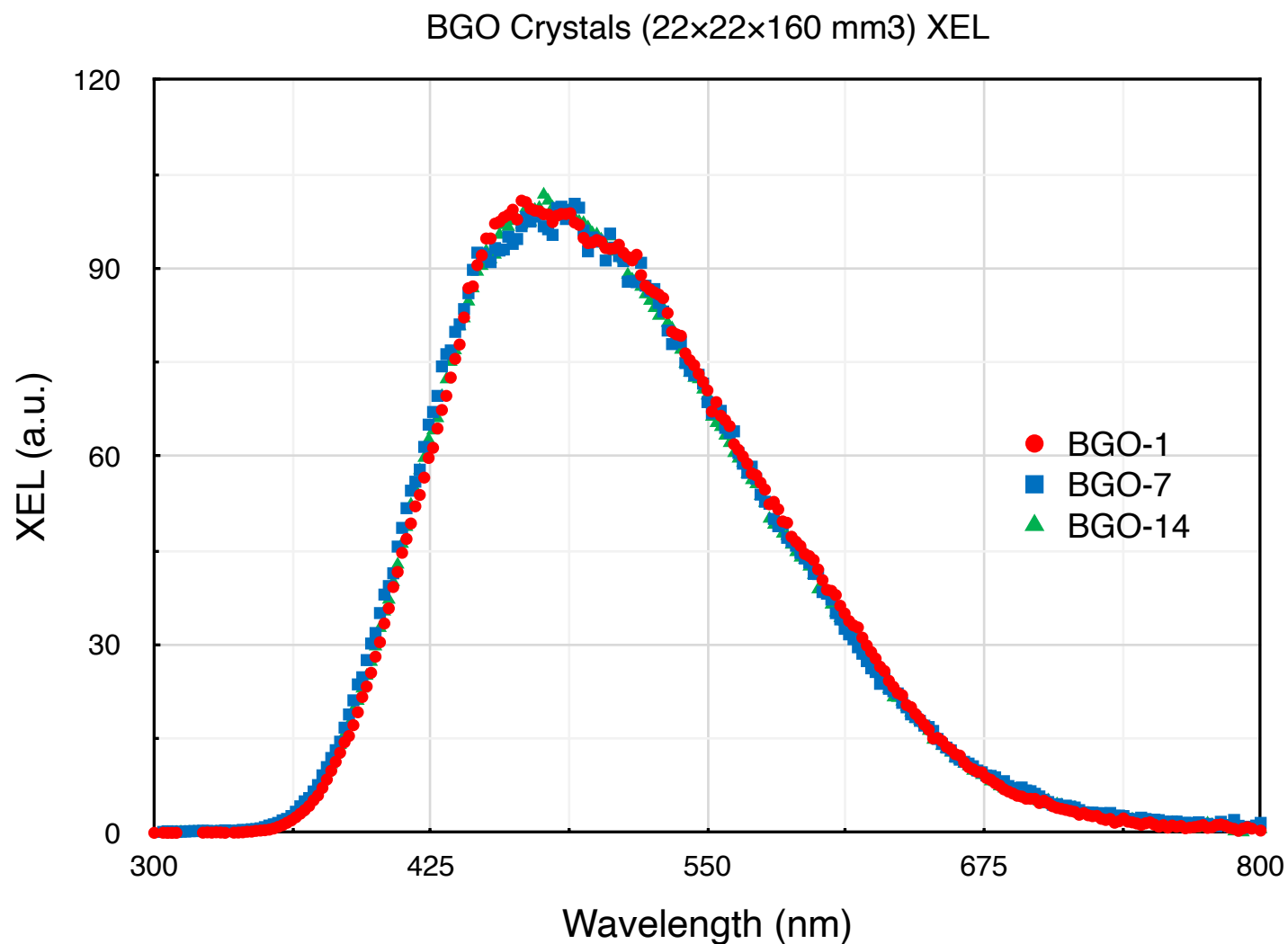


LO & τ

LO & Decay Kinetics: **A**
Pulse Shape: **A**
LRU/PHS: **A-G** (only
2,000 ns gate for BGO)

