SAND2021-15330C

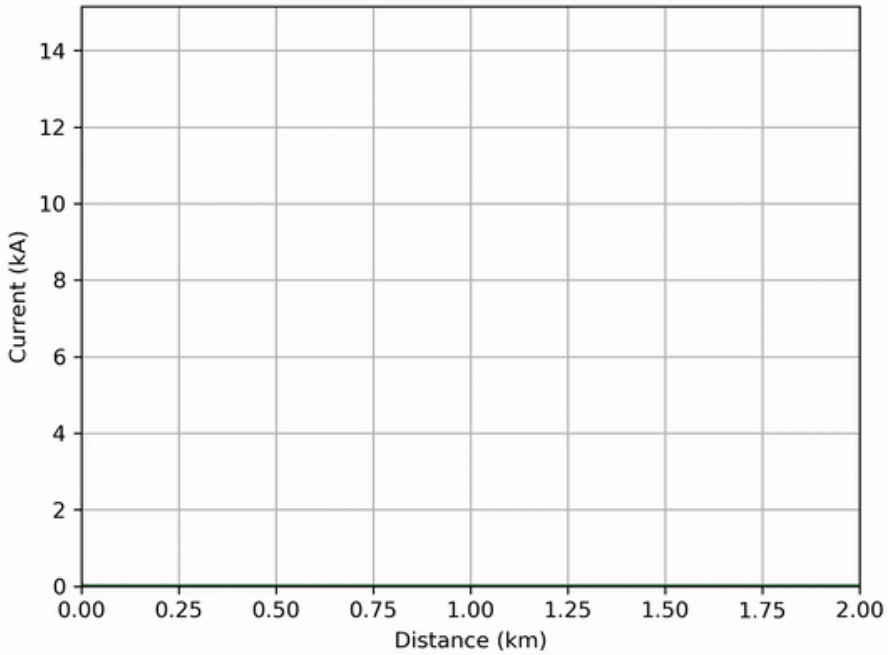
Channel Transformation and Plasma Decay During the Lightning Return Stroke

Caitano L. da Silva
Lydia Wermer
Patrick Barnett
Cameron Radosevich
Harald Edens

Jacob Wemhoner
12/14/21
Graduate Student at New Mexico Tech

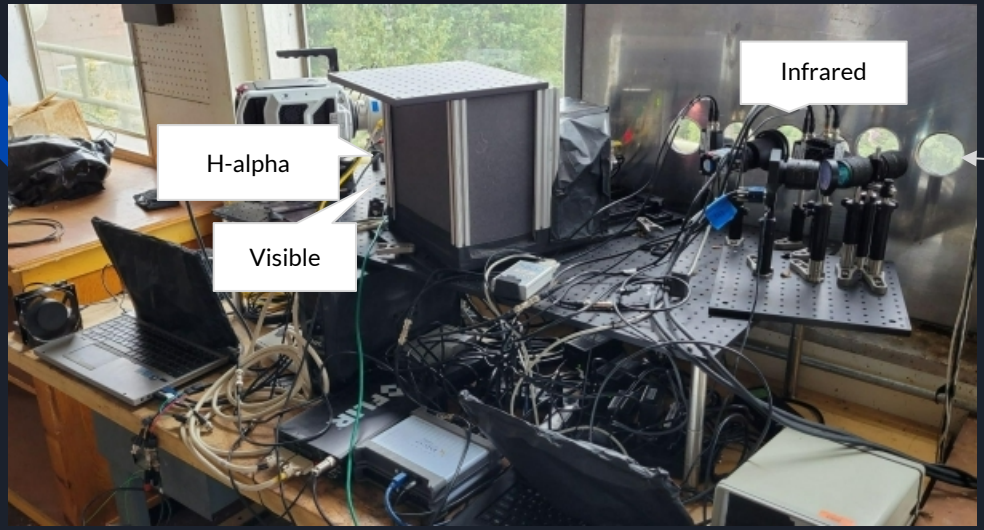
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Modeling Attempts



