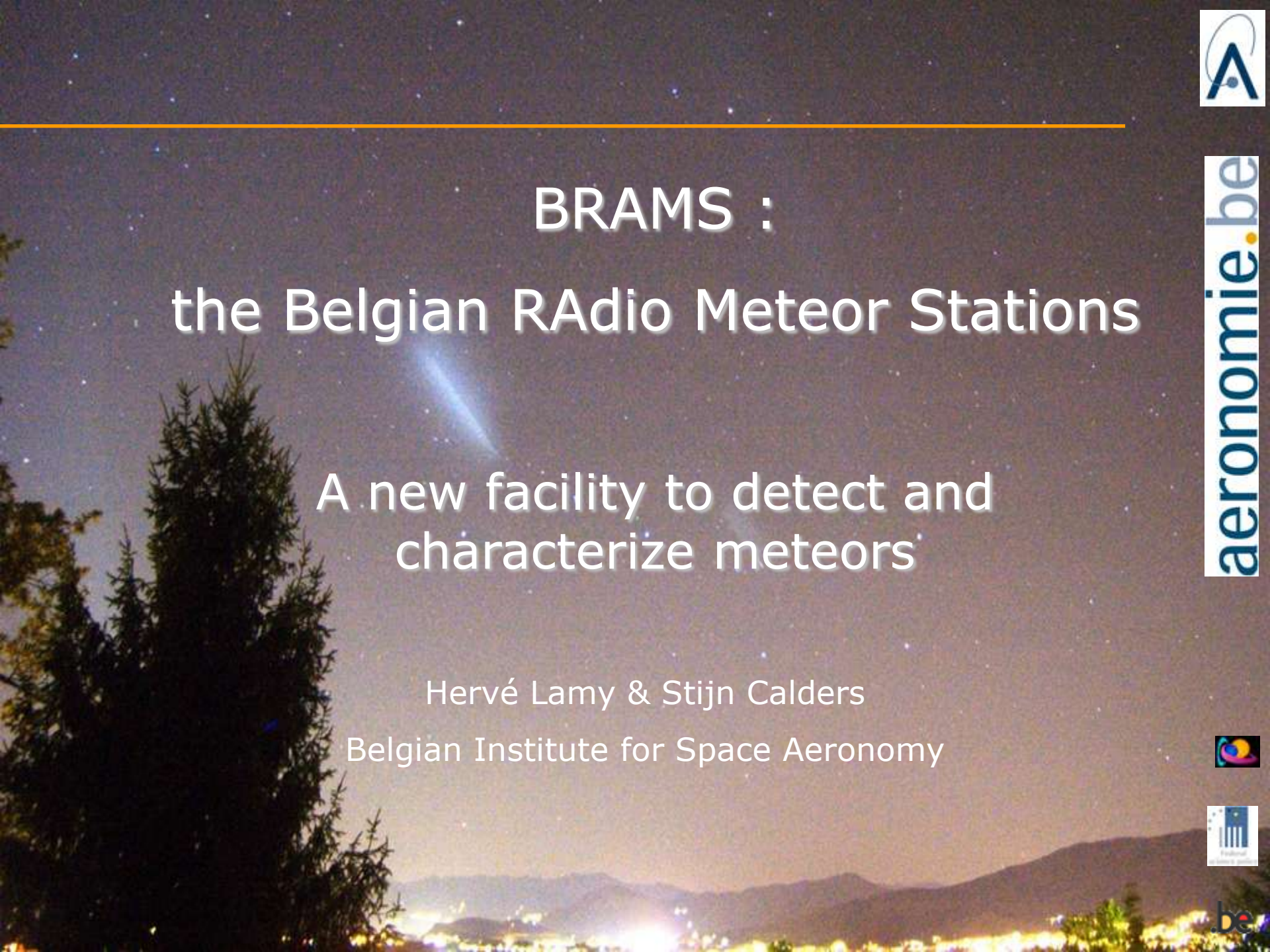


BRAMS :
the Belgian RAdio Meteor Stations

A new facility to detect and characterize meteors

Hervé Lamy & Stijn Calders

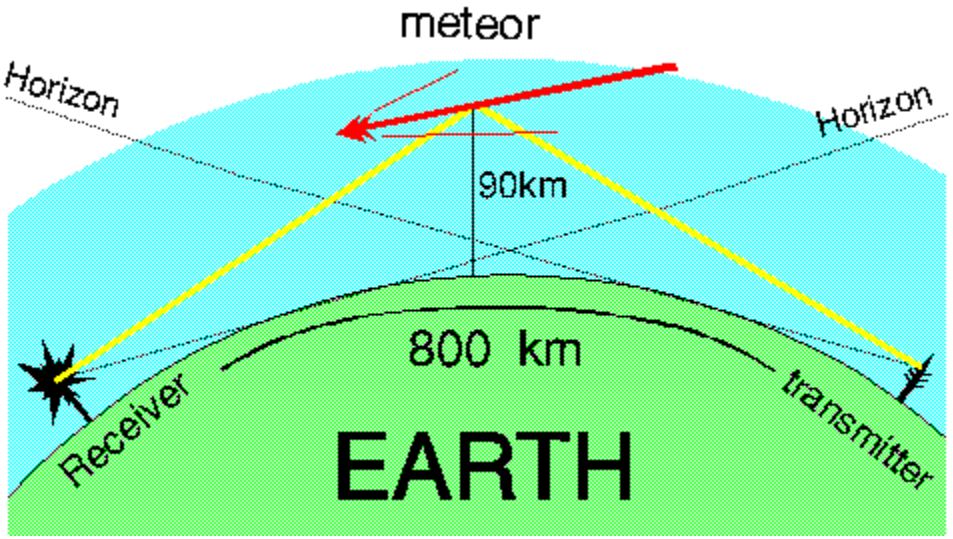
Belgian Institute for Space Aeronomy

Overview

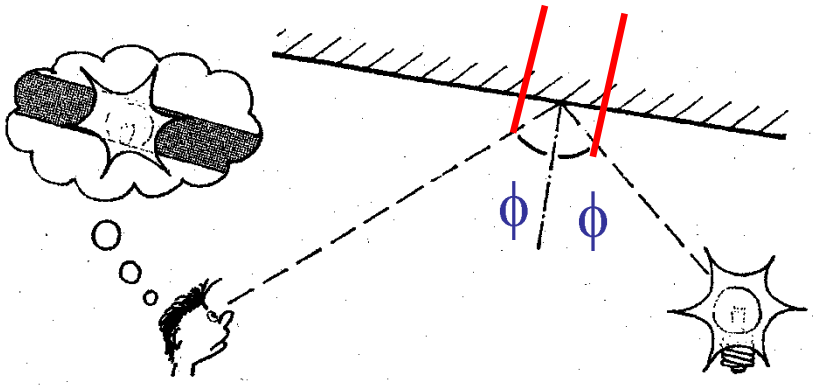
- Radio meteor observations: forward scattering
- Description and status of BRAMS
- Scientific goals of BRAMS
- Future and perspectives

