THE NEED FOR A NEW GENERATION OF METEOR DATA SCIENTISTS

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Meteors are important for:

- Astronomy
- Aeronomy
- Geophysics
- Evolutionary biology
- Planetology
- Science popularization

Meteors are difficult to explore:

- Brief transient events
- Large angular size
- Radom spatial position
- Three different flow regimes

Technological advancements have yielded drastic improvements in
- Quality
- Quantity
- Diversity

of meteor data.

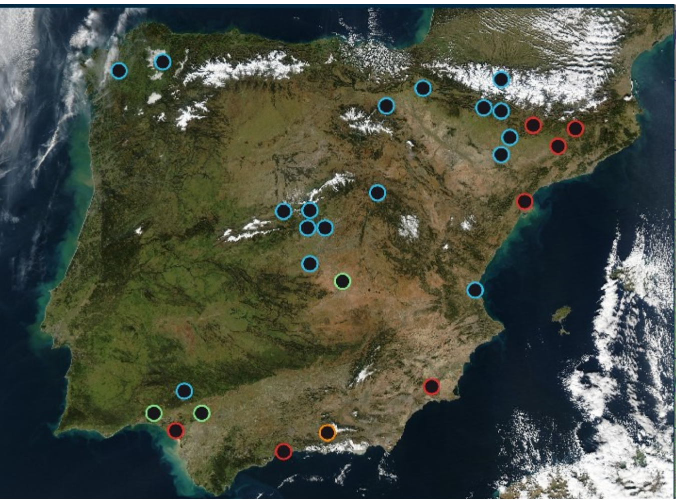
Even more ambitious instruments are about to become operational.

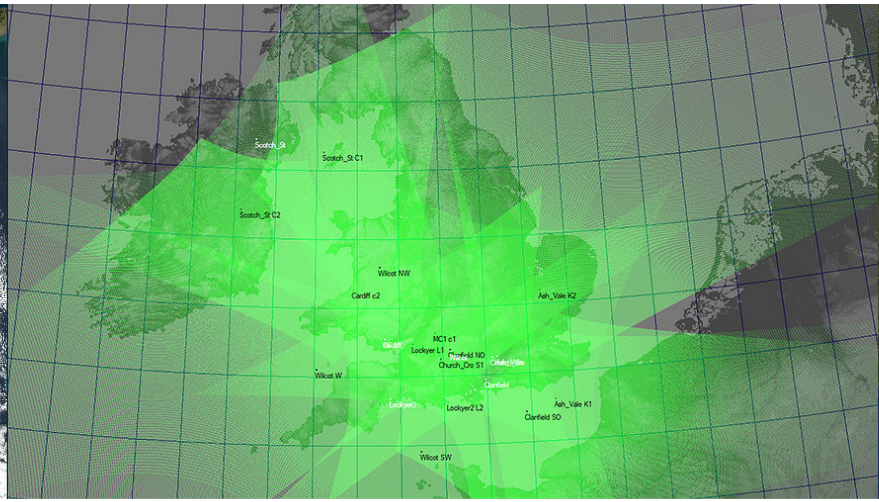
Meteor science in the Big Data era needs:

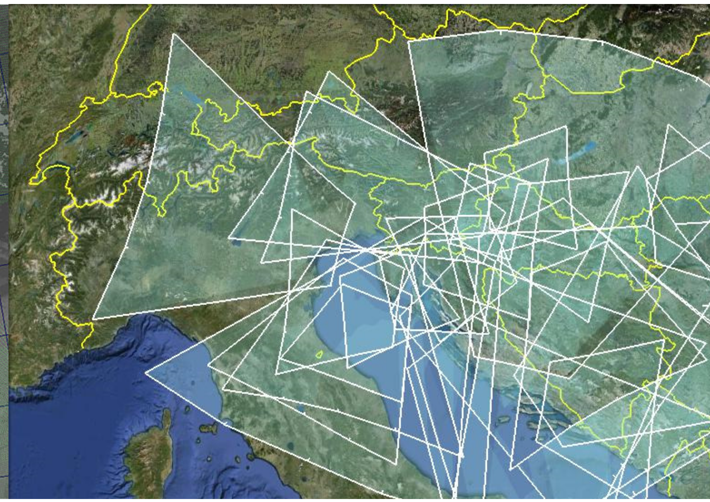
- more complex methodological approaches through interdisciplinary collaborations with other branches of physics and computer science

