Optical, VHF, and Slow Antenna Measurements Alongside Rapid-Scanning Polarimetric Radars

GLM Science Meeting
13-15 Nov 2023

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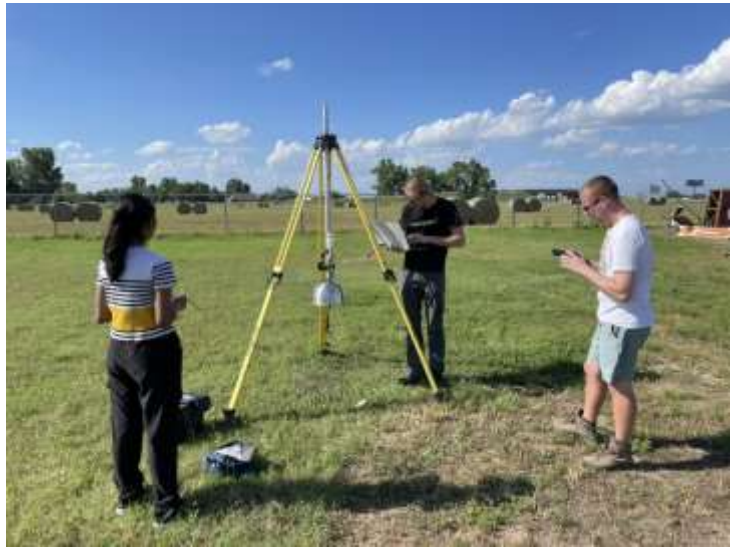

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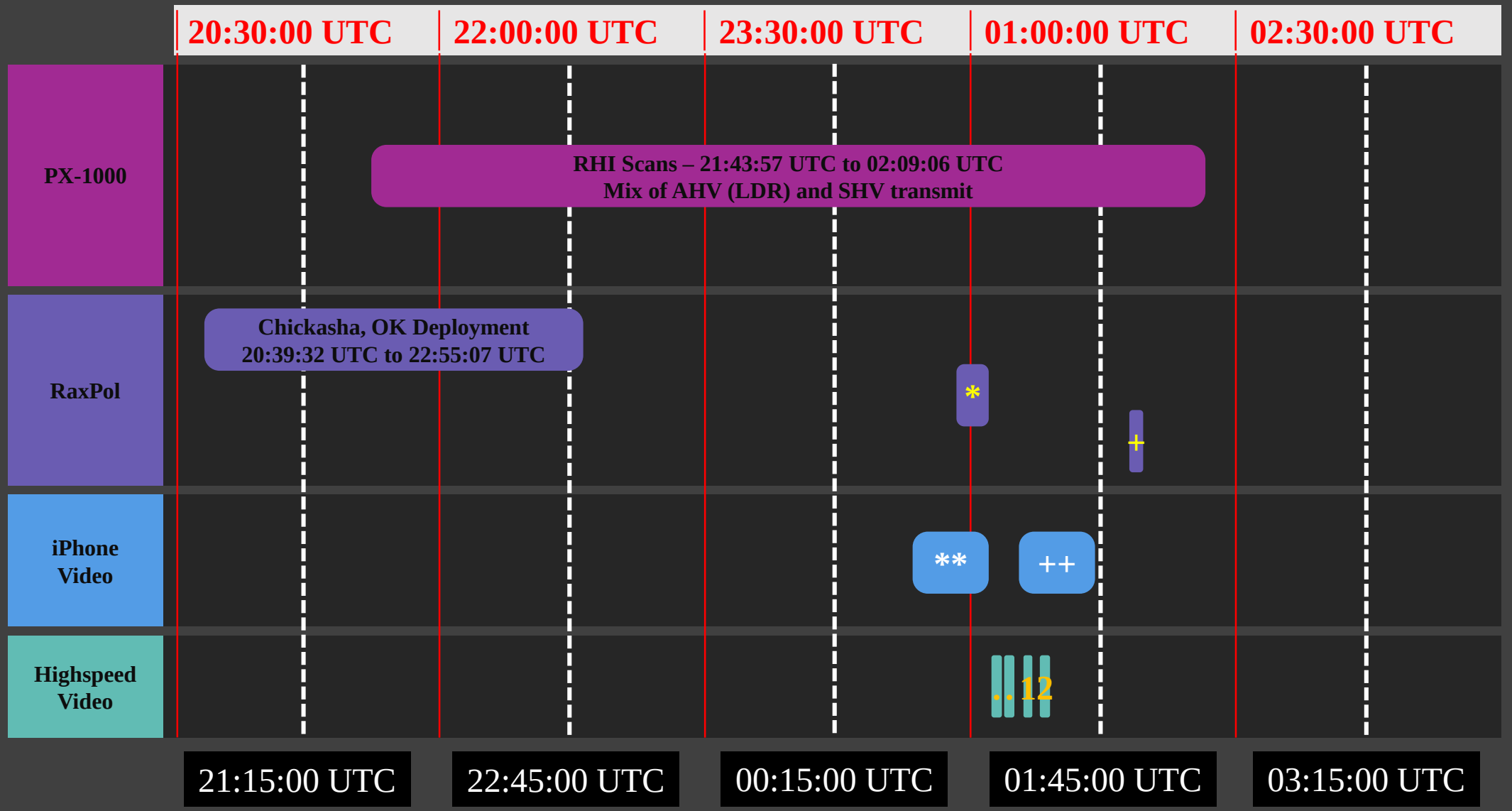
15-16 June 2023 IOP Timeline