No Resistance, Constant Resistance, and Nonlinear Resistance

Experimental Setup

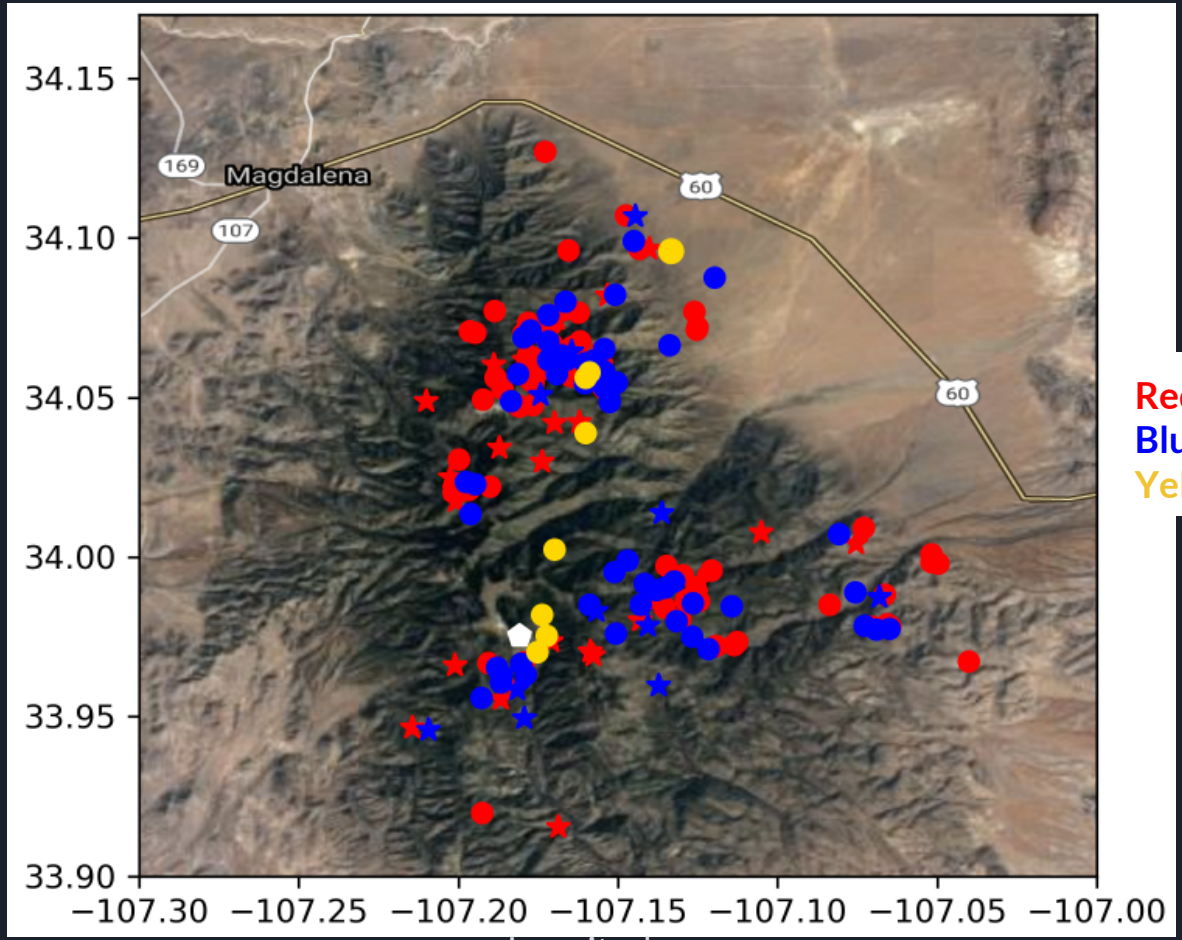


Sapphire Windows

Photodiodes:

