TOTO(TV Observation of Transient Objects) によるガンマ線バーストの光学閃光探査

Optical Flash Search of GRB 030329

Kouji Ohnishi, Eiki Tokita, Shoichi Itou

(Nagano National College of Technology)

Kenichi Torii

(Osaka Univ.)

GRB 030329 Torii et al. ApJ 597 L101, 2003

Photo and other monitor data of GRB 030329 Ohnishi et al. in preparation

Topics of this talk

- **Optical flash survey of GRB 030329**

  From the all sky monitor observation

  of meteor, fireball, ・・・and armature photographs of constellation over the sky in Japan 2003.3.29

  Note: There are many "High- armature" in Japan

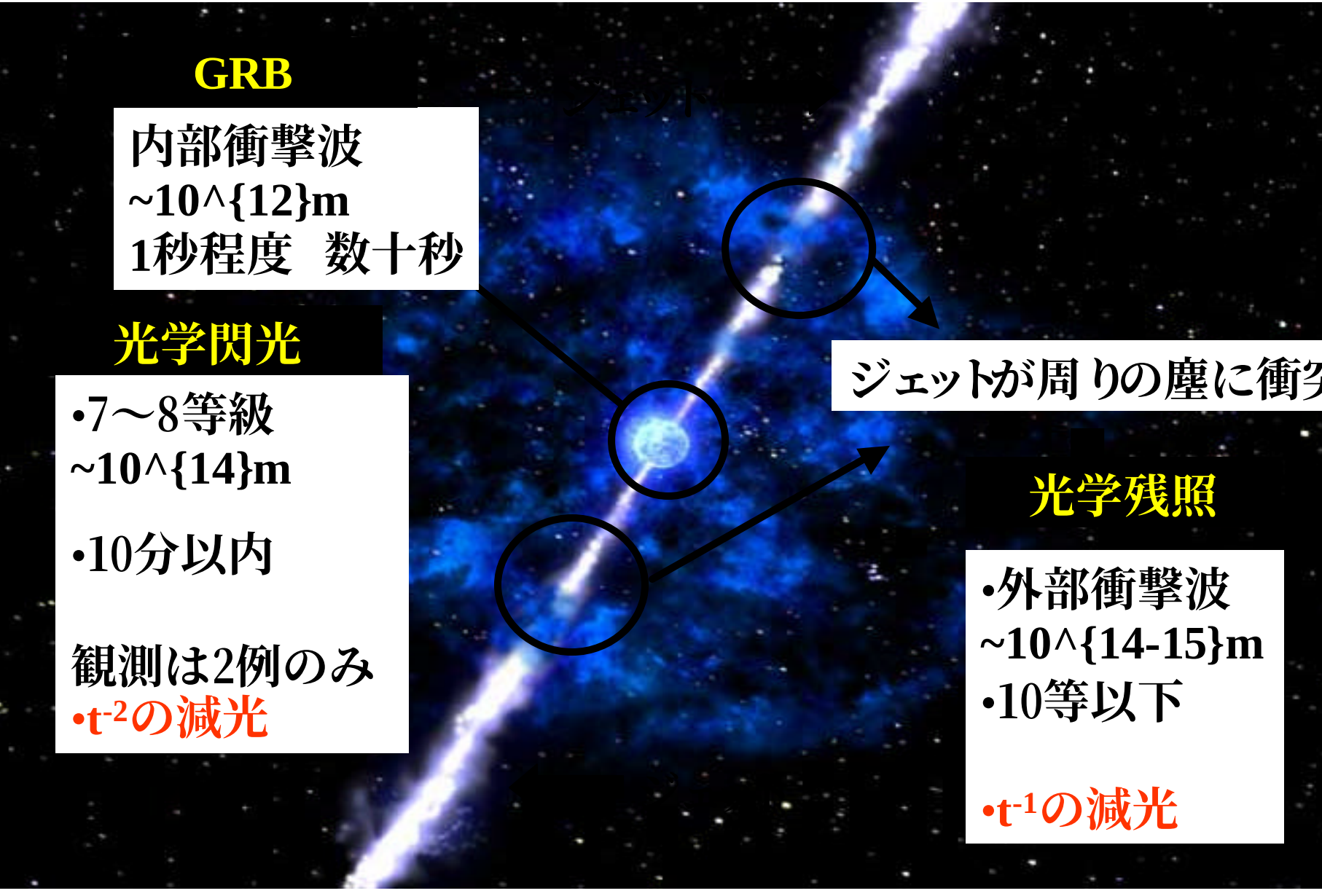
- **Concept of " TOTO "**

  Television Observation of Transient Object

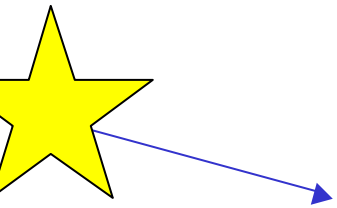
  GRB Optical Flash Monitor Program

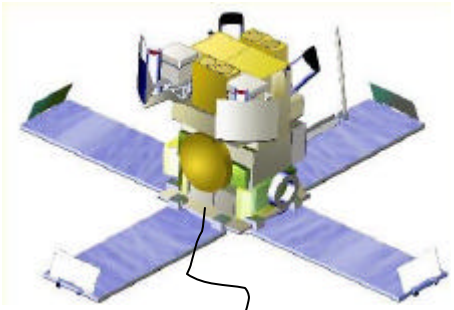
  using Video CCD camera.

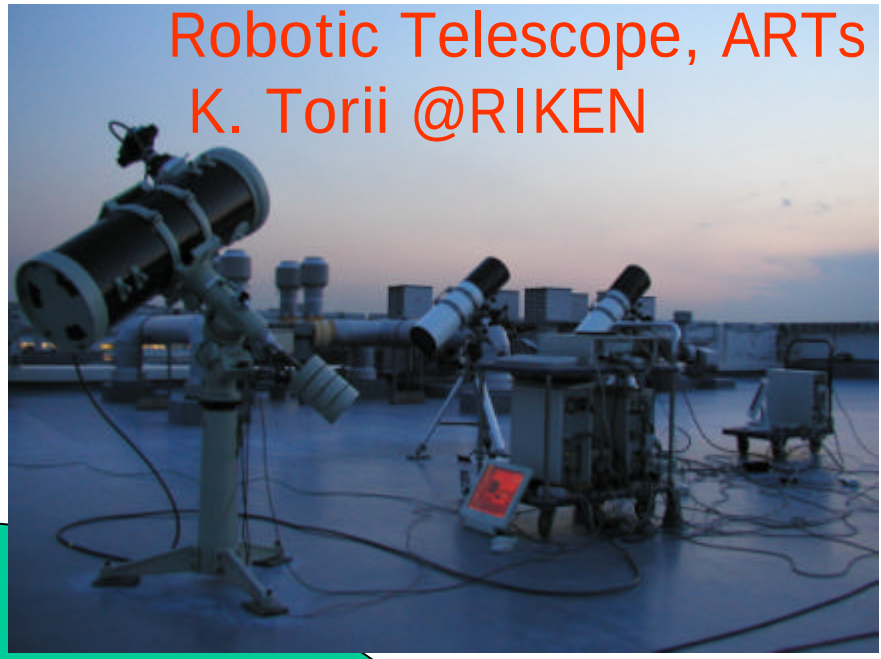
GRB

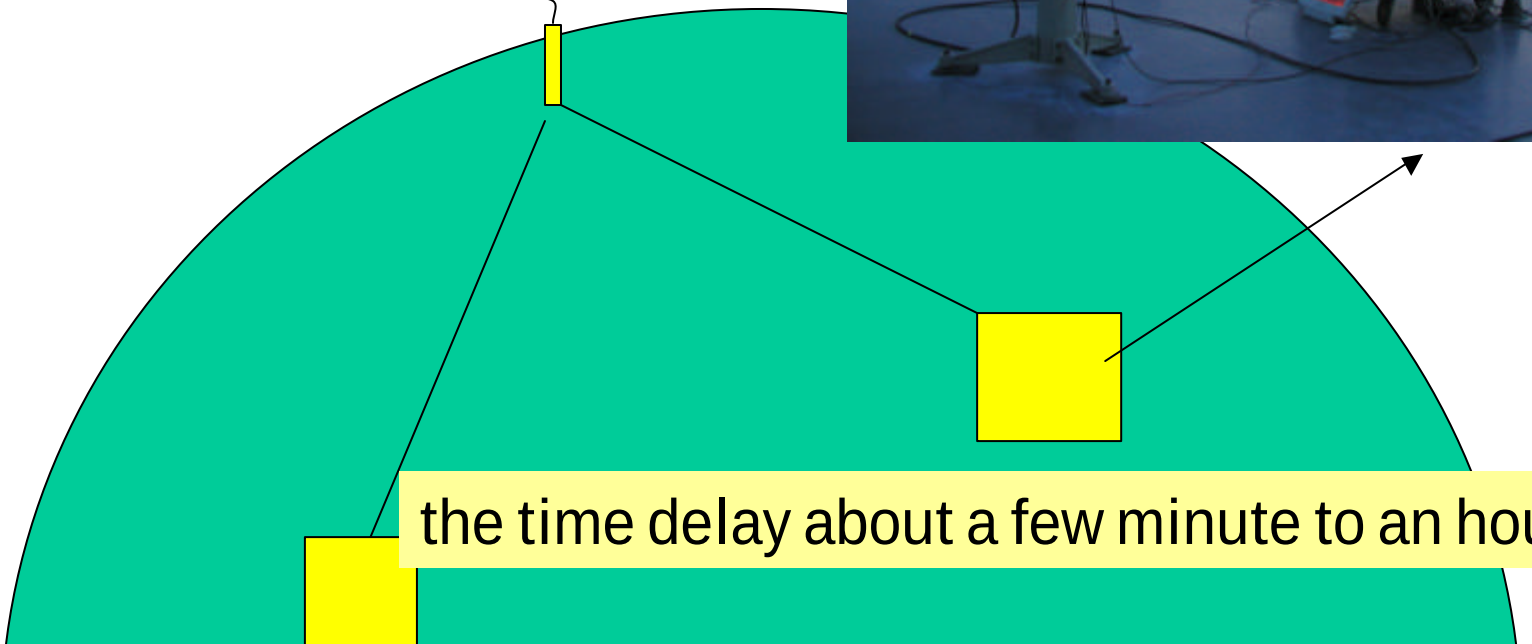

GRB
内部衝撃波
~10^{12}m
1秒程度　数十秒
光学閃光
•7～8等級
~10^{14}m
•10分以内
観測は2例のみ
•t-2の減光
ジェットが周りの塵に衝突
光学残照
•外部衝撃波
~10^{14-15}m
•10等以下
•t-1の減光

