We are about to understand one meteoroid stream *extremely well*

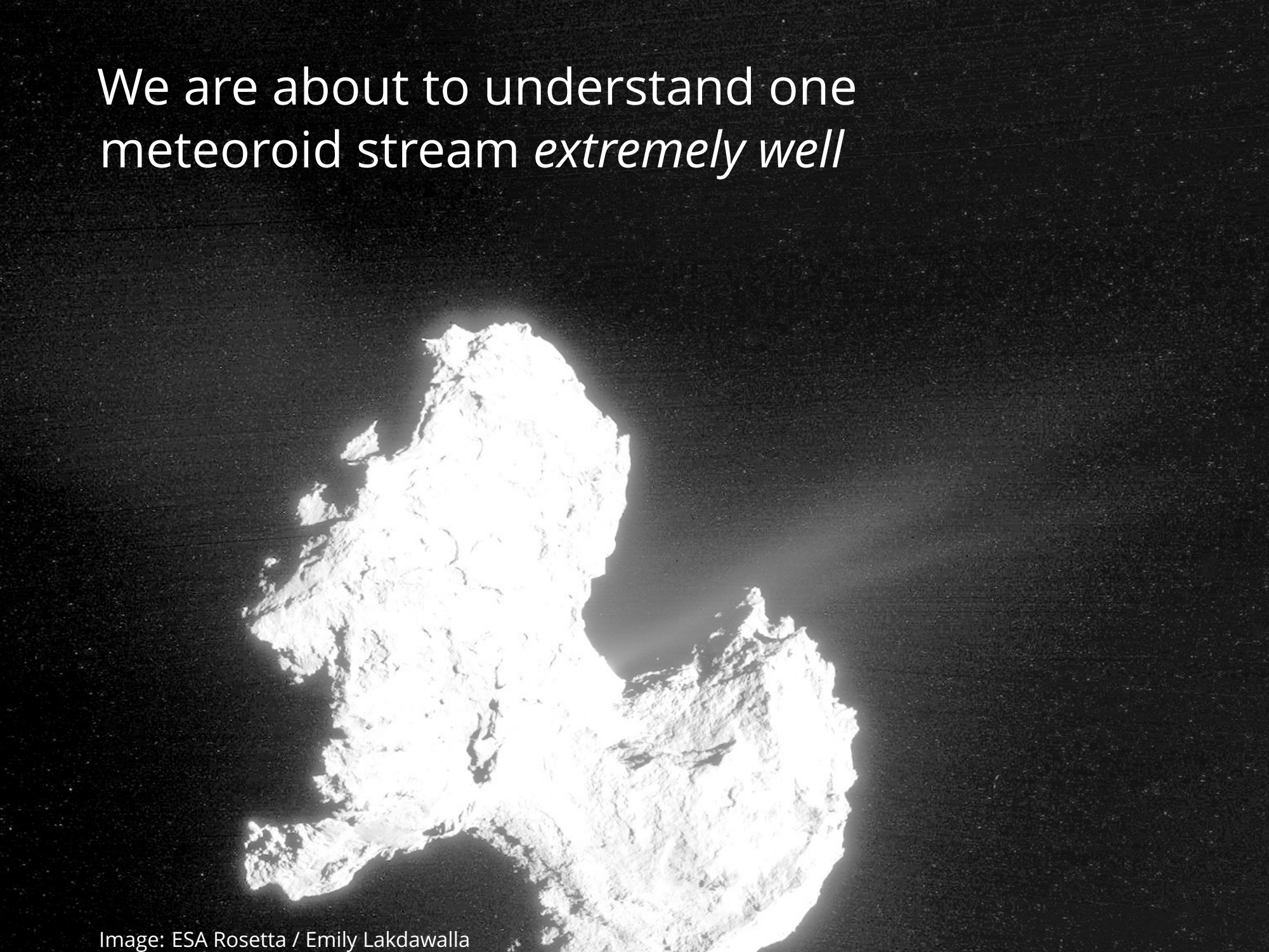
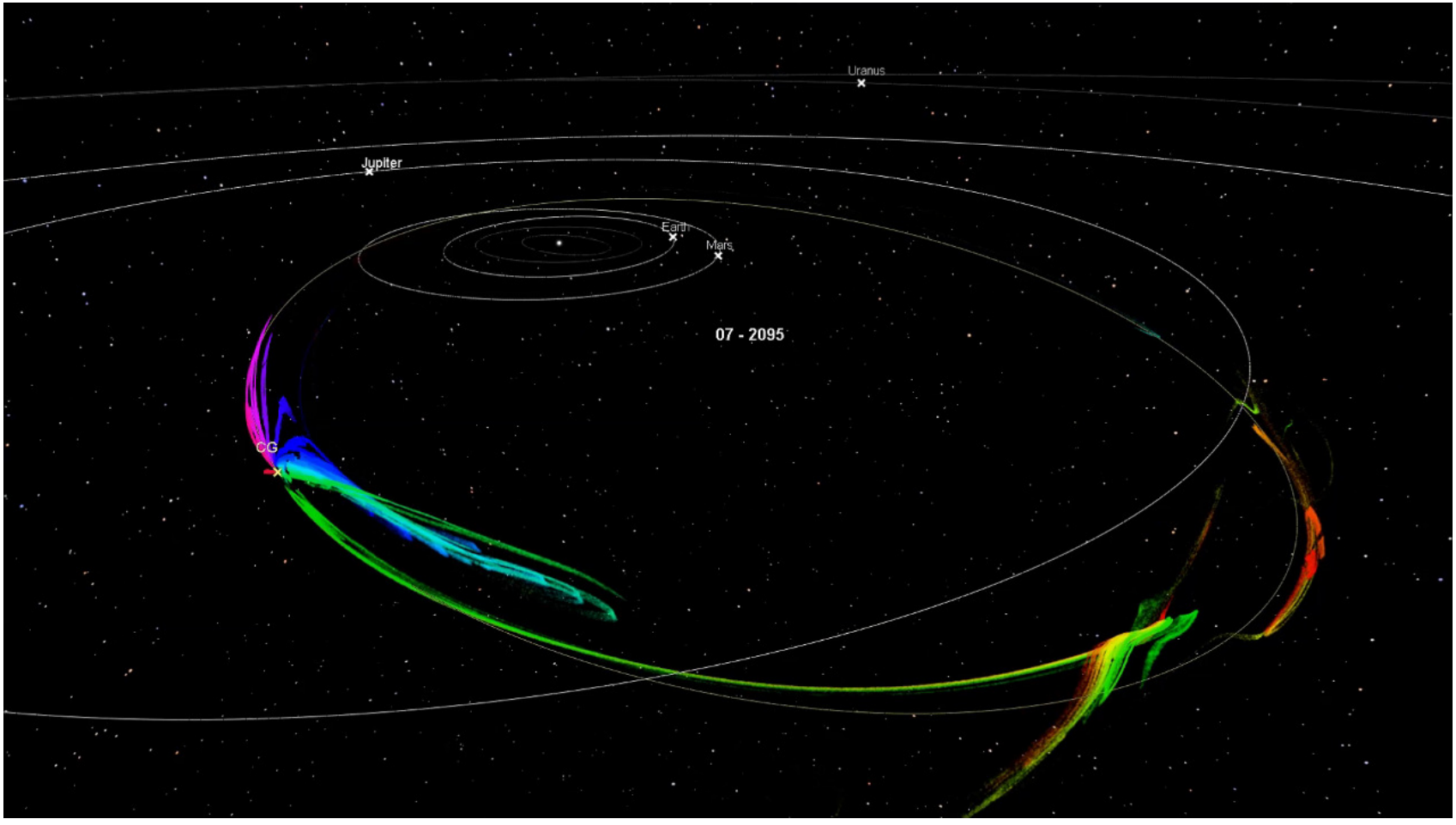


Image: ESA Rosetta / Emily Lakdawalla

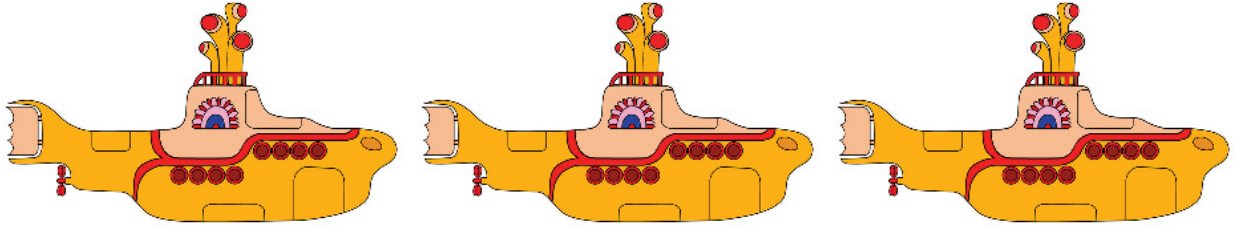
Meteoroid streams are complex (Rachel Soja)



Conference Summary

International Meteor Conference 2014

Geert Barentsen



41 talks, 17 posters

There are a *lot* of cameras

Polish Fireball Network (Przemyslaw Zoladek)

PFN CCTV CAMERAS

Tayama 3102 & 4702 – 41 pcs.

Mintron MTV23X11C – 12 pcs.

Fuho – 5 pcs.

Mintron 12V6 – 4 pcs.

Watec 902 – 5 pcs.

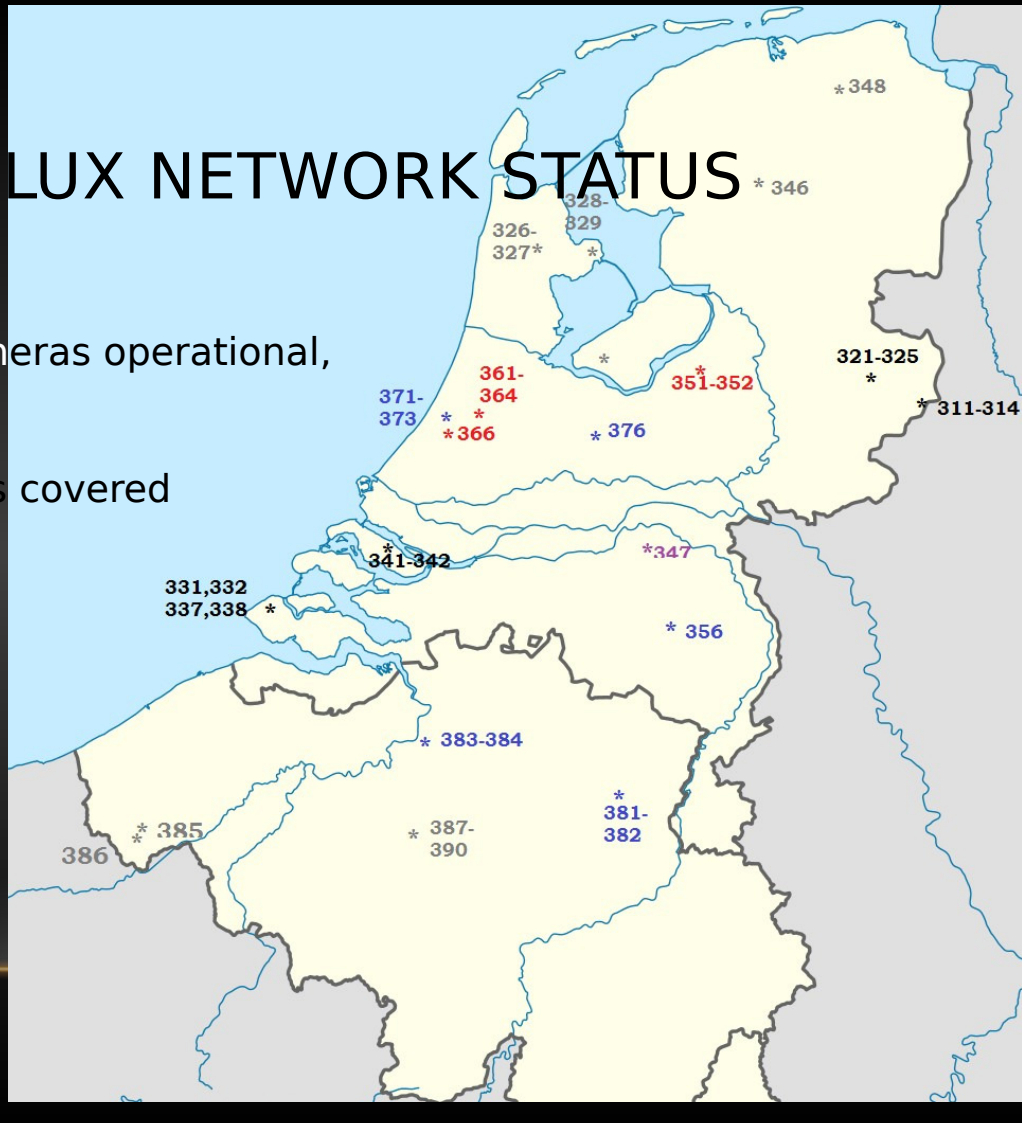
Siemens CCBB1320 – 7 pcs.