- integration into large surveys in astronomy, aeronomy and space physics

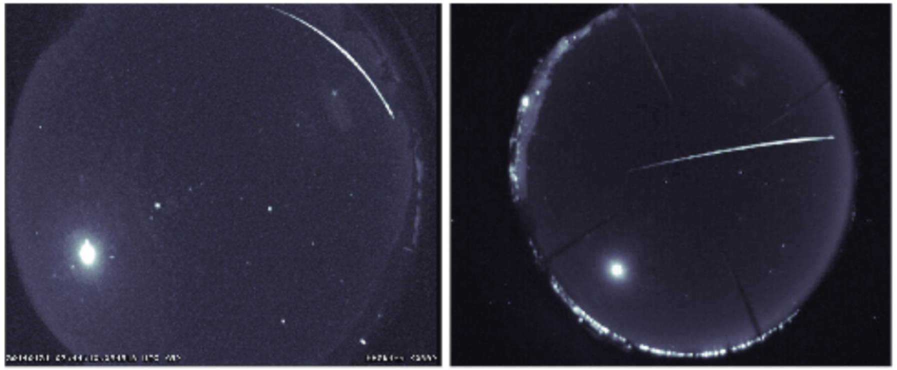
- more advanced theoretical work on the complexity of micro-physics of meteor plasma and its interaction with the atmosphere (ionosphere)



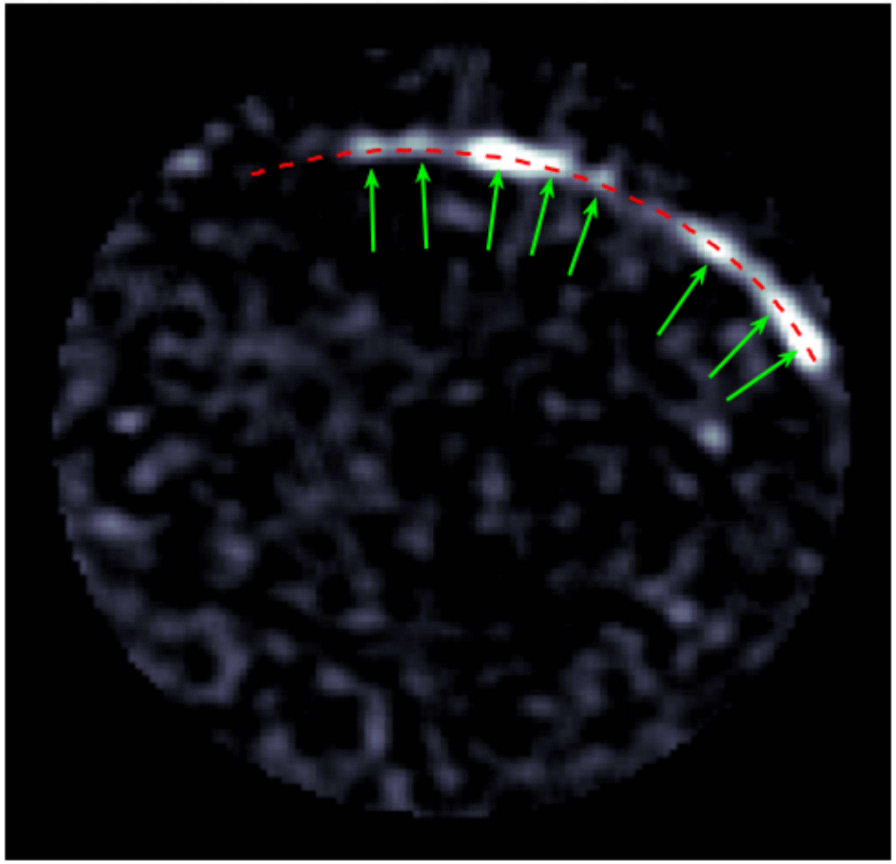




Observing meteors outside the traditional visual bands and comfort zone of meteor astronomers



ground cameras



radio afterglow at 38 MHz and averaged over 15 seconds

Discovery of MHz emission from meteors in the VHF radio band using the LWA1 Radio Telescope (Obenberger, 2014)

The nature of this emission is not understood

The ongoing and upcoming radio sky surveys will produce petabytes and soon exabytes of data (LOFAR, SKA).