RADIO FORWARD SCATTERING OBSERVATIONS OF METEORS

Radio forward-scattering observations



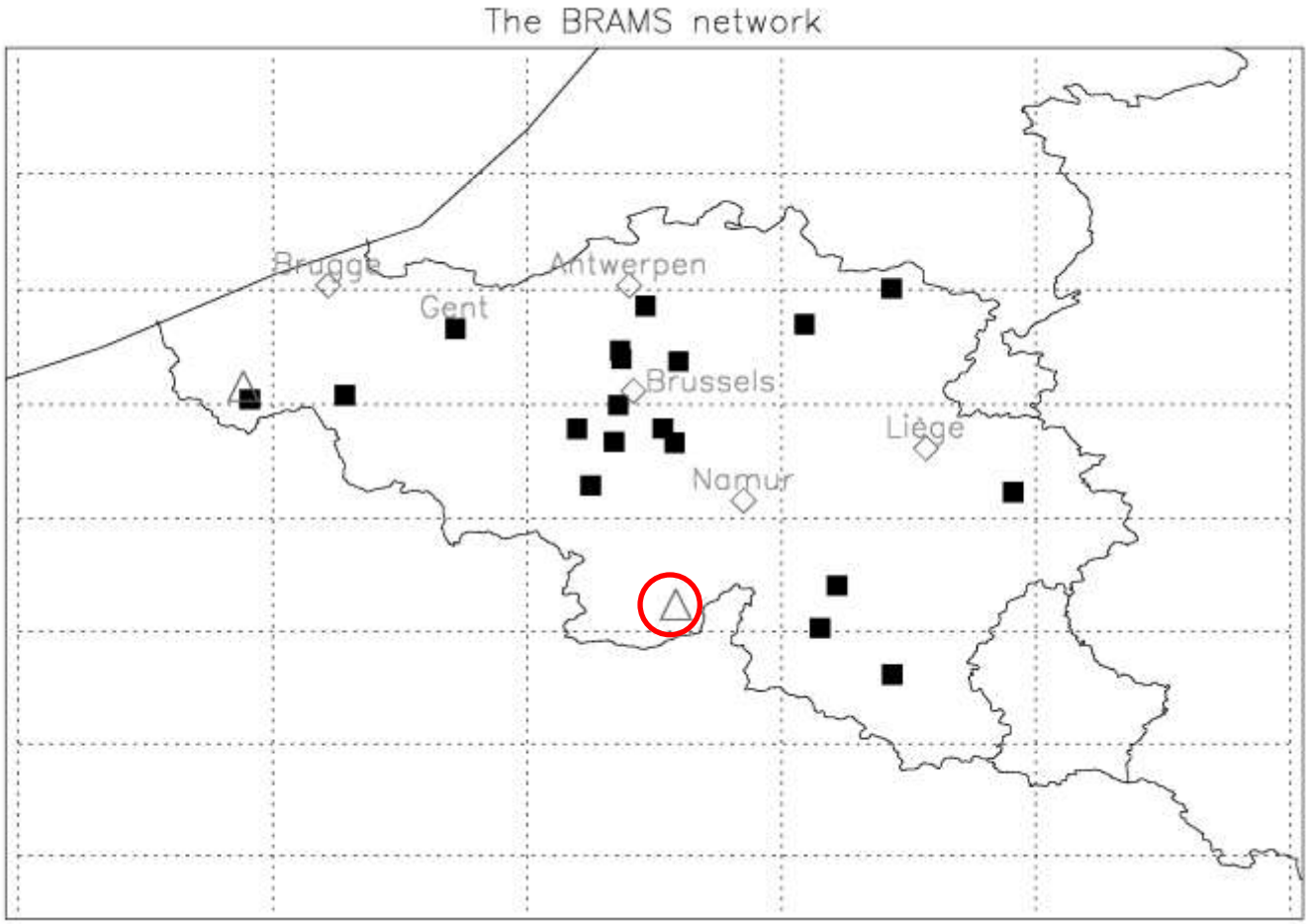
Duration of the « meteor echo » depends on the lifetime of the electron trail released in the wake of the meteoroid (from a fraction of a second up to a few minutes) and of the sensitivity of the receiver



aeronomie.be
.be

BRAMS: the Belgian RAdio Meteor Stations

The BRAMS network



A dedicated beacon in Dourbes

- ✓ 49.97 MHz
- ✓ 150 W
- ✓ pure sine wave with circular polarization
- ✓ altitude ~ 230m

