DIGITAL ALL-SKY CAMERAS (VII): HHEBBES! FIRST 6 MONTHS OF OPERATION

Felix Bettonvil

Aim

- Automatic, robust & cheap All-sky camera

1. Accurate astrometry (error in semi major axis <0.01AU)
2. Accurate velocity determination (idem)
3. Good photometry (for mass estimate)

Astrometric accuracy

Astrometric accuracy = 5-6’

Aquarid ‘test’ meteor

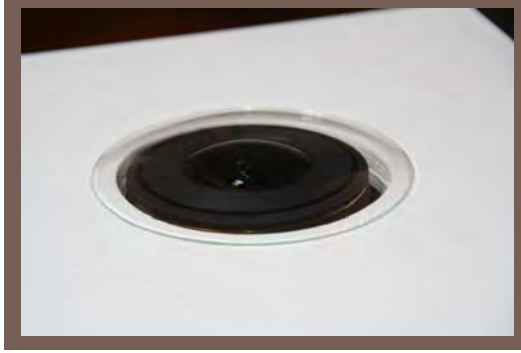
Radiant				
Radiant	Observed	Geocentr.	Heliocentric	Error
R.A. [˚]	342˚,959	343˚,201		±0,100
Decl [˚]	-05˚,281	-07˚,367		±0,100
Heliocn. Longitude [˚]			288˚,647	-
Heliocent. Latitude [˚]			-0˚,179	-
Velocity [km/s]	32,292	30,183	34,967	-
Orbital elements				
Longitude of ascending node [˚]		(Ω)	322˚,528	±0,339
Inclination [˚]		(i)	0˚,322	±0,161
Argument of perihelion [˚]		(ω)	131˚,029	±0,432
Semi major axis [AU]		(a)	1,6758	±0,0095
Perihelion distance [AU]		(q)	0,2415	±0,0012
Aphelion distance [AU]		(Q)	3,1102	±0,0178
Eccentricity [AU]		(e)	0,8559	±0.0001

