Carl von Ossietzky Universität Oldenburg

university of groningen

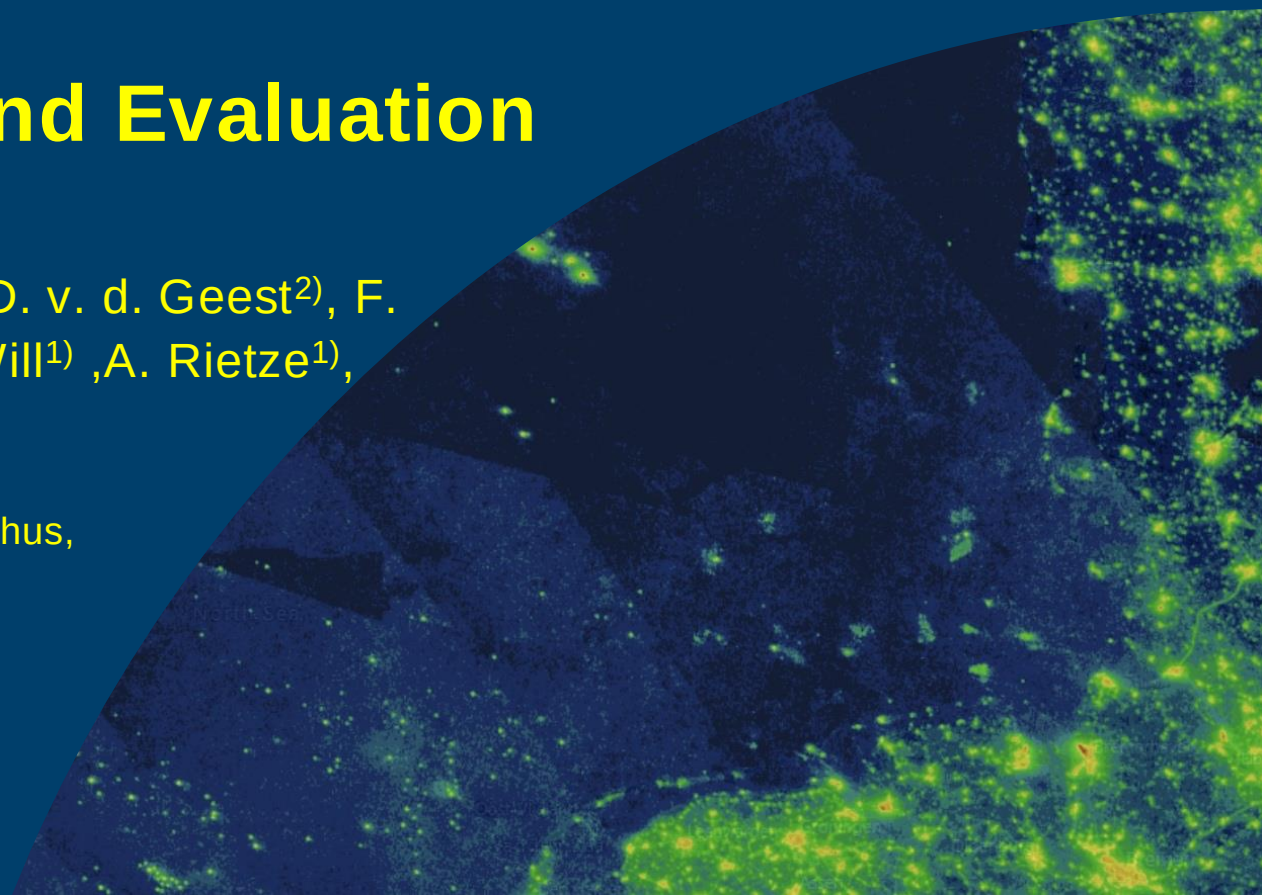
AARHUS UNIVERSITY

Interreg North Sea

Co-funded by the European Union

KID

KID-Keep-it-Dark
Detectors, Cross-Calibration and Evaluation



B. Poppe[1)], R. Peletier[2)], J. Noel-Storr[2)], T. Jurriens[2)], D. v. d. Geest[2)], F. Sahah[2)], H. Kjeldsen[3)], L. Cordes[1)], T.Hoffmann[1)], R. Will[1)] ,A. Rietze[1)], M. Gehlen[1)], C. Nazarri[4)], A.Hänel[5)]

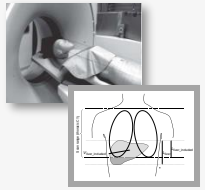
[1)]University of Oldenburg, [2)]University of Groningen, [3)]University of Arhus, [4)]Common Wadden Sea Secretariat, [5)]Dark Sky Germany, *

Radiation Physics and Space Environment
(University Clinic for Medical Radiation Physics)

Radiotherapy

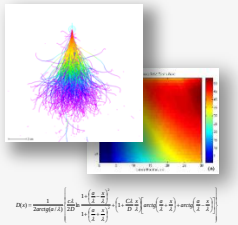
center for NW-Germany, 1200 patients/a

Radiology



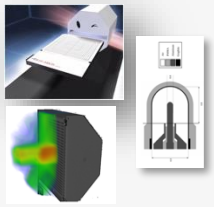
Dose Optimization and Calculation

Modelling



Monte Carlo and Analytical Methods

Radiation Detection

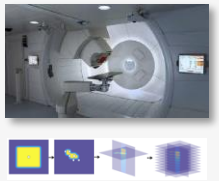


Detectors, Flux, Dose, Activity, Signal-Theory

Space Environment

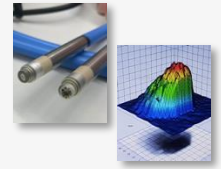
Radiation, Small Bodies, Instrumentation

Particles and Protons



2D Dosimetry, Non Reference Dosimetry

Extreme Beams



2D Dosimetry,

Non Reference Dosimetry

Main Research: Detector Development and Standardization

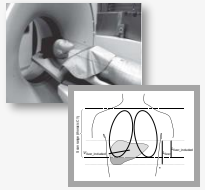
- members app 40: (4 Habil/PI, 4 physicists, 18 Phd students,…)
- 10-12/a Peer Reviewed papers
- Standardization: SSK, DIN, IEC, NAR, AAPM ..

Radiation Physics and Space Environment
(University Clinic for Medical Radiation Physics)

Radiotherapy

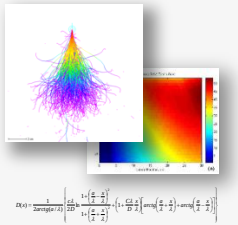
center for NW-Germany, 1200 patients/a

Radiology



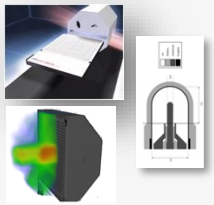
Dose Optimization and Calculation

Modelling



Monte Carlo and Analytical Methods

Radiation Detection

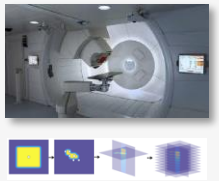


Detectors, Flux, Dose, Activity, Signal-Theory

Space Environment

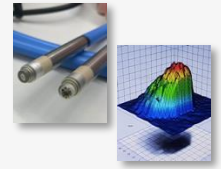
Radiation, Small Bodies, Instrumentation

Particles and Protons



2D Dosimetry, Non Reference Dosimetry

Extreme Beams



2D Dosimetry,

Non Reference Dosimetry

Main Research: Detector Development and Standardization

umcg, esa, PTB (Messen · Forschen · Wissen), CERN, EURAMET, SSK, DIN, IEC, NAR, AAPM

- members app 40: (4 Habil/PI, 4 physicists, 18 Phd students,…)
- 10-12/a Peer Reviewed papers
- Standardization: SSK, DIN, IEC, NAR, AAPM ..

