The Hunt for
Sporadic E……

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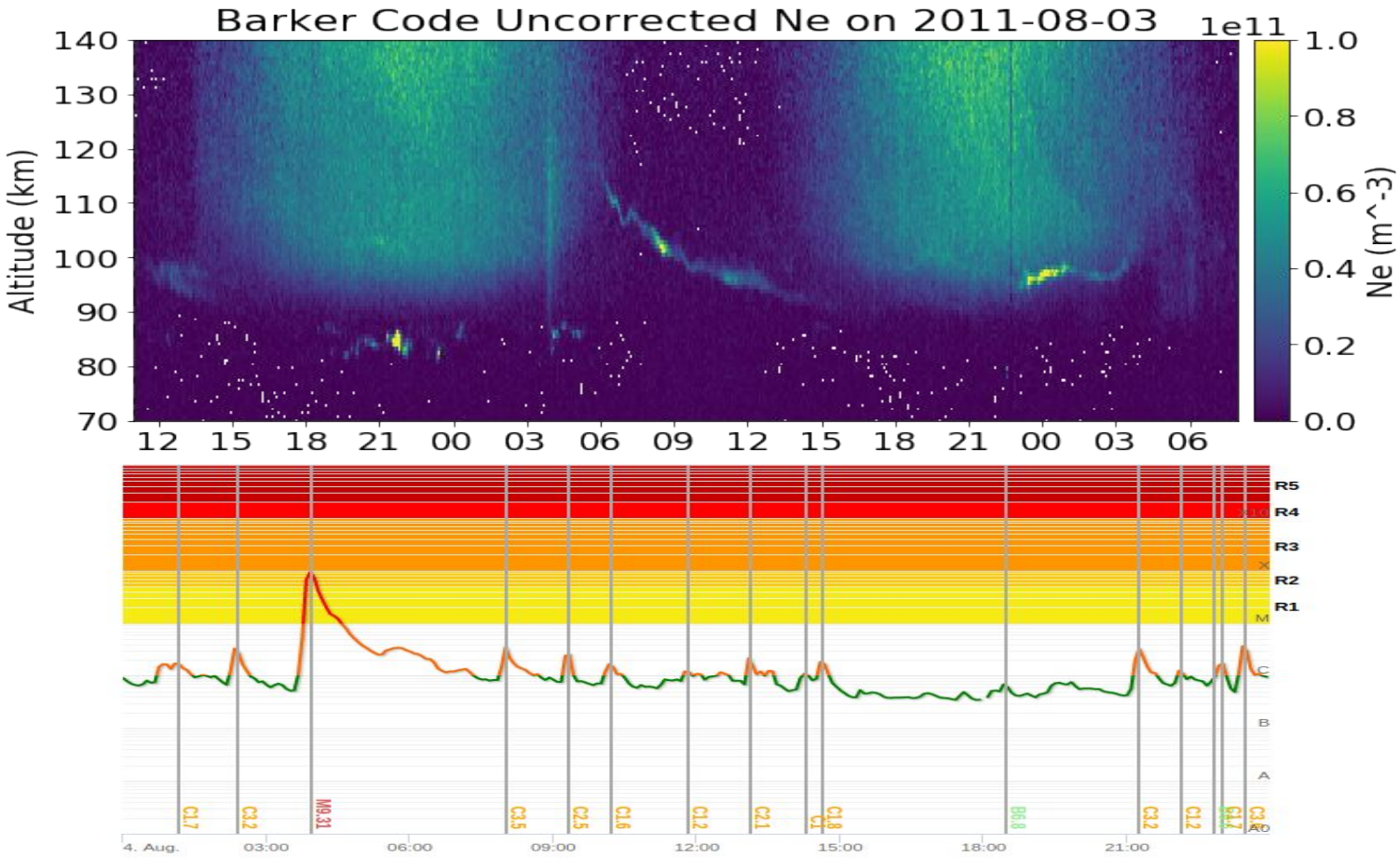
Sporadic E - what's and why's?

- Narrow layers of metallic ion plasma in the ionospheric E region at altitudes usually between 90 and 120 km.
- Physics relies on "windshear theory" which is now widely accepted as the mechanism responsible for their formation.
- Can happen at almost any time; it does, however, display seasonal patterns.
- Sporadic E activity peaks predictably in the summertime in both hemispheres.

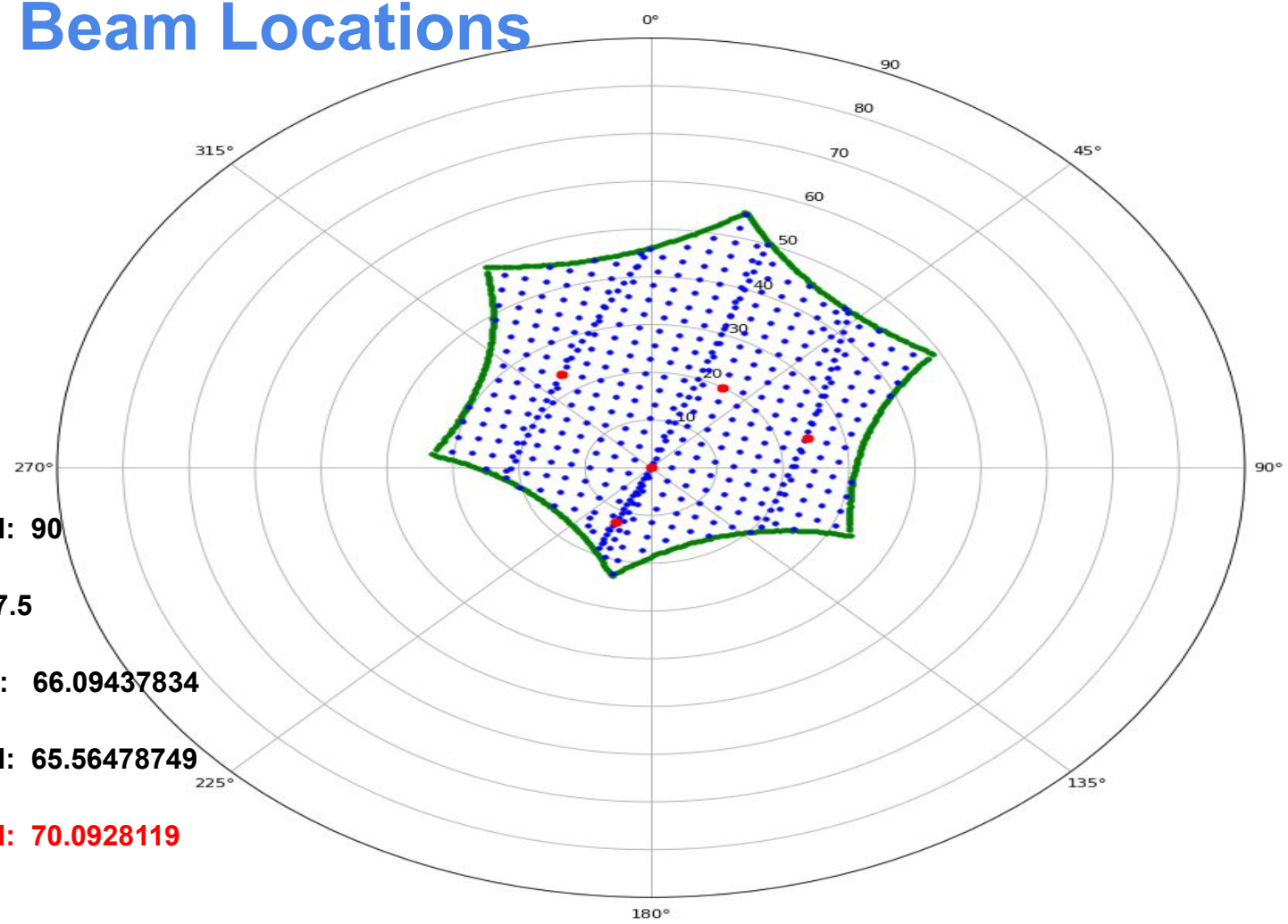


https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2007JA012322

- Goal = see Sporadic E !!
- Chose the **MSWinds26.v03** experiment and an extra beam **64931.**
  - **Focus on D and E region(where Sporadic E are usually found).**
  - **Used Barker code which is best suited for D and lower E measurements.**
  - **Experiment ran from 01:00 - 03:00 UTC**
- Barker Code: Barker codes are binary numbers using two to 13 bits and have unique auto-correlation functions.
- Sidelobe ratio = -22.3dB
- 15 s, 1 min, 5 min integration times
- Alternating code:
  - 10, 5 min integration times
- Long pulse:
  - 1 min, 5 min integration times

Barker Code 2	10
Barker Code 3	110
Barker Code 4	1011
Barker Code 5	11101
Barker Code 7	1110010
Barker Code 11	11100010010
Barker Code 13	1111100110101

