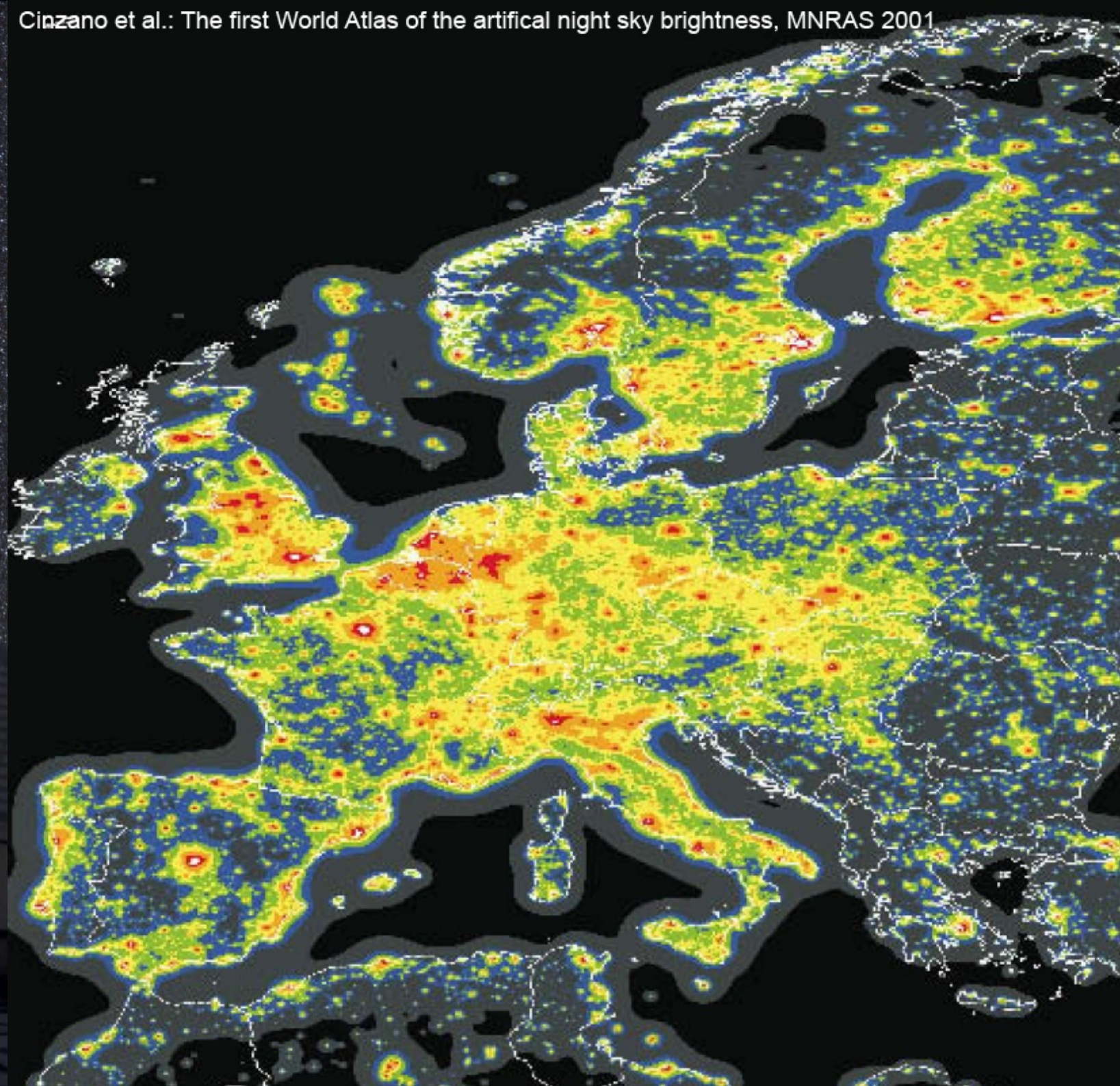




# Monitoring Night-Sky Brightness with a lightmeter network?

Günther Wuchterl

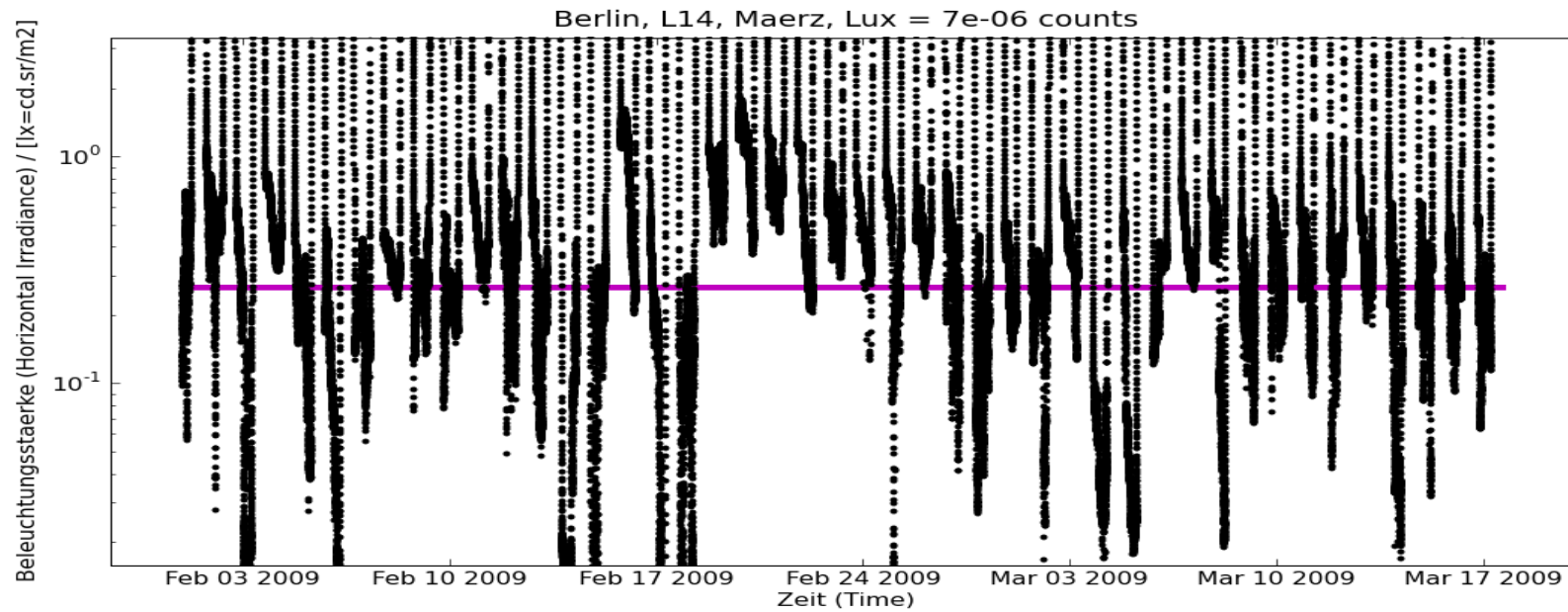
Thüringer Landessternwarte, Tautenburg und Kuffner-Sternwarte, Wien



# First station in Jena, Okt 2005



# Simple, continuous monitoring



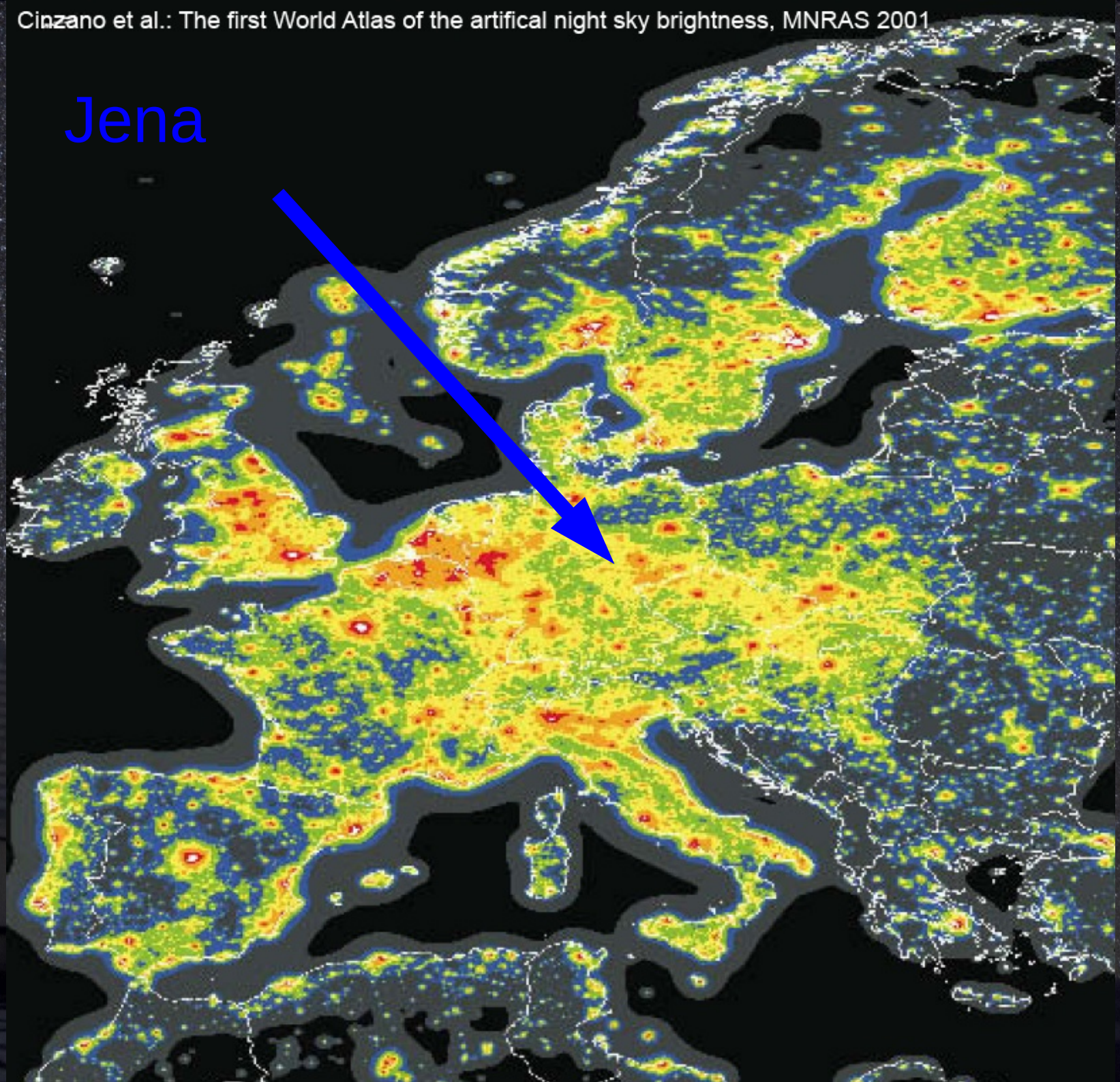
# Lightmeter

- Mark 2.2: August 2008
  - Amorphous Si solar cell
  - USB-connection
  - Sun in zenith to 50 mikro-Lux
  - Daylight part non-linear (from full moon)
  - 1 Hz (20 Hz with Skysensor software)
  - 2 kHz with the linux-version (experimental)

# Lightmeter

- Mark 2.3: August 2009 – IYA Lightmeter
  - ... as Mark 2.2, August 2008
  - Extra pre-calibrated day-sensor 1 lx to 60 klx
  - Selected cells - typically factor 4 more sens.
  - Nonlinearity from 0.1 lx (Moon!)
  - Detection limit estimated a few mikro lx (single stars!)

Jena





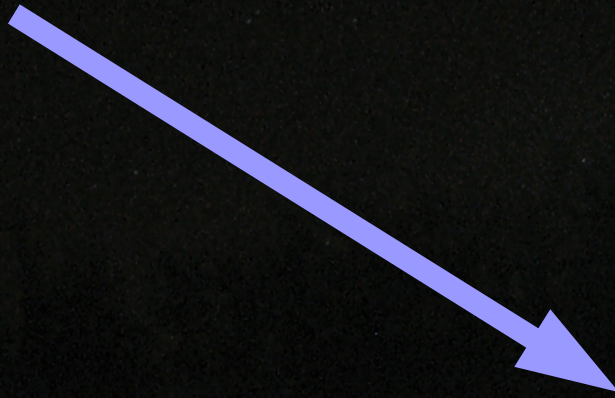
# Die Astronomische Nacht

$\mu\text{Lux}$  Bereich

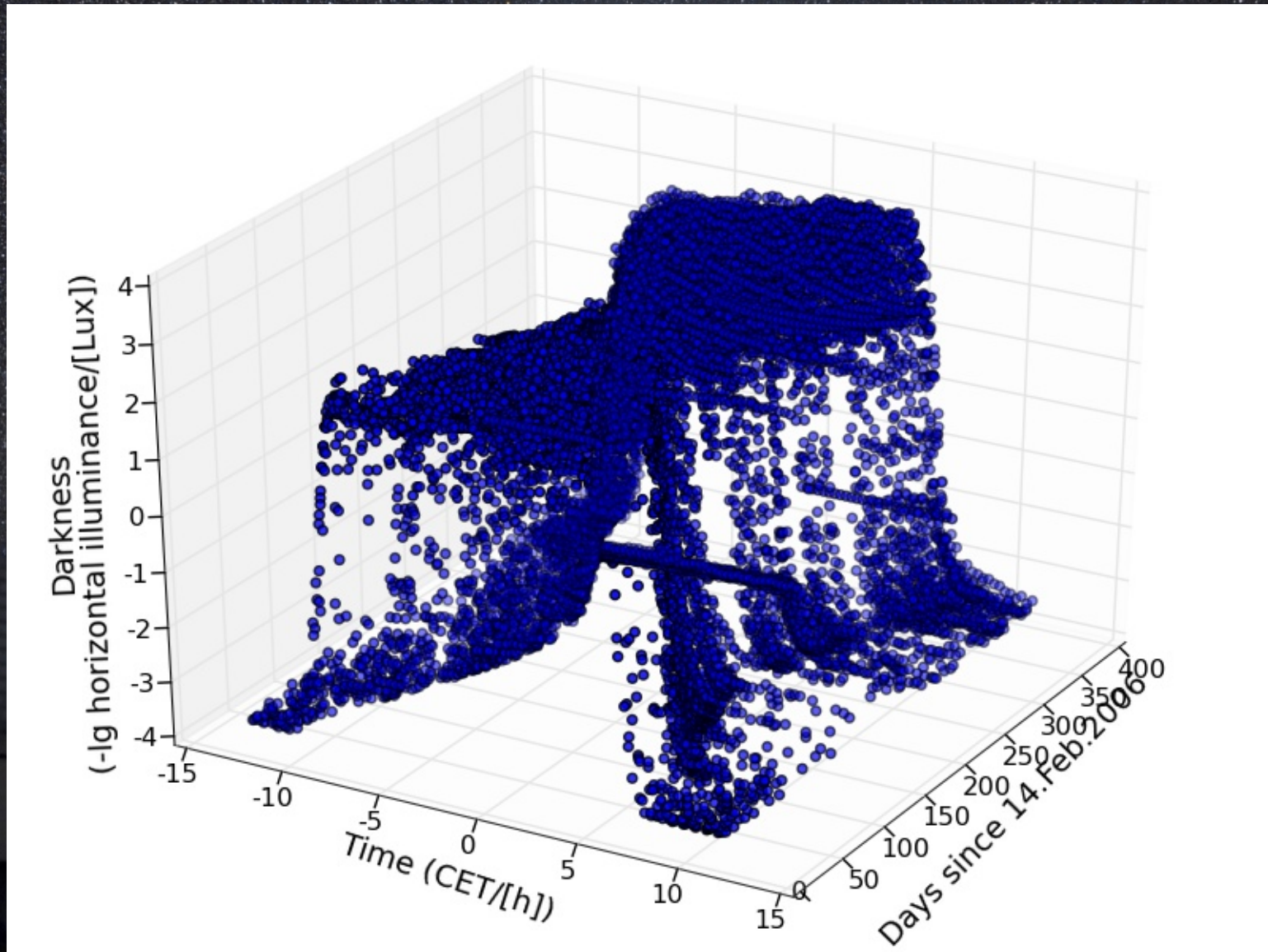
Sirius	10 $\mu\text{lX}$
Venus	170 $\mu\text{lX}$
Alle Sterne	200 $\mu\text{lX}$
NH-Leu	2000 $\mu\text{lX}$