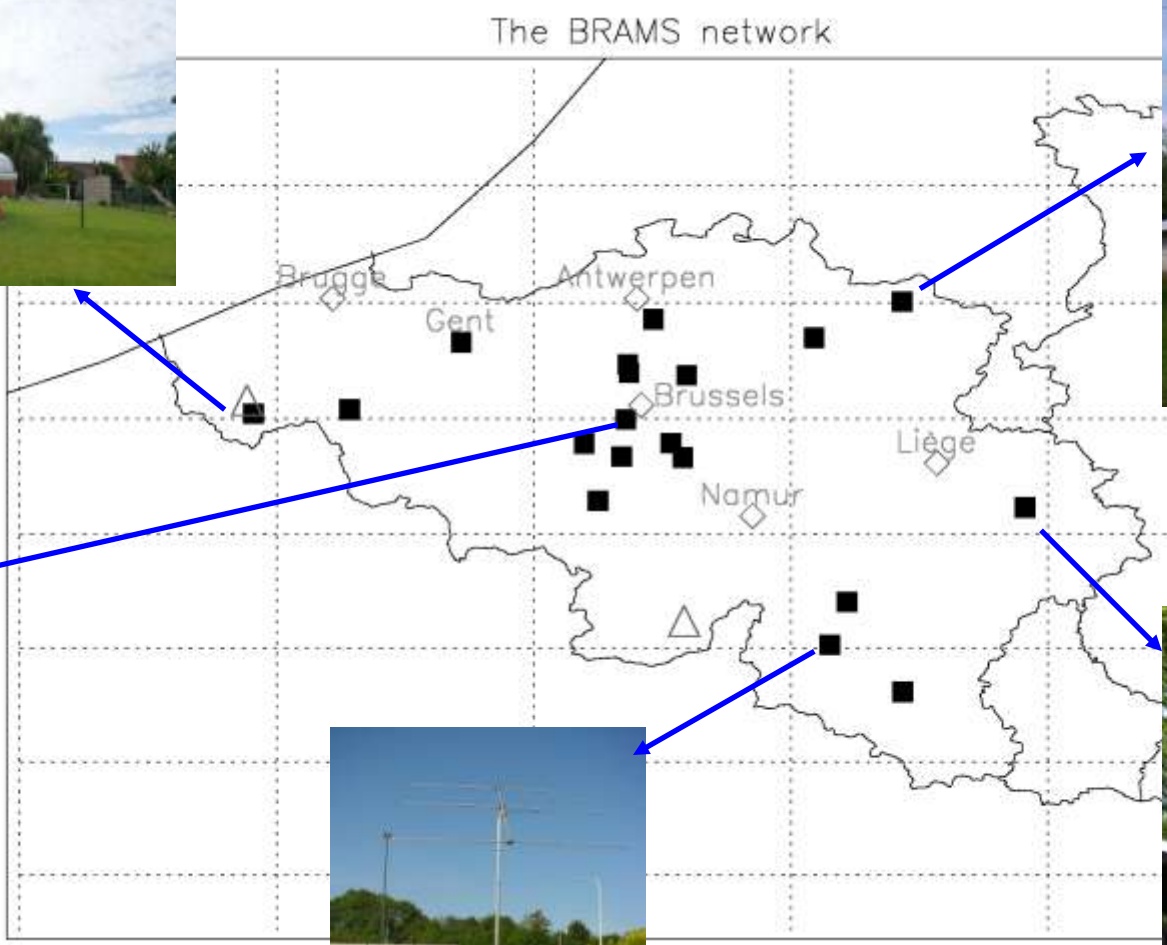
aeronomie.be
.be

A typical receiving station

AGC switched off

aeronomie.be

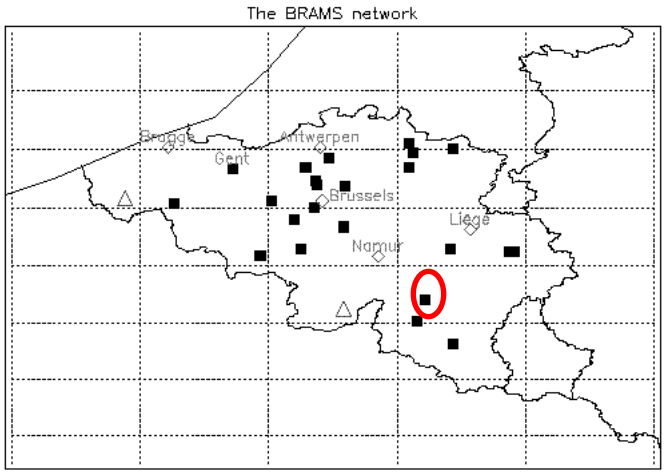
Current status of BRAMS



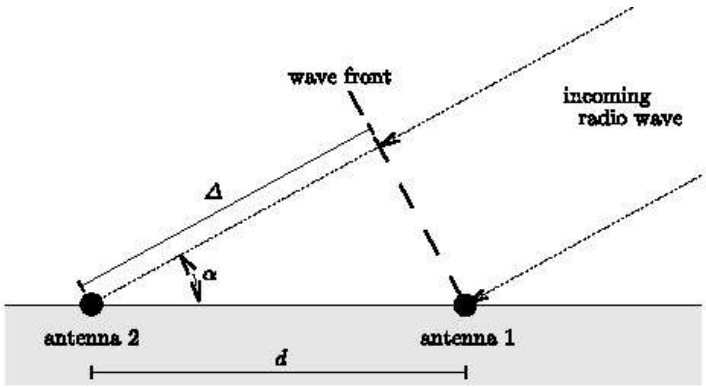