MSWinds26 Beam Locations



64016 az: 14.03624347 el: 90

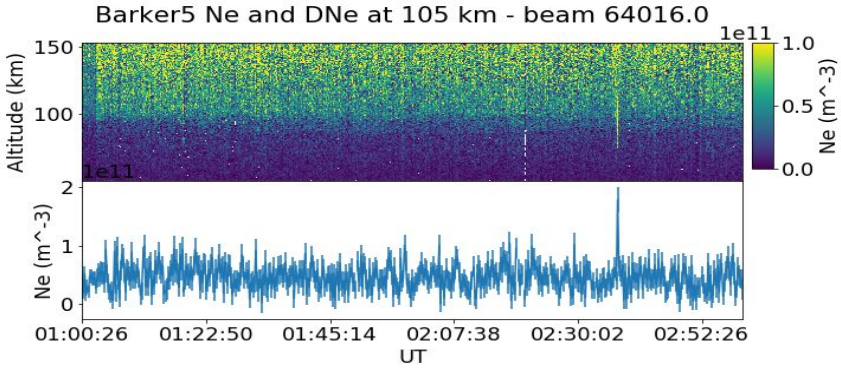
64157 az: -154.3 el: 77.5

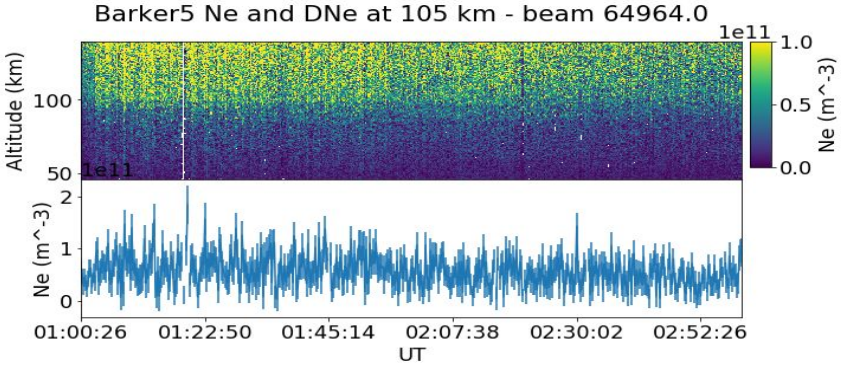
64964 az: -34.6912402 el: 66.09437834

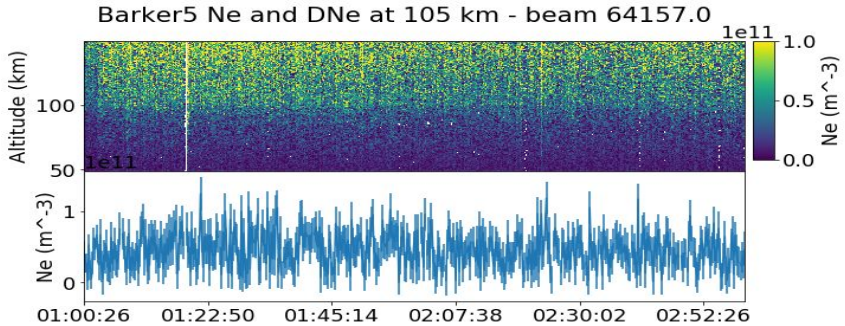
65066 az: 75.03447518 el: 65.56478749

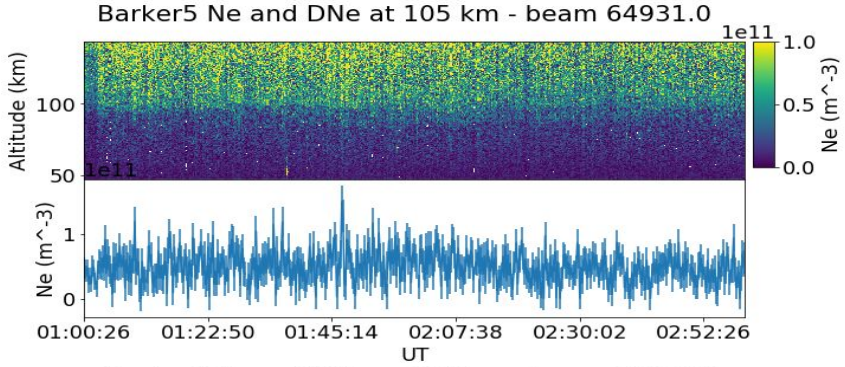
64931 az: 32.87777373 el: 70.0928119

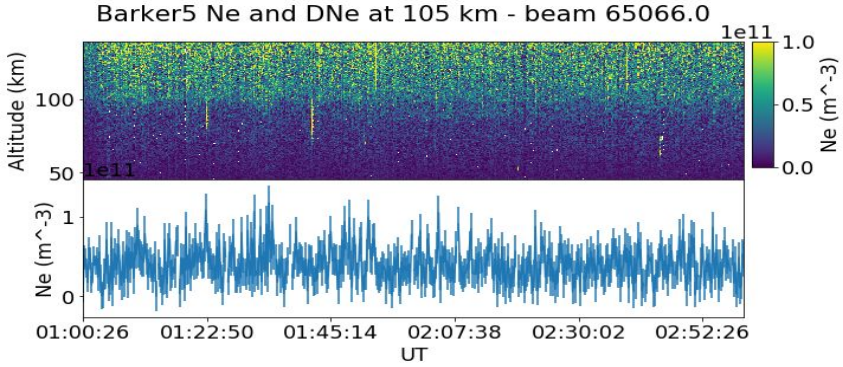
Electron density profile and the associated error at 105Km (for Barker5) - 15s integration



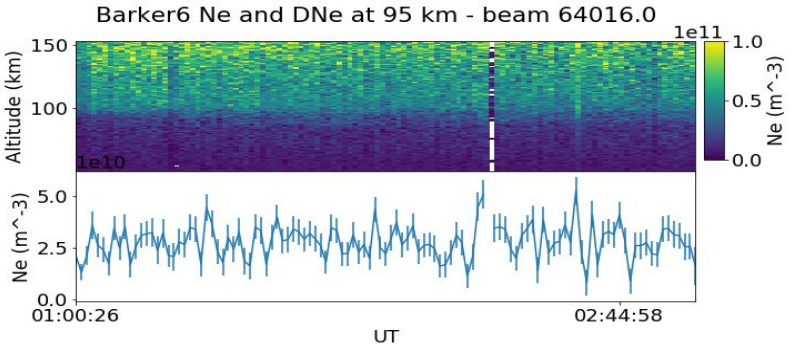


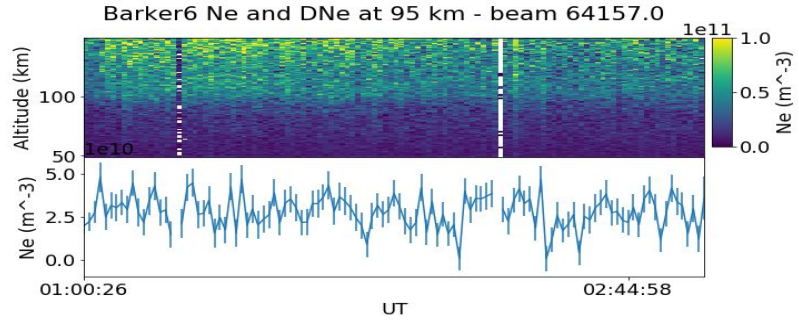


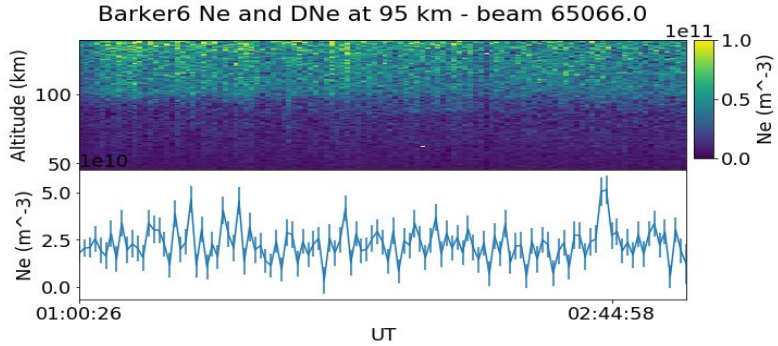


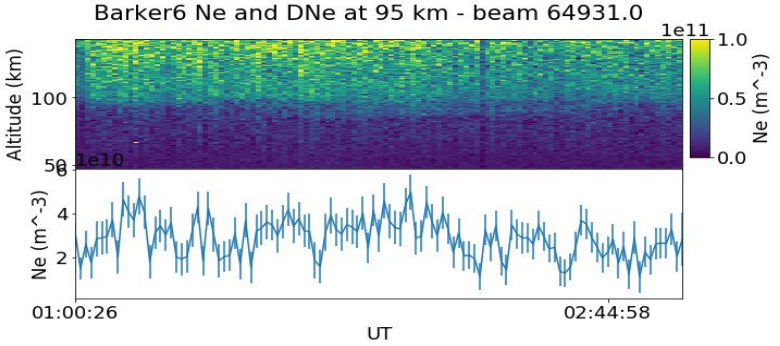


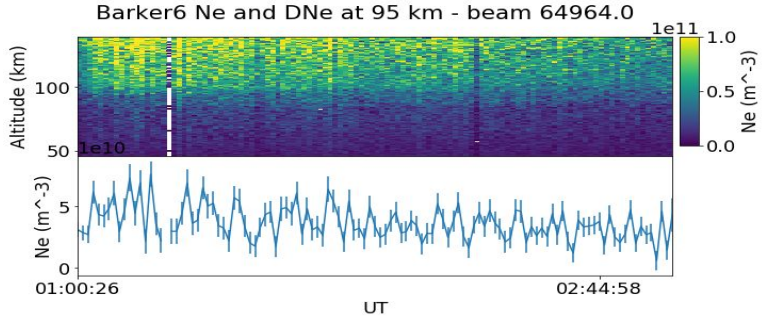
Electron density profile and the associated error at 95Km (for Barker6) - 1min integration



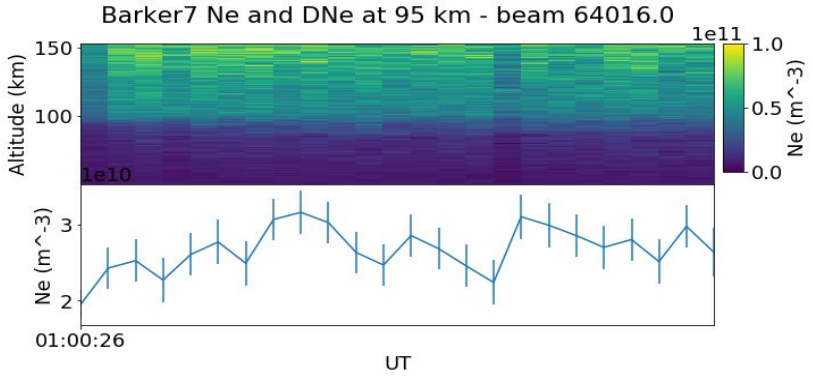


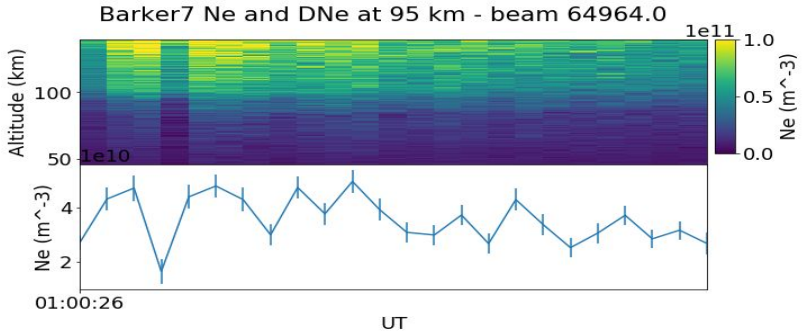


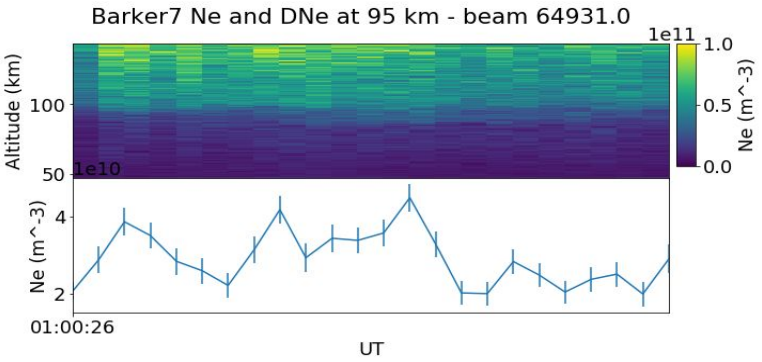


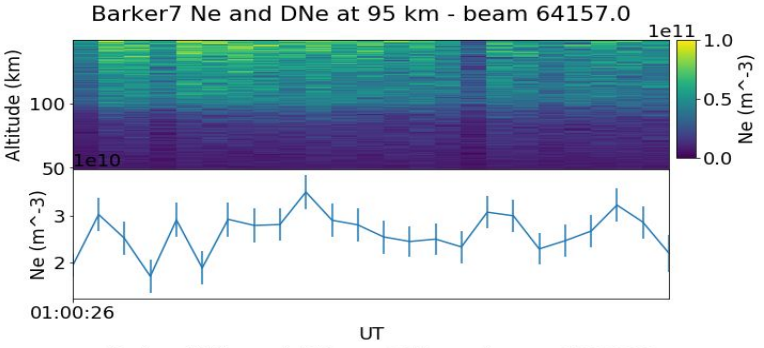


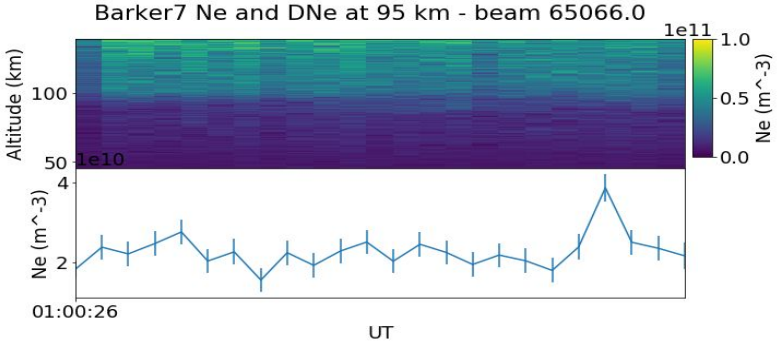
Electron density profile and the associated error at 95Km (for Barker7) - 5 min integration



