University of New Hampshire

Magnetosphere Ionosphere Research Lab

Incoherent Scatter Radar (ISR), Pulsating Aurora, & Ion Outflow

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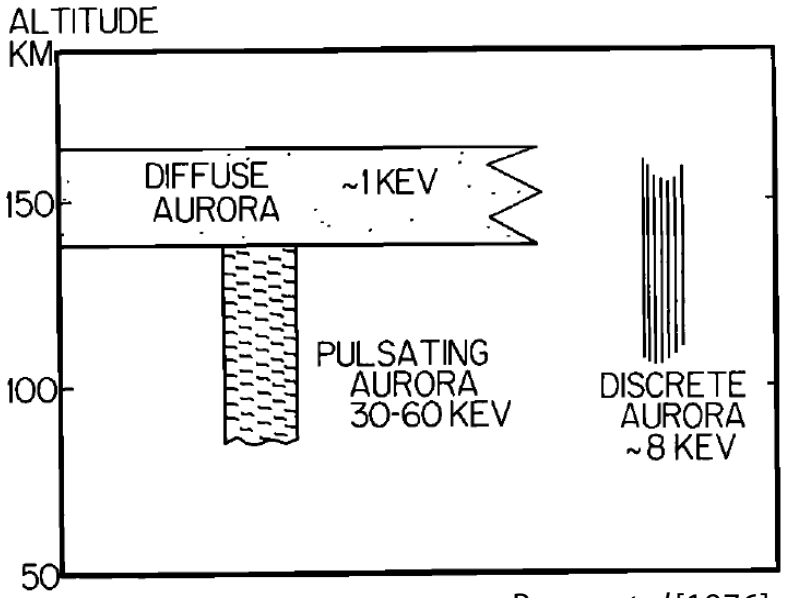
Outline

- Background
  - Pulsating Aurora
  - Ion Outflow
- ISR examples
  - Ion Upflow
  - Pulsating Aurora
- Motivation – e-POP observations
- Proposed experiment

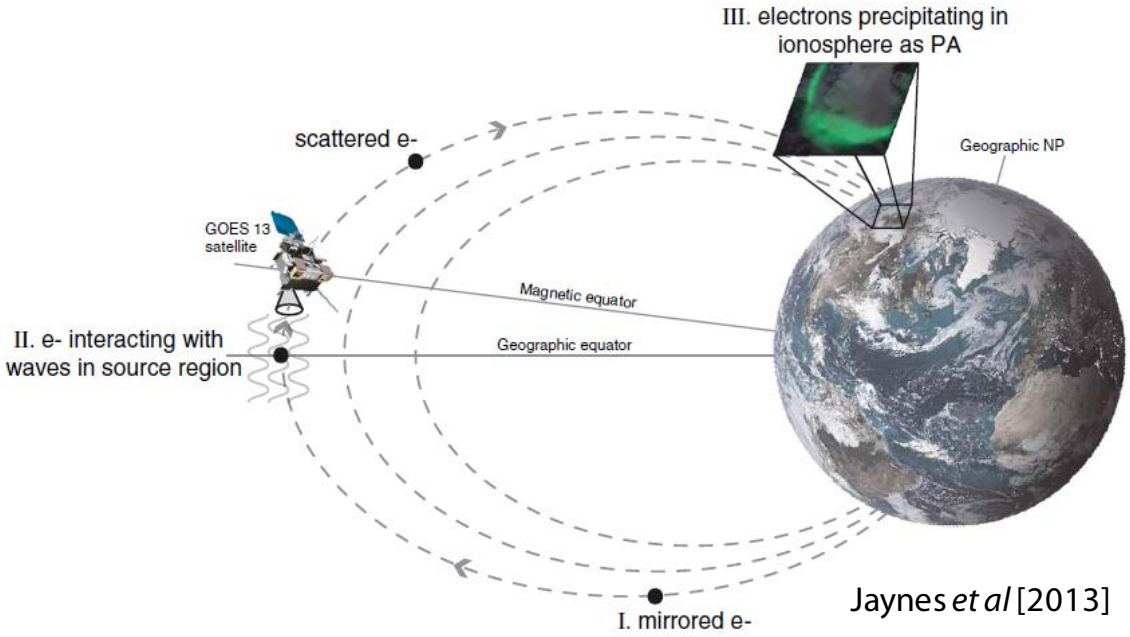
Pulsating Aurora

Pulsating Aurora

- Irregular shape
  - 10s - 100s km wide
  - Vertically thin
- Irregular period
  - 2-20 s
  - 8 s average
- Optically dim
  - ≈1 kR (427.8 nm)
- Consistent energy range



