

A Proposal of Measurement of Night-sky Brightness using Digital Still Camera

Hoshizora Kodan

<http://www.kodan.jp/>



Nonprofit and voluntary
group for co-existence of
starry sky and city lights

Established in 2007 and
consists of over a
hundred members

Continual surveillance of
night sky in Japan from
2008



Night-sky Brightness Measurement using Digital Still Camera

～街と星空の共存を目指して～
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We measured night sky brightness using digital still camera over 2,000 points in Japan

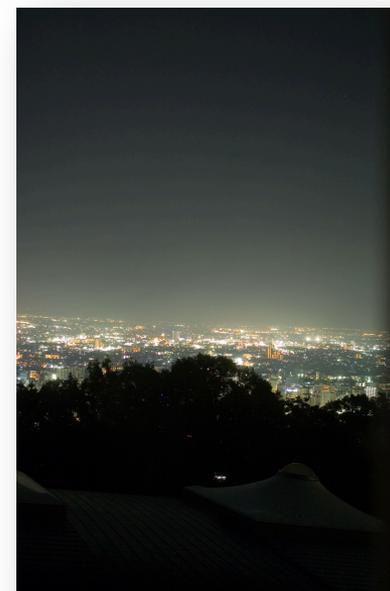
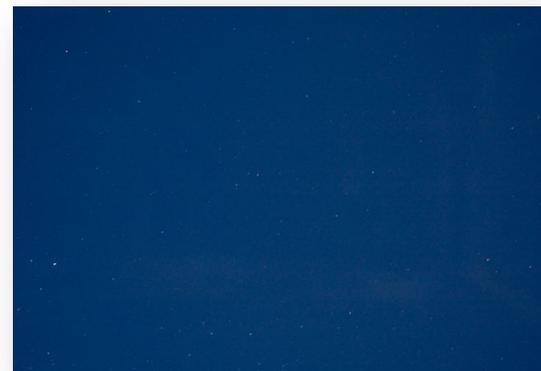
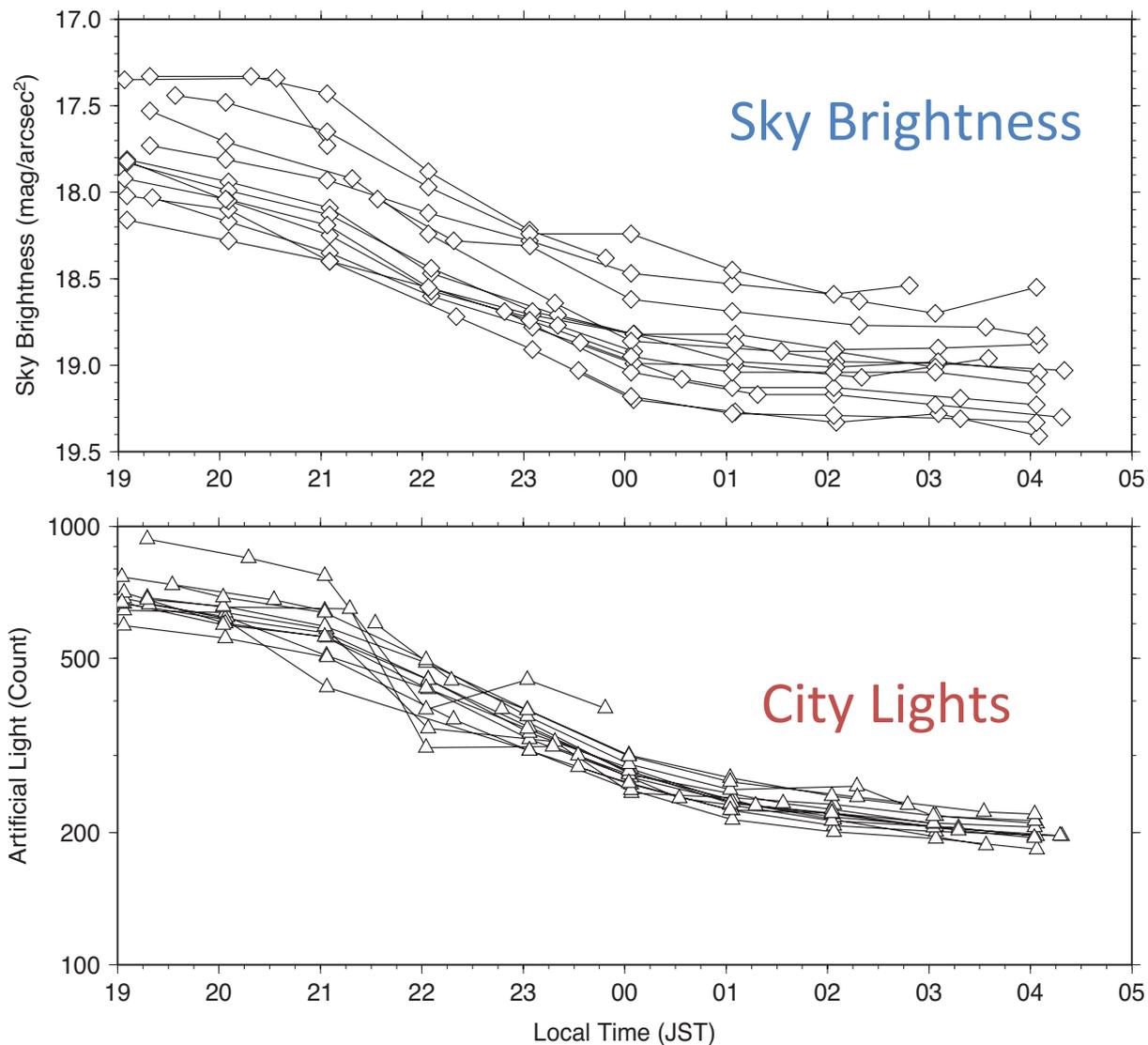
Data was acquired by many collaborators

RAW image take by camera is submitted via web browser and analyzed immediately



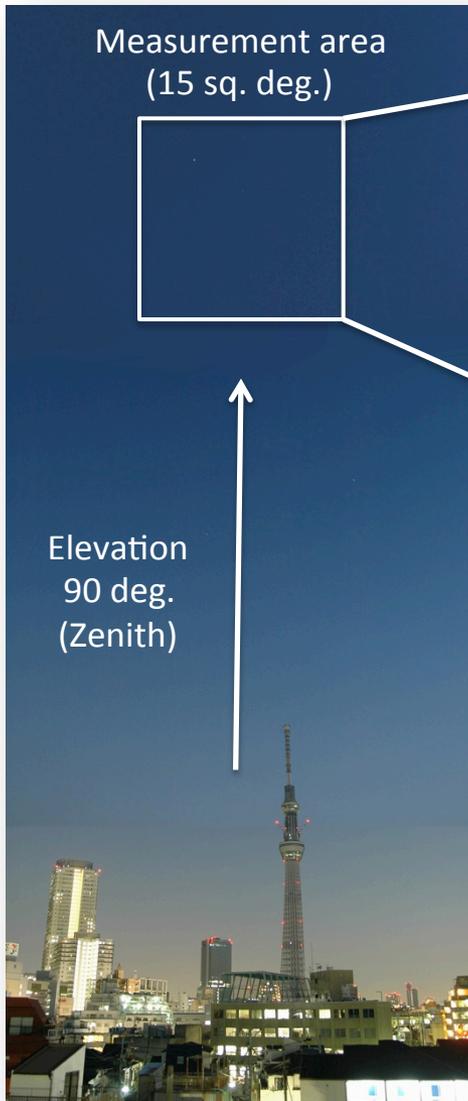
Comparison of City Lights and Night-sky Brightness

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Fixed Point Observation of Night-Sky Brightness of Tokyo, Japan

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Before the earthquake
4-Mar-2011 20:00 [JST]



After the earthquake
4-Apr-2011 20:00 [JST]

We achieved a fixed point observation of night-sky brightness of Tokyo.

[Location]

Lifelong Education Center of Sumida Ward, Tokyo. ($35^{\circ}43'15''$ N, $139^{\circ}49'06''$ E)

[Observation Time]

Every night from 2010 to 2013.
Data is acquired every 10 minutes from 18:00 to 6:00.