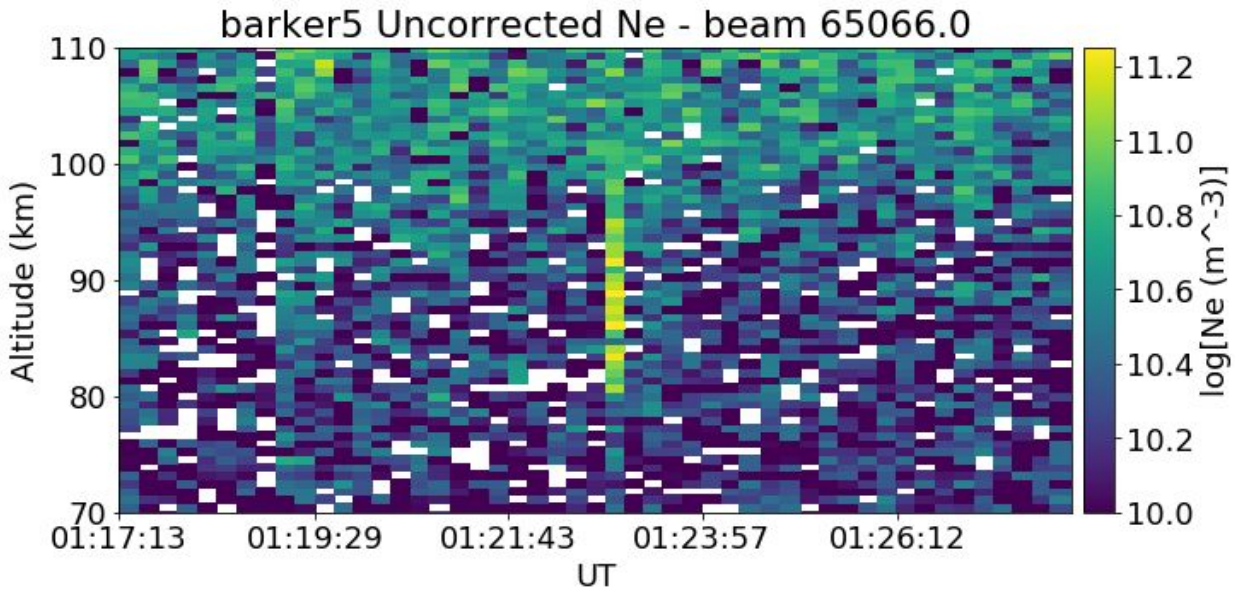






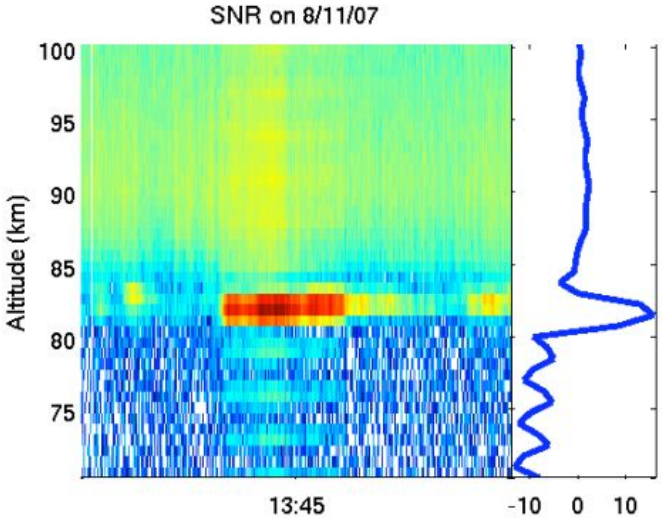


Meteor! - between 80 and 100 km which is where we expect it



-Can see the side lobes of the 13 baud barker code.

-Chau and Varney - CEDAR 2009

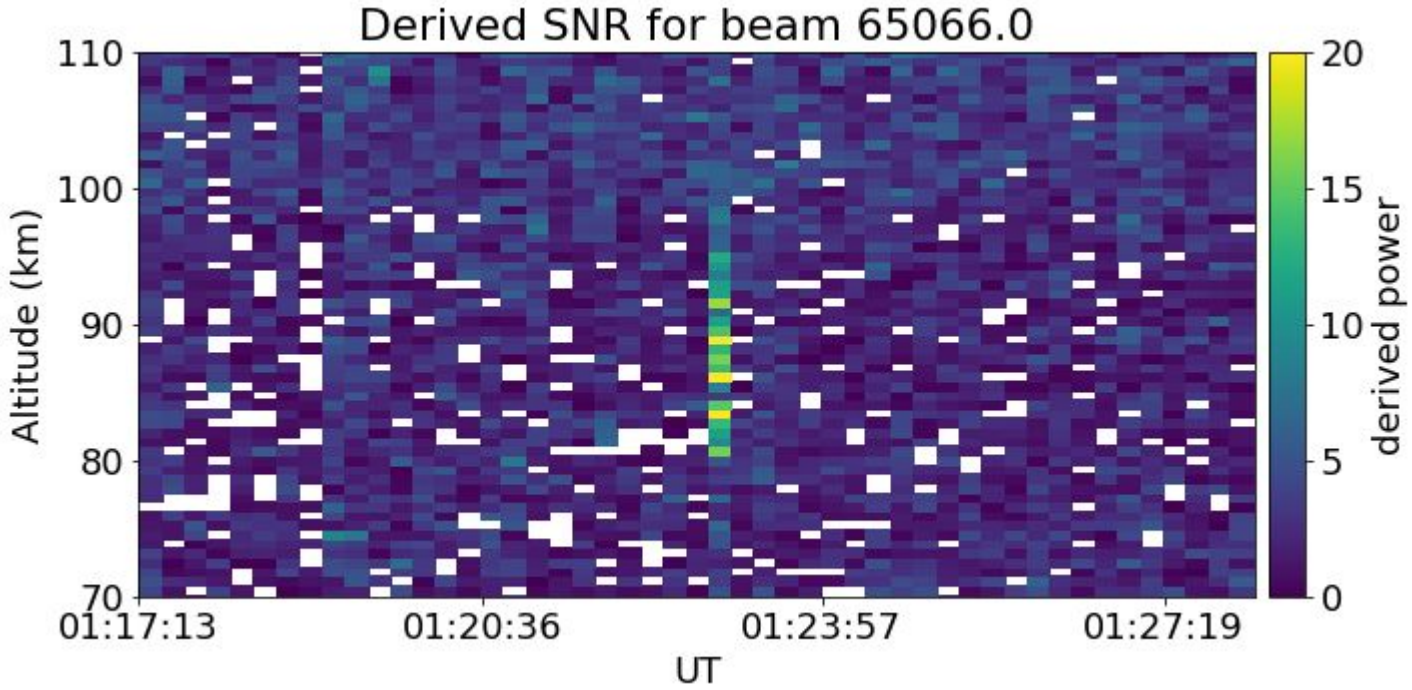


ISR equation for received power:

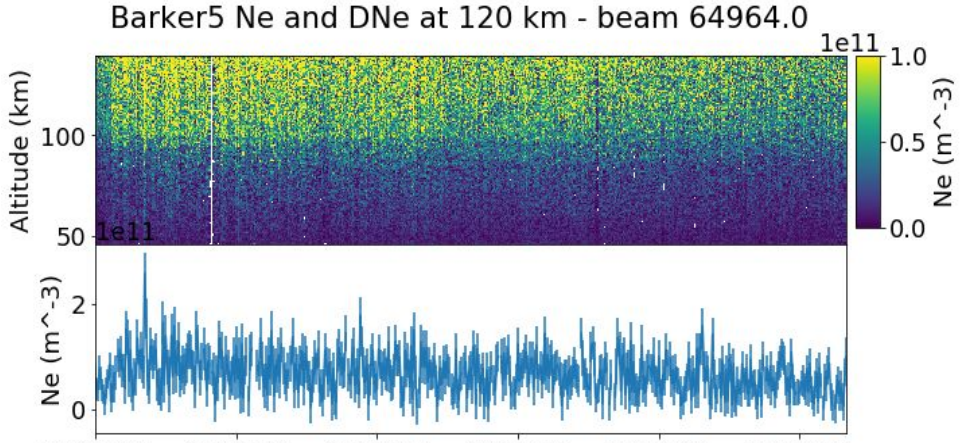
$$P_r = \frac{P_t \tau_p}{R^2} K_{sys} \frac{N_e}{(1 + k^2 \lambda_{De}^2)\,(1 + k^2 \lambda_{De}^2 + T_e/T_i)}$$

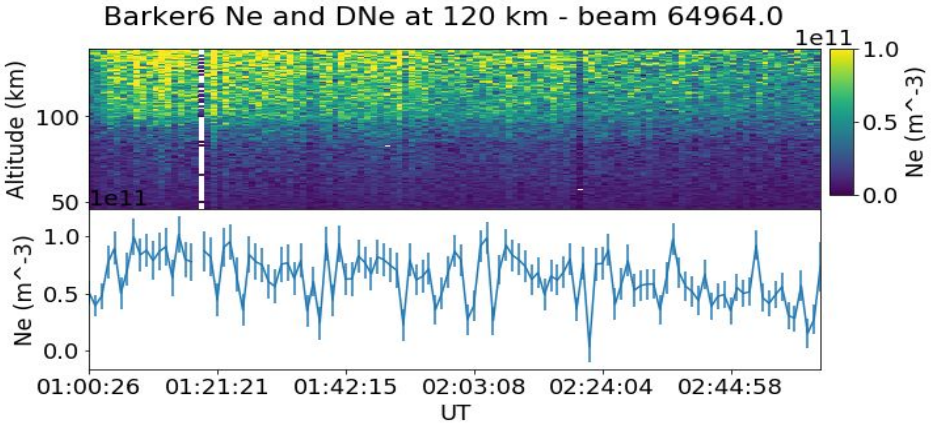
$$\lambda_{De} = \sqrt{\frac{\epsilon_0 k_B T_e}{e^2 N_e}} \quad k = \frac{4\pi}{\lambda_{\mathrm{Tx}}} \quad R = \text{Range} \quad \tau_p = \text{Pulse Length (s)}$$