Benelux network (Felix Bettonvil)

CAMS BENELUX NETWORK STATUS

Currently 32+*3* cameras operational, in 14 stations

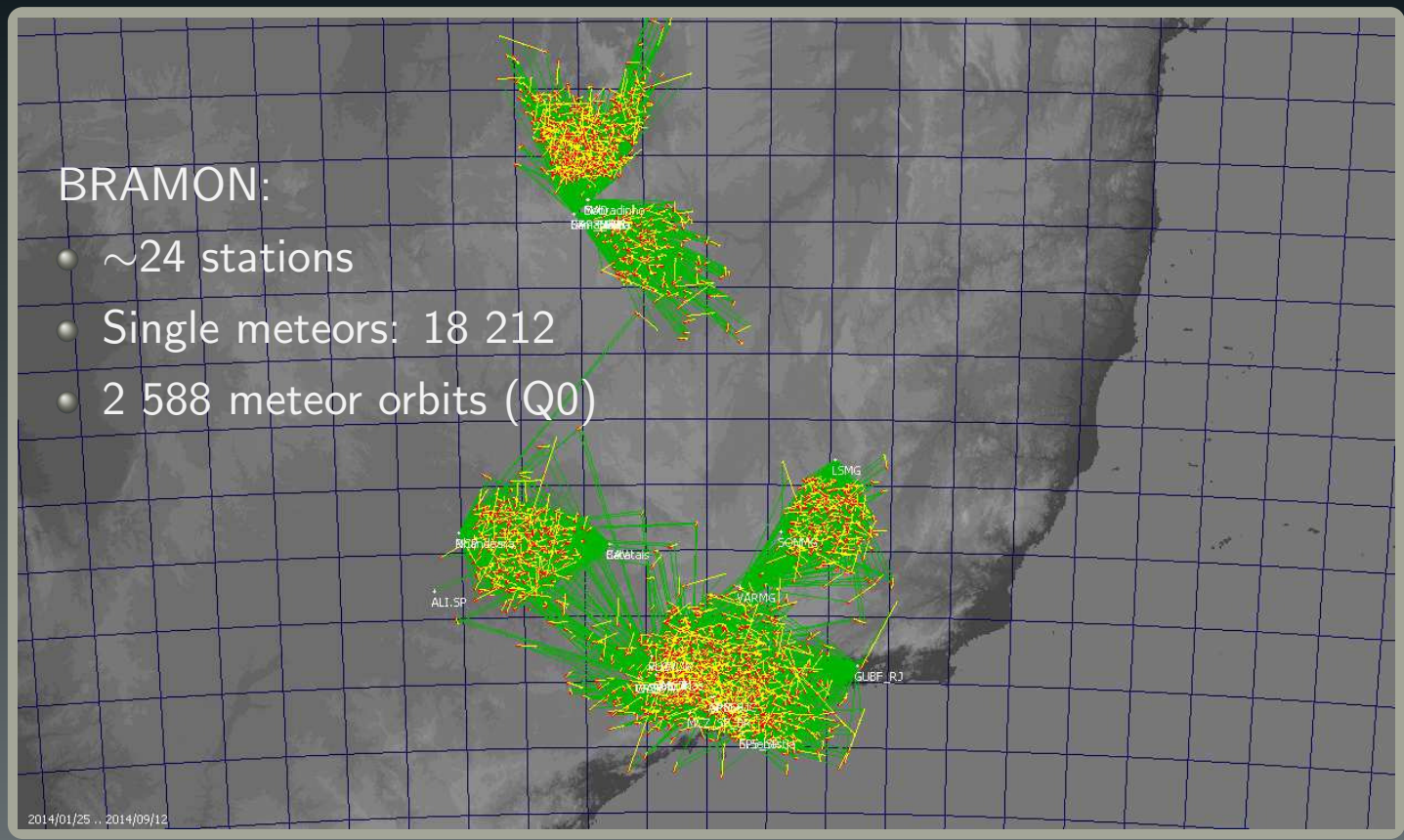
Most of Netherlands covered



New stations in Romania (Ana Georgescu)

New stations in Brazil (Regina Rudawska)

Scientific interest

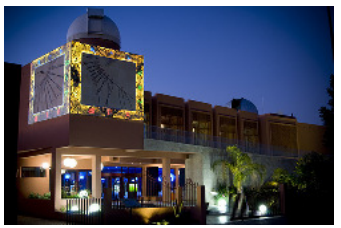


Thanks to Jakub Koukal and Roman Piffl (EDMOND consortium)

New stations in Morocco (Meryem Guennoun)

Double station

	station 1 : Oukaimden	station 2 : AGM
Longitude	31°12'32" N	31°37'28"
Latitude	7°52'52"W	7°59'35"
Altitude	2700 m	466 m



LPHEA
LABORATOIRE DE PHYSIQUE DES HAUTES ENERGIES ET ASTROPHYSIQUE

Why do you have cameras?

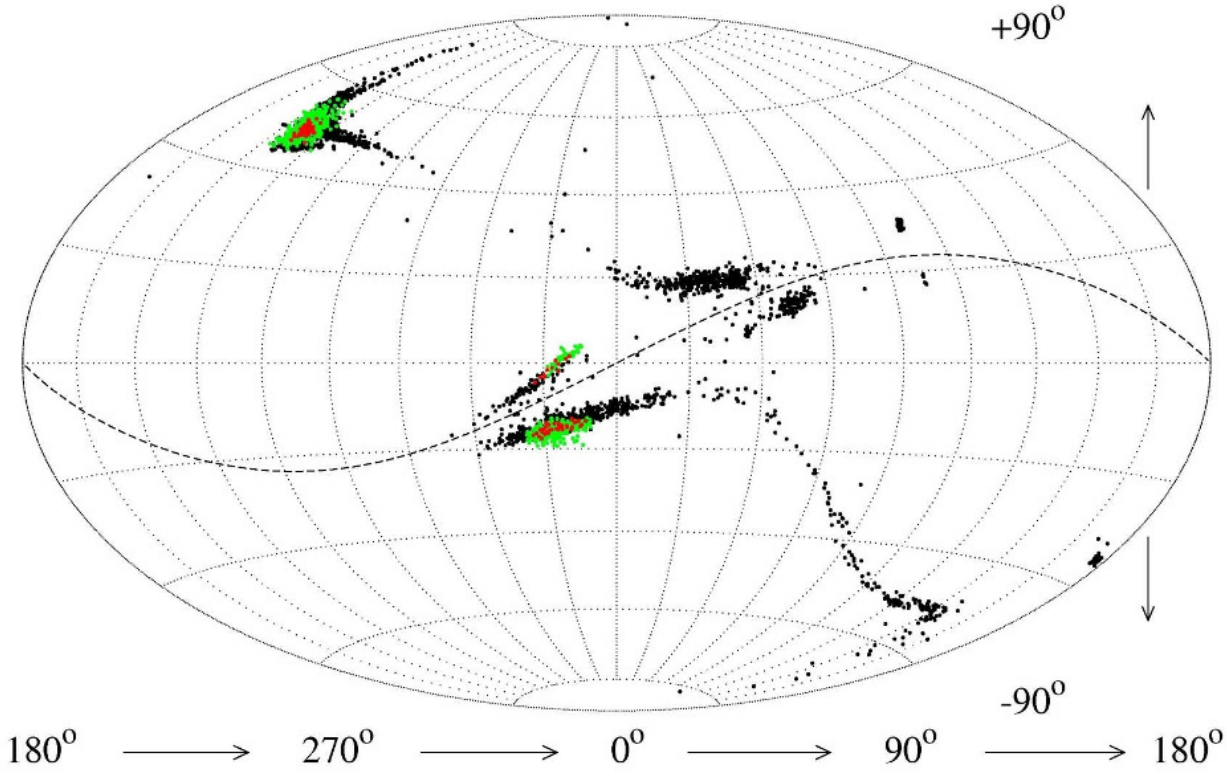
Identify new streams (Damir Segon)

Confirm candidate streams (Juraj Toth)

Wood Mountain site – awaiting …

Test stream models (Maria Hajdukova)

ASTEROID 2003 EH1



- Video meteors
- Photographic meteors

Verify IAU shower parameters (Zeljko Andreic)