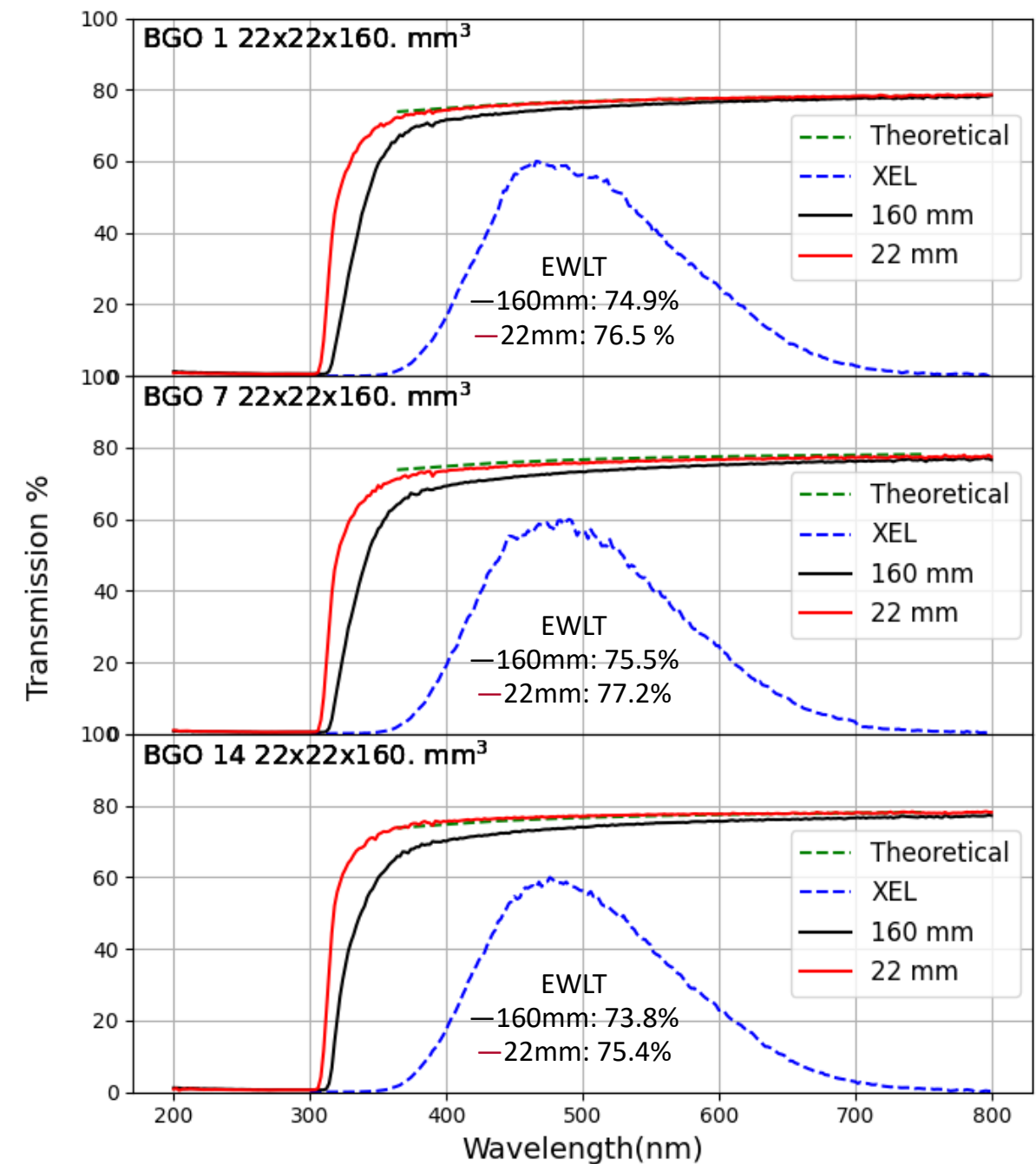
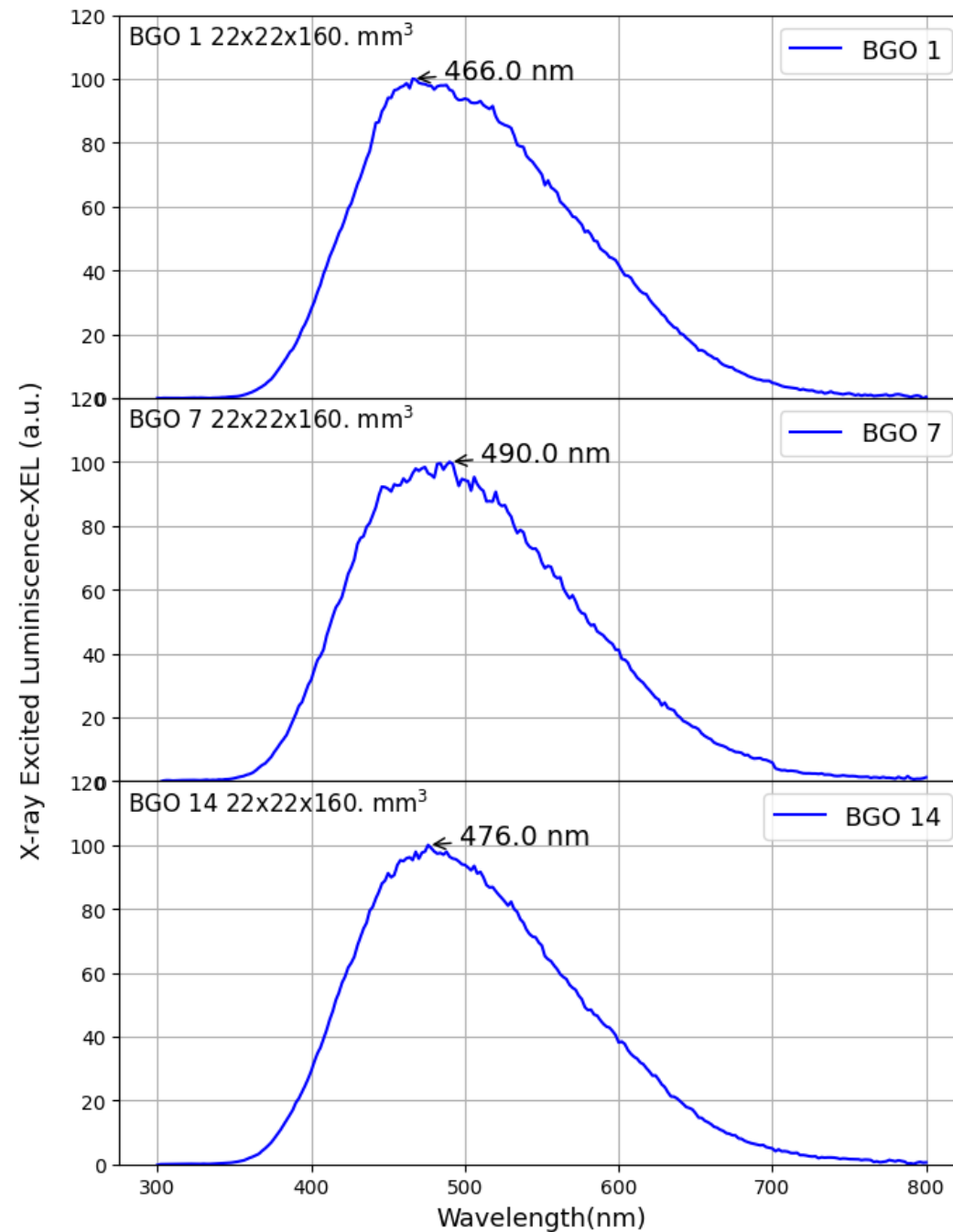
XEL and EWQE

- The X-ray excited luminescence (XEL) was measured for 3 BGO crystals, the emission spectra are consistent.
- The average of XEL spectra is used to calculate Emission Weighted Quantum Efficiency (EWQE) of the photo-detector (PMT R2059) in the light output measurement.