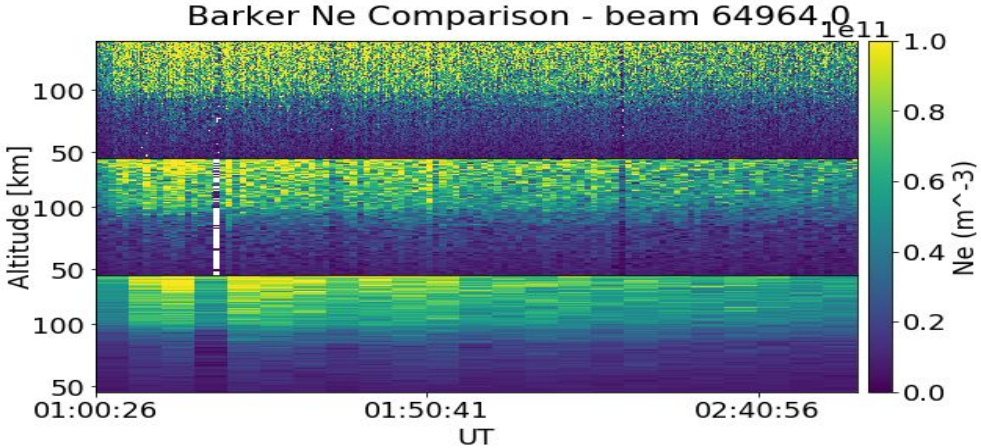
Barker code is symmetric

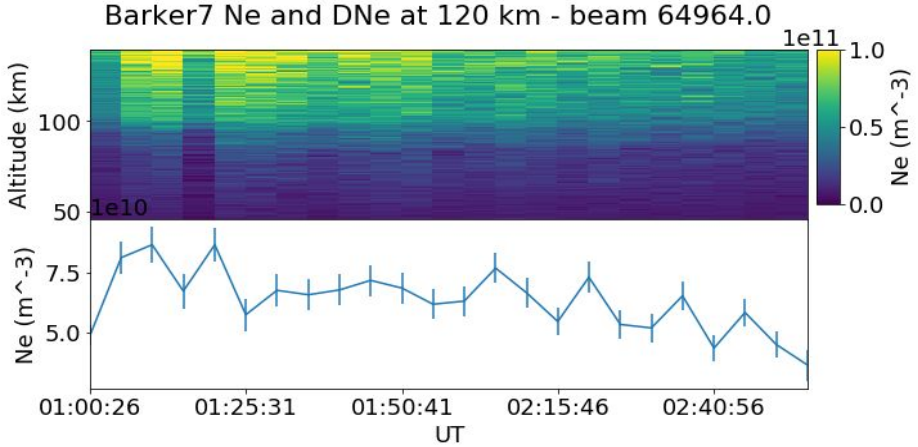


Beam with enhanced density comparison - beam 64964 - beam 3 - error at 120 km center of enhanced density



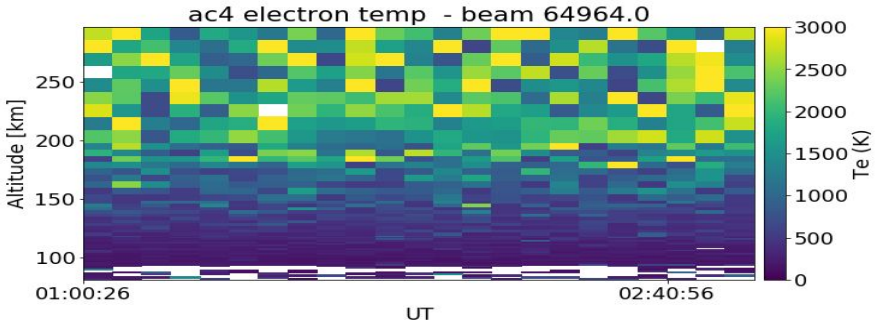


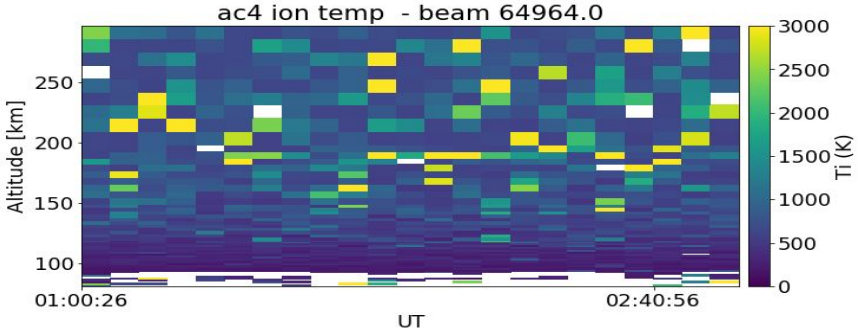


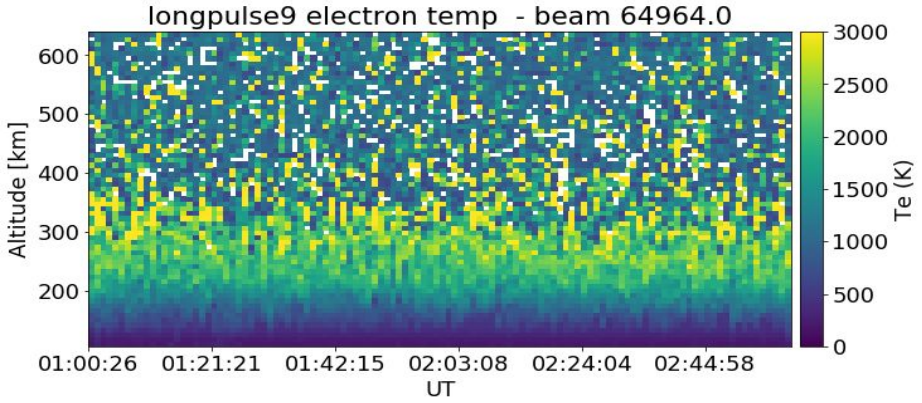


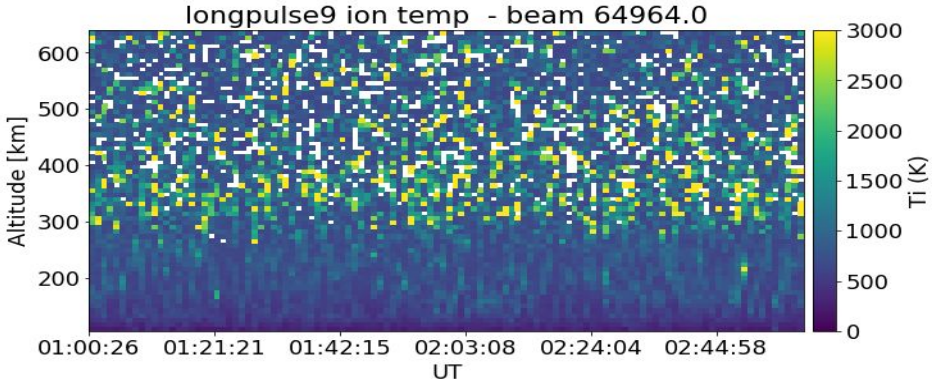
For Future: Calculate collision frequency in enhanced region