Oklahoma LMA
Three 10 ksps slow antennas, RC=100 ms
Bistatic dual-Doppler with KTLX



Tuttle, OK Deployment

***: 00:52:36 to 01:07:25 UTC**

Newcastle, OK Deployment

+: 01:58:11 to 02:00:53 UTC

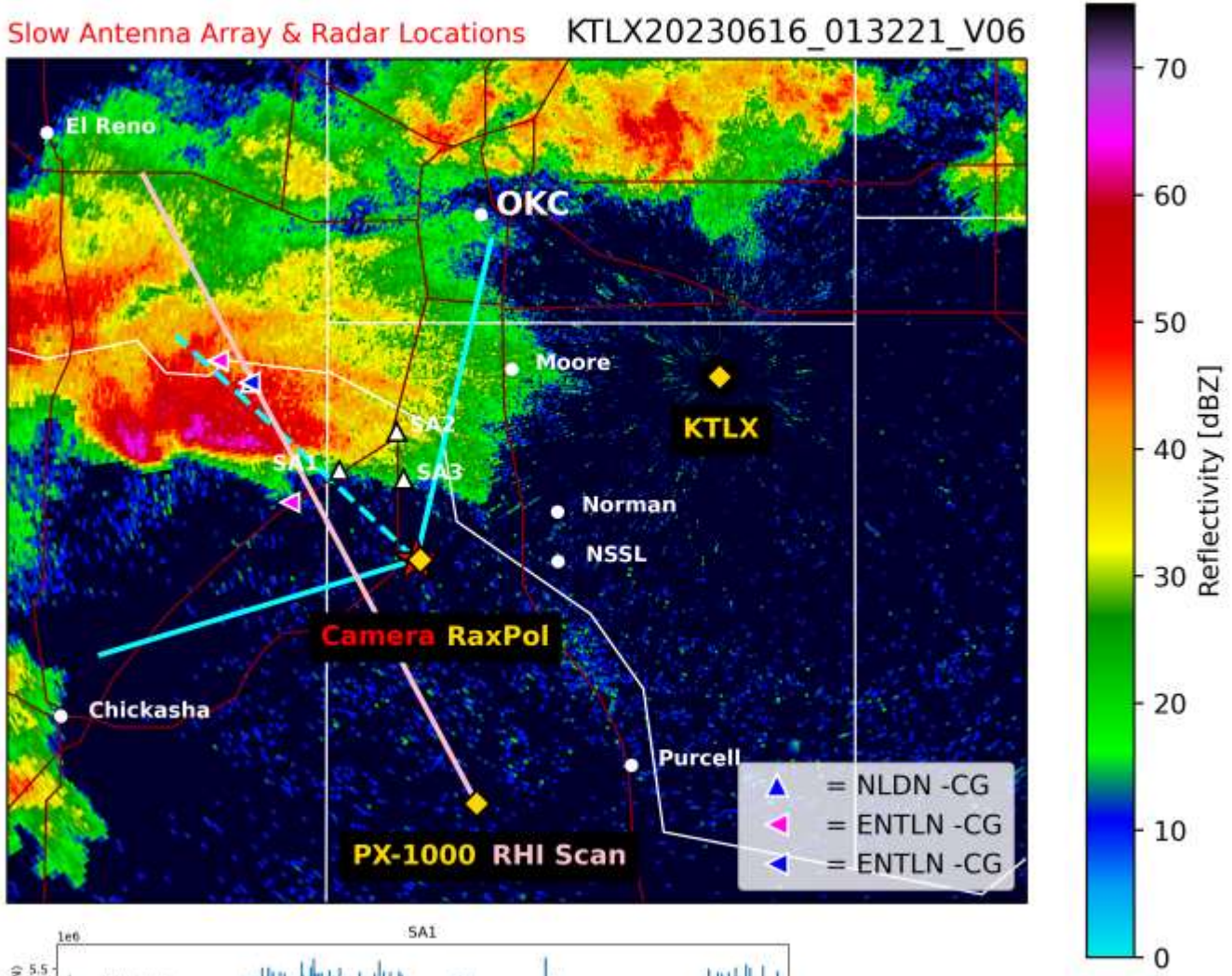
****: 00:38:33 to 01:07:45 UTC**

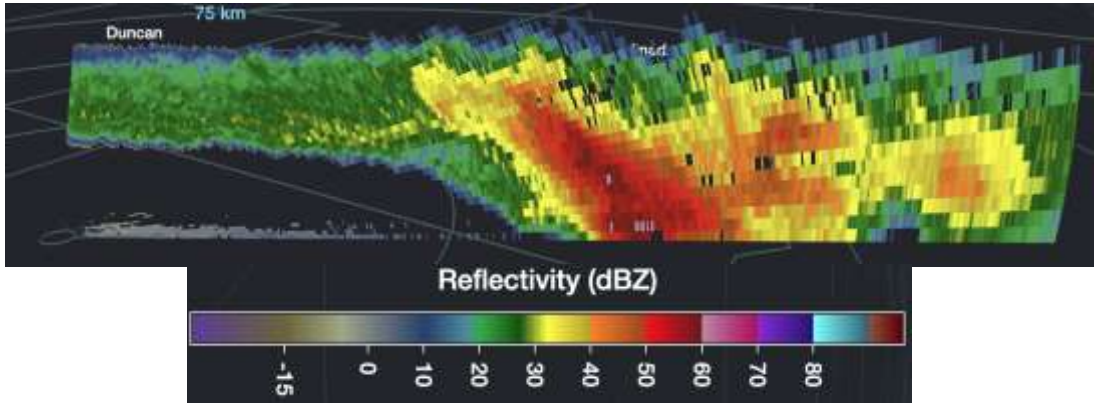
