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# Dependence of ZnO-based Phosphor Spectral Emission on UV and X-ray Excitation Pulse Width

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APS March Meeting 2023

March 6, 2023

Las Vegas, NV

**PURDUE** Argonne  
UNIVERSITY NATIONAL LABORATORY

SAND2023-00062C



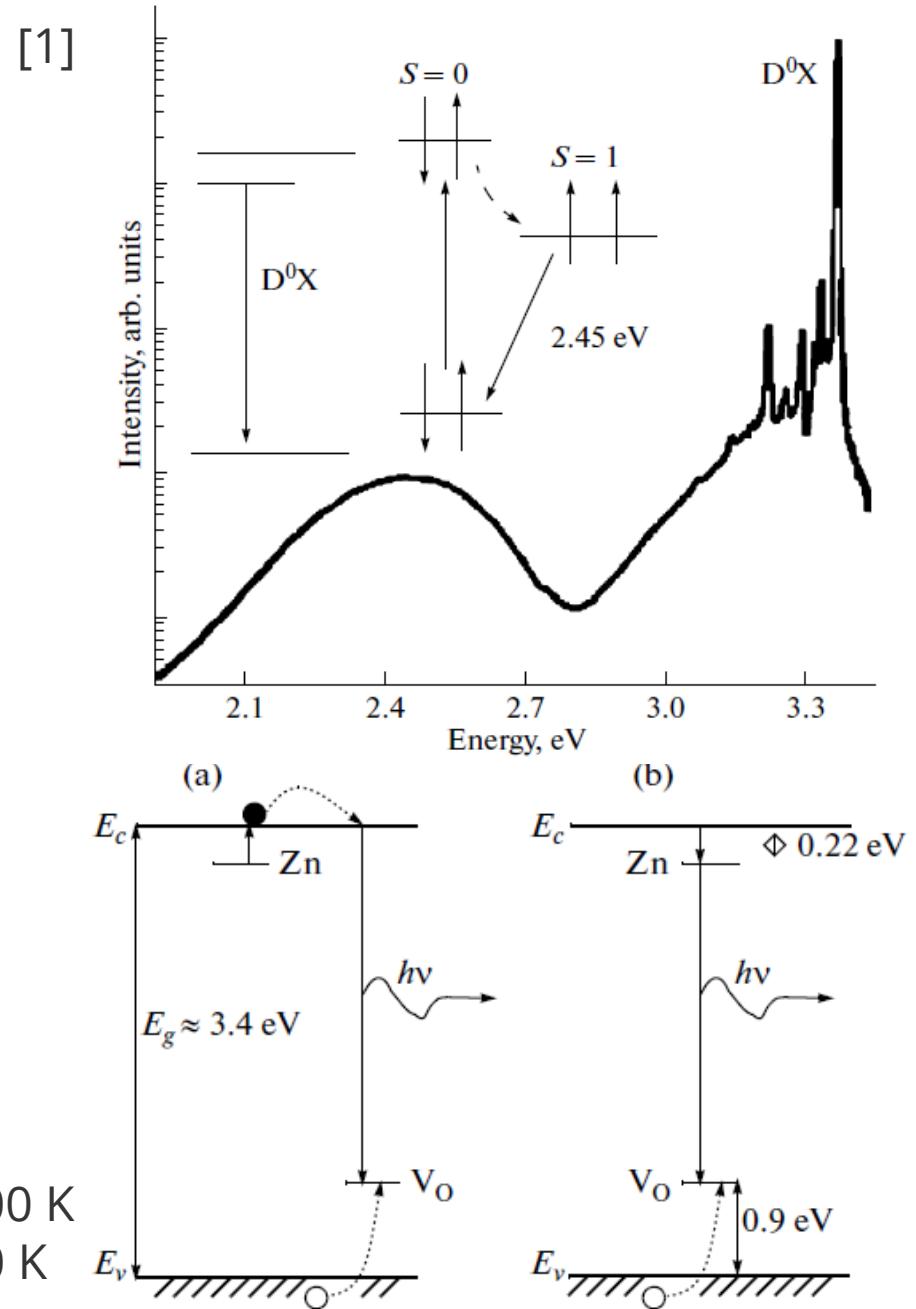
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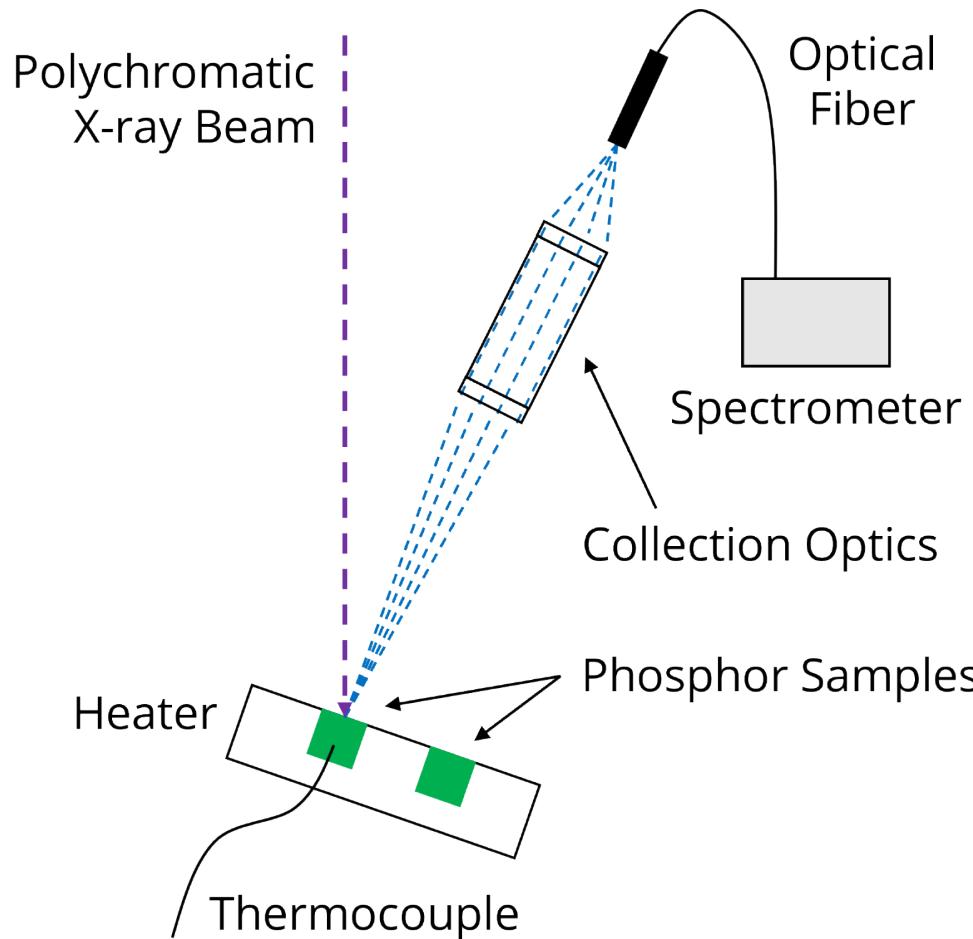
# Introduction