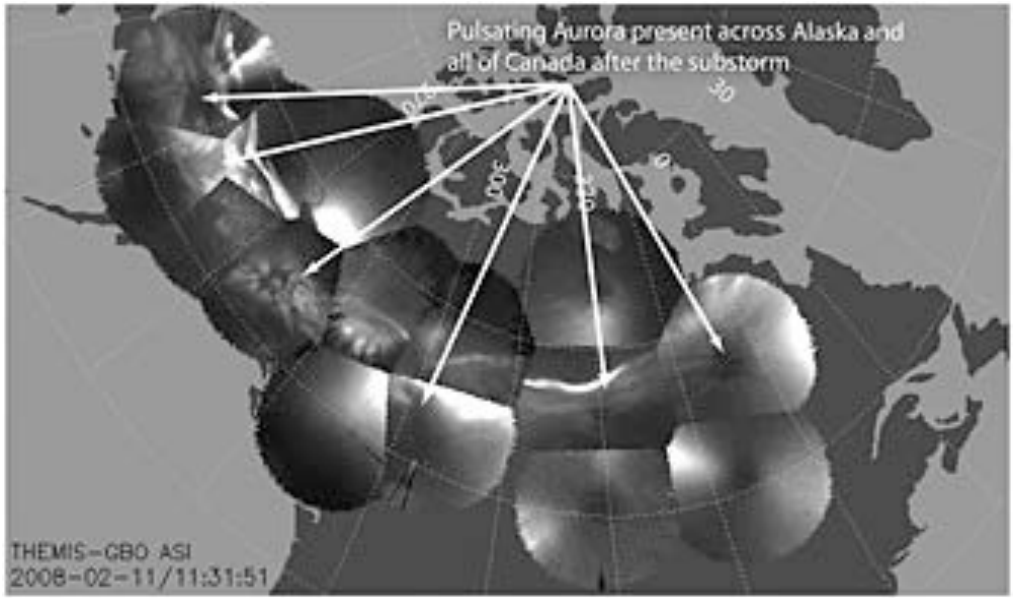
Brown *et al* [1976]



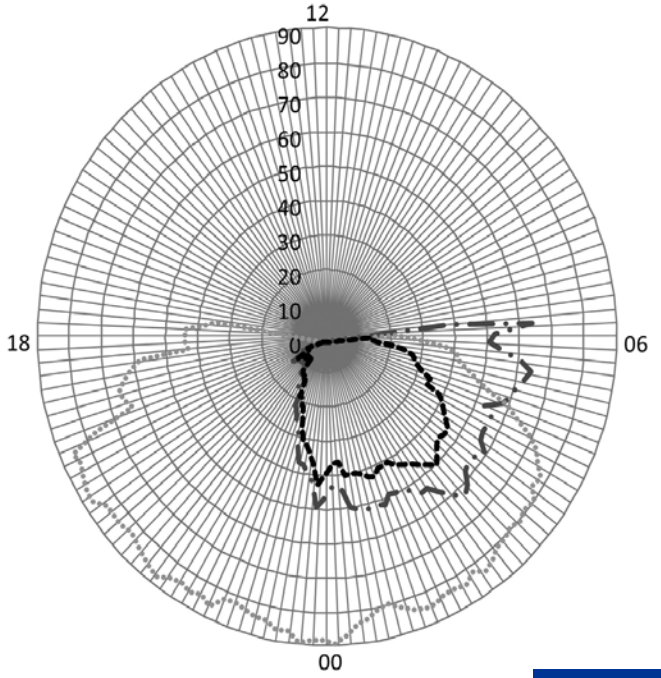
Jaynes *et al* [2013]

Pulsating Aurora

- Widespread temporally and geographically
- From Jones, *et al* [2011] statistical study:
  - Most probable duration 90-120 min
  - 31% clear optical data exhibit PA
  - 69% of PA occur post substorm
  - 54% probability to occur after magnetic midnight



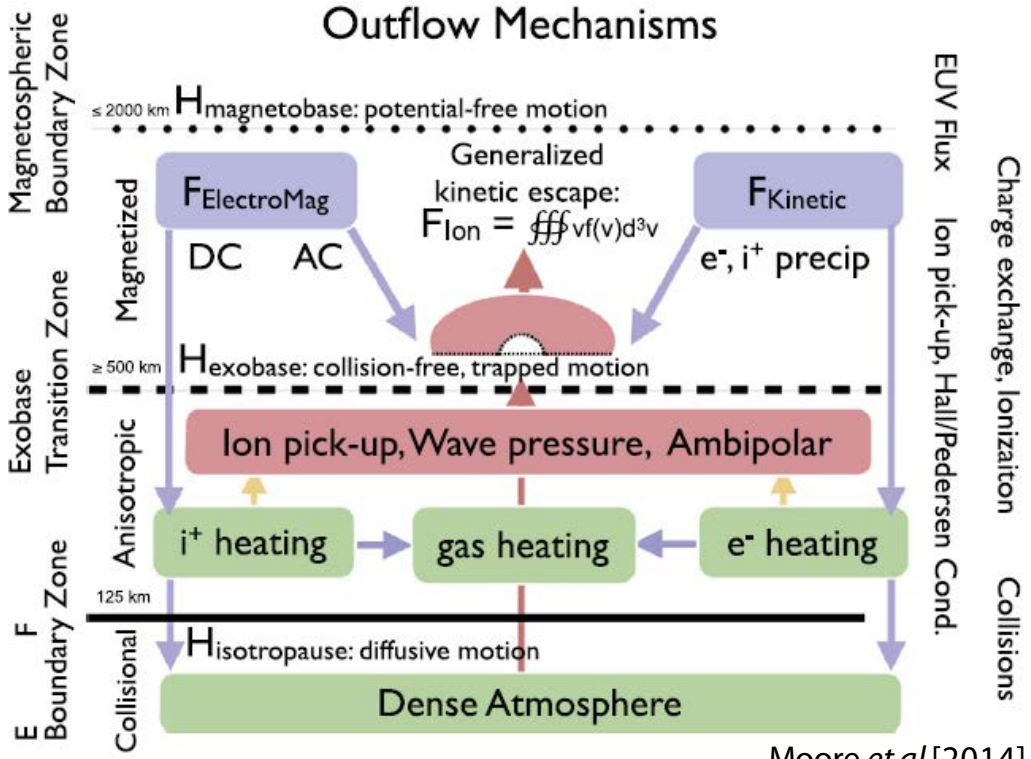
Jones, *et al* [2013]