++: 01:25:29 to 01:42:09 UTC

1: 01:33:08 UTC

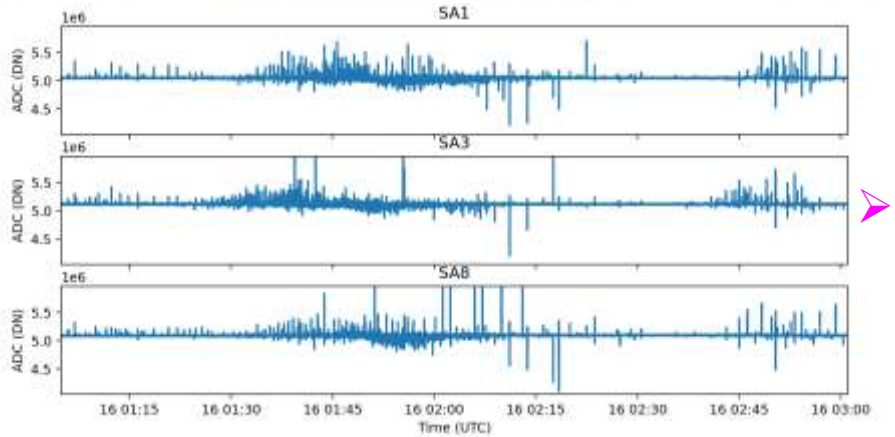
2: 01:34:54 UTC

“.”: Missing Times

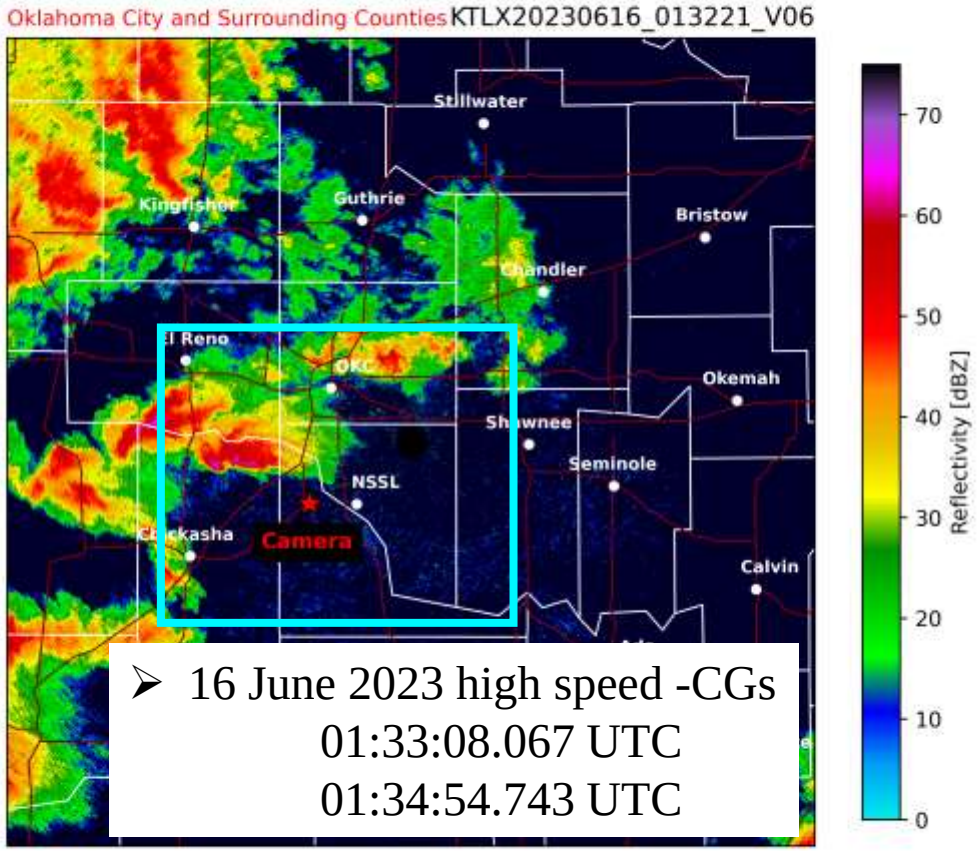




PX-1000 RHI at 01:32:09 UTC Az 332.0°



- Continuous slow antenna data (2 hr shown)