1. Determine which pulse should be used to obtain Te and Ti

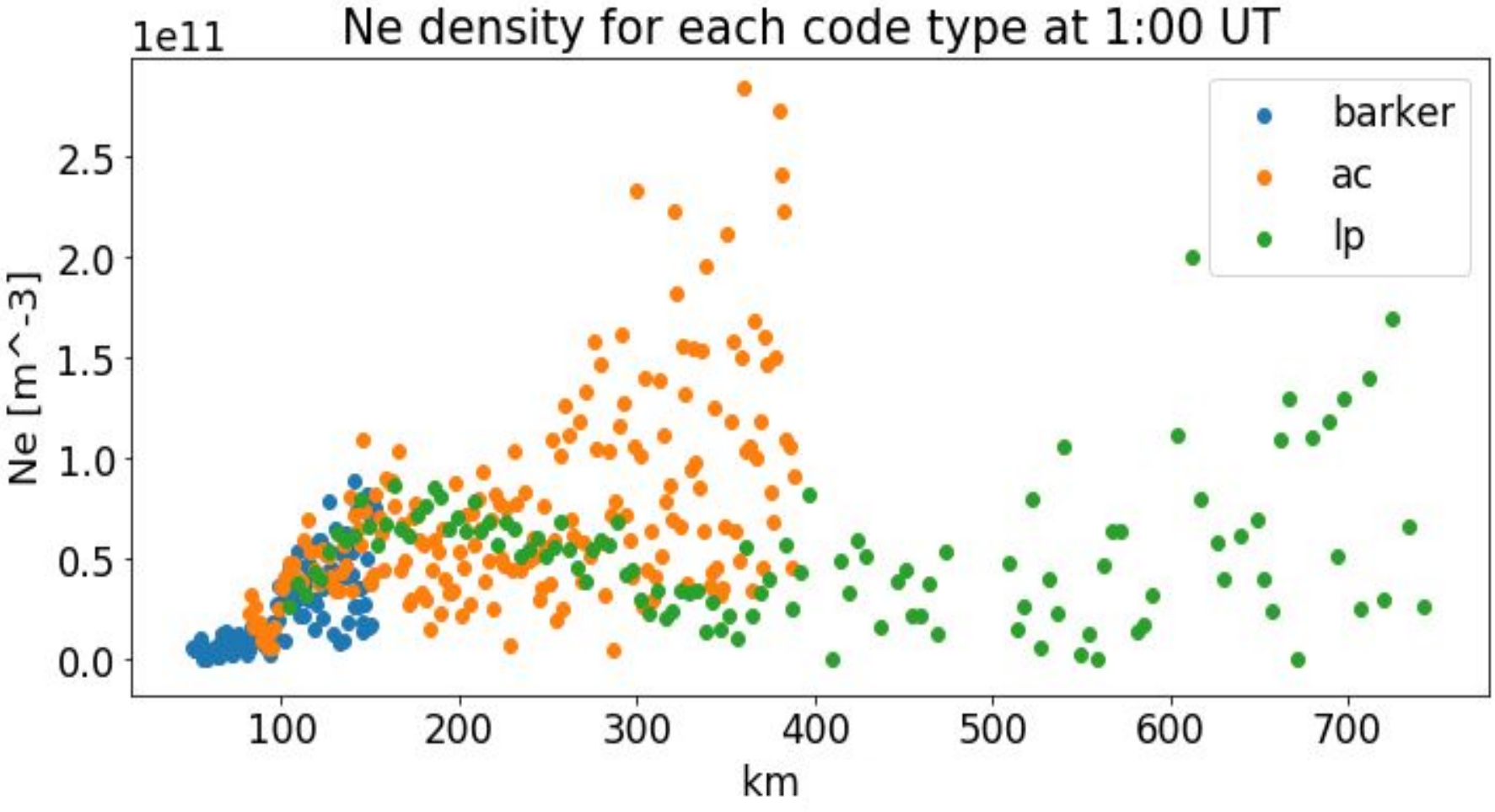


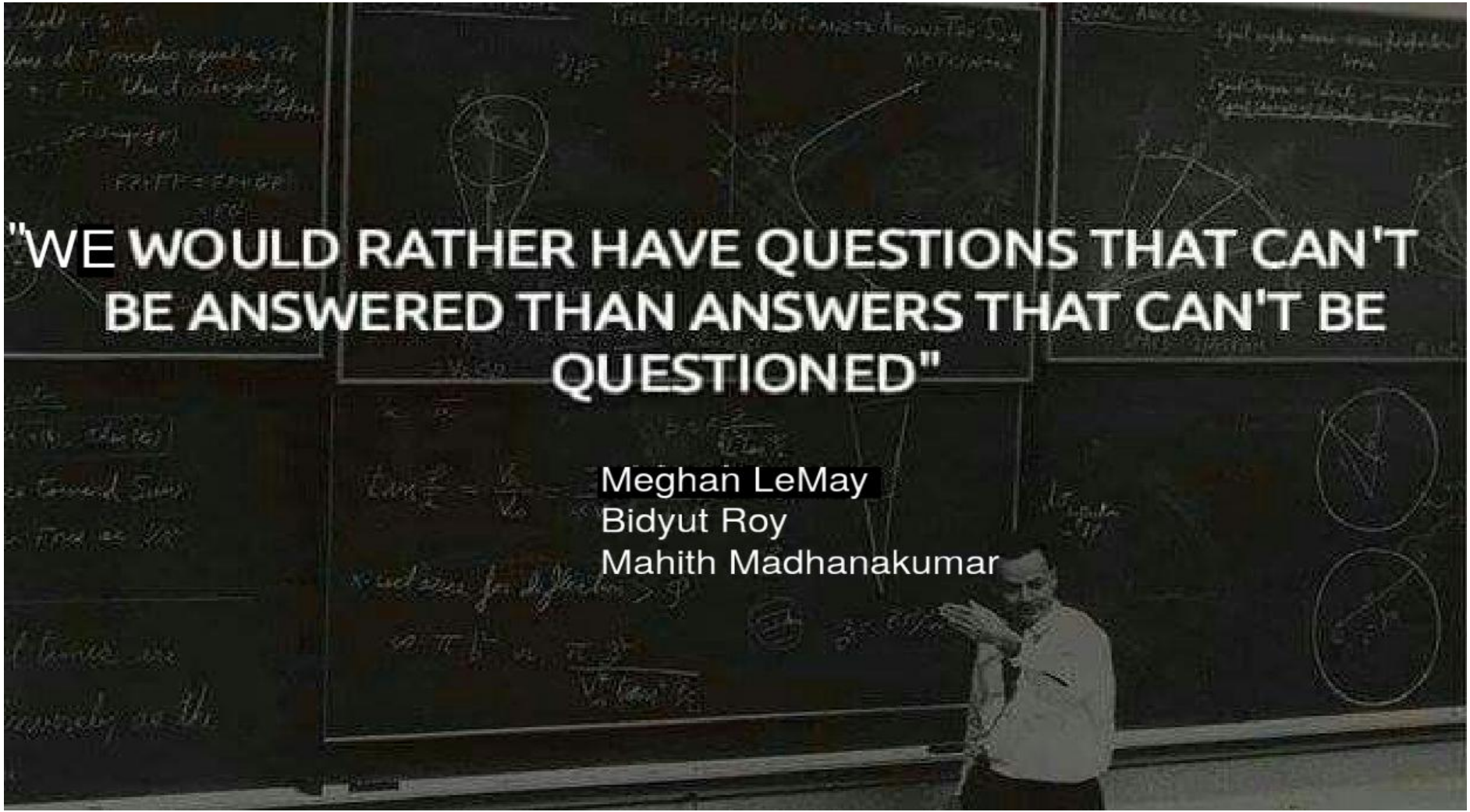


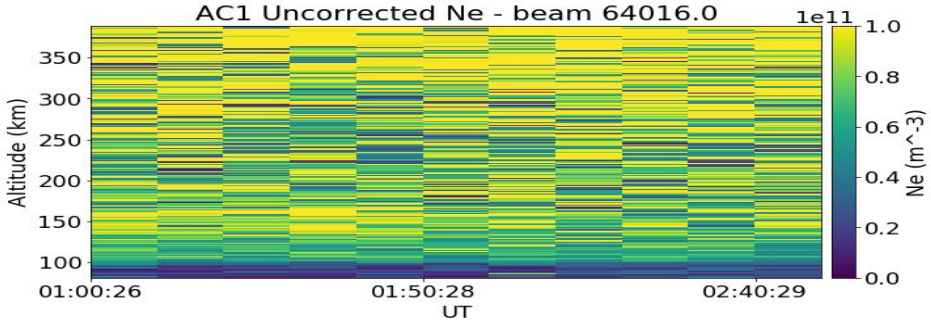


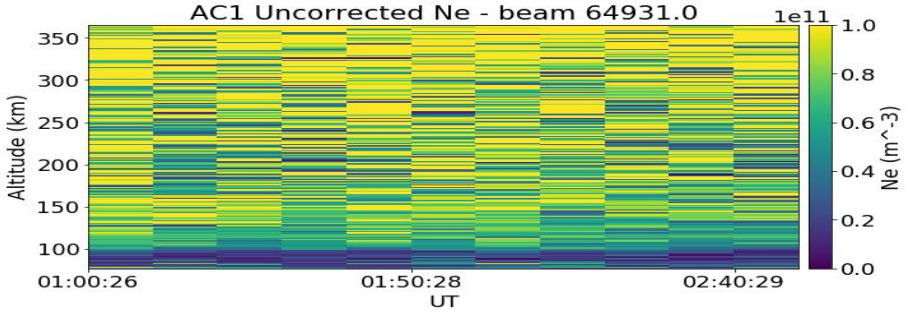


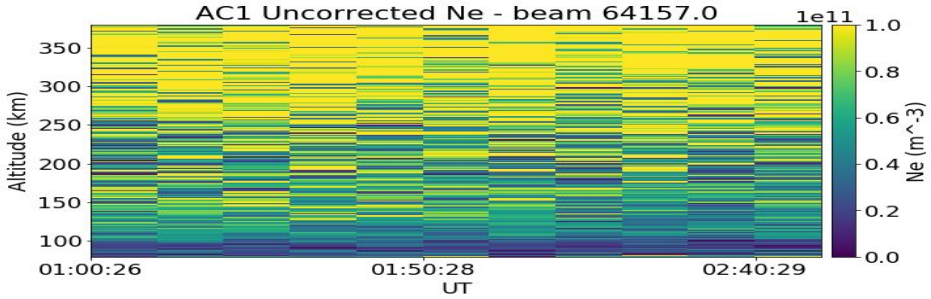
2. Calculate lat/lon of Te and Ti using az/el
3. Input parameters into flipchem

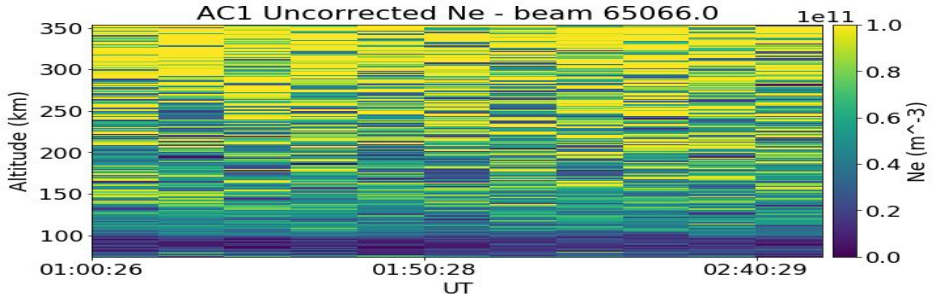

Ne density for each code type at 1:00 UT
1e11
Ne [m^-3]
2.5
2.0
1.5
1.0
0.5
0.0
100
200
300
400
500
600
700
km
barker
ac
lp

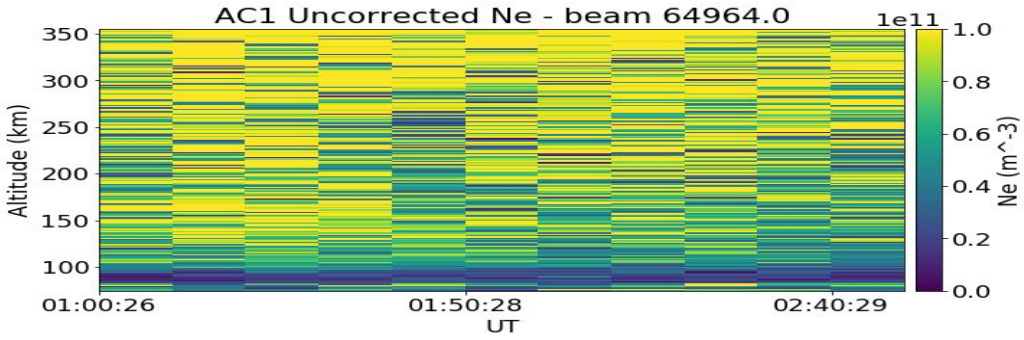

"WE WOULD RATHER HAVE QUESTIONS THAT CAN'T BE ANSWERED THAN ANSWERS THAT CAN'T BE QUESTIONED"
Meghan LeMay
Bidyut Roy
Mahith Madhanakumar