GRB Observation Net-work



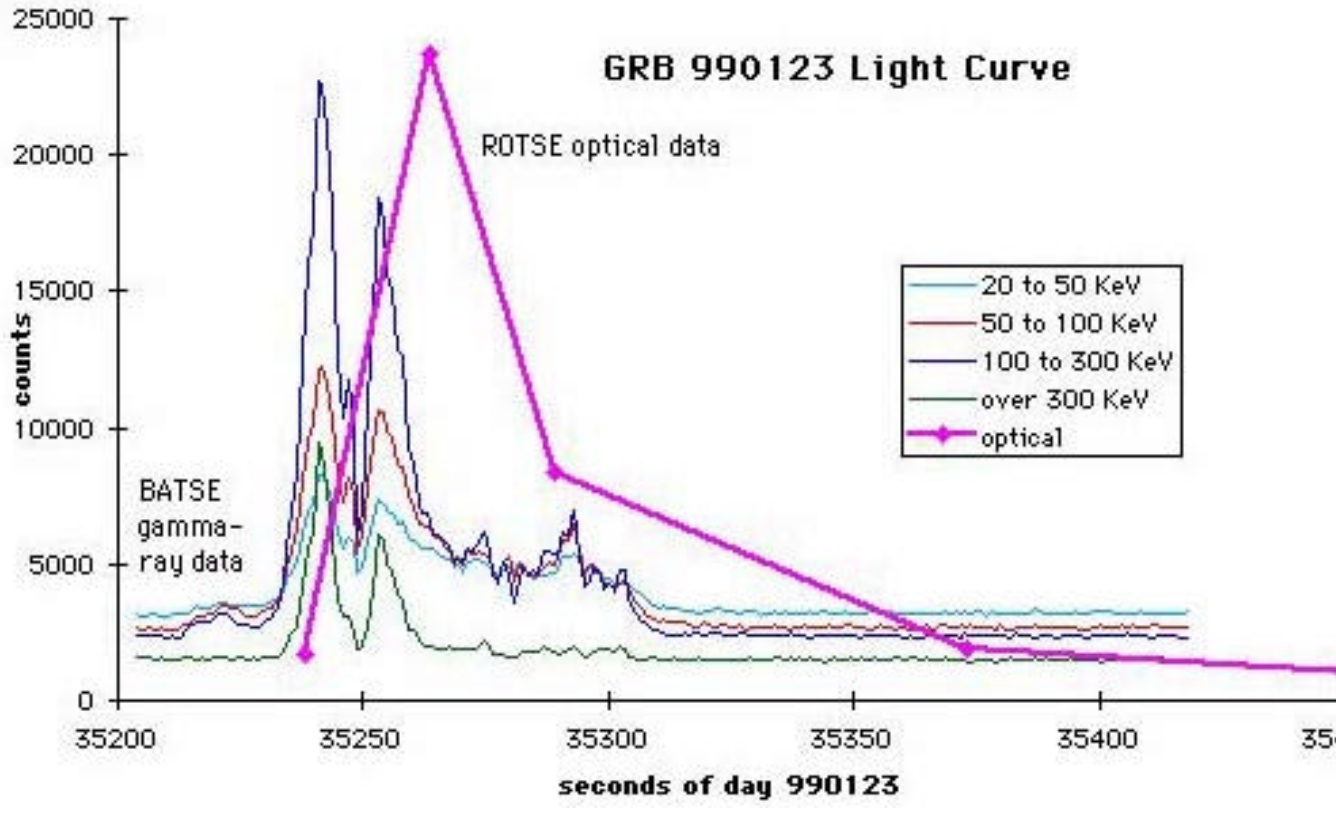


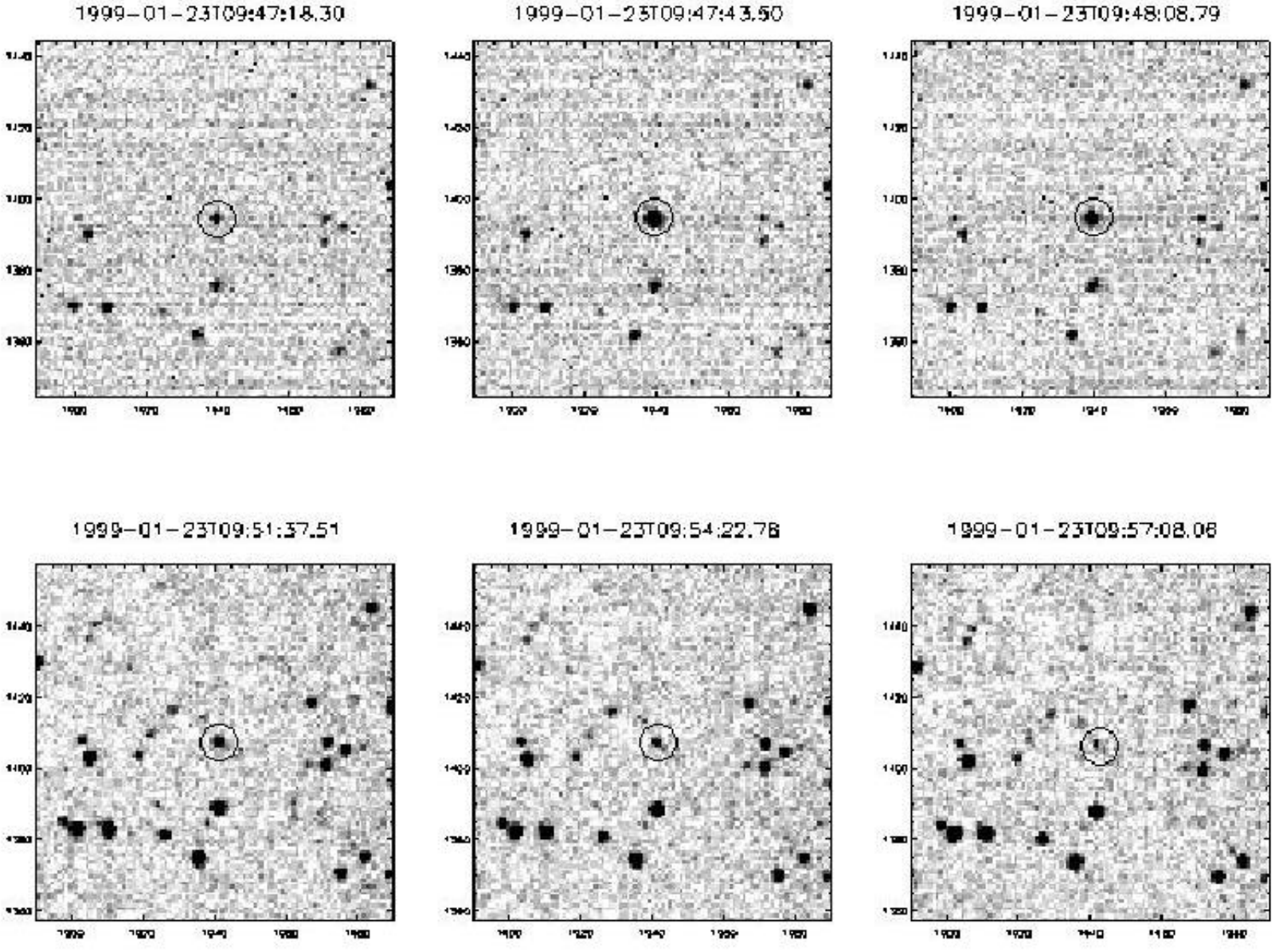




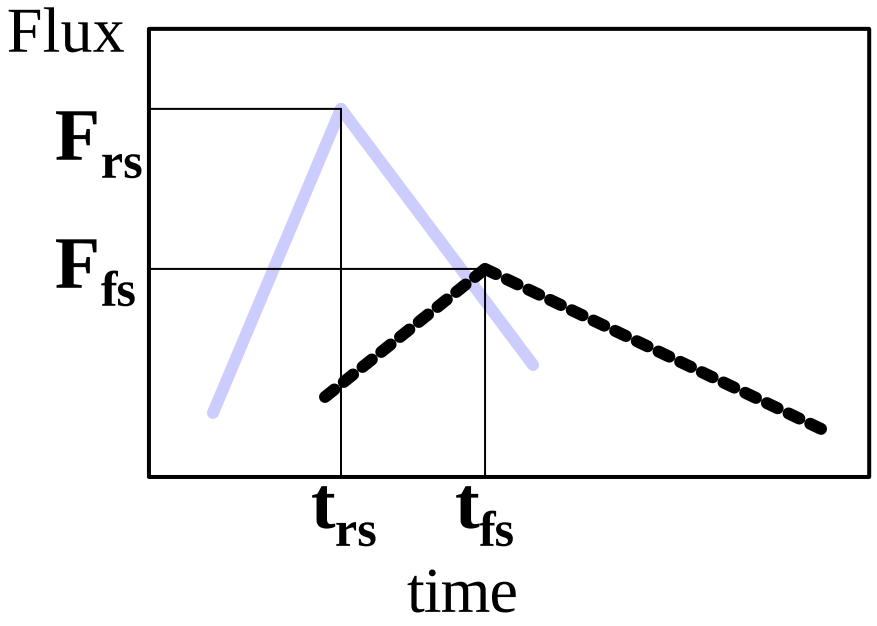
the time delay about a few minute to an hour

GRB Optical Flash




1999-01-23T09:47:18.30
1999-01-23T09:47:43.50
1999-01-23T09:48:08.79
1999-01-23T09:51:37.51
1999-01-23T09:54:22.76
1999-01-23T09:57:08.06