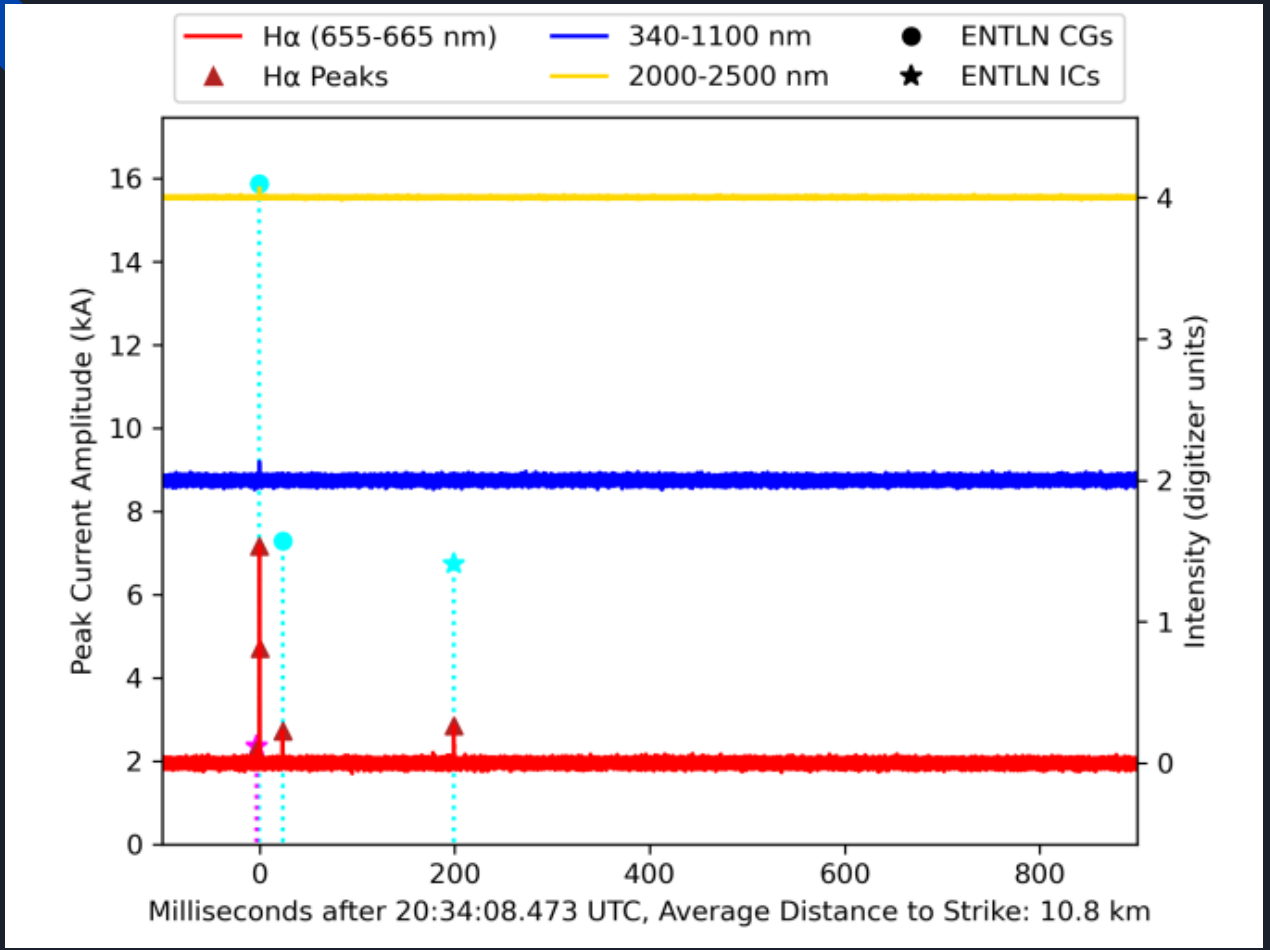
- Hα (655-665 nm)
  PDA 100A – 22.6 deg FFOV
- Visible (340-1100 nm)
  PDA 100A – 5.7 deg FFOV
- Infrared (2000-2500 nm)
  PDA 10DT – 0.6 deg FFOV