aeronomie.be

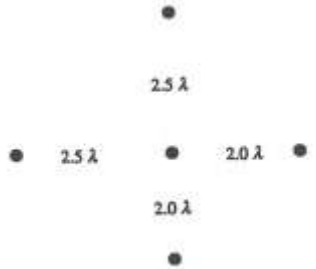
.be

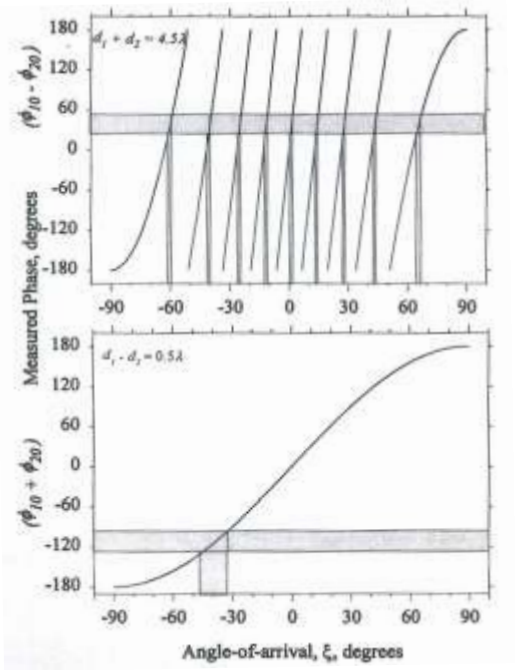
Interferometric station in Humain



Based on the method proposed by Jones et al (1998)