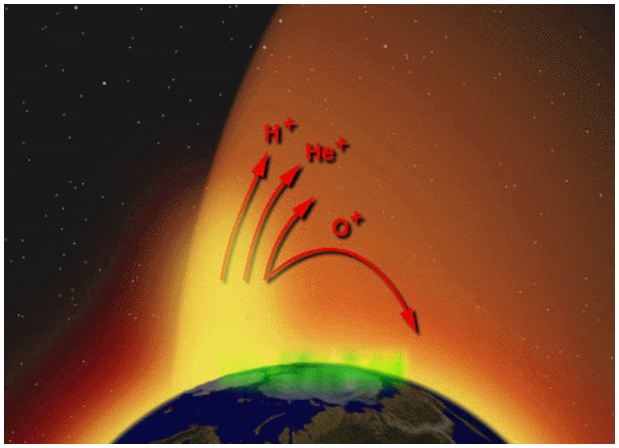
Jones, *et al* [2011]

Ion Outflow

- Magnetosphere-Ionosphere coupled in many ways
  - Polar outflow
  - Particle precipitation
  - Ion outflow
- Addition of heavy ions (i.e. O^+) to magnetosphere from ionosphere



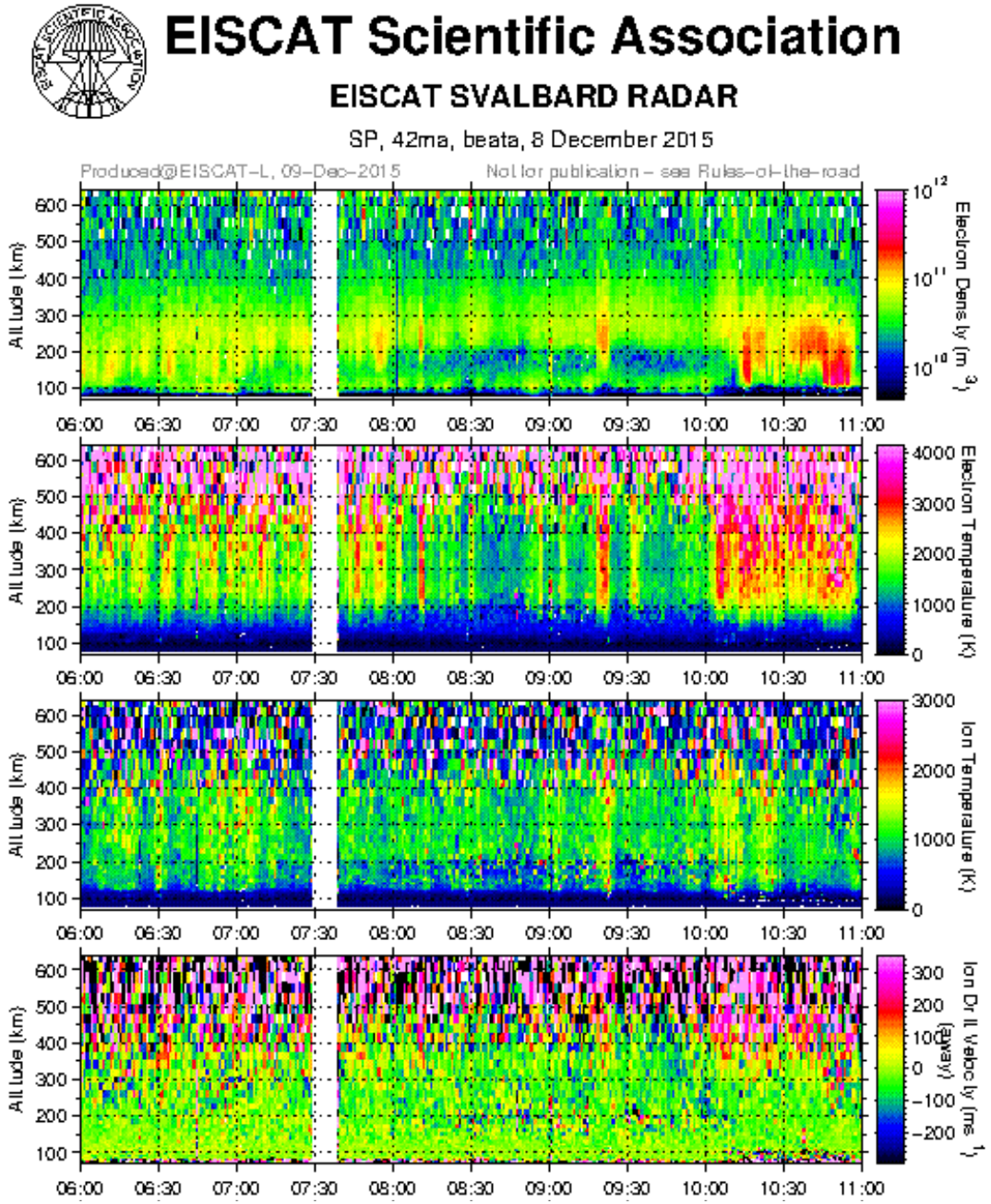
Moore *et al* [2014]