Lightning Map



Red: H-alpha only
Blue: Visible & H-alpha
Yellow: All 3 channels

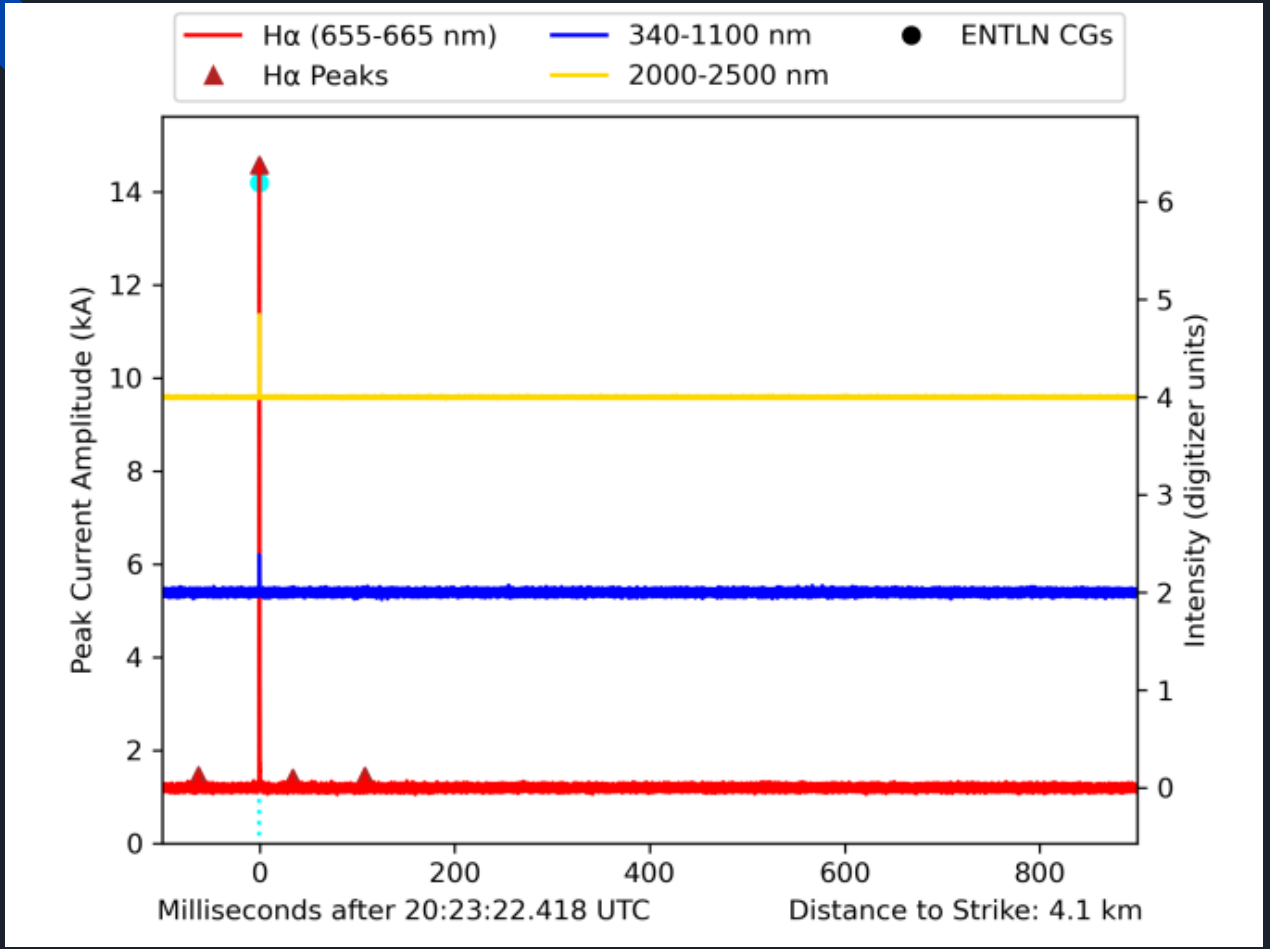
Time Series