- ZnO phosphors can exhibit UV and visible (green/yellow) emission bands
  - UV: exciton emission
  - Visible: various proposed luminescent centers, including  $V_{Zn}$ ,  $V_O$ ,  $Zn_i$ ,  $Zn_O$ , and  $Cu^{2+}$  ions
- Present study: ZnO:Ga and ZnO:Zn
  - ZnO:Ga: UV emission line resulting from exciton (edge) recombination
  - ZnO:Zn: UV band and broad green emission resulting from  $V_O$  point defects
- Application: **Phosphor Thermometry**
  - Both phosphors exhibit temperature sensitivity in their time-resolved and time-integrated spectral response

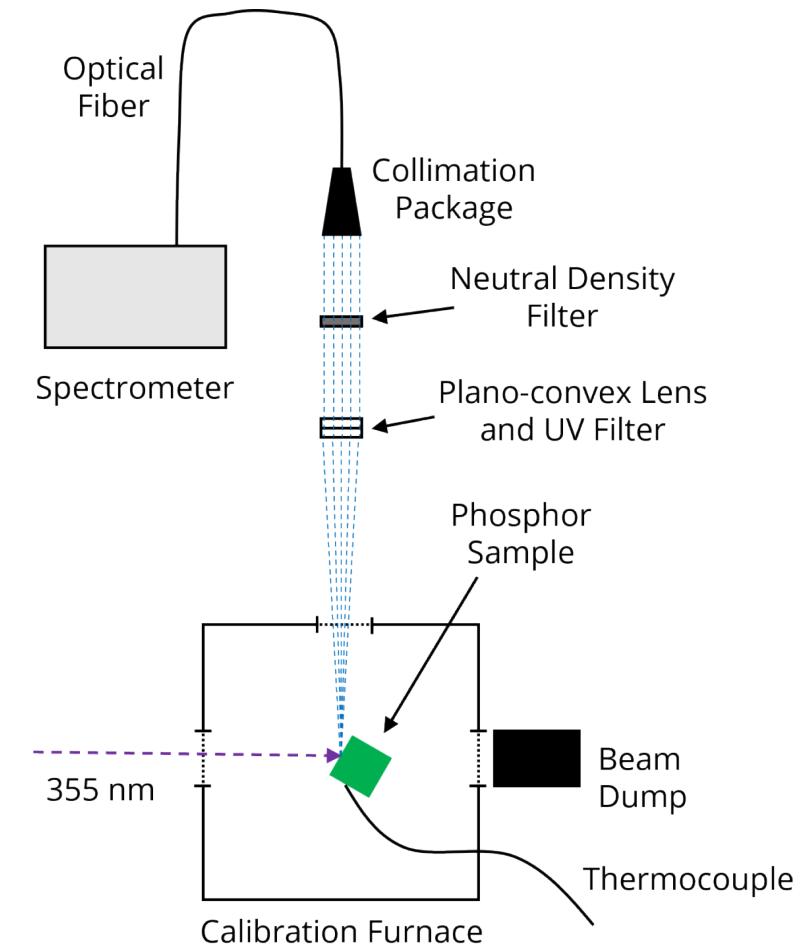


# Experimental Methods

## Synchrotron x-ray excitation

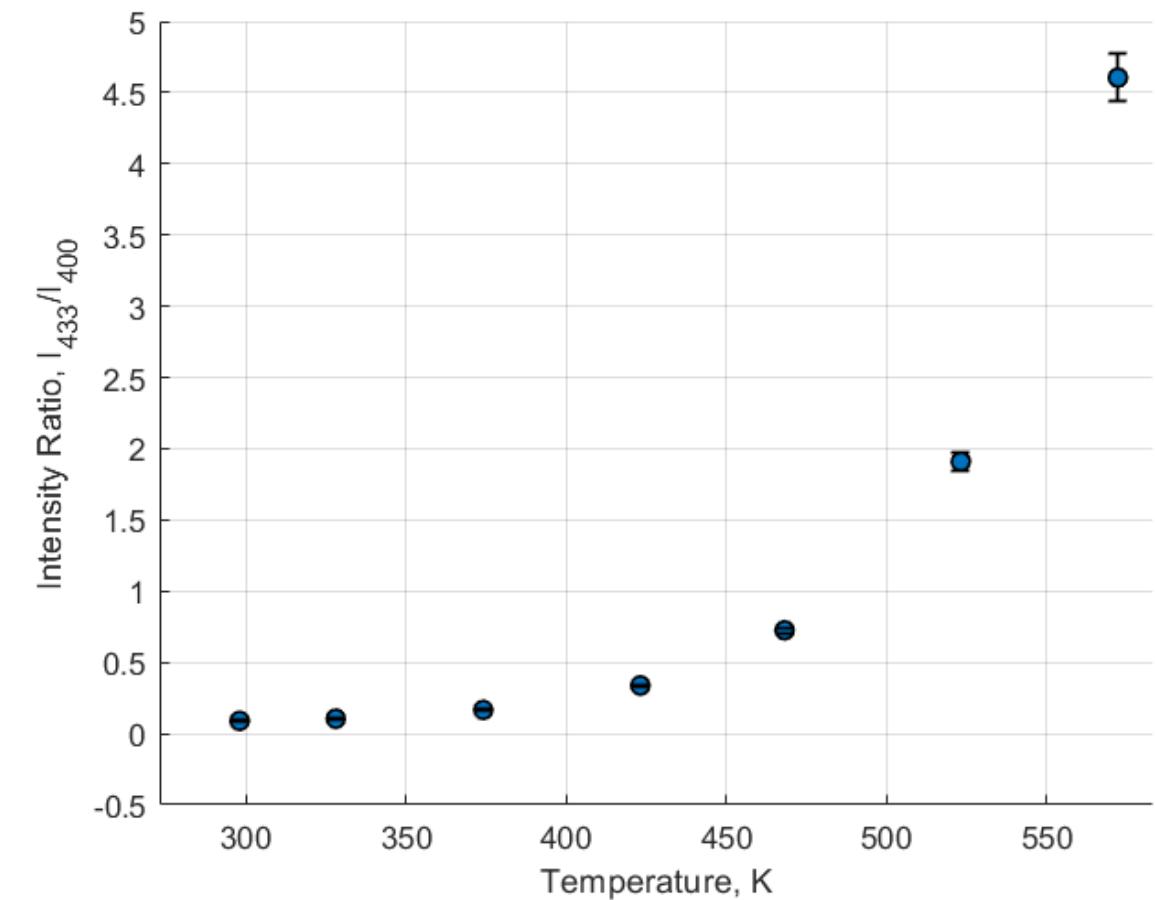
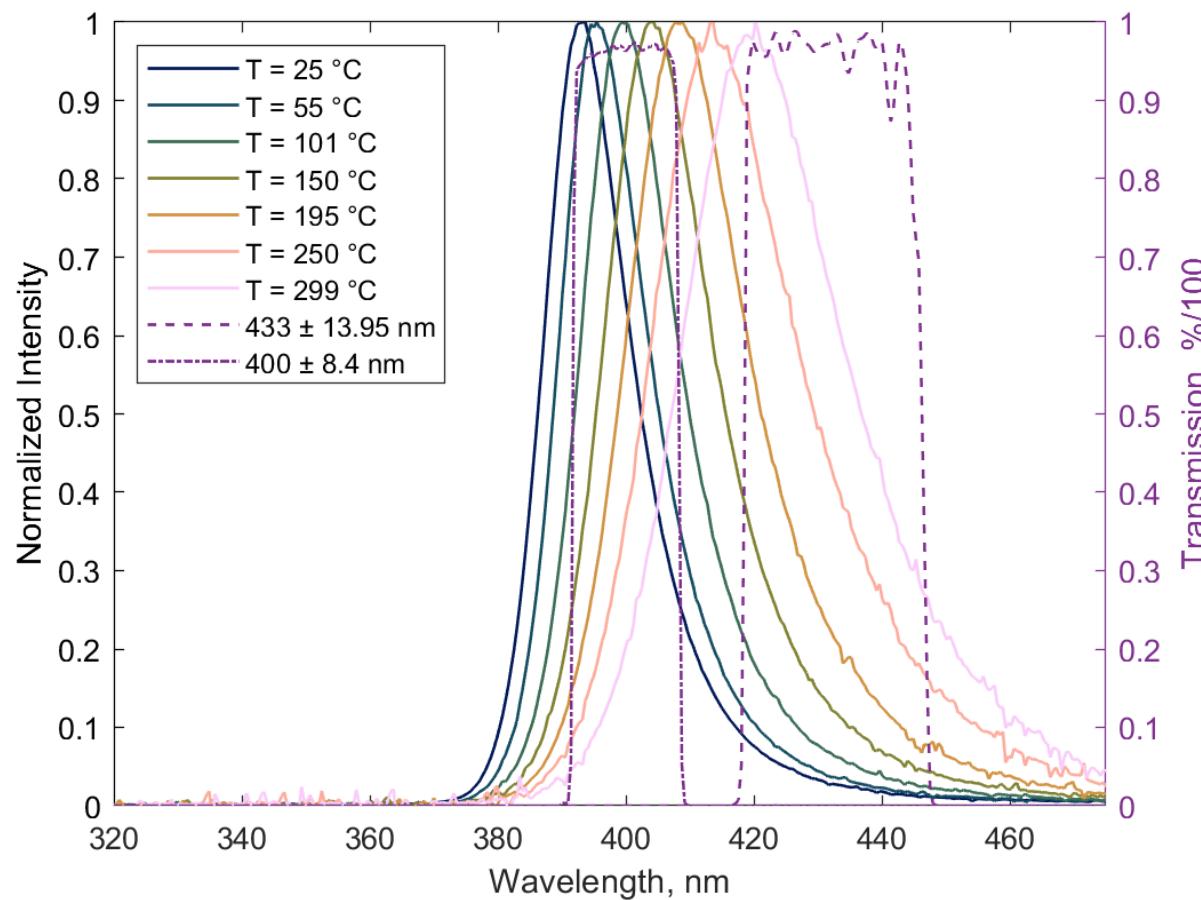