A STATISTICAL WALK THROUGH THE IAU MDC DATABASE

Željko Andreić, Damir Šegon and Denis Vida

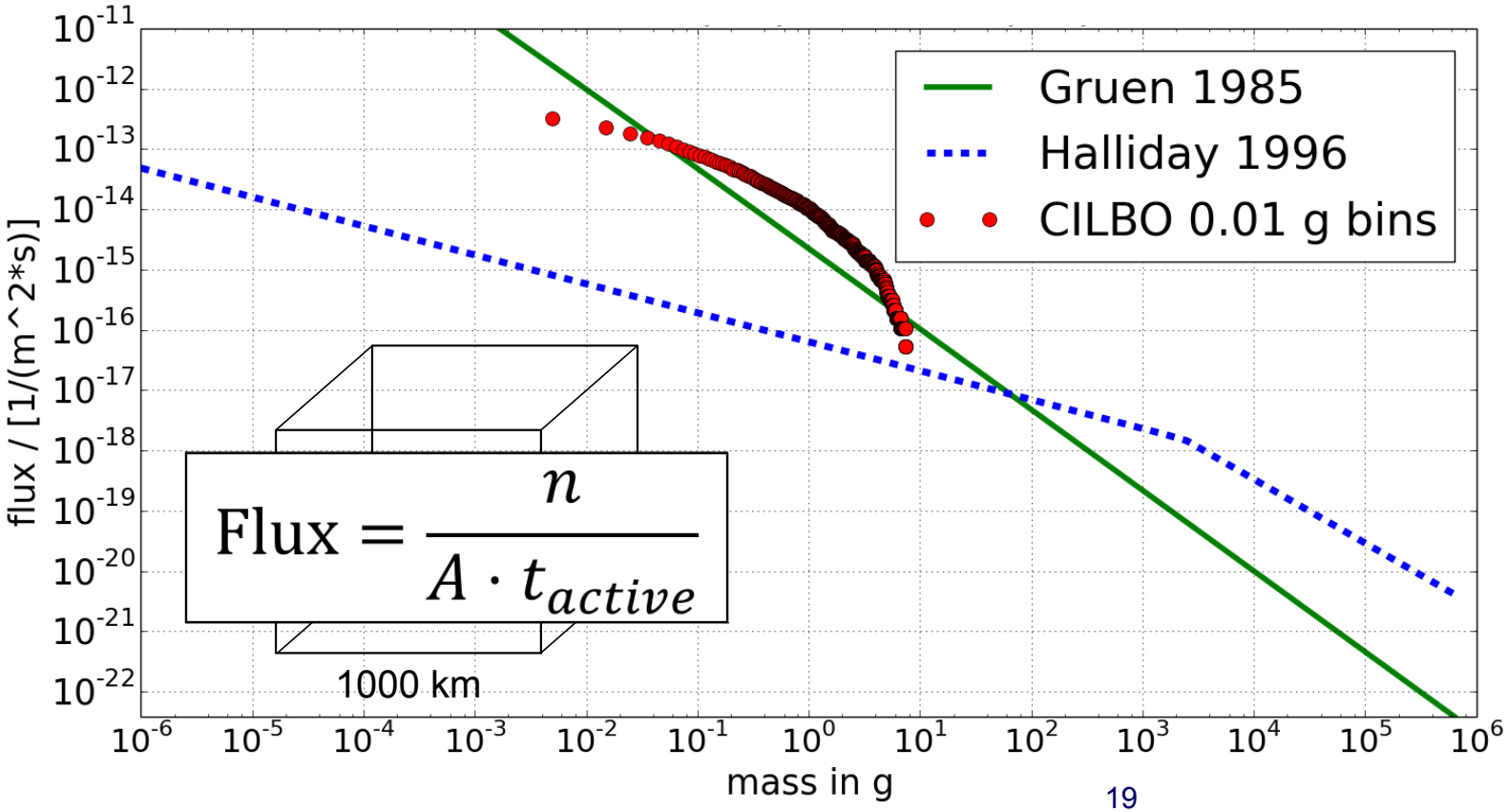
Croatian Meteor Network

E-mail: cmn@rgn.hr http://cmn.rgn.hr

Fluxes (Esther Drolshagen & Theresa Ott)

CARL VON OSSIETZKY universität OLDENBURG

Flux



Mass index (Sirko Molau)

Derivation of a New Procedure (II)

- First an illustrative explanation with a totally fictitious example...

Fish-eye camera
fov 180°, lm +2 mag

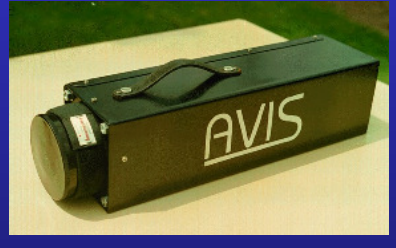


Image-intensified camera
Fov 60°, lm +6 mag

Leo 1998 **(r=1.4)**

100 LEO in 5h

Ratio 1:2

200 LEO in 5h

Gem 1996 **(r=2.6)**

20 GEM in 5h

Ratio 1:10

200 GEM in 5h

The ratio depends on the population index

Calculate a table of expected ratios

r	Ratio
1.4	1:2
1.6	1:3
1.8	1:4
2.0	1:5
2.2	1:6.5
2.4	1:8
2.6	1:10
2.8	1:12
3.0	1:14.5
3.2	1:17

r=2.0

Per 2014 **(r=???)**

40 PER in 5h

Ratio 1:5

200 PER in 5h

Accuracy matters

Semi-major axis matters (Francois Colas)

Dynamic studies need data **(700 000 astéroïds !!)**

- Families are the result of impacts

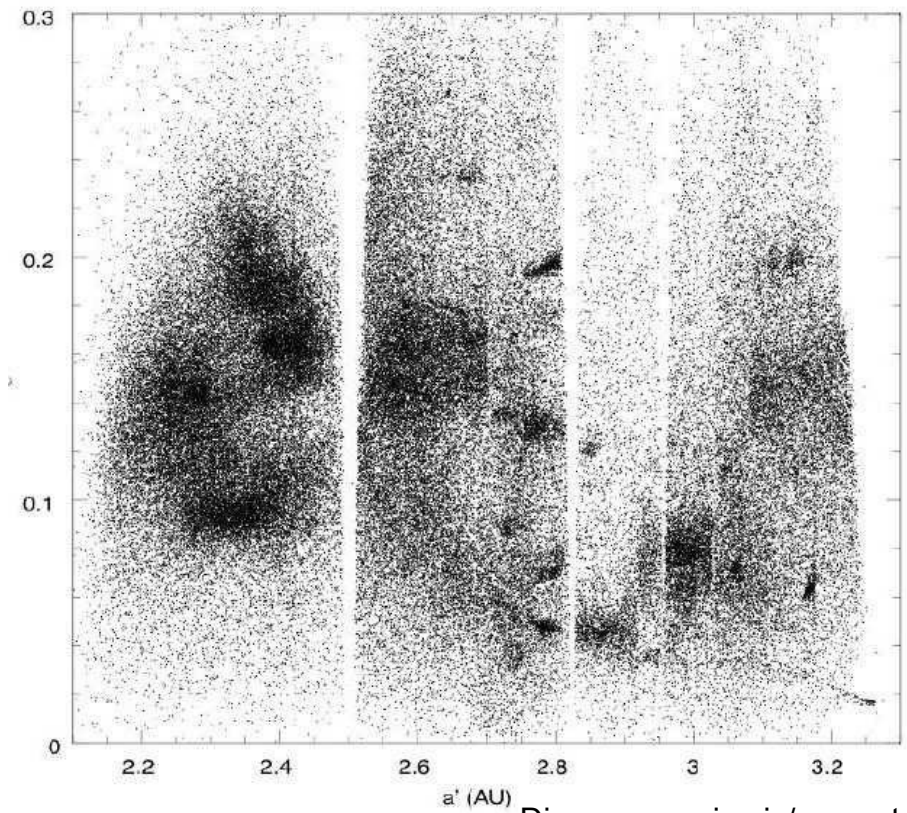
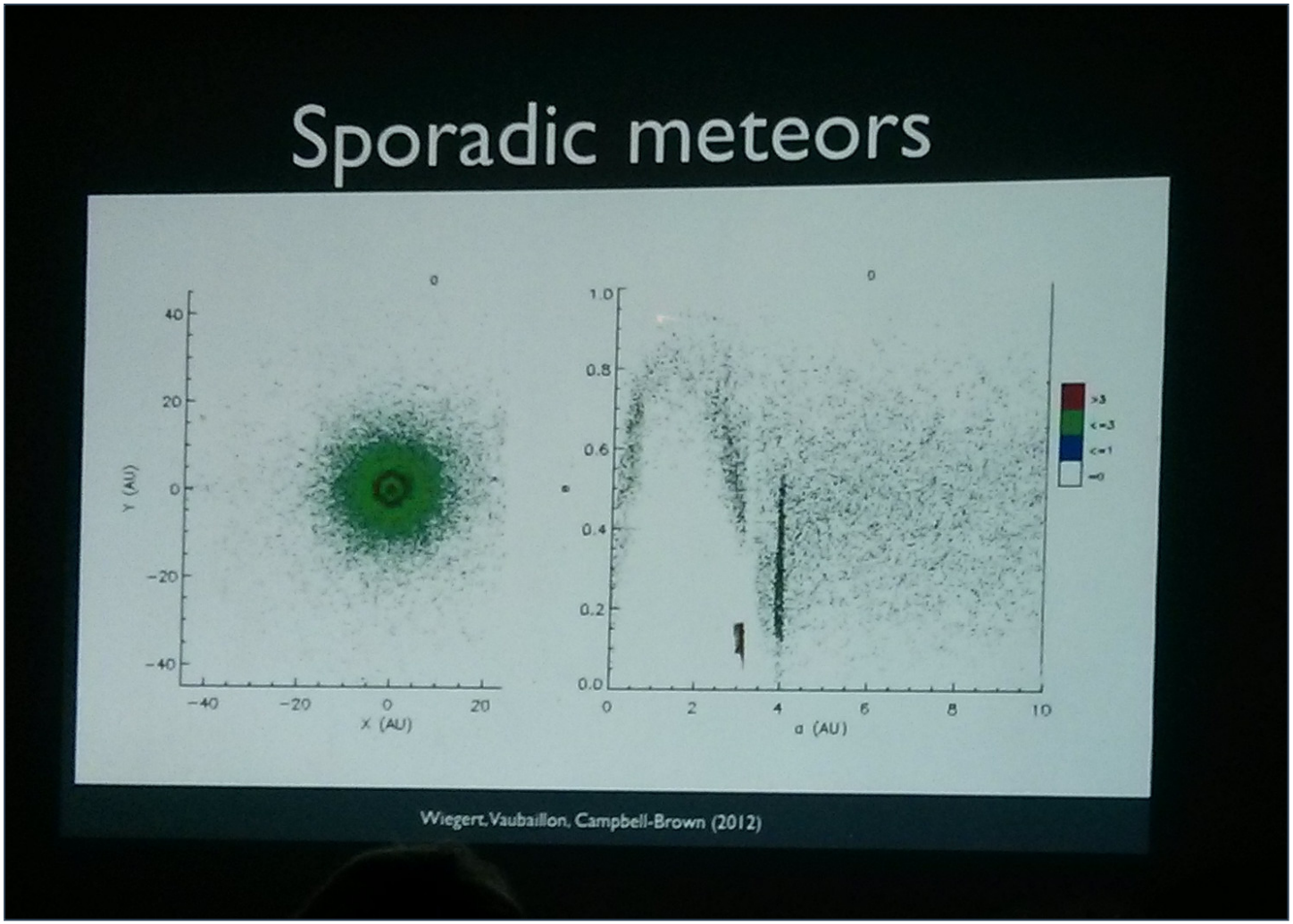
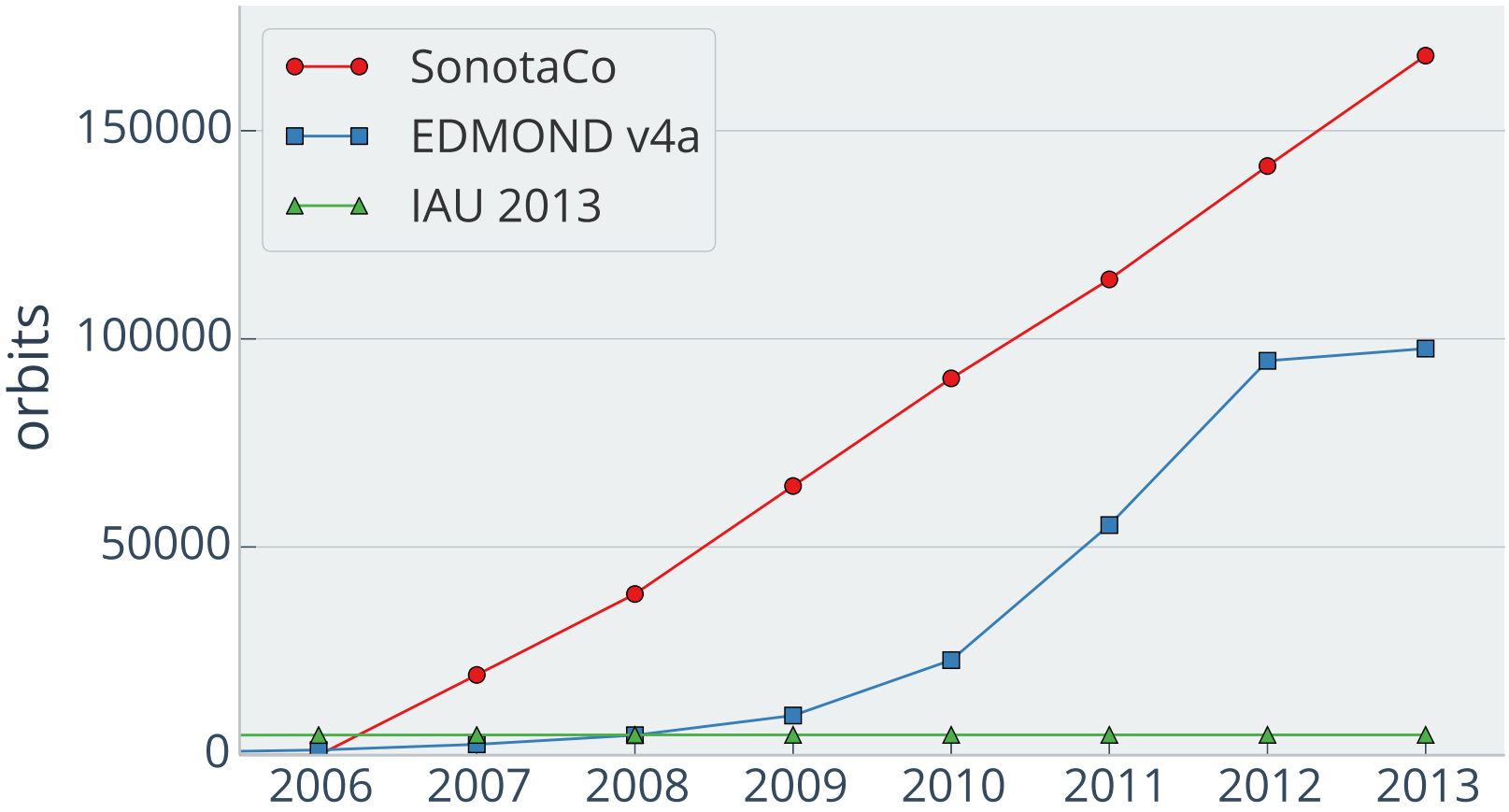