Negative current

Positive current

Time Series

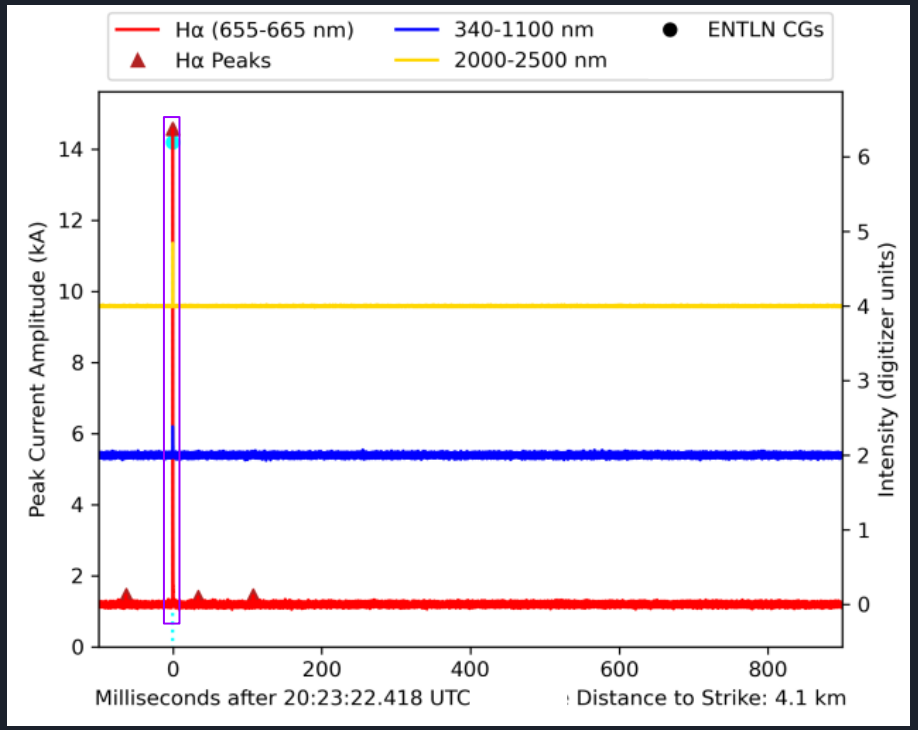


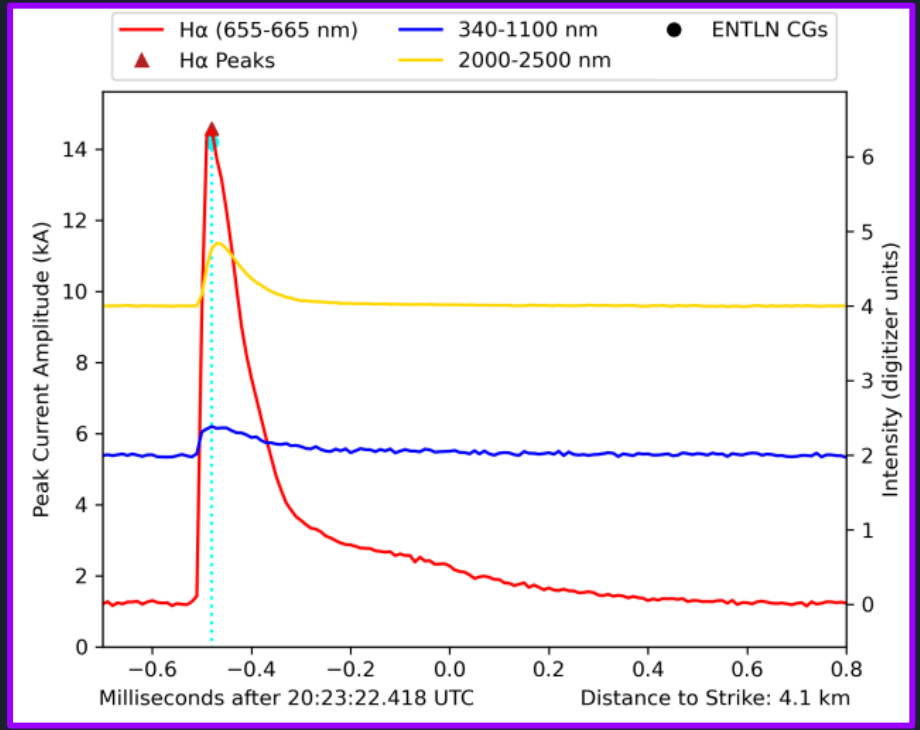