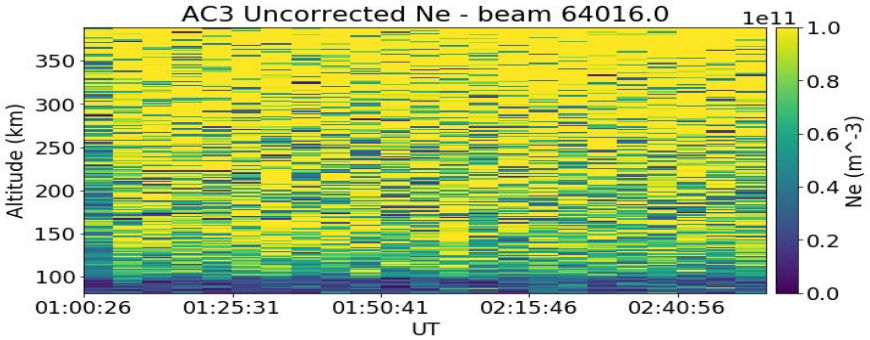


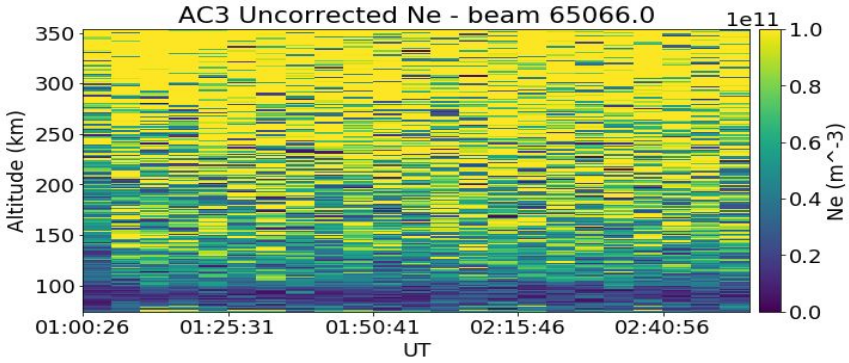


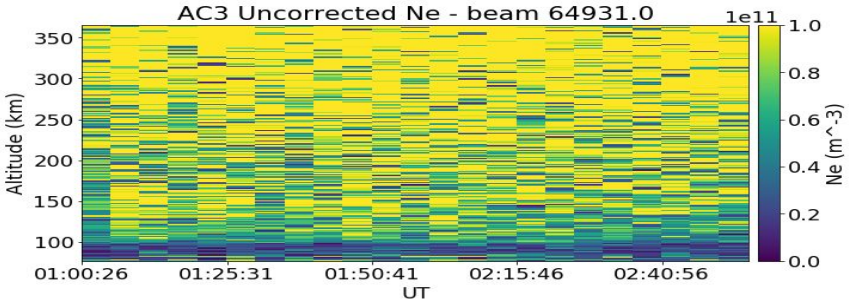


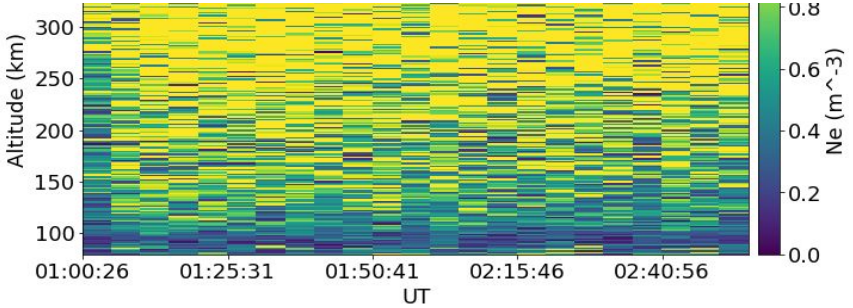


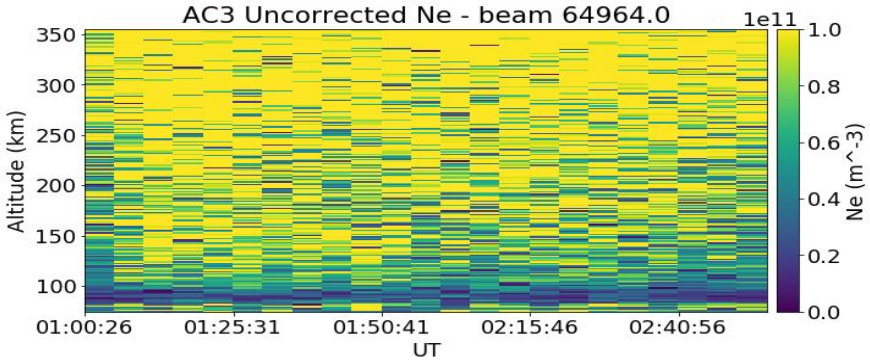
Alternating code 1
Integration = 10 mins



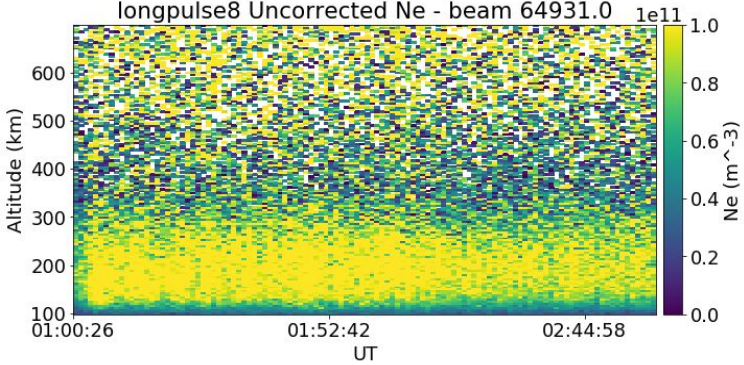


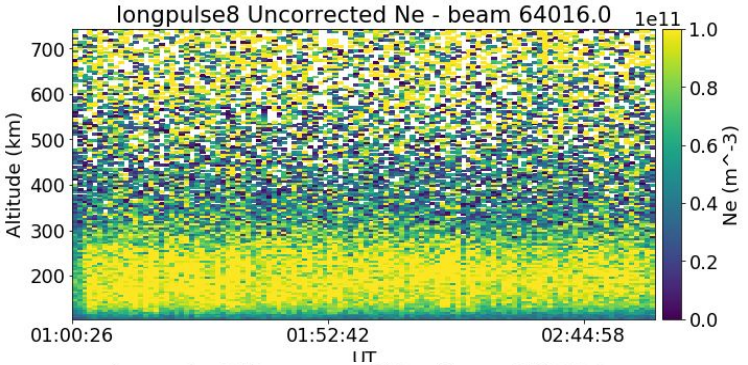


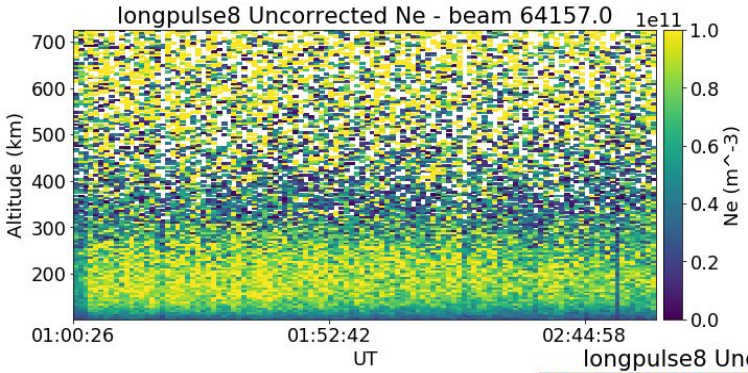


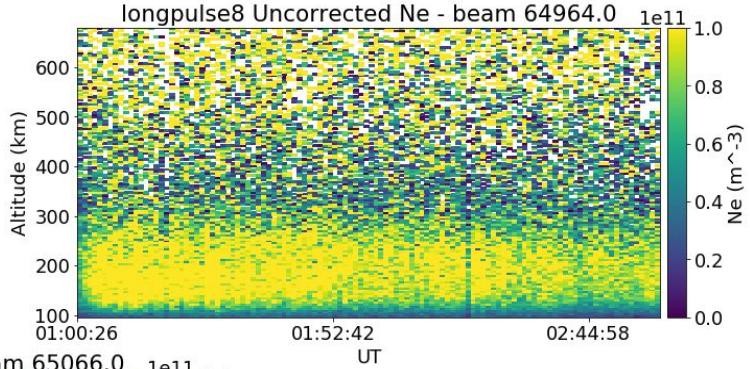


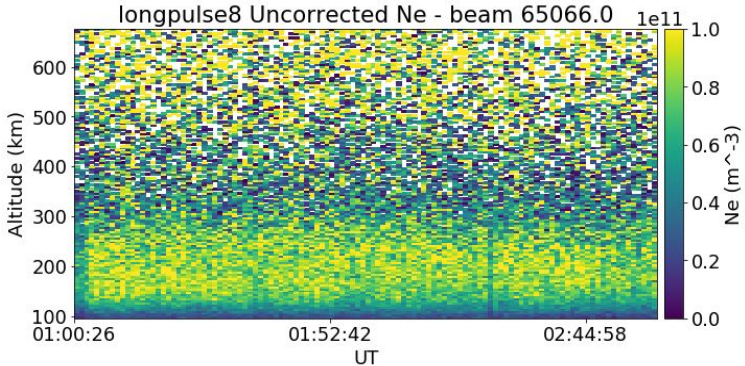
Alternating code 3 - integration = 5 mins