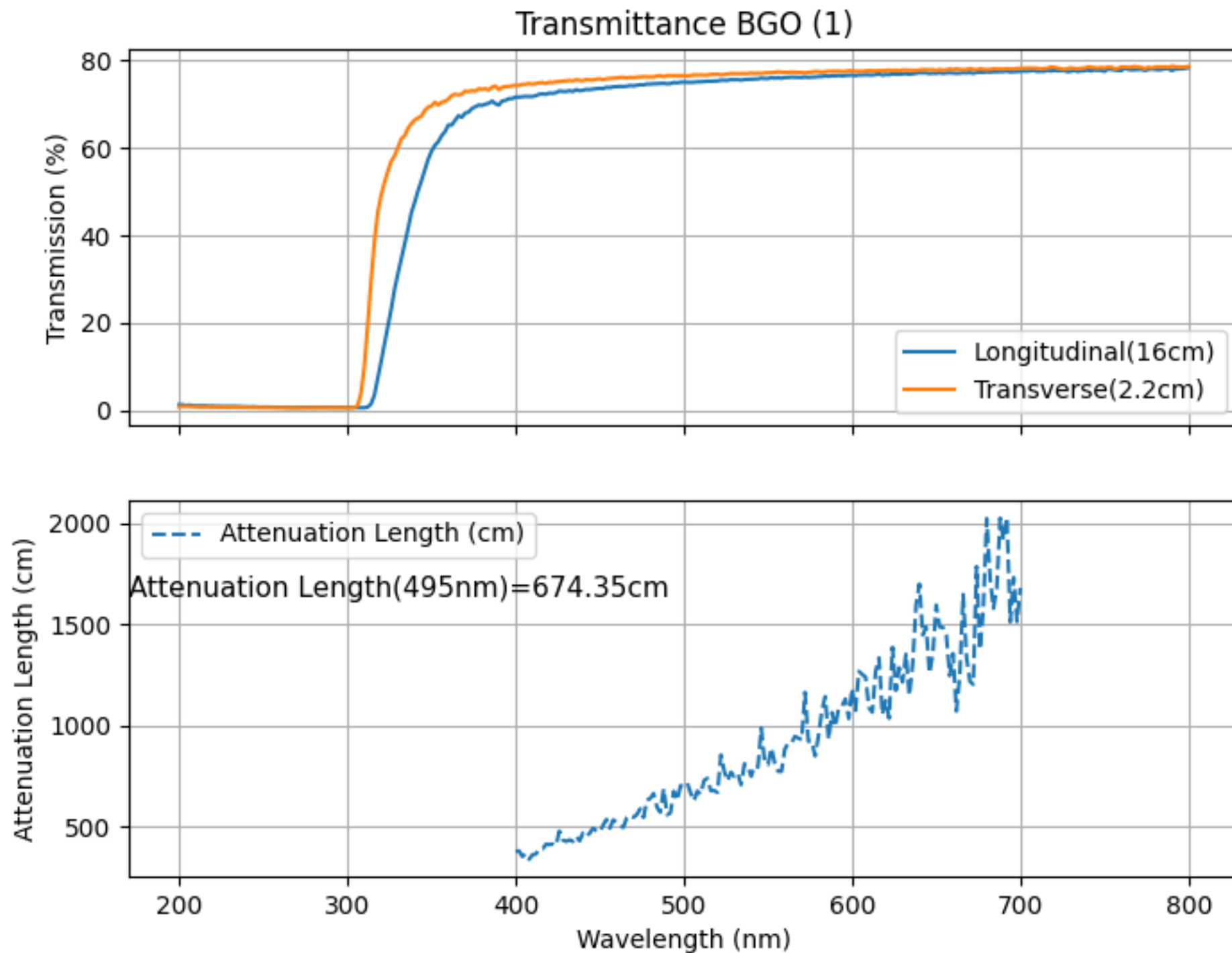


XEL, LT, TT Spectra and EWLT

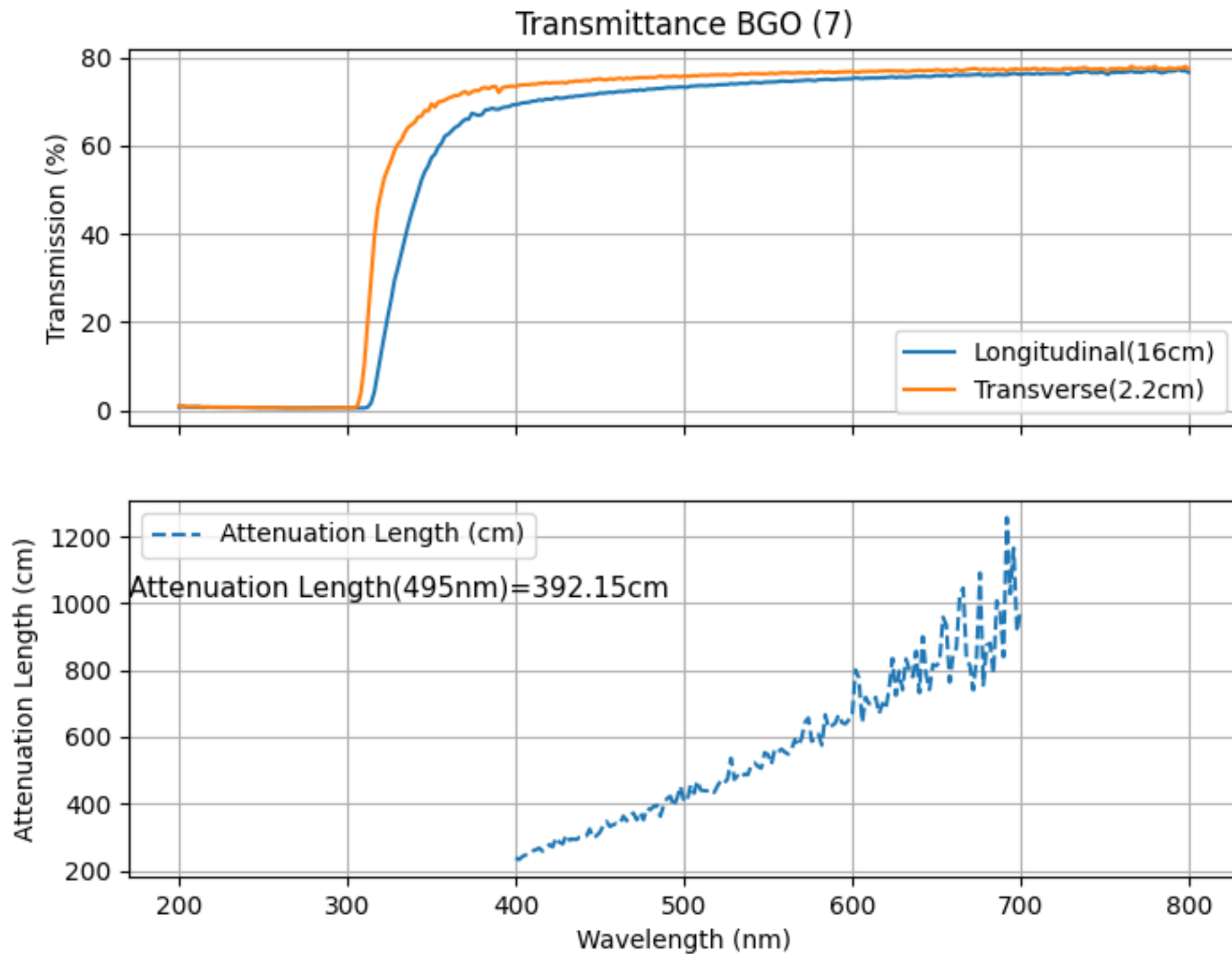
- XEL Peaked at (466 - 490)nm
- Transverse Transmittance if measured at the centre of the crystal.