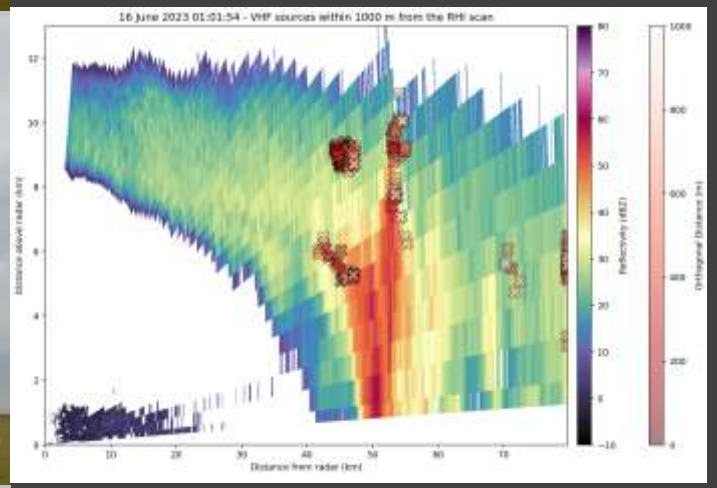


- 16 June 2023 high speed -CGs
  01:33:08.067 UTC
  01:34:54.743 UTC

June 15, 2023 – Newcastle, Oklahoma

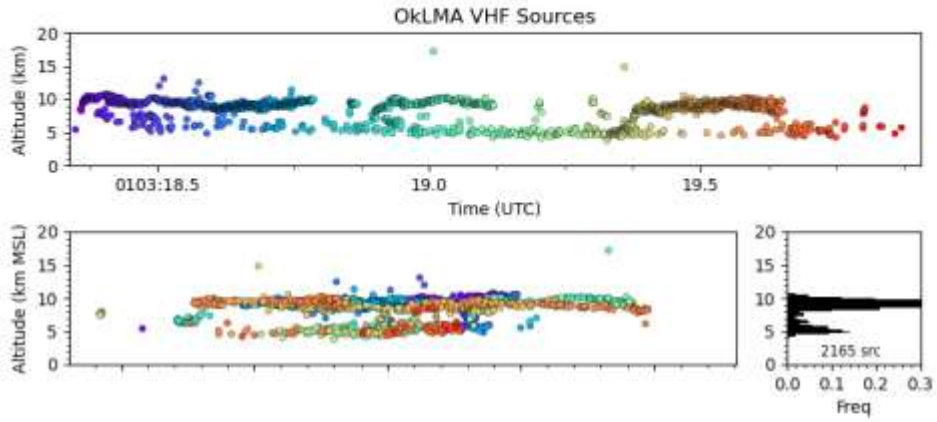
Timestamp Camera App - iPhone

Flash Times are in CDT

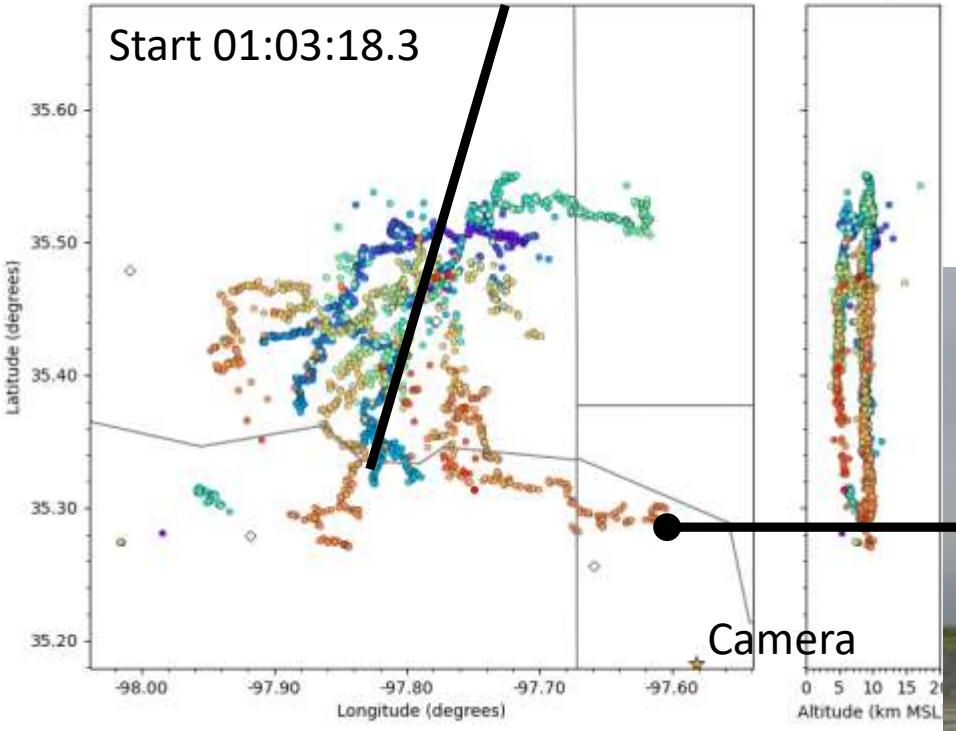


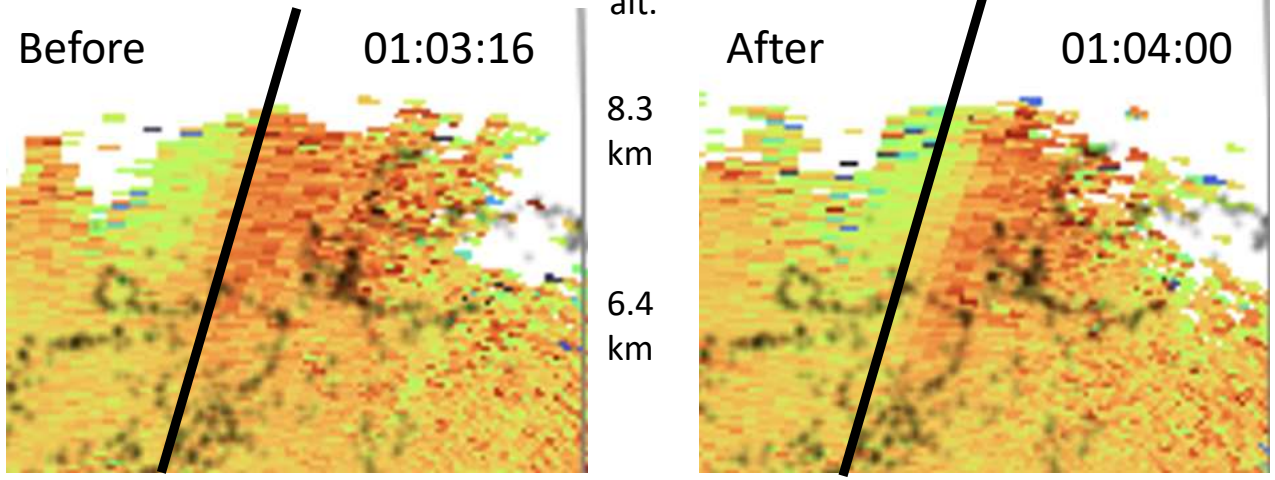
1) 20:01:49.756 – distant CG
2) 20:01:55.843 – large IC
3) 20:02:03.195 – IC branching towards tower
4) 20:03:19.657 – distant IC approaching filming location
5) 20:06:01.389 – large IC
6) 20:06:53.499 – IC

RaXPol PPI through altitude of initiation (large **E**) before and after lightning (4)