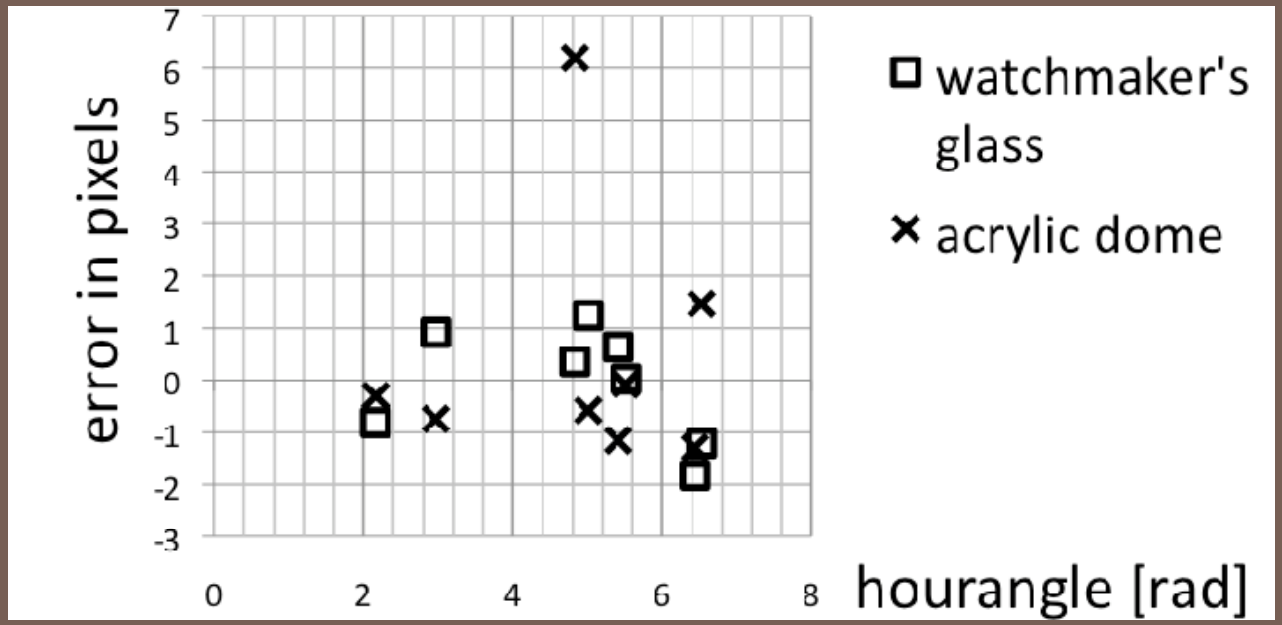
Previous talk

Astrometric accuracy

Acrylic dome

Watchmaker's glass





Previous talk

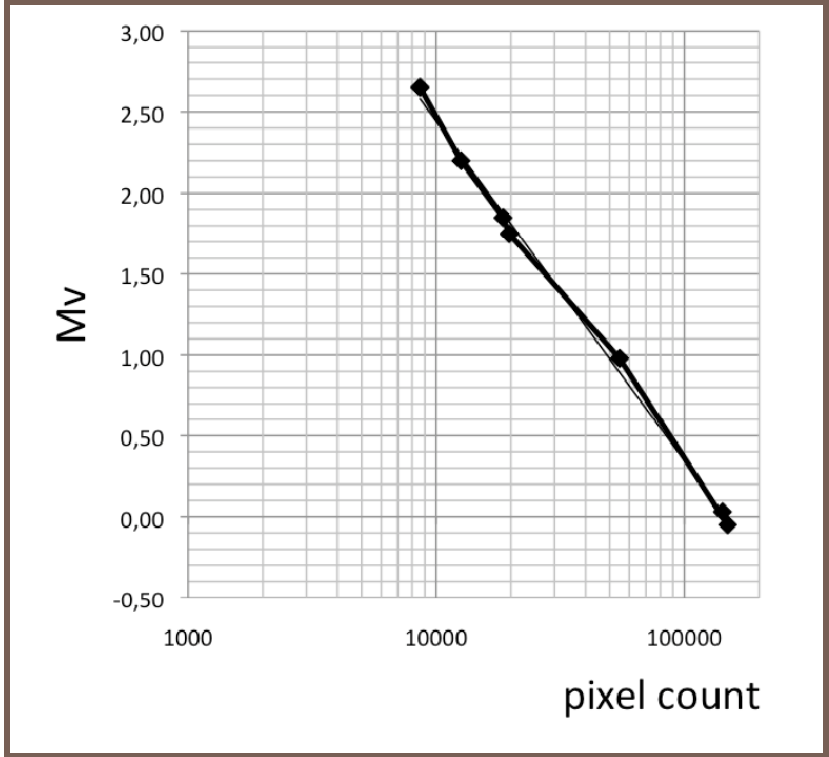
Velocity accuracy

Velocity accuracy = 0,3%

Radiant					
Radiant	Observed	Geocentr.	Heliocentric	Error A	Erro
R.A. [˚]	342˚,959	343˚,201		±0,100	-
Decl [˚]	-05˚,281	-07˚,367		±0,100	-
Heliocn. Longitude [˚]			288˚,647	-	-
Heliocent. Latitude [˚]			-0˚,179	-	-
Velocity [km/s]	32,292	30,183	34,967	-	±0,096
Orbital elements					
Longitude of ascending node [˚]		(Ω)	322˚,528	±0,339	±0,024
Inclination [˚]		(i)	0˚,322	±0,161	±0.019
Argument of perihelion [˚]		(ω)	131˚,029	±0,432	±0,057
Semi major axis [AU]		(a)	1,6758	±0,0095	±0,0135
Perihelion distance [AU]		(q)	0,2415	±0,0012	±0,0011
Aphelion distance [AU]		(Q)	3,1102	±0,0178	±0,0282
Eccentricity [AU]		(e)	0,8559	±0.0001	±0,0018