LSST can map the entire visible sky in just a few nights

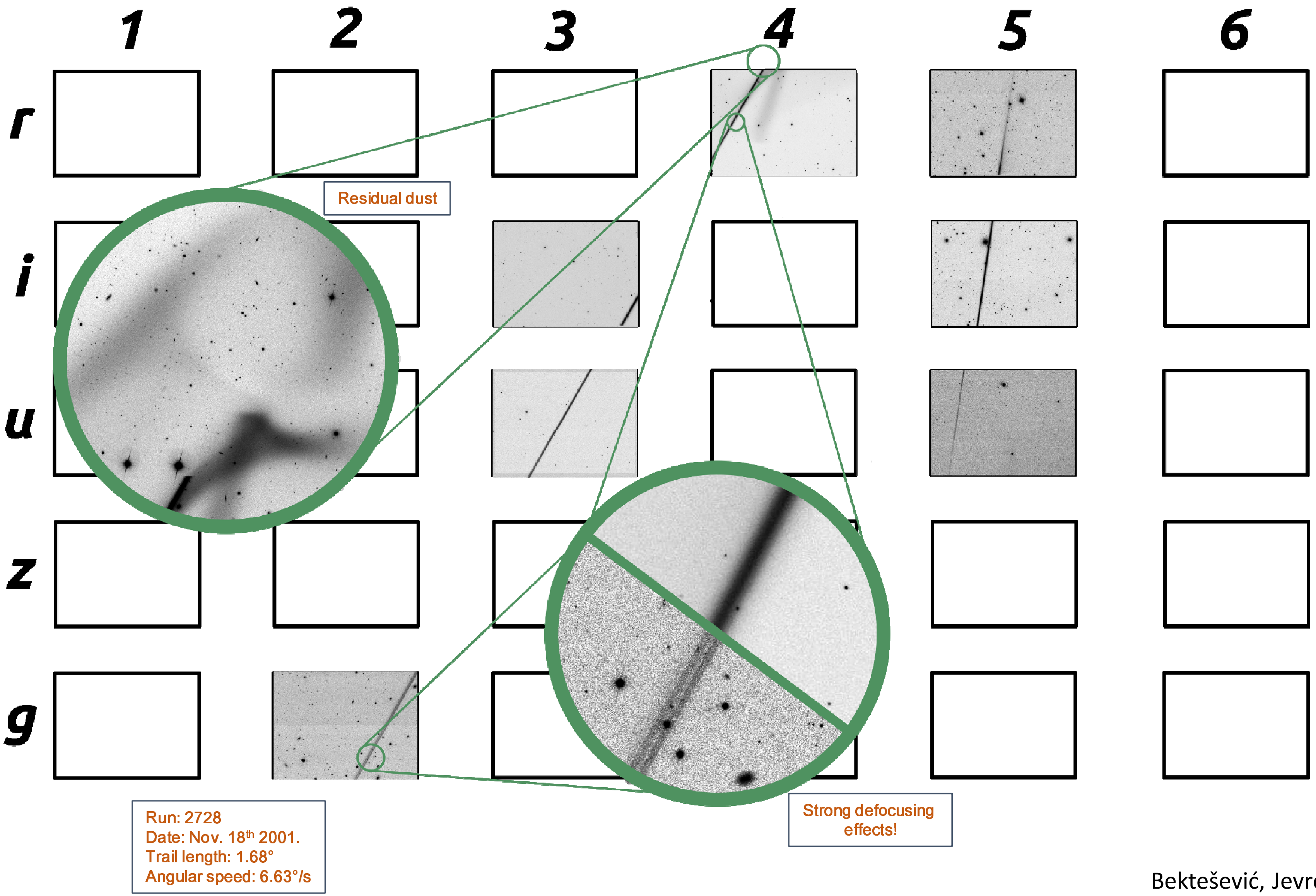
- 3200-megapixel camera (FoV of 40 times the full moon)
- 37 billion stars and galaxies
- 10 year survey of the sky
- EVERY NIGHT: 10 million alerts, 1000 pairs of exposures,15 Terabytes of data

EISCAT_3D: a multistatic radar composed of

- five phased-array antenna fields
- each field ~10,000 crossed dipole antennas
- will act as receivers, transmitting at 233 MHz (VHF band)
- spread over Finland, Norway and Sweden.