Diagram semi axis/ excentricity

Resonances matter (Jeremie Vaubaillon)



The orbit revolution



Why are we collecting orbits?

Deriving shower catalogues from orbits is very useful, but not the end product.

Understanding our Solar System is the final goal.

Poor accuracy in the semi-major axis, and the scarcity of spectral information, is a worry.

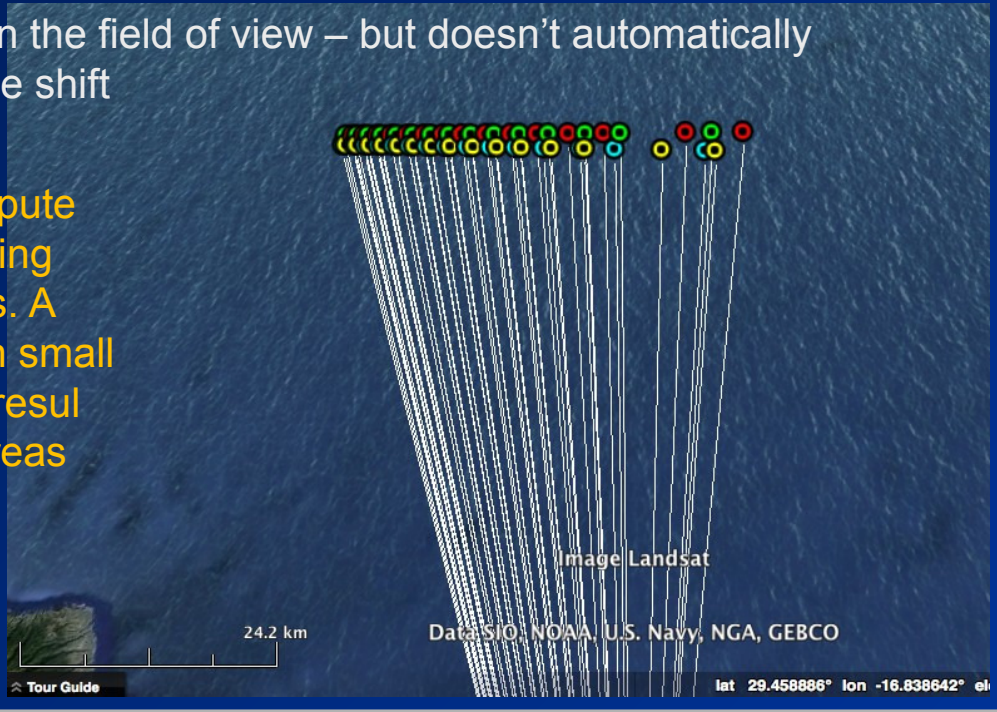
Pushing the boundaries

Pixel-level instabilities matter (Detlef Koschny)

esa SCIENCE

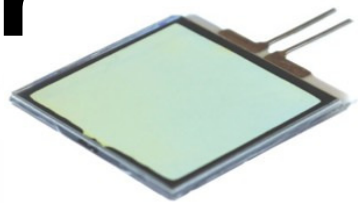
Lessons learned

- Pointing direction changes
  - Happen (thermal changes?) – affect astrometric quality (shift visible in MetRec, i.e. >1 pixel) – not good for high-quality orbits
  - MetRec follows stars in the field of view – but doesn't automatically correct positions for the shift
  - Errors ~200 m
  - => MetRec could compute RA/Dec of meteors using detected star positions. A least for cameras with small field-of-views this will resul in a measureable increas in accuracy.



The electronic shutter (Felix Bettonvil)

Optical chopper

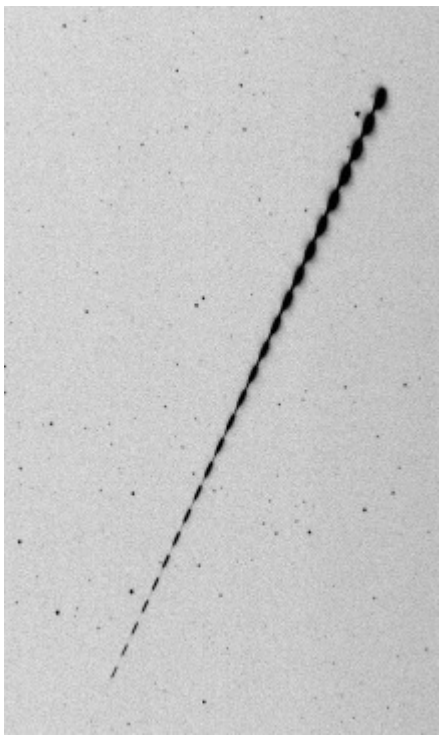


	X-FOS(G2)	*X-FOS(G2)-AR*
Open state transmittance[5]	≥37.5%	≥36.5%
Open state color	u'=0.203 ± 0.01 v'=0.501 ± 0.01	u'=0.203 ± 0.01 v'=0.501 ± 0.01
Contrast	≥1,800:1 @ V_D=18V	≥1,800:1 @ V_D=18V
Angular dependence	Contrast @ V_D=18V ≥ 100:1 -31° ≤ θ ≤ +31° horizontal, -28° ≤ θ ≤ +25° vertical	Contrast @ V_D=18V ≥ 100:1 -31° ≤ θ ≤ +31° horizontal, -28° ≤ θ ≤ +25° vertical
T_{50} voltage	2.15V ± 0.2V	2.15V ± 0.2V
Closing time (T_{100}-T_{10})	≤50µs @ V_D=18V	≤50µs @ V_D=18V
Opening time (T_0-T_{90})	≤1.6ms @ V_D=18V	≤1.6ms @ V_D=18V
Reflectance per surface	≤2%	≤0.5%
Surface quality	N/A	60/40 scratch/dig
Beam deviation	N/A	≤1 arc min
RMS average power consumption[6]	≤12mW	≤12mW
Peak current[6]	≥28mA	≥28mA

CHIPOLATA

Shutters on high-res cameras improve the velocities *significantly* (Auriane Egal)