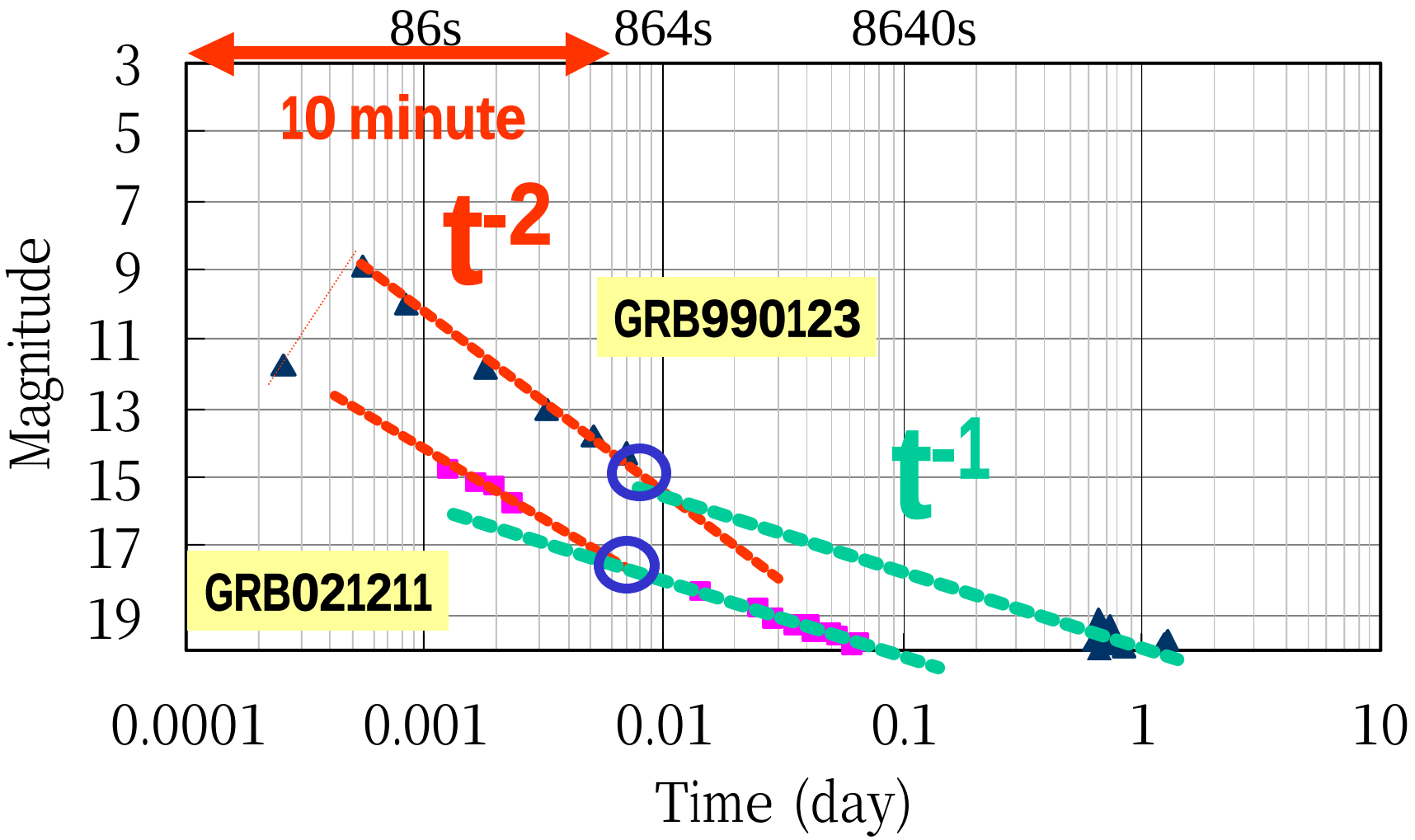
Optical Flush



$$\Gamma \sim 120\, E_{52}^{-1/8}\, n^{1/8}\, (t_{rs}/1\mathrm{min})^{-3/8}$$ (Sari& Piran 1999)

F_{rs}/F_{fs} , t_{rs}/t_{fs} ➔ B_r/B_f (Zhang et al. 2003)

Observed GRB Optical Flash



To Survey of GRB Optical Flash

Requirement

Regular, Continuous Monitor

Wide field view
(more than 1 stellar-radian)

Deep field (9 mag.>)

Present Status

Fireball network

Meteor
(Automatic Observation)

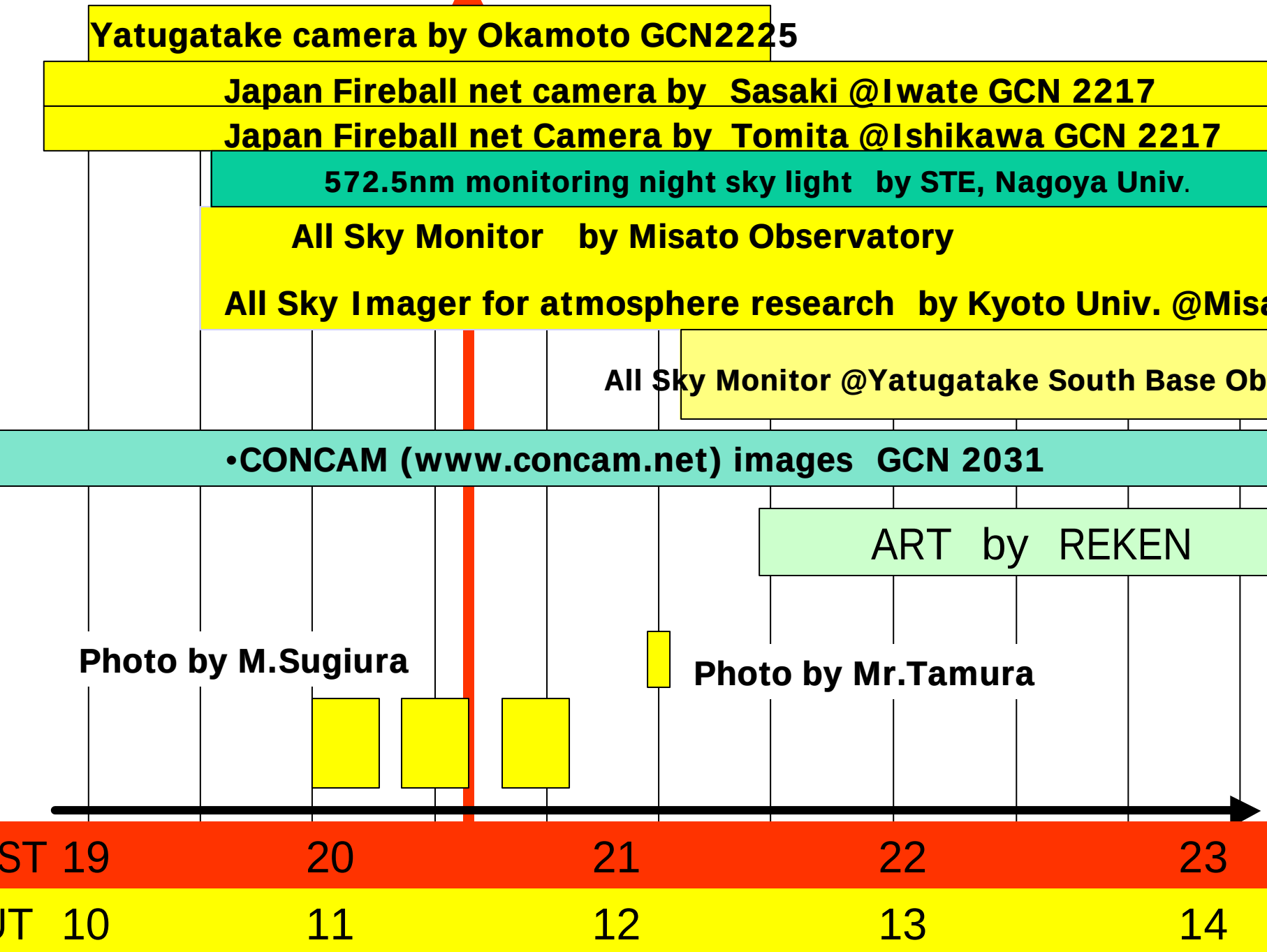
Variable star
Search

A)To make a exclusive system
B)To use other purpose (monitor) data

Trial study of GRB030329 to search for Optical Flash(OF) from "other monitor"

Day (2003)

3/29	• Appearance of GRB , follow-up observation of GRB afterglow.
3/31	• K. Torii asked me for to call for GRB data from meteor observers.
4/2	•Call for observation data to meteor observer Mailing List, fireball network, and the other amateur networks by K. Ohnishi
4/3	• **Observation Report of the video observation at Yatugatake by Y.Okamoto**
	• Appear in Astro-Arts HP about "Calling for GRB observation data"
	• **Observation Report by Masayuki Tomita (Japan Fireball network)**
	• **Observation Report by S.Toyomasu at Misato Obs.**
4/5	• **Observation Report by I Sasaki (Japan Fireball network)**
4/15	• **Observation Report by A.Hashimoto at Nankai Obs.**
4/18	• Appear in a ASAHI newspaper about "Calling for observation data".
4/24	• **Observation Report by K.Kushida at South Yatugatake Obs.**
5/2	• Appear in Astro-Arts HP about "Calling for GRB observation data"
	• Appear in Tenmon-Guide about "Calling for GRB observation data"
5/8	• Report the OF limiting magnitude from fireball network data on GCN Cire. 2217
5/12	• Report the OF limiting magnitude from video data on the GCN Circ 2225
5/31	• Appear the review paper of GRB by K.Ohnishi in Gakkan Tenmon
6/1	• **Observation Report of Photo just after GRB by Masato Sugiura**


Yatugatake camera by Okamoto GCN2225
Japan Fireball net camera by Sasaki @Iwate GCN 2217
Japan Fireball net Camera by Tomita @Ishikawa GCN 2217
572.5nm monitoring night sky light by STE, Nagoya Univ.
All Sky Monitor by Misato Observatory
All Sky Imager for atmosphere research by Kyoto Univ. @Misa
All Sky Monitor @Yatugatake South Base Ob
•CONCAM (www.concam.net) images GCN 2031
ART by REKEN
Photo by M.Sugiura
Photo by Mr.Tamura
ST 19
20
21
22
23
UT 10
11
12
13
14


All Sky Monitor at Misato Observatory
2003.03.2
20:38 JST

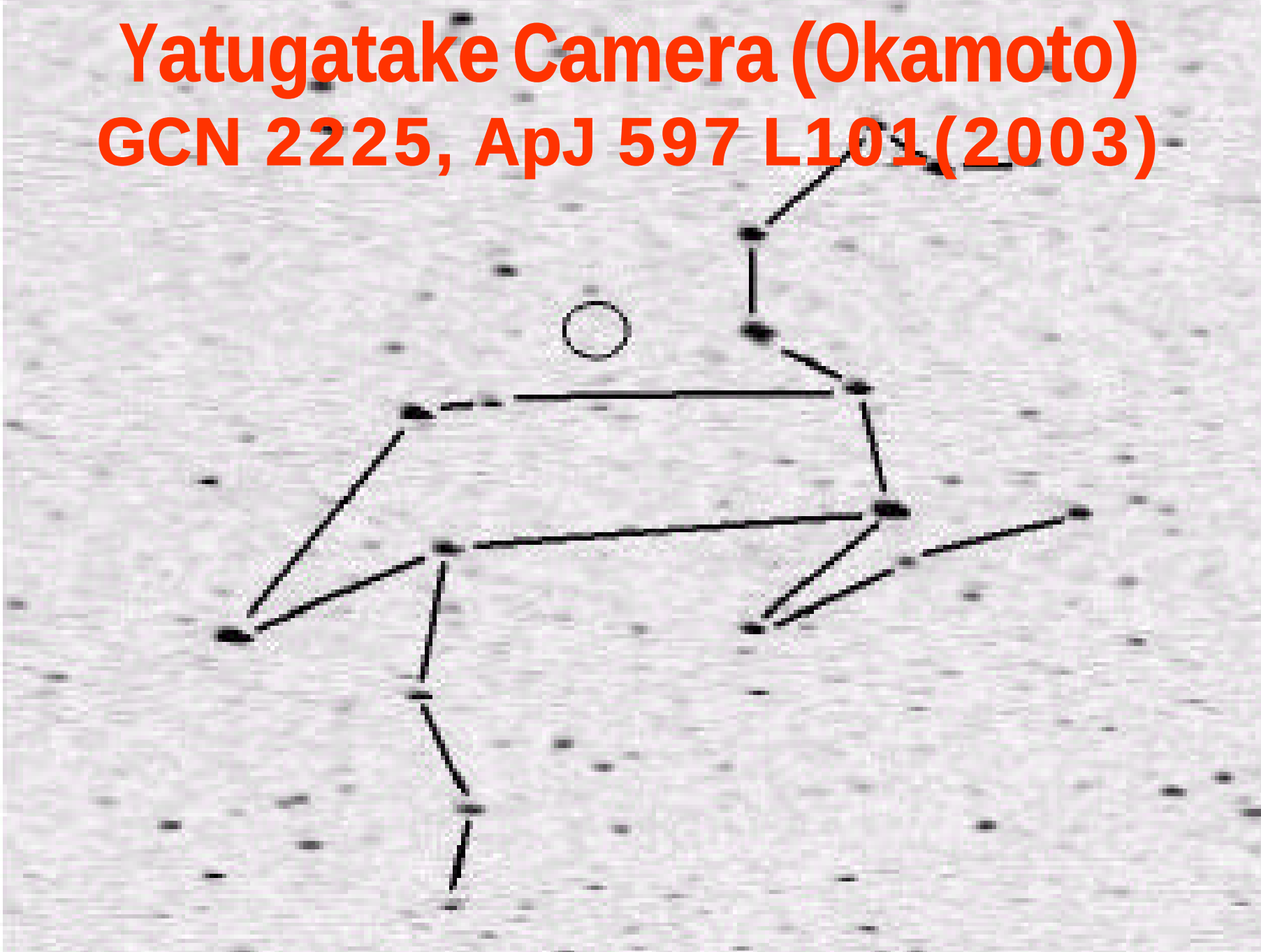
Fireball Network (Tomita@Ishikawa)