~190,000 meteor orbits per day

meteor detections on images from sky survey telescopes

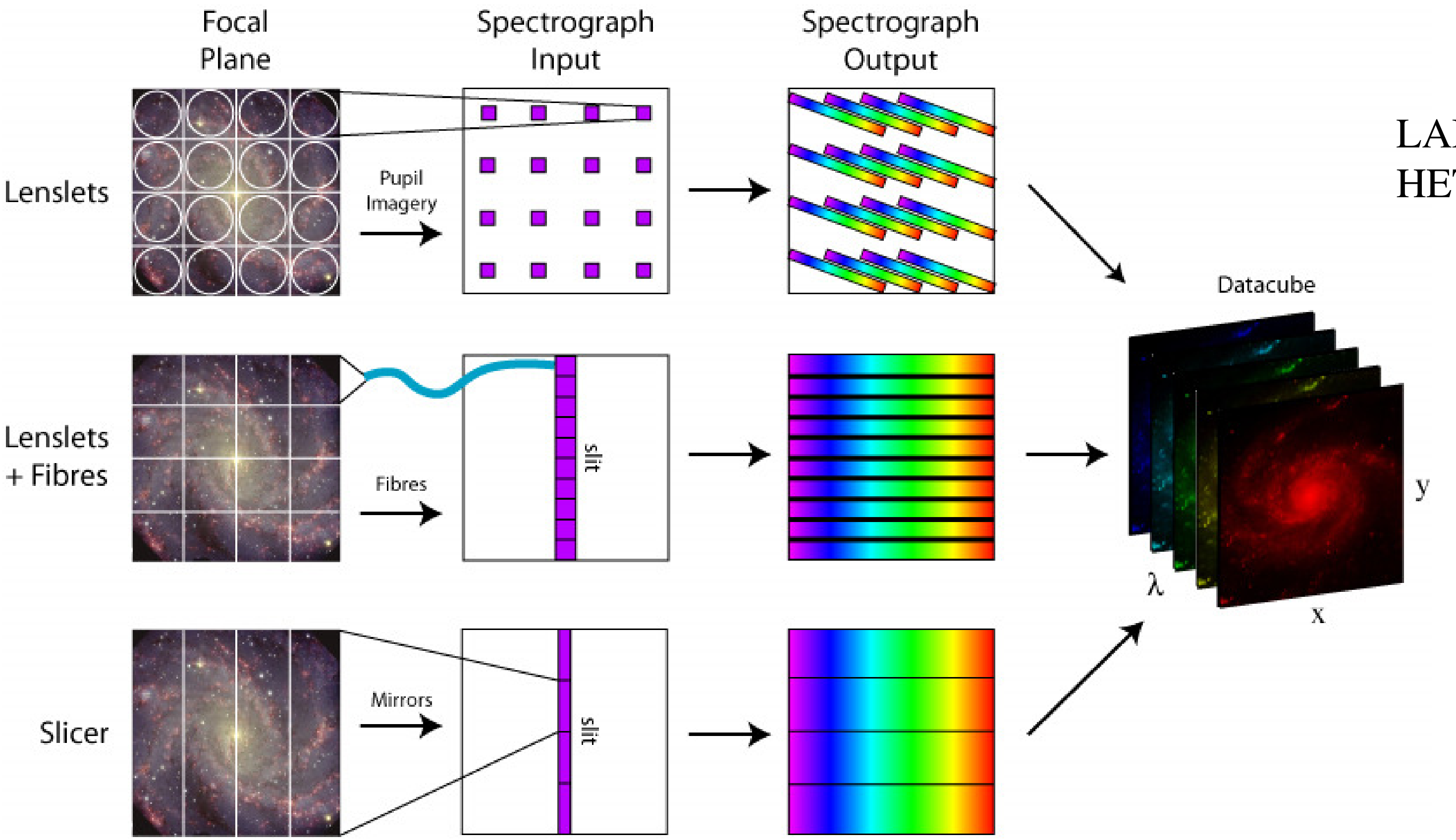


high-resolution
&
high-sensitivity
&
high-precision photometry
&
resolved (defocused)