Negative current

Positive current

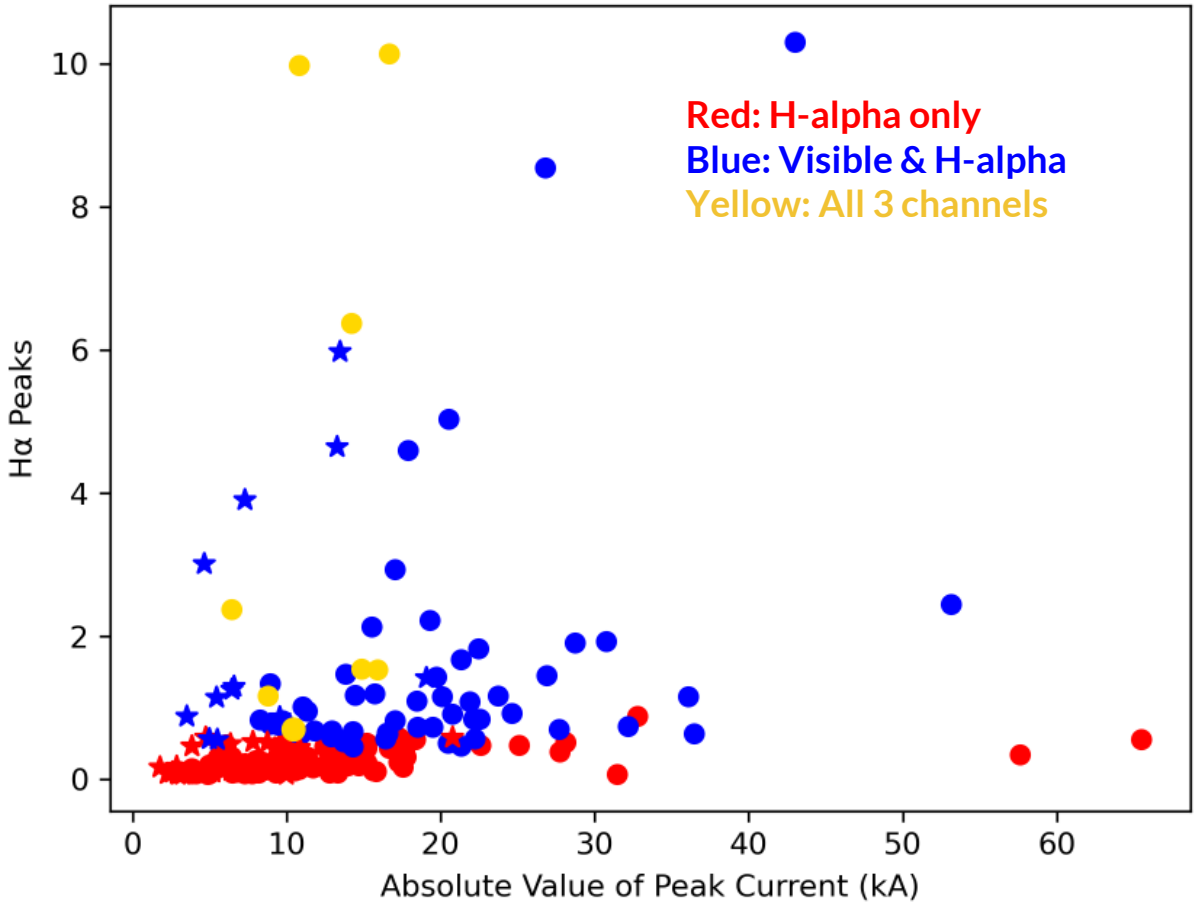
ENTLN time difference within 2 standard deviations