GCN 2217

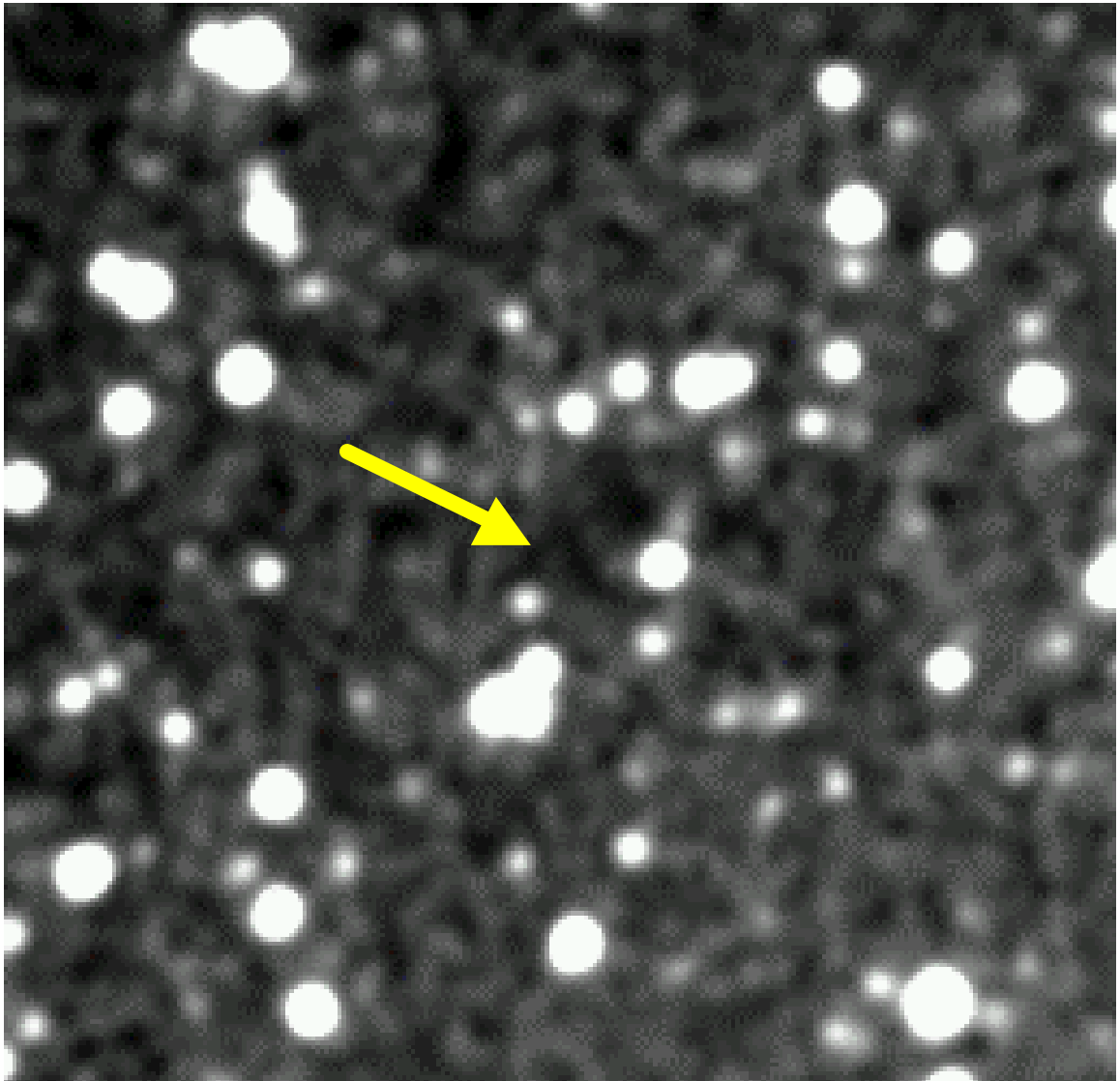

Fireball Network
(Sasaki @Iwate) GCN 2217

Yatugatake Camera (Okamoto)

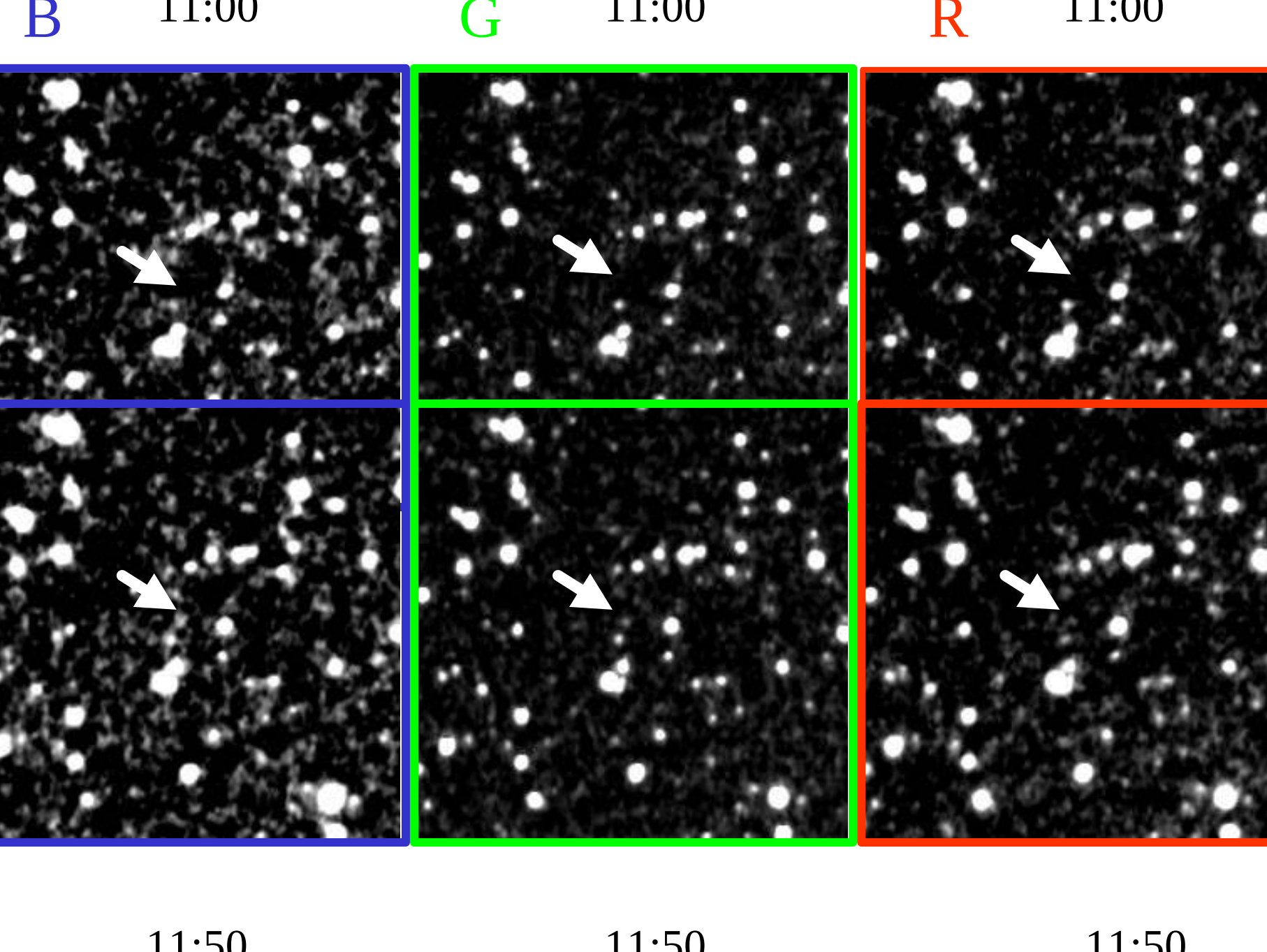
GCN 2225, ApJ 597 L101(2003)



Photograph before and after burst (by M. Sugiura)