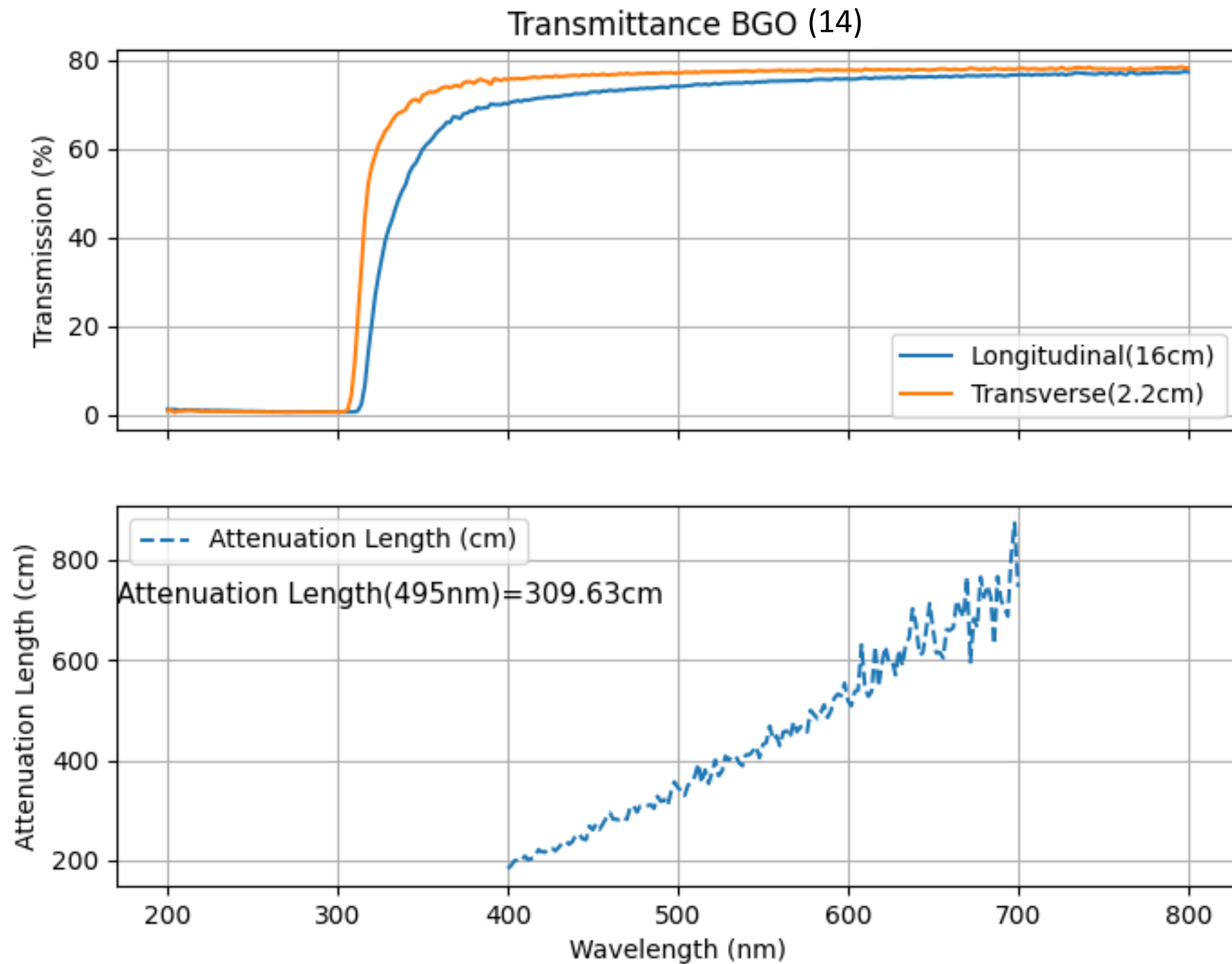
Attenuation Length



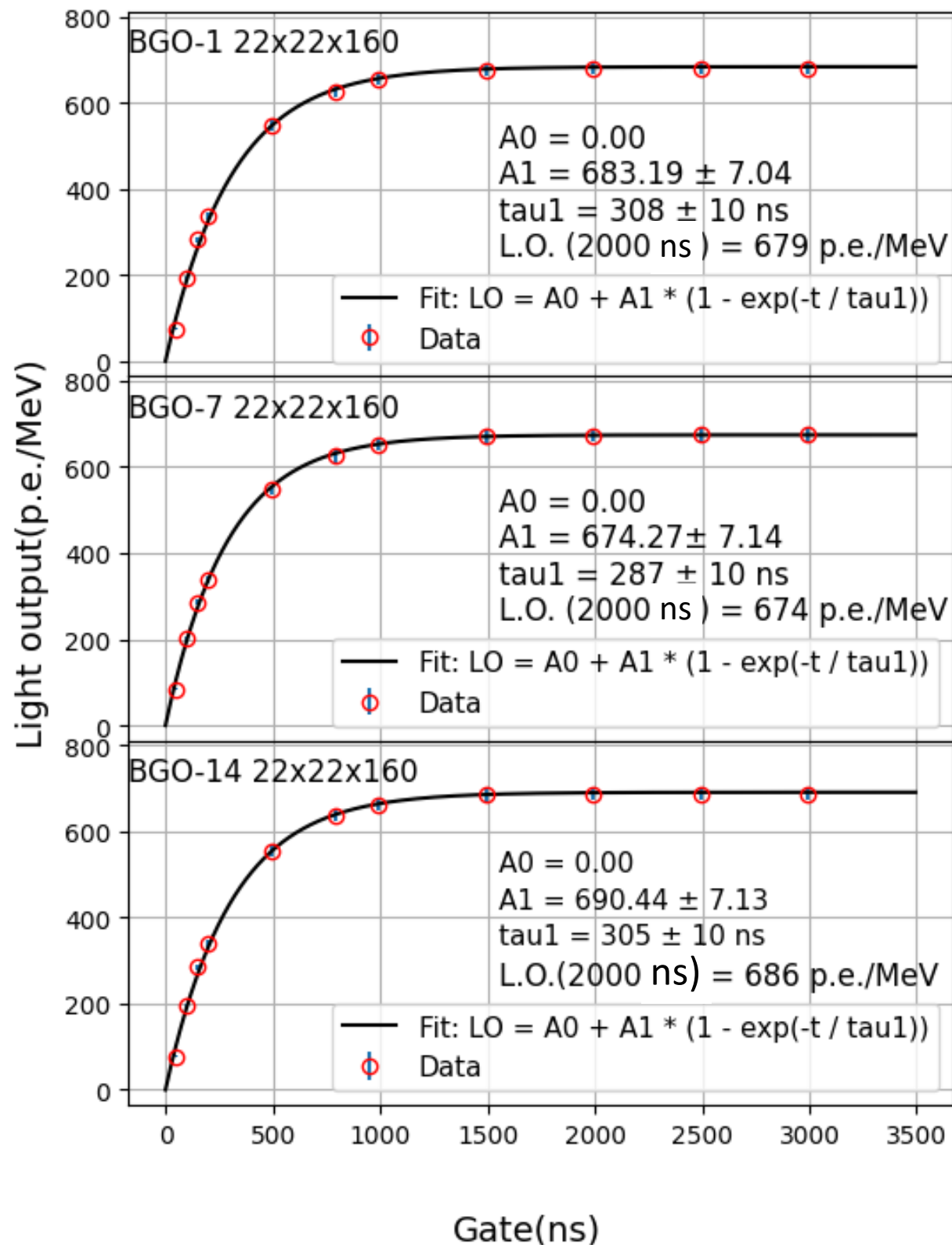