Interreg North Sea

Co-funded by the European Union

KID

Keep-It-Dark

(Multi-channel) measurement options for a long-term survey of Sky Brightness in Wadden Sea- as support for ecological monitoring

a) Compare different devices and procedures

b) develop software to allow survey, comparison and network connection for permanent installation

c) decide on “some” detectors to prepare larger roll-out

d) Connect measurements to ecological studies
(->multi-color, permanent -> not only clear skies)

e) long-term storage

university of groningen

Lead-Partner

- Management
- (Washetdonker) Network
- connection to Astronomy
- national partner

CARL VON OSSIETZKY UNIVERSITÄT OLDENBURG

Detectors and Systems

- Adaptation/development of systems
- calibration, evaluation etc.
- connection to Meteor Science
- national partner

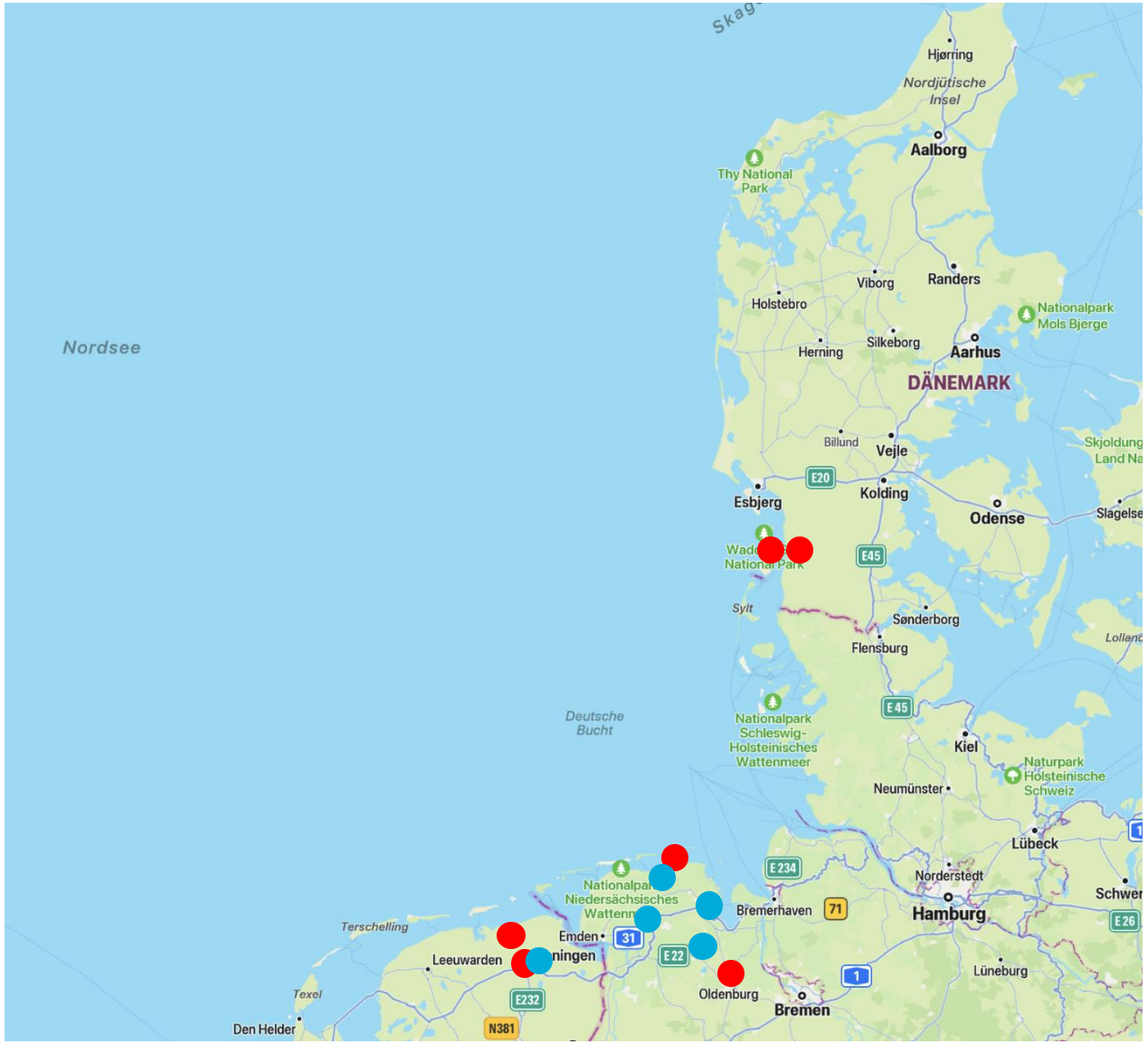
AARHUS UNIVERSITY

Upscale Partner

- Field test of KID-Systems
- national partner

Carl von Ossietzky
Universität
Oldenburg

Locations:



Denmark:

Bright-Sky: Ribe
Dark Sky: Mandø

Netherlands:

Bright-Sky: Groningen
Dark Sky: Lauwersmeer

Germany:

Bright-Sky: Oldenburg
Dark Sky: Spiekeroog
Mobile: TinyObs

- Permanent Station
- Mobile Station (several weeks)

Carl von Ossietzky Universität Oldenburg

Detectors adapted and tested in KID

Oldenburg
SQC
RP
SQM-LU

SQM-DL
TASS
FRIPON
ALLSKY7
Oculus
SG-Was

Alpy600
KID-RP-Birdnet
RICOH-Theta

Spiekeroog
RP
SQM-LU
SQM-DL

Allsky7
Fripon
Alpy600

TinyObs
RP-Birdnet
SQM

TESS-W-1039
TESS-4C-1089
Alpy600

Groningen
SQC
RP
SQM-LU

Lauwersoog
SQC
RP
SQM-LU

Ribe
RP
SQM-LU

Mandø
RP
SQM-LU

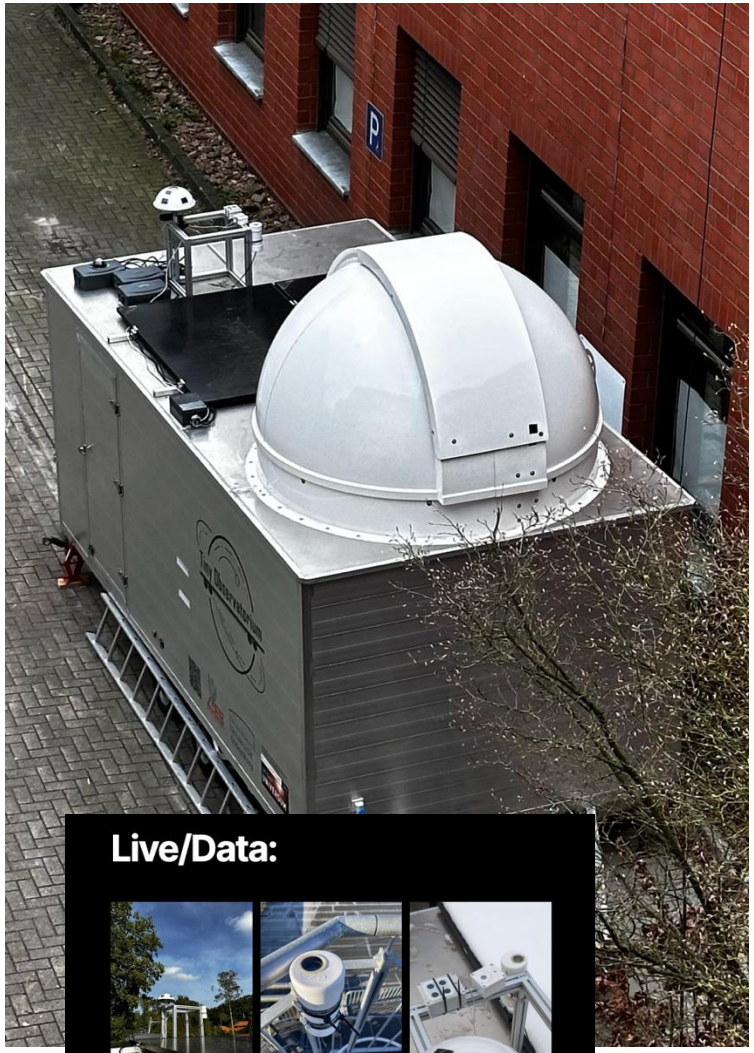
Spin-Offs/Upscales:

DARKER SKY | Interreg North Sea | Co-funded by the European Union

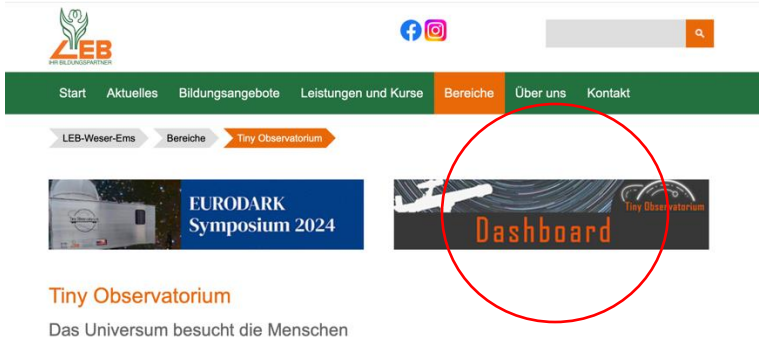
Emden, Burlage, Norddeich. Borkum Lauwersmeer

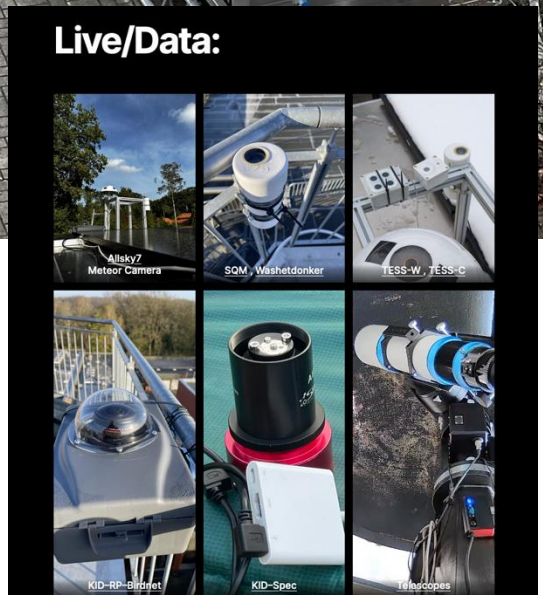
Carl von Ossietzky
Universität
Oldenburg