SDSS example

Bektešević, Jevremović, Vinković, in preparation, 2016

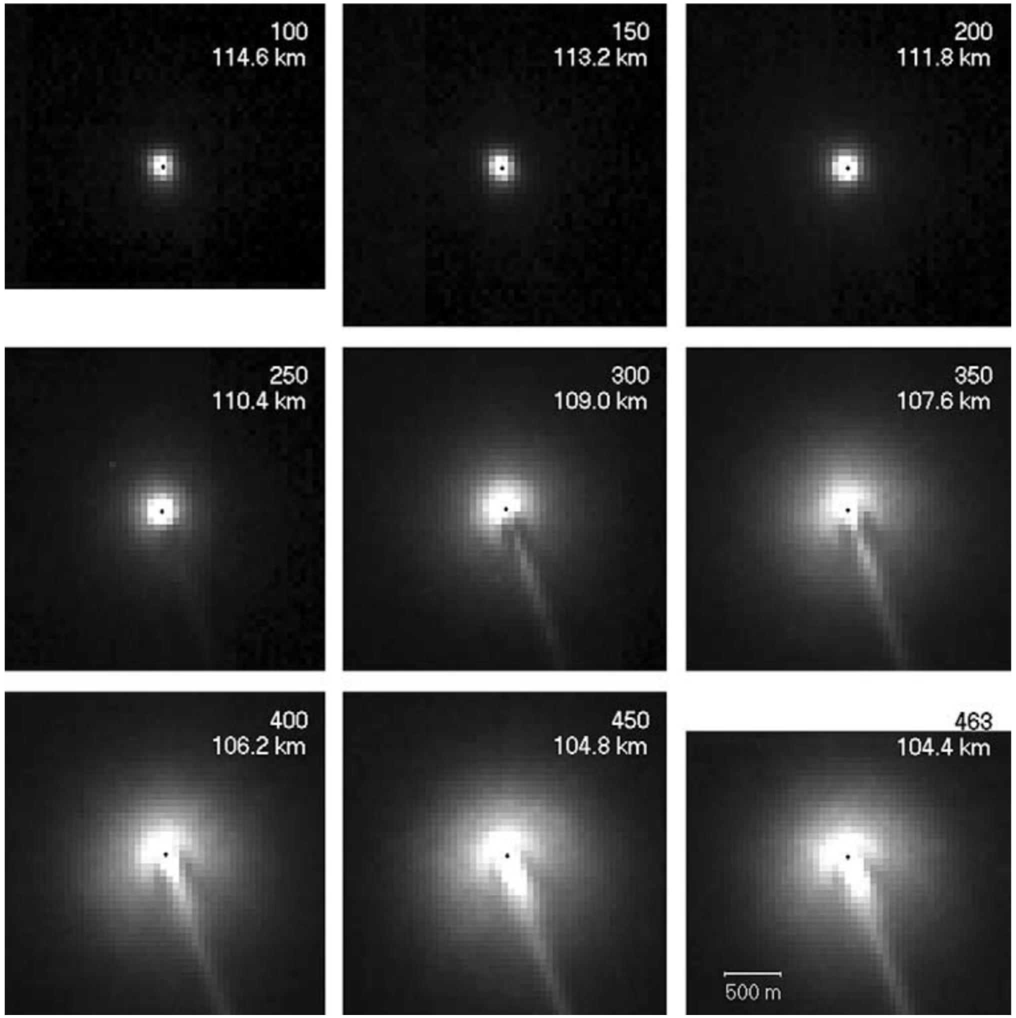
integral field spectroscopy



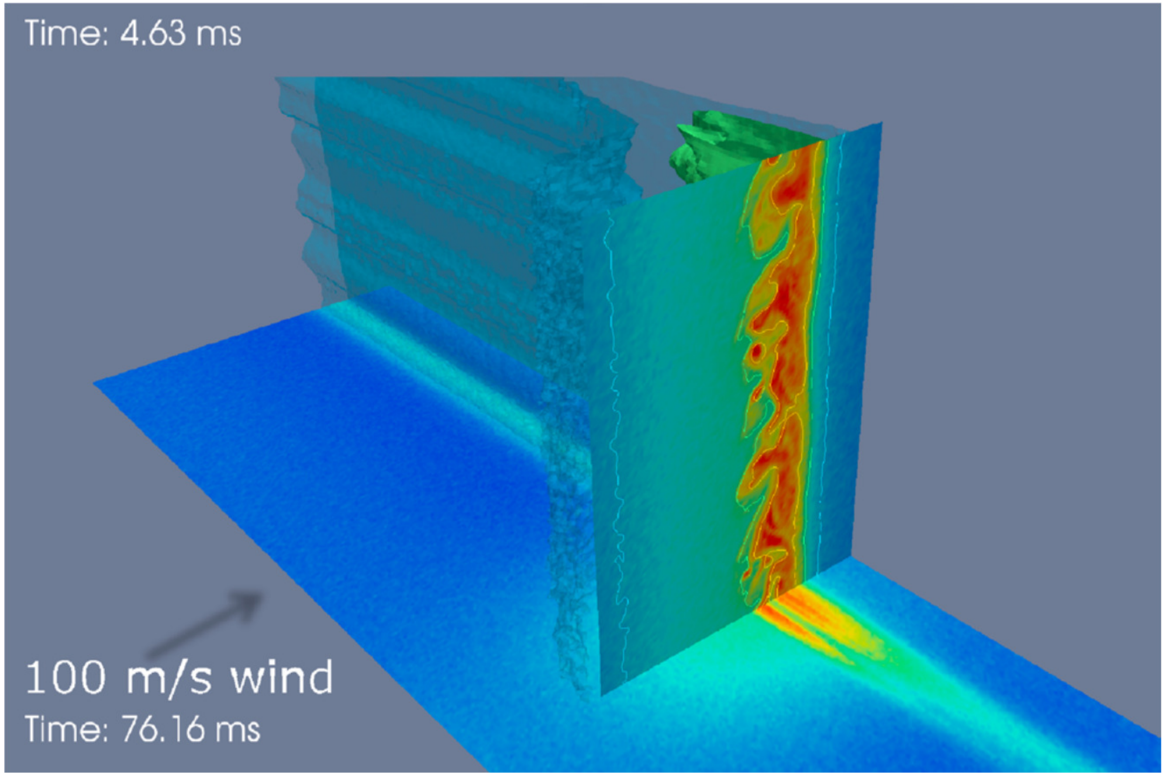
http://ifs.wikidot.com/what-is-ifs

wide-field spectroscopic surveys with an exposure time of tens of minutes to several hours

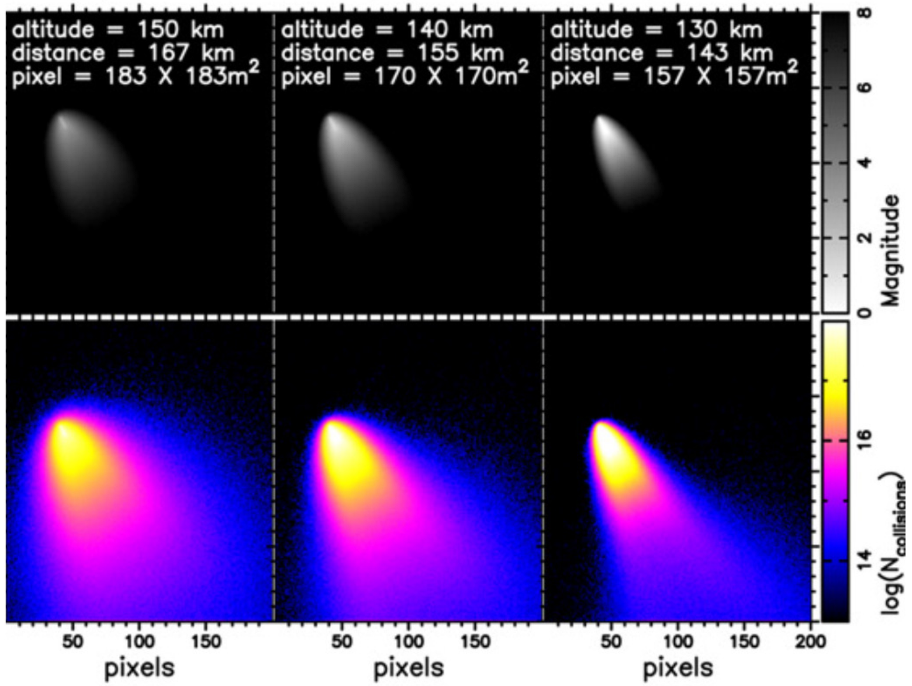