Attenuation Length



Attenuation Length



Decay Time Kinetics



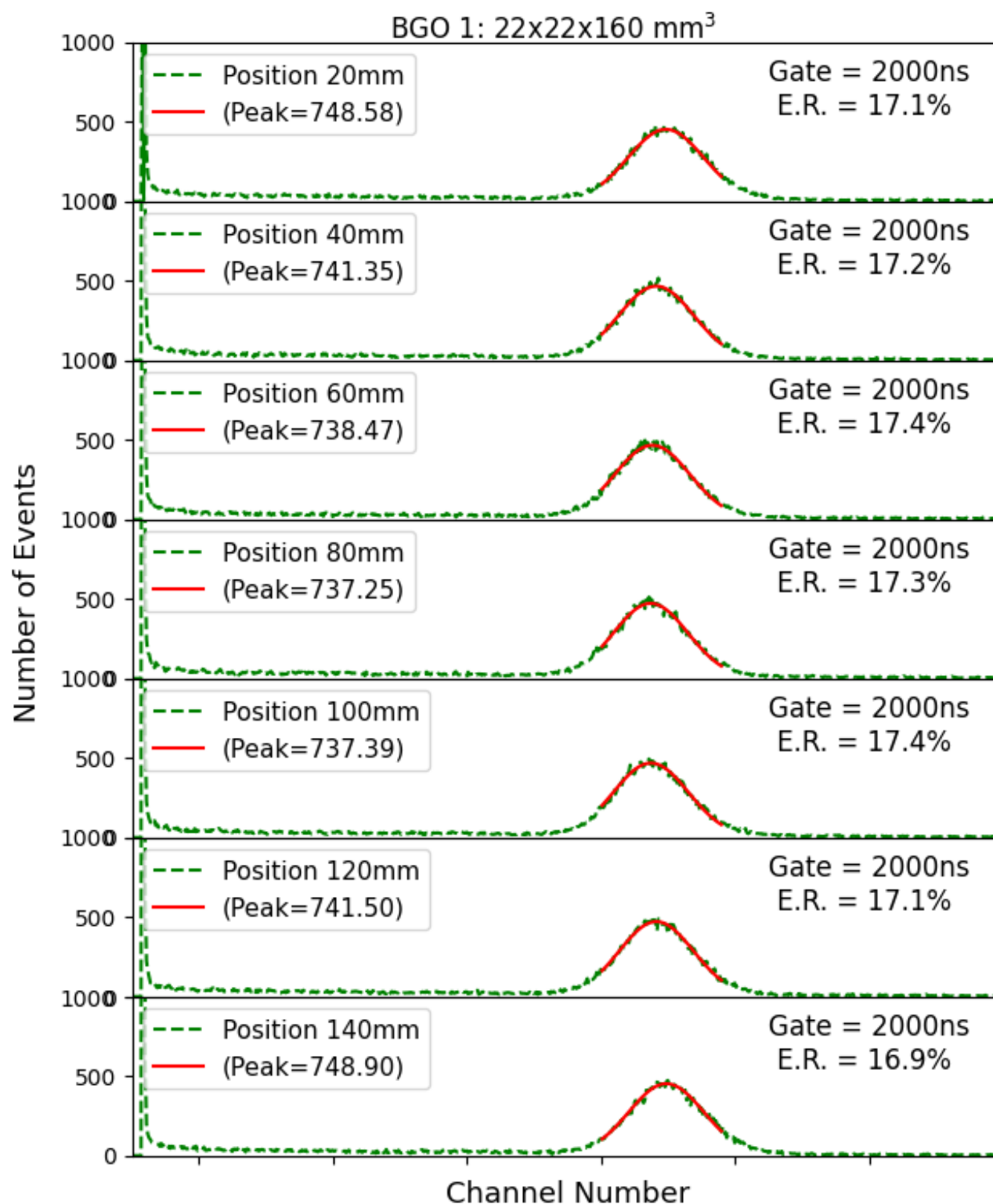