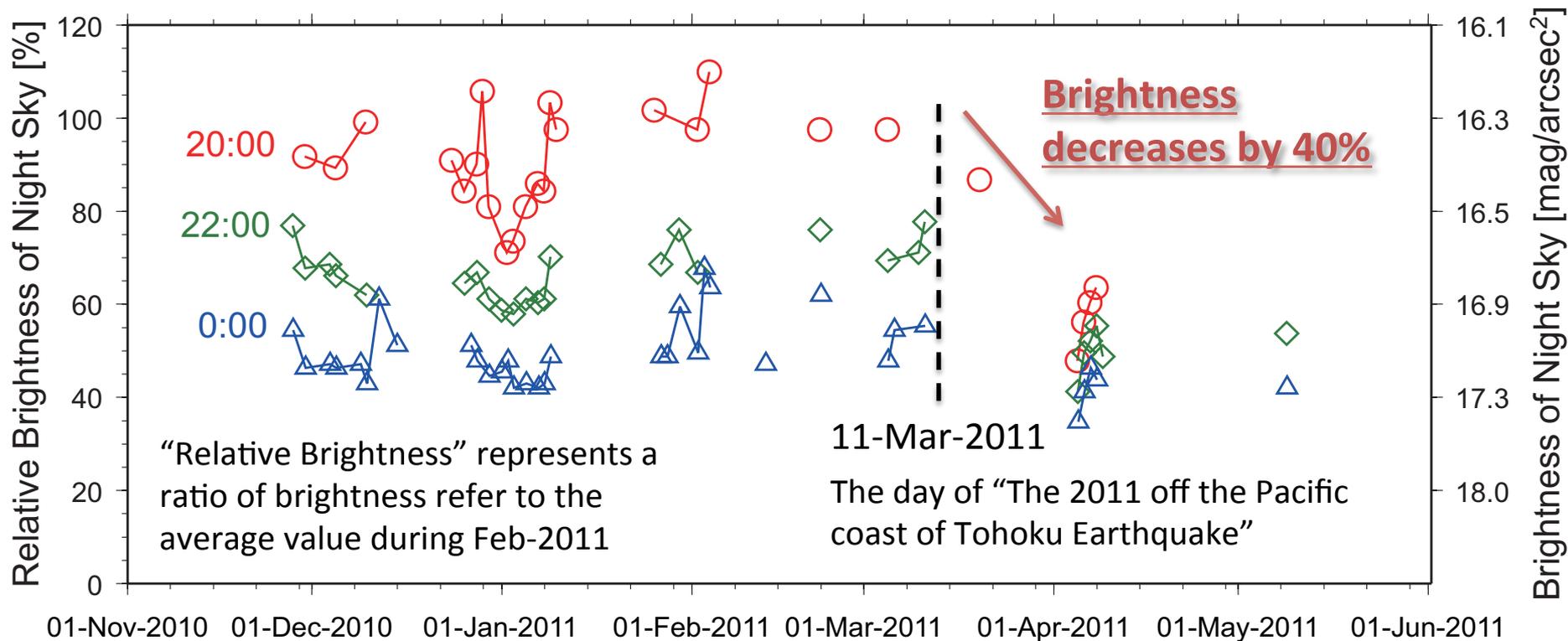
[Measurement Technique]

Measure the sensor count of calibrated Digital Still Camera (Canon EOS Kiss Digital) and take an average of 15 square-degree.



Night-Sky Brightness Decrease by 40 % after the Earthquake

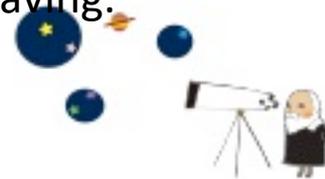
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Night-sky brightness at 20:00 over the Tokyo decrease by 40% after the earthquake compared with the brightness during Feb-2011.

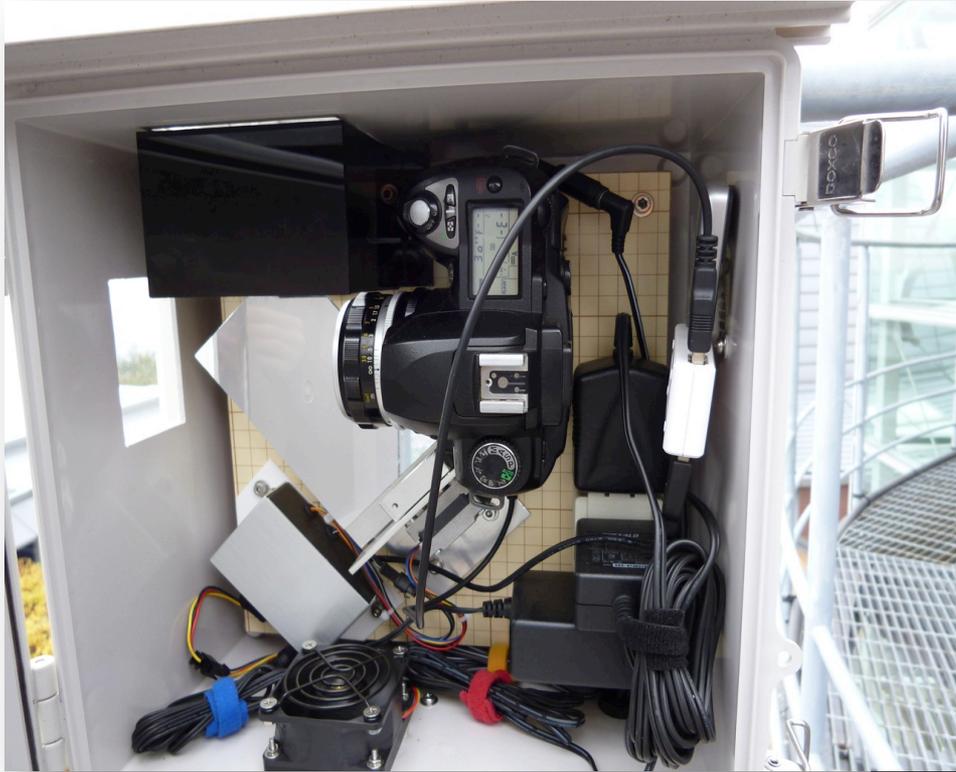
No power outage occurred during the observation.

This result indicates that the decrease of the brightness is the effect of power saving.



Night-sky Brightness under Light-down event in Yamanashi

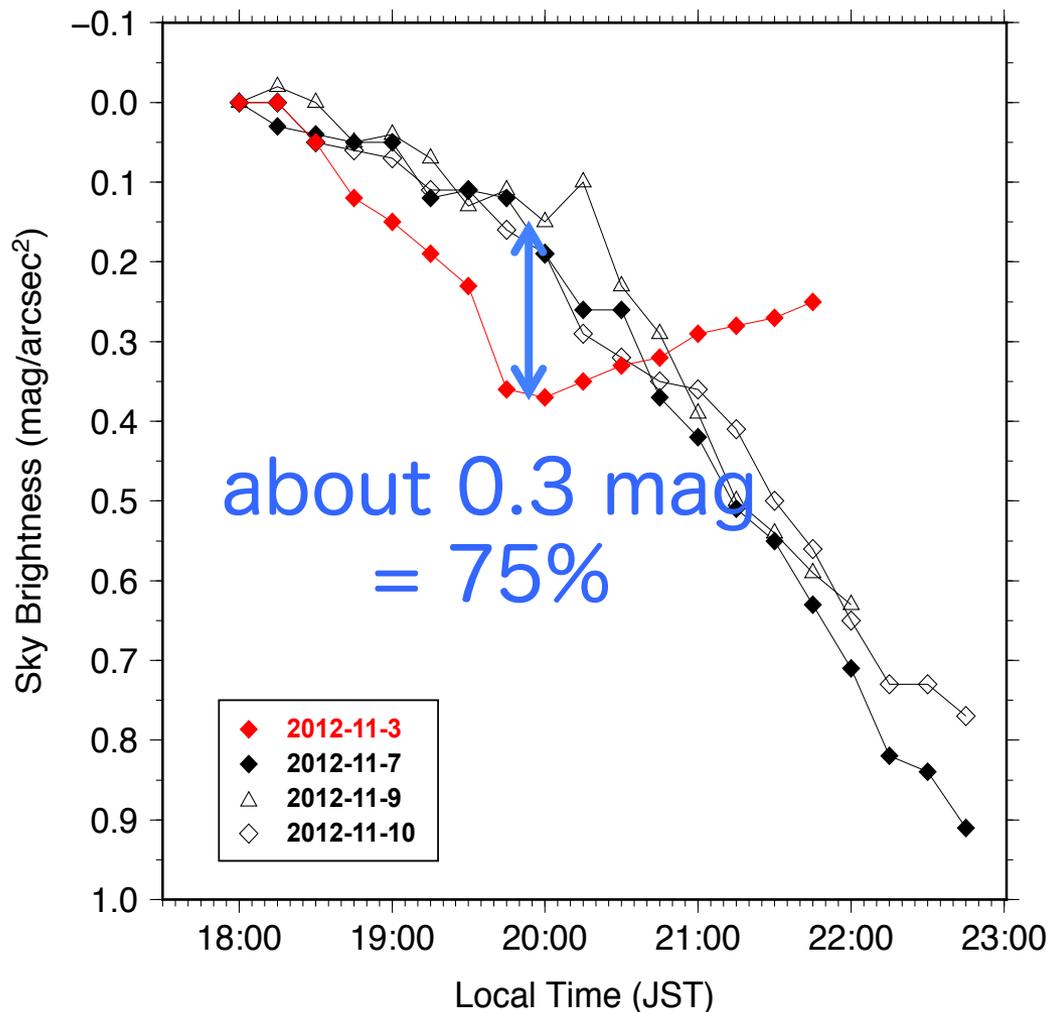
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We observe night sky brightness with automated camera during light-down event in Yamanashi