Previous talk

Photometry



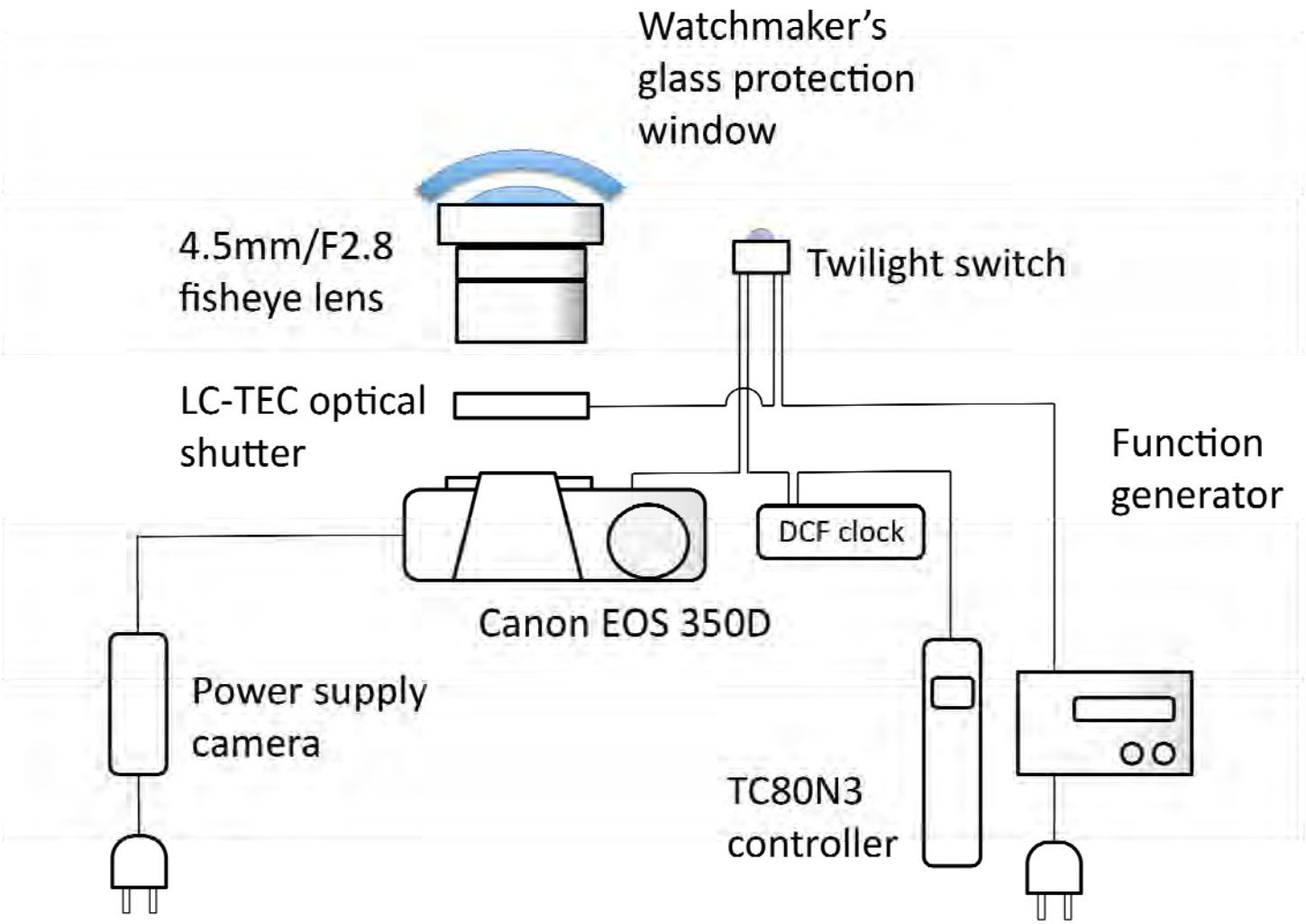
$$\log M = 6.31 - 0.4 m_v^{abs} - 3.92 \log V_\infty - 0.41 \log(\sin(h_r))$$