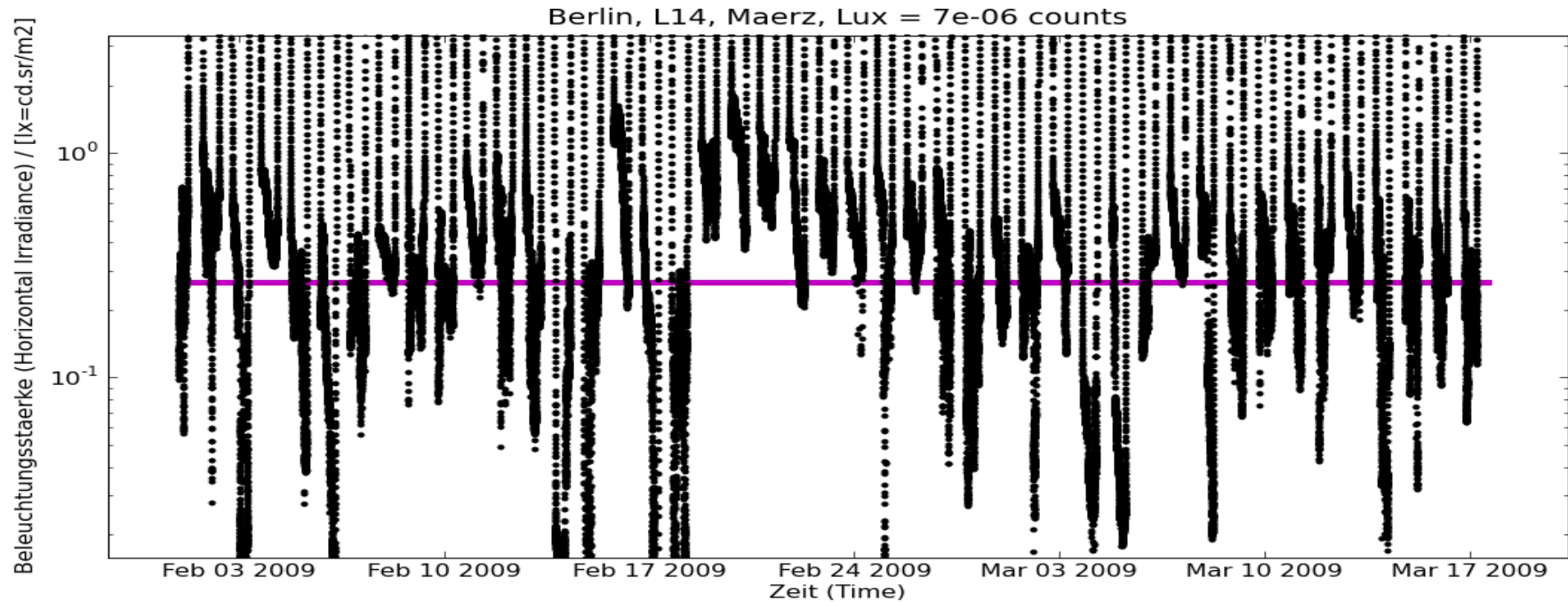
# Dunkelheit 2006-2008



# Beleuchtungsstärke 2007

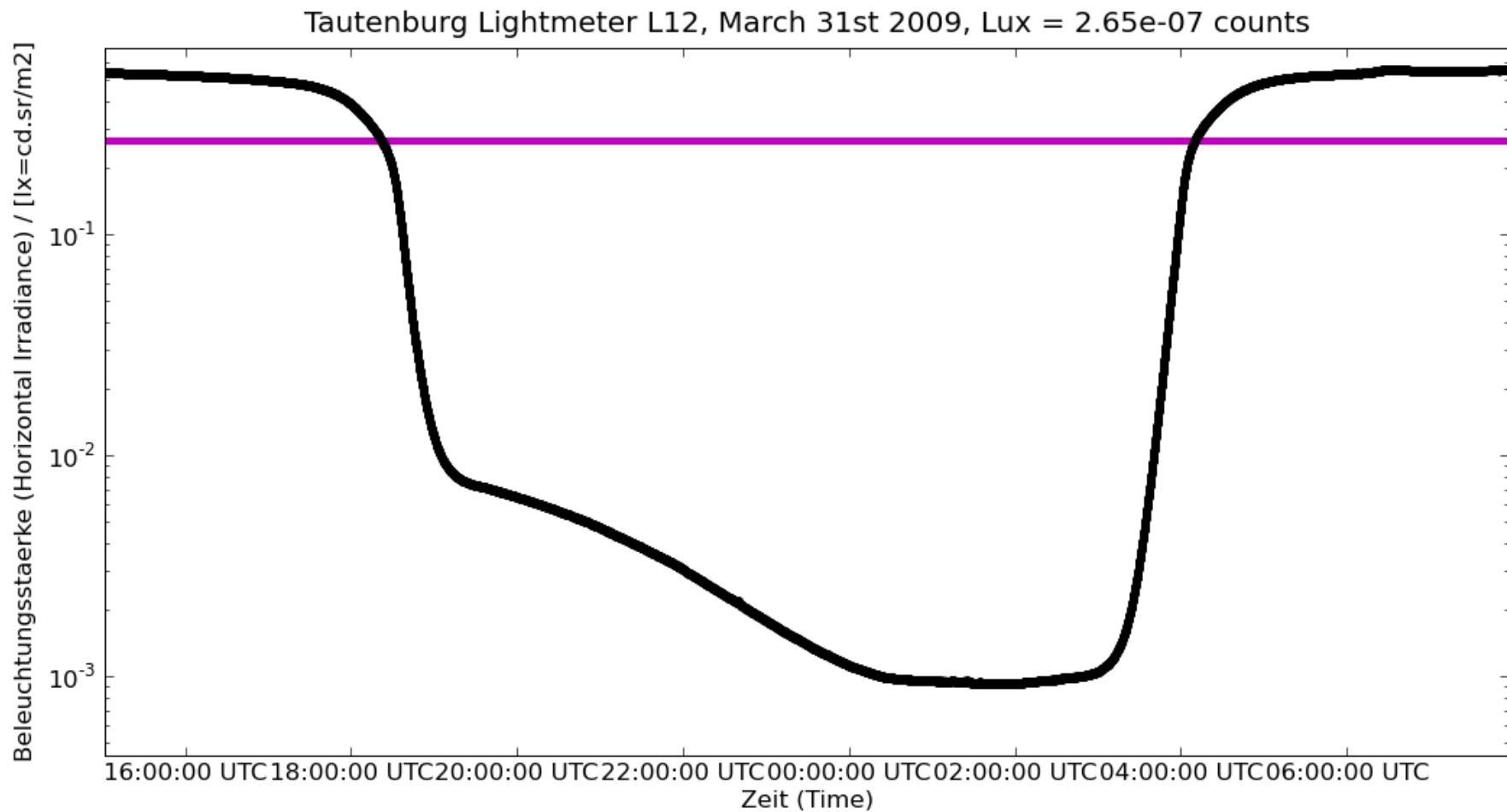


# Nachthimmelshe lligkeit kontinuierlich aufzeichnen



# Lightmeter Mark 2

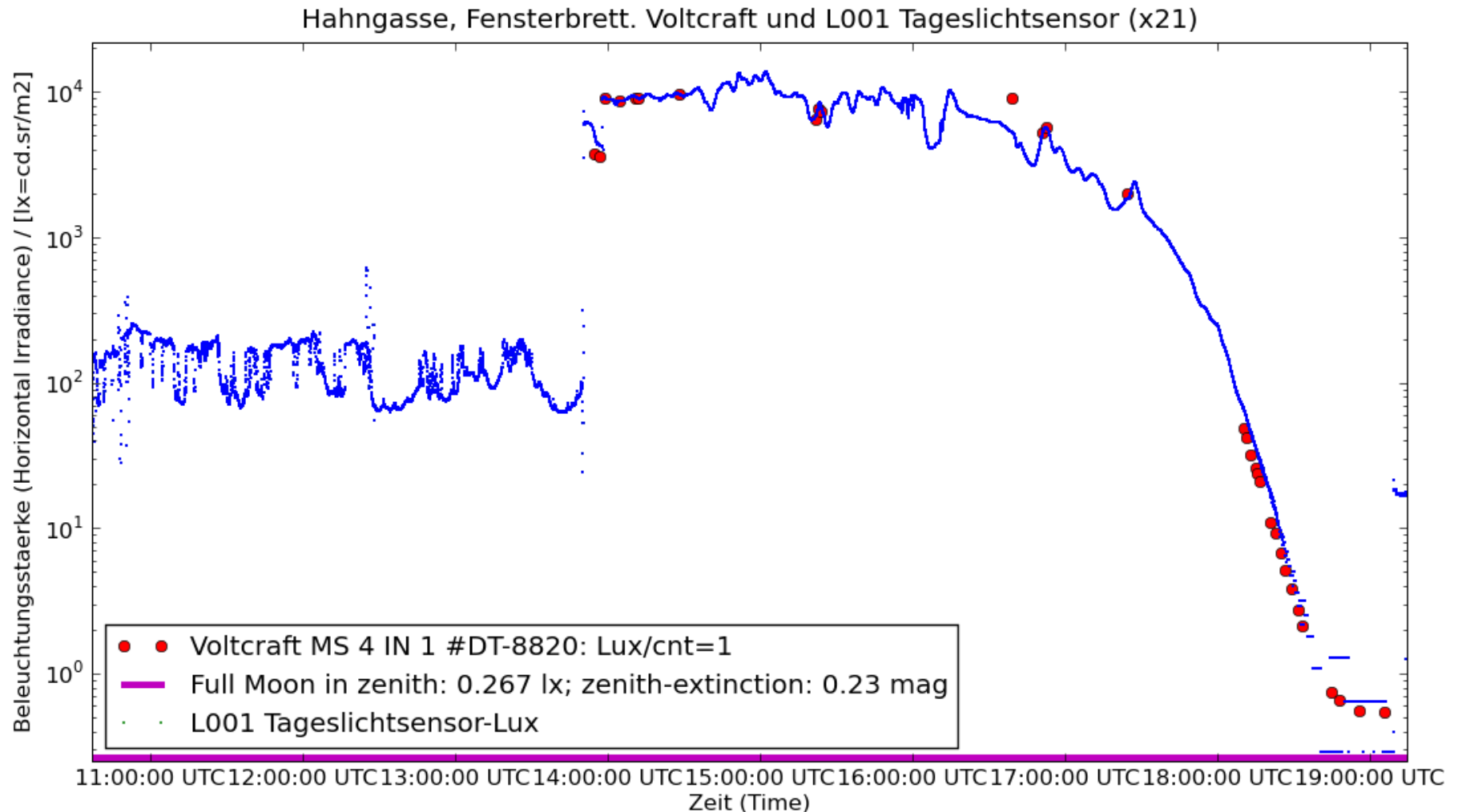
## A night in Tautenburg



# Calibration

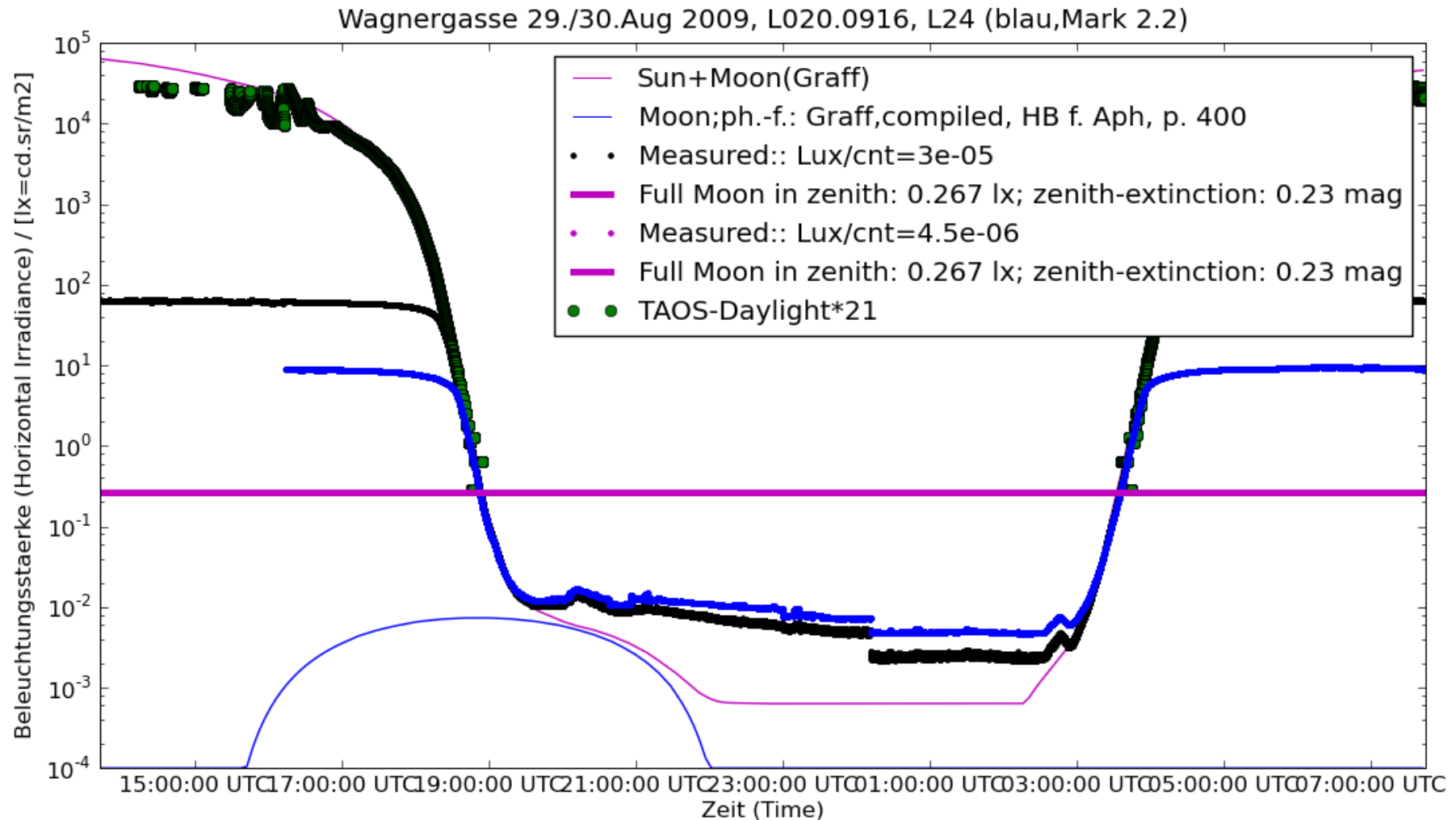
- Simultaneous measurements with other instruments (Luxmeter, SQM)
- Sun + twilight
- Moon
- Daylight-Sensor (Mark 2.3 IYA-Lightmeter)

# Day-Sensor vs. handheld Luxmeter



# Lightmeter Mark 2.3 – IYA 2009

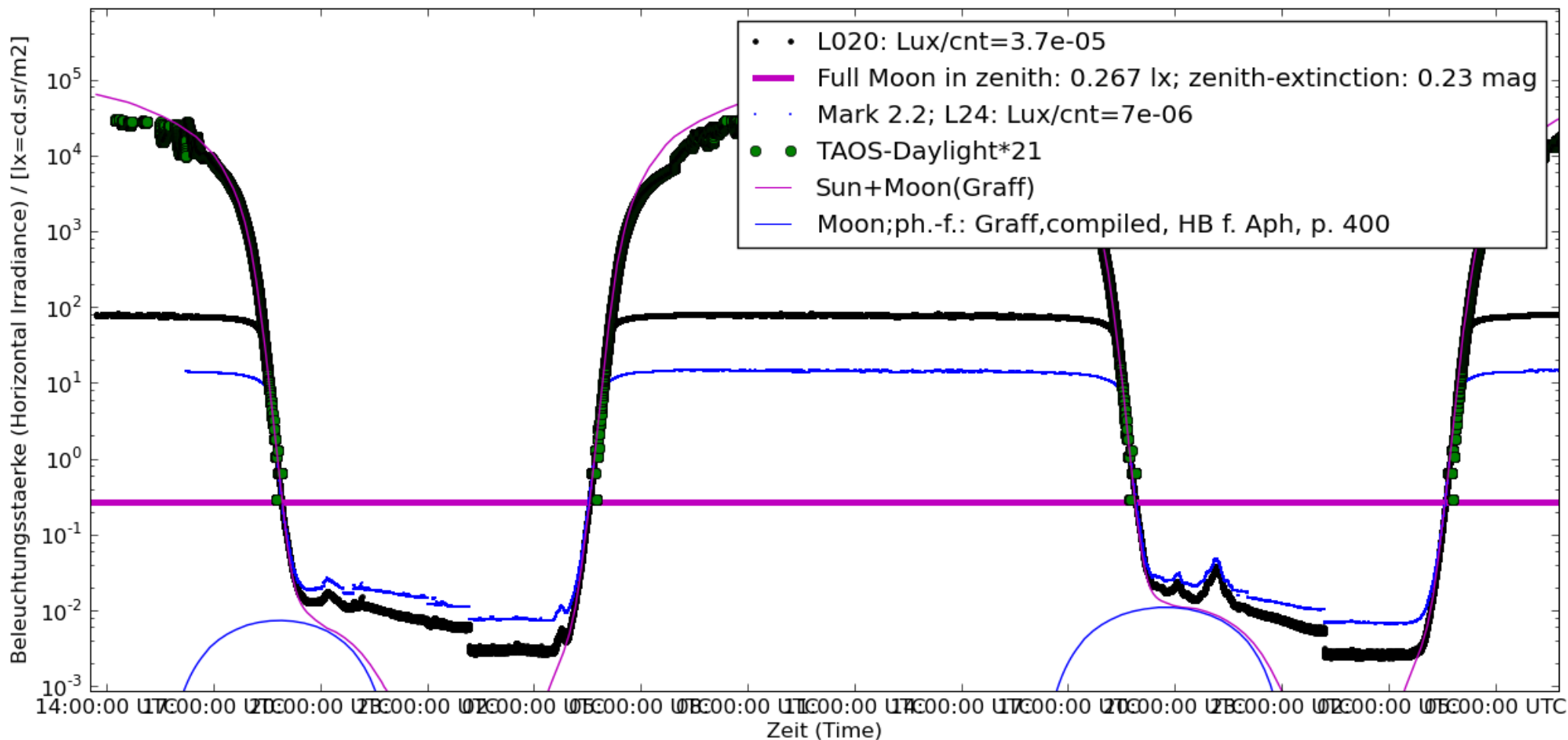
## Light in the city





# Light in the city

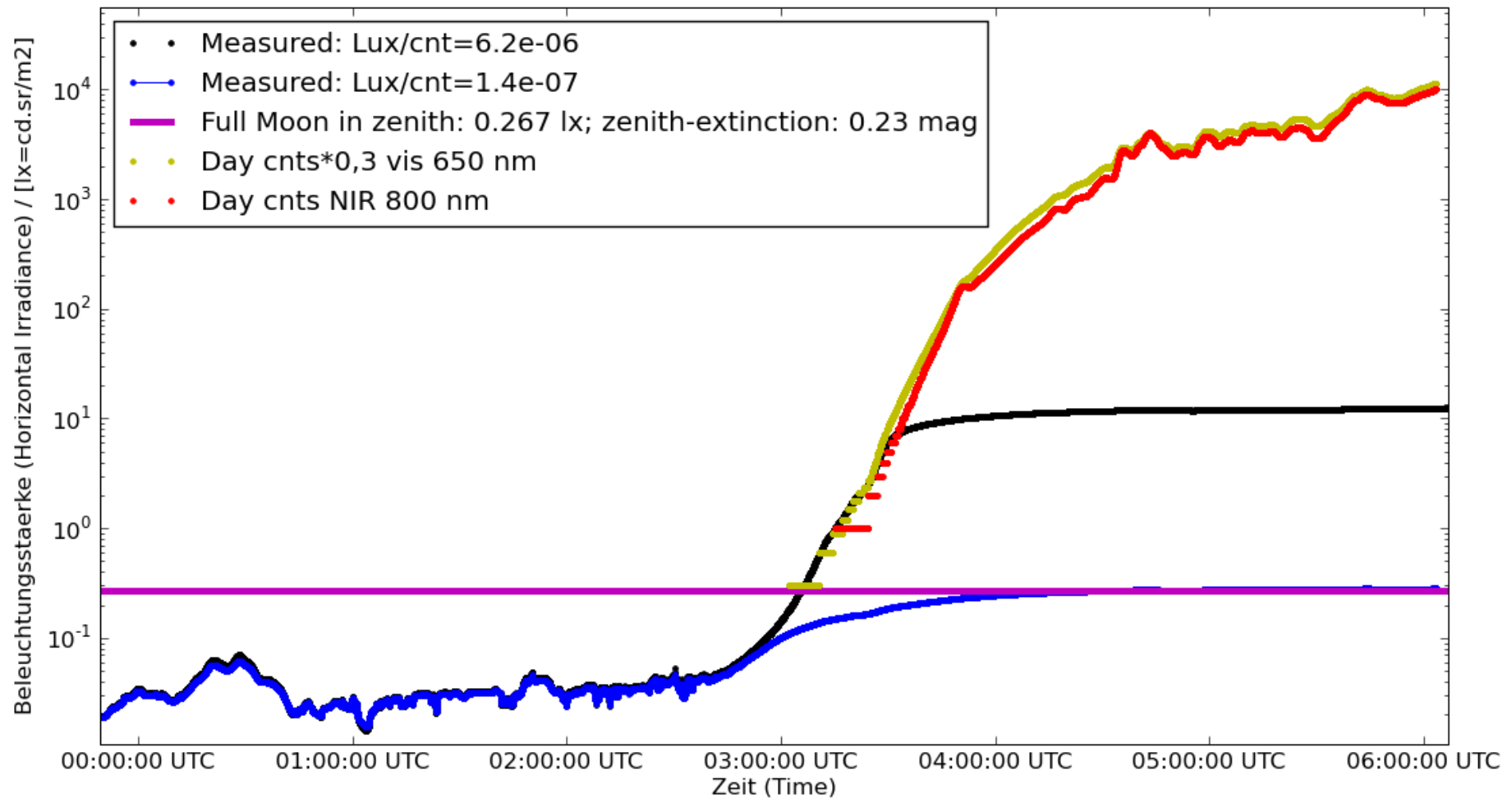
Wagnergasse, 29-31 Aug. 2009, L020 (black) daylight (green), L24 (blue)