Time Series

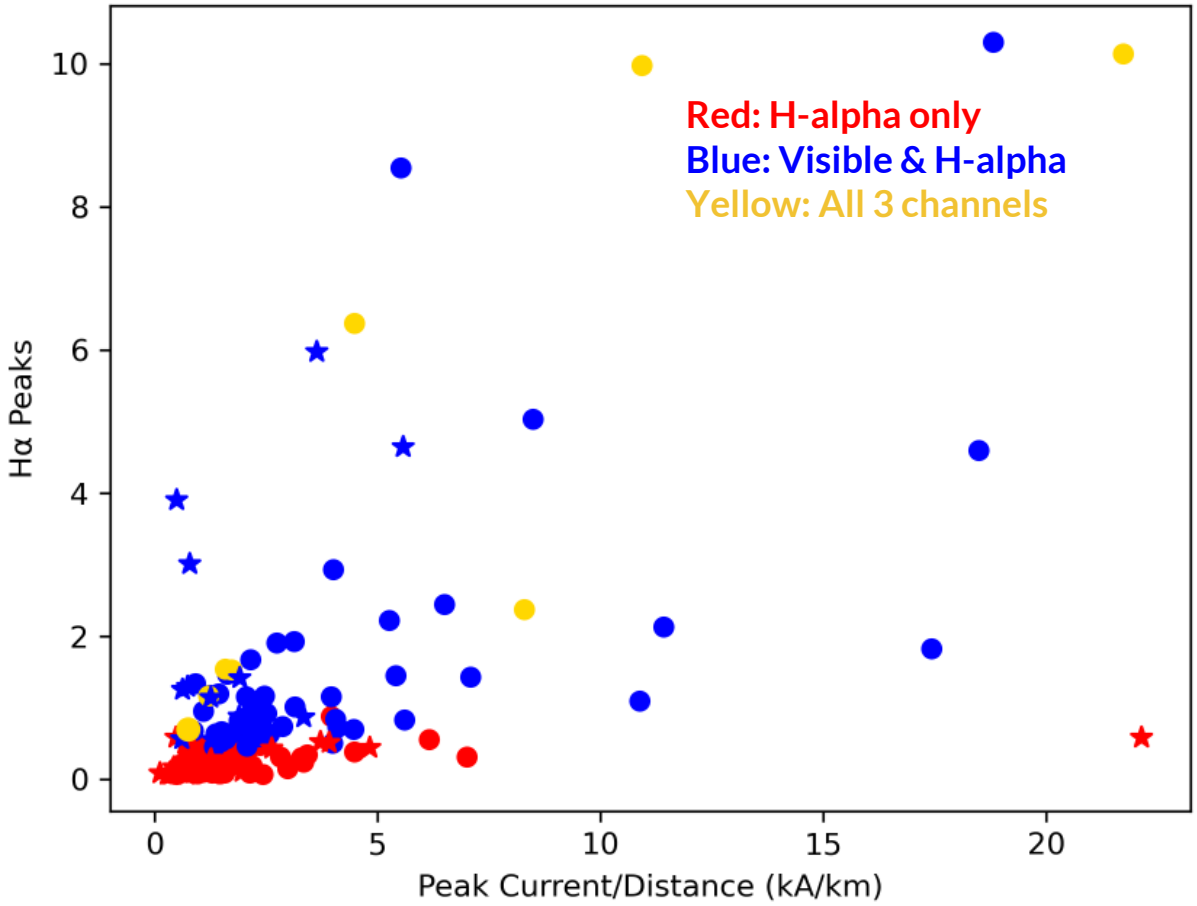

Hα (655-665 nm)
Hα Peaks
340-1100 nm
2000-2500 nm
ENTLN CGs
Peak Current Amplitude (kA)
Intensity (digitizer units)
Milliseconds after 20:23:22.418 UTC
Distance to Strike: 4.1 km


Hα (655-665 nm)
Hα Peaks
340-1100 nm
2000-2500 nm
ENTLN CGs
Peak Current Amplitude (kA)
Intensity (digitizer units)
Milliseconds after 20:23:22.418 UTC
Distance to Strike: 4.1 km

Intensity vs. Current



Intensity vs. Current/Distance



Summary & Conclusions

- Infrared emissions correlate with visible ones
- There needs to be at least 6.5 kA of Current in the return stroke to generate infrared emissions
- IC events do not produce infrared emissions
- Infrared emissions in the 2000-2500 nm band can be seen up to 15 km away

Acknowledgements: This research has been supported by NSF CAREER award AGS-2046043 to New Mexico Tech and by the Laboratory Directed Research and Development program at Sandia National Laboratories, 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 DE-NA0003525. We also thank Earth Networks for providing ENTLN lightning location data, lightning height, and peak current in the lightning strike.