## Pulsed UV laser excitation



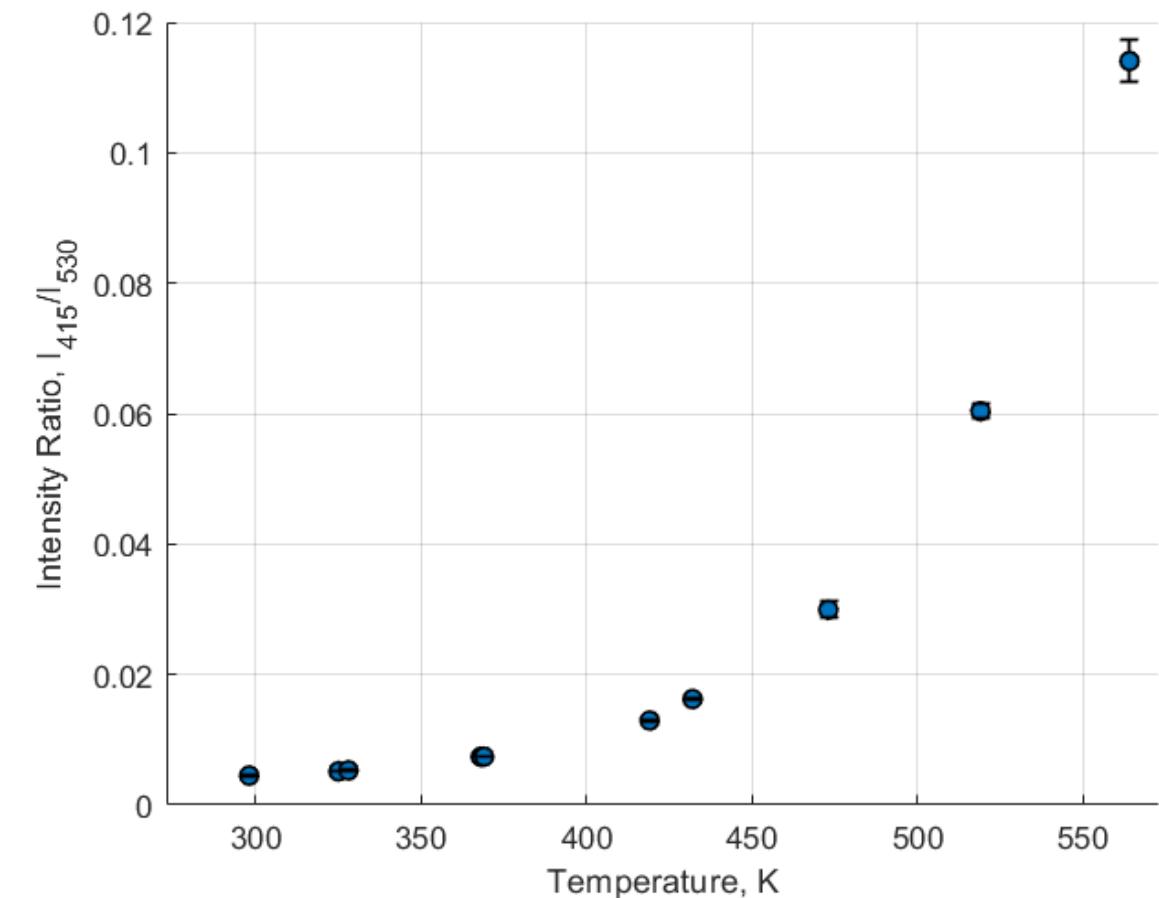
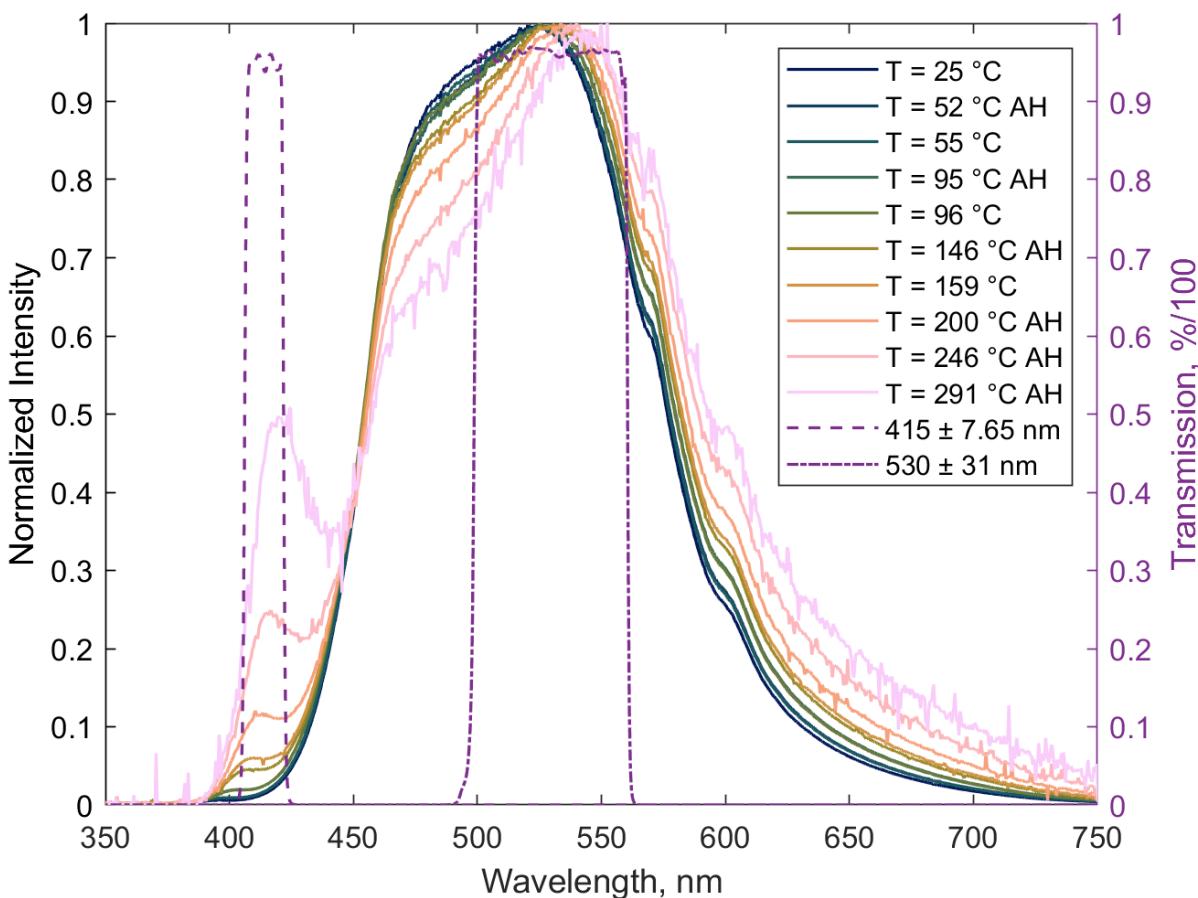
# Results - ZnO:Ga