# Daylight, vis und NIR

## Lightmeter Mark 2.3

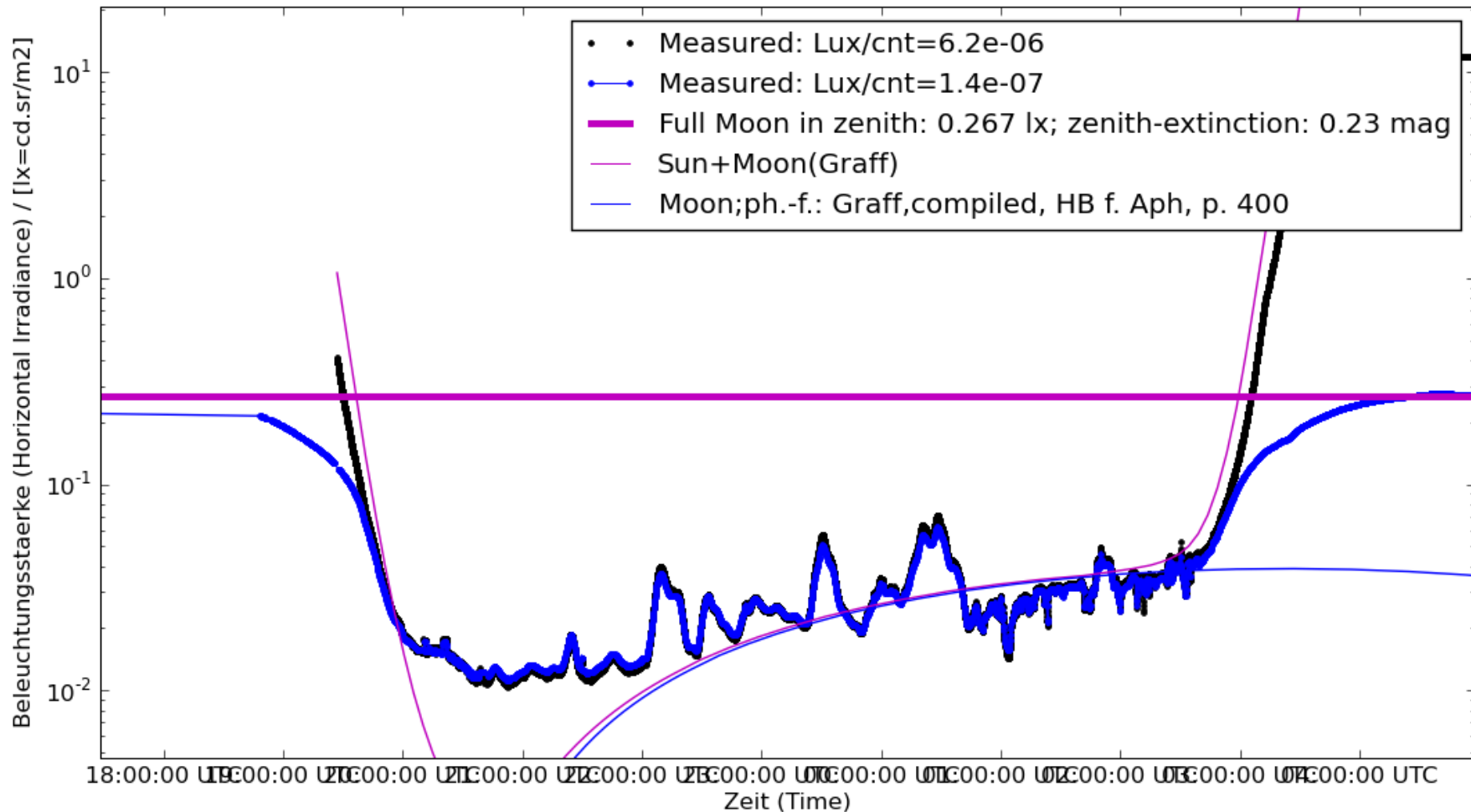
Mark 2.3 (blau) und Mark 2.2 L18, Lux = 1.4e-07 counts



# Daylight Nonlinearity

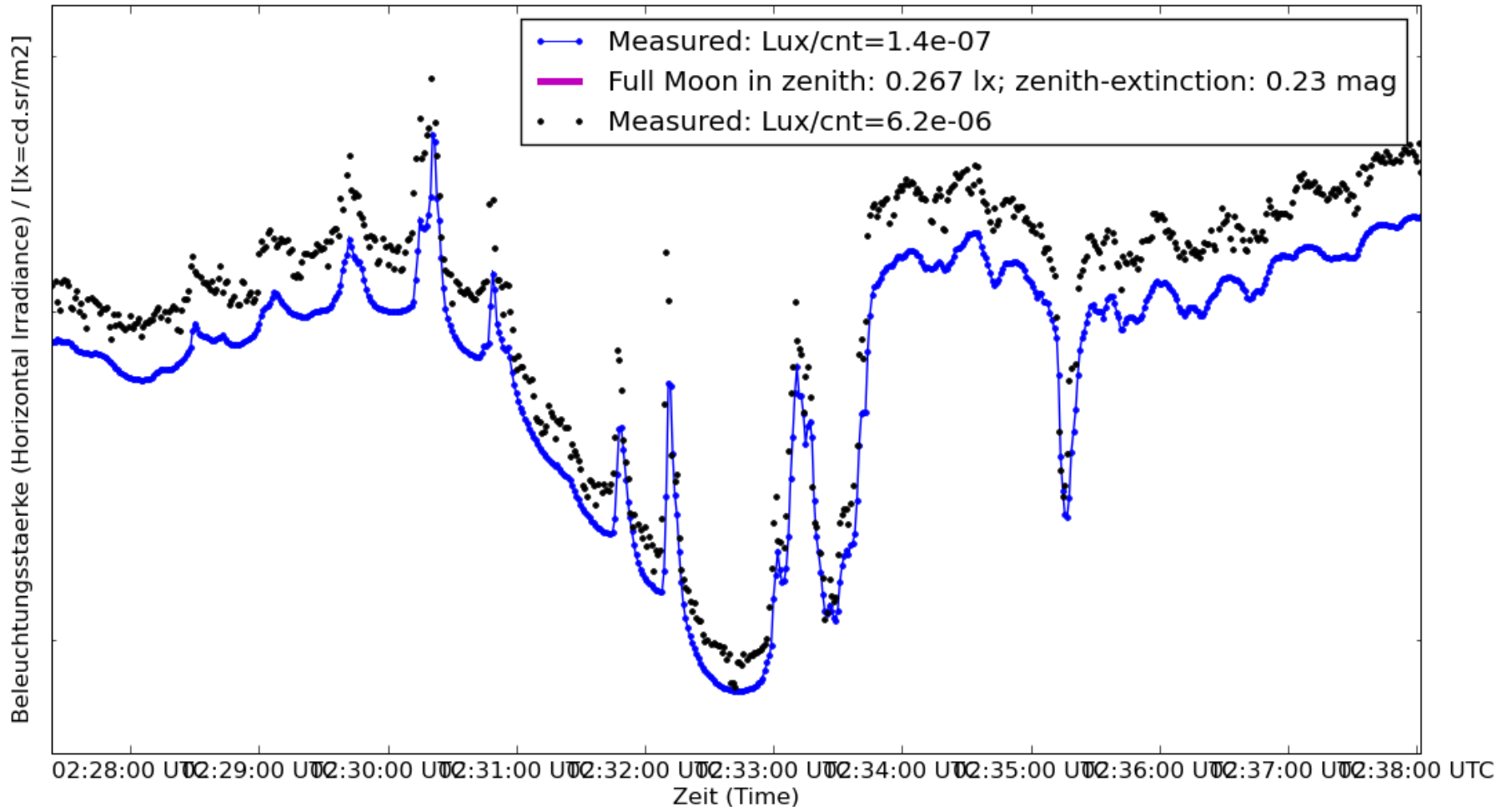
## Lightmeter Mark 2.3

Mark 2.3 (blau) und Mark 2.2 L18, Lux = 1.4e-07 counts



# August 12 anomaly

Wagnergasse West-DachLuke - Perseiden durch Wolken, Mark 2.3 (blau) und Mark 2.2 L18

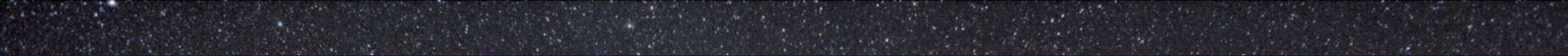


# Austrian Network May 2009

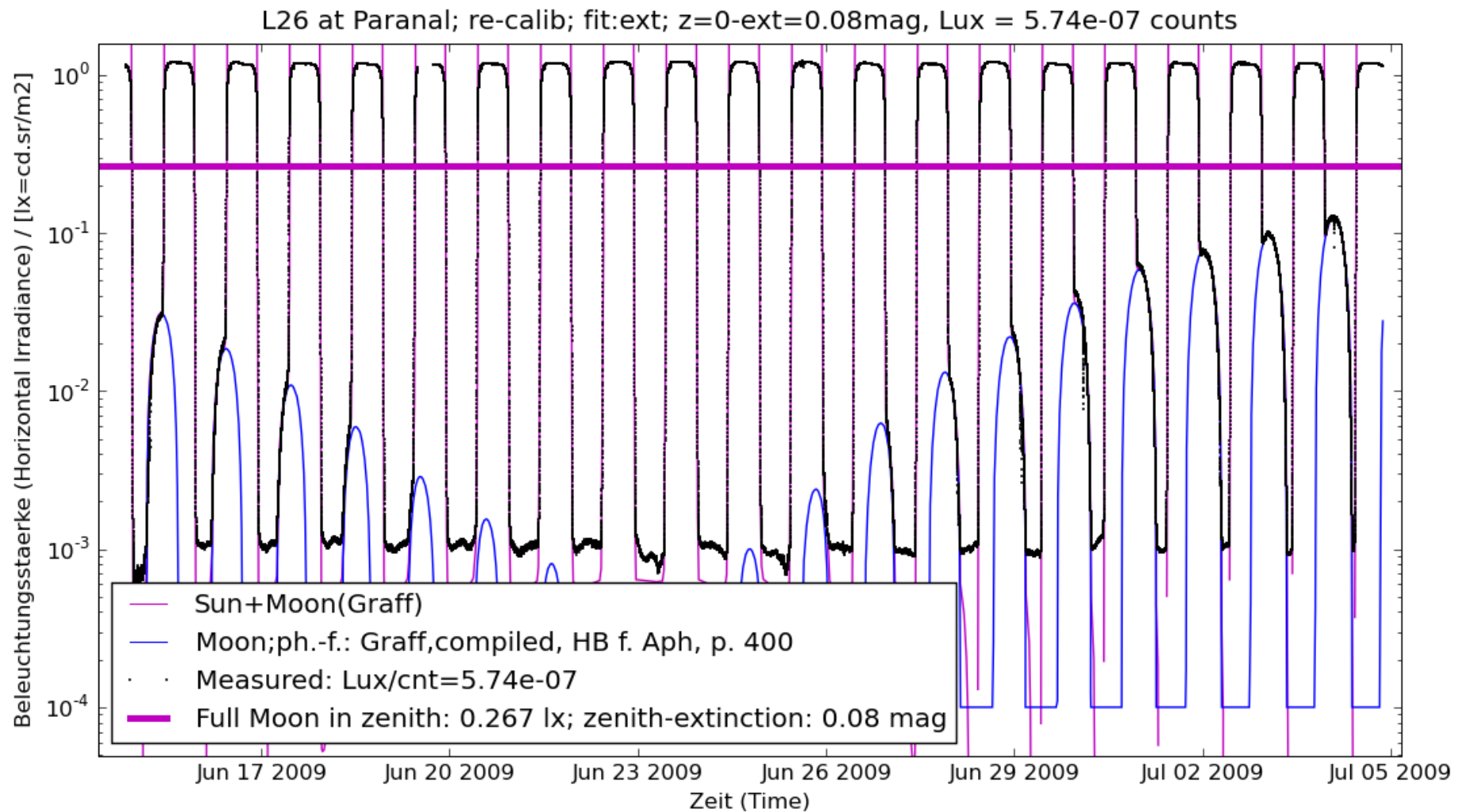
- Wien, Kuffner-Sternwarte
- Linz, Johannes Kepler-Sternwarte
- Graz, Inst. Für Weltraumforschung
- Schöpfl, Leopold Figl Observatorium
- Kanzelhöhe, Sonnenobservatorium
- Bregenz (Salzgeber), Dornbirn (Wehmut)
- Innsbruck, Inst. Für Astro-Teilchenphysik
- Salzburg-Bergheim, AAK am Haus d. Natur

A night sky filled with a dense field of stars, ranging from small pinpoints of light to larger, brighter stars. The stars are scattered across the dark blue and black expanse of the sky. In the foreground, the silhouettes of several futuristic, multi-story buildings are visible, their forms dark against the starry background. The buildings have a modern, angular design with some windows that appear to be lit from within. The overall scene is a blend of natural beauty and advanced technology.