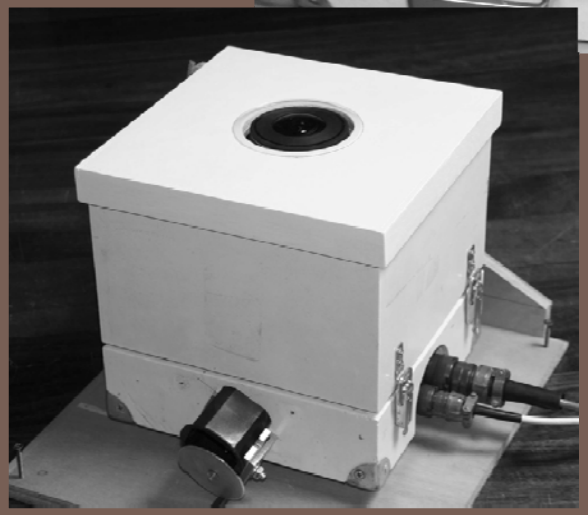
Jenniskens 2006

For cometary fireballs, V=25 km/s, d=100km, h=30˚, an error in magnitude of 0.1 results in a mass error of **10%**

Previous talk

Basic design

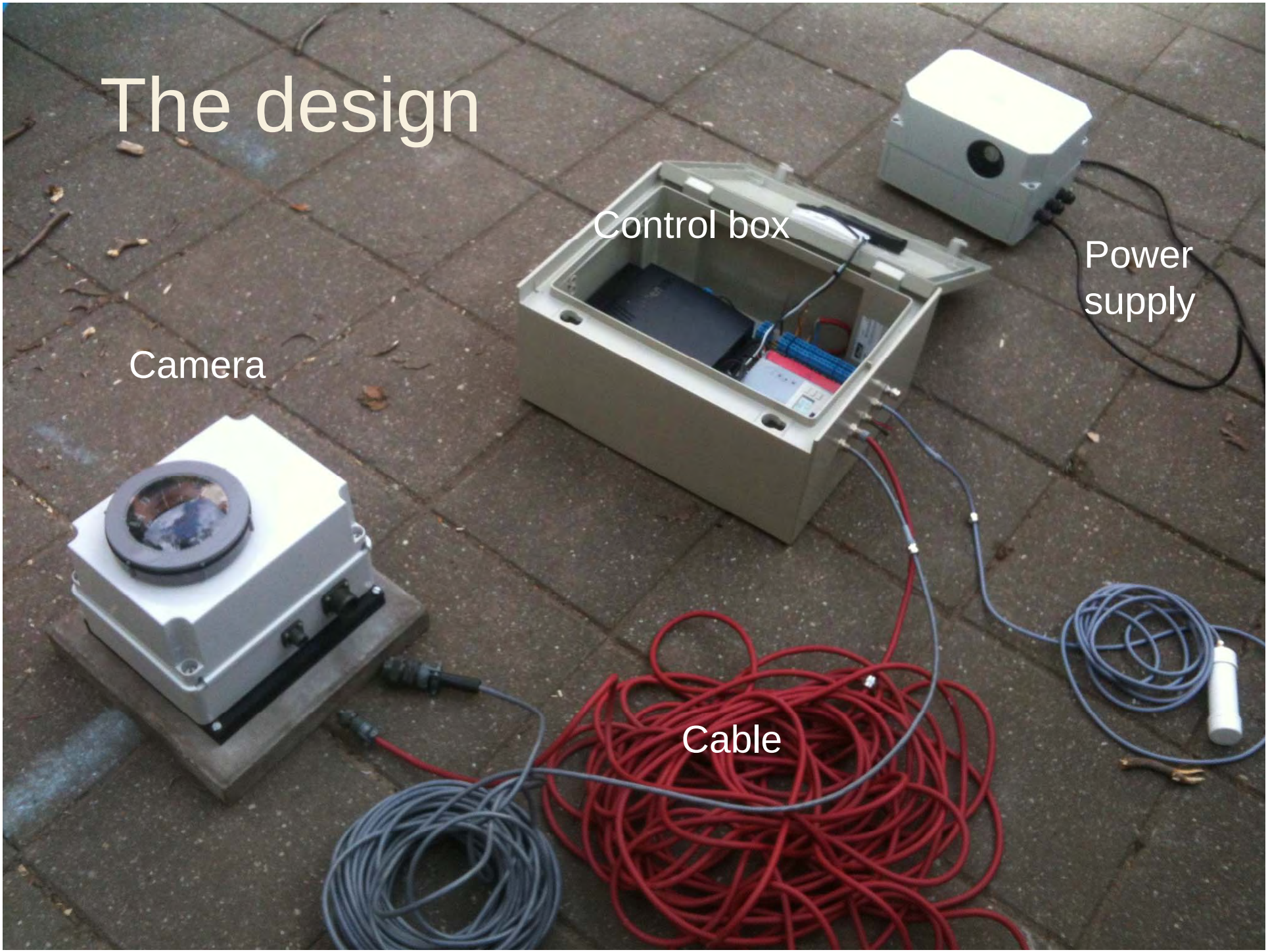




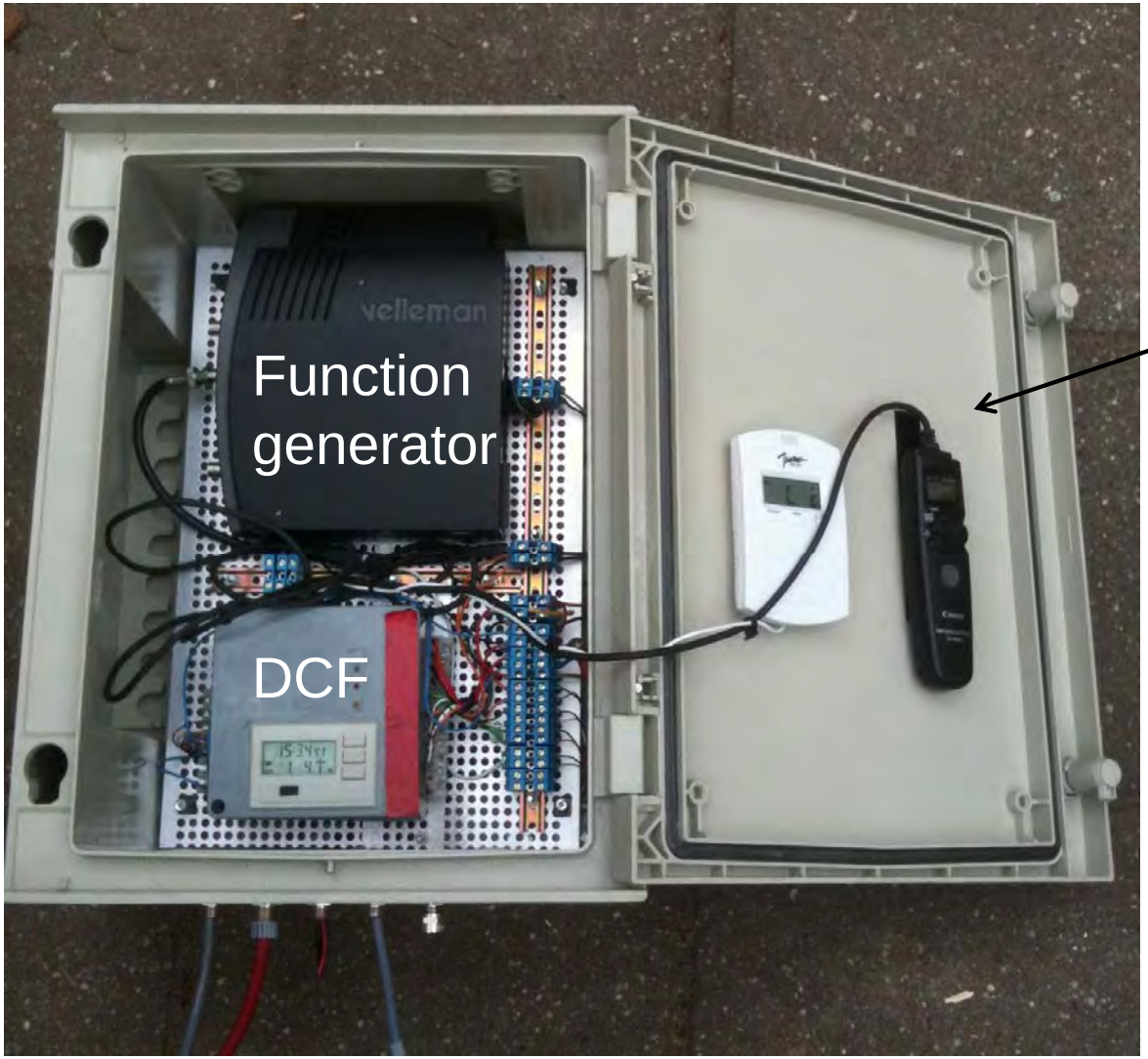
Test installation in Los Cancajos – La Palma