1)20:00
2)20:50
15min exposure
Pentax 67、
55mm F=4


B
11:00
G
11:00
R
11:00
11:50
11:50
11:50

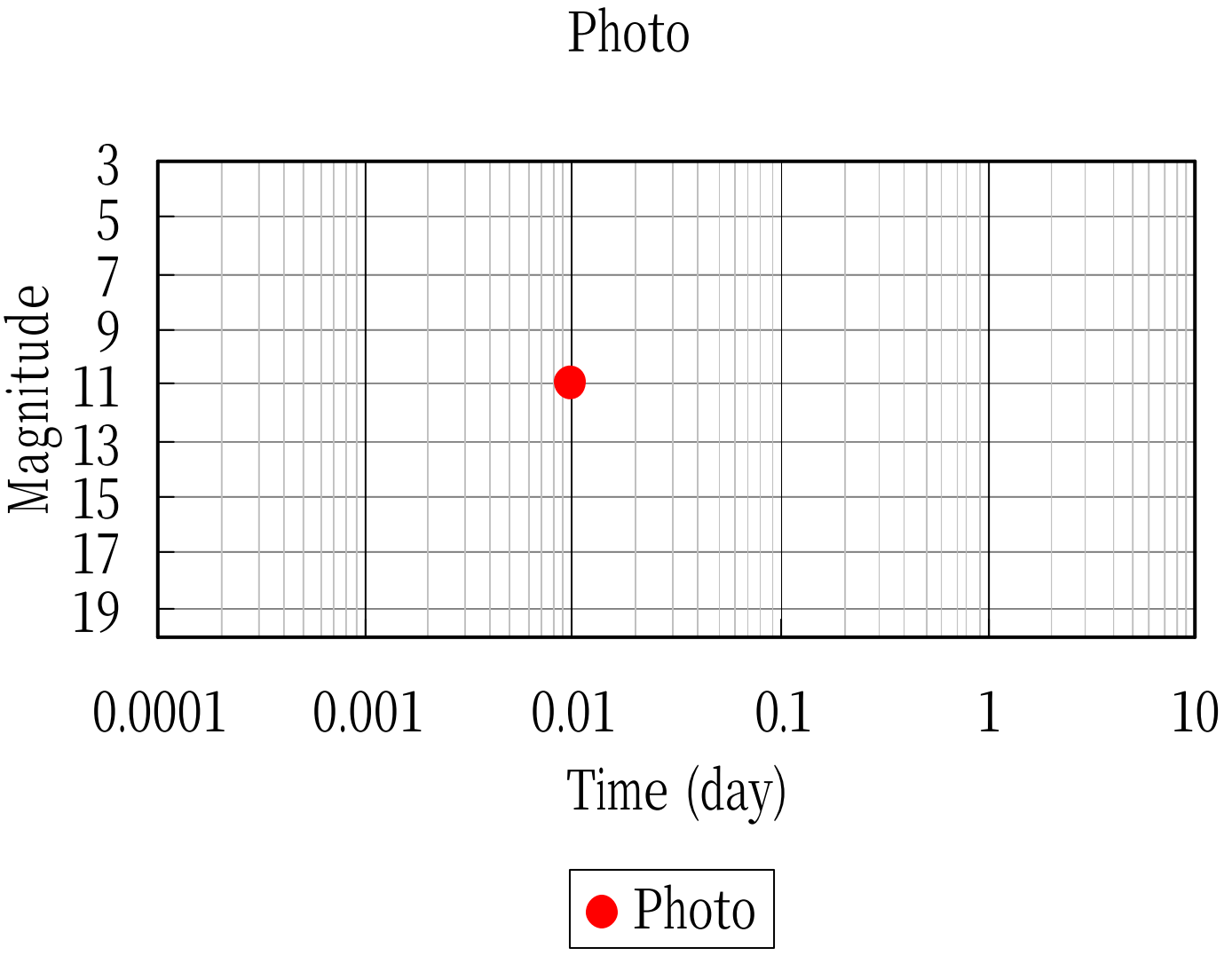
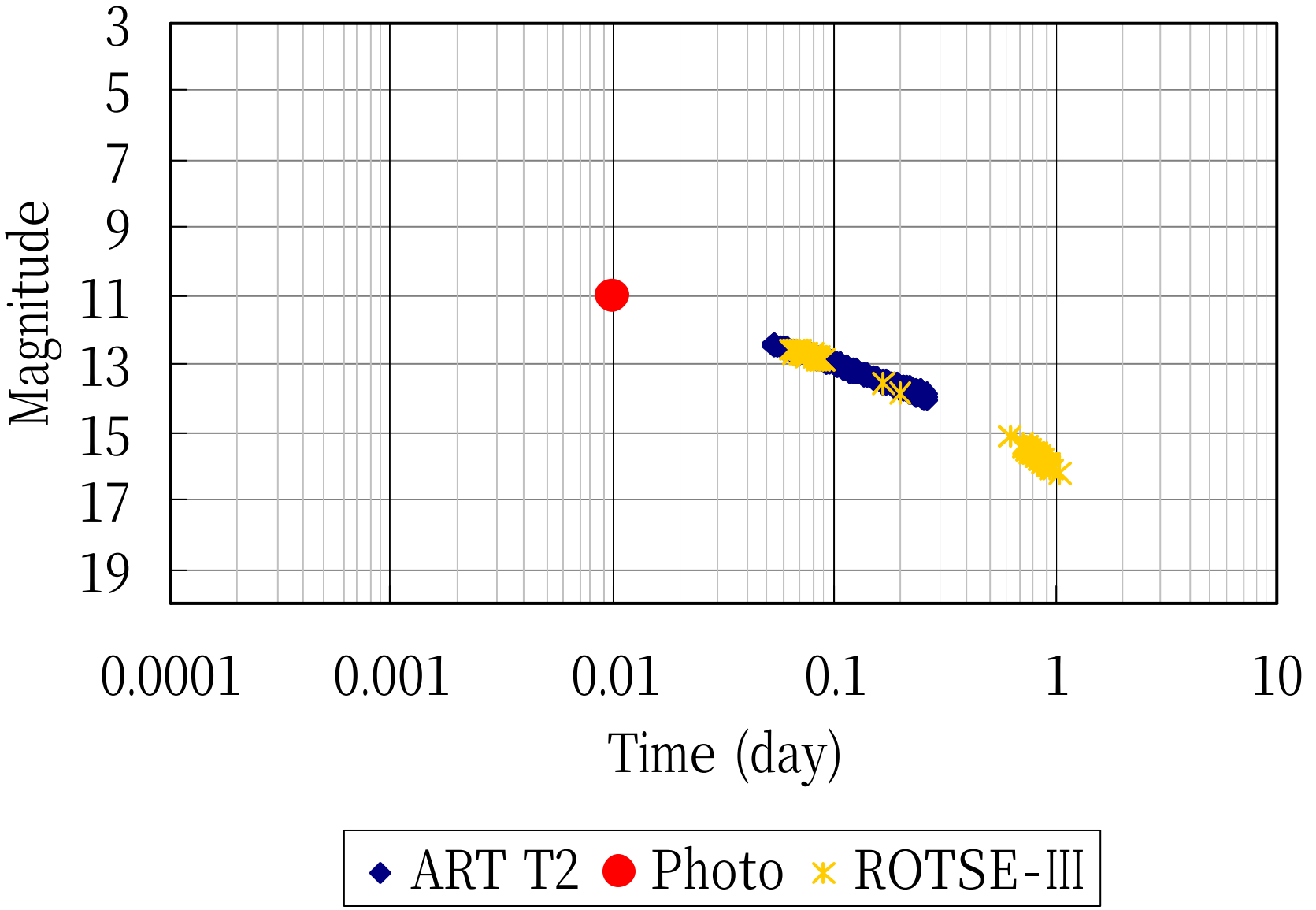
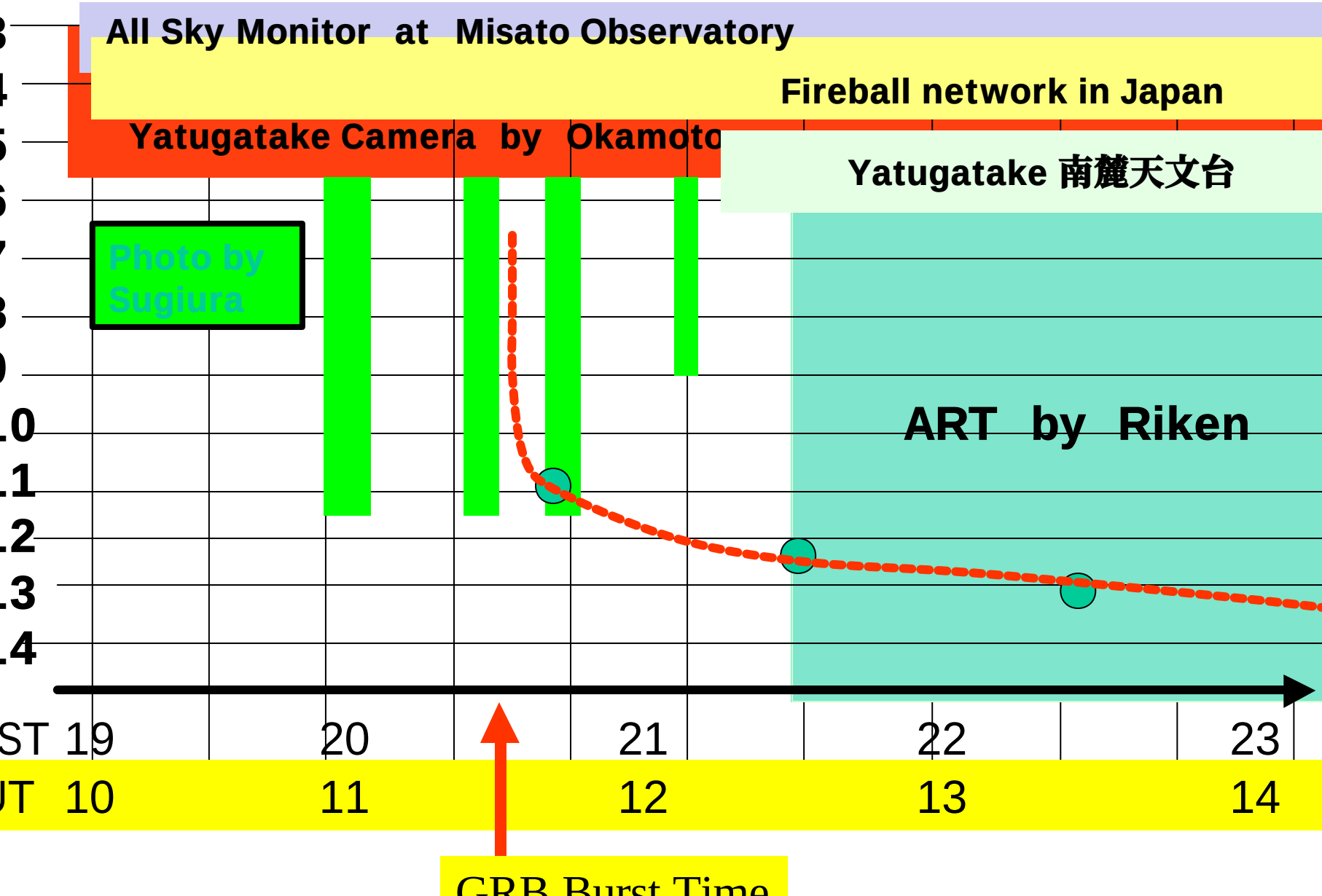