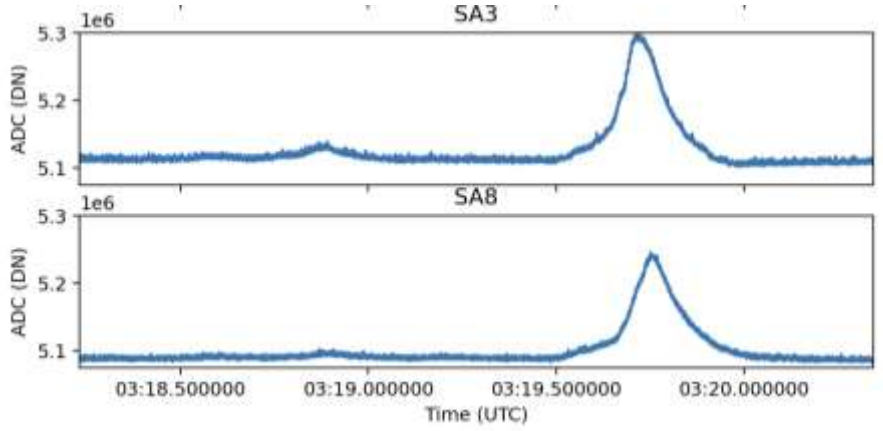


Init @ 8.4 km

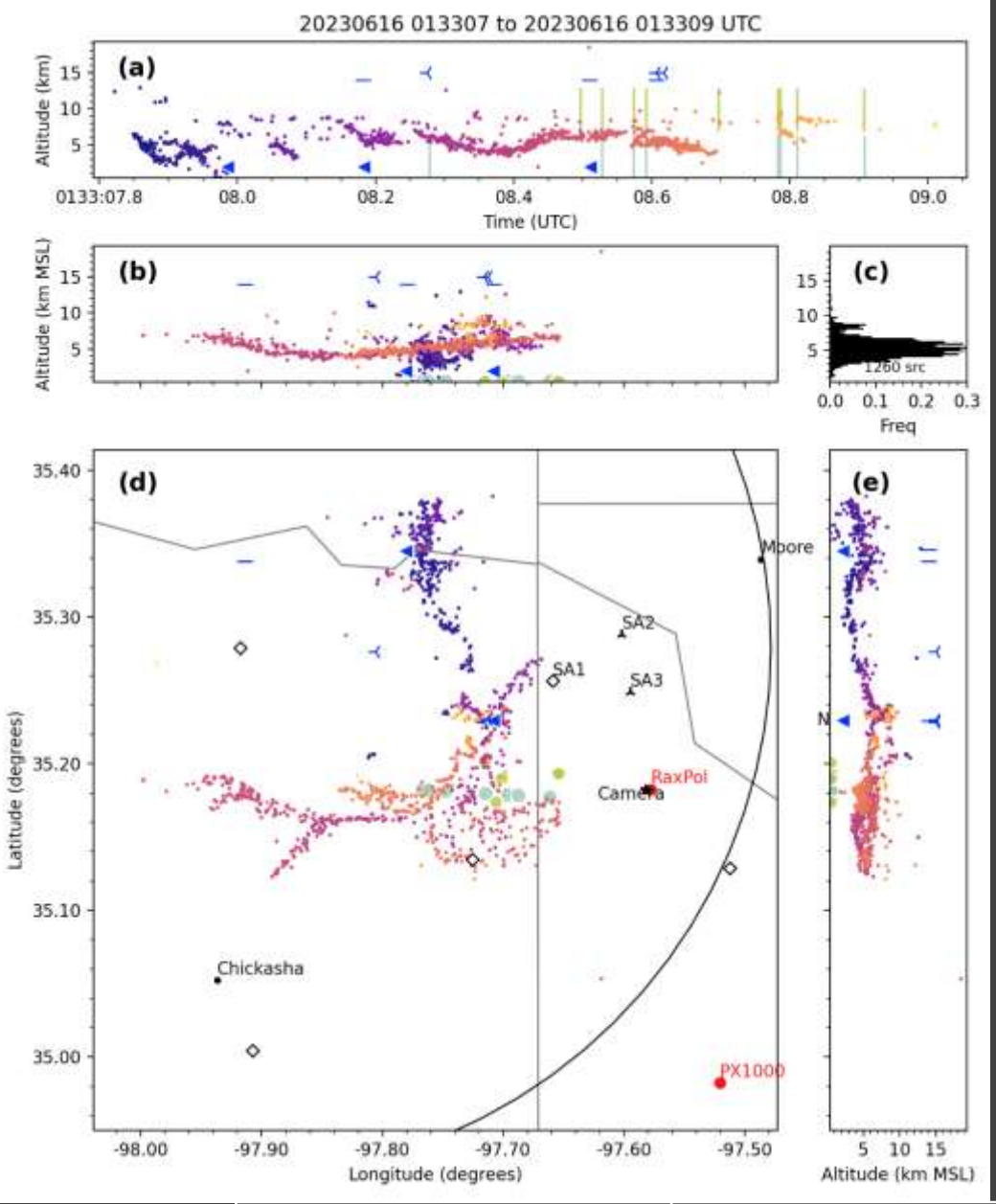


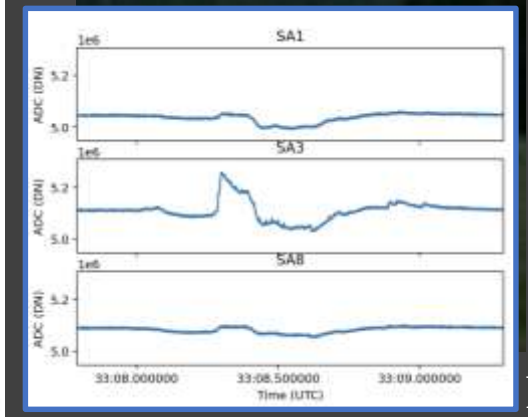


Zdr change along line shown indicates ice crystal realignment at altitude consistent with large E during flash initiation



June 15, 2023 – Newcastle, Oklahoma Multicell