“Sky-Brightness Observatory”



SQM
SQC
KID-RP-Birdnet
TESS-W
TESS-4C
Spectrometer
Meteor Cam
Telescops

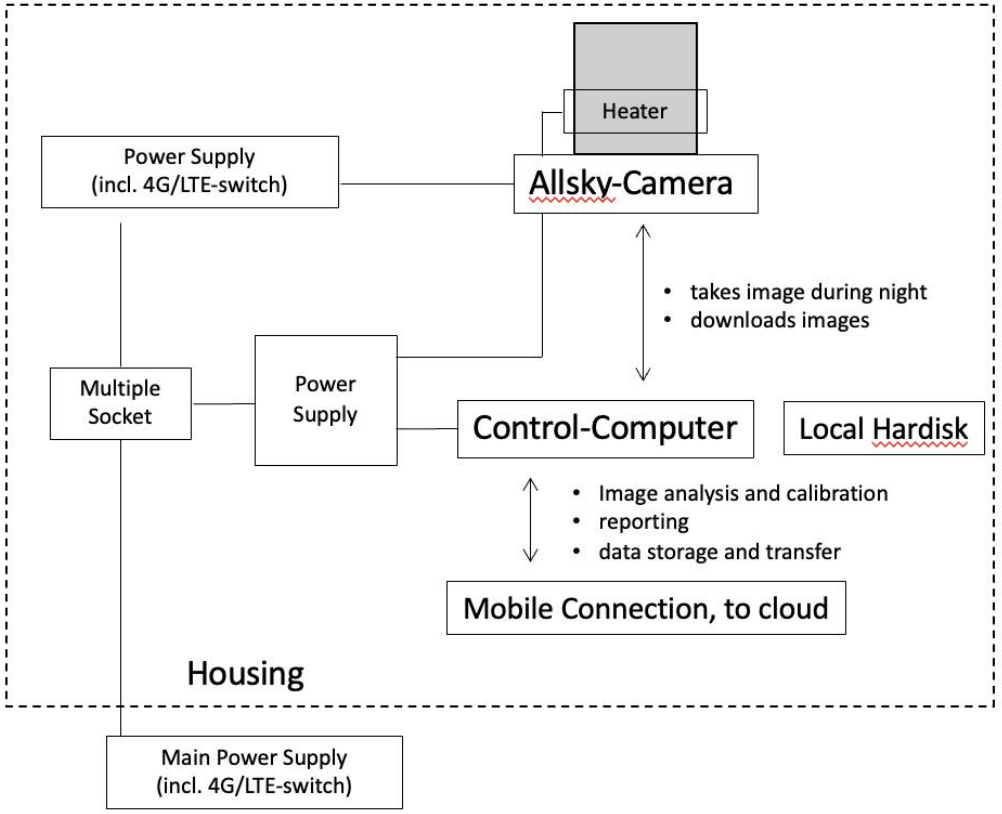




Carl von Ossietzky Universität Oldenburg

KID-Camera System Architecture:

Camera and lenses are exchangeable!



(a)

(b)

see poster of D. van der Geest or TinyObs

more than 20 systems working at the moment

Interreg North Sea
Co-funded by the European Union

Carl von Ossietzky Universität Oldenburg

KID Camera System:

System 1:

- Canon 6D Mark II + Canon Fisheye 8-15mm f/4
- ”SQC in the Box”
- realized 3 times (Groningen, Oldenburg)
- agreement between all systems better than 5%!!!
- Reference Detector

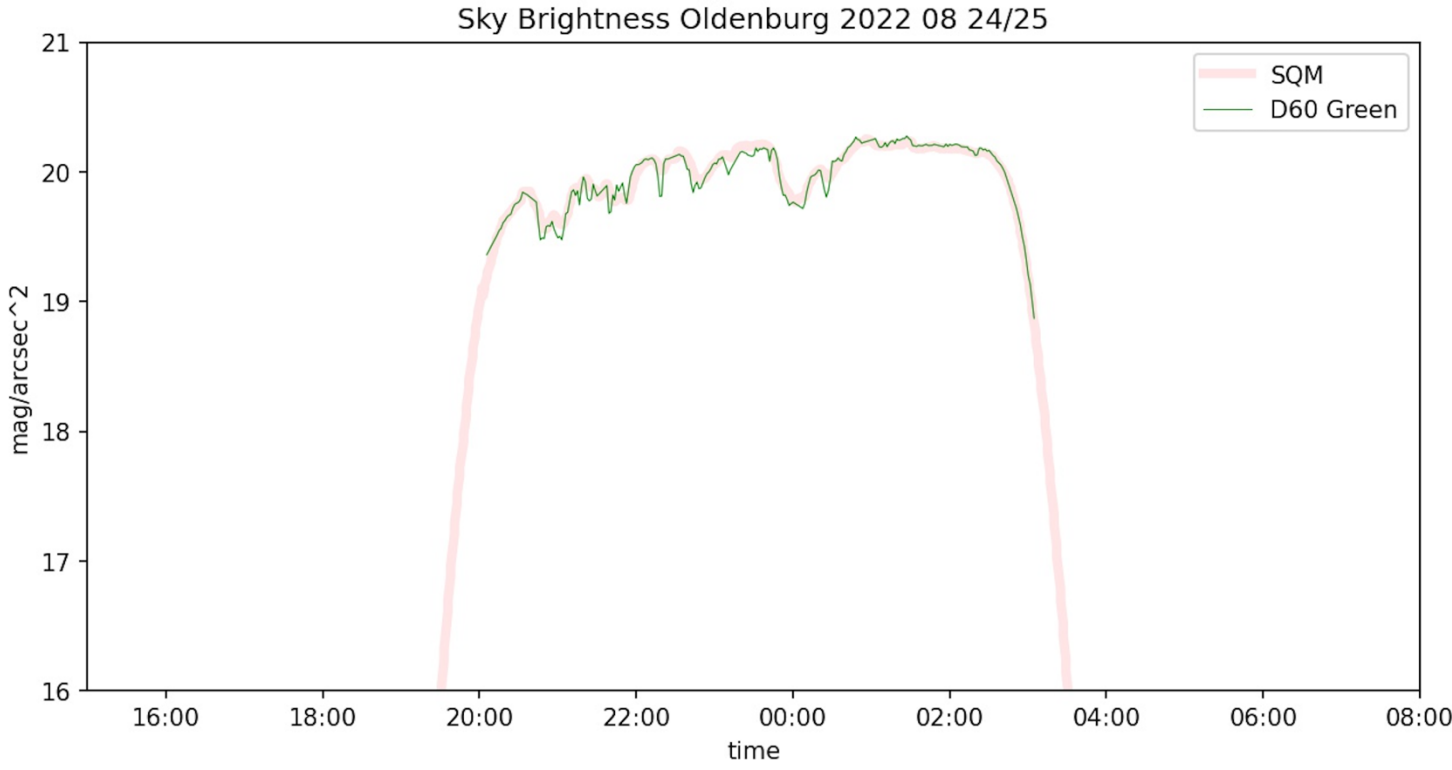
System 2:

- Canon RP mirrorless cam + Canon Fisheye 8-15mm f/4
- same chip as 6D Mark II (different wiring)
- mirrorless (no mechanical parts, we take several hundred pics per night)
- cross-calibration in project
- RGB data stored for later-color analysis
- realized 10 times (at all pilots)

see TinyObs

All-Sky Cameras: comparison with SQM/TESS

transform



$mag_D = -2.5 \log_{10}(\overline{ADU_{zero}}) + cal_D$

within 10° radius FOV in zenith

Carl von Ossietzky
Universität
Oldenburg

The calibration problem in Sky Brightness Measurements:

Problem: Different Detectors have different physical properties!

Sky Brightness Detectors:

- spectral sensitivity
- Field-of-View
- temperature dependence
- linearity
- age
- pixel size..

Usual procedure:

- Define Reference Spectrum and Reference Detectors
- consider deviations in both as “correction” factors

BUT: there is NO generally accepted or agreed on reference spectrum, reference sky or reference detector!!

Many different approaches, each has it’s justification!

Calibration in KID:

Reference Detector: Sky-Quality Camera

we use

- 10° radius FOV in around Zenith
- arranged in KID Box
- window is considered as w_B (0,05 mag/arcsec^2)

$$SB = m_{SQC} = m_{SQC,\,B} - w_B$$

Cross Calibration Factor cal_{Det}

- perform measurements under same sky
- magnitude of detectors in its system m_{Det}

$$SB = m_{SQC} = m_{SQC,\,B} - w_B = m_{Det} - w_{Det} + cal_{Det}$$

- cal_{Det} : cross-calibration factor

- similar to “Spectral Mismatch Correction Factors” (Bouroussis et al 2018, CIE 69)

Calibration in KID:

cal_{Det} depends on the “incoming” spectrum!!!