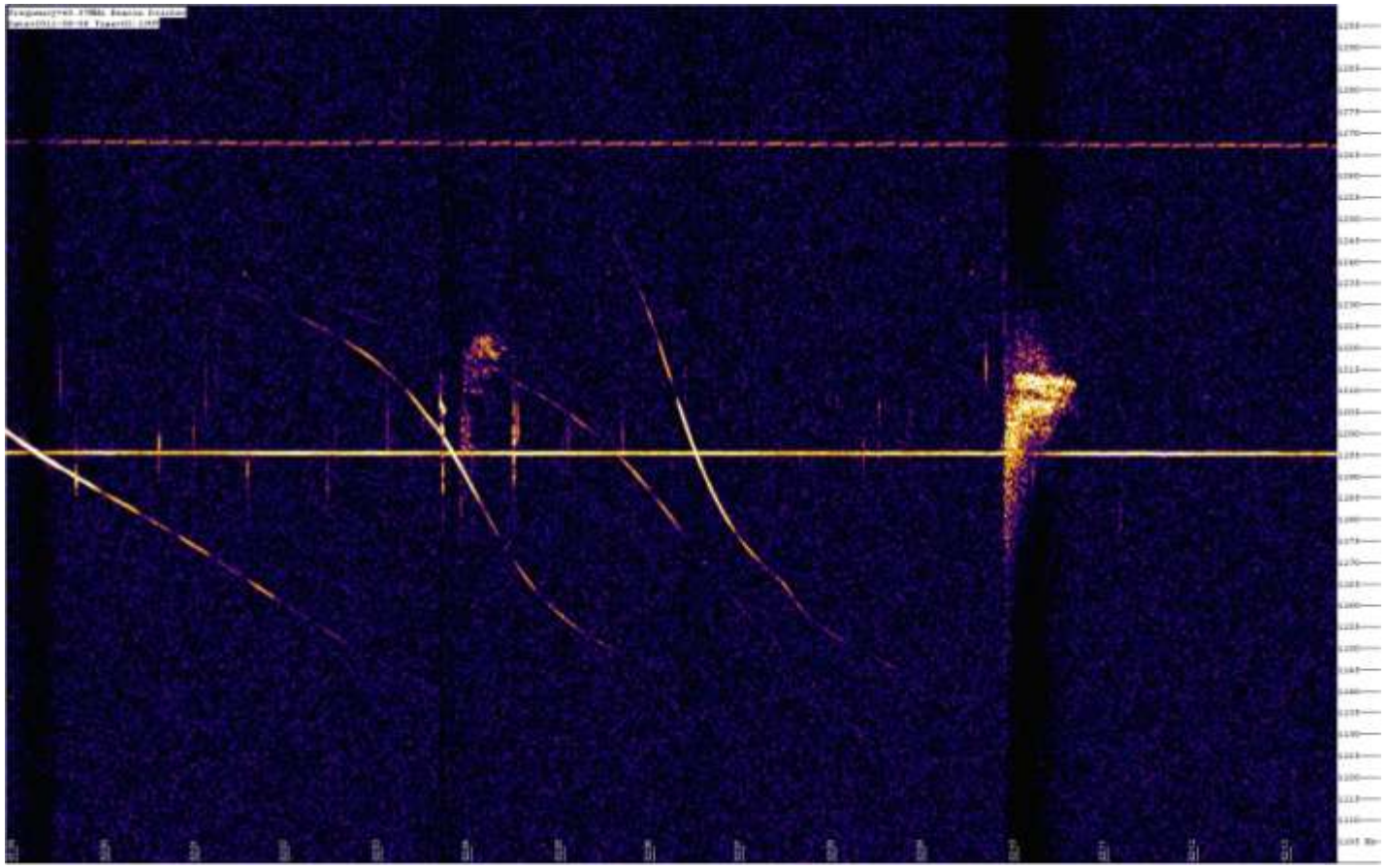






Analysis of the signal

- We make a FT of the sampled signal to obtain spectrograms



Frequency

Δf=200Hz

06/08/2011 2h13 UT BEUCCL

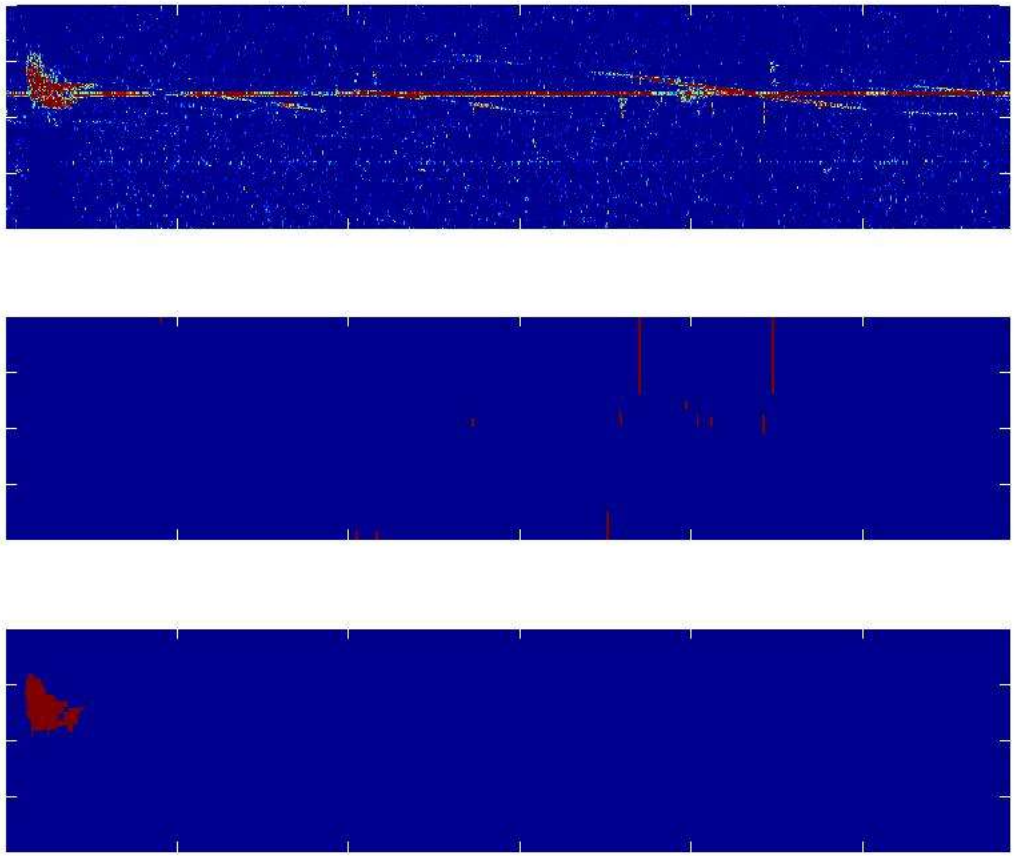
time

Δt = 1 min

Automatic detection of meteor echoes

Mathieu Deltour (EPHEC)