Design considerations

- Robust is not easy
- Sealing
  - Dust & insects come everywhere -> perfectly closed housing
  - Humidity can lead to camera malfunctioning, fog on lens -> Heating, and not inside but outside.
- Camera noise
  - Limits exposure time -> keep temperature camera low

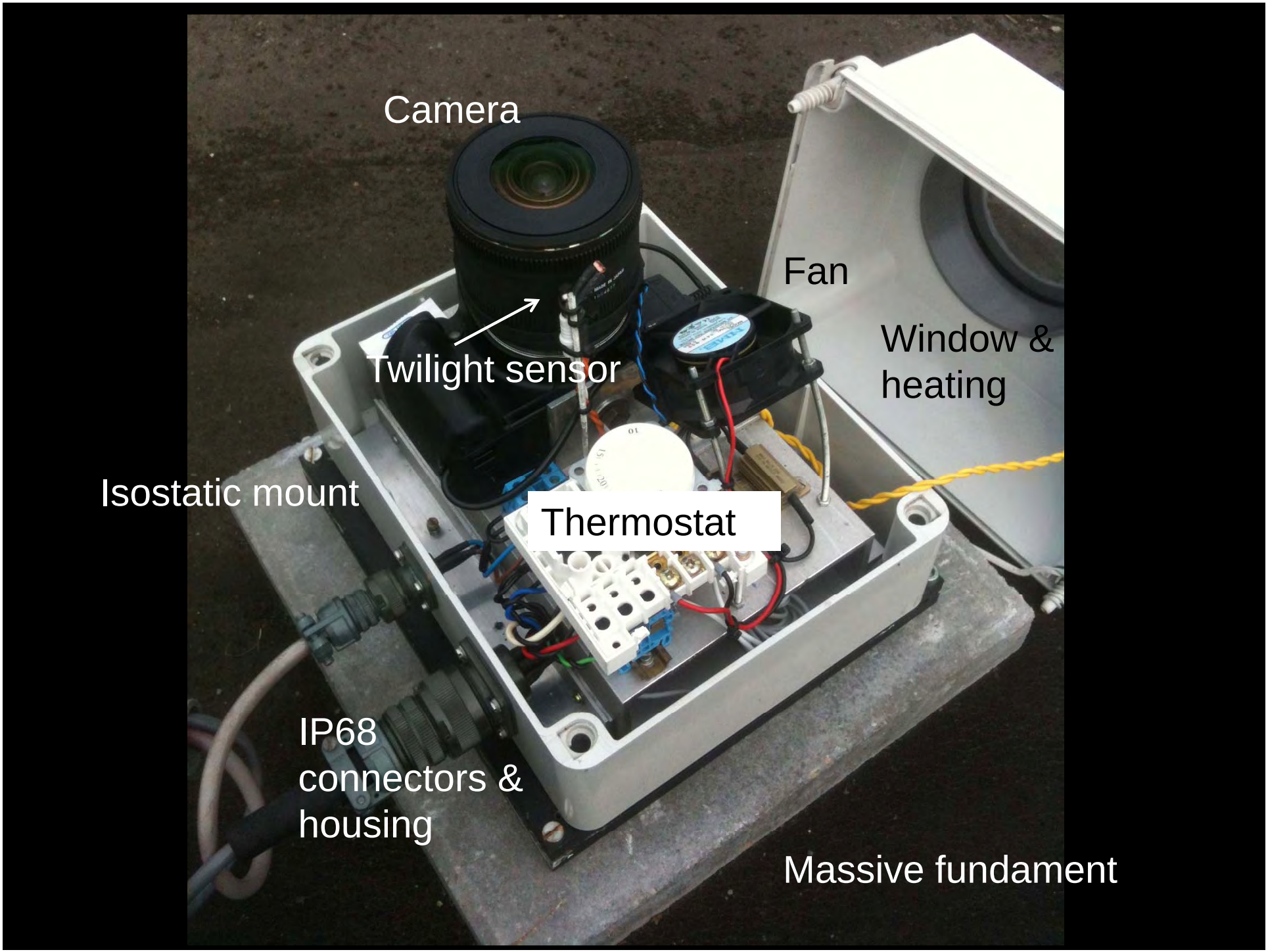

The design
Control box
Power supply
Camera
Cable

Control housing



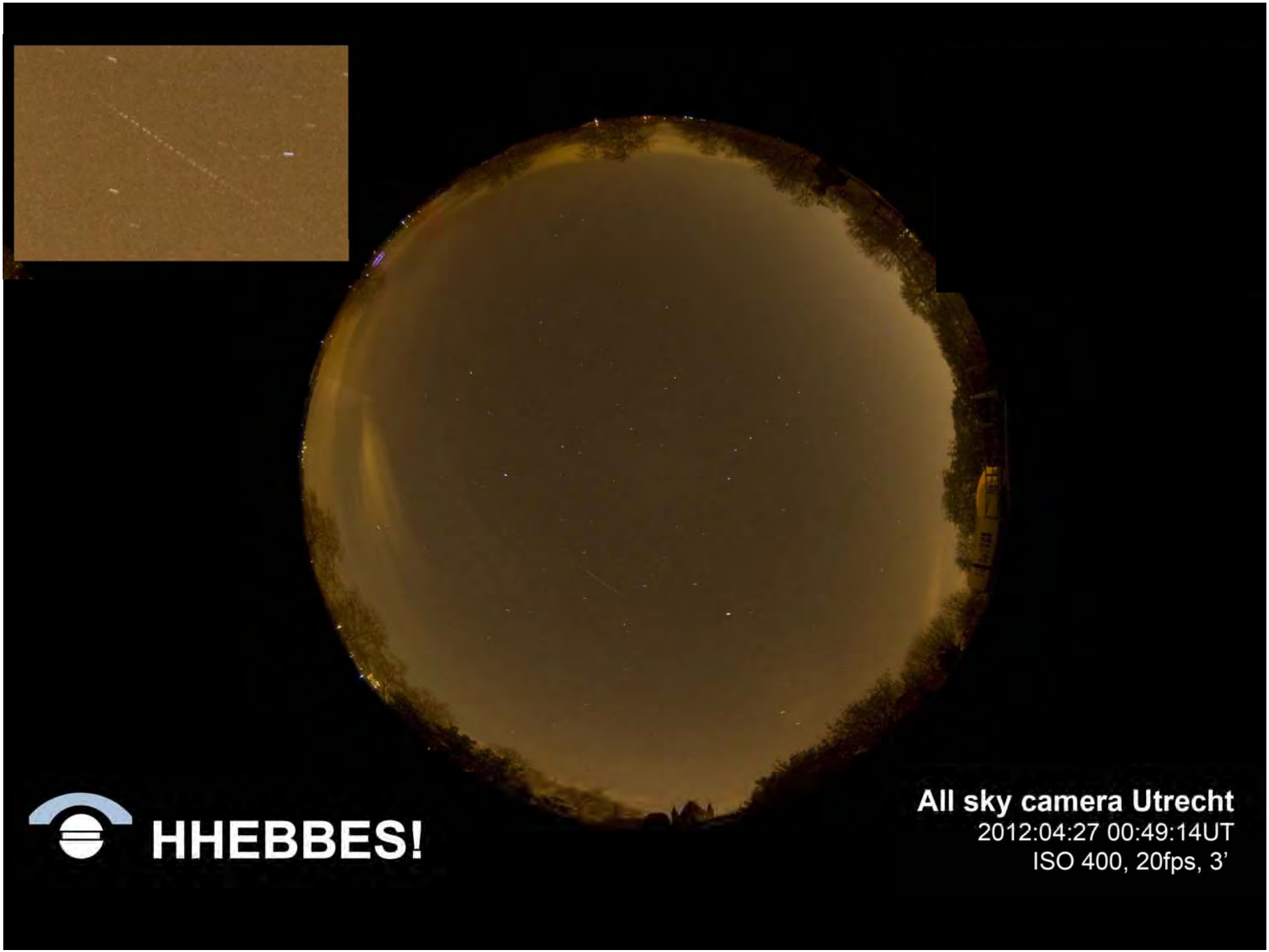
Exposure controller

SMS control


Camera
Fan
Twilight sensor
Window &
heating
Isostatic mount
Thermostat
IP68
connectors &
housing
Massive fundament



- Utrecht university observatory
- Strategical located in center of The Netherlands
- Downtown, thus light pollution


HHEBBES!
All sky camera Utrecht