About CABERNET



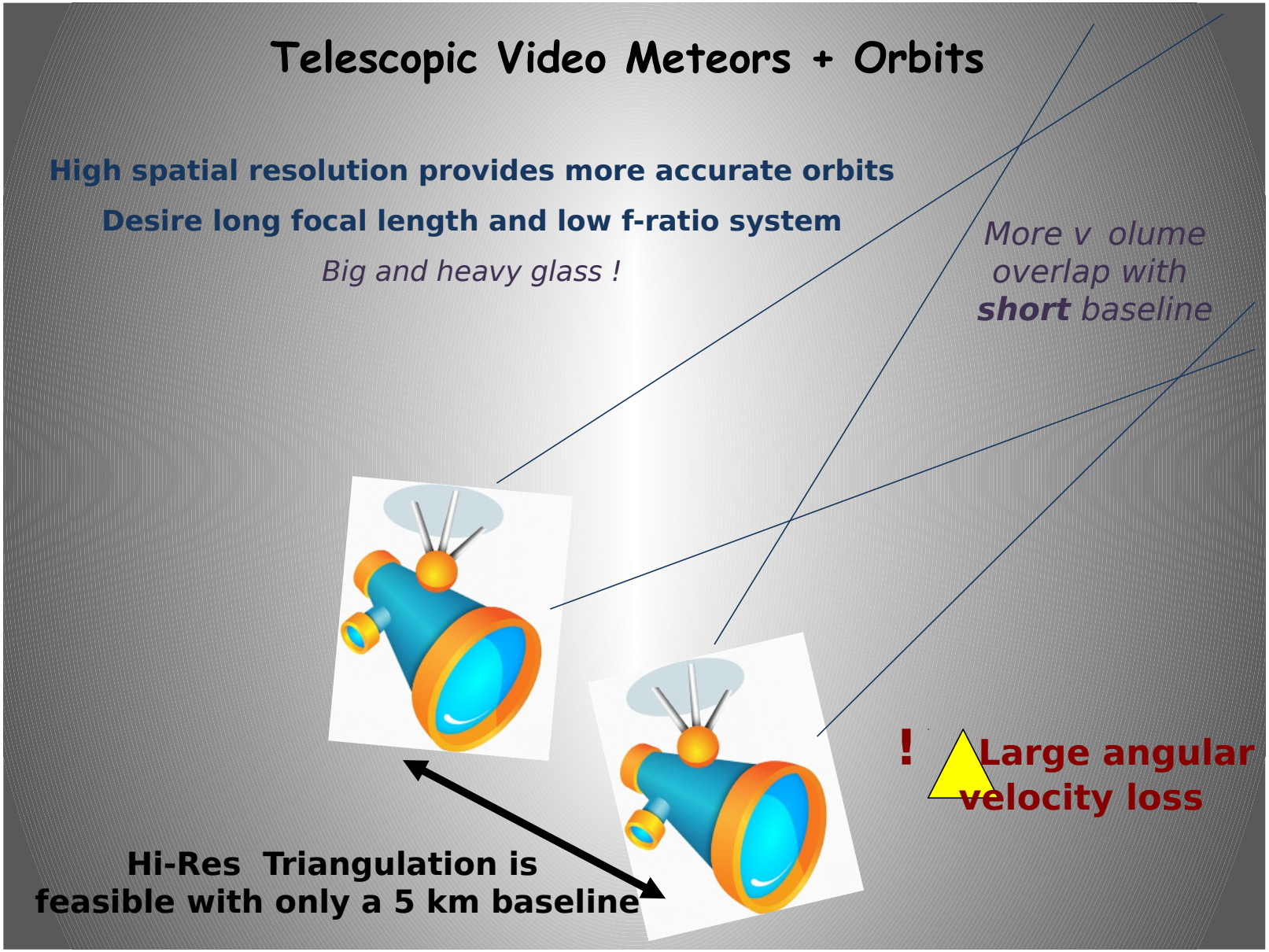
Meteor detected by a CABERNET camera

CABERNET : find parent bodies of meteors showers

$\rightarrow$ accurate 3D trajectory and velocity

- **Meteor position in the image**
- **Information about velocity**
  $\rightarrow$ electronic shutter

Why are we not using telescopes? (Pete Gural)

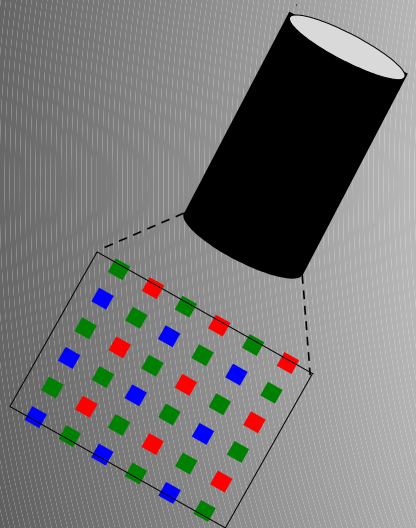


Colours provide cheap ~spectra (Pete Gural)

Very Low Resolution Spectroscopy

Color Camera

RGB Focal Plane

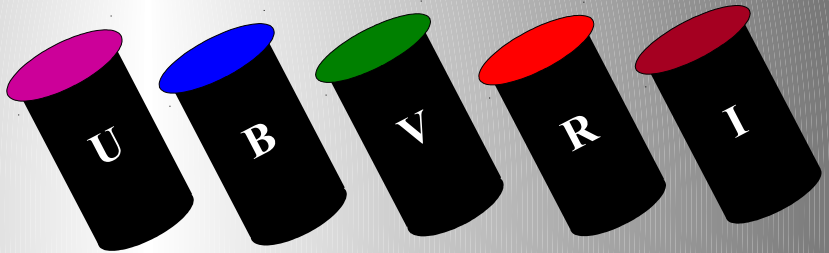


Sensitivity ?
Band Response ?

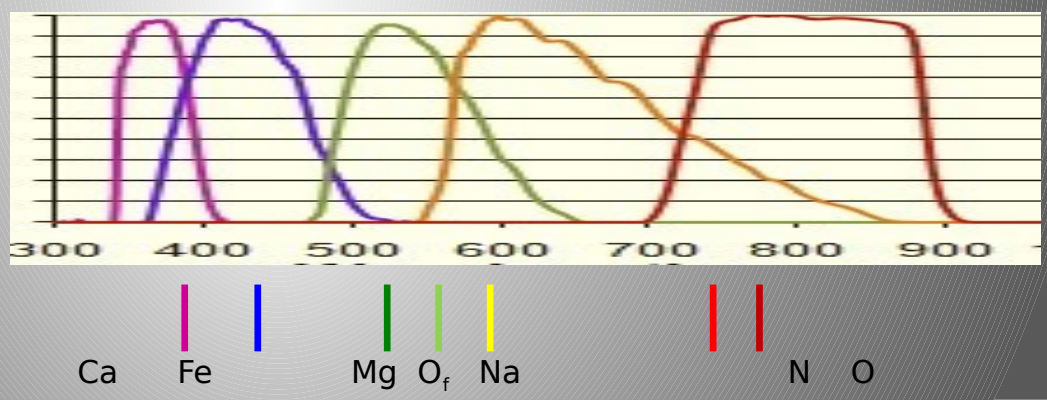
Multiple Monochrome Cameras

Johnson-Cousins Color Filters

(or narrower pass bands)



Color Index for fainter meteors



New cheap camera options? (Pete Gural)

Poster Session

15

Jim Wray & Dave Samuels

The Performance of New Low Cost 1/3" Security Cameras for Meteor Surveillance

Colours are interesting (Thomas Weiland)

Results – General Appearance

- Trains:

  2 % left a train (-7 to +3 magnitude class),

  9 % a short train (-6 to +4 magnitude class)

- Colours:

  yellow: 62 %

  white: 21 %

  blue: 9 %

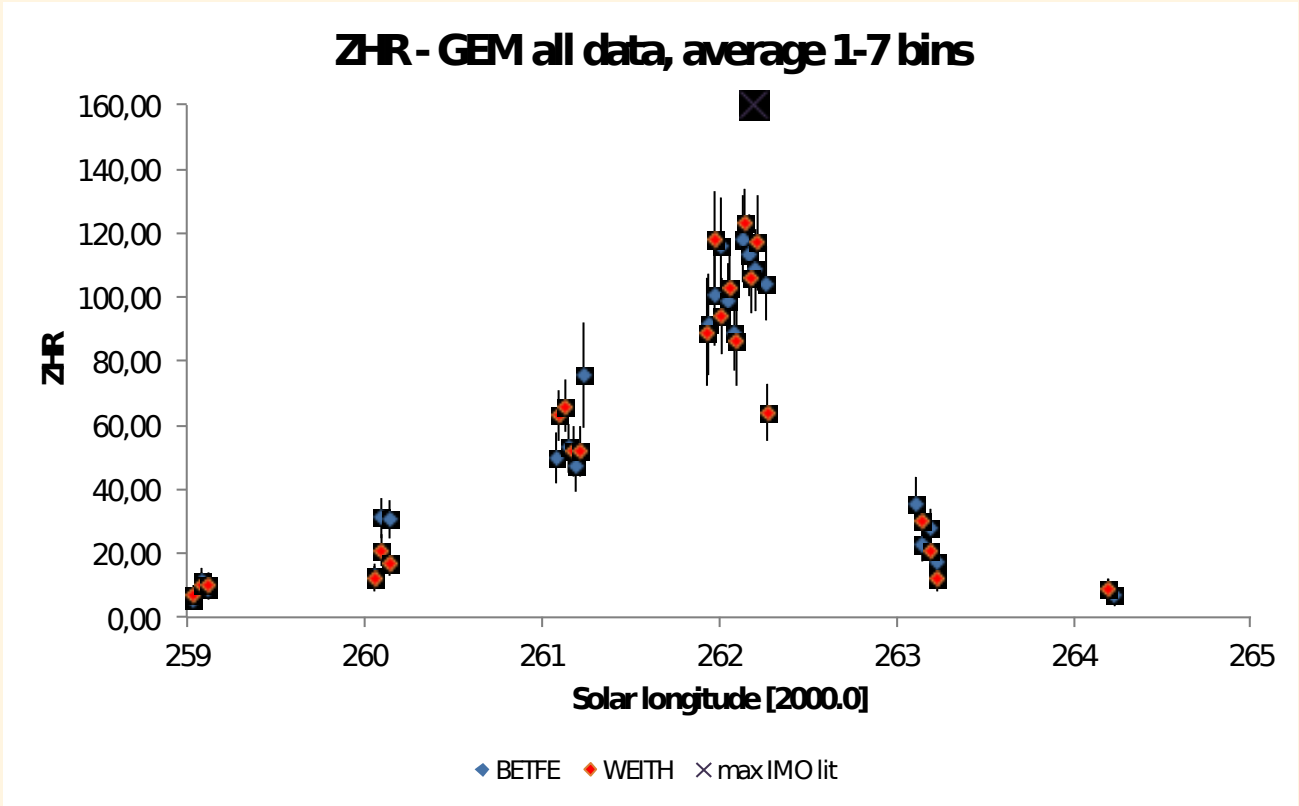
  orange: 7 %

  green: 1 %

Visual observing matters

Activity profiles (Thomas Weiland)

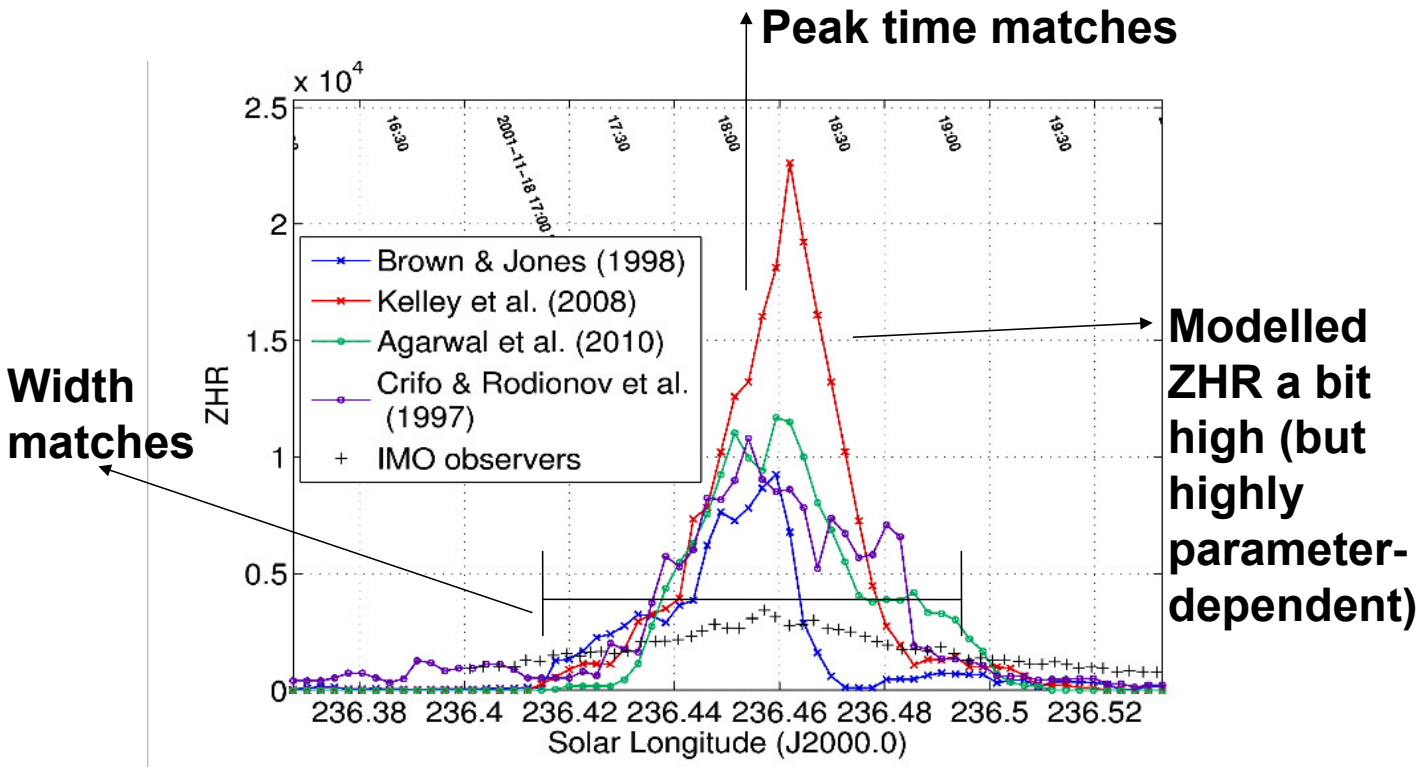
Results – ZHR



Visual data constrain models (Rachel Soja)

Verifying the model (1): Meteor Storms Leonids in 2001

- ZHR profiles for different velocity models



Visual data can even constrain daytime showers (Jürgen Rendtel)

Observing possibilities

Optical data?