UV emission line redshifts with increasing temperature



# Results - ZnO:Zn

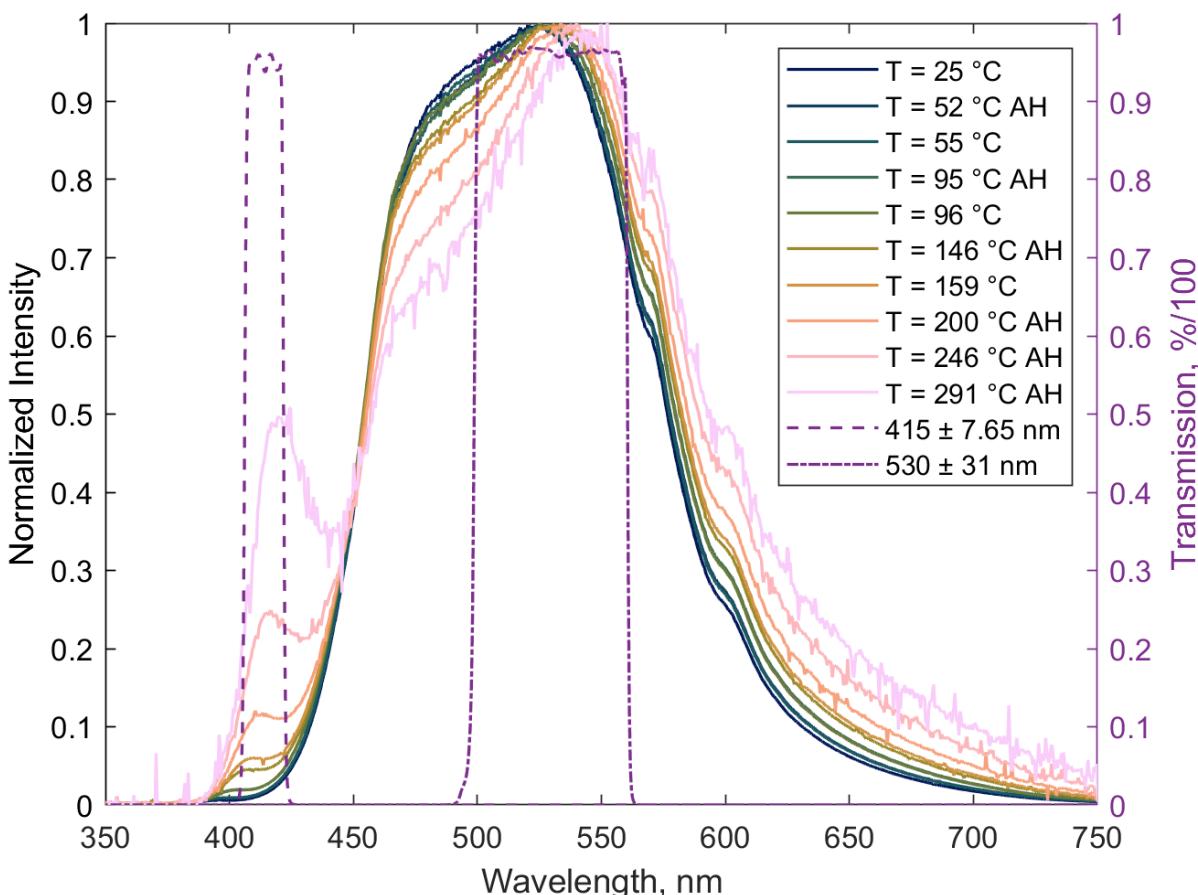
Same redshift of UV emission line, in addition to wide green emission band