# A Quantum of Solace

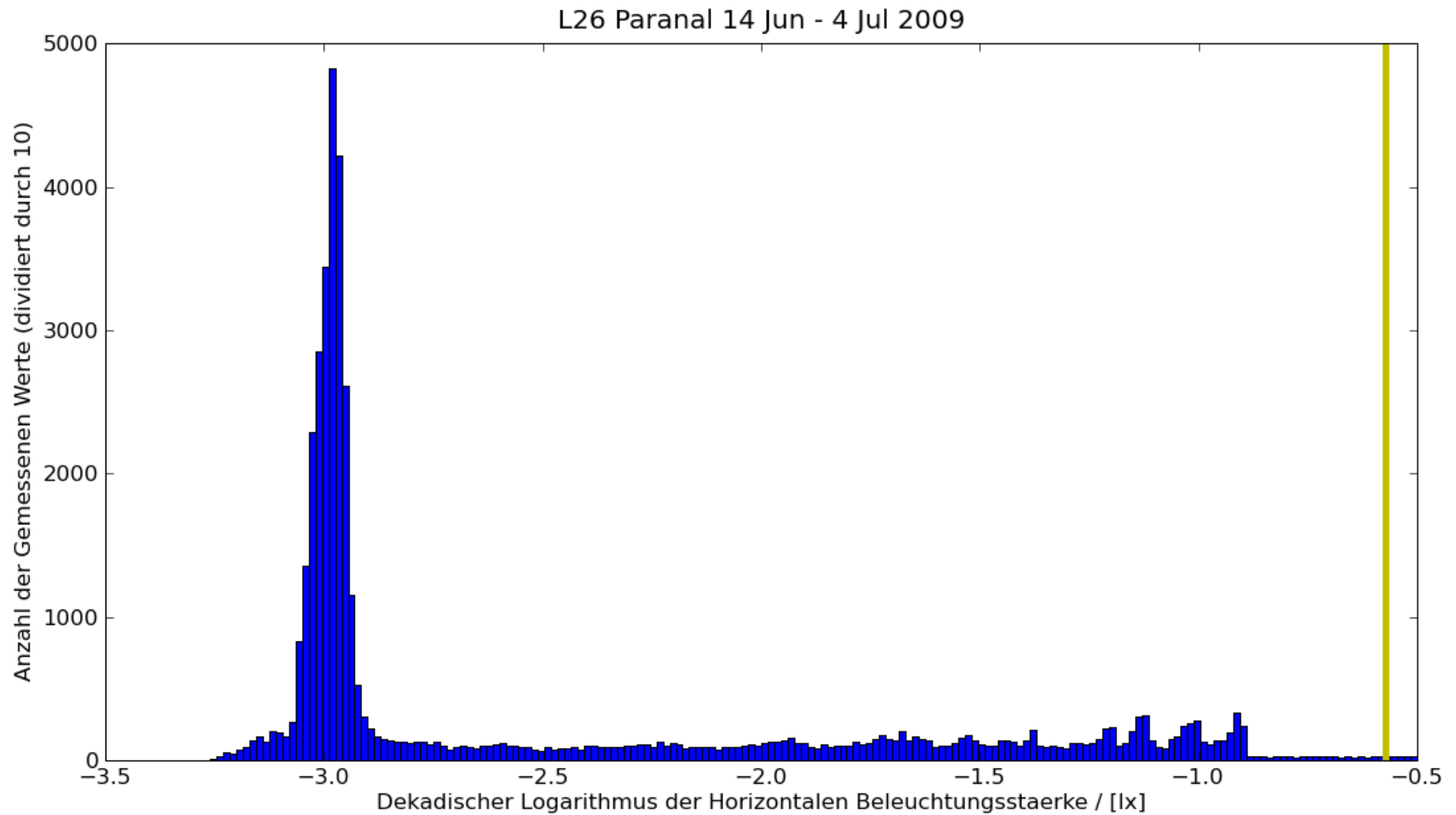


# Paranal June/July 2009



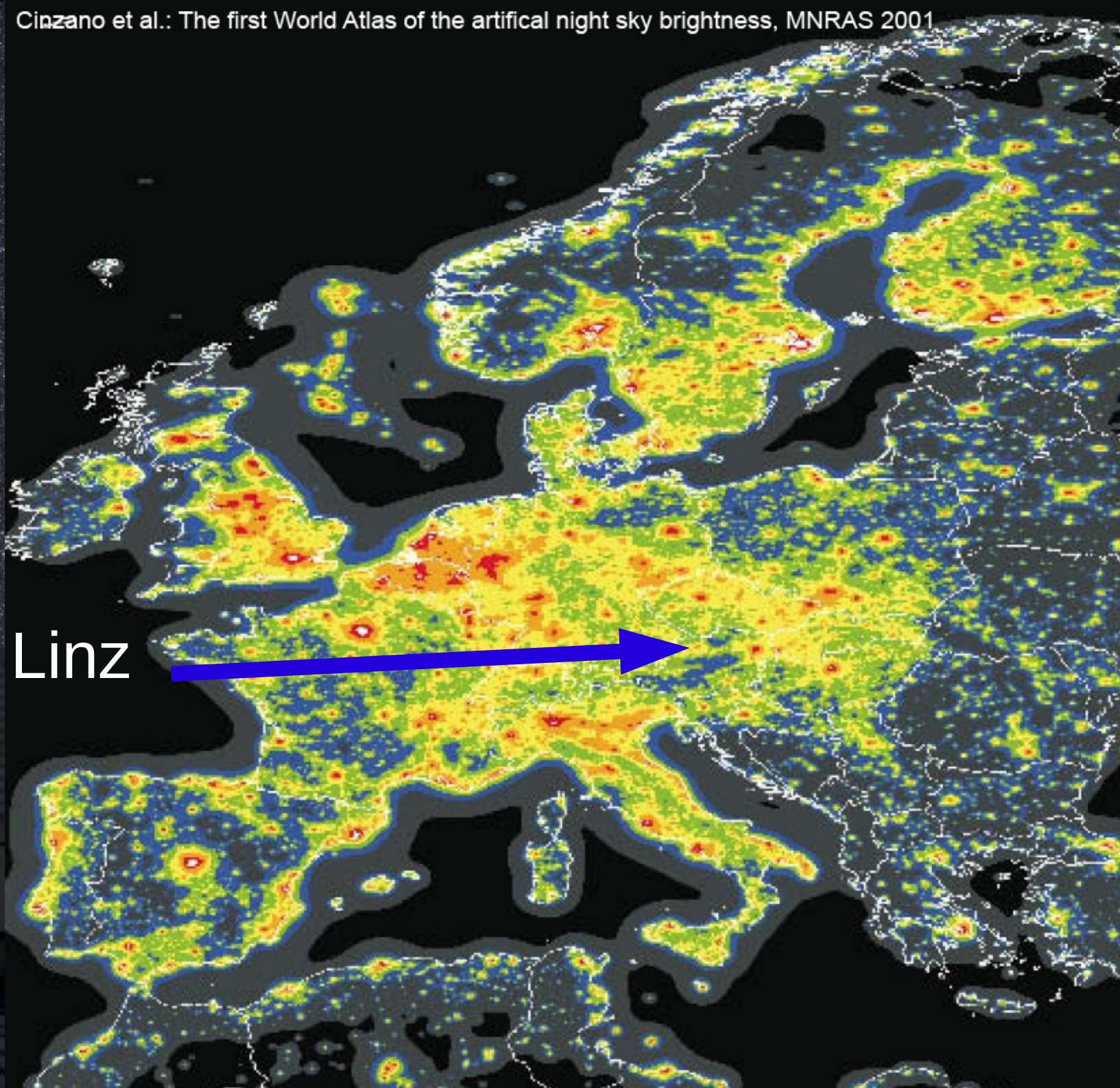


# Night-brightness - Cerro Paranal



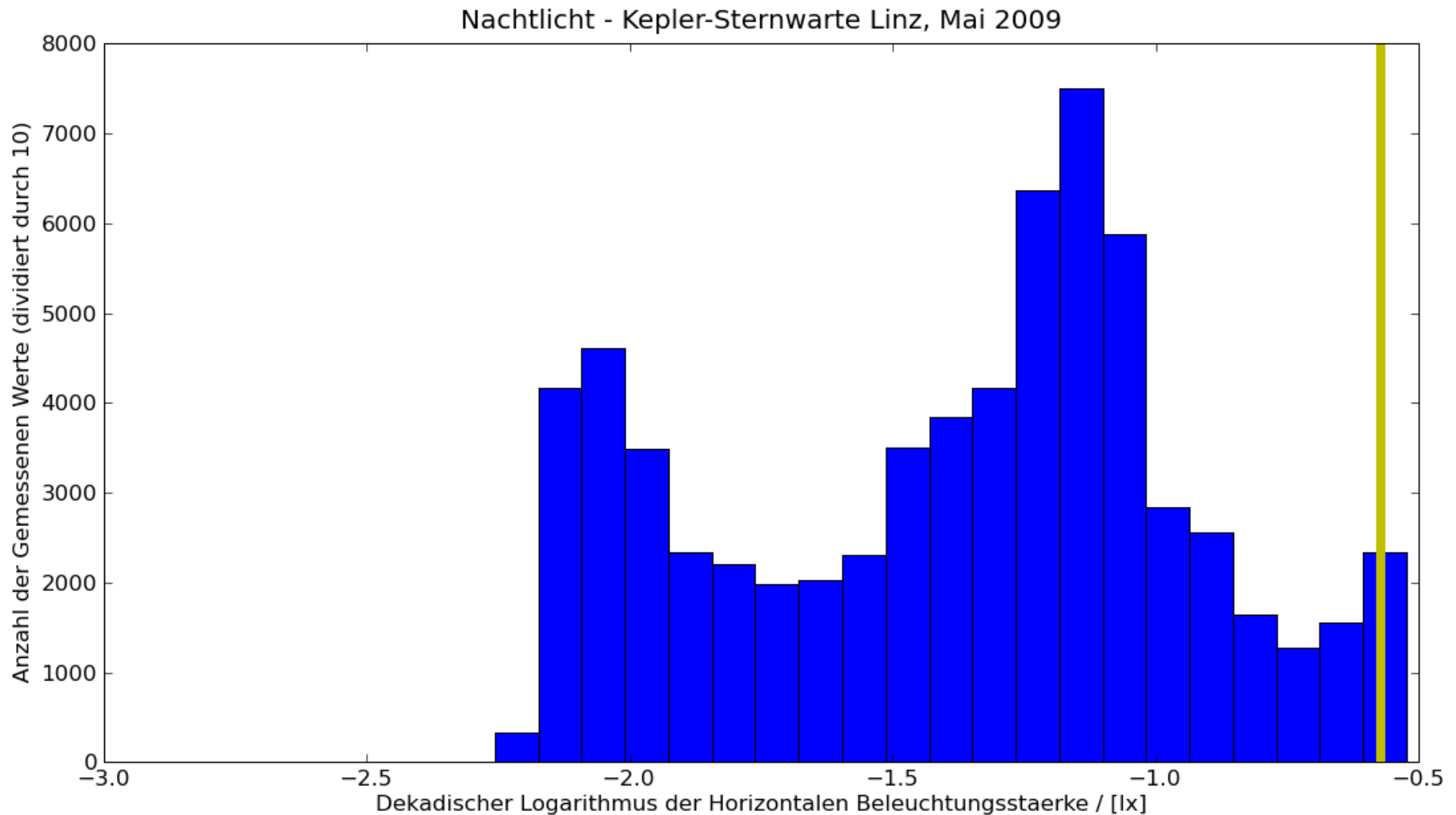
A night sky filled with stars, with a building visible in the lower-left corner.

# Linz Johannes Kepler Observatory



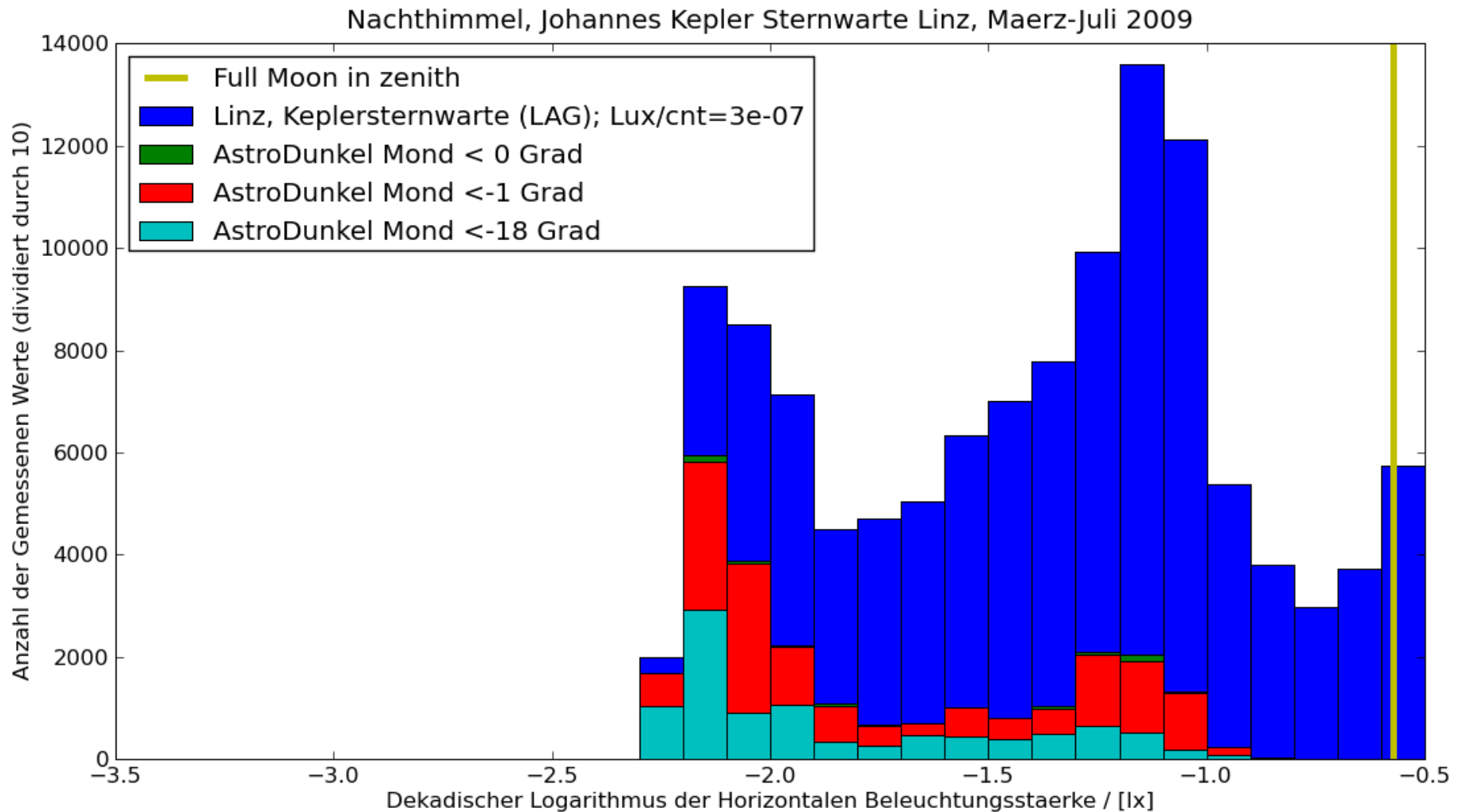
Linz

# Kepler-Sternwarte, Linz



# Linz, Keplersternwarte

## Linzer Astronomische Gemeinschaft





NightLight Linz  
Spring - Summer 2009

About 0,1 Lux

One third of full moon in zenith

# Sind die Nächte heller?

1609: 0,001 Lux

Atacama, Paranal, Aug. 2009

2009: 1,4 Lux

Paris, 14. Arr., Feb.2009

0,6 Lux

Wien, 16. Bez., Kuffner-Sternwarte, 22. Feb.

0,1 Lux

Linz, Kepler-Sternwarte; Spring/Summer

# Lightmeter = LichtMessger: Linz

## Schlossberg, yesterday:

0,04 Lux total

0,025 Lux city light return

## Spring-summer 2009:

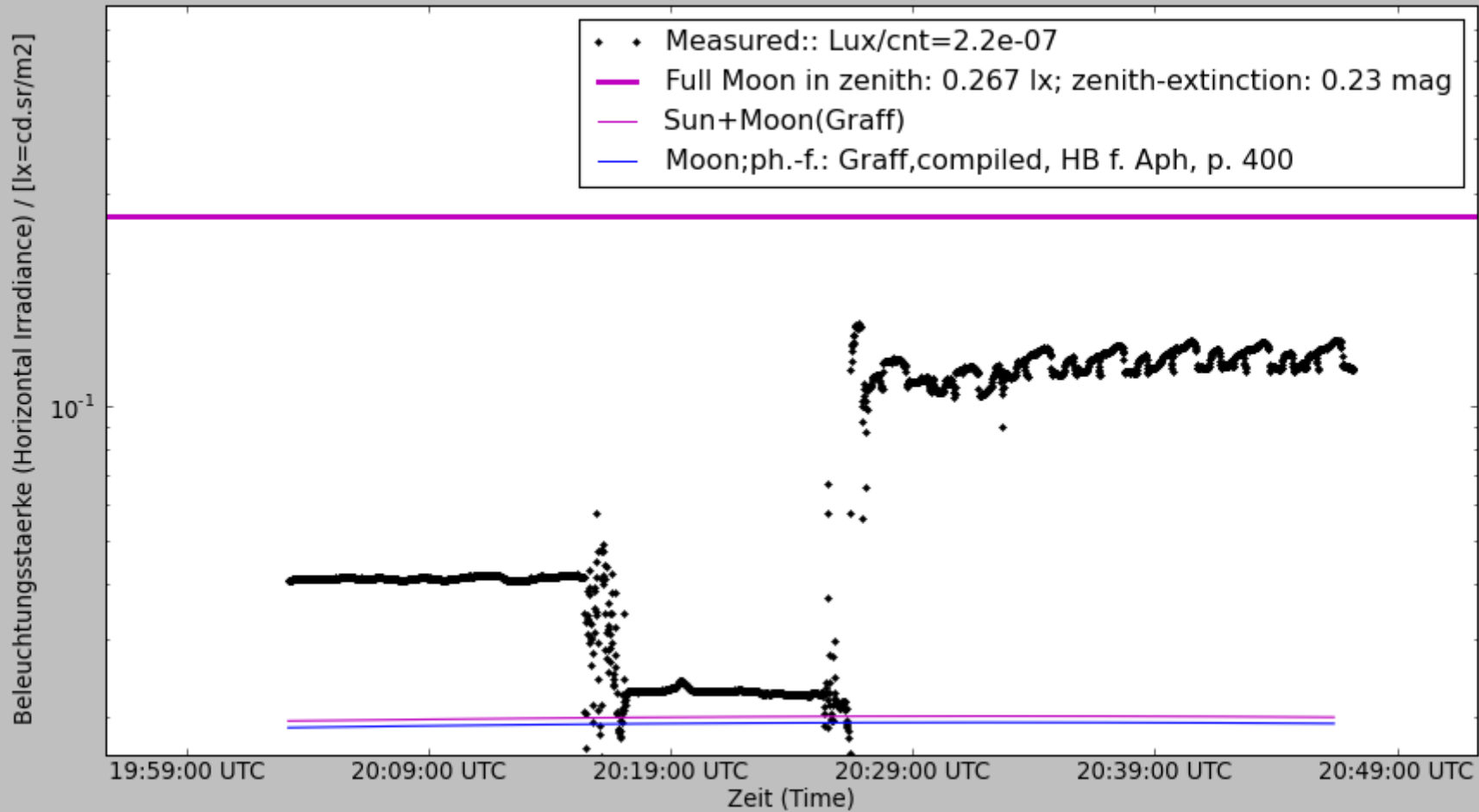
0,1 Lux; corresponds to  $0,001 \text{ Watt/m}^2$   
Annually at 10h per day:  $4 \text{ Wh}/(\text{m}^2 \text{ Jahr})$   
Downtown Linz:  $4 \times 4 \text{ km}$ :  $64 \text{ MWh} / \text{Jahr}$

Cost:  $15 \text{ k€} / \text{year} / \text{A}$ ; Stw. Jena



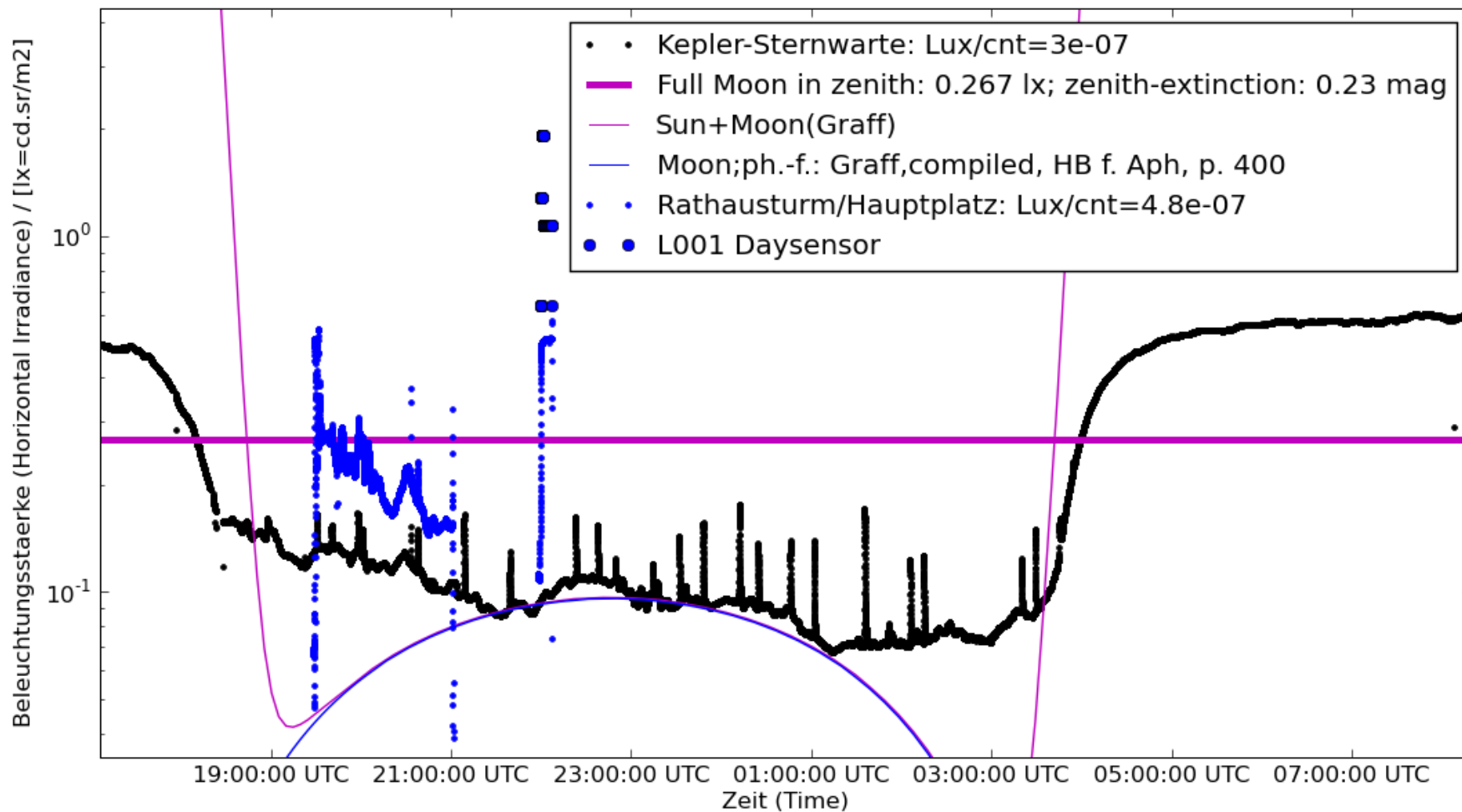
# Linz Schlossberg, 31. Aug.