171 ARI early June

Radiant 10 deg (twilight)

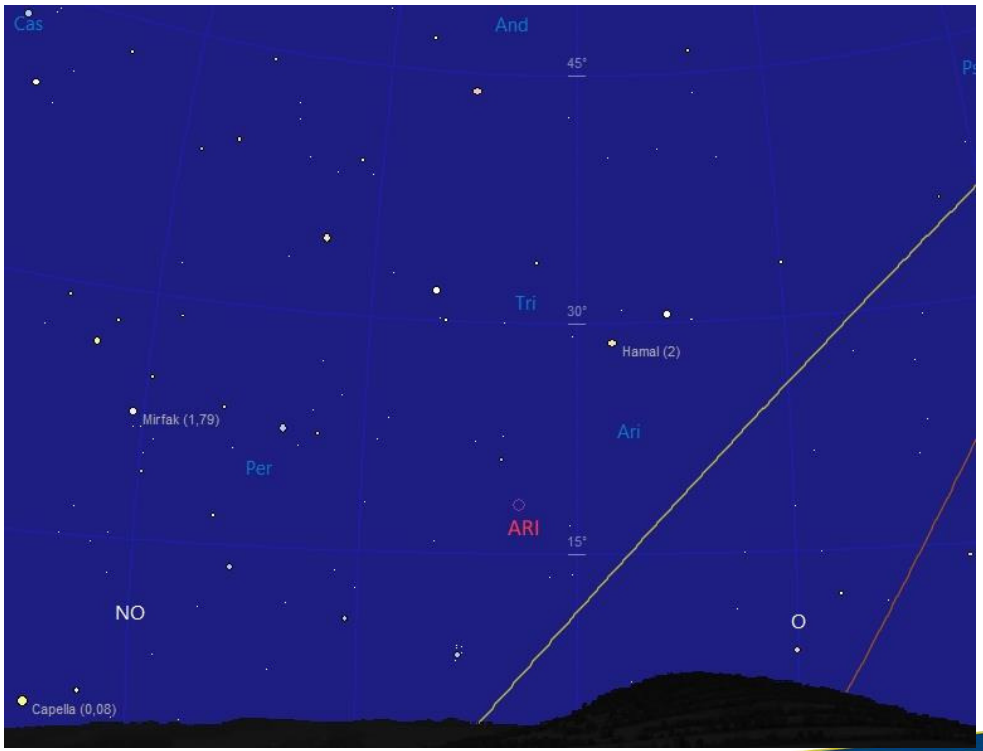
ZHR 10: n=2 (LM 6.5)

n=1 (LM 5.5)

ZHR 100: n=20 (LM 6.5)

n= 8 (LM 5.5)

Here: 30 deg N, 0430 h LT



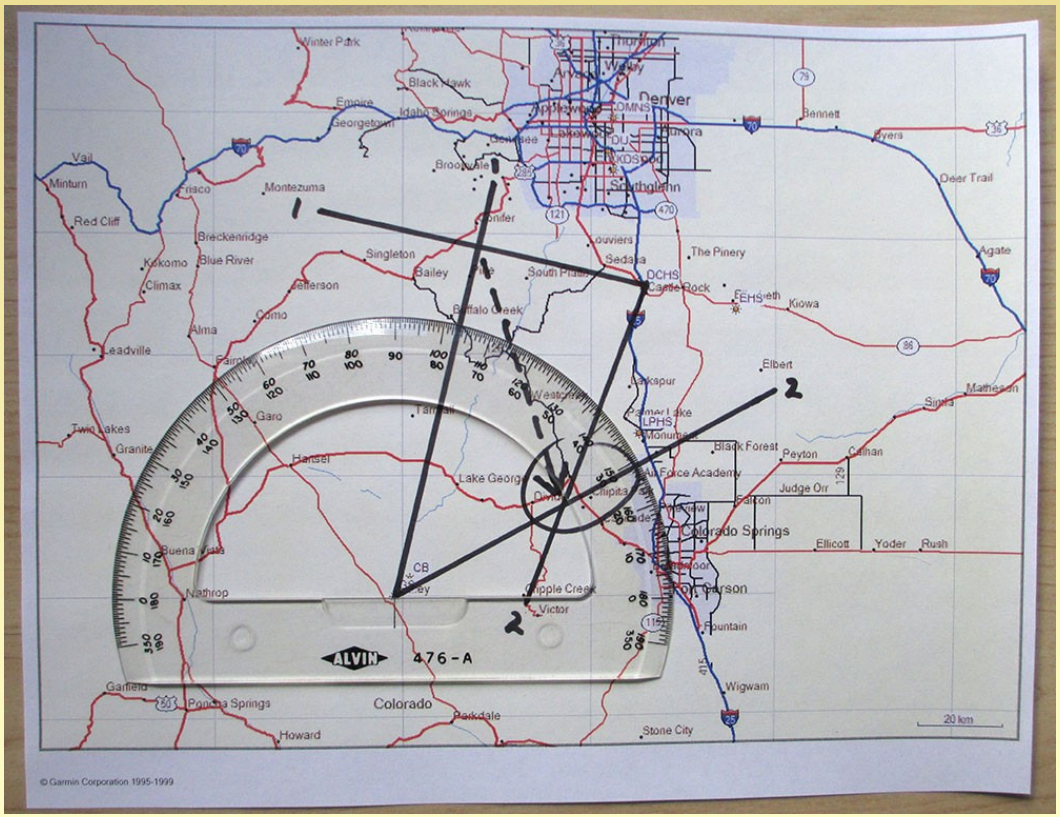
Unique new fireball data is arriving (Mike Hankey & Vincent Perlerin)

Meteors as an education tool (Chris Peterson)

Cloudbait Observatory

DENVER MUSEUM OF NATURE&SCIENCE

Maps and Directions



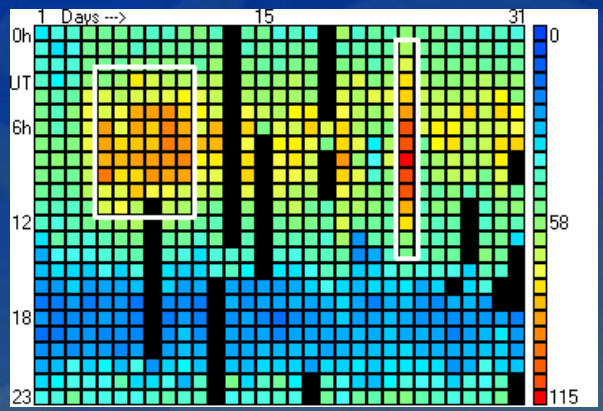
- PS
- MS

S.T.E.**M**.

The radio view

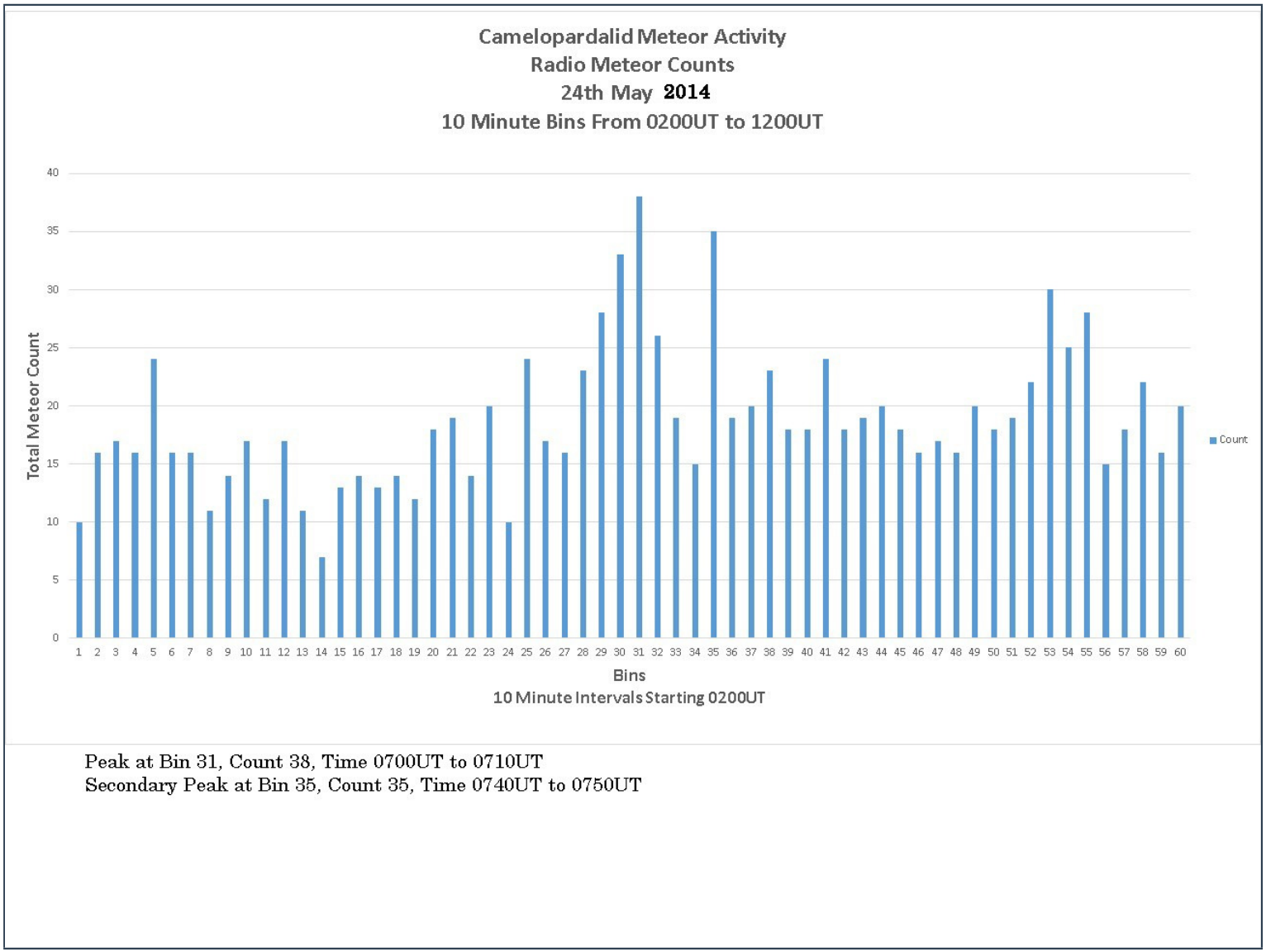
Radio picks up outbursts (Chris Steyaert)

Combining GRAVES 6 observations



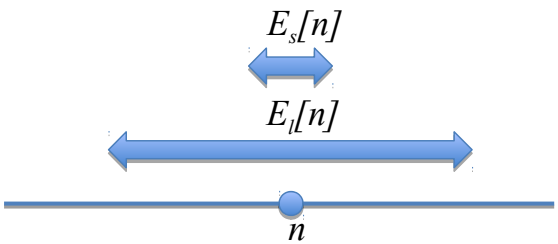
- Geometrical mean = $(n_1 n_{2...} n_6)^{1/6}$
- Observed 1h UT to 13h UT
- Peak 7 – 8 h UT
- Stronger than eta Aquarids?