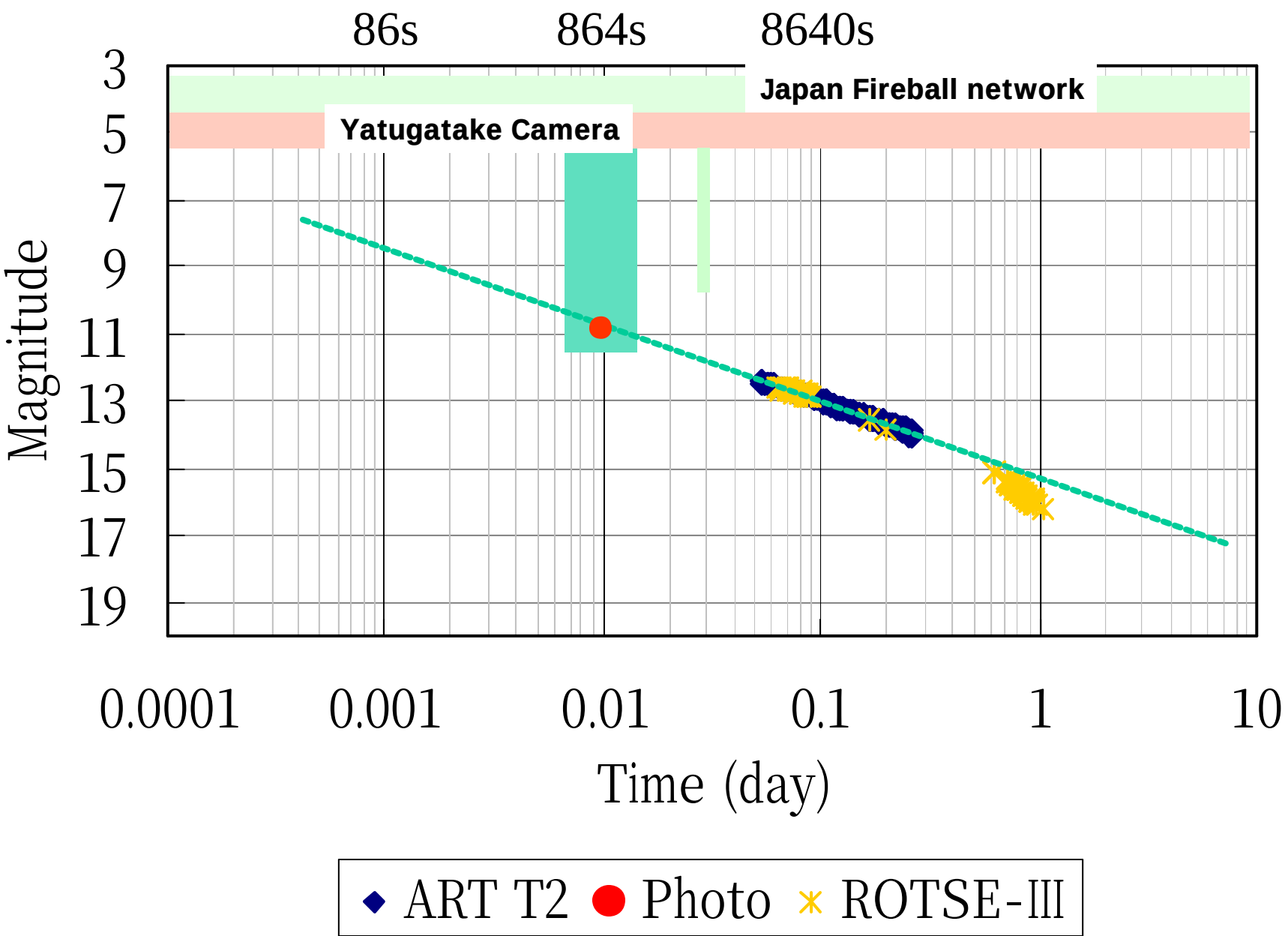
Photo
Magnitude
3
5
7
9
11
13
15
17
19
0.0001
0.001
0.01
0.1
1
10
Time (day)
Photo


Magnitude
3
5
7
9
11
13
15
17
19
0.0001
0.001
0.01
0.1
1
10
Time (day)
ART T2
Photo
ROTSE-III

Limiting in Magnitude of Monitor Observation in Japan



GRB030329 , Observed magnitude

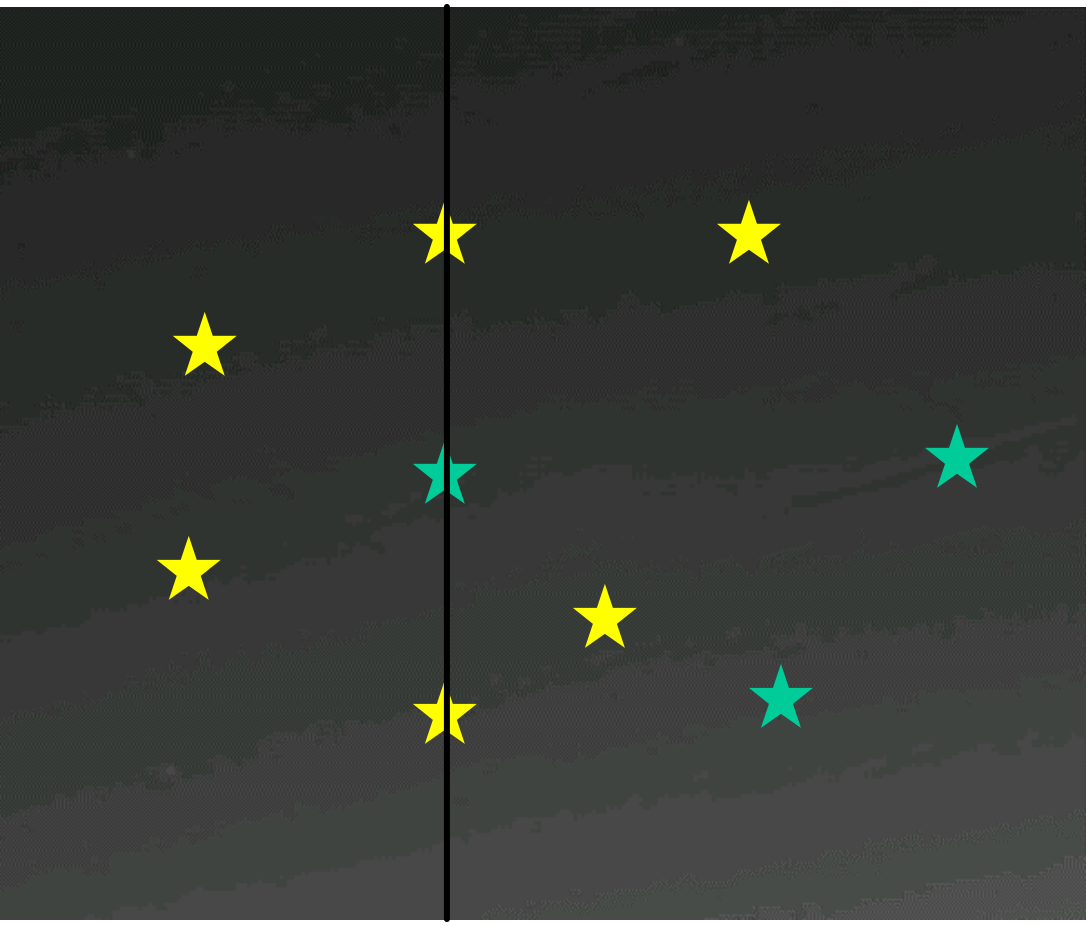


ビデオデータの解析
GRB030329の例

- ビデオデータの解析手法は確立されていない。
- オリジナルデータのキャプチャーでは、限界等級が4.5等星(@ GRB030329 by 八ヶ岳カメラ)
- “うまい”Flat & Darkを作ることで、
  限界等級が2-3等星深くなった。
- ➔ **No Optical Flush！**