LAMOST survey = 4000 fibres of over 5°
HETDEX survey = 33600 spectra in 22 arcmin



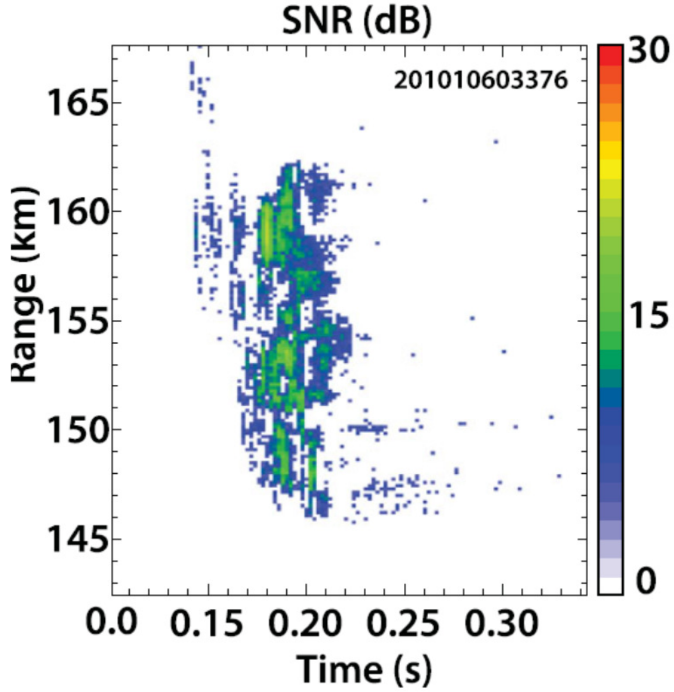
large halo around a meteor detected in a high-speed recording (Stenbaek-Nielsen and Jenniskens, 2004)



magnetization of trail electrons = faster drift along B (Oppenheim and Dimant, 2015).