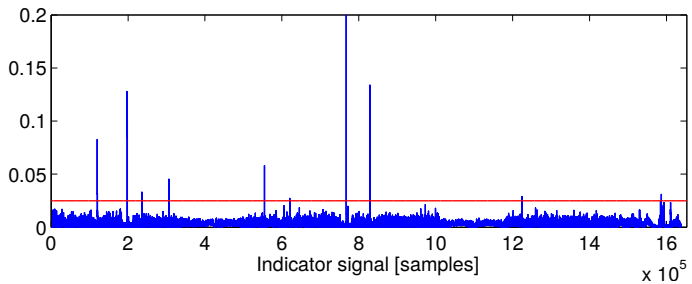
Radio picks up outbursts (Bill Ward)



Treat the data carefully (Tom Roelandts)

Consider doing radio meteor detection using the time signal!





Doppler shifts can aid optical orbits (Francois Colas)

GRAVES RADAR

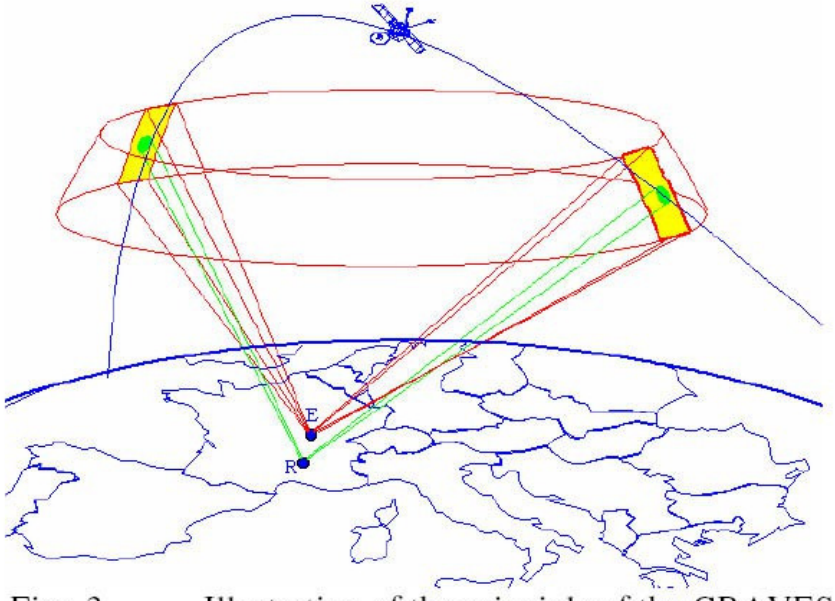


Fig : 3. Illustration of the principle of the GRAVES radar

143 MHz

Software is part of the instrumentation

Visual data analysis (Kristina Veljkovic & Ilija Ivanovic)

Software for analysis of visual meteor data

Kristina Veljkovic and Ilija Ivanovic
Petnica Meteor Group, Serbia

Automated feedback to observers (Denis Vida)

CMN Status report

- Every day at 22:00h

CMN status 2014081415 - ALERT! - FIREBALL ALERT! Inbox x HMM x

[redacted]@gmail.com Aug 15 (4 days ago) Reply to all

to me, zandreic, gljaljic, damir.segon

ACHTUNG, ACHTUNG!
The following stations are not working properly:
bpalanka
ogulin
valpovoa
krizevci
brocanac
zagrebm
sisak1
sisak2
hum

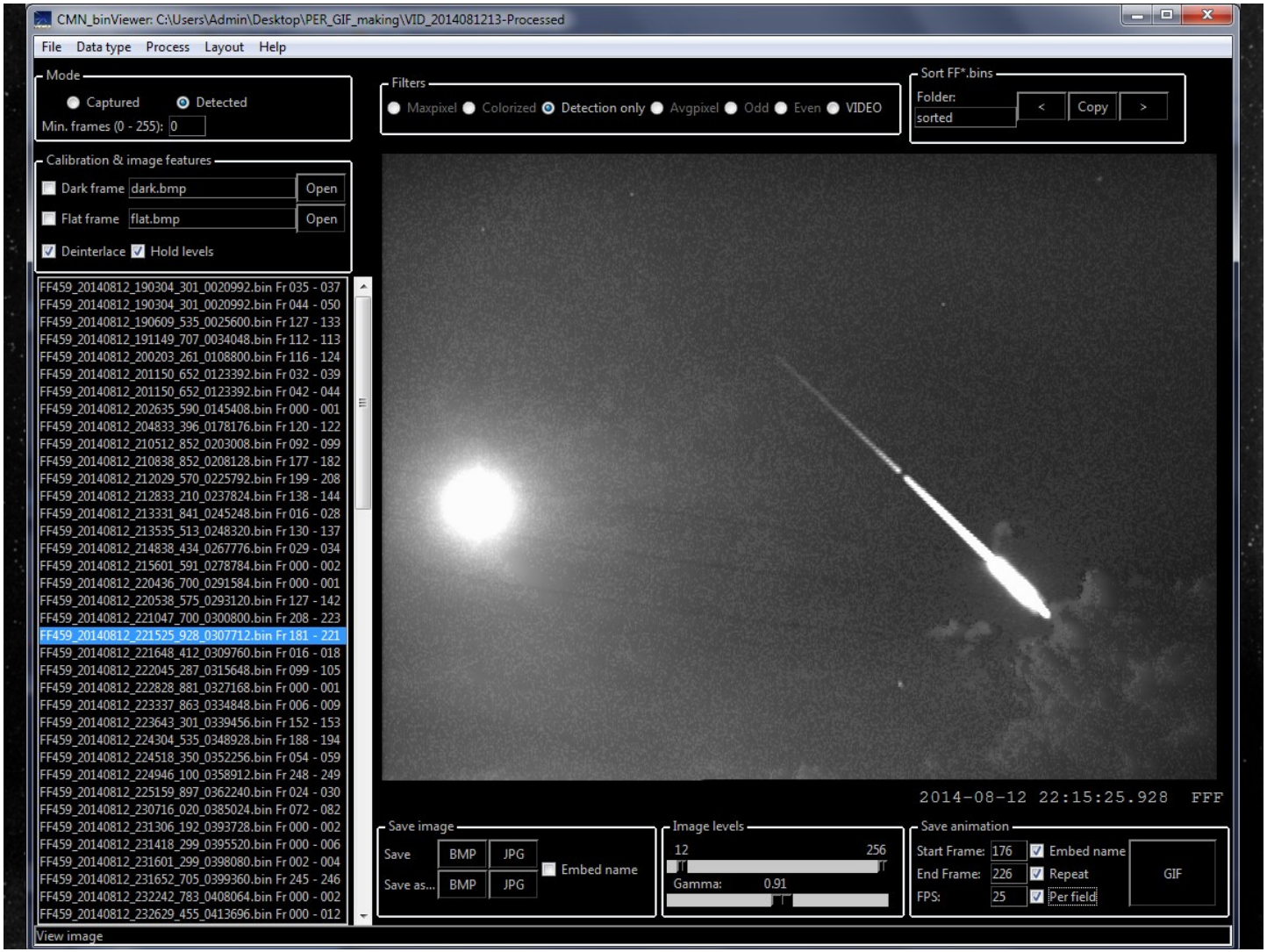
Offline stations

The following fireballs were detected:

Station	Time	Image_number	Max_value	Mean	Std_dev	Duration (sec)
visnjan1	19:09:22:666	C_00000138-0003	4053	2546	844	0.98
pulaa	19:09:23:579	C_00000150-0001	8523	6313	2007	0.3
apevec	19:41:03:309	C_00000368-0001	1221	834	236	0.5
zagrebt	19:50:11:426	C_00000450-0005	5633	924	1365	0.8
petrovsko	19:50:11:744	C_00000103-0001	4181	1476	1064	1.76
visnjan2	20:57:13:464	C_00000746-0001	2512	1281	647	0.74
rijekaa	20:57:13:623	C_00000778-0003	1571	951	455	0.54
rijekab	20:57:13:638	C_00000785-0003	2314	1161	650	0.82

Fireballs

New software built on top of existing tools (CMN_binViewer, Denis Vida)



New software arriving thanks to FRIPON (Yoan Audureau & Min-Kyung Kwon)

Main features

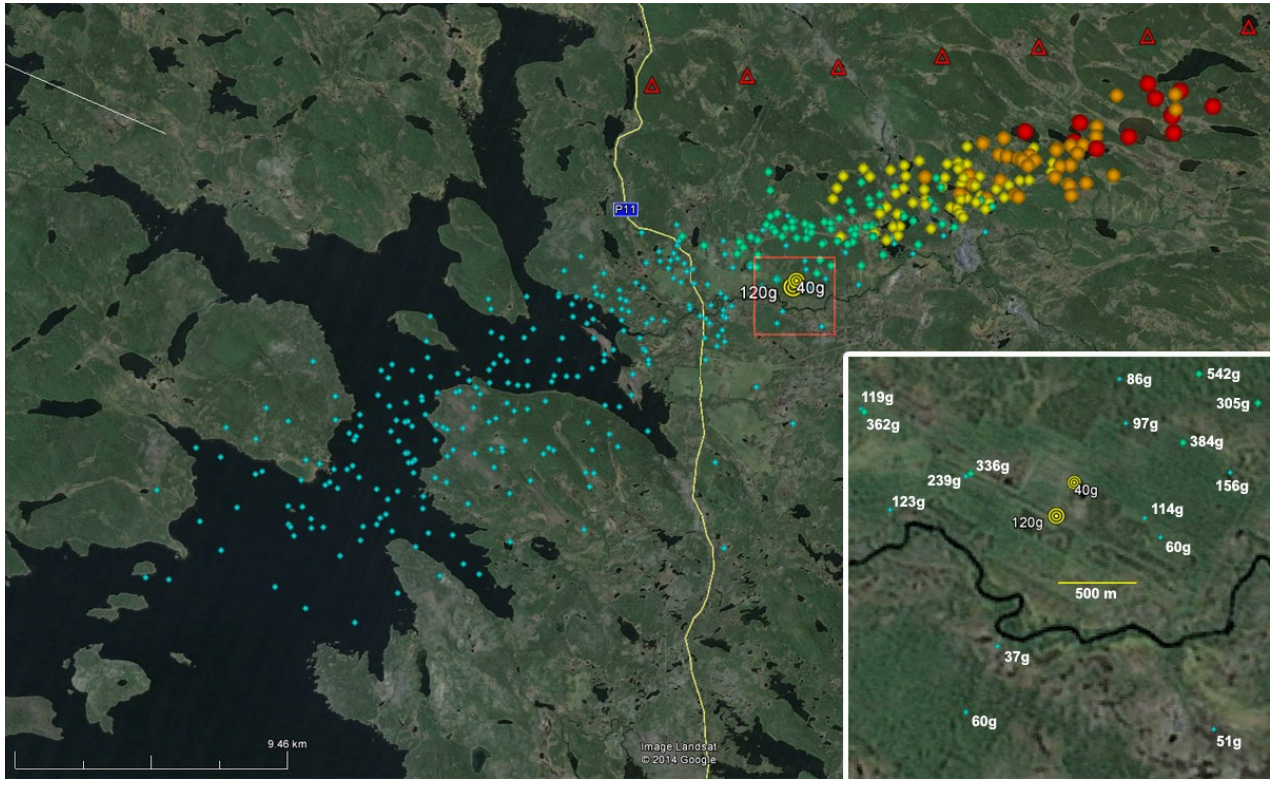
- C++ / Cross platform (linux/windows)
- Open source code with documentation, Github
- Continuous real time meteor detection day and night
- Can take videos in input
- Acquisition stack
- Fits 3D and 2D in output
- No destructive compression