ISR and Ion Upflow

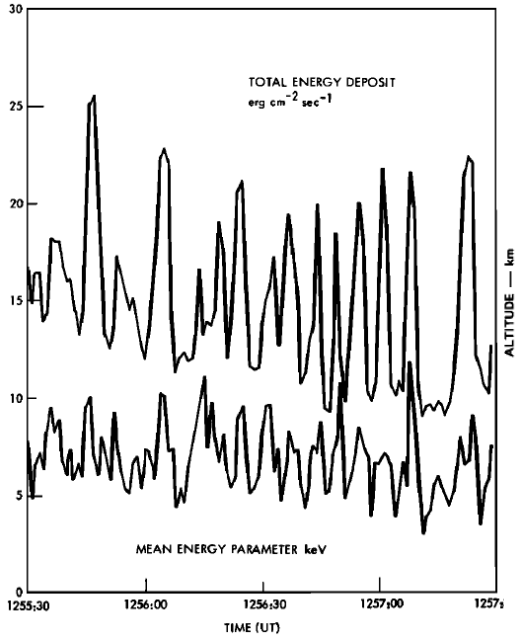
RENU 2

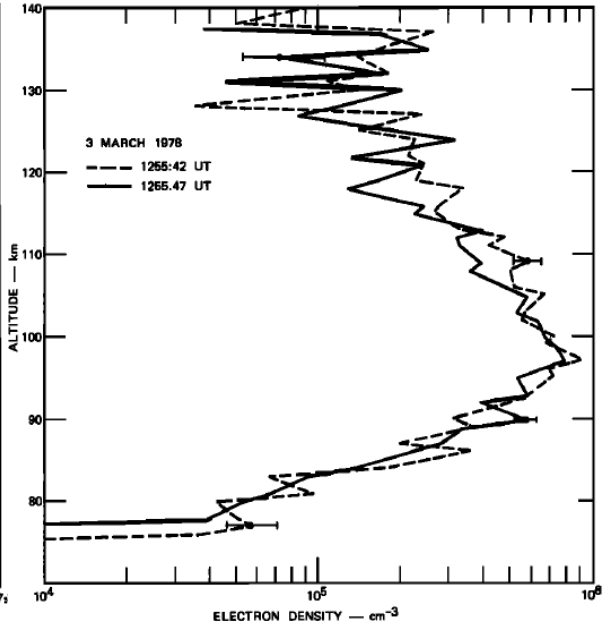
- Strong enhancement in electron temperature/density after 10:00
- Slight increase in ion temperature
- Visible vertical drift of ions associated with enhancement

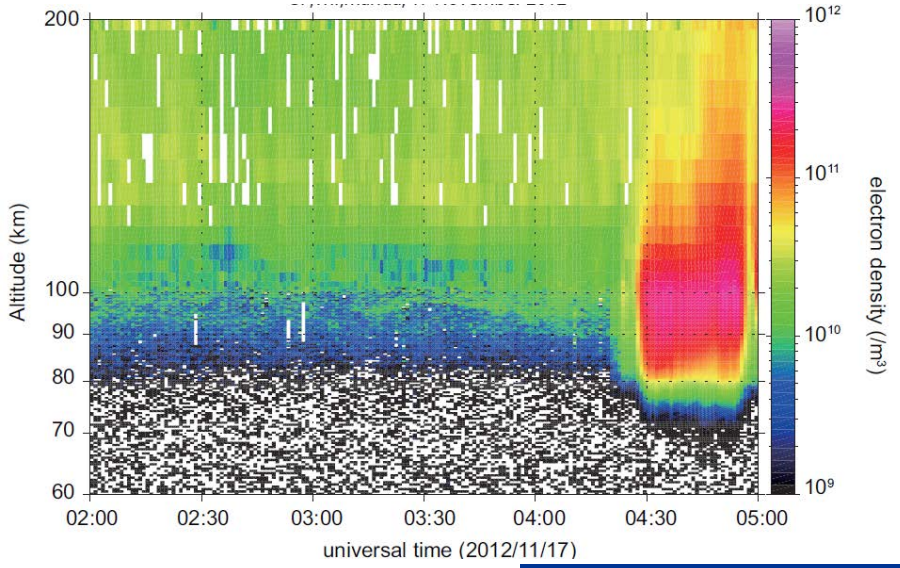


ISR and Pulsating Aurora

- Chatanika, AK
  - Foster *et al* [1978]
  - Sears and Vondrak [1981] (figs. top right)
- EISCAT
  - Miyoshi *et al* [2015] (fig. bottom right)
  - Hosokawa and Ogawa [2015]
  - Turunen *et al* [2016]
- AMISR
  - Jones *et al* [2009]
  - Cosgrove *et al* [2010]