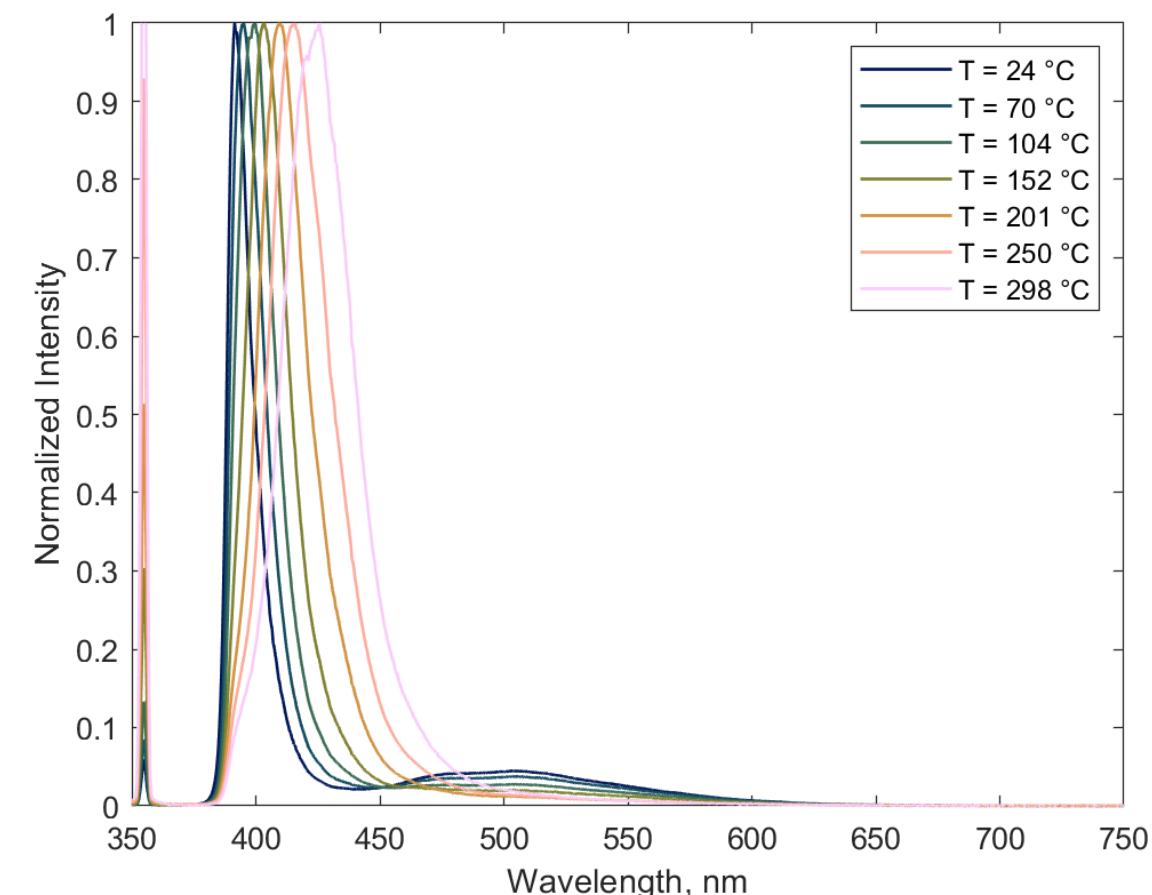
# Results - ZnO:Zn

Large difference observed in the relative intensities of ZnO:Zn emission

Synchrotron x-ray excitation



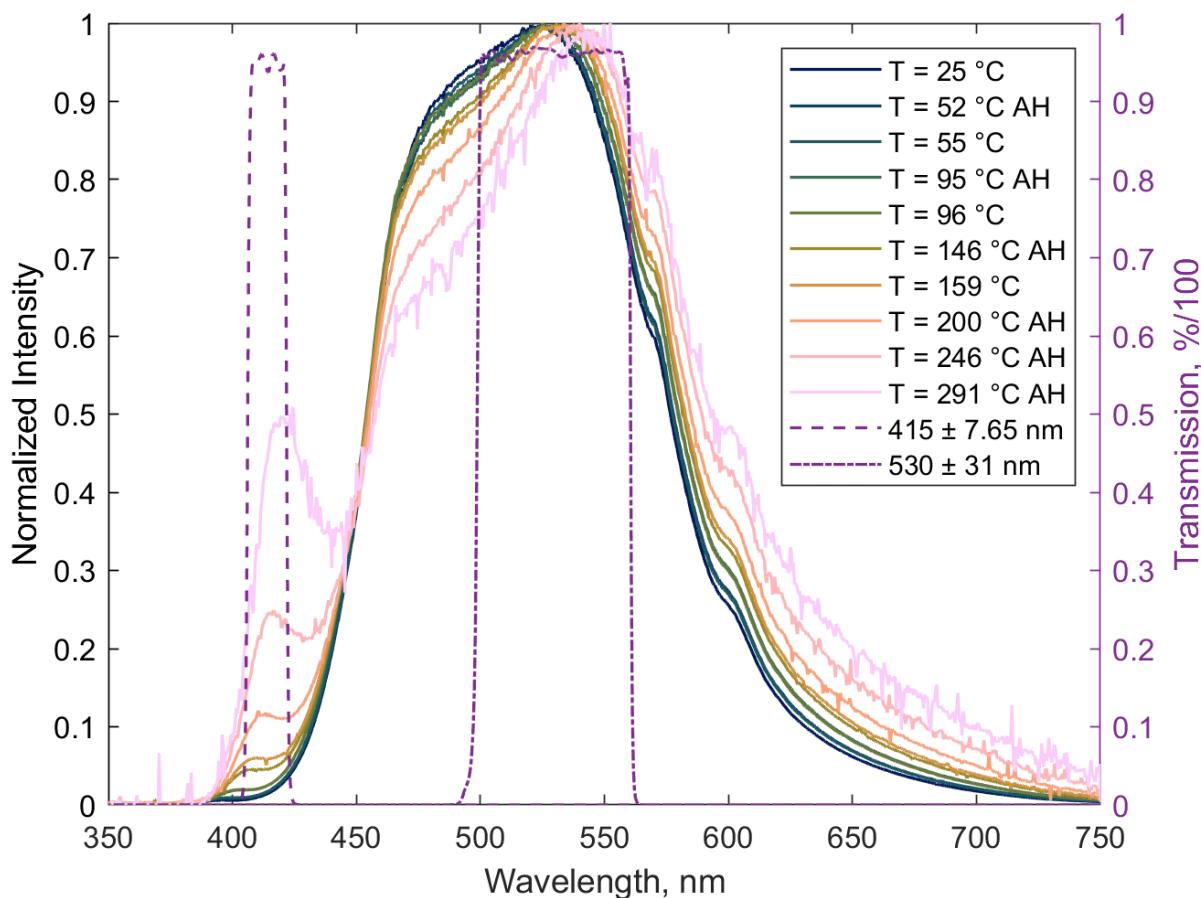