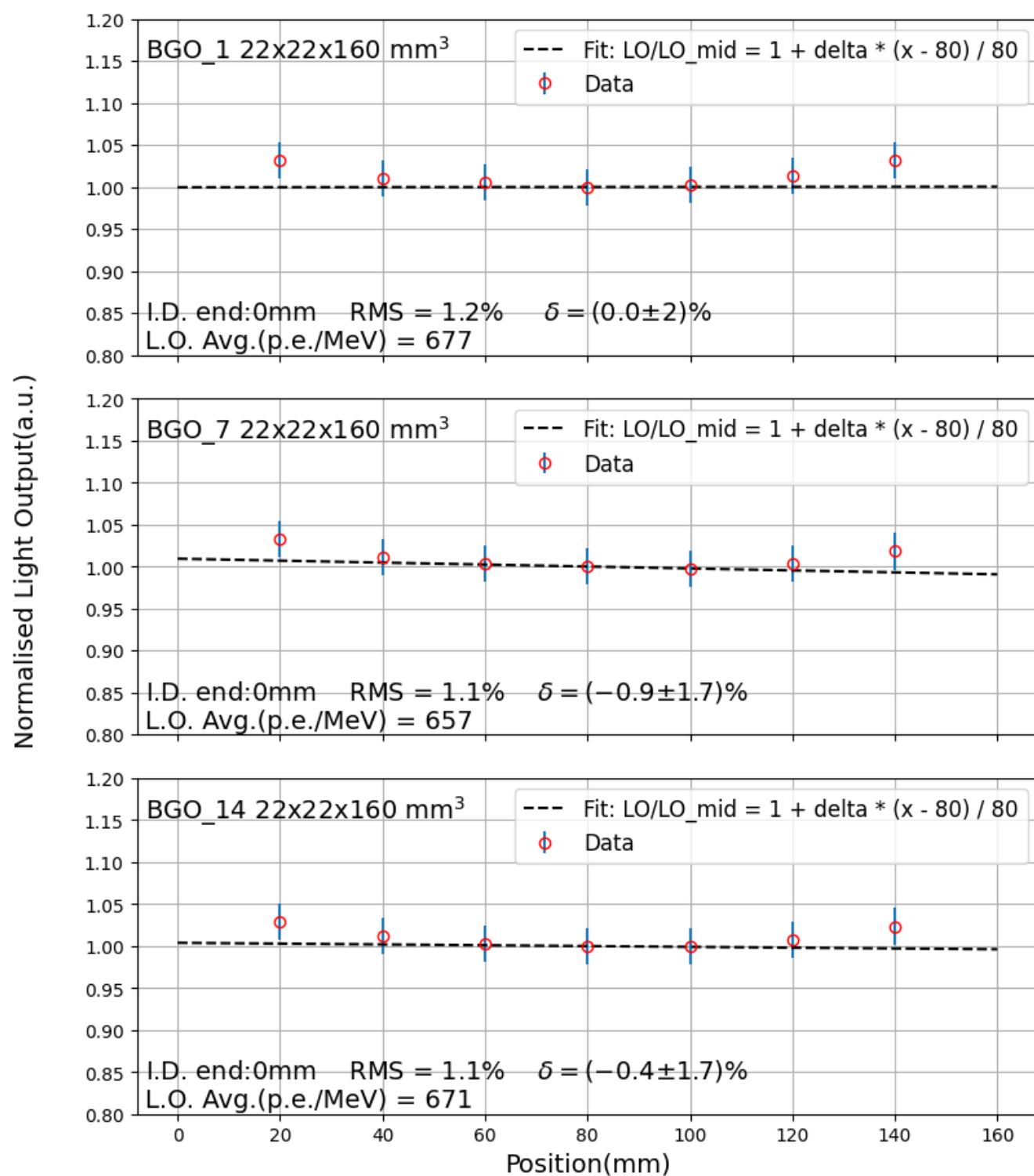
- Decay Time for the three BGO crystals