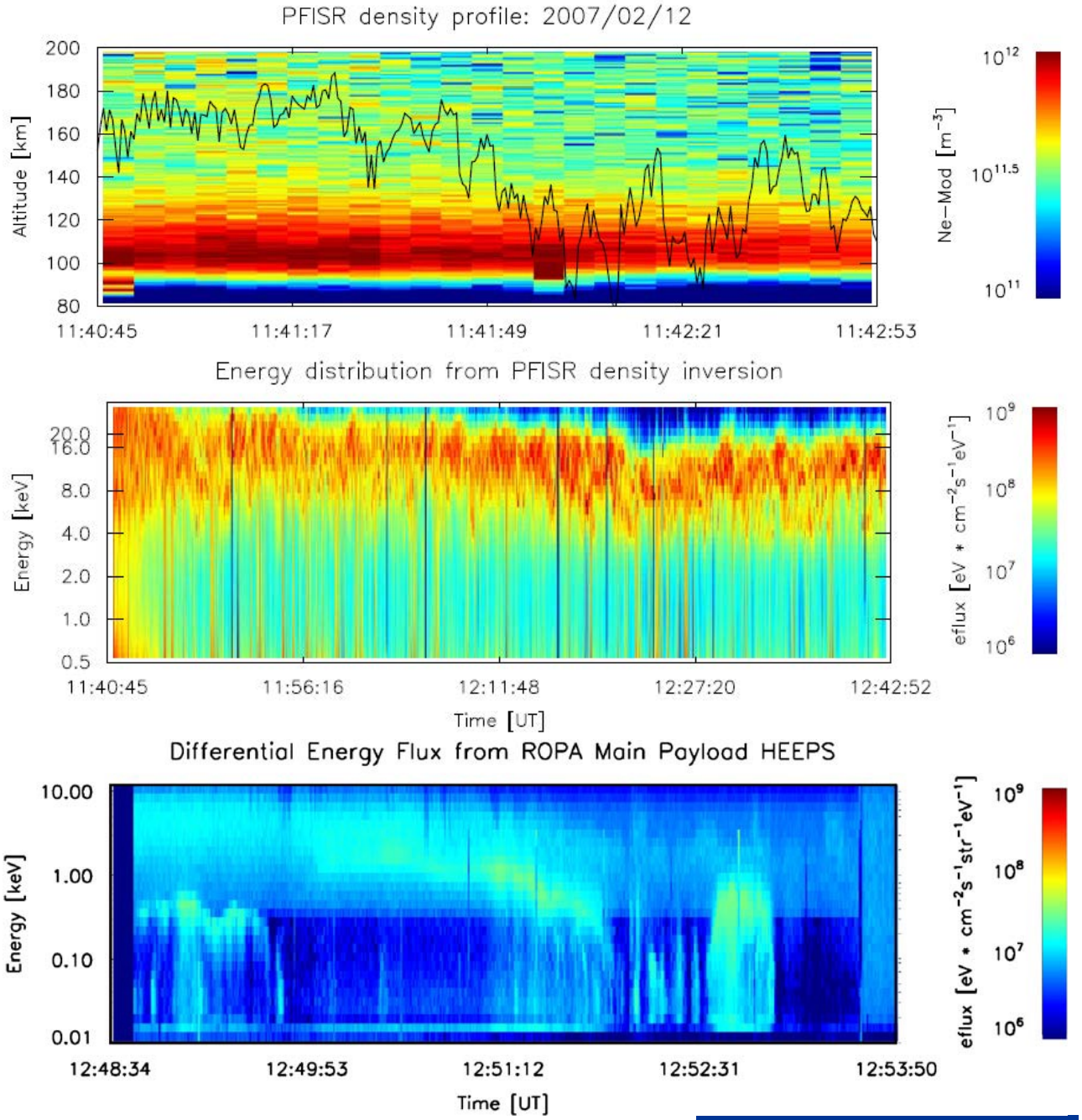






Rocket Observations of PA (ROPA)