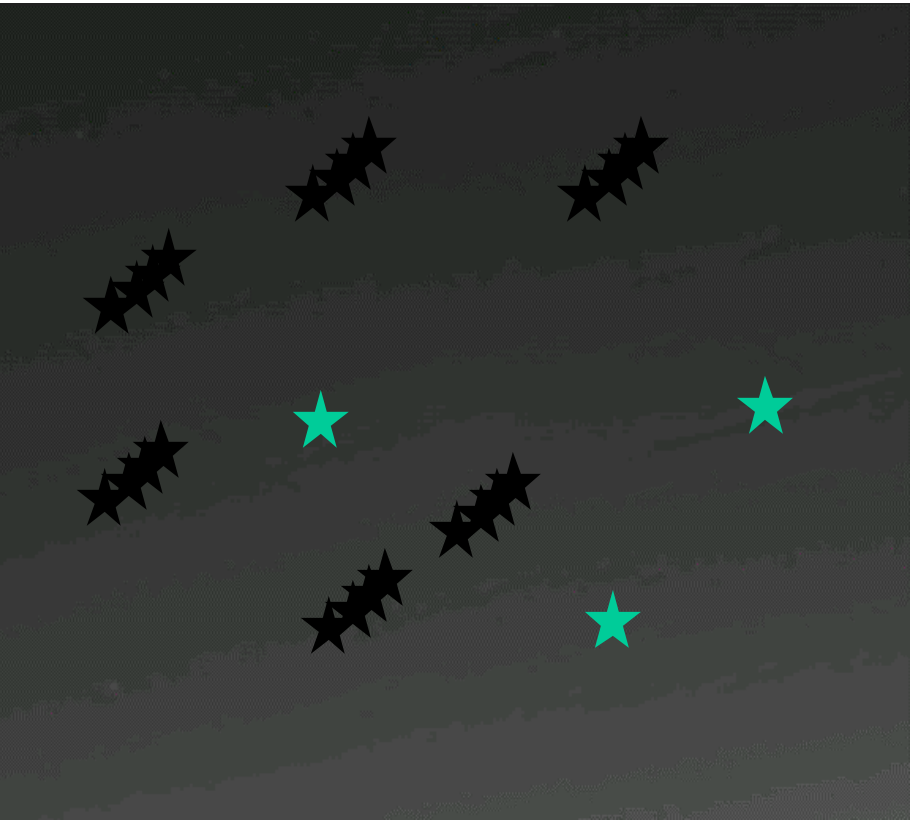

03-03-29 SAT
20:35:42

Bad Pixelと露光ムラ



★:Bad Pixel　★:天体

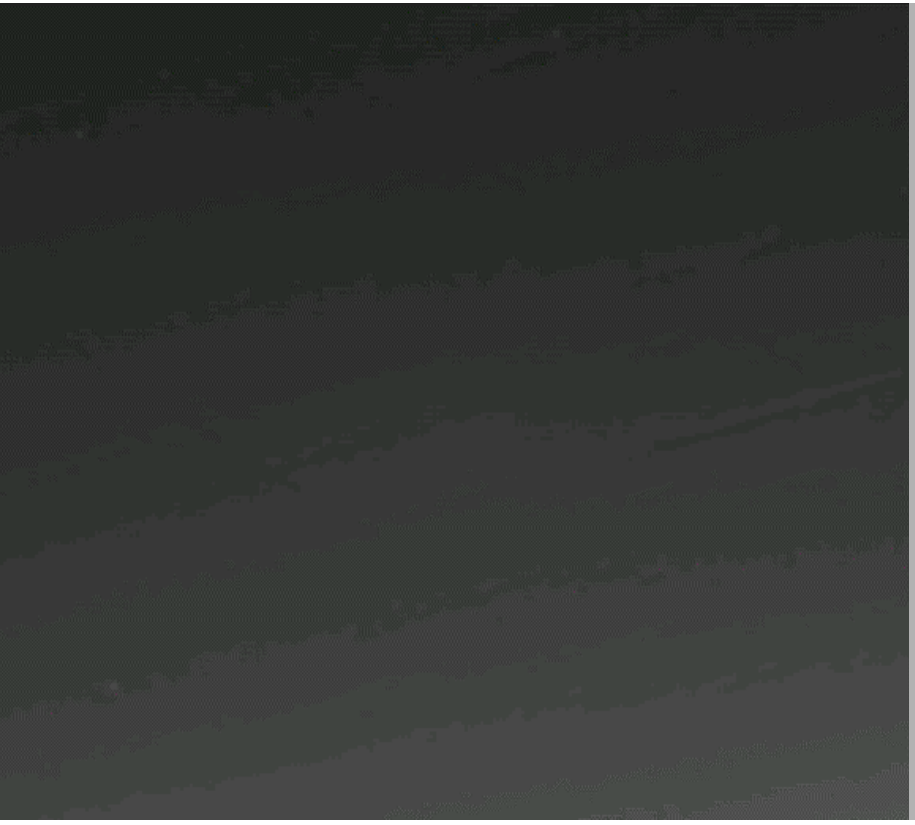
混合フレーム作成

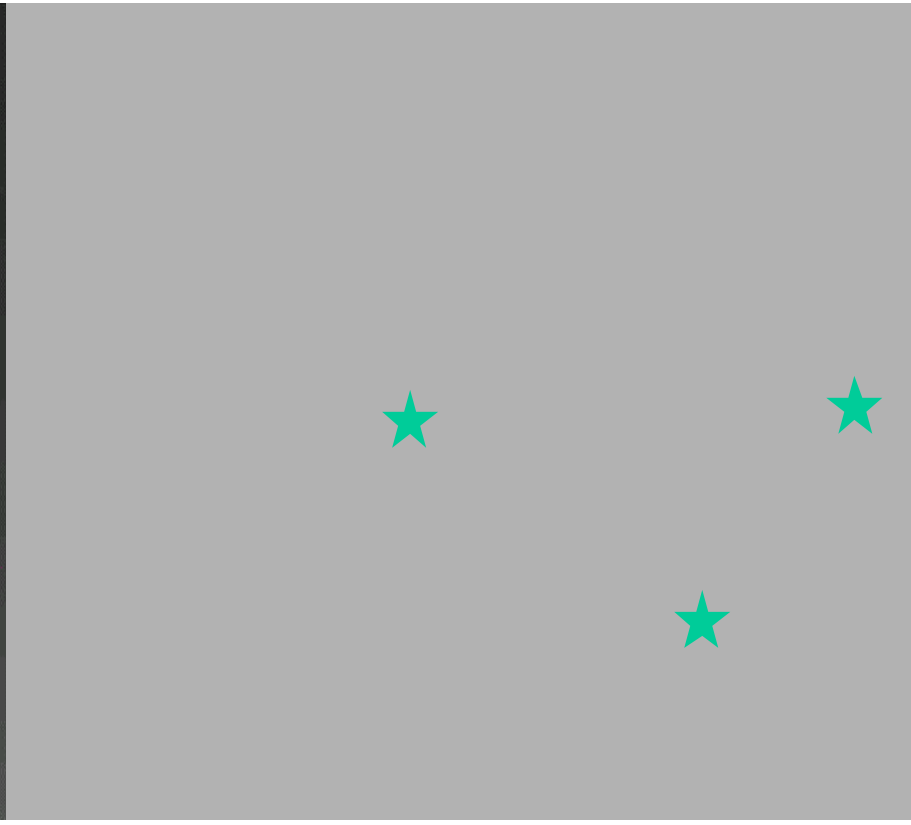


多フレームを平均
星の軌跡が含まれてしまう

各PIXELごとにLPFを通し平均
星の軌跡が含まれない

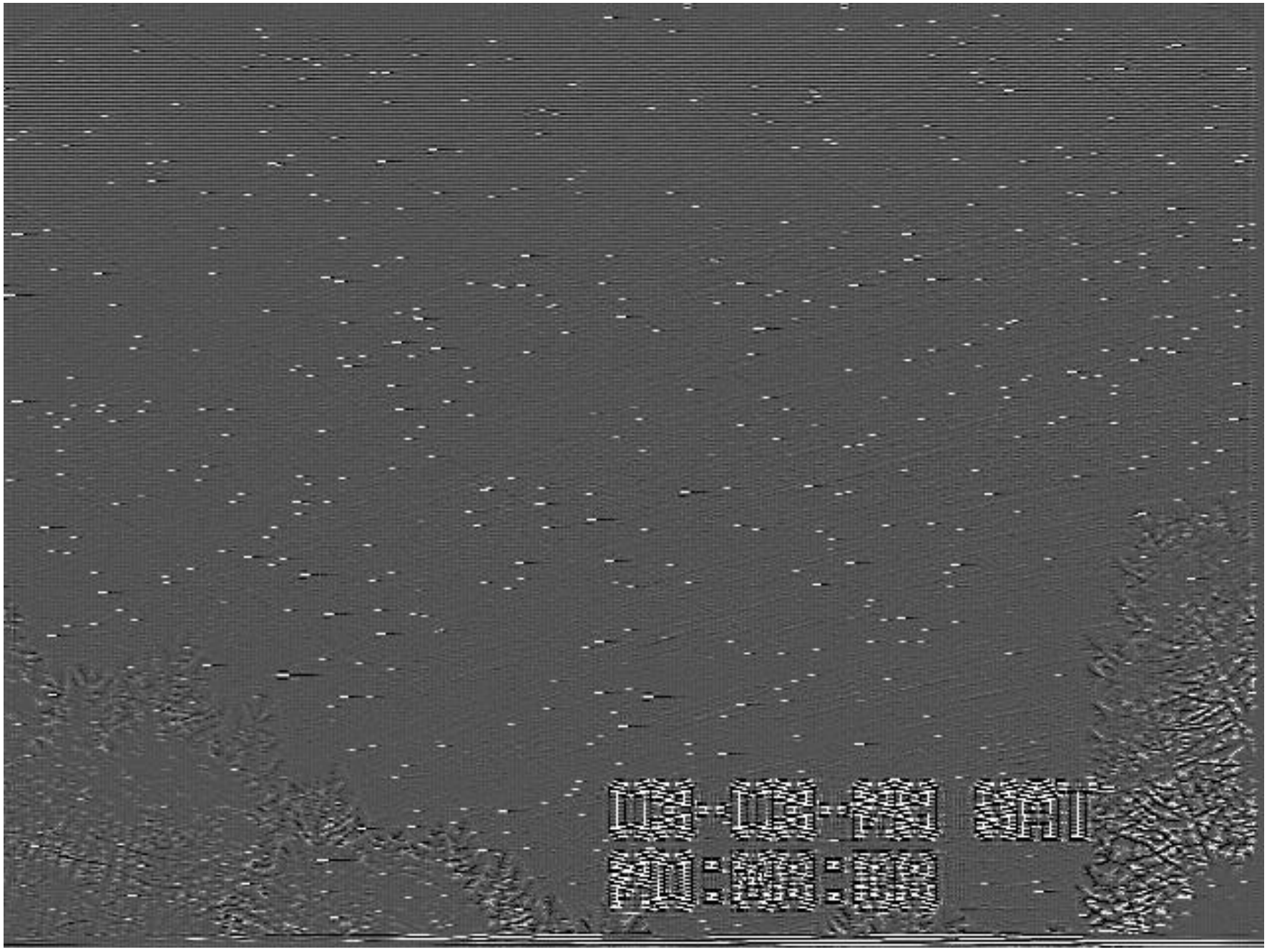
ダーク、フラットの分離





混合フレームにメディアン
フラットフレーム

混合－フラット
ダークフレーム




03-03-29 SAT
20:38:38

スタック

キャプチャー

↓

ダーク、フラット作成

↓

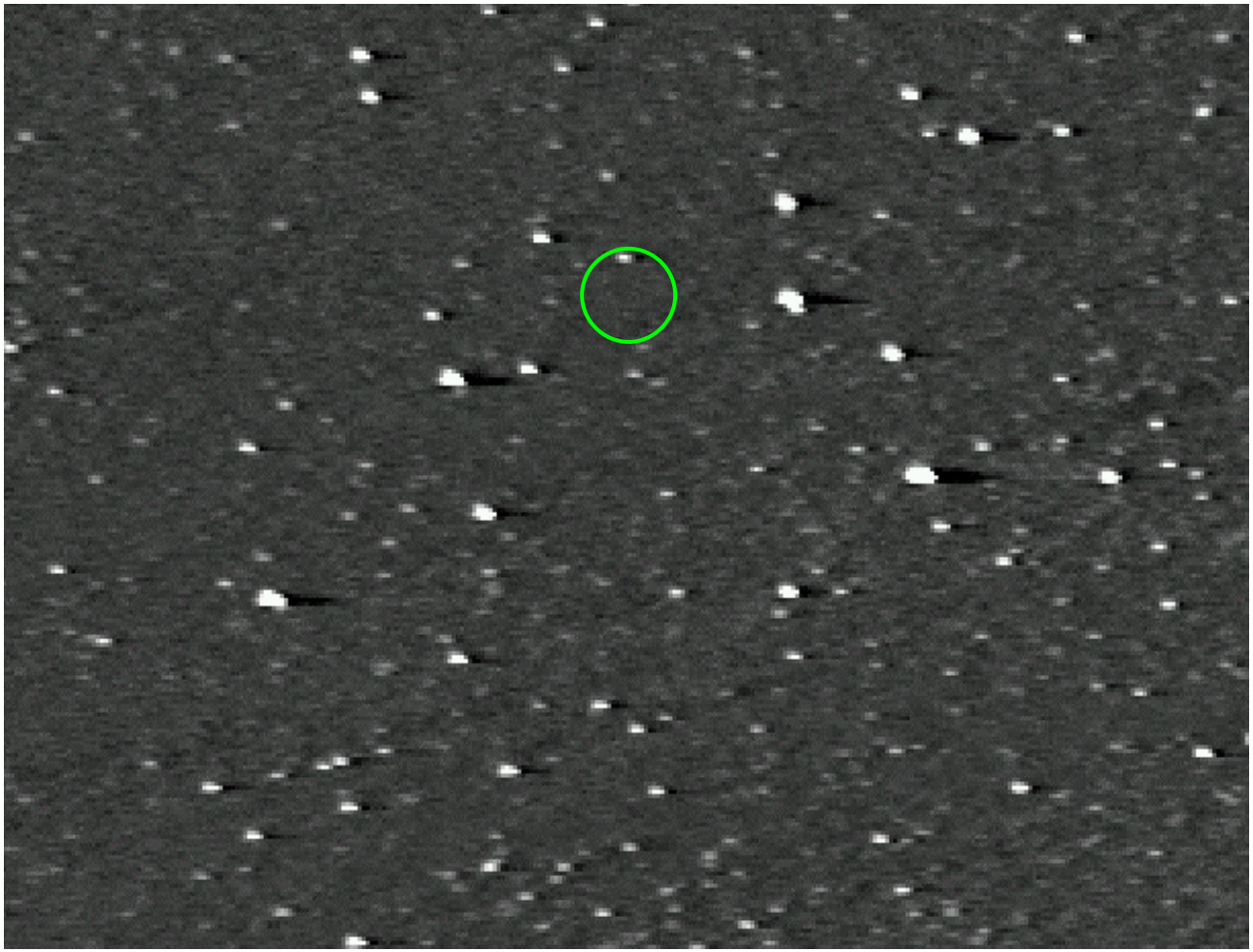
ダーク処理

↓

フラット処理

↓

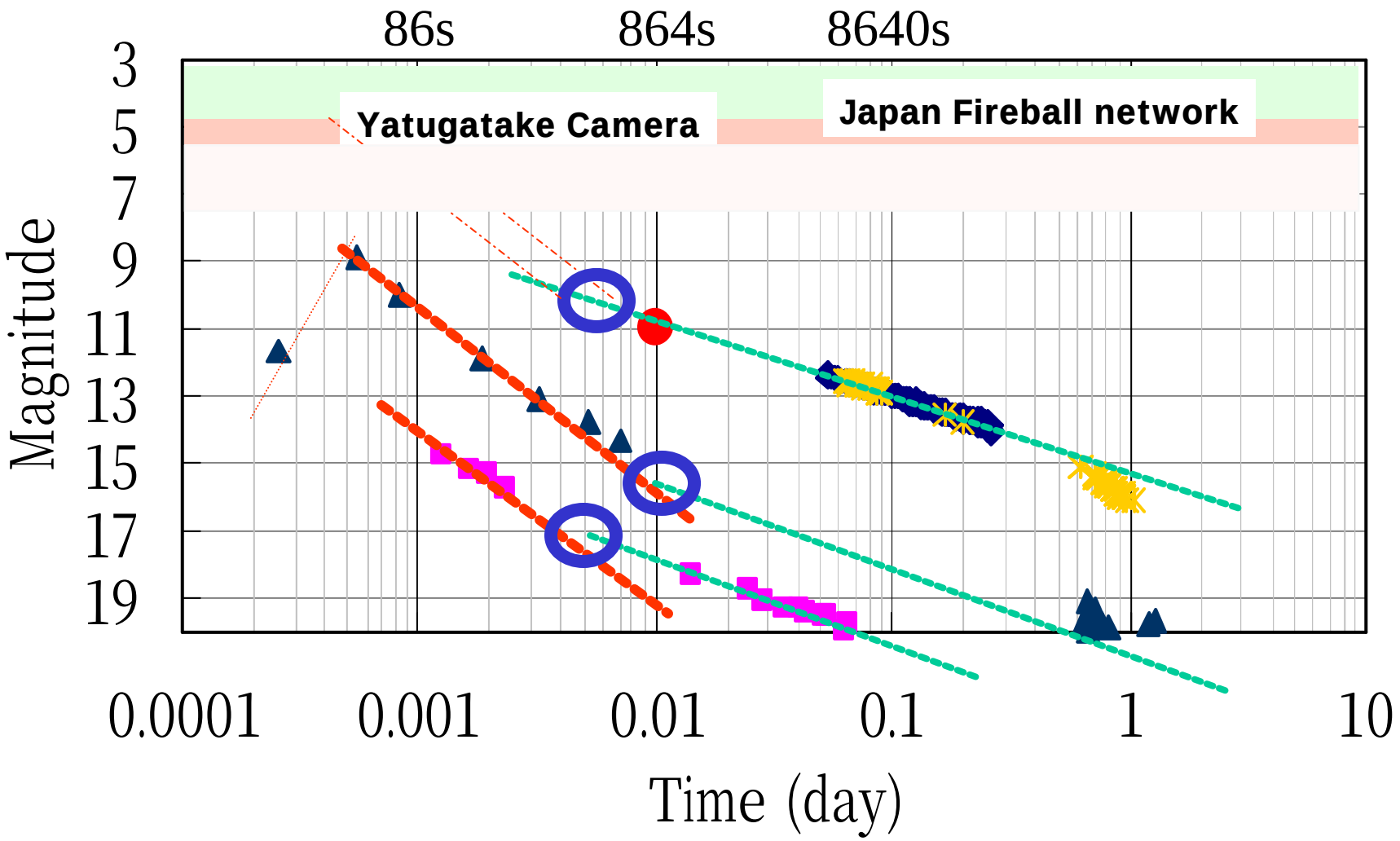
位置合せ、スタック



スタック40フレーム

今回開発した解析　　限界等級 7～ 8等

GRB030329 No Optical Flash

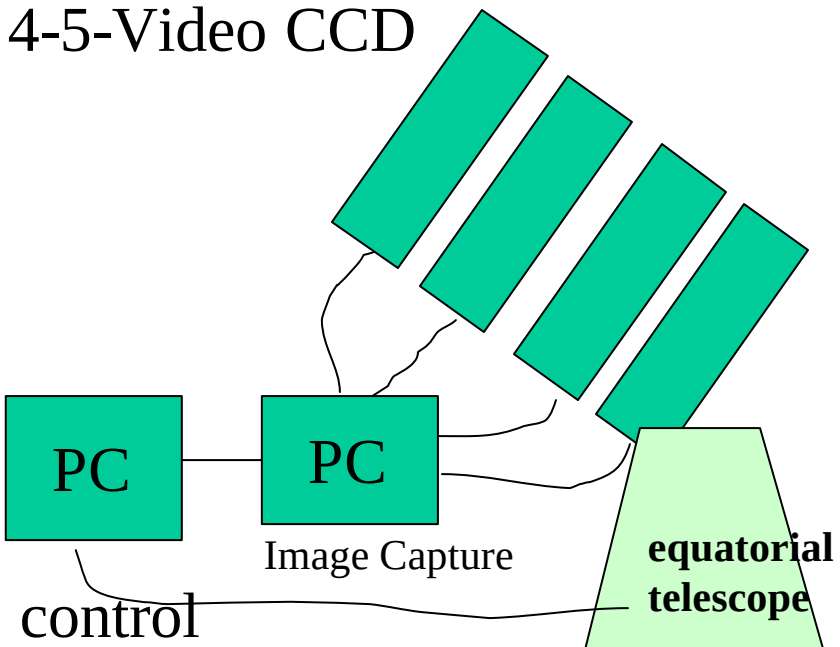


TOTO System

- **TOTO**

(Television Observation of Transient Object)

利点 :安い（100万程度-）、簡単、高時間分解能（1秒程度）