Light-down Effect



Compare the variation based on brightness at 18:00

Light-down effect for night-sky is estimated about 0.3 magnitude (or 75 %)

After the light-down event, the Moon was raised and sky became more brighter



Lunar Eclipse at Dec 10, 2011

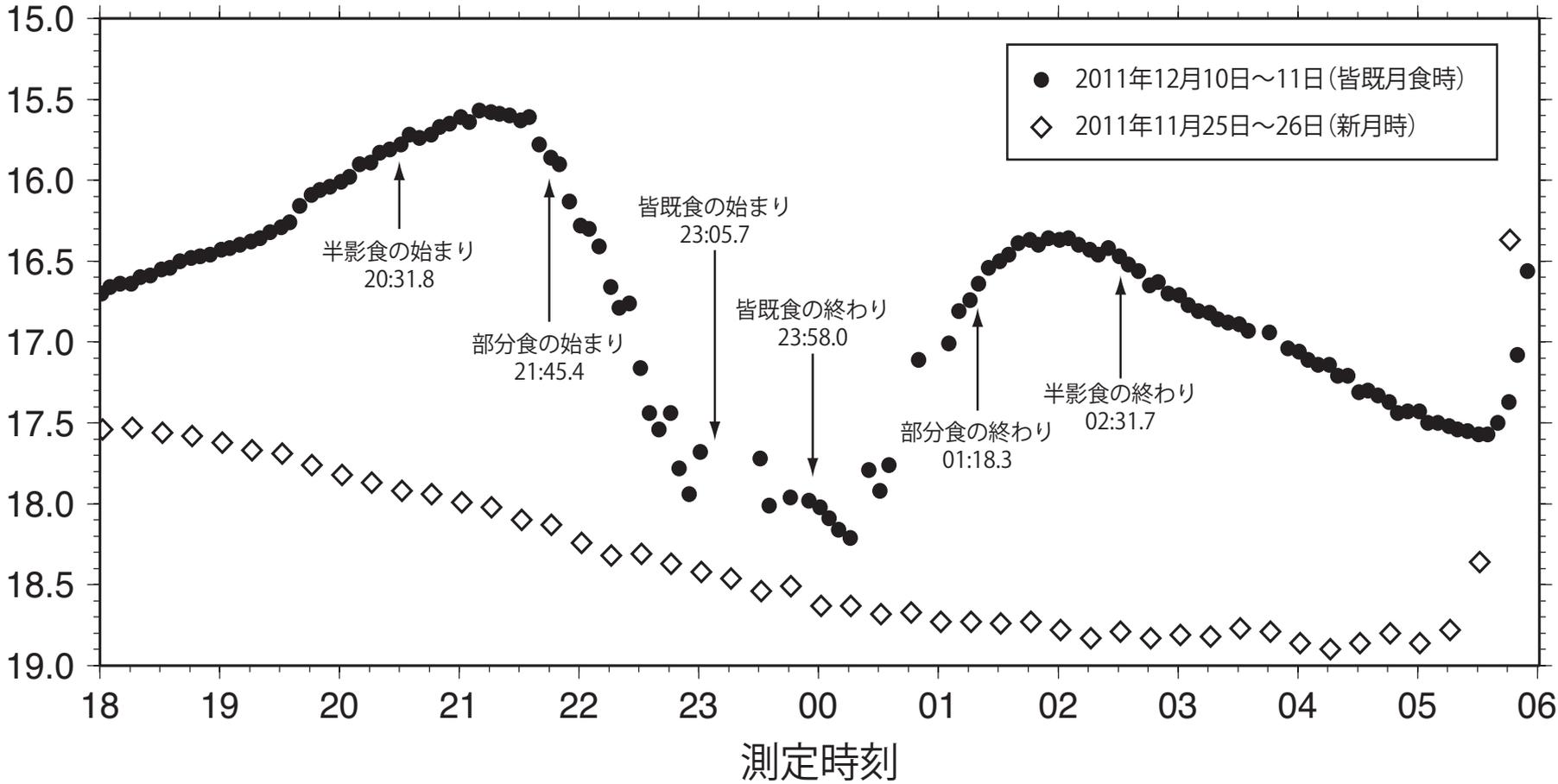
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Lunar Eclipse at Dec 10, 2011

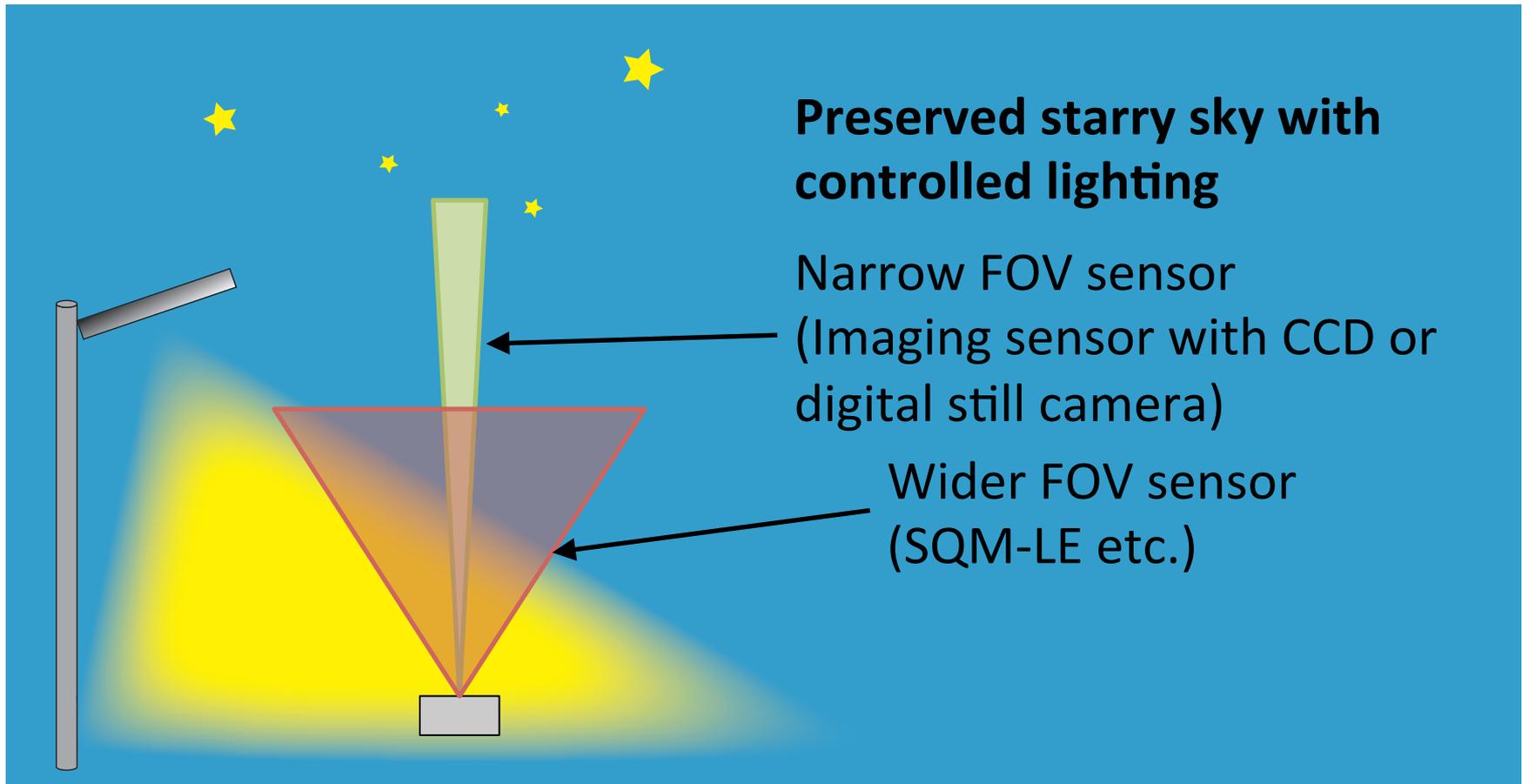
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夜空の明るさ [等級/□"]