FRIPON

Numerical simulations of the strewn field (Vasily Dmitriev)

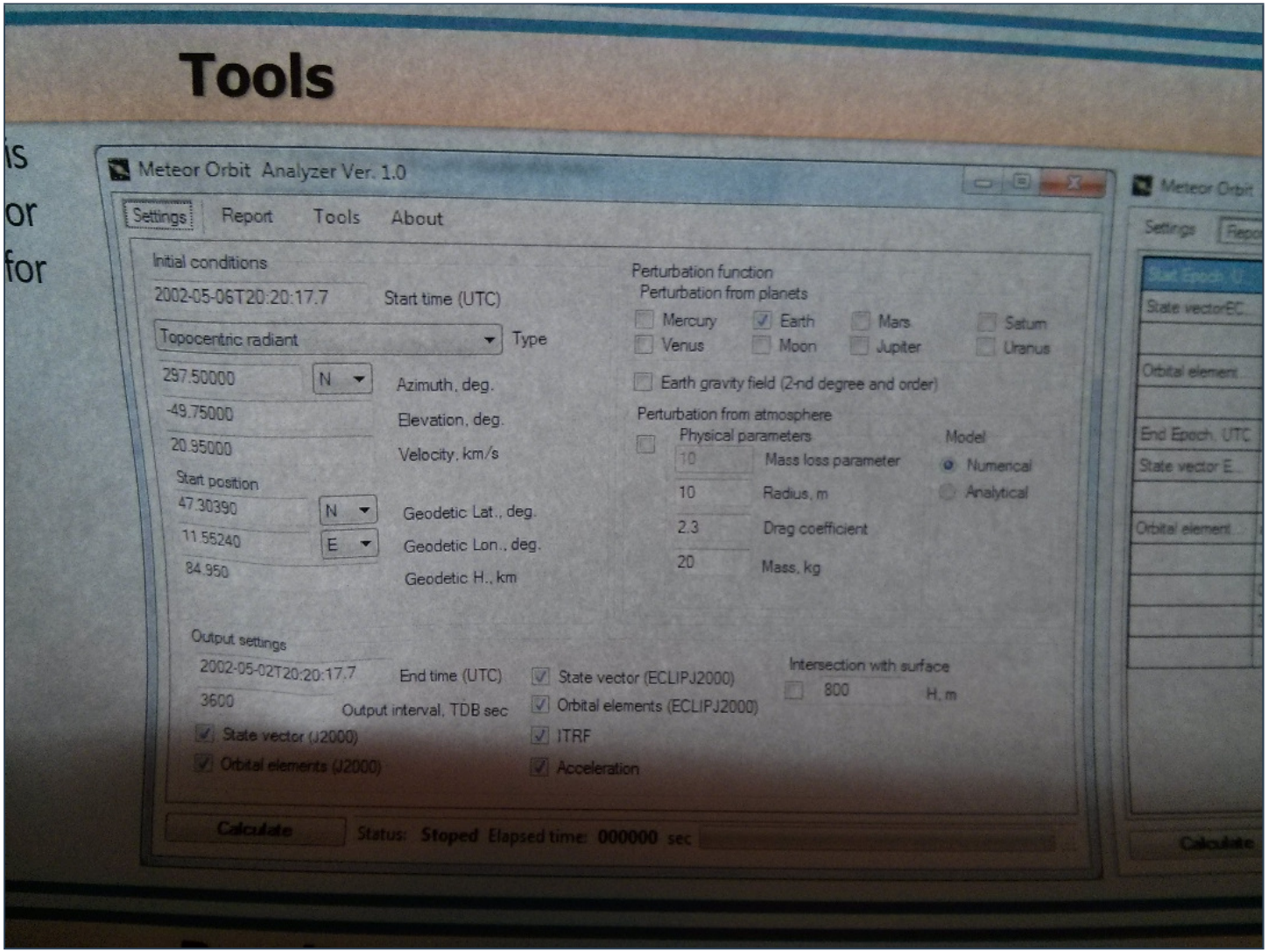
Numerical simulations

North →



Color code of simulated fragments: blue are <0.3 kg, green 0.3 - 1 kg, yellow 1 - 3 kg, orange 3 - 10 kg, red >10 kg

Numerical simulations of the strewn field (Vasily Dmitriev+)

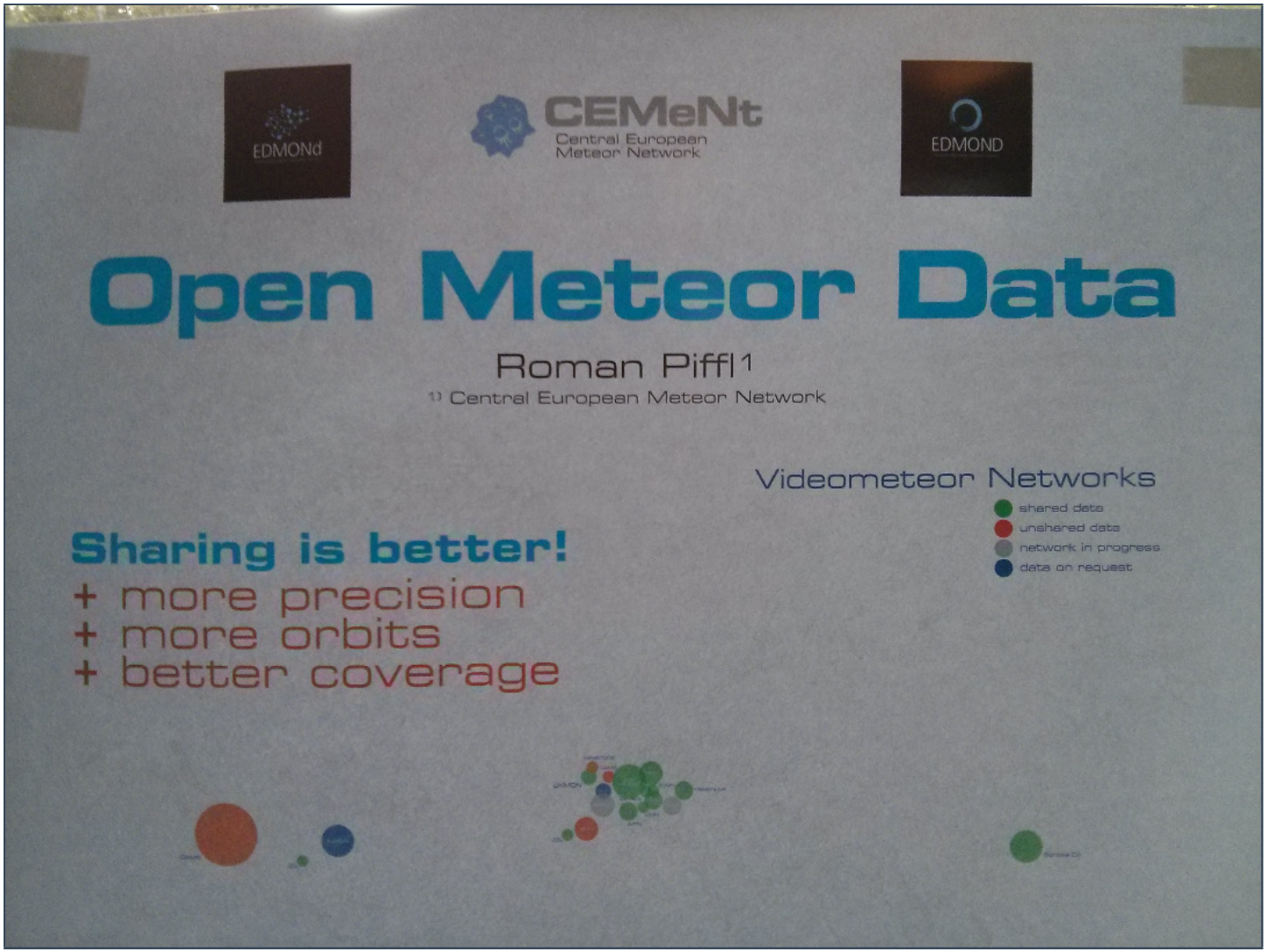


What could we do better?

My brief rant on

- open data;
- open software;
- statistical theory.

Open data is important (Roman Piffl)



Public data sets

Currently:

- many amateurs use private money & share the data;
- many pros use public money & keep data private.

Why open your data?

- science needs to be reproducible;
- you will be rewarded:
  - more citations and feedback;
  - your expertise cannot be stolen;
  - funding panels will notice.
- **raises the profile of meteor science!!**

What about open software?

Why are we sharing our data, talks & publications, but so little source code?!

Open source, re-usable software components can revolutionize the efficiency and accuracy of our networks.

Reasons to open your source:

- you will benefit
  - citations, bug reports, respect;
  - you can choose the license, eg. demand co-authorship.
- papers cannot capture all the details;
- you do not *have* to offer support;
- we all have dirty code.

Software in astronomy

Astronomy is seeing a revolution in new, re-usable software components, e.g. AstroPy has 60+ contributors:

Modern tools available to manage open source software, eg.

GitHub

All of us would benefit from a vibrant, more open, meteor software community.

Statistical theory matters

When data is noisy, correct parameter inference *always* involves probability distributions and hence Bayes' law:

$$P(model \mid data) \propto P(data \mid model) \cdot P(model)$$

e.g. $P(flux|counts)$, $P(stream|orbits)$, $P(trajectory|astrometry)$

Summary

- there are a *lot* of cameras;
- we need to reflect on how the exciting new orbit data can best help us understand the Solar System;
- our community would gain from having more open data and software.

Other highlights

Best non-meteor (Ana Georgescu)

Best non-meteor (Anna Kartashova)

Best logo (Mariusz Wisniewski)

Best IMO shop (Marc Gyssens)

Best LOC (merci bien les fripons!)