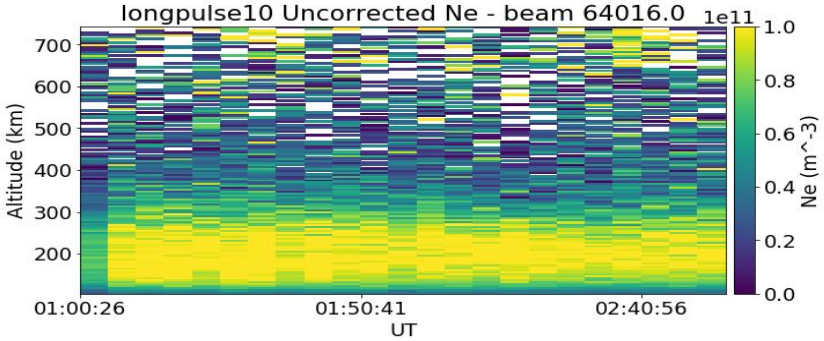


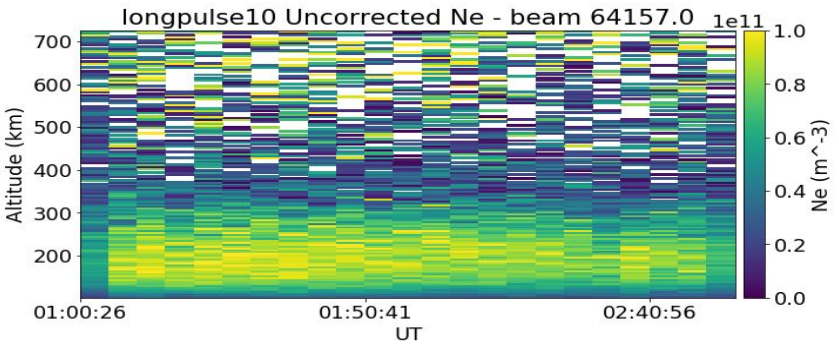


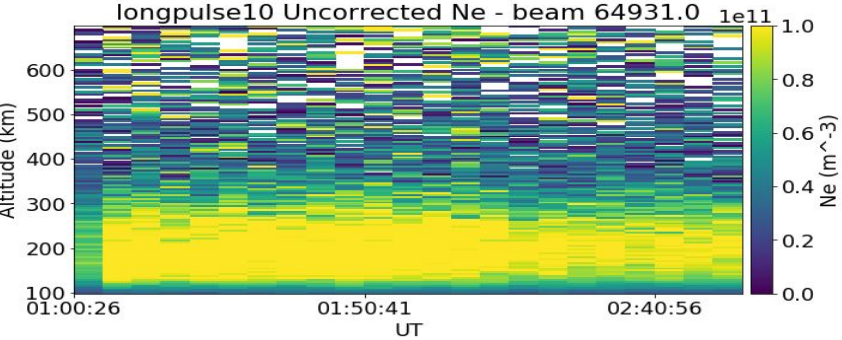


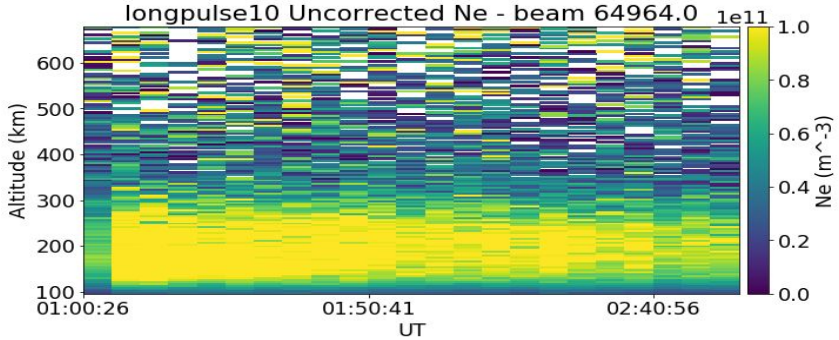


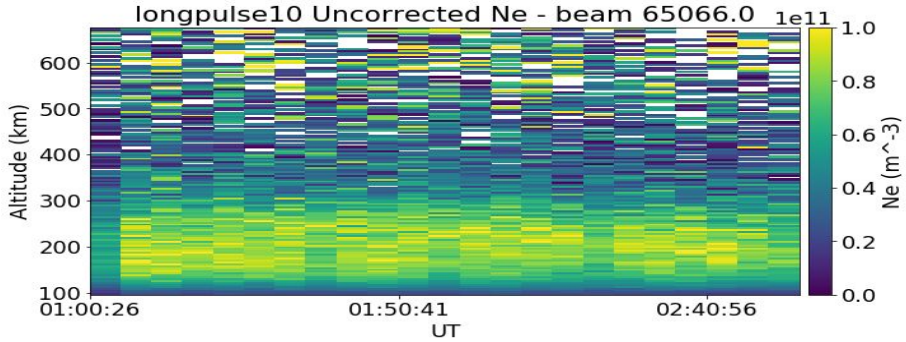
longpulse 8 -
integration time= 1 min



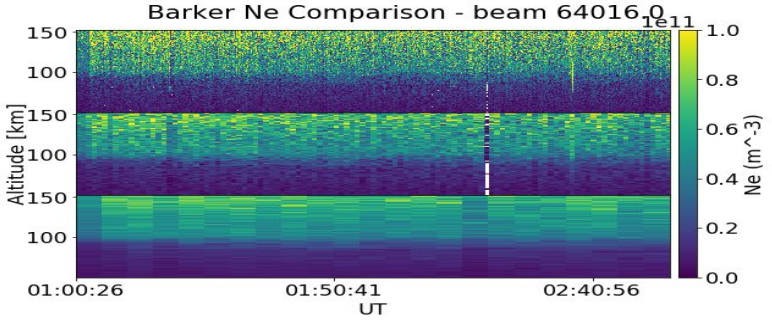


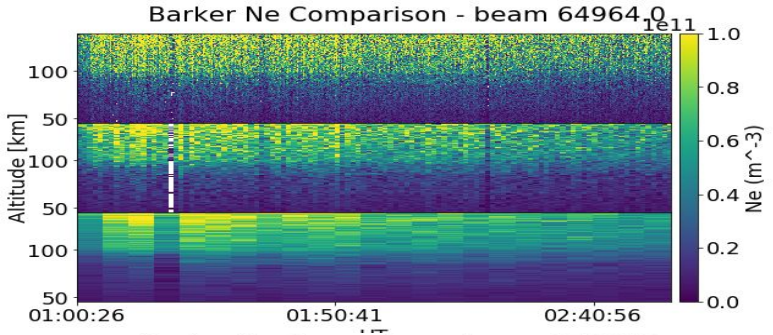


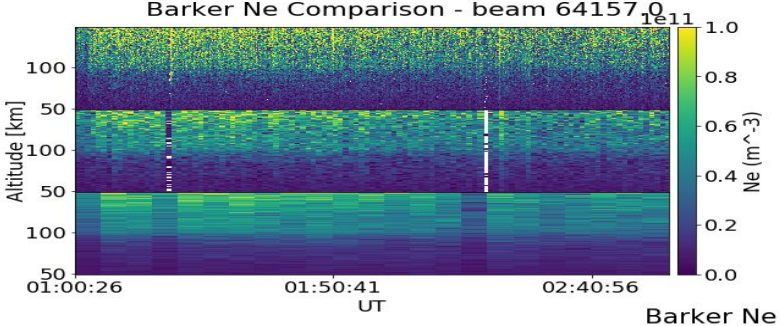


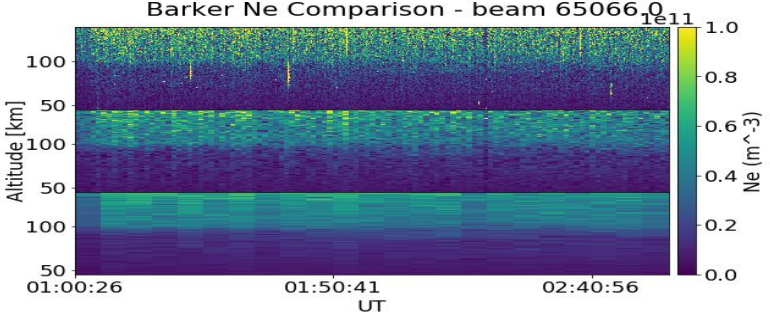


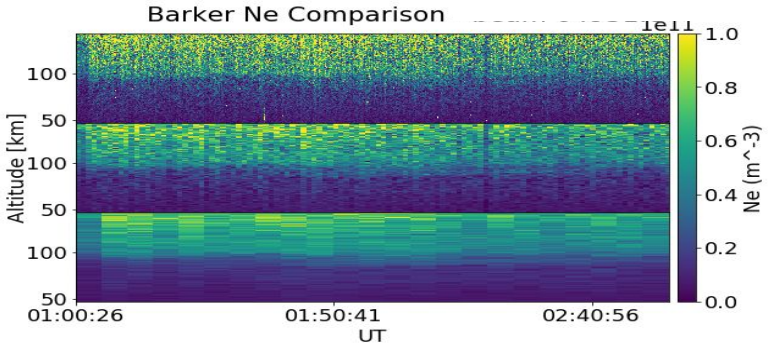
Longpulse 10
integration = 5 min


Barker Ne Comparison - beam 64016.0
1e11
Altitude [km]
Ne (m^-3)
UT
01:00:26
01:50:41
02:40:56


Barker Ne Comparison - beam 64964.0
1e11
Altitude [km]
Ne (m^-3)
01:00:26
01:50:41
02:40:56


Barker Ne Comparison - beam 64157.0
1e11
Altitude [km]
Ne (m^-3)
UT
01:00:26
01:50:41
02:40:56


Barker Ne Comparison - beam 65066.0
1e11
Altitude [km]
Ne (m^-3)
UT
01:00:26
01:50:41
02:40:56


Barker Ne Comparison
1e11
Altitude [km]
Ne (m^-3)
UT
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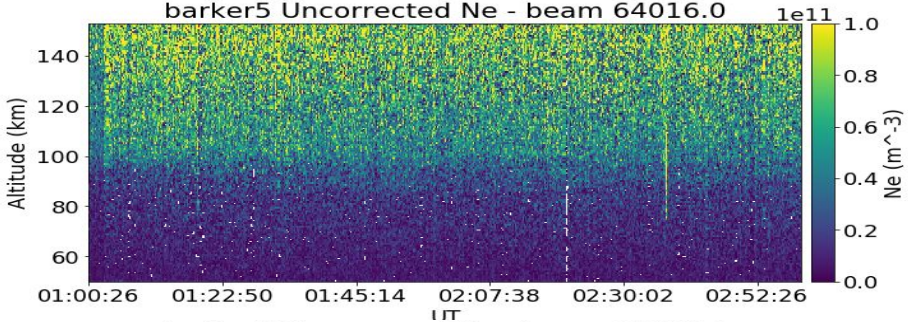
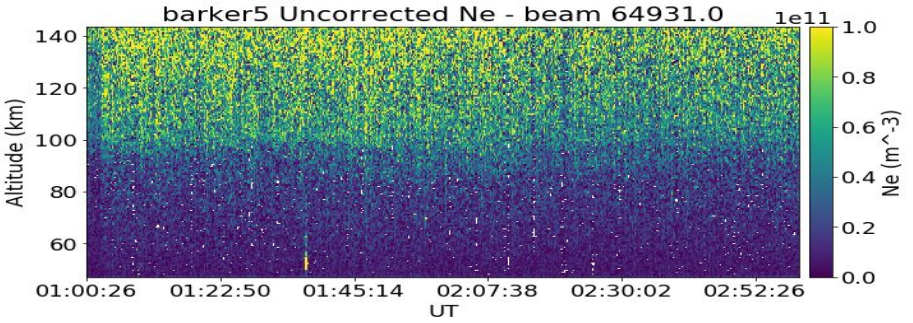
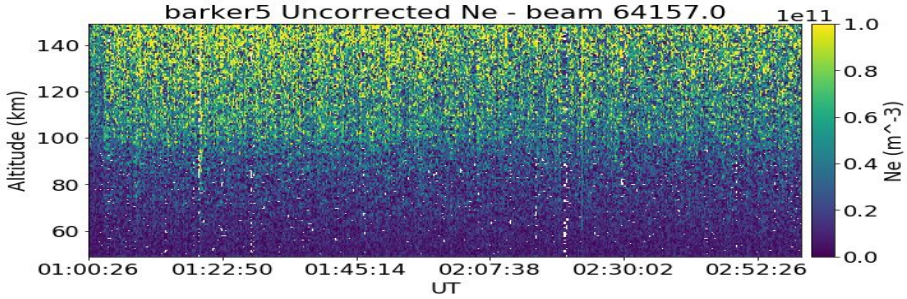
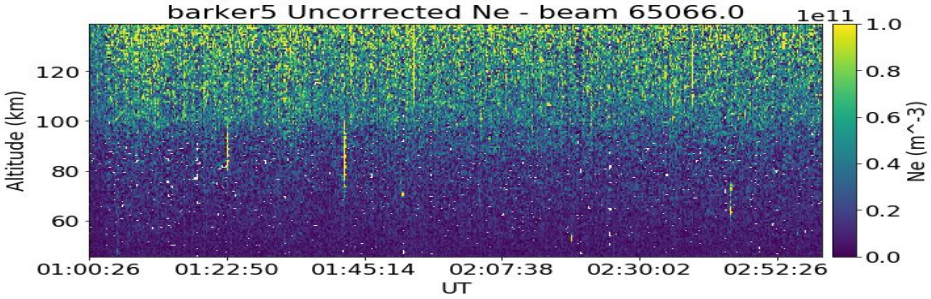
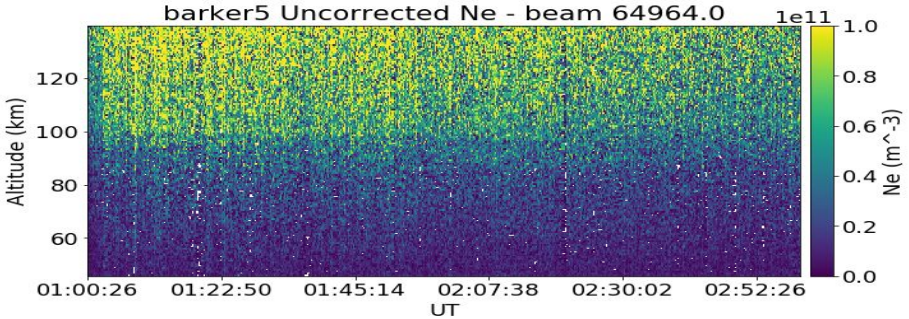