1. BGO 1: $\sim 308 \text{ ns}$
2. BGO 7: $\sim 287 \text{ ns}$
3. BGO 14: $\sim 305 \text{ ns}$

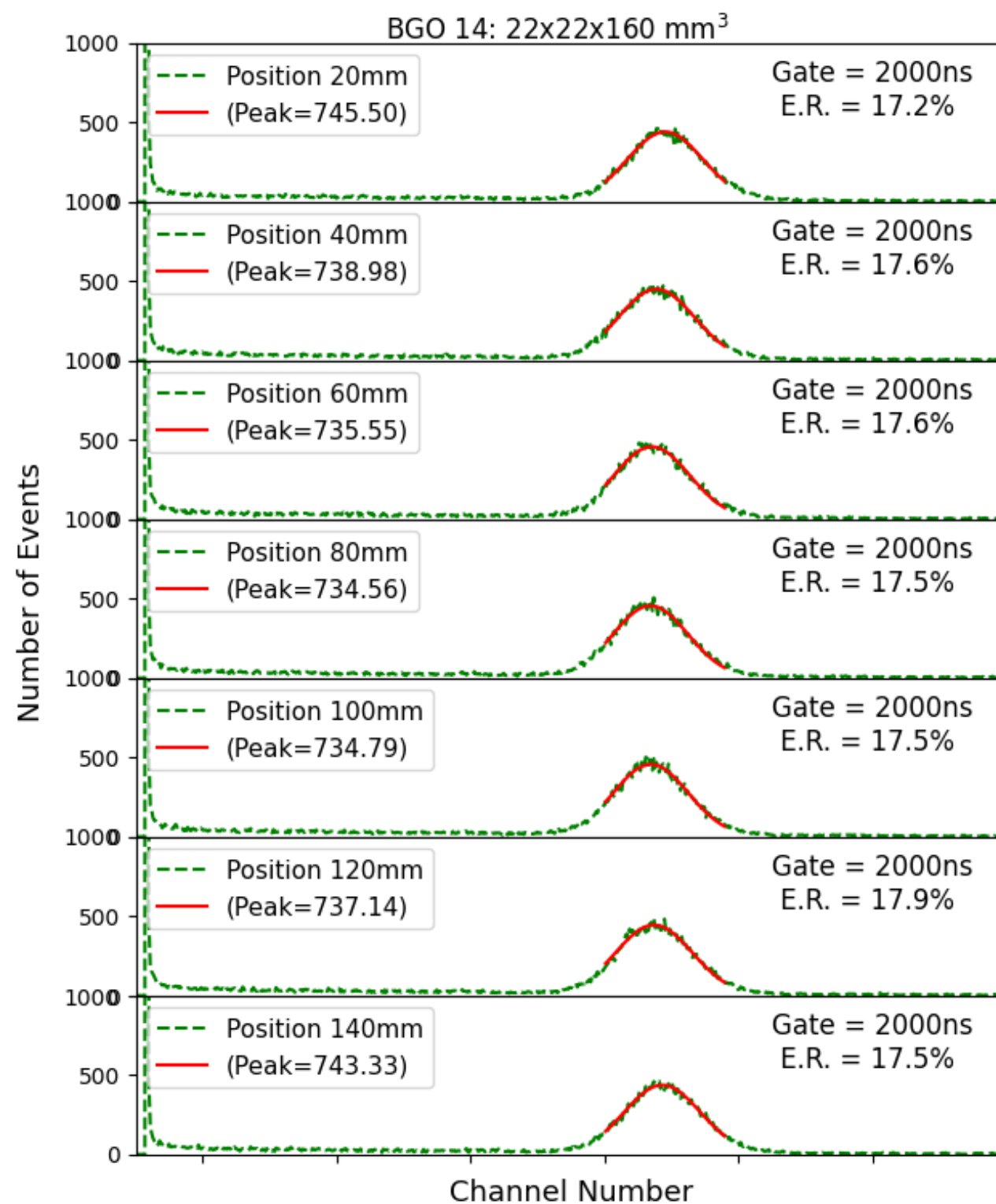
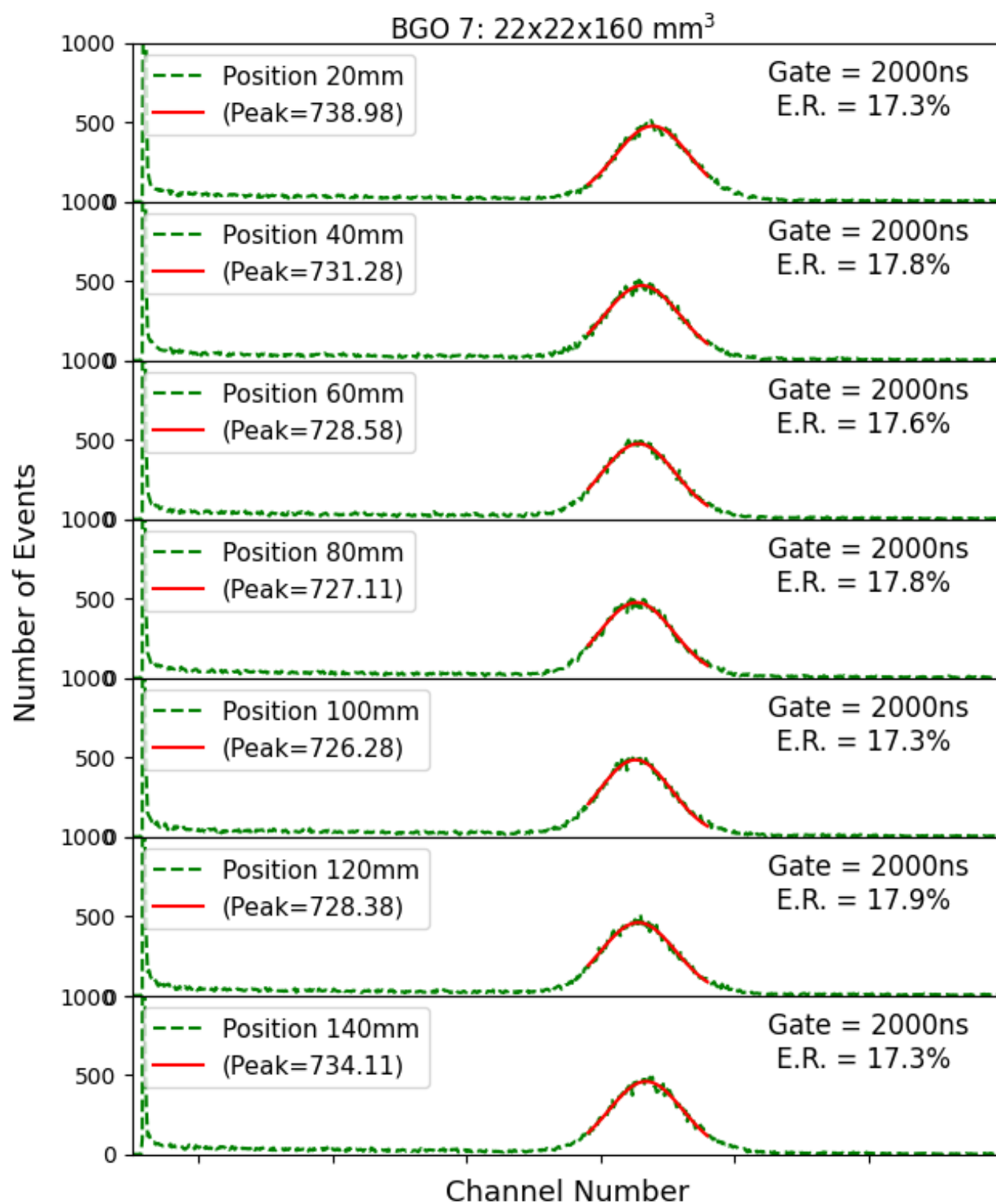
- Light Output for a 2000ns Gate:

1. BGO 1: 679 p.e./MeV
2. BGO 7: 674 p.e./MeV
3. BGO 14: 686 p.e./MeV

Light Response Uniformity(LRU)