(*16 June 2023 - 01:33:08.067 UTC*)





NLDN +CG	NLDN -CG	NLDN +IC	NLDN -IC
0	0	0	3

ENTLN +CG	ENTLN -CG	ENTLN +IC	ENTLN -IC
0	3	0	3

First GLM flash detected after initial LMA Time

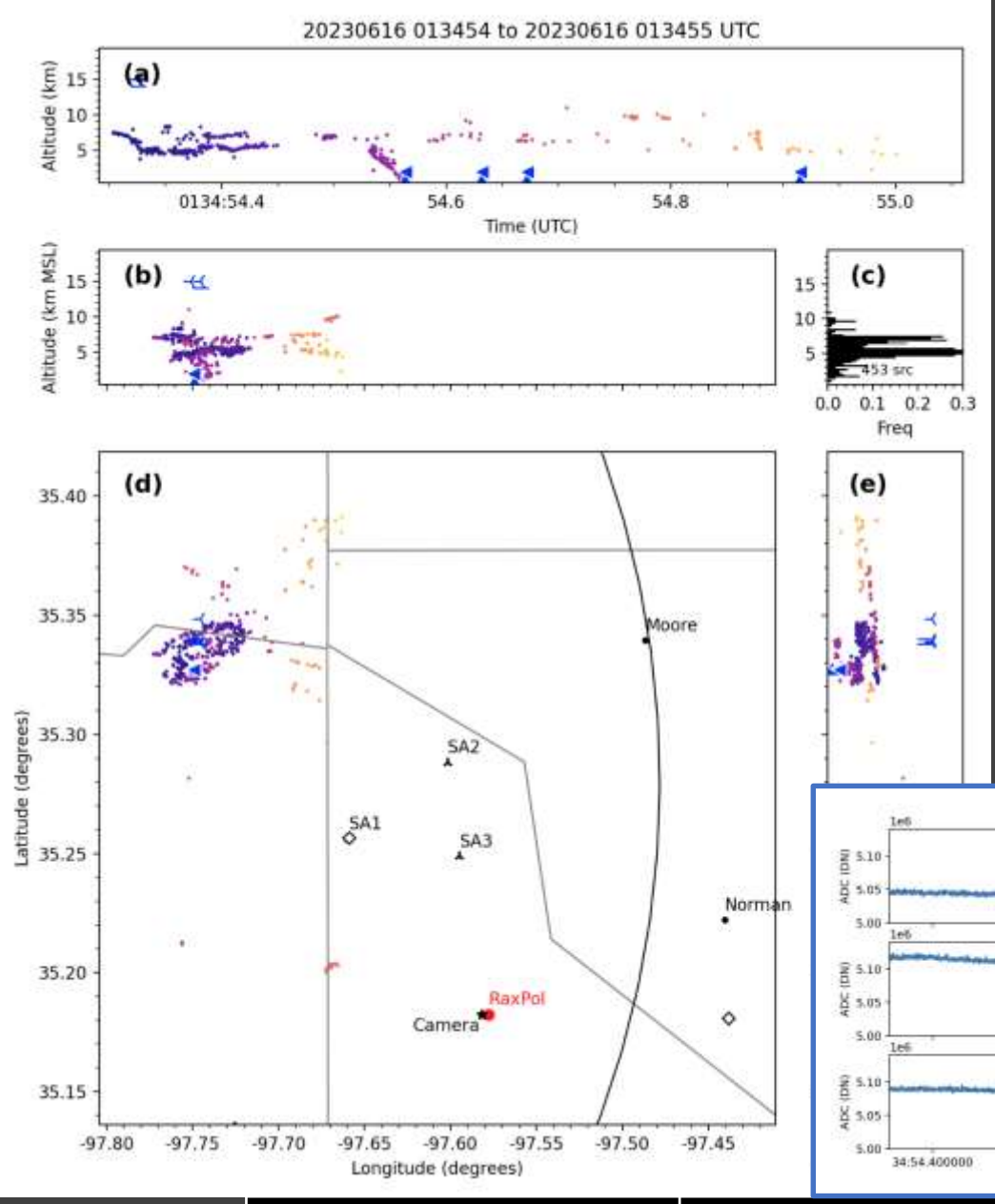
LMA Time (UTC)	First GLM 16*	First GLM 18*	GLM 16 Count	GLM 18 Count
01:33:07.822	0.455 s	0.674 s	8	9

