## RADIO METEOR OBSERVATIONS: POSSIBLE DEVELOPMENTS IN THE FRAME OF PRISMA NETWORK

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PRISMA DAYS 2020



#### **OVERVIEW**

• All-sky cameras: orbit parameters, impact location

Computation of meteor velocity affected by large uncertainty (sampling rate, spatial resolution)

- Radio data: provide a precise estimate of meteor velocity through the measurement of Doppler frequency drift
- Aim: improve PRISMA network efficiency by measuring meteor radio echoes



#### **METEOR TRAIL**

• A meteoroid creates a long column of free electrons when hitting the air molecules of the Earth atmosphere

• The ionized trail and the plasma surrounding the body are able to reflect radio waves

 The head echo is affected by a variable frequency shift due to Doppler effect

#### **DOPPLER SHIFT**

- The moving target is illuminated by a continuous wave train
- The outgoing sinusoidal wave is Doppler-shifted to higher or lower frequencies by the ionised meteor trail according to the radial velocity





#### **Double Doppler shift due to:**

- Radial velocity between the transmitter and the meteor
- Radial velocity between the meteor and the receiver



$$F_{shift} = F_{tr} \frac{1 + \frac{V \cos(\alpha)}{c}}{\frac{1 - V \cos(\beta)}{c}}$$

Geocentric velocity estimate strongly depends on trajectory computation

Synergy between optic and radio measurements

Rault, 2014



### **GRAVES RADAR**

- Located near Dijon in the central France
- Used by French Air Force to detect spacecraft and space debris as it crosses the French airspace over the Mediterranean
- It transmits 24 hours a day a continuous wave of 143.050 MHz
- Each of the 4 antenna systems scans an azimuthal sector of 45° (from 90° to 270°) in the southern direction of Dijon

#### **RADIO SIGNAL DETECTION**





FUNcube Dongle Pro + FRIPON network (Rault, 2014)

- Radio data are recorded 24 hours a day and stored in 2 min audio files with two channel (I-Q signal, in phase and in quadrature)
- Actually PRISMA network has two radio receivers (Rovigo and Finale Ligure)
- A MATLAB code is being developed in order to quantify with high precision the frequency shift corresponding to the meteor radio echo

#### SPECTROGRAM OF A SIGNAL



Credit: Mathworks.com

- Visual representation of the spectrum of frequencies of a signal as it varies with time
- Short Time Fourier Transform (STFT): the signal is divided into segments and then the Discrete Fourier Transform is computed for each segments
- MATLAB code developed: maximum flexibility in the setup of time-frequency resolution and trail echo detection







#### **RADIO DETECTION OF CAVEZZO BOLIDE**





#### LOOKING TO THE FUTURE



# MATLAB code refinement





# PRISMA: All-sky camera and radio network

Many meteor detections!