Pulsed UV laser excitation (355 nm)



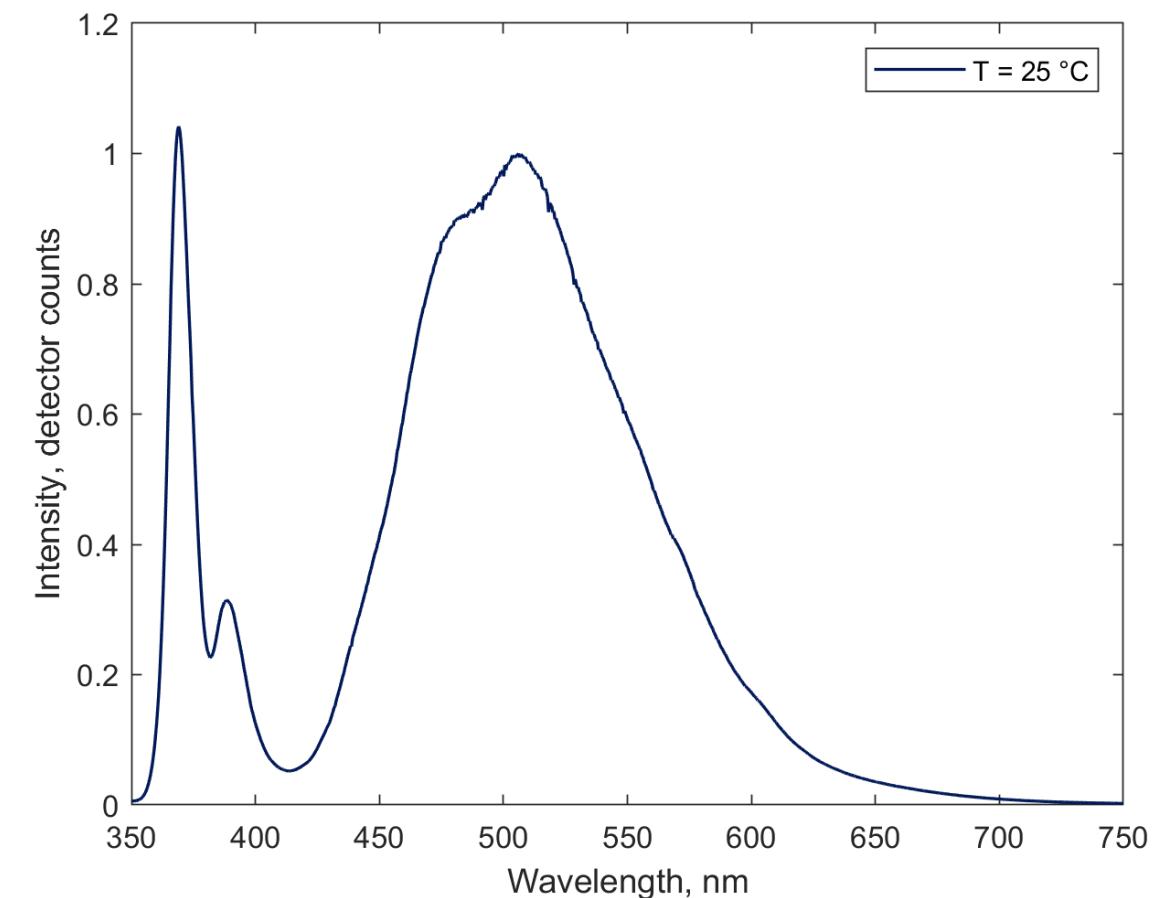
# Results - ZnO:Zn

Hypothesis: pulse duration, rather than photon energy, responsible for this behavior