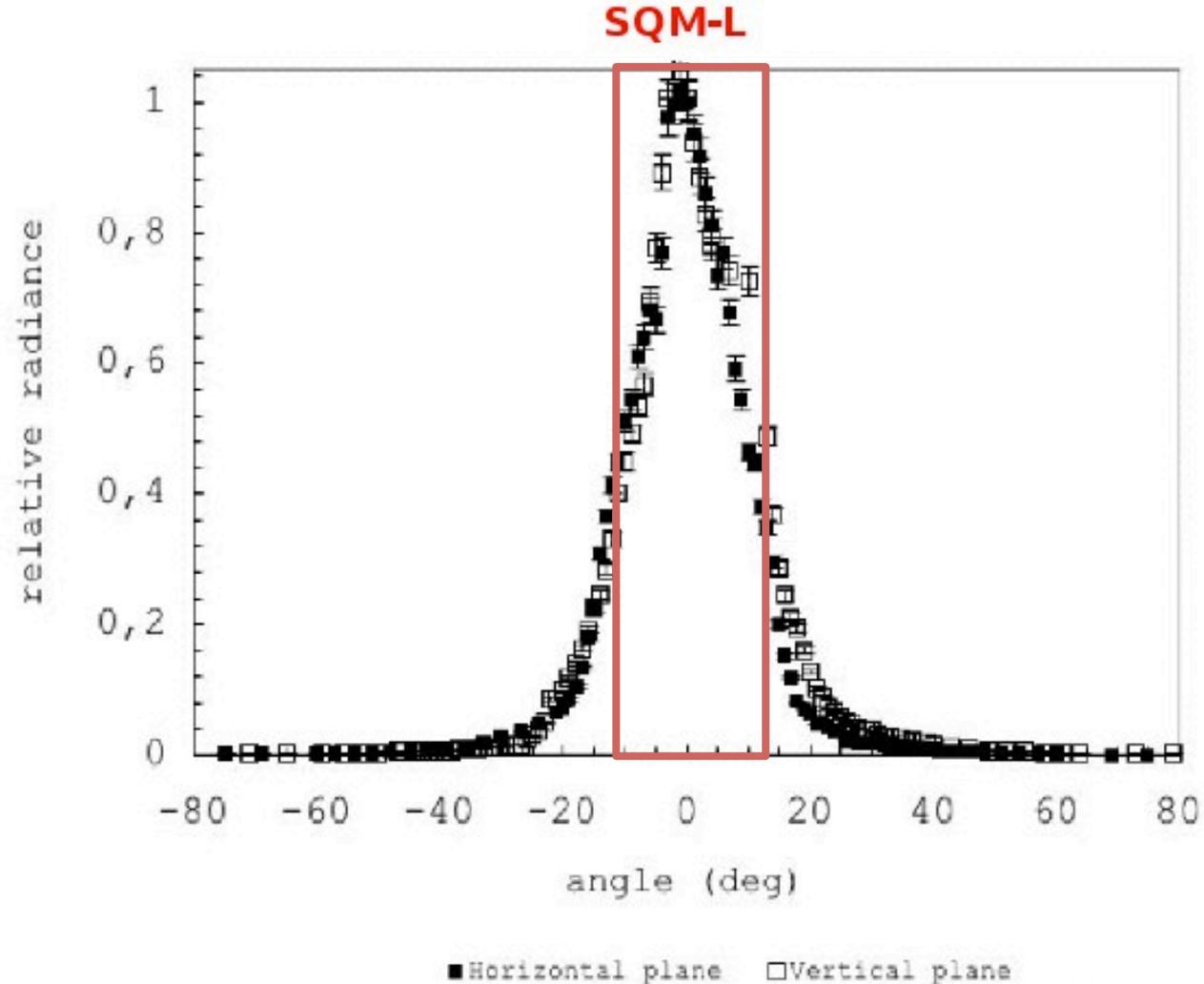
Why don't we use SQM

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Wider FOV sensor is affected by well controlled lighting and underestimates good lighting design



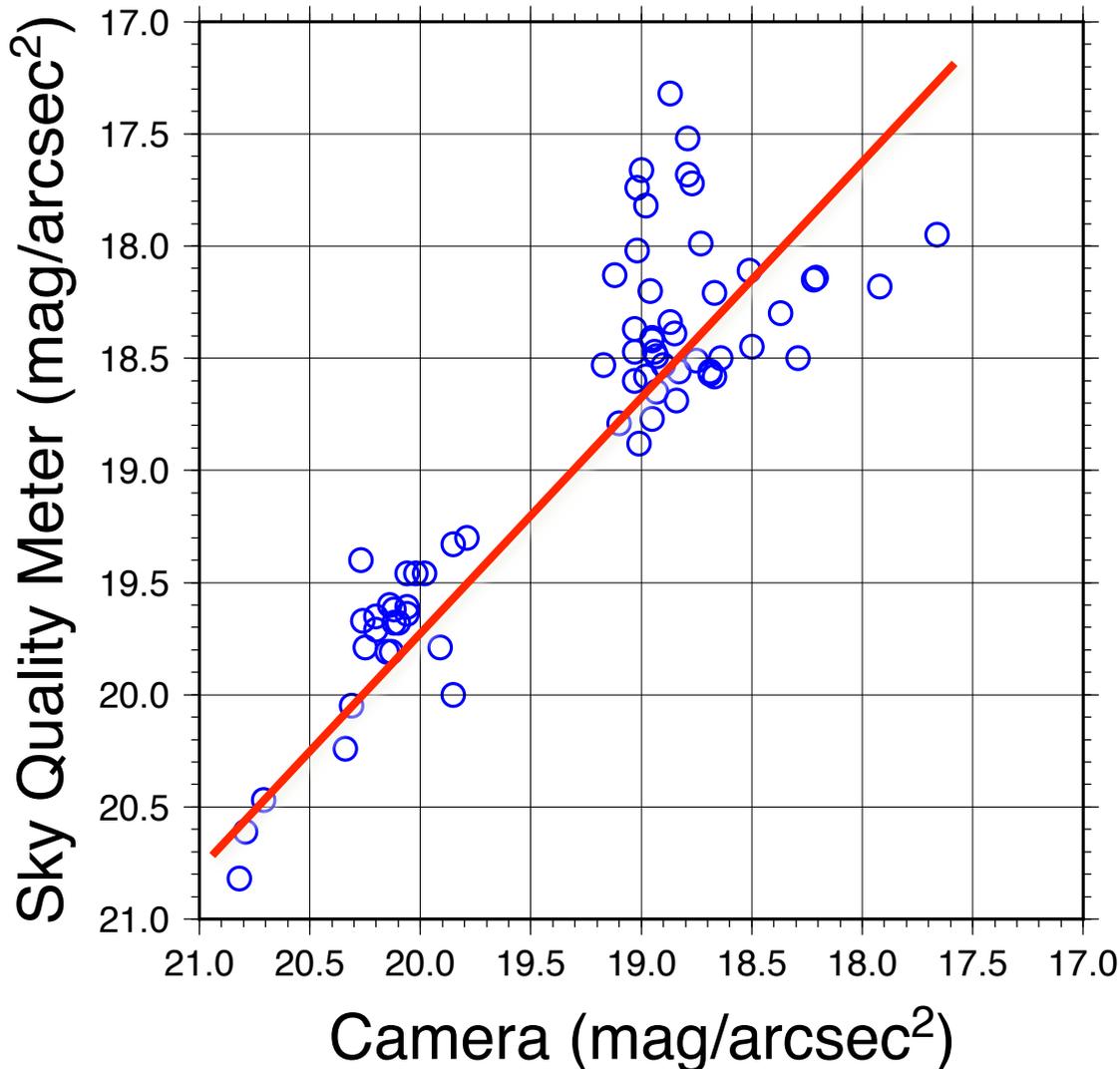


SQM has half maximum full-width of 20 degree,
but has sensitivity over 40 degree



Comparison SQM and Digital Camera

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Both has good relation
under dark night