2012:04:27 00:49:14UT
ISO 400, 20fps, 3’


HHEBBES!
All sky camera Utrecht
2012:08:12 02:30:43UT
(Halley/Heesch) ISO 400, 20fps, 3’


HHEBBES!
All sky camera Utrecht
2012:08:12 01:32:46UT
(Halley/Heesch) ISO 400, 20fps, 3’

First half year

- In regular operation since April 24, 2012
  - Every night regardless conditions
- Not one single night missed so far
- Maintenance once every 1- 4 weeks
  - Data card change; cleaning

It is a succes!

What did we learn?

- Dust
  - perfect closed housing works
- Humidity
  - Heating of air around lens works
- Too hot during day?
  - 47˚C max. OK

What did we learn more?

- Power cuts
  - Camera does not (always) recover automatically -> UPS
- Sometimes non-responsive DSLR in standby mode
  - -> power cycling at start up
- DCF sometimes freezes. Hard reset
- CF card too small
  - JPEG instead of RAW?
- Noise
  - DSLR (350D) has noise variation with

To do

- RAW vs JPEG
- Verification aim
- Setting up of image processing software

Thank you

Sonnenborgh, Utrecht, The Netherlands

Camera	Canon EOS 350D – 6 Mpxl	‘High-res’, 100EUR
Lens	Full frame Sigma 4.5mm/ F2.8 fisheye	Full sky, 600EUR
Exposure control	Canon TC80N3 timer controller, twilight switch, no PC	Autonomous, reliable
Timing	DCF clock for reference marks in star trails	For accuracy
Chopper	LC-TEC optical shutter (10-100Hz) Between lens and camera	High accuracy, no moving parts, 100EUR
Storage	8GB CF Card	Easy, no capture software

LC shutter