“Reference” Training - Sky:

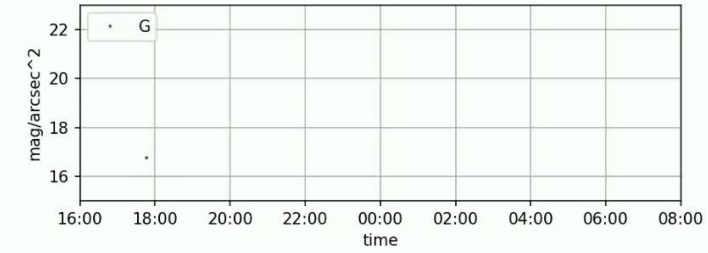
- Difficult to define
- should be representable for measurement task
- for us “Oldenburg” in clear moonless night
  - easy to reach
  - typical suburban sky
  - light pollution and natural light
  - changing conditions (good to check methods)
- each detector used in KID can be traced to SQC in OL

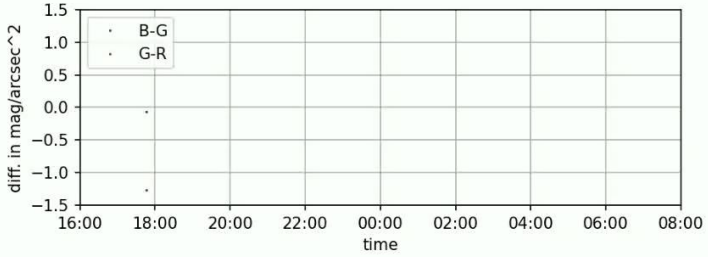
cal_{Det} specific calibration factor

Carl von Ossietzky
Universität
Oldenburg

KID System: Nightly Results at each station for each camera

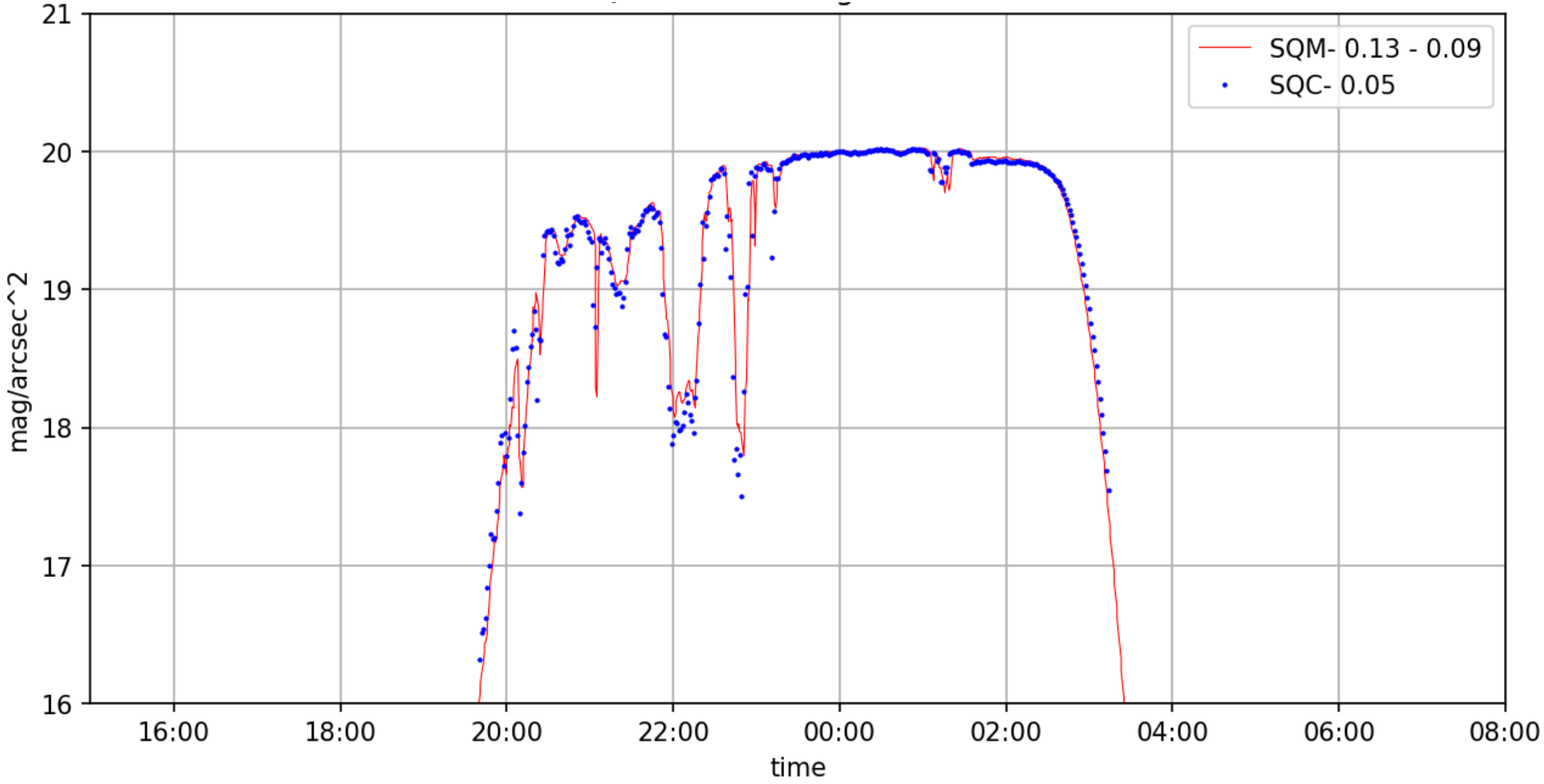
Spiekeroog - RP
2024-01-17T17-46-30





Carl von Ossietzky
Universität
Oldenburg

SQM vs SQC

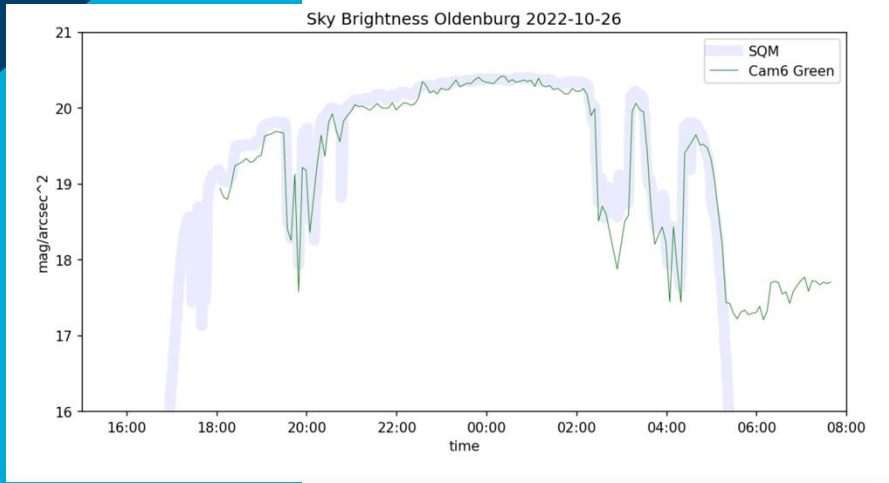


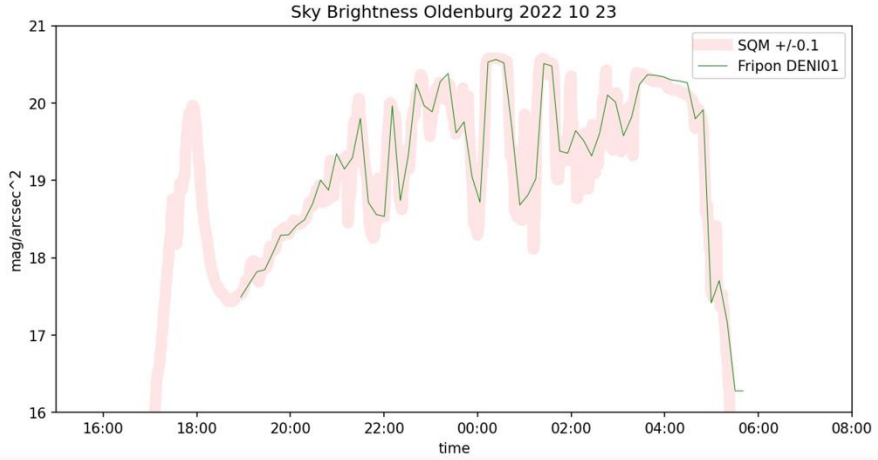
Measurement Options Zenith: All-Sky Cameras