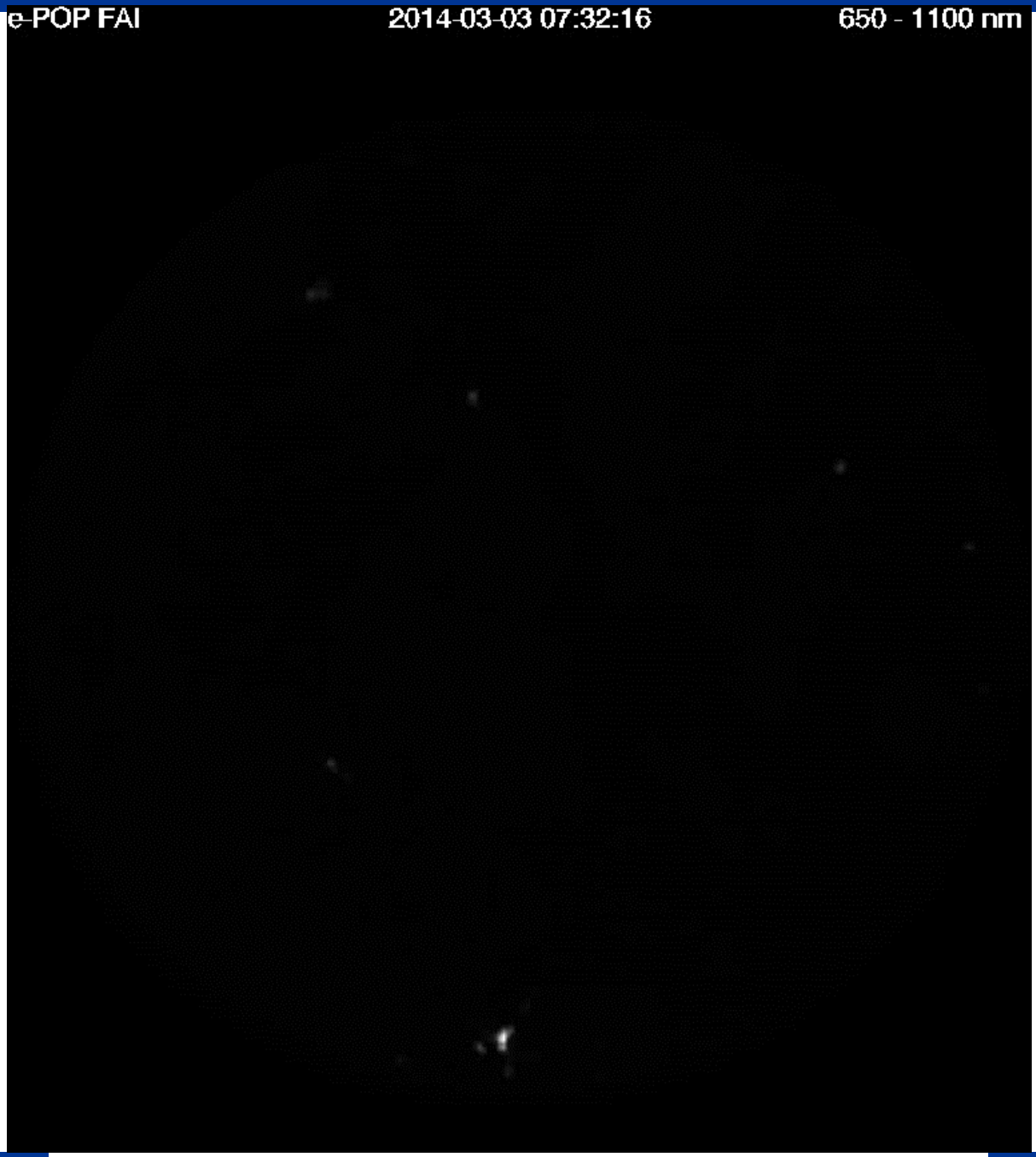
- First PFISR campaign
  - Spatial resolution: 1 km
  - Temporal resolution: 5 s
  - 480 μs long pulse interleaved with a 13 baud (10 μs) Barker code on two frequencies
- Invert electron density profile to determine energy distribution



Jones *et al* [2009]