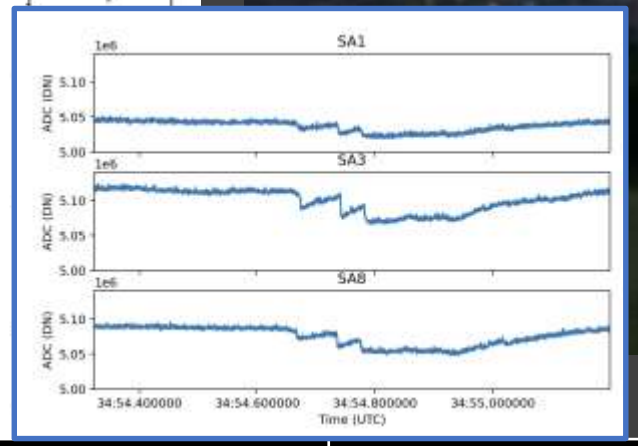
June 15, 2023 – Newcastle, Oklahoma Multicell
(*16 June 2023 - 01:33:08.067 UTC*)

LMA Time (UTC)	Timestamp App (iPhone)	Highspeed Camera
01:33:07.822	**01:33:07.669 UTC**	**Image #2390/7765**

- iPhone 12 Pro Max (60 fps) – wide view 120°
  - First CG = 20:33:08.052 CDT
  - Second CG = 20:33:08.569 CDT
  - Time between strokes = 0.517 seconds
- High Speed (10,000 fps) – shows 2 strokes with multiple pulses
  - Total images = 7765
  - First CG = #2390
  - Second CG (return stroke) = #7638
  - Illumination from #2390 - #7638 (0.5375 seconds)
  - Time between strokes = 0.5248 seconds

June 15, 2023 – Newcastle, Oklahoma Multicell
(*16 June 2023 - 01:34:54.743 UTC*)





NLDN +CG	NLDN -CG	NLDN +IC	NLDN -IC
0	4	0	2

ENTLN +CG	ENTLN -CG	ENTLN +IC	ENTLN -IC
0	4	0	3

* First GLM flash detected after initial LMA Time

LMA Time (UTC)	First GLM 16*	First GLM 18*	GLM 16 Count	GLM 18 Count
01:34:54.303	-	-	0	0

June 15, 2023 – Newcastle, Oklahoma Multicell
(*16 June 2023 - 01:34:54.743 UTC*)

LMA Time (UTC)	Timestamp App (iPhone)	Highspeed Camera
01:34:54.303	**01:34:54.596 UTC**	**Image #3442/7765**

- iPhone 12 Pro Max (60 fps) – wide view 120°
  - First CG = 20:34:54.627 CDT
  - Second CG = 20:34:54.693 CDT
  - Third CG = 20:34:54.726 CDT
  - Fourth CG = 20:34:54.977 CDT
  - Time between strokes = 0.031, 0.066, 0.033, 0.251 seconds
- High Speed (10,000 fps) – shows 4 strokes with multiple pulses
  - Total images = 7765
  - First CG = #3442
  - Return strokes = #4124, #4527, #6957
  - Illumination from #3438 - #6968 (0.353 seconds)
  - Time between strokes = 0.0686, 0.0403, 0.243 seconds

Future work

- Systematically summarize flash detection efficiency across all instruments
- Improve understanding of discharge physics through coupled meteorological study
- Summer 2024:
  - Collect more slow antenna and optical data alongside LMA and operational datasets
  - Add HORUS to RaXPol and PX-1000 data for volumetric context and multi-Doppler storm-scale wind synthesis
- Two test datasets already collected with OU ARRC HORUS S-band polarimetric phased-array radar
  - RHI mode
  - Direct scattering from lightning plasma channel observed with 3 s update times
  - Implementation of spoiled-beam imaging mode should allow sub-100 ms update times for a full RHI plane
  - Spectral polarimetry to assess microphysical diversity within radar volumes