Mondlicht (12 min), Mondschatten (10 min), Ars Electronica Center (vertikal,10m)  
L003 Linz, Schlossberg nahe Kepler-Denkmal, 31. Aug 22h03-22h47 MESZ



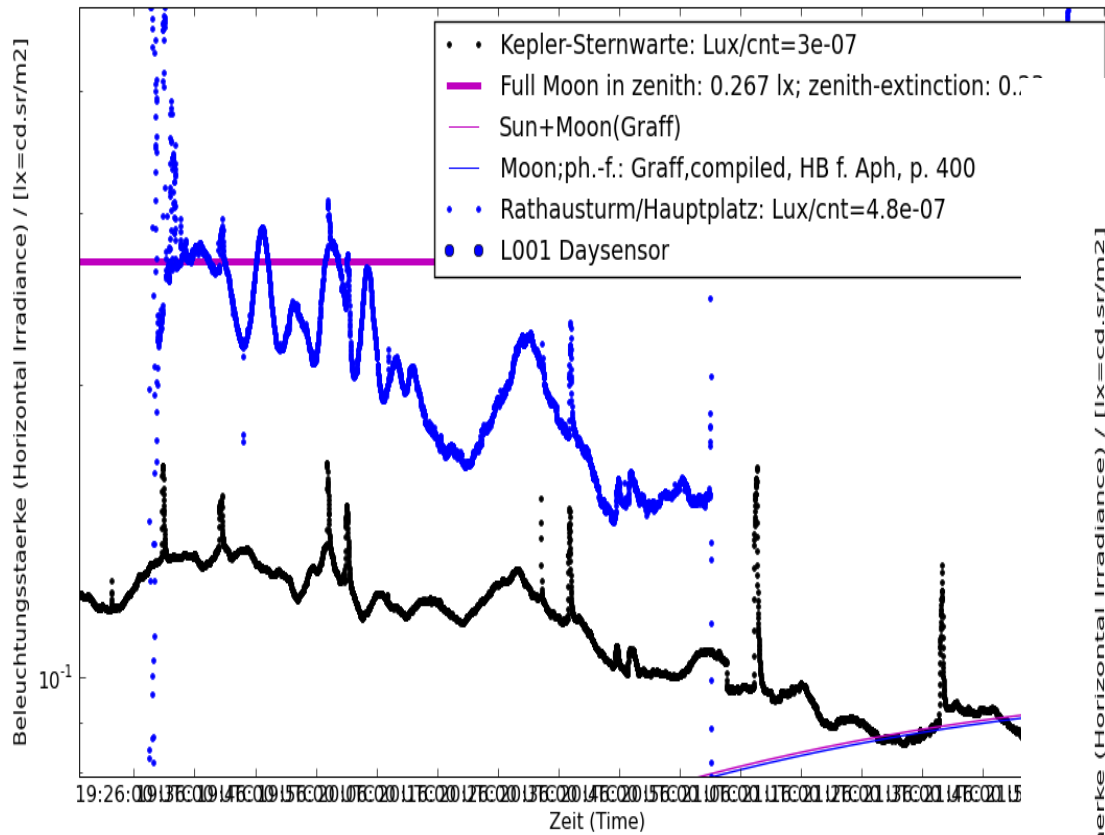
# Licht aus Linz

Licht aus Linz, 3.9.2009. bis 23h MESZ (21 UTC: Rathausurm, ab 23h55 Hauptplatz 2,5m Hoehe

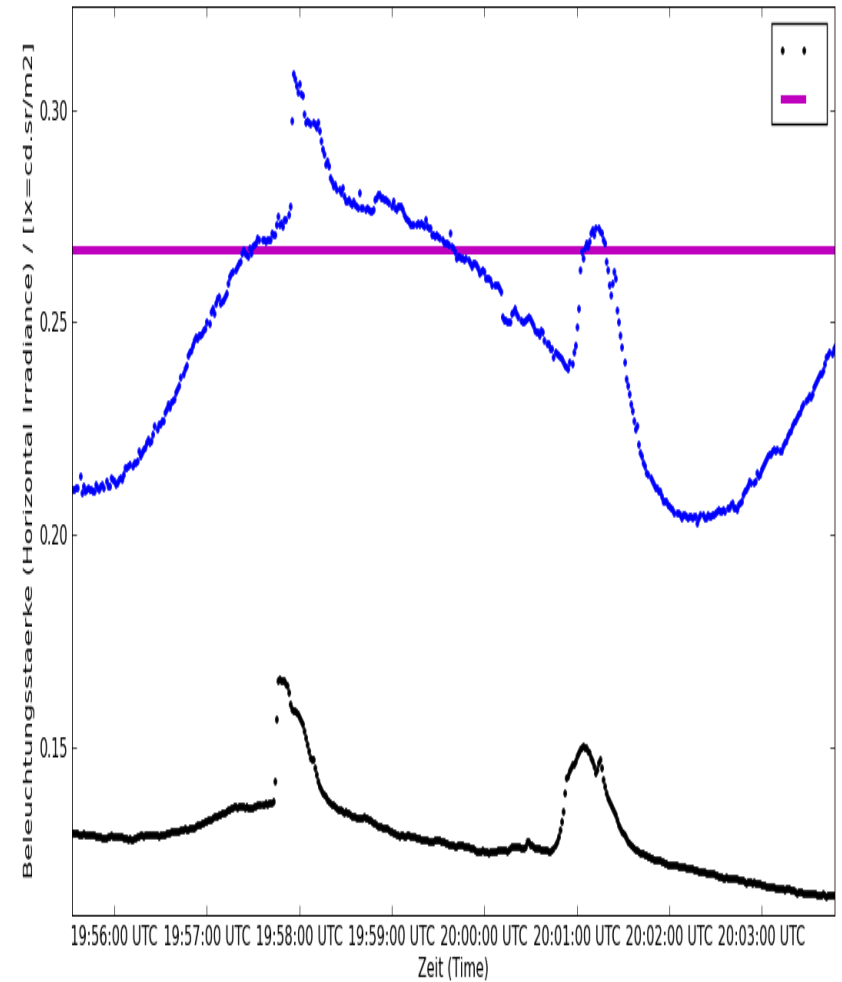


# Hauptplatz aus

Licht aus Linz, 3.9.2009. bis 23h MESZ (21 UTC: Rathausurm, ab 23h55 Hauptplatz 2,5m Hoehe)



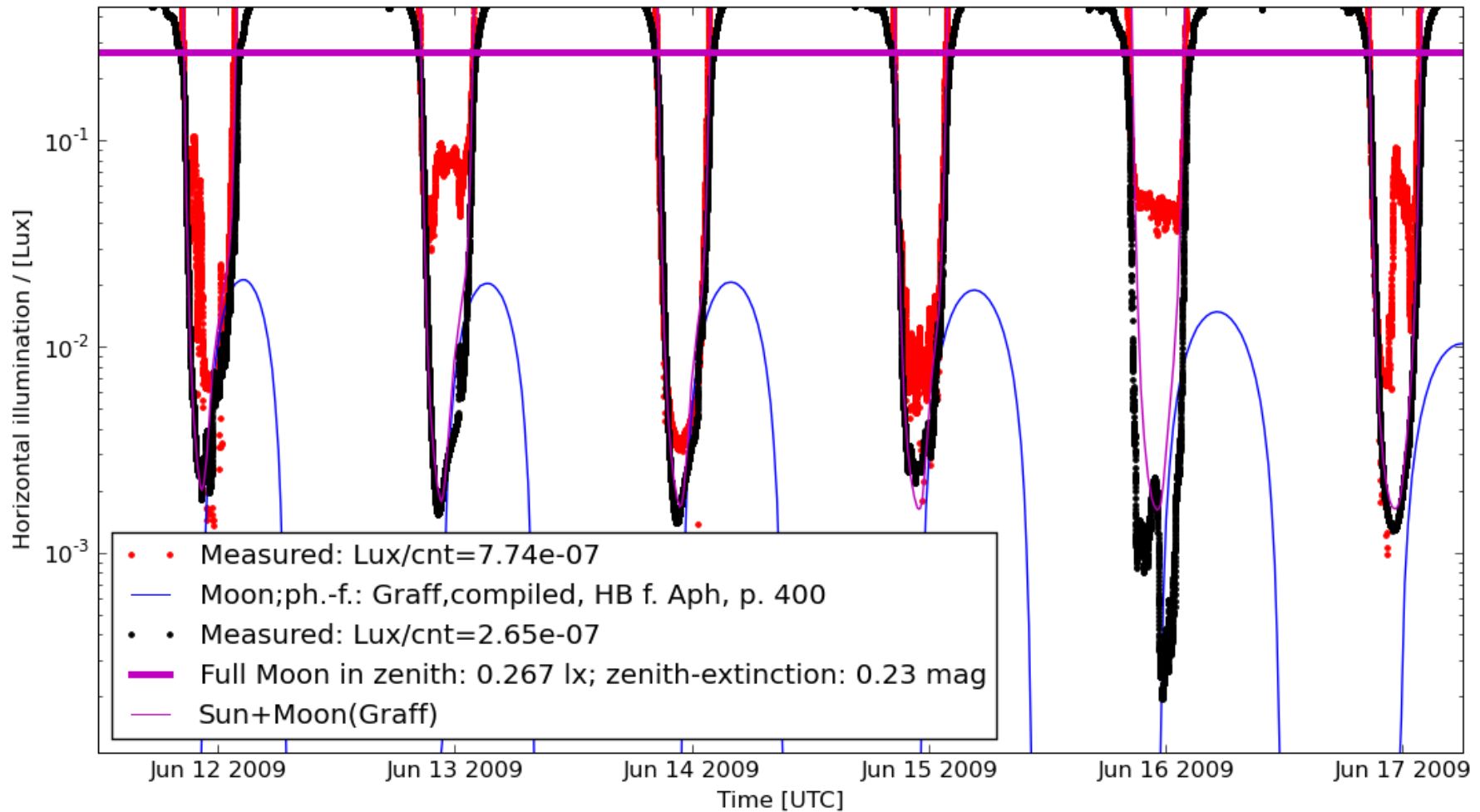
Licht aus Linz, 3.9.2009. bis 23h MESZ (21 UTC: Rathausurm, ab 23h55 Hauptplatz 2,5m Hoehe)



# Berlin vs Tautenburg

How many stars can we still see? - Year of Astronomy Lightmeter Network

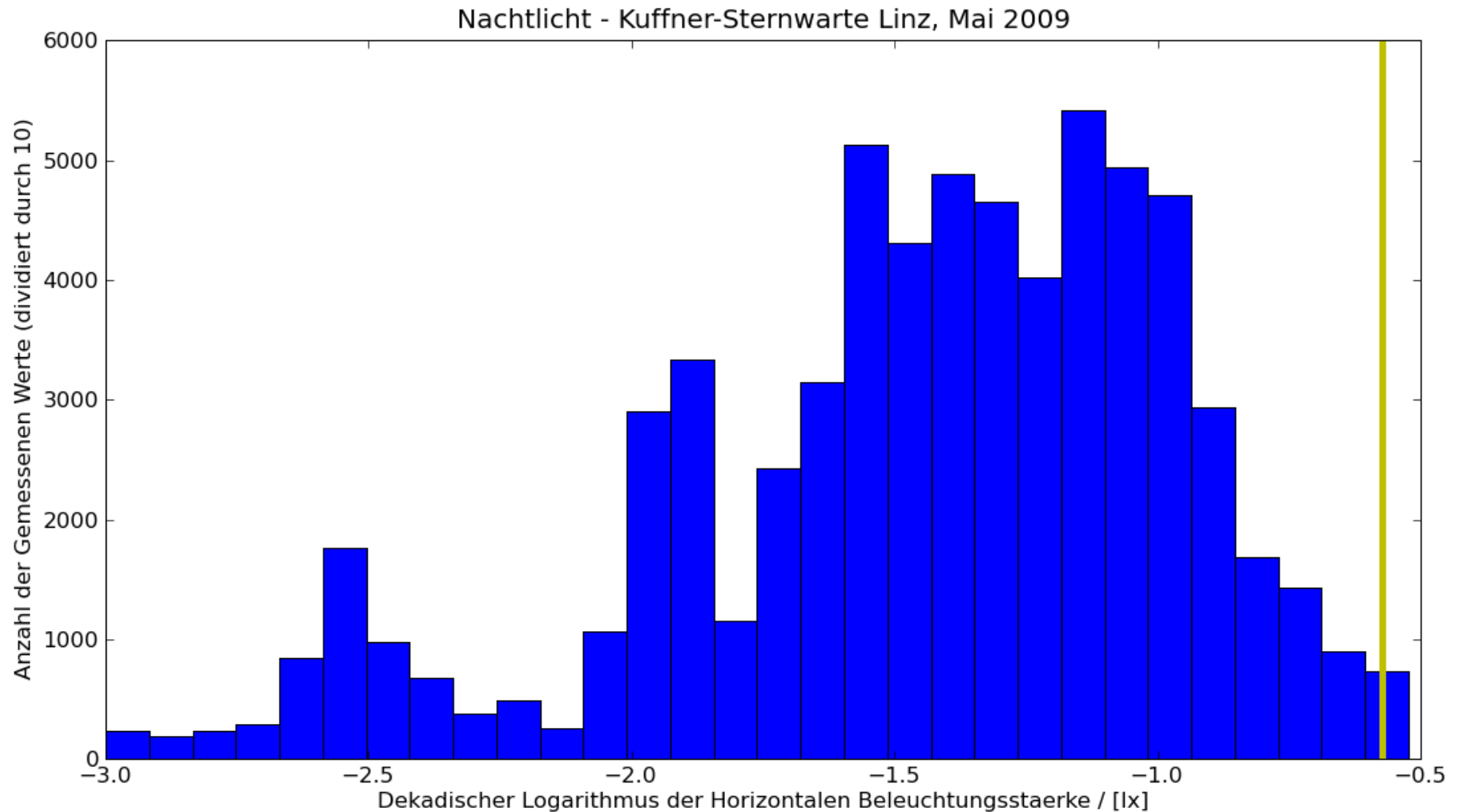
Night brightness: city sky (Berlin in red) and near natural sky (Tautenburg in black), June 2009