Motivation

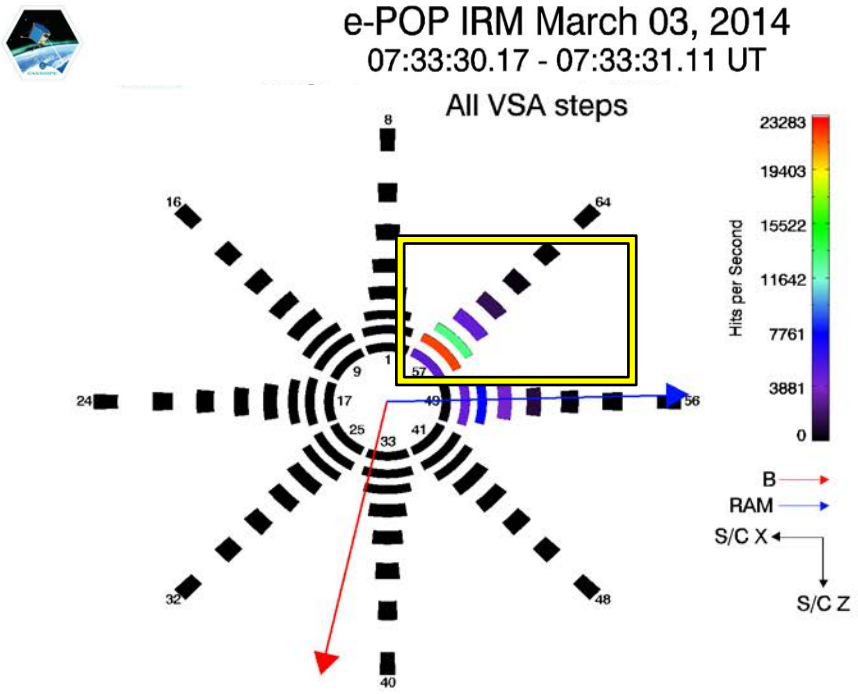
e-POP FAI

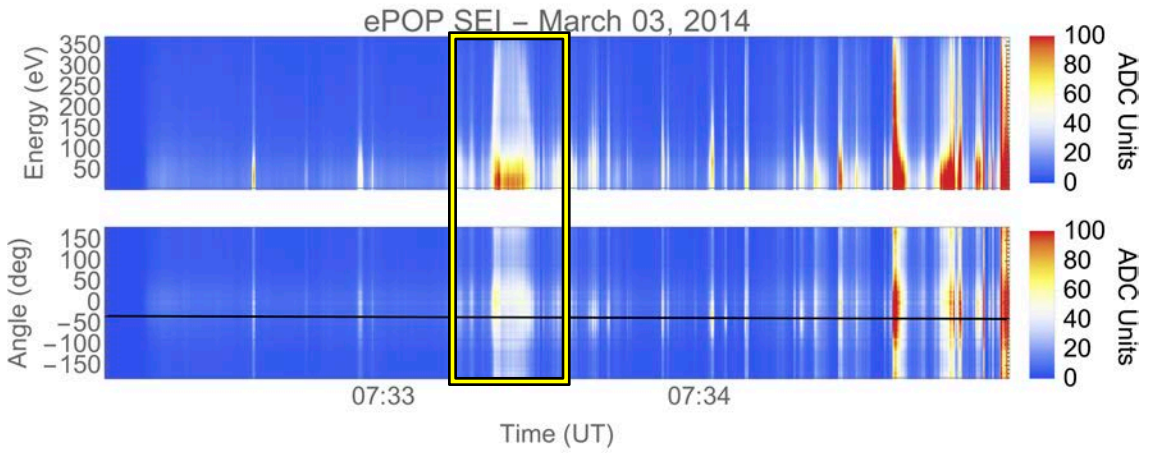


Motivation

e-POP observation

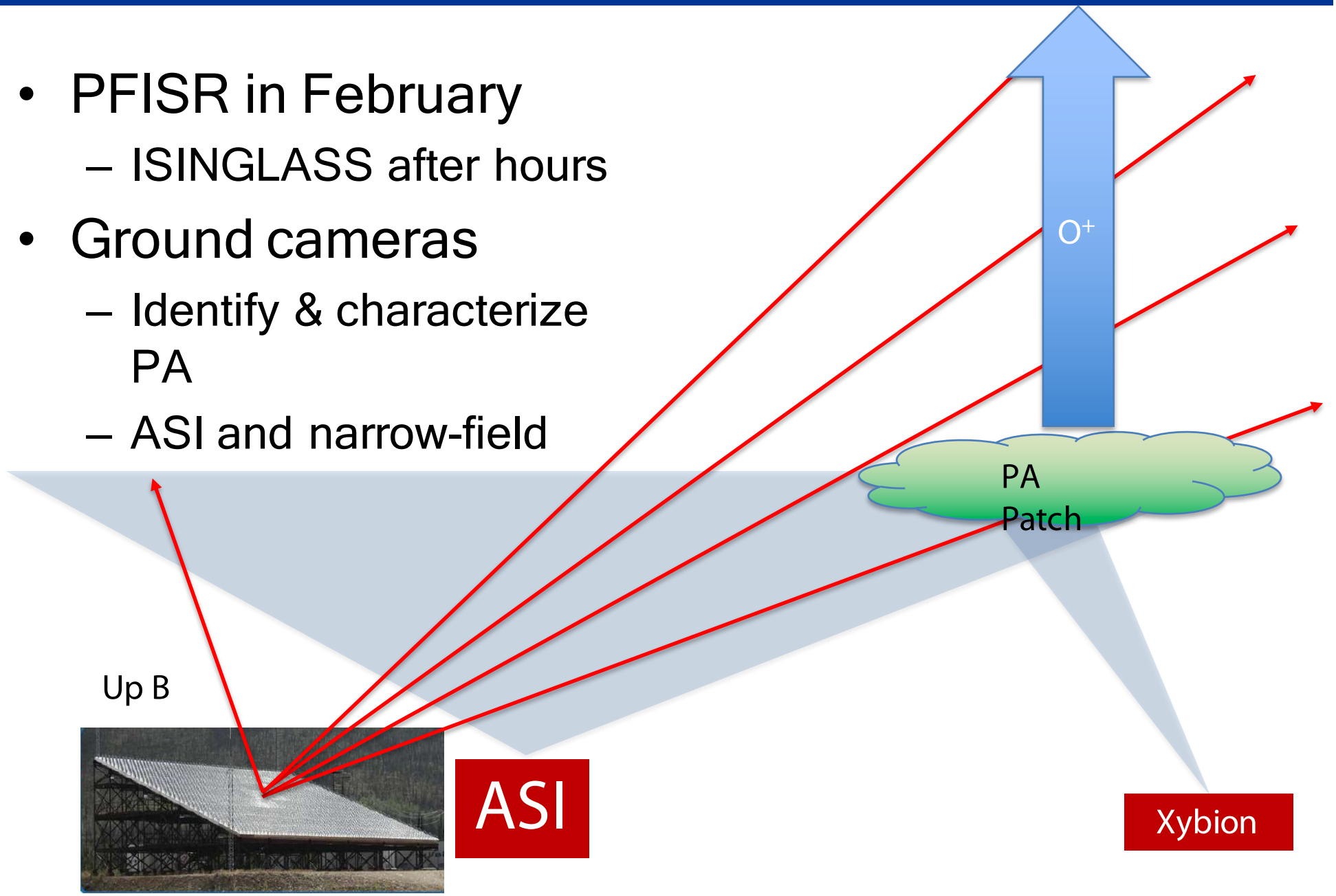
- IRM (ions)
  - Yellow box highlights upflowing O^+
  - Estimated velocity ~3 km/s
- SEI (electrons)
  - Low energy (~50 eV), isotropic electrons
  - thought to be backscatter