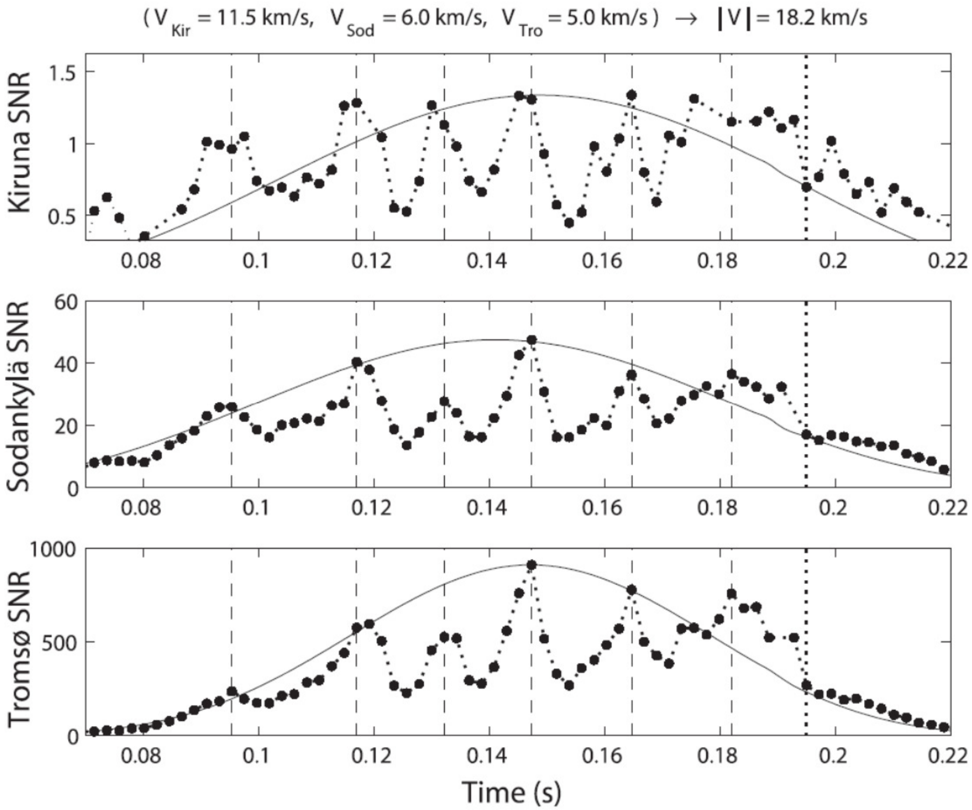


High altitude meteors (above 130 km) from sputtering (Vinković 2007), but microphysics is missing