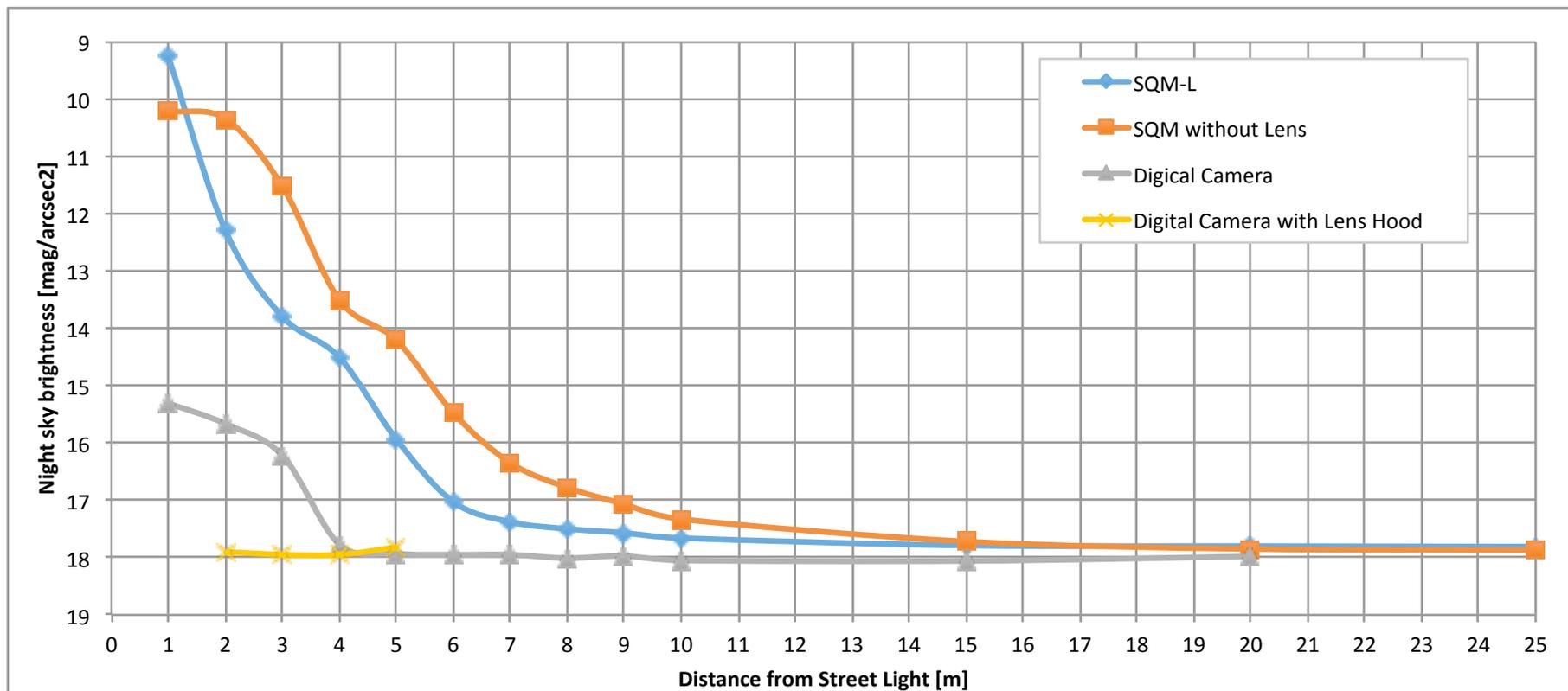
SQM has some offset
about 0.3 magnitude

Under the bright sky, SQM
indicate more brighter
than digital camera



Effects of Street Lights for SQM

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SQM-L and SQM (without Lens, older model) is affected by the street light over 15 meters while digital camera affected under few meters.

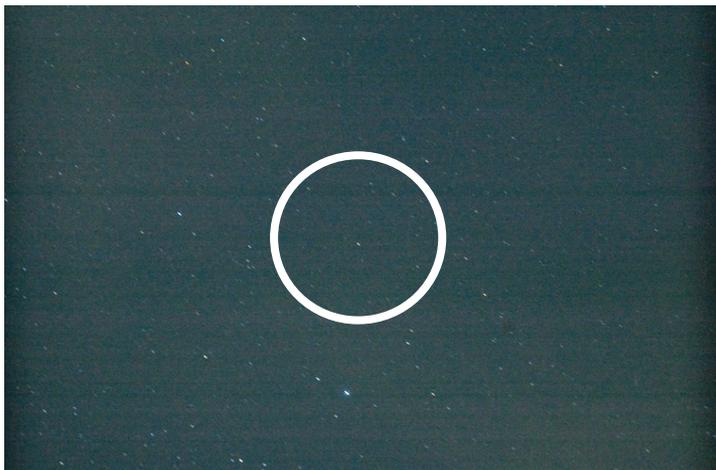
It's impossible to get off more than 15 meter from the light in the inner-city area.



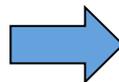
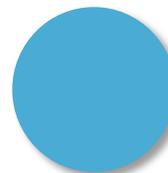
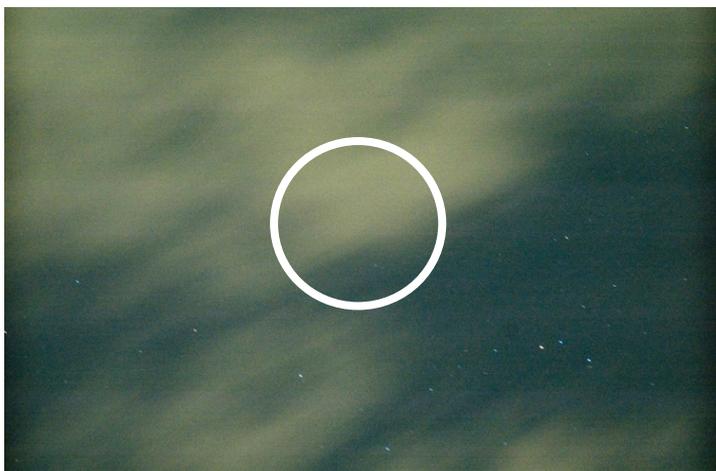
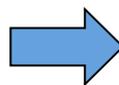
How to check the sky condition?