Use of Matlab functions such as edge detection, labelisation, erosion and dilatation



underdense

overderdense

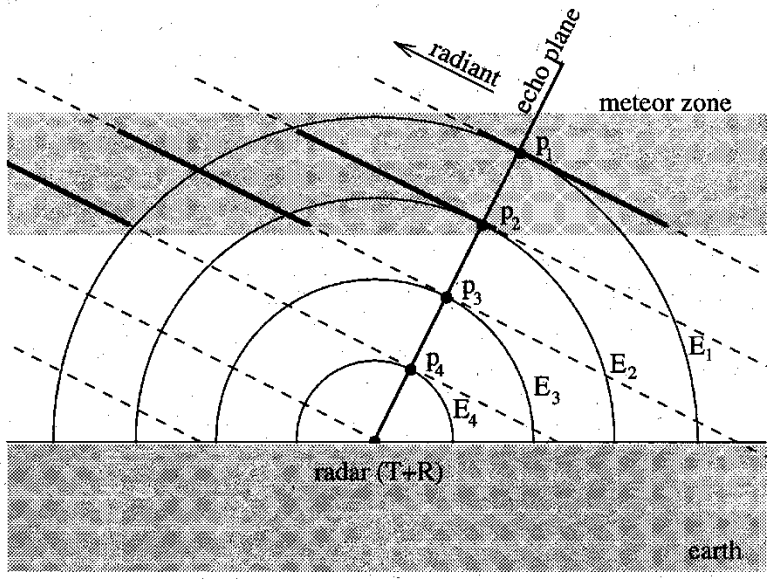
Must be validated but looks promising

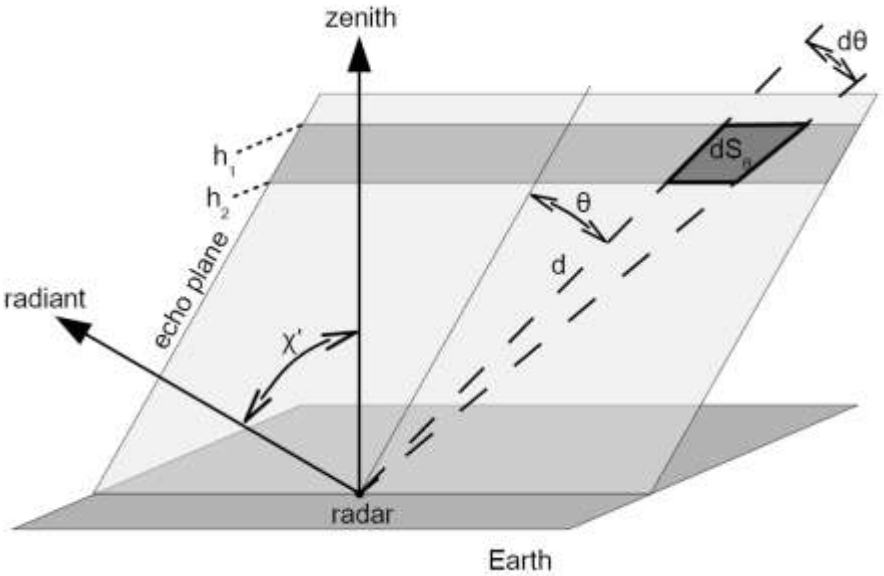
Scientific goals of BRAMS

Meteoroid flux densities for meteor showers

- Meteoroid flux density $Q(m)$ = number of meteoroids having masses greater than m that intersect a unit area perpendicular to the meteoroid velocity vector (or radiant) per unit time

- Based on meteor echo countings and following the methods of Kaiser (1953) and Belkovich (1971, 2006) and extended to forward scatter systems by Ryabova (2006, 2007). Two different methods using all observed meteor showers and only overdense meteors