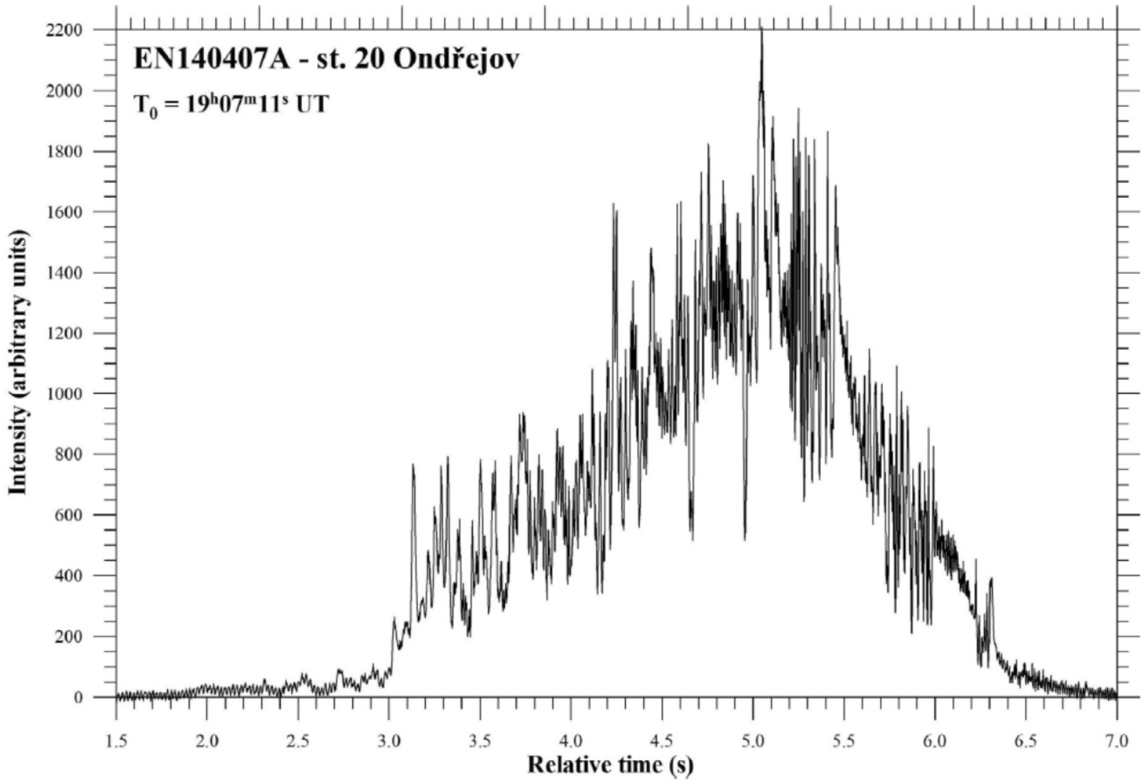
High altitude ”dragon” events from a high-power, large-aperture radar (49.92 MHz) (Gao and Mathews, 2015)

Sometimes precise meteor time & position require corrections to the Standard Atmosphere models (Lyytinen & Gritsevich, 2016)

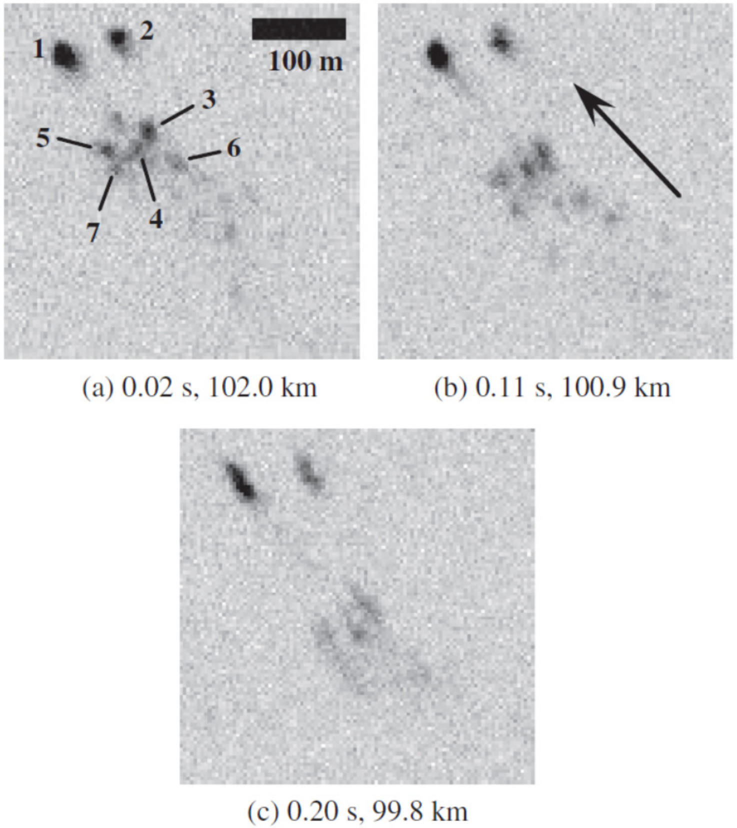


Pulsations of meteor head plasma detected using tristatic 930 MHz EISCAT UHF radar system (Kero et al 2008)

(and submillimeter fragmentation events from radars)



Millisecond flares (Spurný & Ceplecha, 2008)



Fragmentation above 100km with high transverse speeds (Stokan & Campbell-Brown, 2014)

meteors triggering sprites?
(Suszcynsky et al 1999)

Our understanding of meteor plasma and hypervelocity shock physics in rarefied partially ionized and partially magnetized ionospheric plasma is NOT complete.

Diverse observational techniques:

- Cameras on the ground (images, spectra, triangulation, photometry)
- Detectors in orbit (images, spectra – UV)
- Images and spectra from big telescopes and sky surveys
- Three dimensional radar observations (EISCAT_3D)
- ELF/VLF/LF radio signals
- etc.

Theory should go beyond the standard phenomenology!