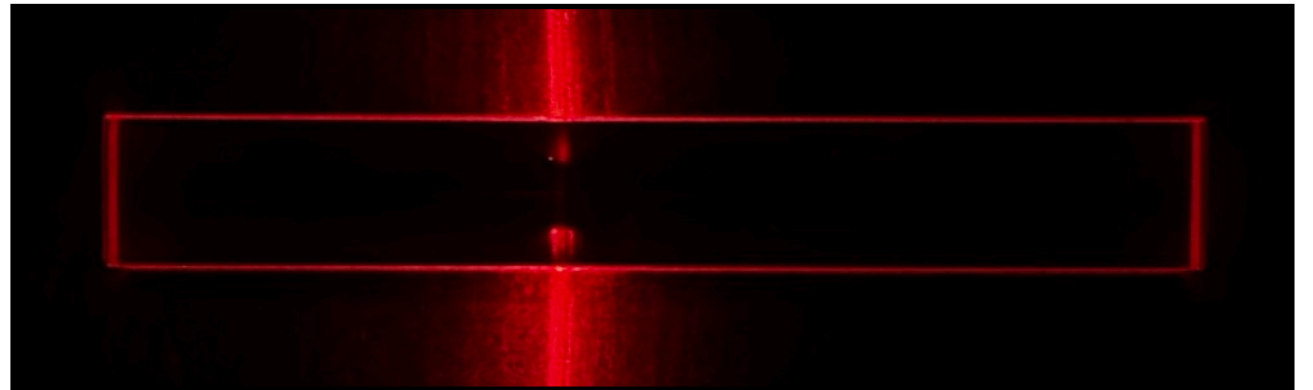
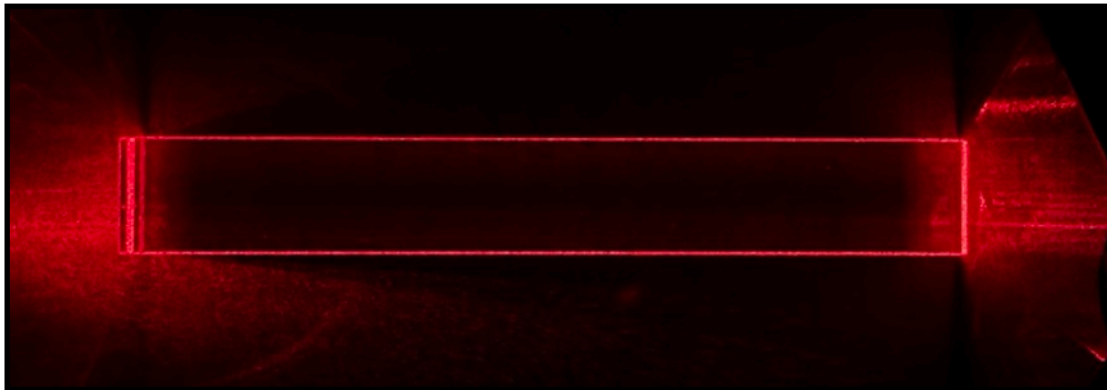


Light Response Uniformity(LRU)

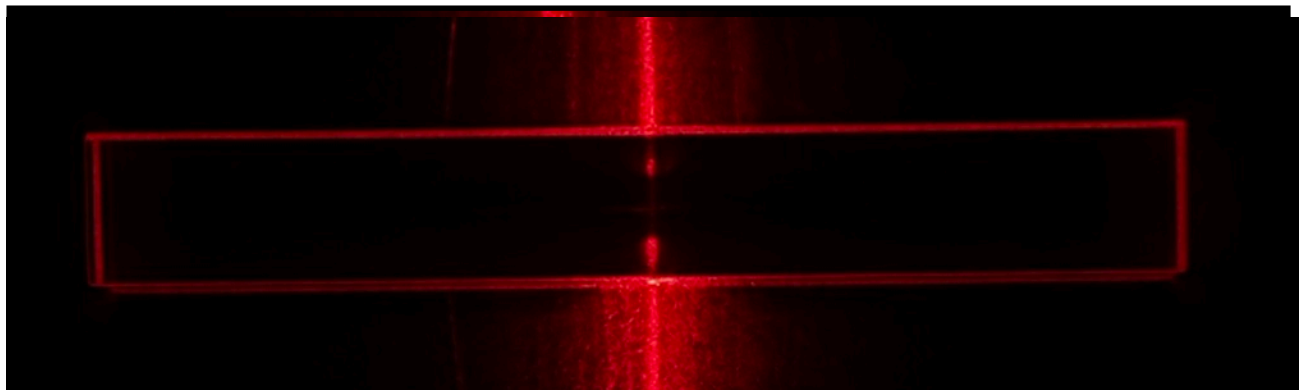


He-Ne Laser Scattering

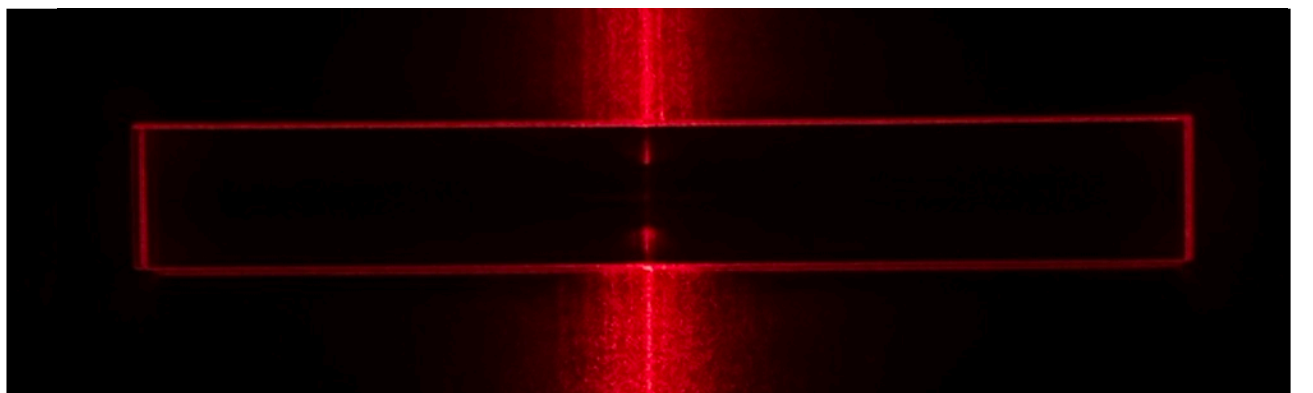
BGO 1



BGO 7



BGO 14



Summary

BGO	EWLT(%)	Light Output (p.e./MeV)	Avg. Energy Resolution(%)	LRU(%)	Time Decay (ns)
BGO 1	74.9	677	17.2	1.2	308
BGO 7	75.5	657	17.6	1.1	287
BGO 14	73.8	671	17.5	1.1	305

- 20 BGO crystals, each of 16cm long respectively were received at Caltech. 3 out of those were tested. Their XEL, LT, TT and PHS spectra, EWQE, LO, τ and LRU were measured at Caltech HEP Crystal Lab.
- The 3 BGO shows an average Light output for 2000ns gate of 668 p.e./MeV
- Qualitative verification of any macroscopic differences in the crystal composition was done using the He-Ne laser by observing the scattering effects.

Next Steps...

- Transmission spectrum needs be measured for all 20 crystals.
- We can avoid measuring XEL for all to avoid excessive radiation exposure to the crystal, However exposing crystals to X-ray did not effect the transmission or LRU of the crystal.
- 8 more 22x22x160 (mm³) are expected to arrive at Caltech.
- More than 100 small crystals are also expected to arrive at Caltech.
- Similar approach could be applied for testing the small crystals to have them ready for the test beam.

Thank You!

Questions?