Synchrotron x-ray excitation

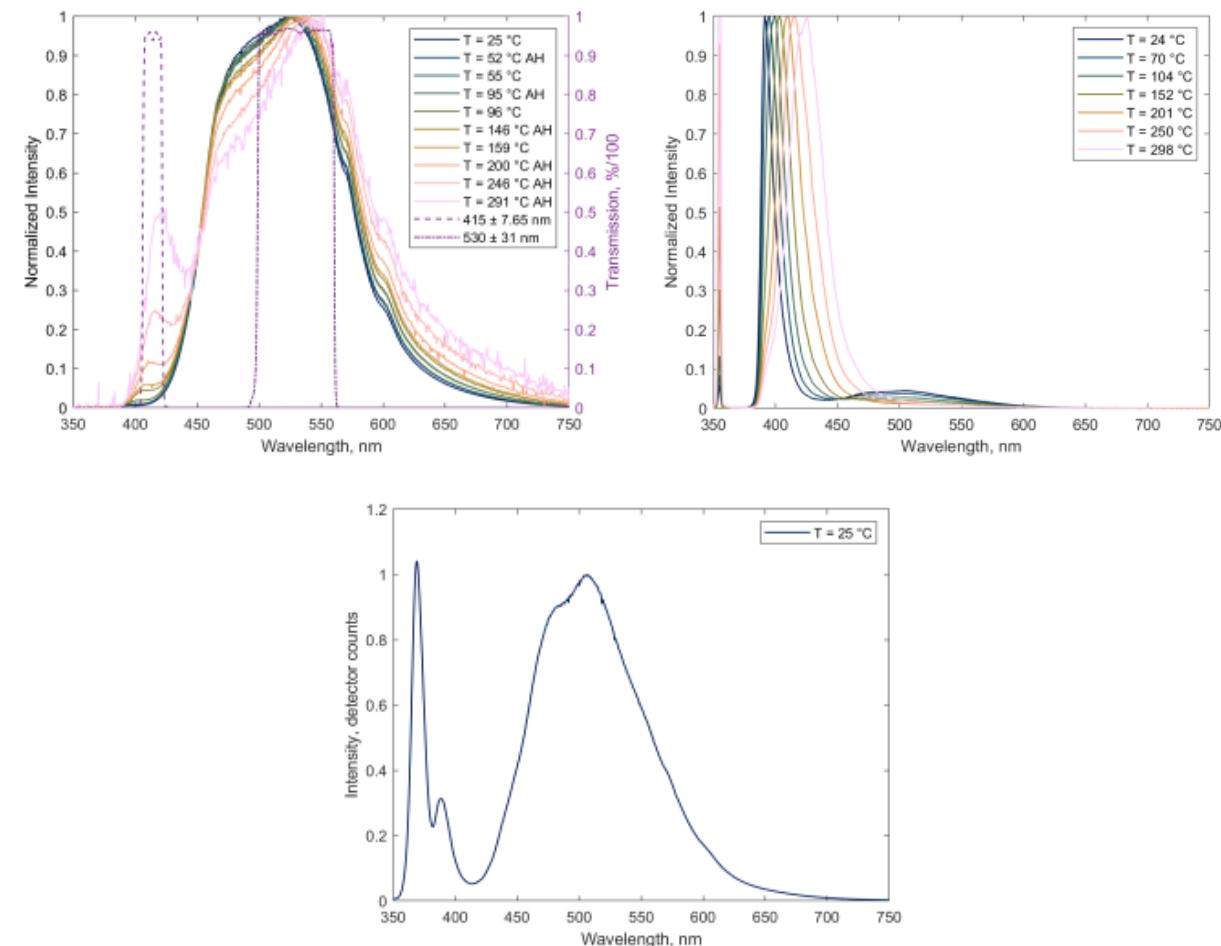


Continuous UV LED (365 nm)



# Conclusions

- UV exciton luminescence observed from ZnO:Ga and ZnO:Zn
- Green emission band seen from ZnO:Zn
  - $V_O$  deep trap recombination process
- UV line redshifts with increasing temperature
  - Suggests a decrease in the band gap
- Relative intensities of UV and green emission bands differ dramatically between synchrotron x-ray and pulsed UV excitation
- Preliminary results suggests this is caused by the difference in pulse duration between sources
- Future Work:
  - Determine if there is a pulse width regime which shifts emission from UV dominant to visible dominant





## Acknowledgements

NASA Space Technology Research Fellowship grant No. 80NSSC17K0190 (E. R. Westphal)

This work was supported by the Laboratory Directed Research and Development program at Sandia National Laboratories. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under Contract No. DE-NA0003525.