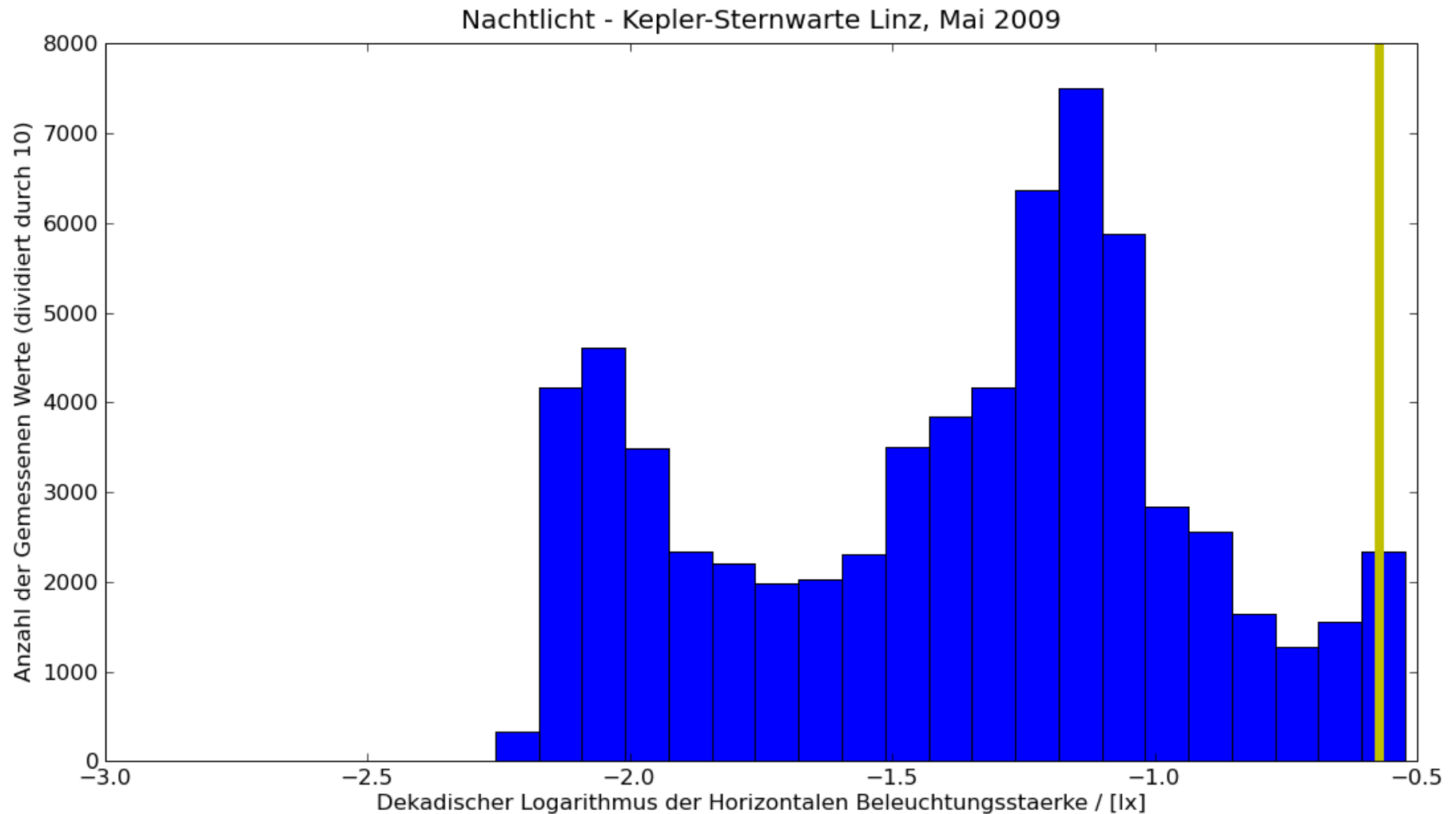
Summer – Light-weather



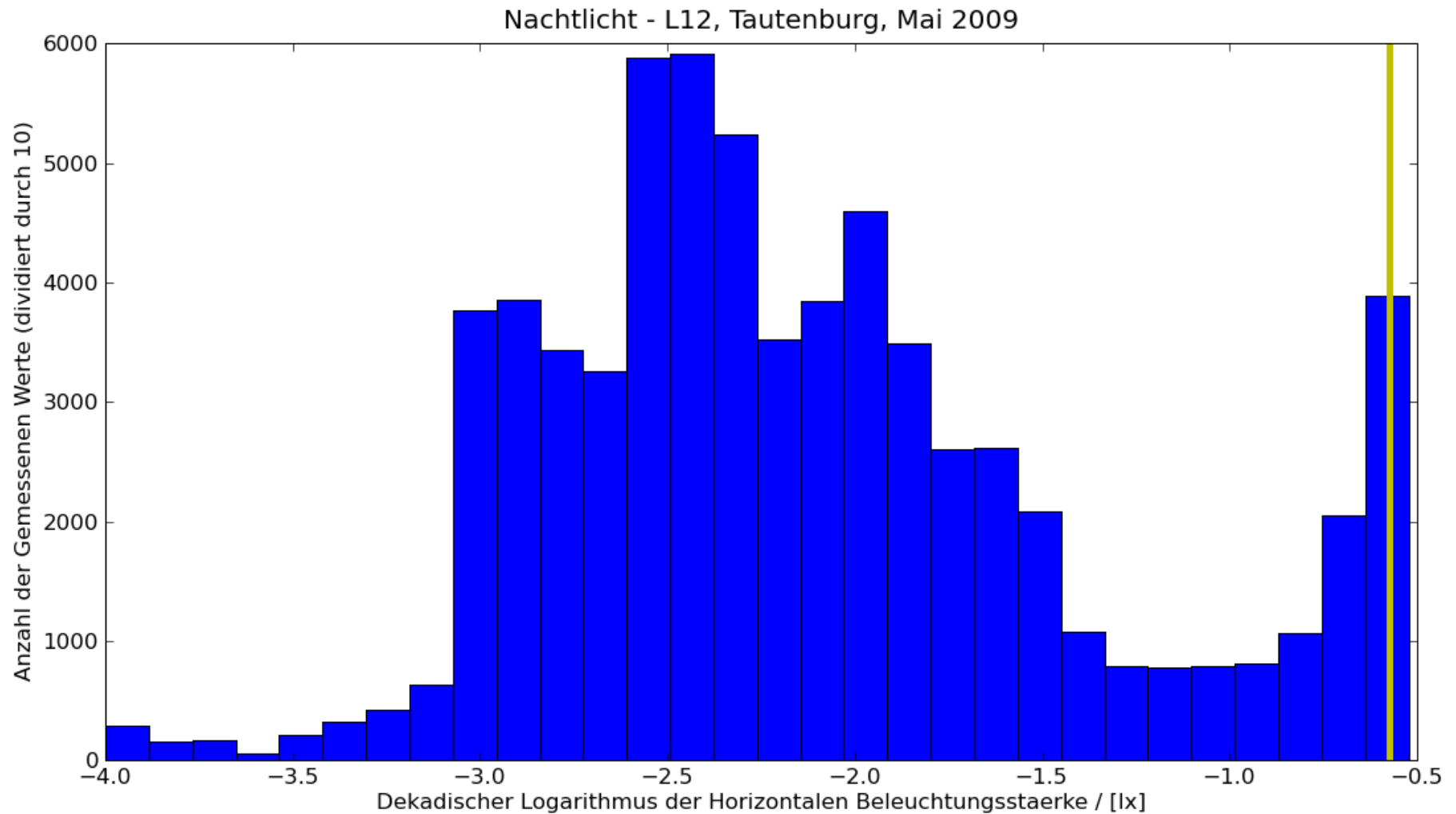
# Kuffner-Sternwarte, Wien



# Kepler-Sternwarte, Linz



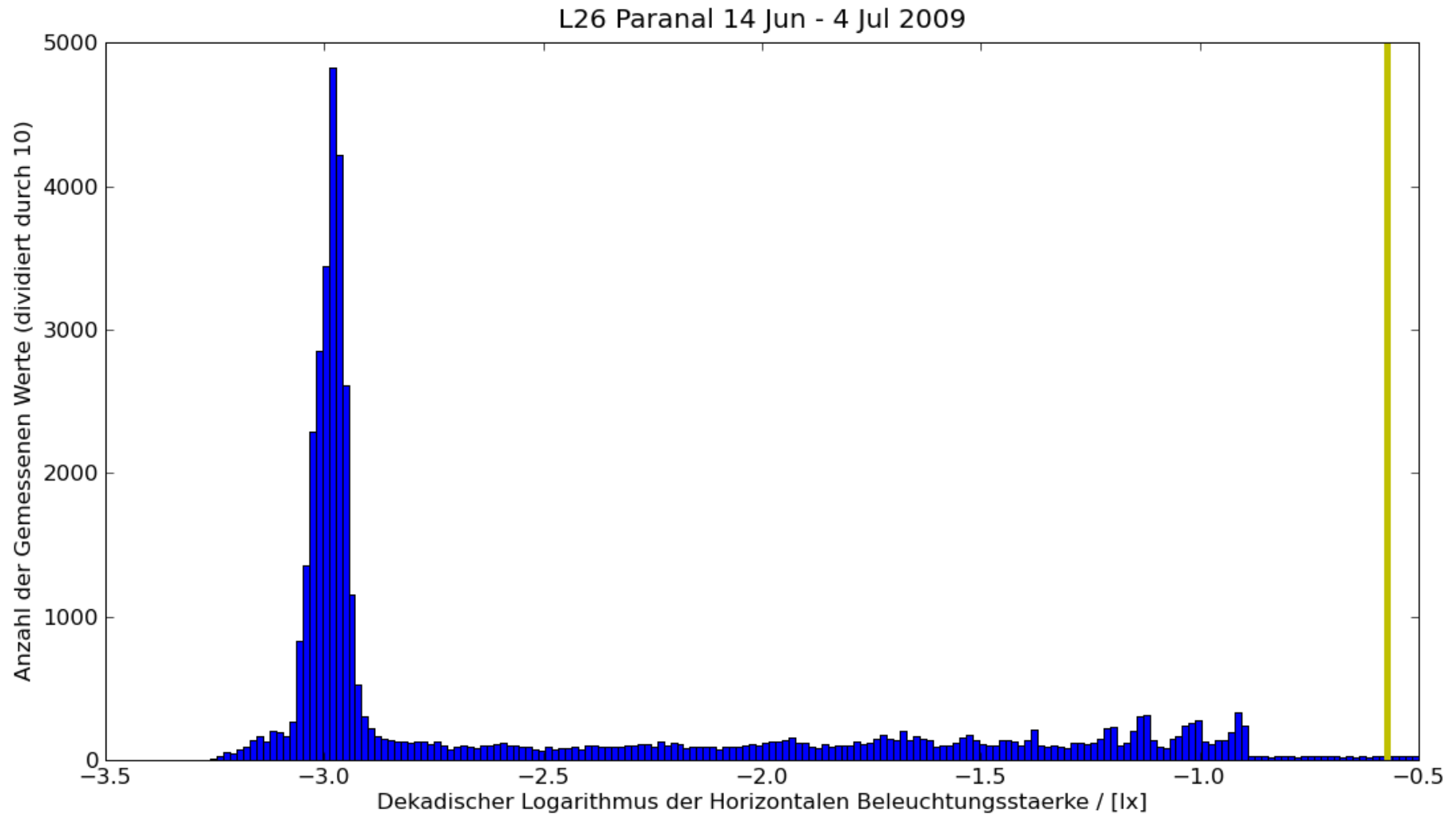
# Tautenburg





# Atacama Wüste, Chile

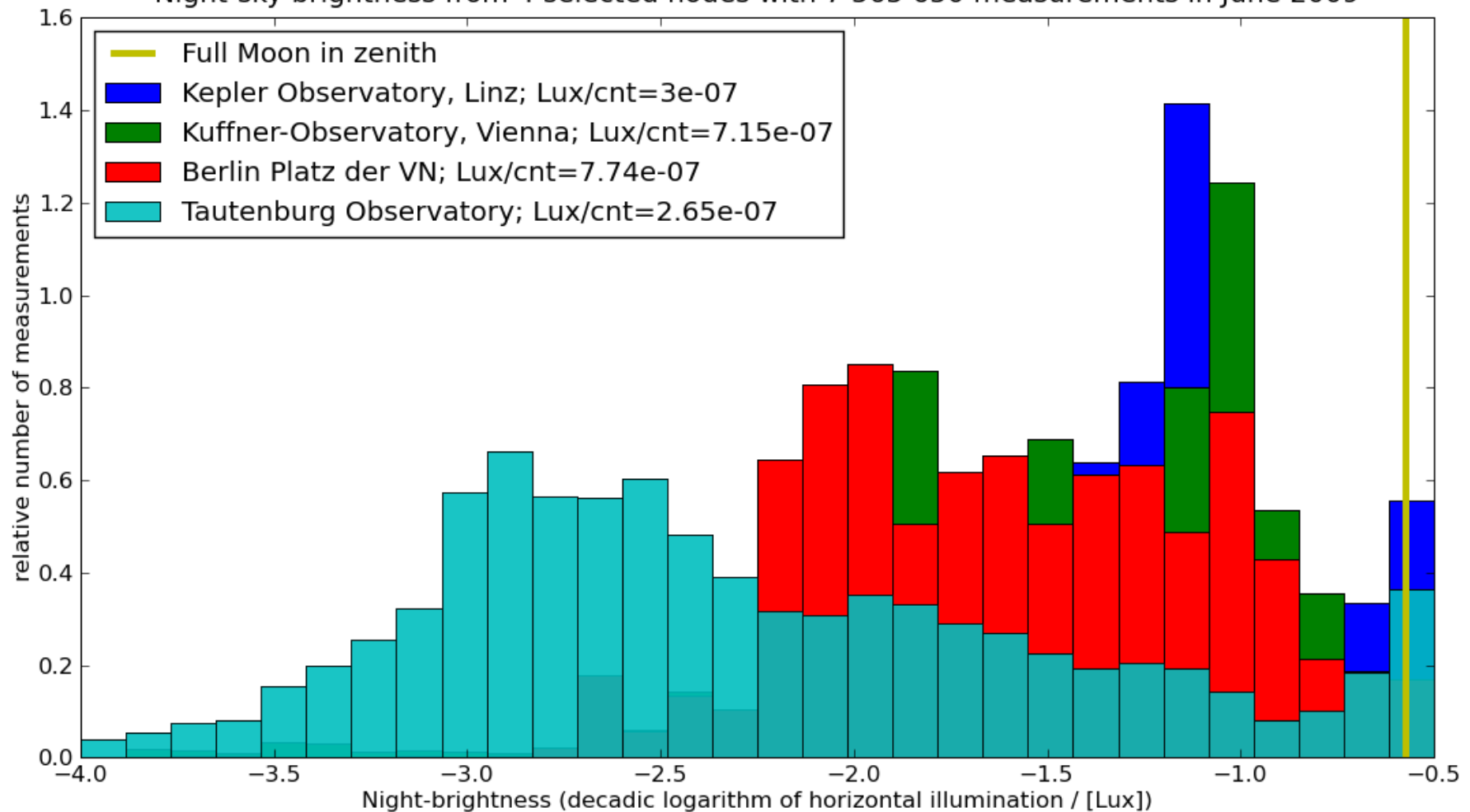
## ESO Cerro Paranal



# June: Berlin, Linz, Vienna, Tautenburg

How many stars can we still see? - Year of Astronomy Lightmeter Network

Night-sky brightness from 4 selected nodes with 7 565 650 measurements in June 2009



# City in White – Vienna Feb. 2009

wien.at 2009-02-21 11:18:12



The view from  
above





# The day after



# The day after



# The day after

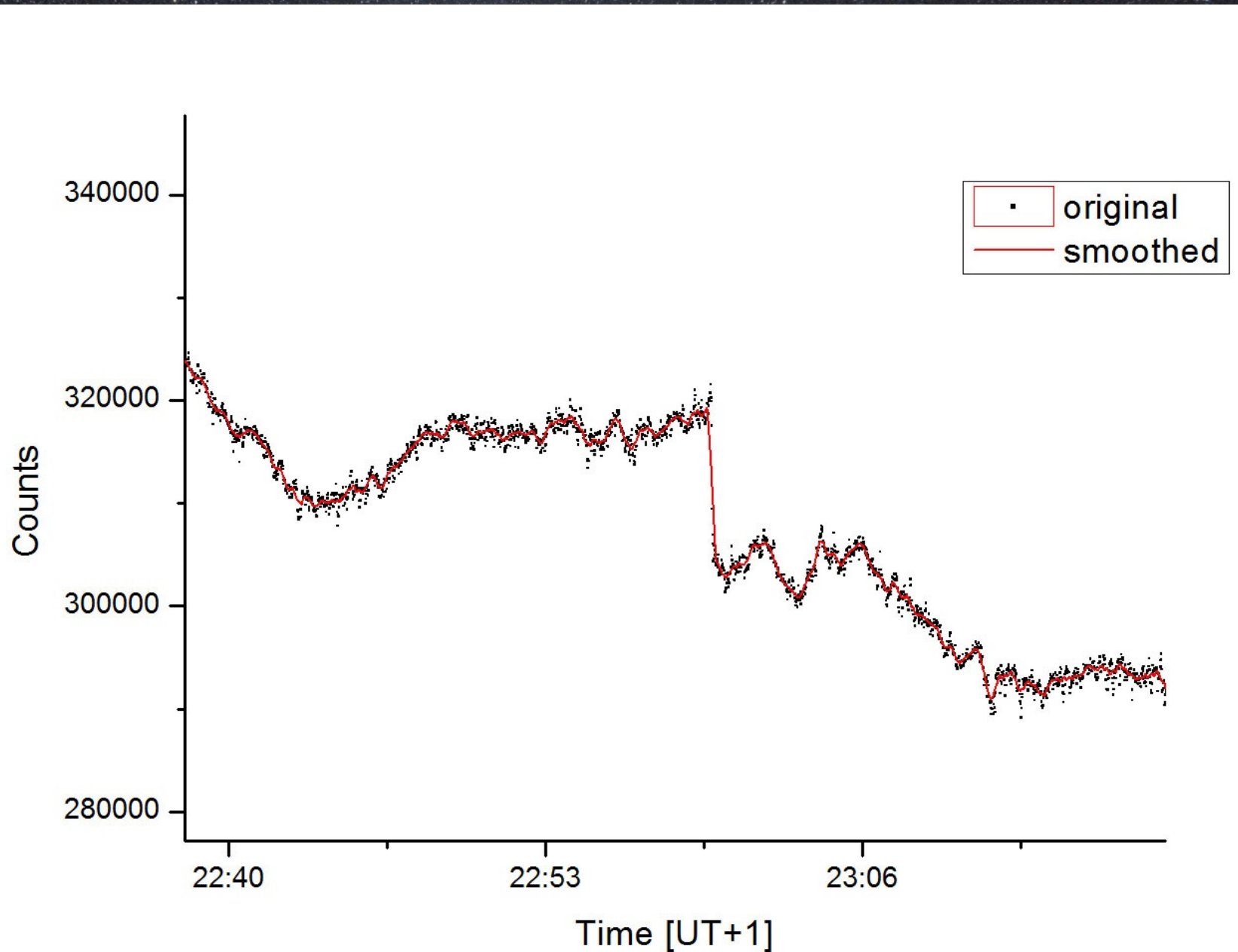




# Lights in snow-covered Vienna:

Effect  
of  
turning  
50 %  
off:

only  
5.5 %!



**Jena, Saturday 4. April 2009**

**21h – 24h**

**Switch off all public lights  
Some commercial lights  
Some monument lights**

# Where are the „bad“ lightsources?

City of Jena, Germany

“Off”



“On”