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Sky Condition



SQM-L response



It's hard to check the sky condition using only SQM

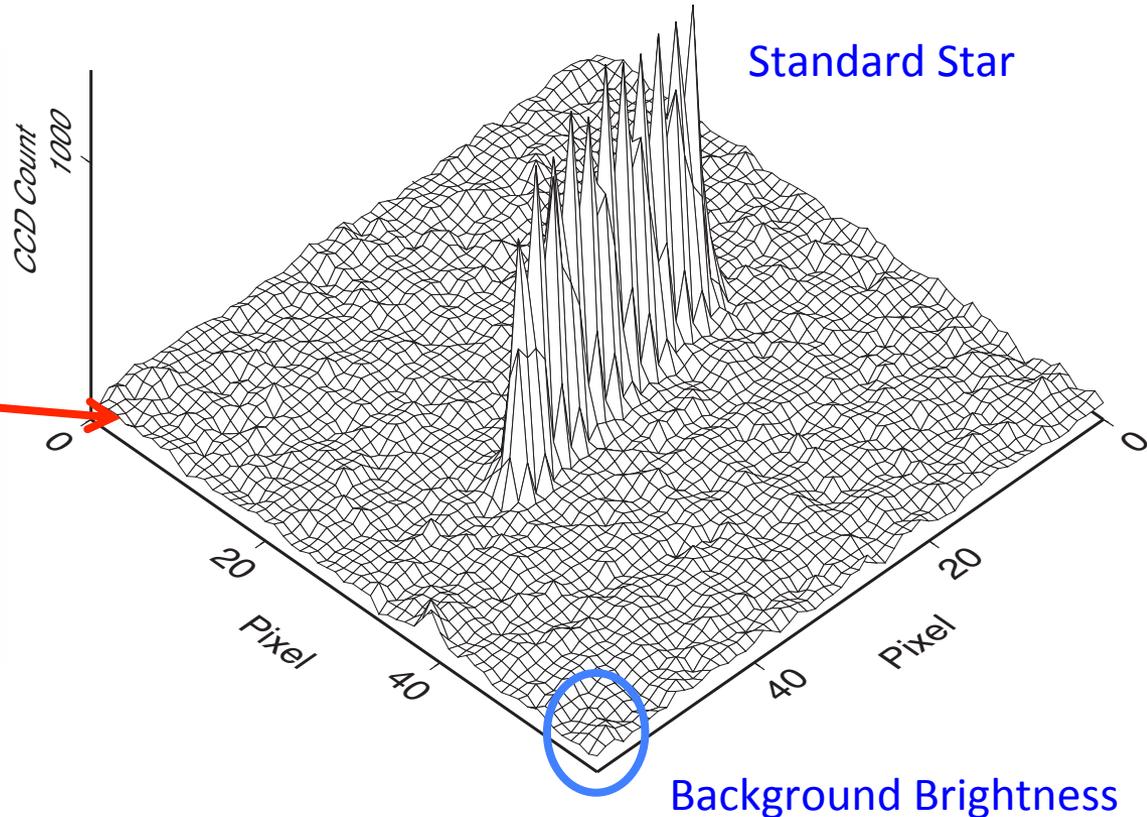


Measurement technic using digital still camera

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Raw Image of Camera



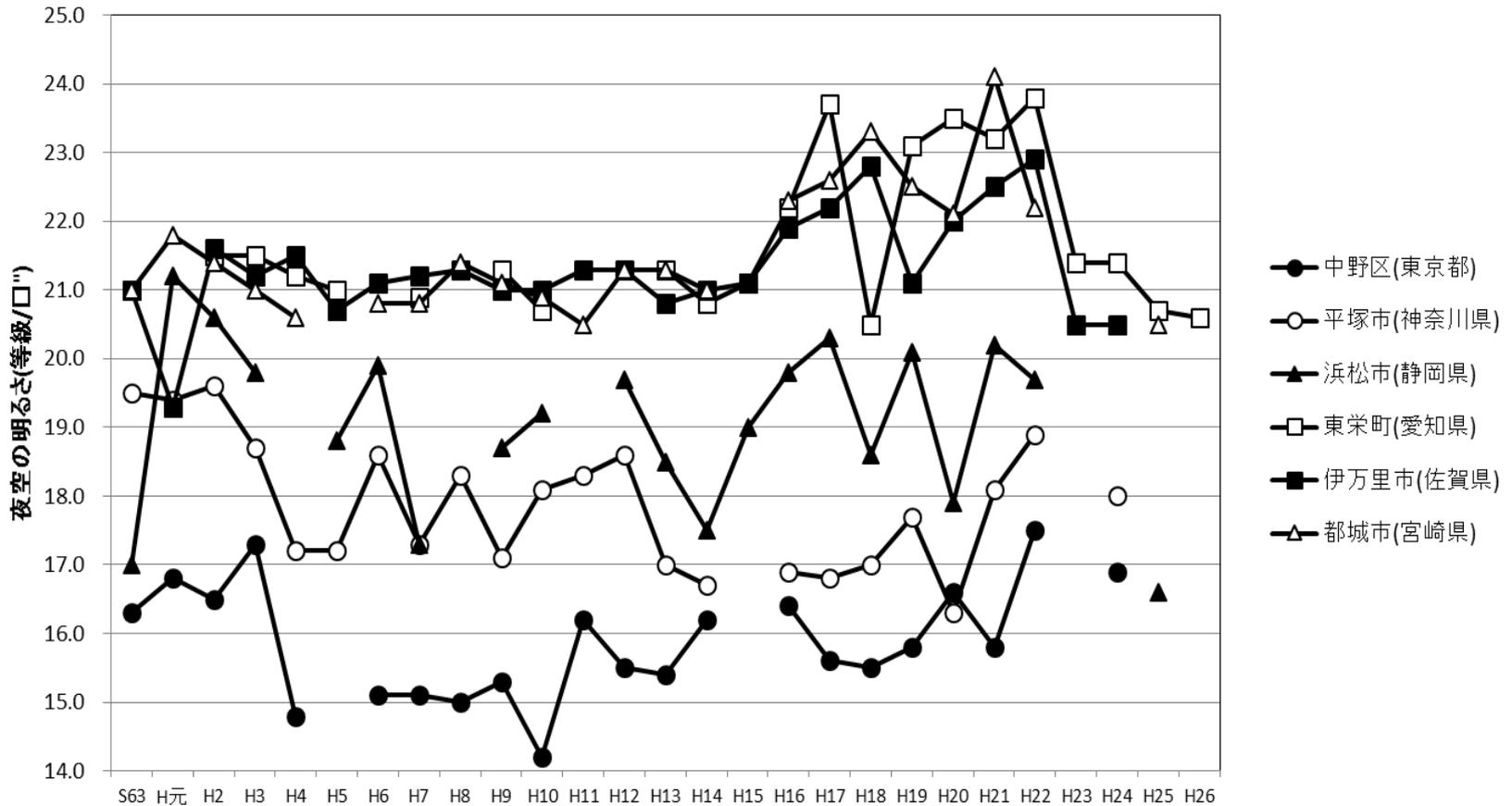
Measure the background brightness comparing standard star intensity

Sensor gain of camera is calibrated with standard star



Long-period observation in Japan

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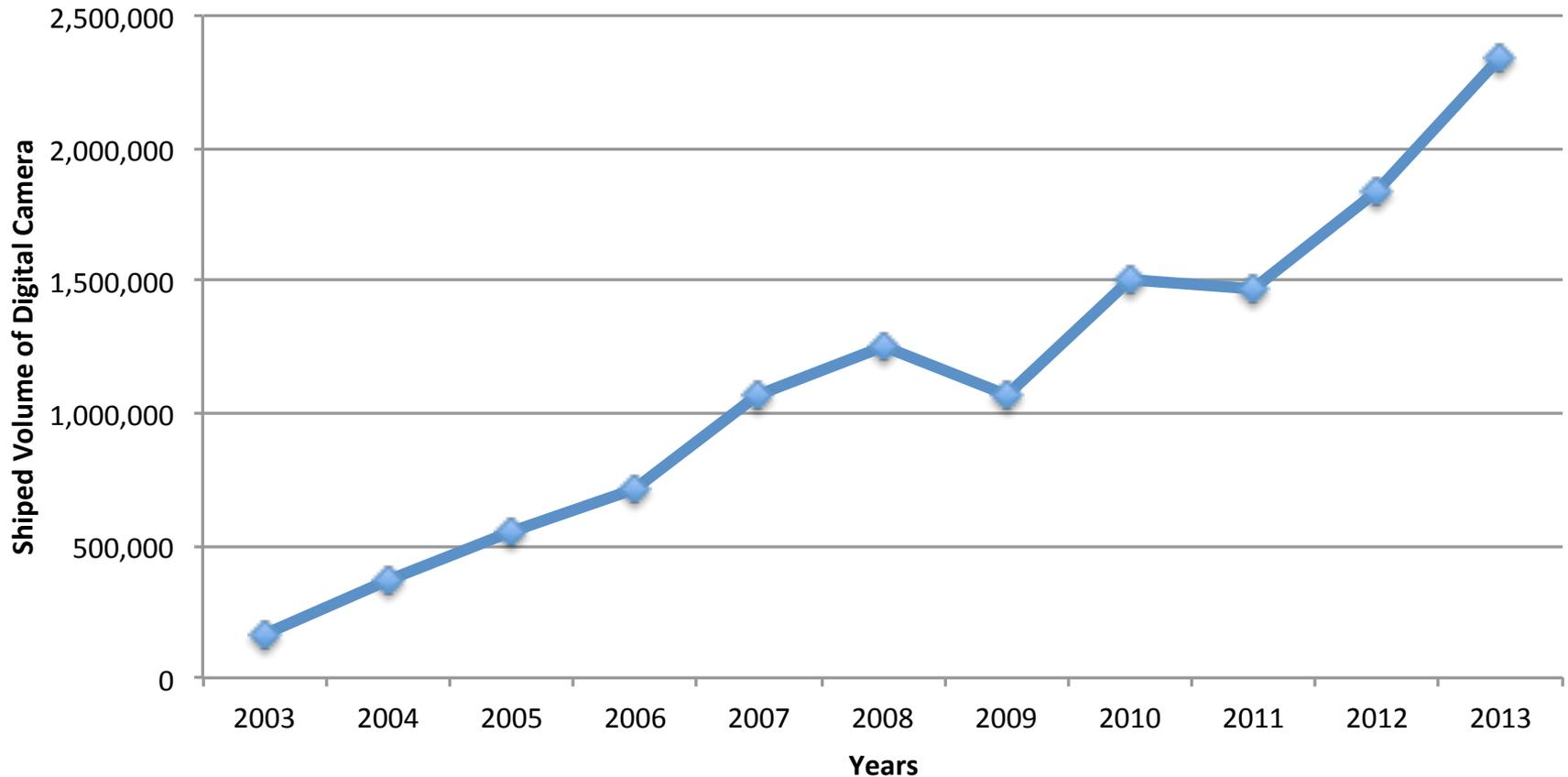