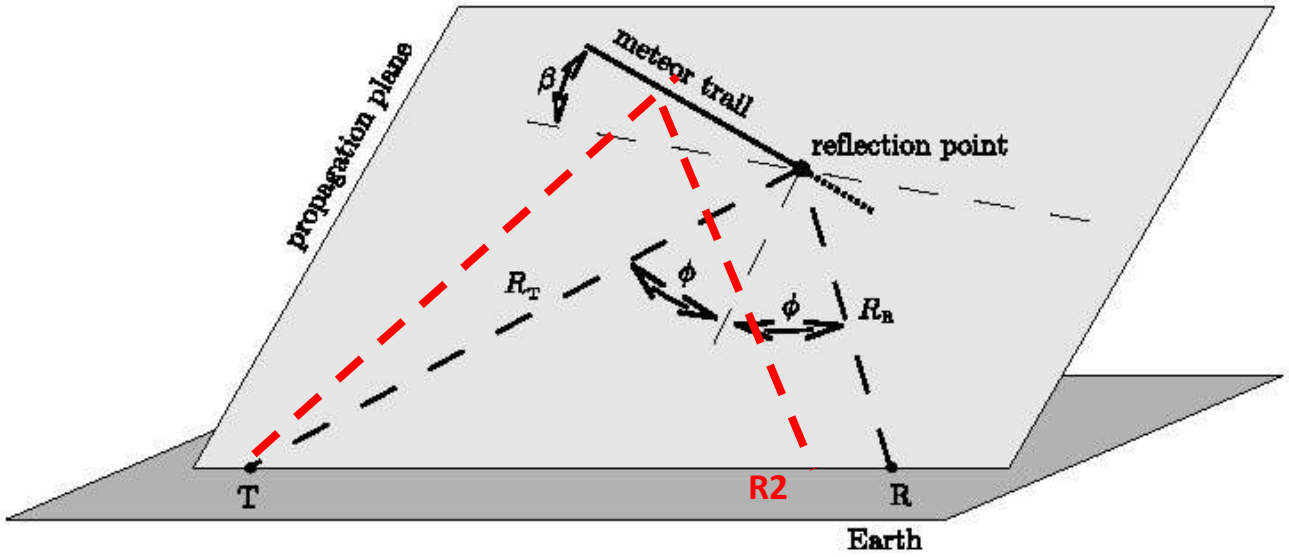


Meteoroid flux densities and mass index for meteor showers

- The previous methods assume that we can estimate the mass index *s* of the shower (e.g. from the slope of the cumulative logarithmic amplitude distribution of meteor radar echoes)

- Belkovich (2006) proposed another method to fine-tune both meteoroid flux densities $Q(m)$ and mass index *s* of a meteor shower at the same time.

Retrieval of meteoroid trajectories



Retrieval of meteoroid trajectories (2)

- **Multi-stations observations of the same meteor** : the meteor trajectory must be tangential to a set of ellipsoids whose foci positions are the locations of the transmitter and receiver.

- **Multi-stations observations of the same meteor** : by accurately measuring the start of the echo (linked to the positions of the various specular points) at each station, it is in principle possible to retrieve the meteor trail path. This needs at least six stations (3 DoF for position and 3 for velocity) synchronized by GPS. Problem : this assumes no deceleration of the meteor unless we can measure it from another method (e.g. from Fresnel oscillations in underdense meteor echoes)

aeronomie.be
.be

Retrieval of meteoroid trajectories (3)

- **Multi-stations observations of the same meteor including the interferometer** : from the interferometer data, the direction of one specular point can be accurately determined as well as a direction perpendicular to the meteor path. Three other stations are necessary since only the distance, path orientation and velocity still have to be determined.

- **Particular case of head echoes** : measurements of Doppler shifts and slope of the head echoes can be used to retrieve trajectory and speed of a meteor observed by at least 6 stations.

aeronomie.be
.be

Future activities coordinated with BRAMS

- Development of a radar system located next to the beacon in Dourbes. Among others goals, to compare and calibrate meteoroid fluxes obtained with back scattering and forward scattering systems. In particular, test of the echo ceiling effect preventing backscattering systems to detect small and/or fast meteors at high altitude.

- Addition of an optical camera in Humain → simultaneous optical / radio detections of meteors ➔ better accuracy on the trajectories.

- Meanwhile, coordinated observation campaign with a SPOSH (Smart Panoramic Optical Sensor Head) camera from ESA?

Conclusions

- BRAMS will be a unique tool to detect and characterize meteors. By end of 2011, BRAMS will have ~20-25 stations, one interferometer and a dedicated beacon.

- BRAMS will be challenging, both in terms of new methods to develop and test, but also in terms of data storage and analysis.

- BRAMS is currently a Belgian project but collaborations with neighbouring countries are already going-on with future stations in the south of Paris, in Lille, in the Netherlands, etc…

BRAMS : the website

http://brams.aeronomy.be


THANKS !