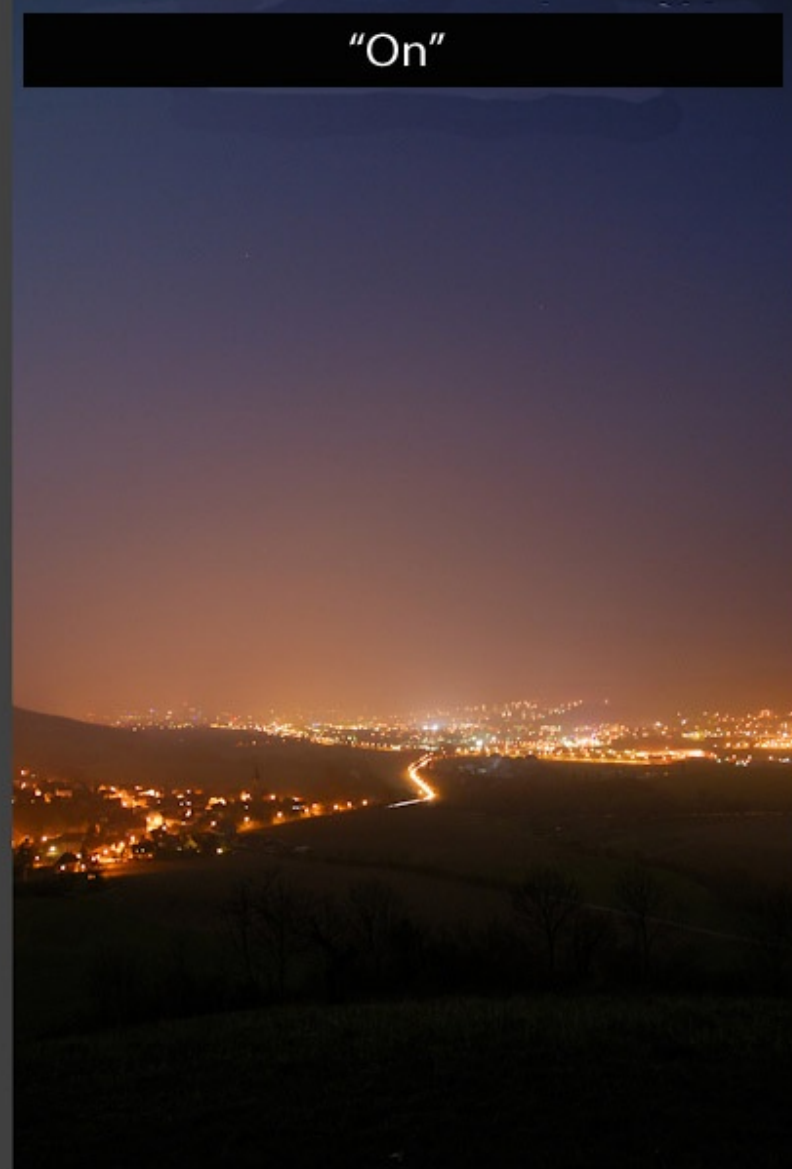




Bild: Holger Lehmann, Thüringer Landessternwarte Tautenburg



Bild: Holger Lehmann, Thüringer Landessternwarte Tautenburg

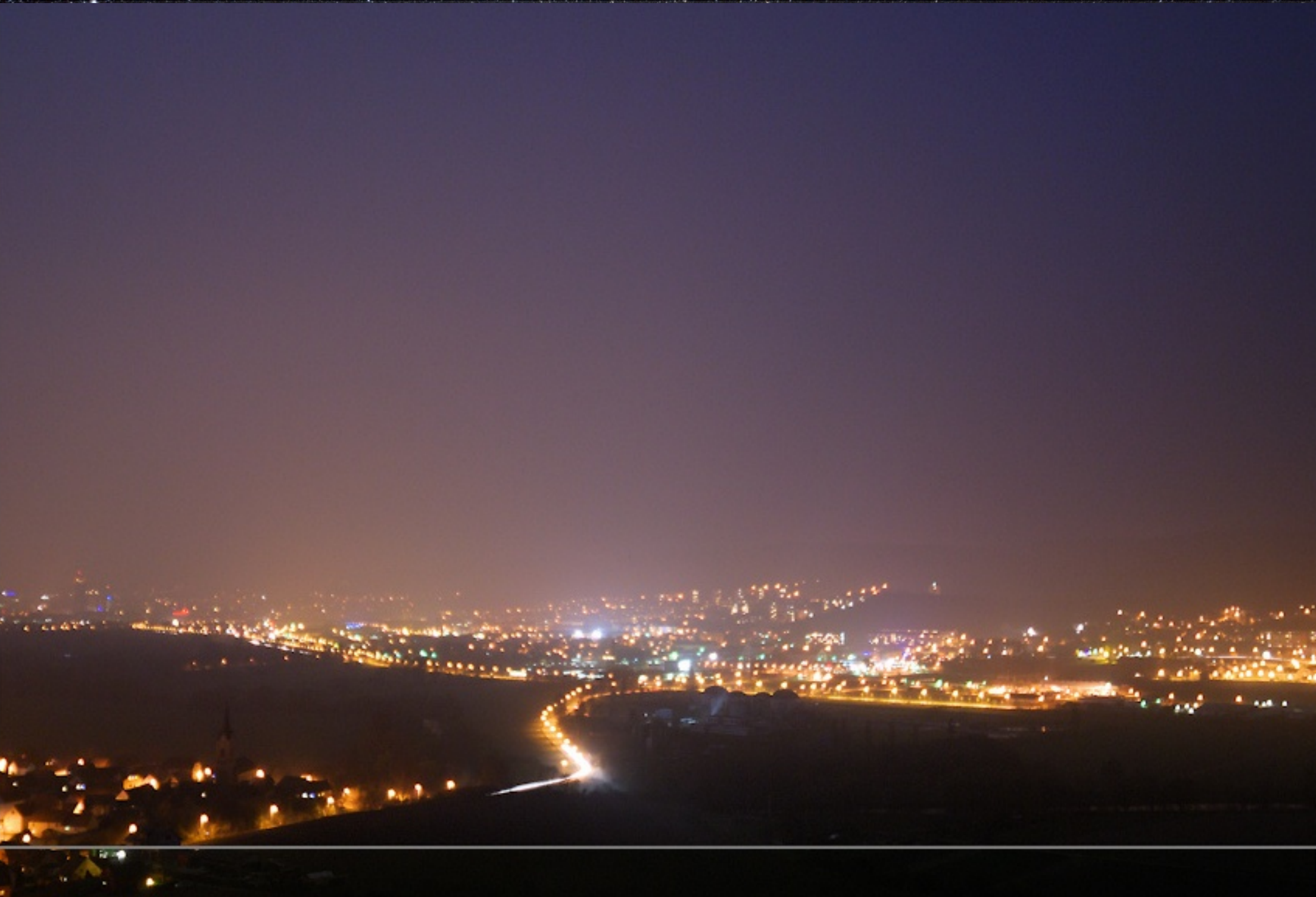
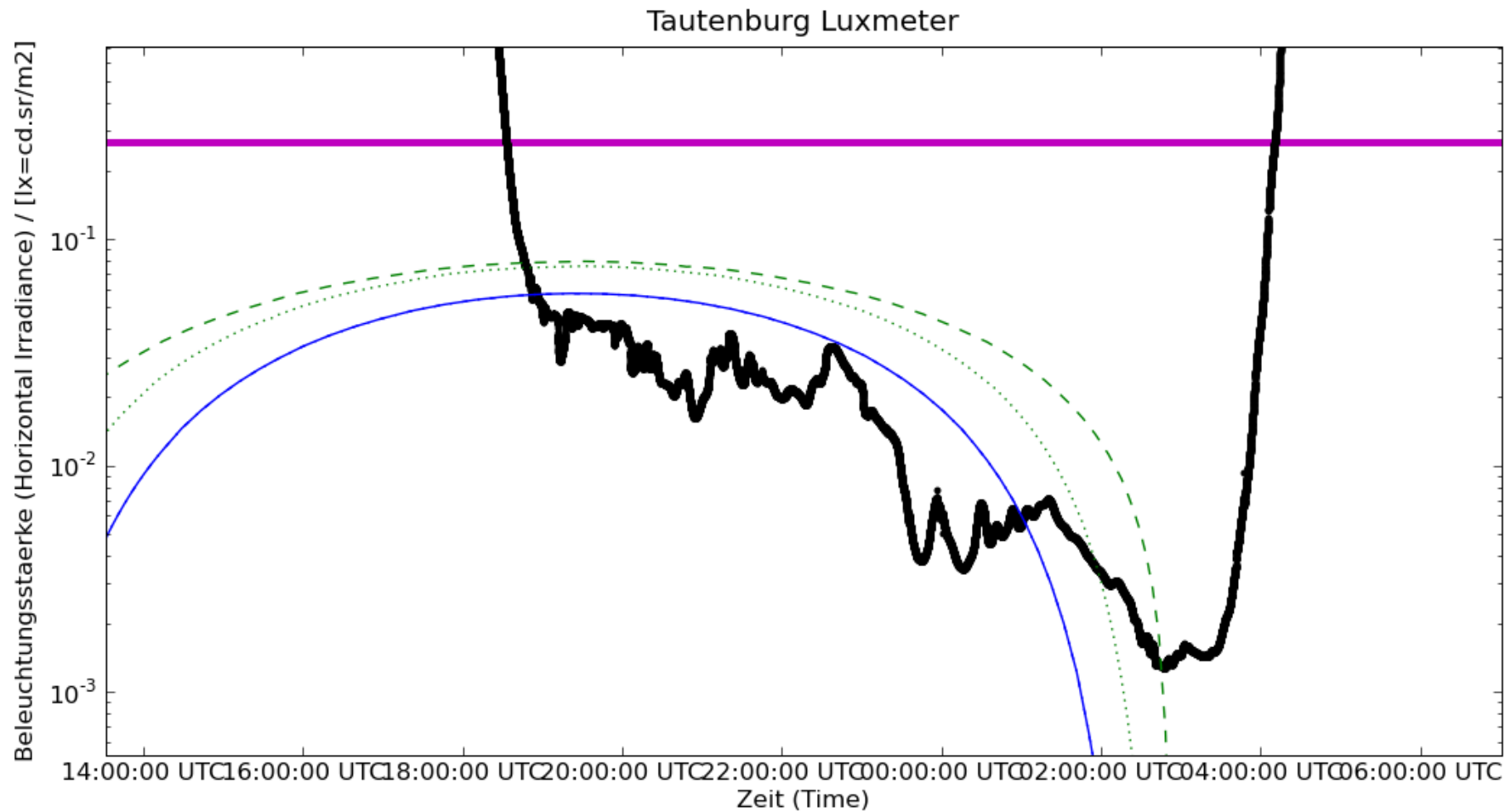


Bild: Christian Högner, Thüringer Landessternwarte Tautenburg



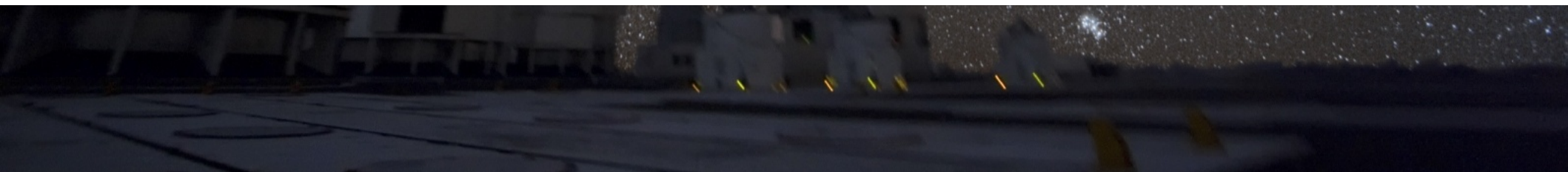
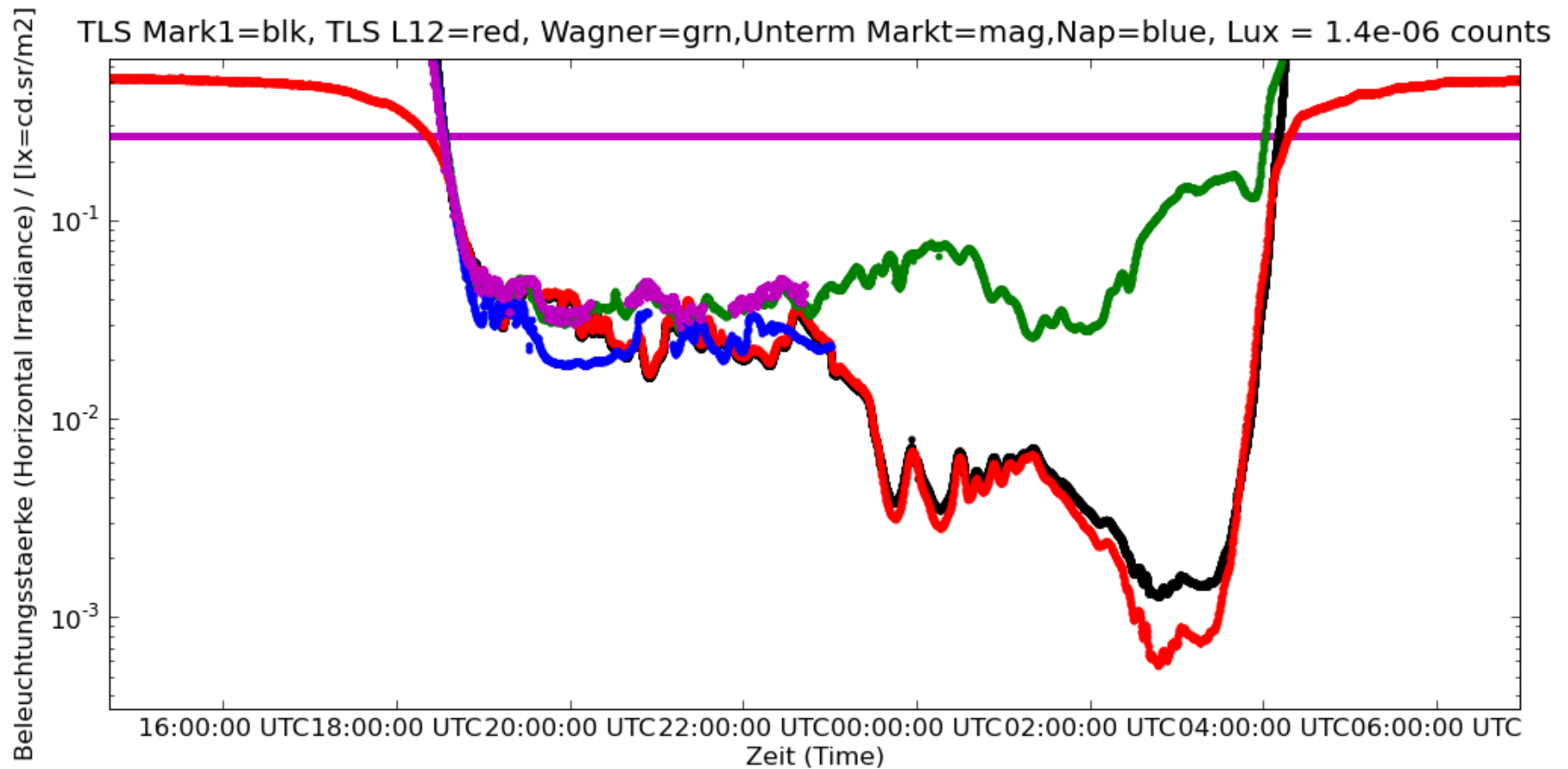
Bild: Christian Högner, Thüringer Landessternwarte Tautenburg