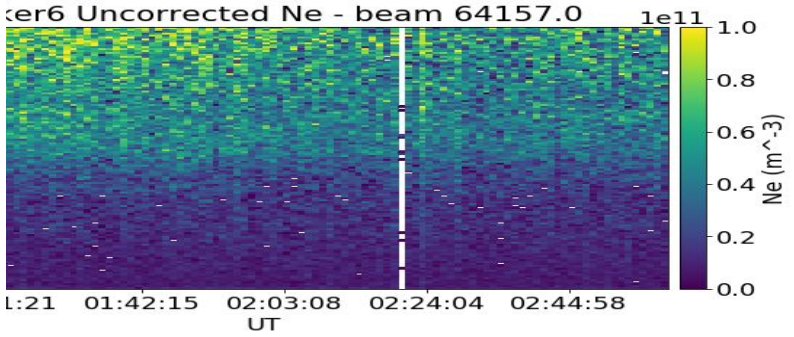


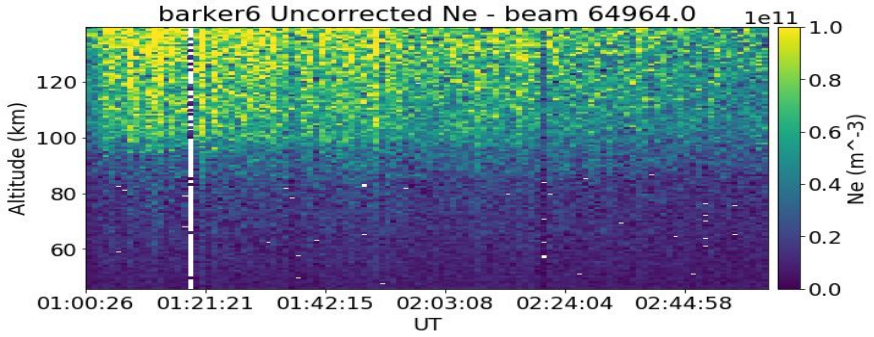


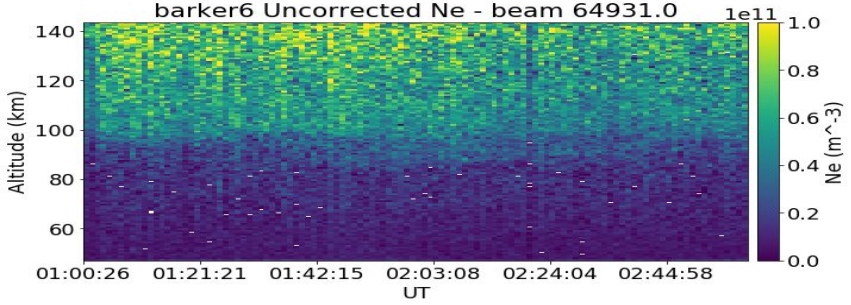


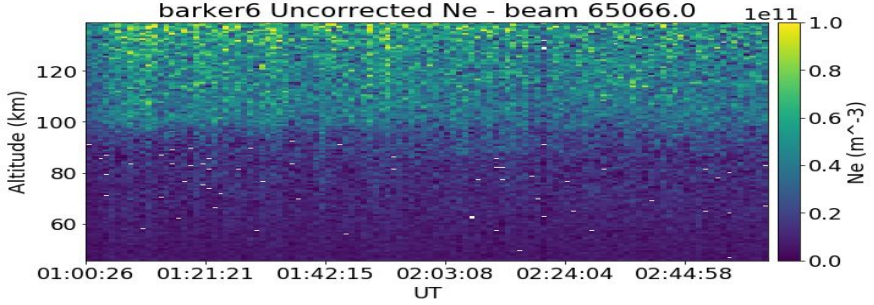


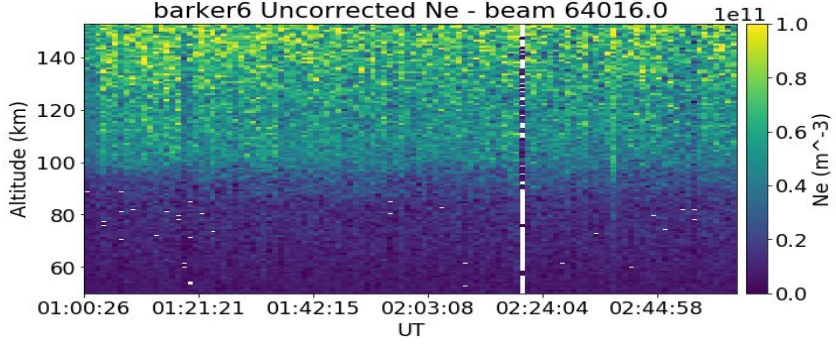
Barker 5 ne - list integration



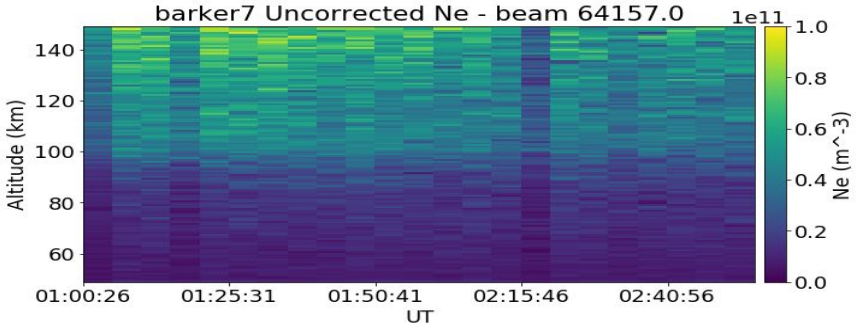


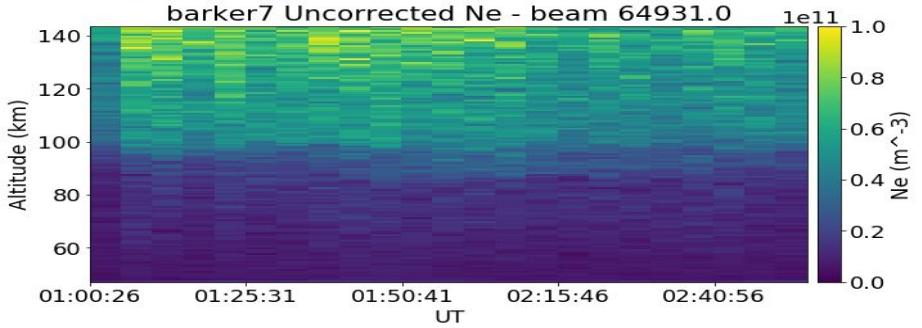


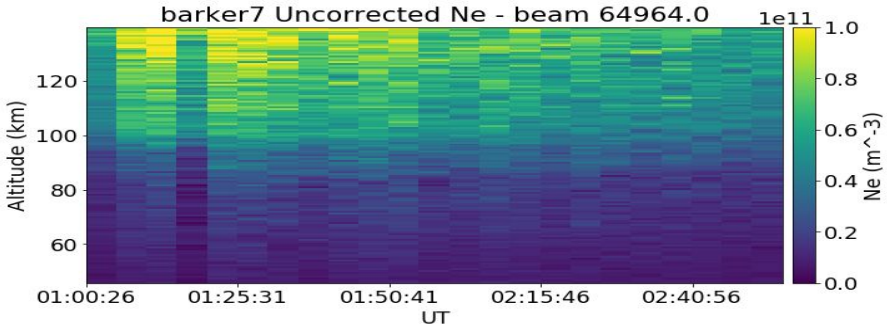


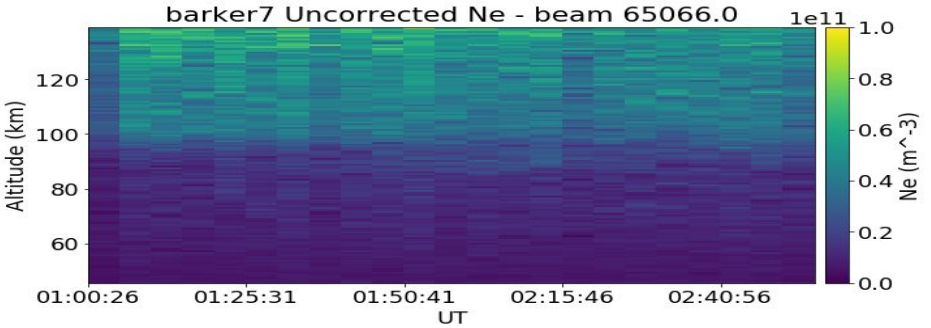


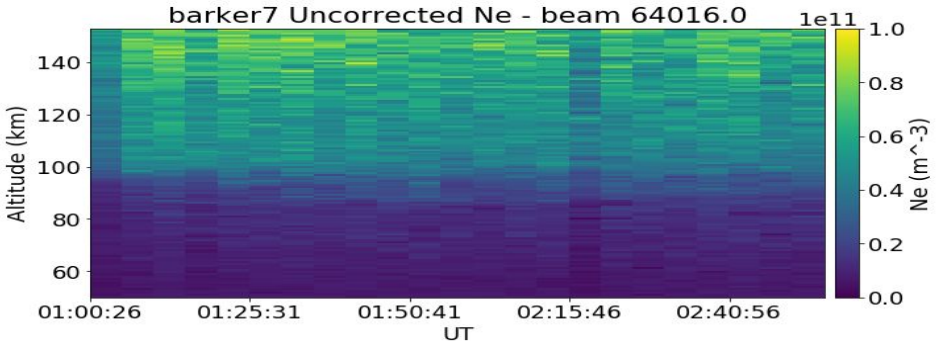
Barker 6 - list integration











Barker 7 - include integra