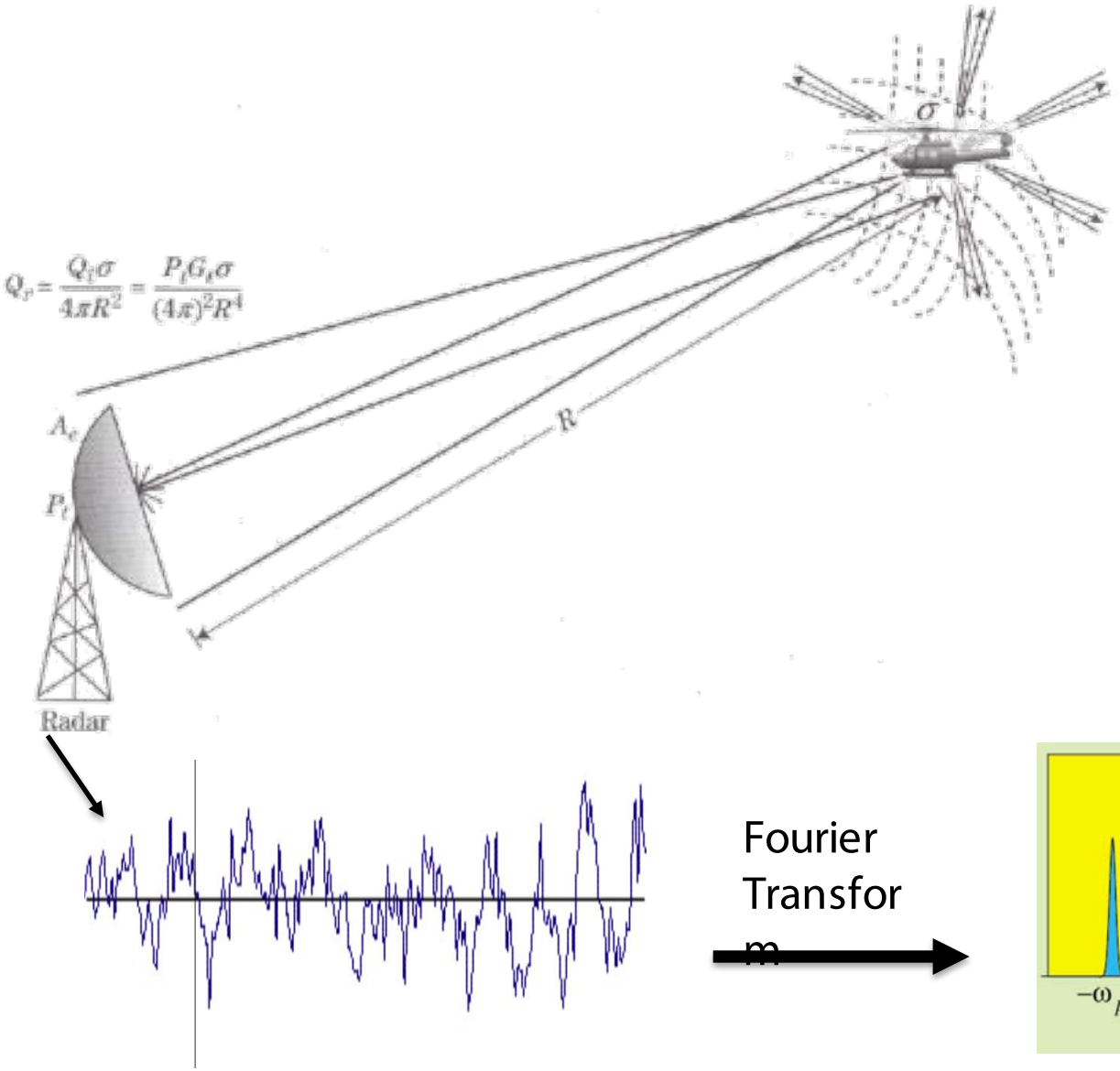
Proposed experiment

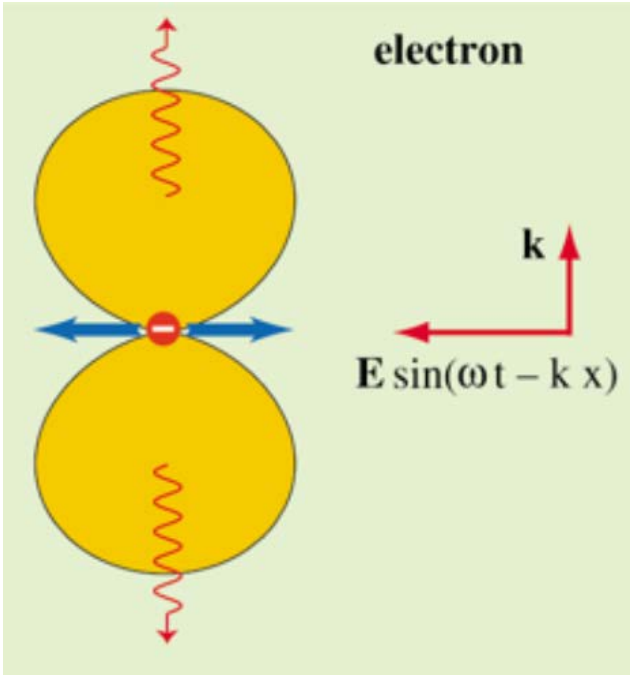
- PFISR in February
  - ISINGLASS after hours
- Ground cameras
  - Identify & characterize PA
  - ASI and narrow-field



Questions

Incoherent Scatter Radar (ISR)





Fourier Transform