Ministry of Environment of Japan had investigated night sky brightness from 1988
Observation by the Ministry was suspended and temporarily continued by us
Film and digital camera are used for measurement



A great number of dormant cameras in Japan

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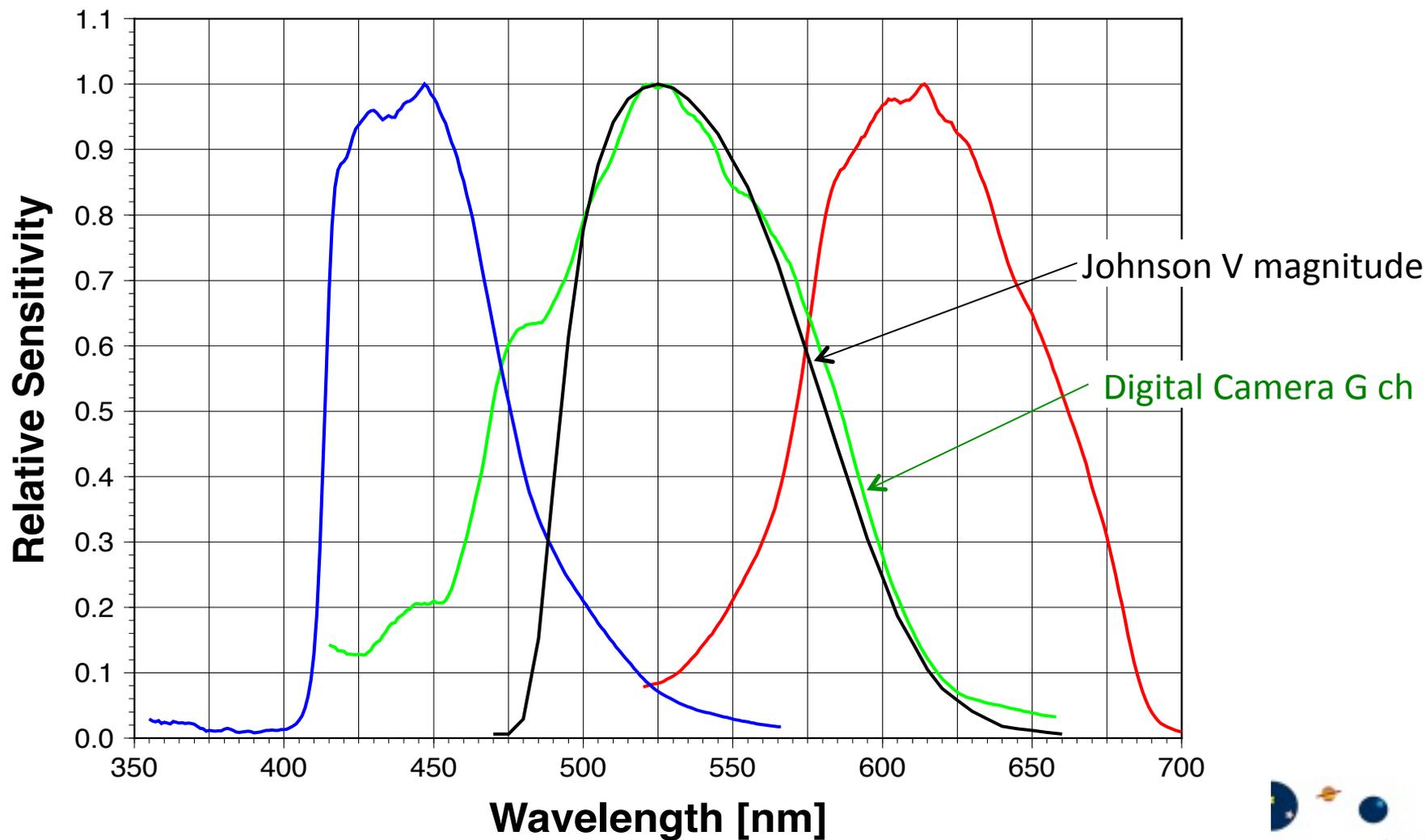
Data from Camera & Imaging Products Association (CIPA) Japan

Over millions of digital camera are shipped and available for measuring night sky



Wavelength Characteristics of Digital Camera

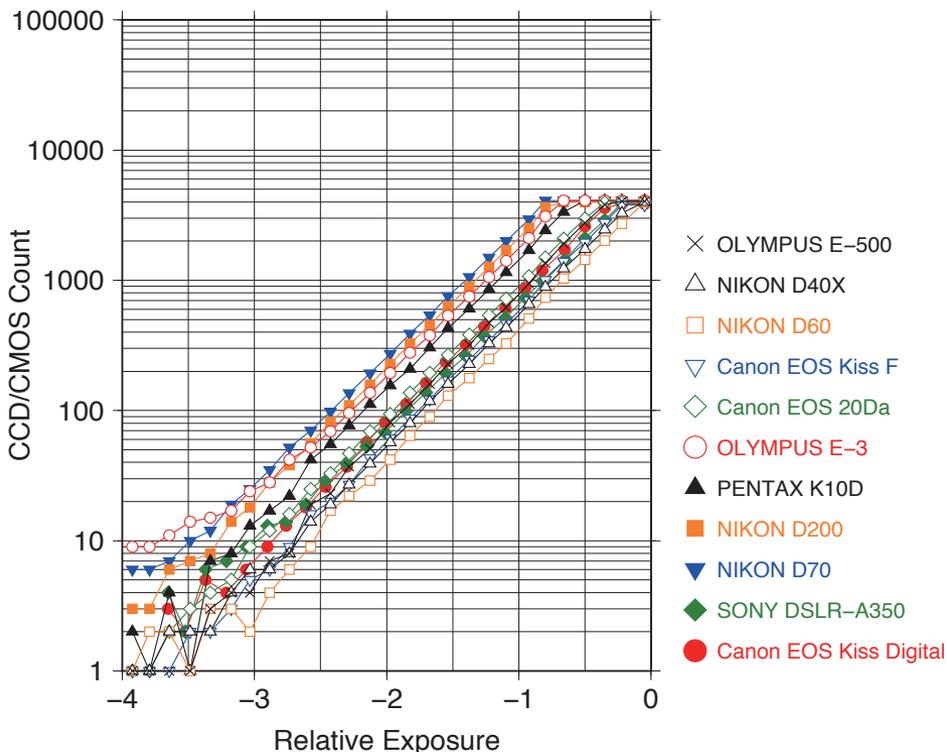
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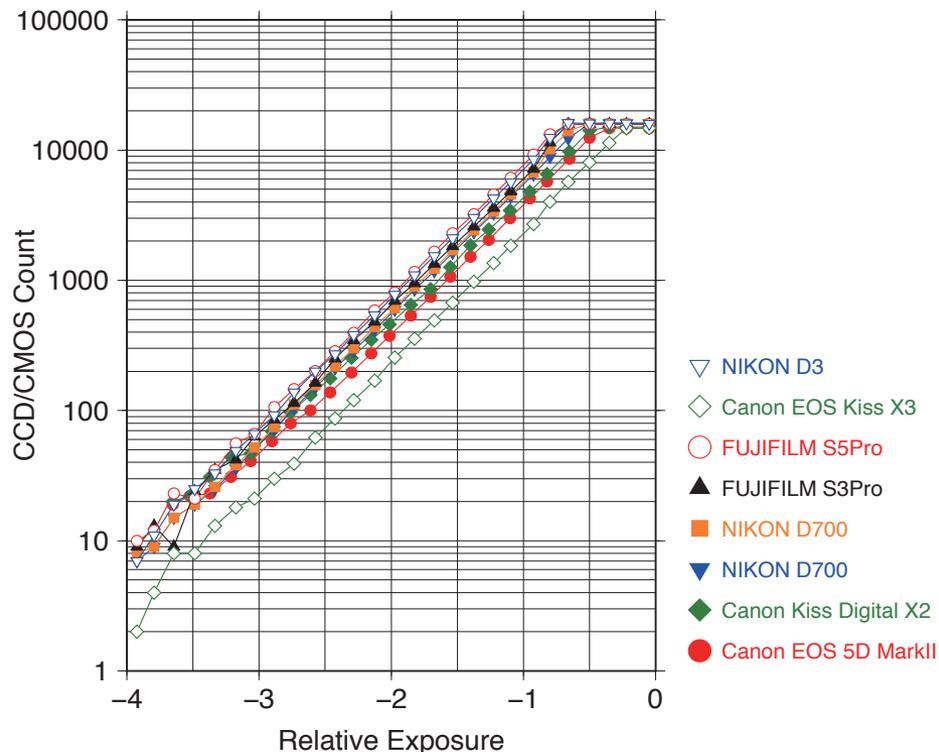
Linearity of Digital Camera Sensor