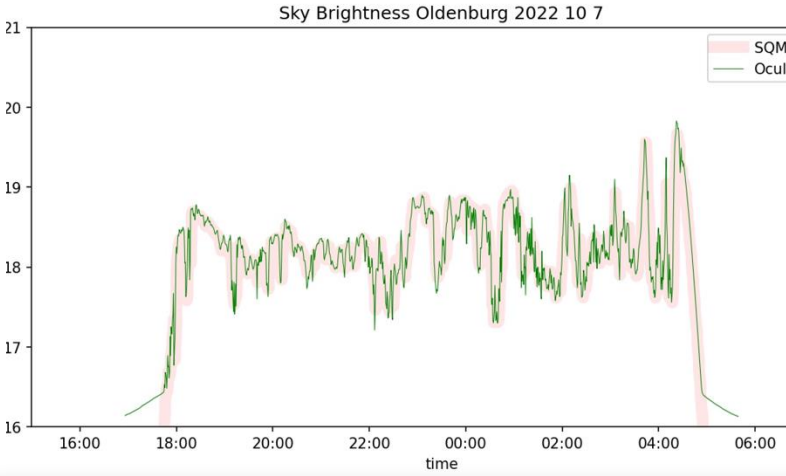
ALLSKY7

Fripon

Oculus





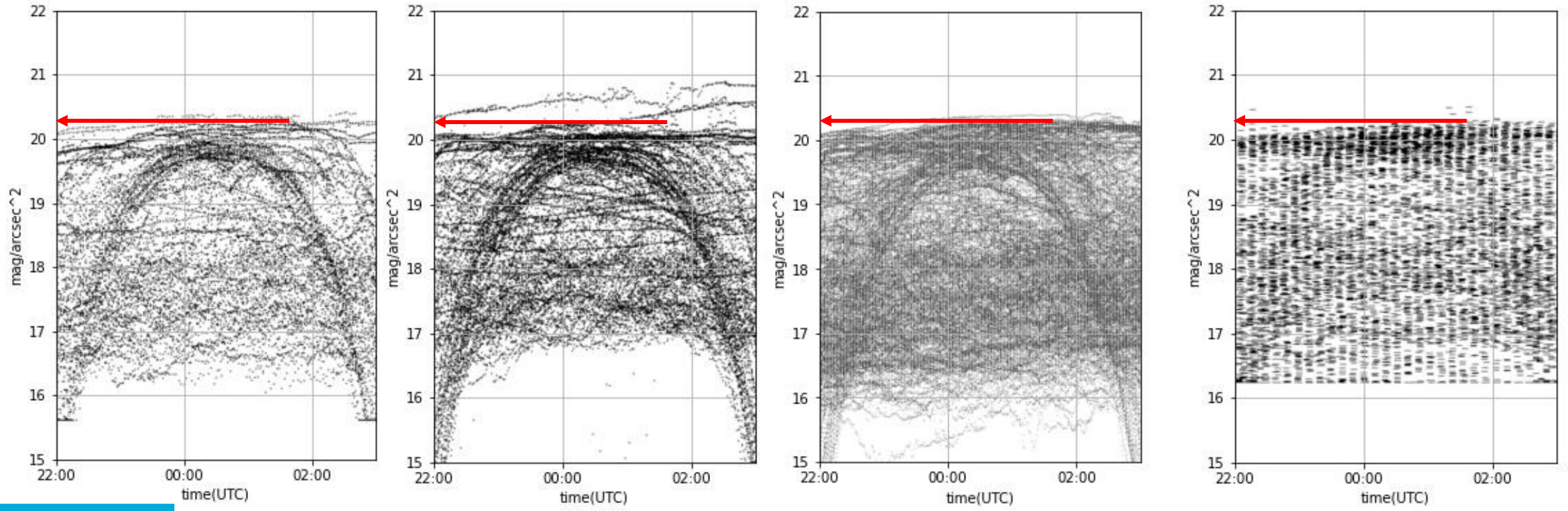


All systems can be calibrated against a reference in an *acceptable limit!*

see poster of A. Rietze (Fripon) , TinyObs or talk of D. Koschny

Carl von Ossietzky
Universität
Oldenburg

Measurements Oldenburg 2023



SQC: 20.30 +/-0,1 mag/arcsec^2

RP: 20.31+/-0.1 mag/arcsec^2

SQM: 20.31 +/-0,1 mag/arcsec^2

Fripon: 20.30 +/-0,1 mag/arcsec^2

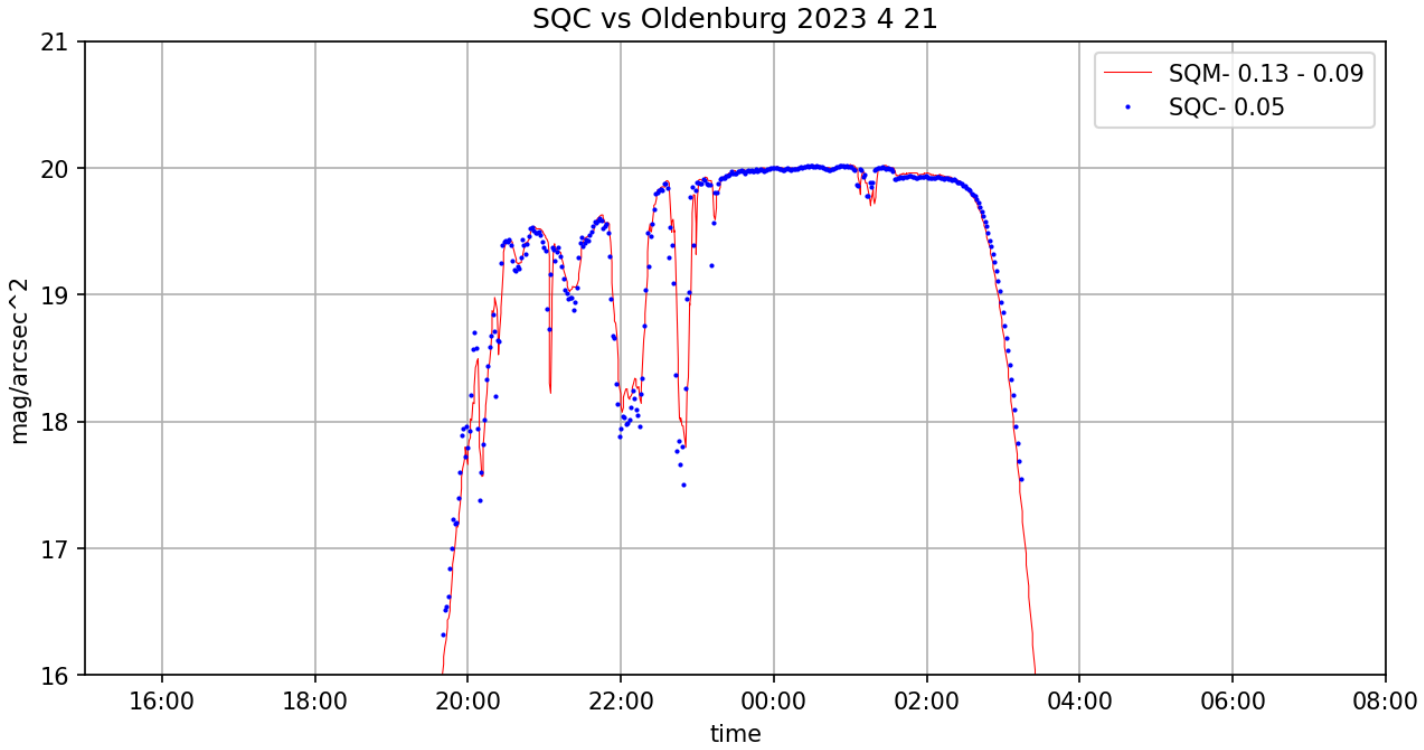
All systems can be calibrated against a reference in an *acceptable limit!*

What is an acceptable limit Problem: How to compare different time series?

Simple “relative” difference at time t is not sufficient in all situations, strictly spoken only possible in slow changing brightness conditions (lab!)