# Lights-off Jena seen from Tautenburg





# Lights-off Jena - city-lightmeter-net

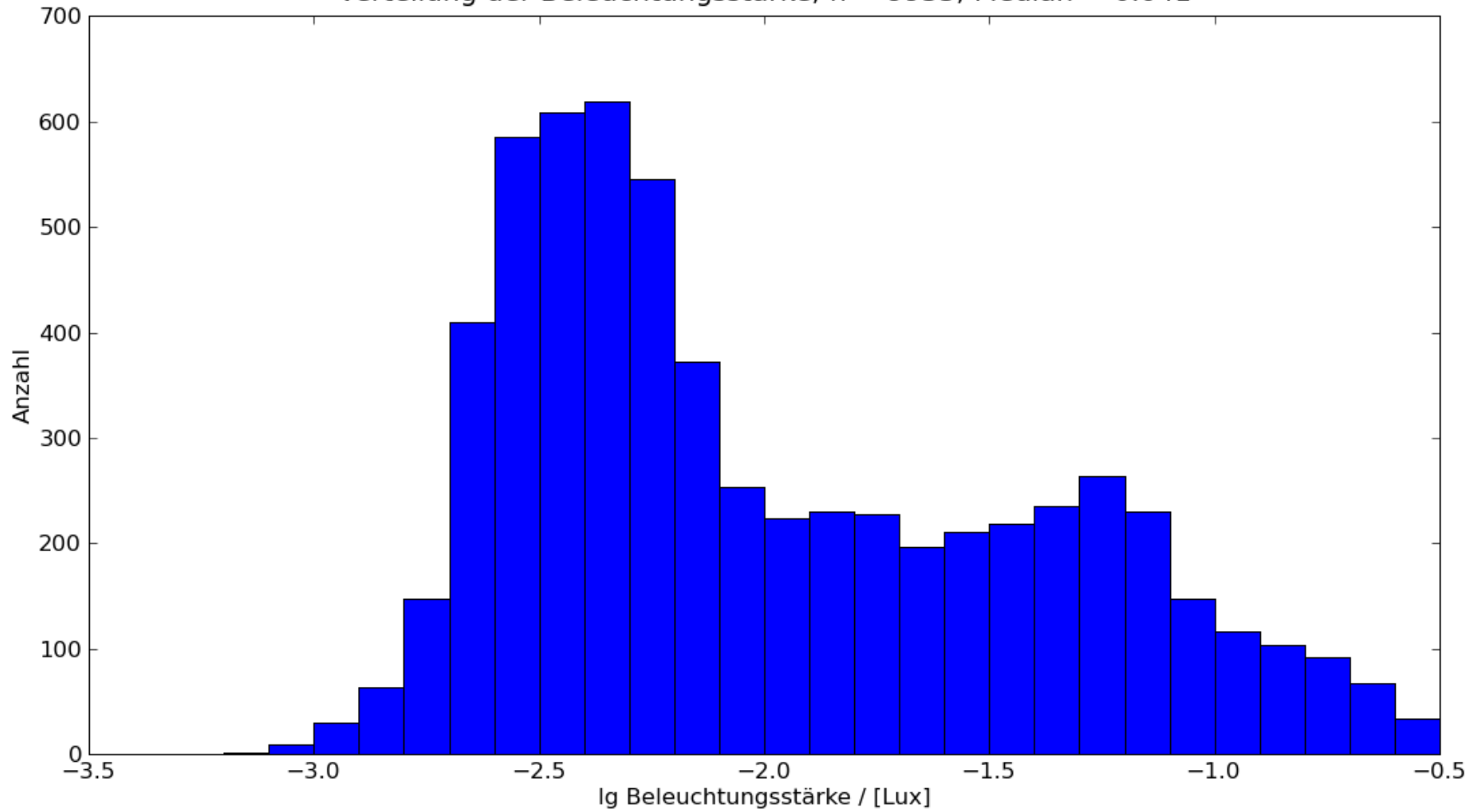




Long Term Monitoring  
Tautenburg 2006 - 2009

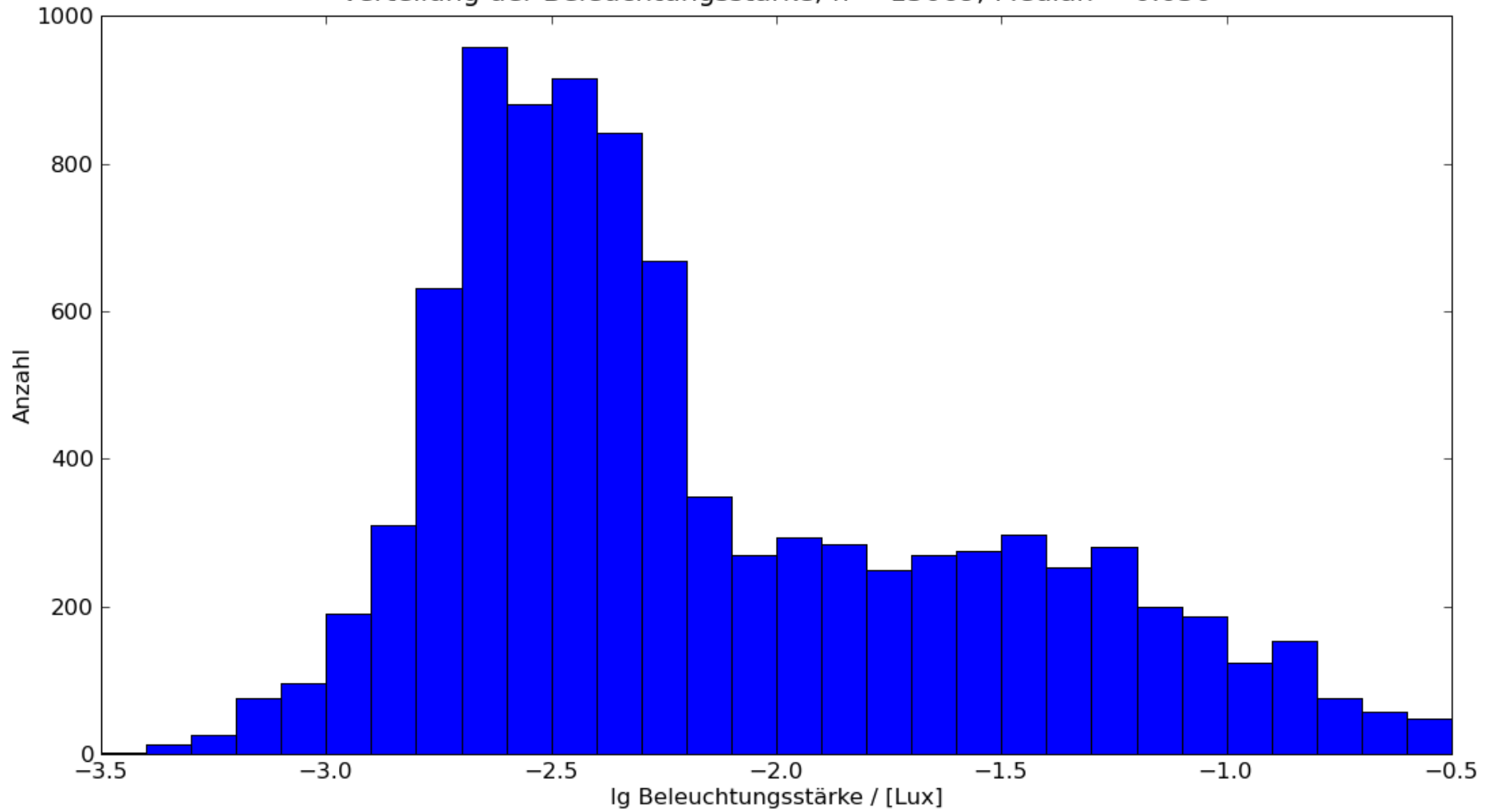
# 2006

Verteilung der Beleuchtungsstärke; n = 9933; Median = 0.041



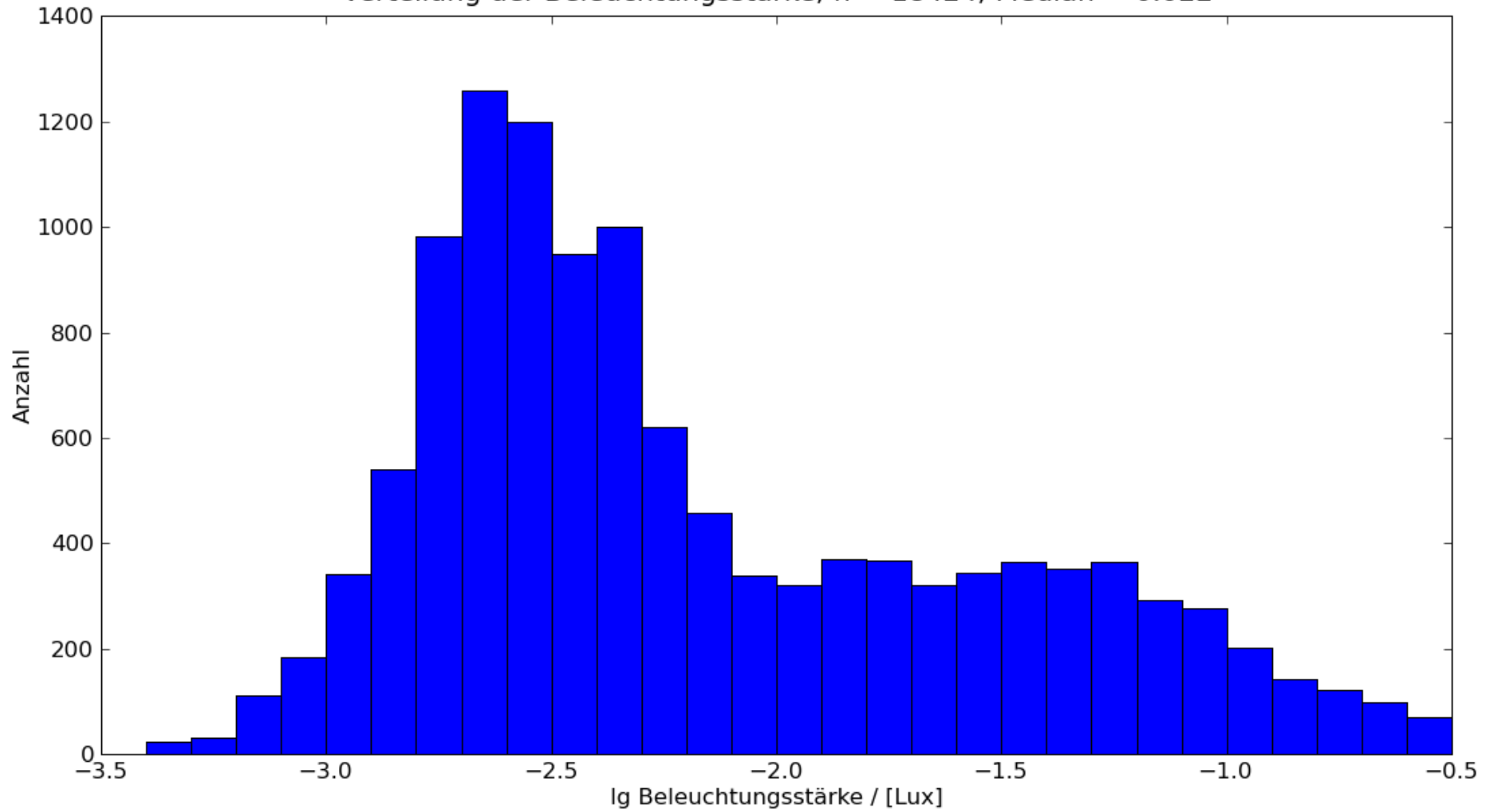
# 2007

Verteilung der Beleuchtungsstärke; n = 15069; Median = 0.030

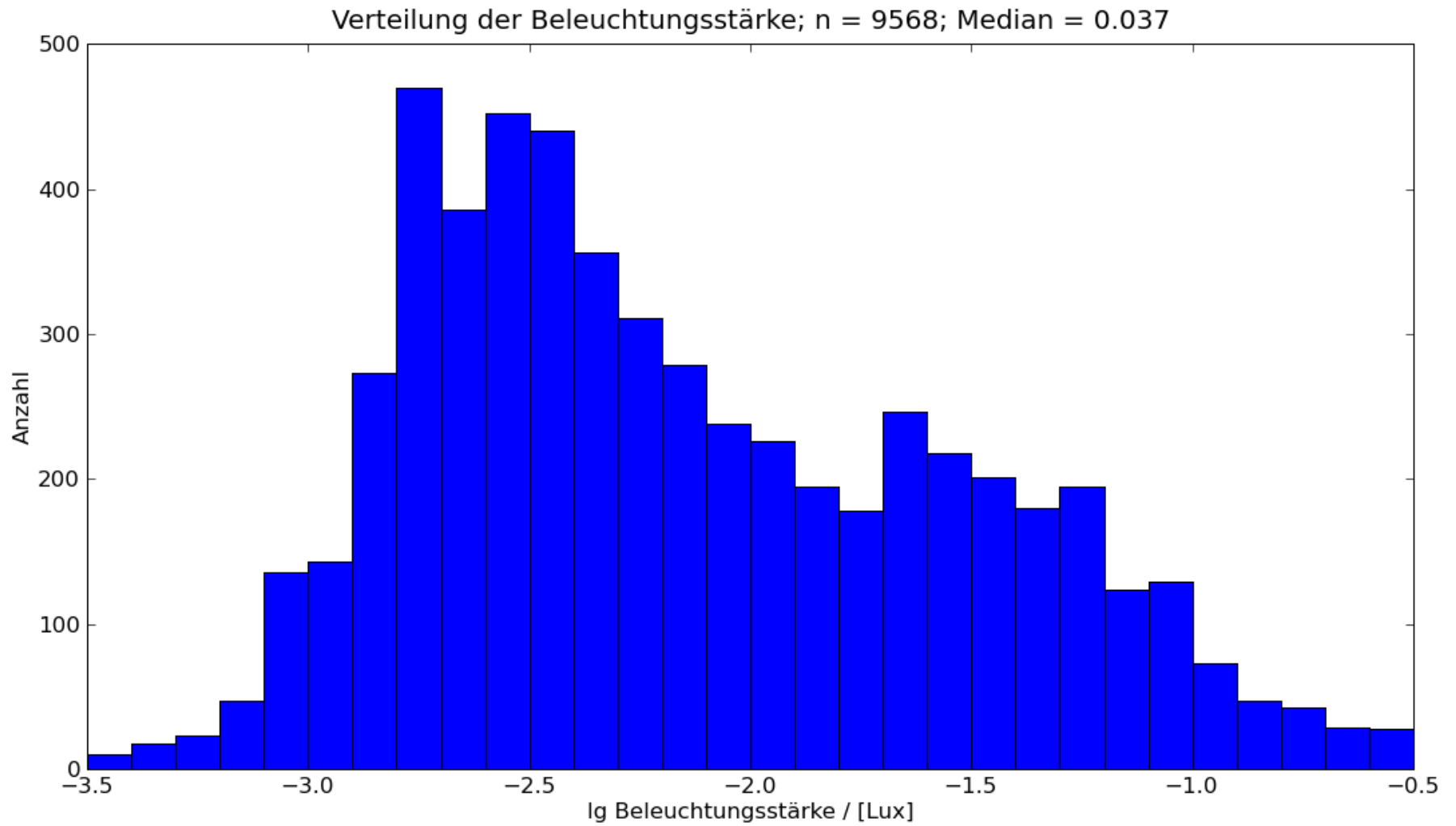


# 2008

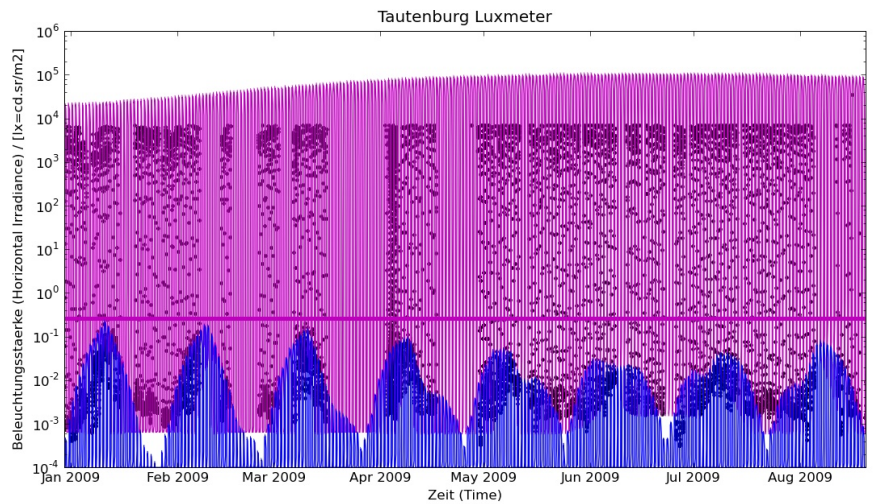
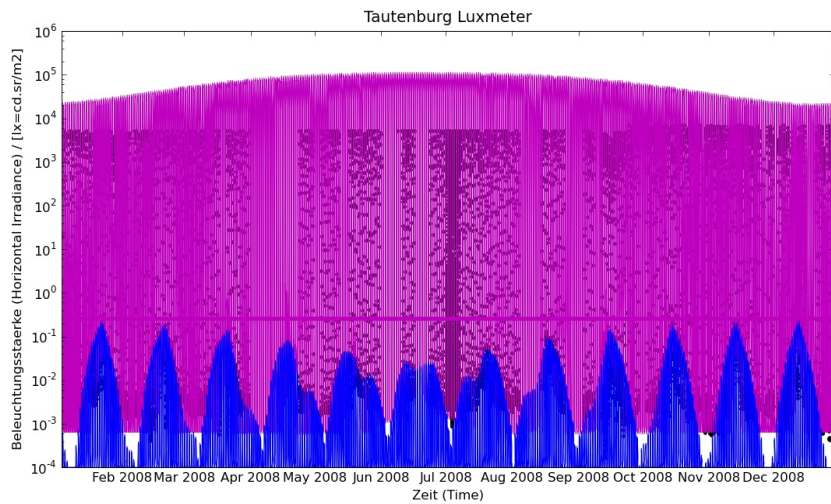
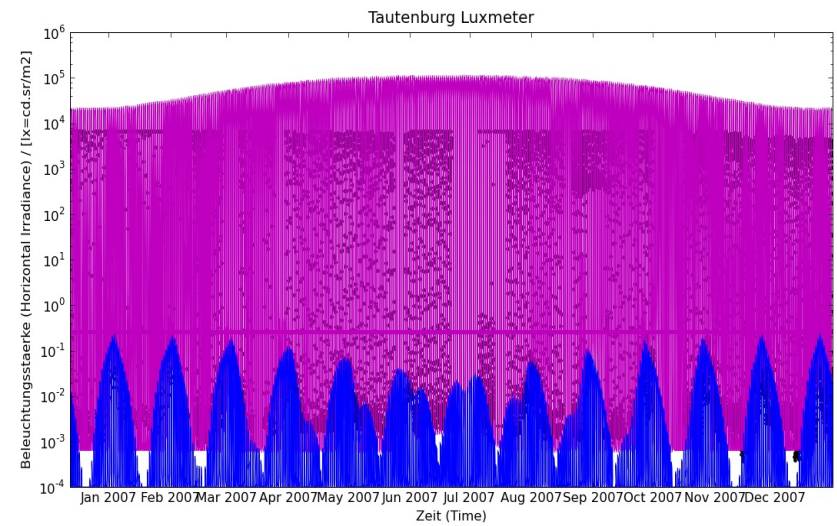
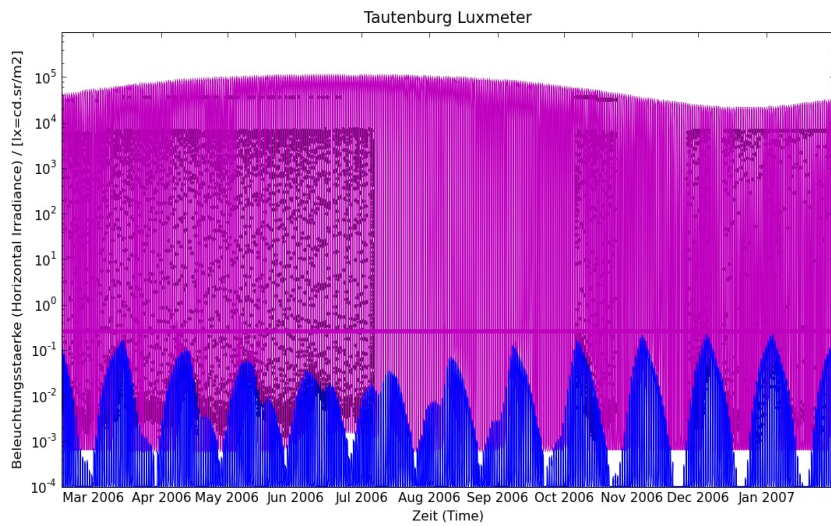
Verteilung der Beleuchtungsstärke; n = 18424; Median = 0.022



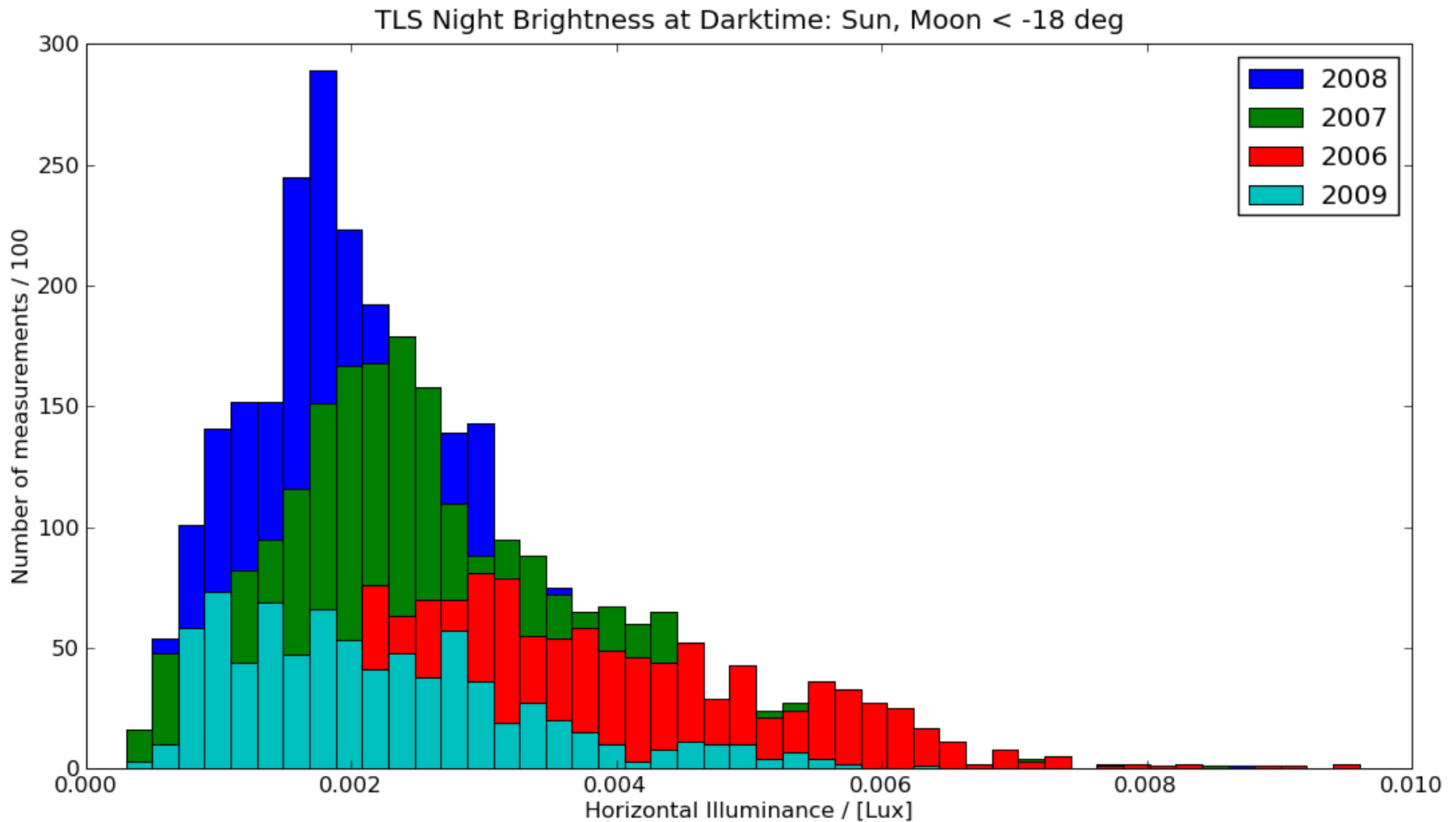
# 2009



# TLS 2006 - 2009



# Long Term Monitoring





A night sky filled with stars, with a cityscape silhouette at the bottom.

lightmeter.astronomy2009.at

wiki: Guest  
pass: IYA2009