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12 bit Sensor Model



14 bit Sensor Model



Digital camera has good linearity of sensitivity and required no calibration



List of Available Cameras

【Canon】

EOS-1D / EOS-1Ds
EOS-1D Mark II
EOS-1Ds Mark II
EOS-1D Mark II N
EOS-1D Mark III
EOS-1Ds Mark III
EOS-1D X
EOS D30 / EOS D60
EOS 10D
EOS 20D / EOS 20Da
EOS 30D / EOS 40D
EOS 50D / EOS 60D
EOS 5D / EOS 5D Mark II
EOS 6D / 7D
EOS Kiss Digital
EOS Kiss Digital N
EOS Kiss Digital X
EOS Kiss X2
EOS Kiss F
EOS Kiss X3 / X4 / X5
EOS Kiss X50 / X6i / X7

【Nikon】

D1 / D1H / D1X
D2H / D2Hs / D2X / D2Xs
D3 / D3X / D4
D100 / D200
D300 / D300s / D700
D800
D70 / D70s

【Panasonic】

DMC-L1 / DMC-L10
DMC-G1 / DMC-G2 / DMC-G3
DMC-GF1 / DMC-GF2 / DMC-GF3
DMC-GF5
DMC-GH1 / DMC-GH2 / DMC-GX1

【PENTAX】

*ist D / *ist DS / *ist DL2 / *ist DL
K100D / K100D Super
K10D / K20D / K200D
K-01 / K-30 / K-5 / K-5 Iis / K-7
K-m / K-r / K-x / Q

All Digital Still Camera with
RAW format is available

【OLYMPUS】

E-1 / E-3 / E-30 / E-5
E-300 / E-330
E-400 / E-410 / E-420
E-500 / E-510 / E-520
E-620
E-M5 / E-P1 / E-P2 / E-P3
E-PL1 / E-PL1s / E-PL2
E-PL3 / E-PM1

【SONY】

DSLR-A100 / DSLR-A200
DSLR-A230 / DSLR-A300
DSLR-A330 / DSLR-A350
DSLR-A380 / DSLR-A550
DSLR-A700 / DSLR-A900
NEX-3 / NEX-5 / NEX-5N
NEX-7 / NEX-C3



How to Capture Night-Sky (part 1)

～街と星空の共存を目指して～
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Set camera mode for Manual
“M”



Set camera parameter to...
Shutter Speed: 30 sec
Aperture: 4.0
ISO: 400
Format: RAW
Noise reduction: ON



How to Capture Night-Sky (part 2)

～街と星空の共存を目指して～
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Capture the zenith sky with tripod.
(also possible without tripod !!)
If you use self-timer, no other
tools needed.



How to Measure Night-Sky (Simple Way)

～街と星空の共存を目指して～
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ファイルアップロード

- 担当者名、E-mailは必ず記入して下さい。
- 30秒、60秒、120秒の3つのファイルをアップロードする必要があります。
- ファイルを送信するには[参照] (または[選択]) をクリックしてファイルを指定した後、[アップロード] をクリックします。
- ファイルの送信には最大5分程度かかることがあります。ブラウザの[戻る]や[停止] をクリックしないようお願いいたします。

撮影情報

担当者名	<input type="text"/>	担当者名(非公開)	<input type="text"/>
TEL(非公開)	<input type="text"/>	E-mail(非公開)	<input type="text"/>

撮影地点名称

撮影場所

下の地図から撮影場所をクリックして下さい。



使用レンズ 焦点距離: mm 絞り設定値(F値):

天候

連絡事項がありましたらご記入ください。



Firefox ファイル 編集 表示 履歴 ブックマーク ツール ウィンドウ ヘルプ

AKATSUKI | PLANET-C

星空公団では、環境省が25年間にわたって続けてきた全国星空継続観測が休止となることから、その代わりとなる星空独自の暫定調査への協力を呼びかけます。これは、これまで25年間連続してきた夜空の明るさのデータがいったん途切れることを防ぎ、継続的なデータの蓄積につなげていくための試みとして、全国のみならずデータ提供の協力をお願いするものです。

詳しく読む

前のページ 1 次のページ

[全国マップ]
大きな地図で見る



地図 航空写真

ただいま撮影データ実行中です。観測は過ぎても「日没後1時間半～3時間半の間」で、かつ月が出ていない時間帯でしたらもう少しの観測から継続観測です。

@KDN_dcdockさん宛にツイートする

We have automated system measuring night-sky from digital camera image

User only send the RAW image with web browser, and brightness shown immediately (needless to find standard star)

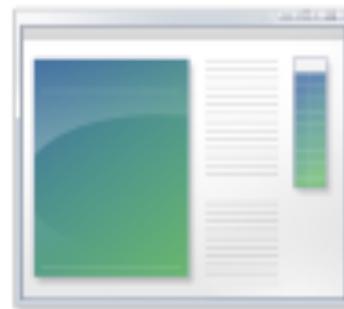
The demo site is <http://dcdock.kodan.jp/demo/> and available now



How to Measure Night-Sky (more Accurate Way)



IMG_0015.CR2



raw2fits.exe

We supply the program for Digital Camera RAW Data to FITS

G1	R	G1	R	G1	R
B	G2	B	G2	B	G2
G1	R	G1	R	G1	R
B	G2	B	G2	B	G2

Split 4 array

G1	R	G1	R	G1	R
B	G2	B	G2	B	G2
G1	R	G1	R	G1	R
B	G2	B	G2	B	G2

Add G1 and G2

G1 +G2	G1 +G2	G1 +G2
G1 +G2	G1 +G2	G1 +G2



How to Measure Night-Sky (more Accurate Way)

～街と星空の共存を目指して～
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開口測光 [IMG_0015.CR2.g.fits]

番号	種別	中心座標	内径	外径	ピクセル数	総計	平均	標準偏差
1	STAR (1595.6, 1178.1)		10.0		349	166460.0	477.0	971.5
1	SKY (1595.6, 1178.1)		12.0	14.0	178	32887.0	186.6	76.4
1	Count = 101345, Method = SEMICTRD							

測定半径(M):
 半自動
 自動
 重心を探す
マーク:
非表示(O)
全表示(B)

半径設定(R):
恒星径 10 ピクセル
SKY内径 12 ピクセル
SKY幅 2 ピクセル
重心検索 3 ピクセル
デフォルト(E)

テキスト出力(T)...
1件削除(D)
全件削除(A)
開じる(C)
ヘルプ(H)



After data conversion,
aperture photometry
is available with
Digital Still Camera



Our Suggestion

- Using SQM-LE (for fixed point observation)
 - ✓ Must use another sensor to check the sky condition
- Using SQM-L (for hand-held observation)
 - ✓ Must not use under the city lights over horizontal edge
 - ✓ Only well trained people should use SQM to check the sky condition
- Using SQM (older version)
 - ✓ Must not use them



Our Suggestion (Addition)

- Alternative sensor is available
- ✓ Digital still camera is useful sensor for measuring Night-sky Brightness
- ✓ It has good ability for measuring under city lights



Digital camera with
single-board computer is
available for automated
observation

Camera settings and
interval capture are
configurable via web
browser

Demo camera is display in
this room