Real Life Problems:

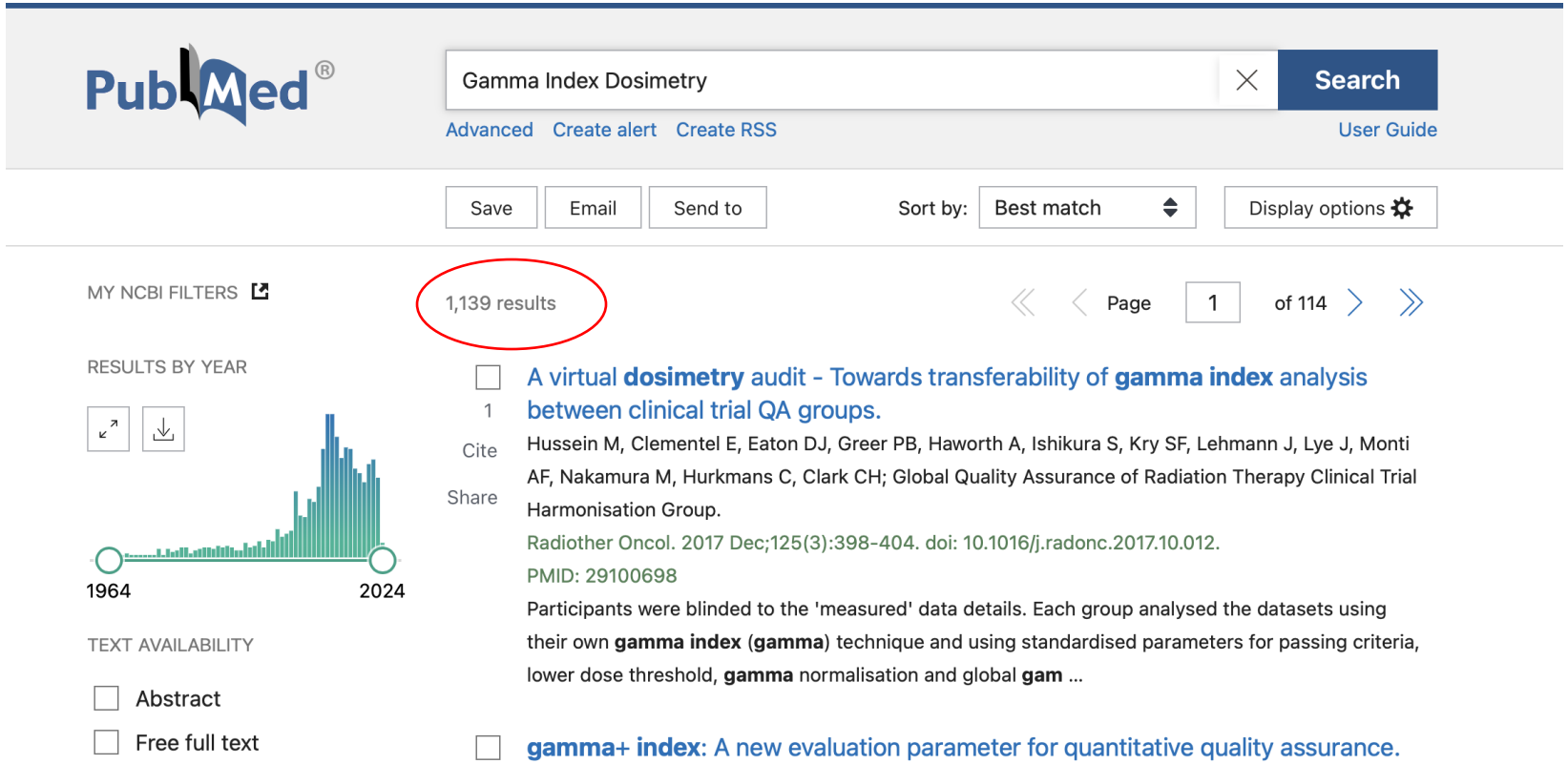
- timing
- sampling time
- sampling interval
- pixel size
- fog/ice
- sampling “area”
- moving clouds
- small deviations in pointing
- spectral mismatch etc. etc.



Carl von Ossietzky
Universität
Oldenburg

Problem: How to compare different time series?

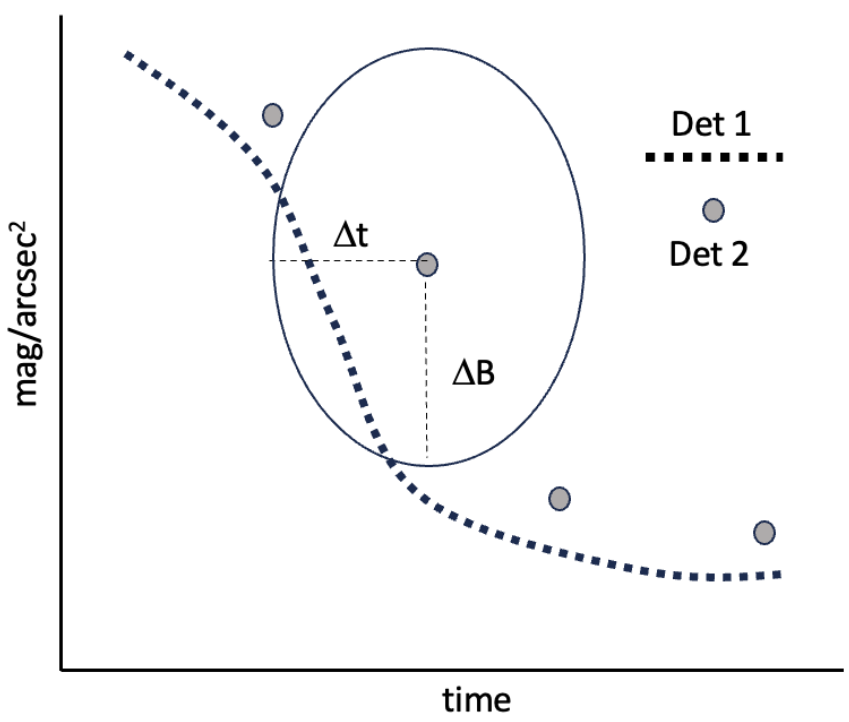
Standard Method to deal with this from Medicine: “**Gamma-Index-Method**”

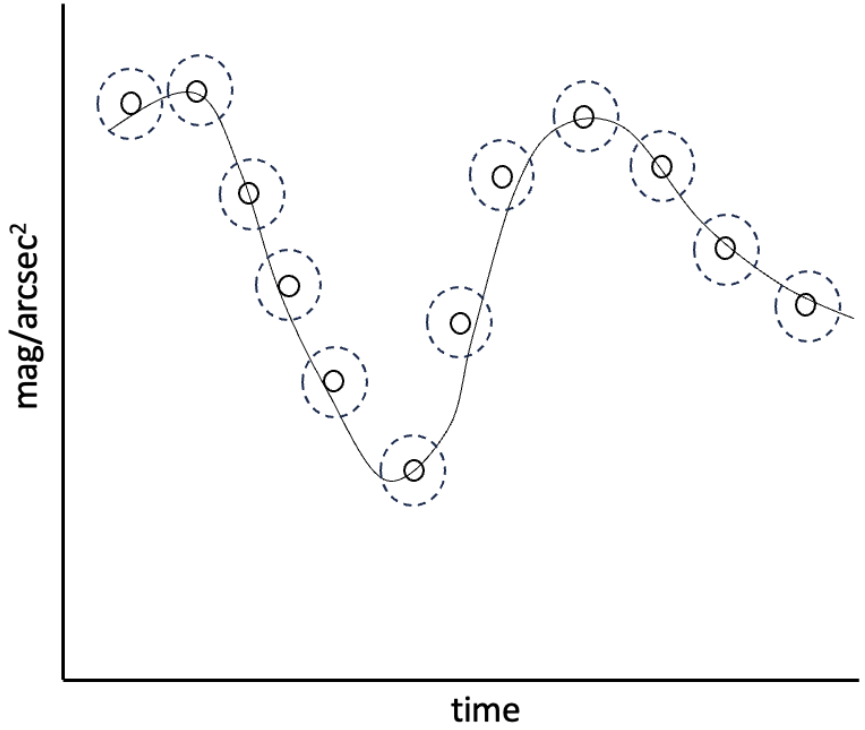


part all major standards and norms on measurements dosimetry.

Gamma-Index Method for comparing sky brightness detectors:

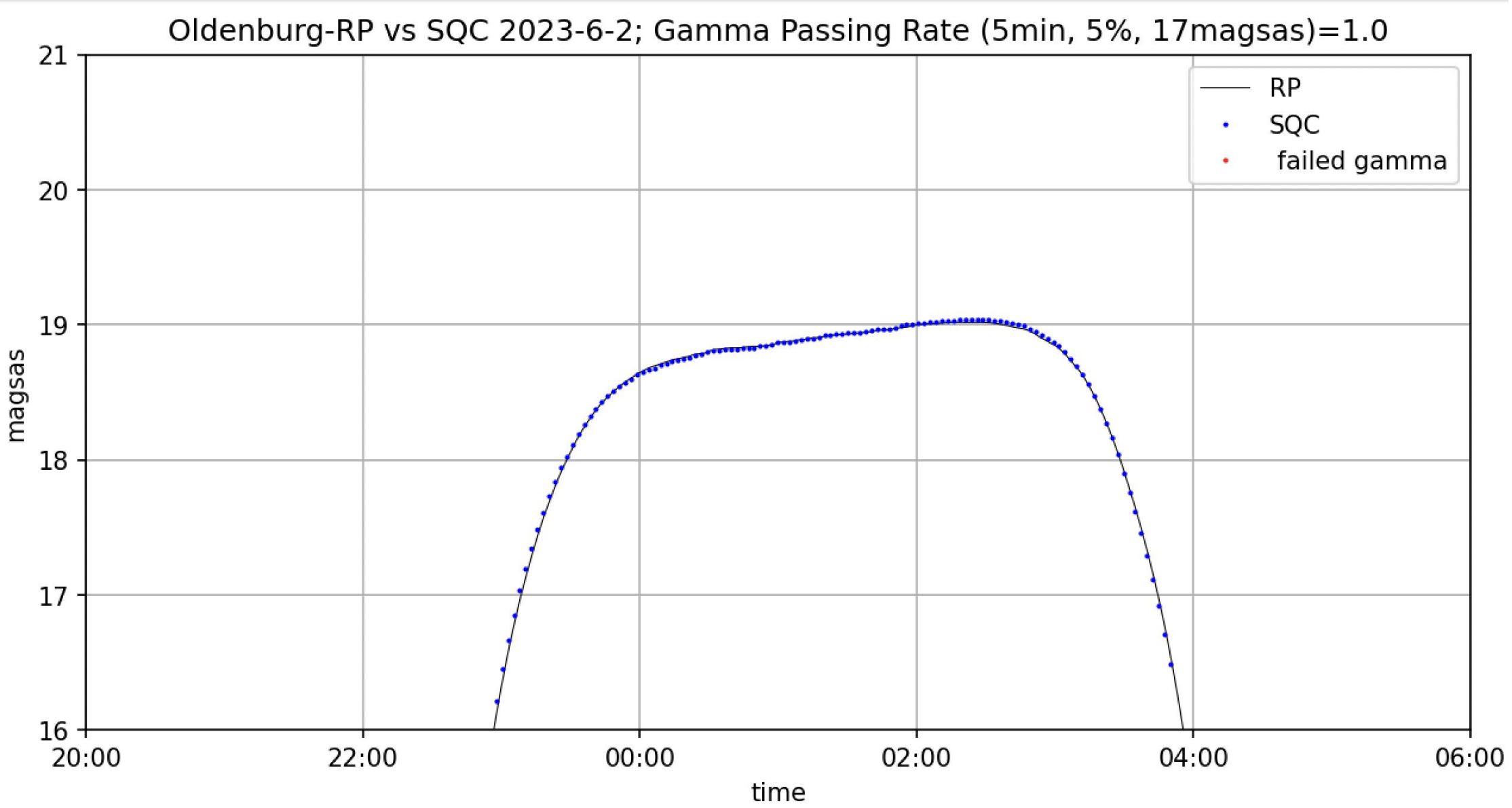
- “allow” a brightness and time difference
- see if a reading of Det 1 falls into ellipsoid around Det 2
- if yes: count as ”acceptable” deviation or “passed” point
- determine “passing” rate as global measure



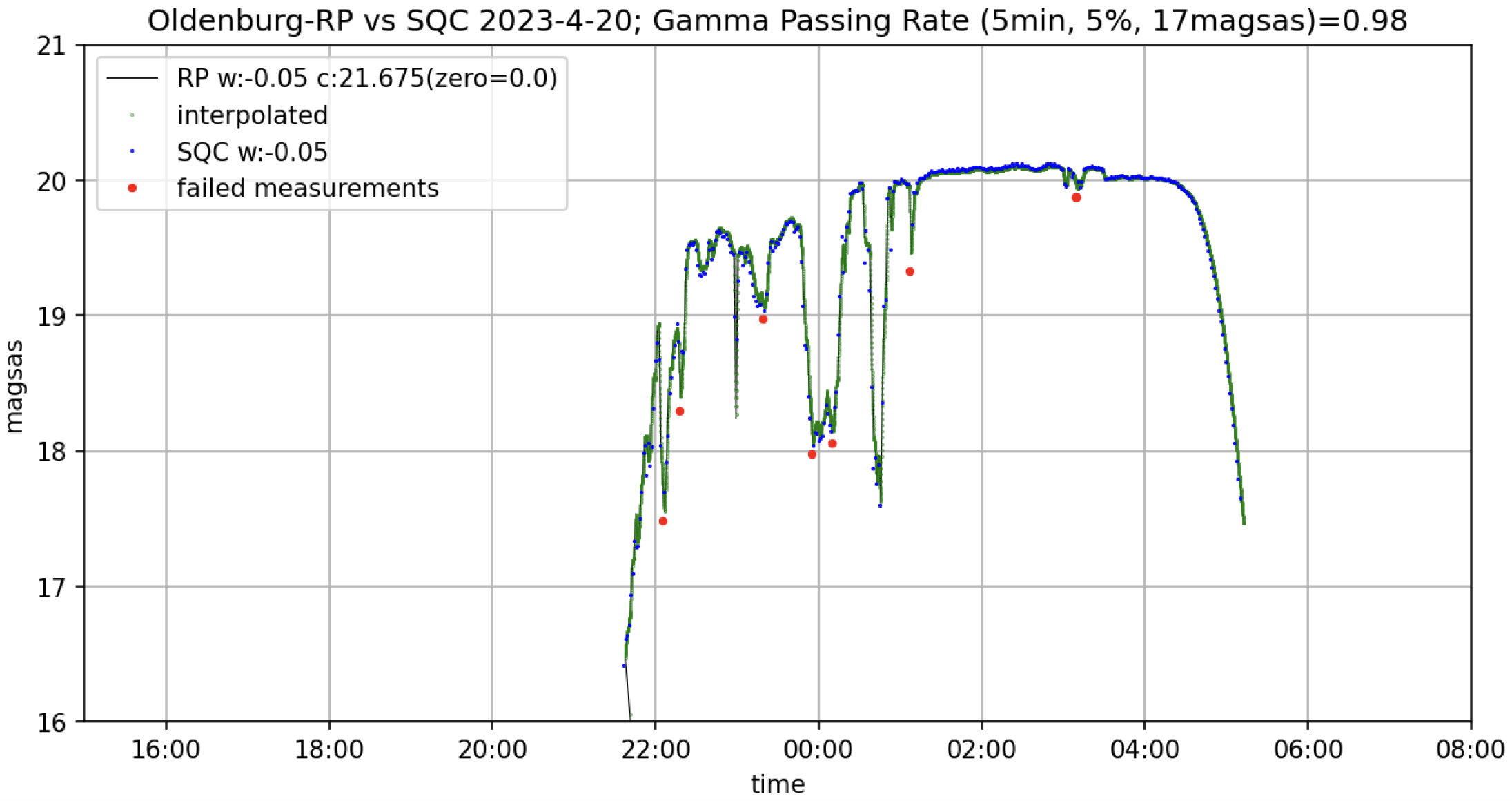


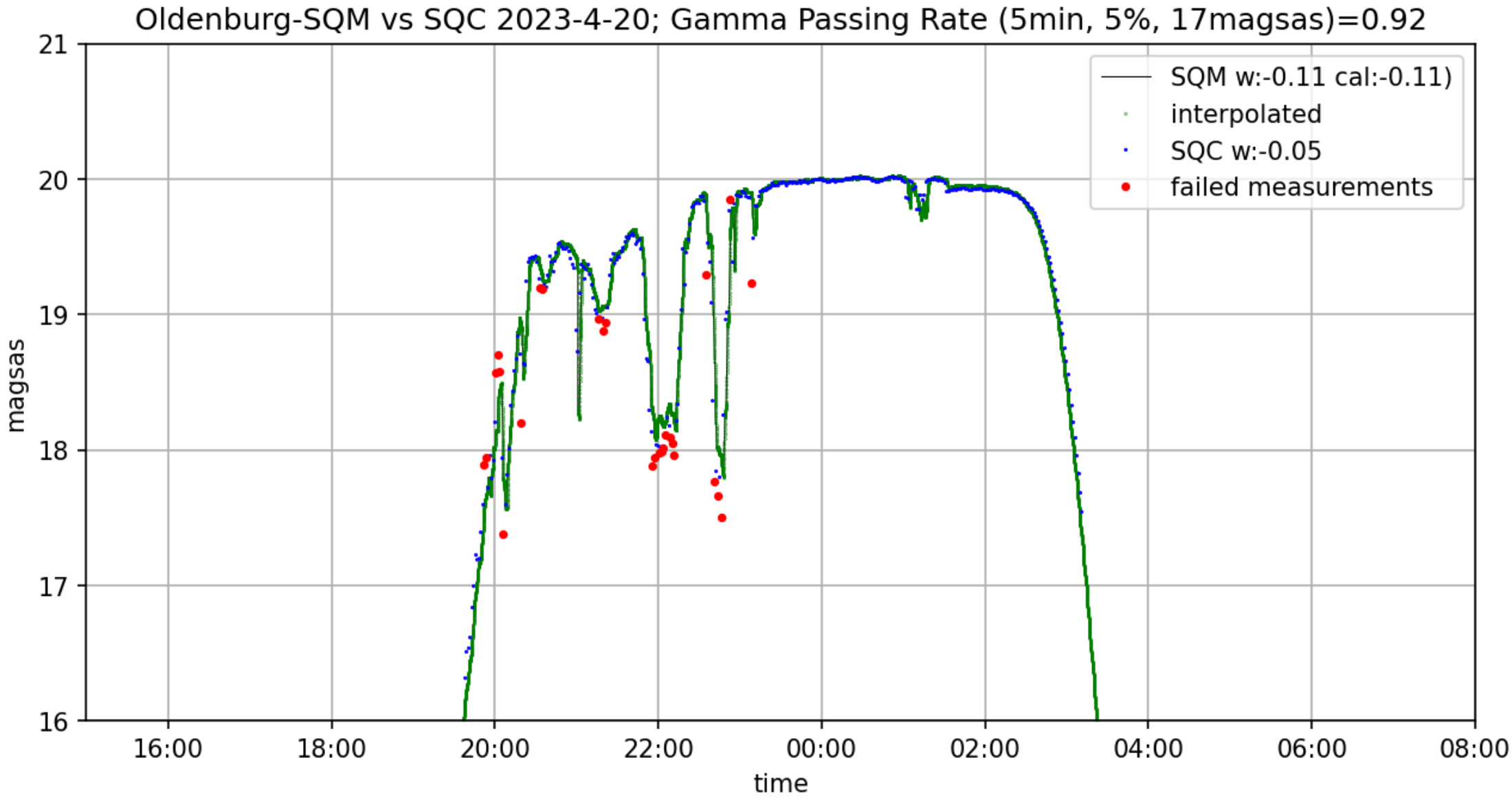
Carl von Ossietzky
Universität
O

Examples:



Examples:


Oldenburg-RP vs SQC 2023-4-20; Gamma Passing Rate (5min, 5%, 17magsas)=0.98
RP w:-0.05 c:21.675(zero=0.0)
interpolated
SQC w:-0.05
failed measurements
magsas
time
21
20
19
18
17
16
16:00
18:00
20:00
22:00
00:00
02:00
04:00
06:00
08:00


Oldenburg-SQM vs SQC 2023-4-20; Gamma Passing Rate (5min, 5%, 17magsas)=0.92
SQM w:-0.11 cal:-0.11)
interpolated
SQC w:-0.05
failed measurements
magsas
time
21
20
19
18
17
16
16:00
18:00
20:00
22:00
00:00
02:00
04:00
06:00
08:00

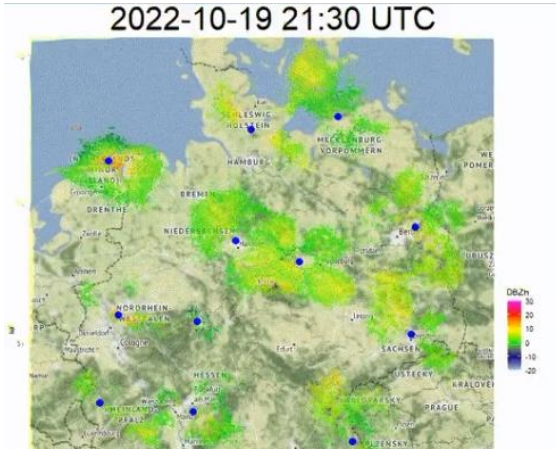
Carl von Ossietzky
Universität
Oldenburg

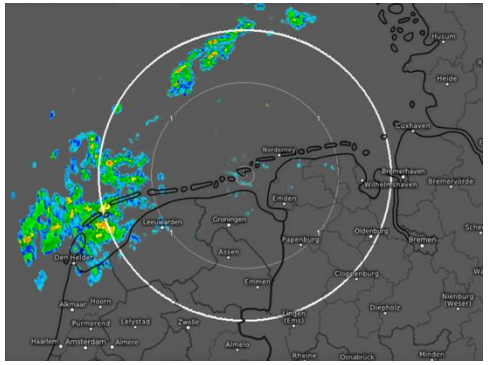
Conclusion KID/Next Steps:

- Wadden Sea wide network with different detectors has been set-up and is running
- Calibration method is introduced by usage of cross calibration factors
- Different detectors can be calibrated and when considering the physical properties
- SQM and KID-RP system are used as our standard detectors (practical reasons!!)
- Important: can be “re-calibrated” once we have a traceable reference standard (hopefully soon!)
- Gamma-Index Method was successfully adapted for Sky Brightness Measurements
- Next Steps:
  - usage of colour information and fish-eye image
  - installation of more systems in region
  - more specific detectors (compbined bird sound-brightness station, horizon station, spectrometer)

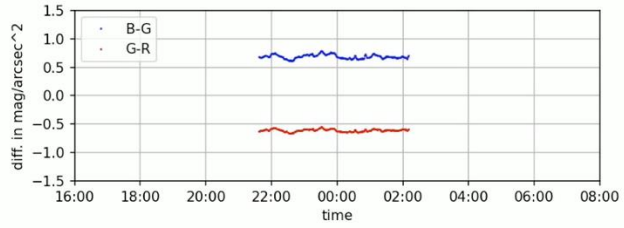
Carl von Ossietzky Universität Oldenburg

Outlook: First Horizont-System, connected to weather radar on Borkum





Borkum - RP1
2024-03-03T02-10-50



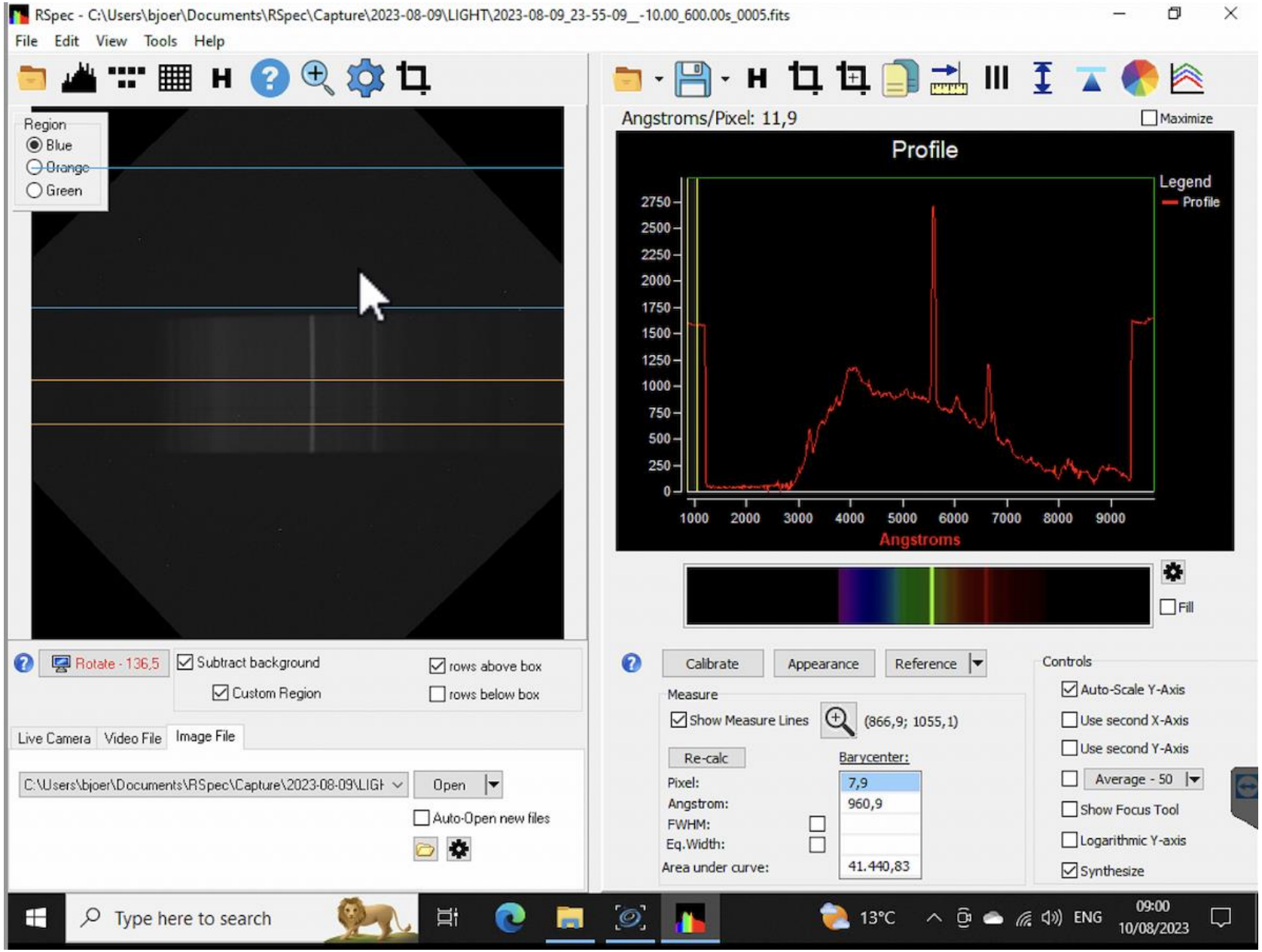
O. Hüppop , X, Nocturnal Bird Migration measured by weather radar stations

DARKER SKY | Interreg North Sea | Co-funded by the European Union

Outlook: Spectral Measurements

ALPY 600 + ASI533mmpro

see poster of R. Will or TinyObs



Carl von Ossietzky
Universität
Oldenburg

Outlook: KID-RP-BirdNetPy

Detections and analysis of BirdSounds and sky brightness

see TinyObs