欠点 :測光精度が悪い(8Bit)



50 degree* 50 degree
Limiting mag. 7-8mag （1sec Integral）

10 degree*10 degree
Limiting mag. 11mag （1sec Integral）
➔High Time Resolution

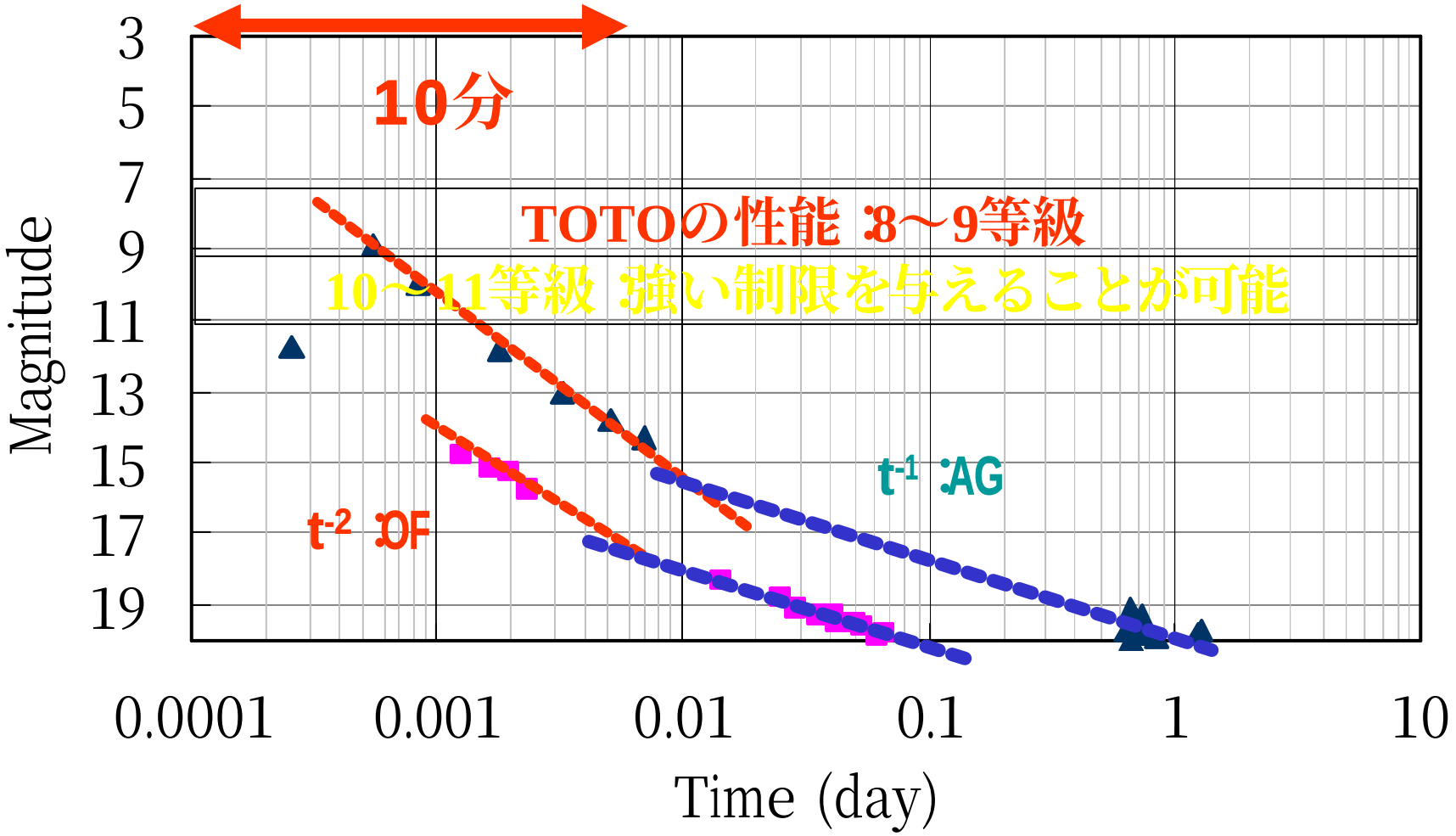
TOTO testbed-0
2-Video CCD 50 deg*50deg
Limiting mag. 8-9mag （1sec Integral

TOTO testbed-0

Camera
Watec N-100
Watec TGV-M *2

Lens
50mm F=1.4 (8 ° *8 °)
CBC 12mm F=0.8 (30 ° *30 °)
25mm F=0.95 (20*20)

TOTOの有効性


10分
TOTOの性能 :8～9等級
10～11等級 :強い制限を与えることが可能
t-1 :AG
t-2 :OF
Magnitude
3
5
7
9
11
13
15
17
19
0.0001
0.001
0.01
0.1
1
10
Time (day)
GRB 021211
GRB 990123

Conclusion

To Survey of Optical Flash of GRB 030329

from monitor data (meteor, fireball,atmosphere) and armature photograph.

Obtain the afterglow data of 15min. after burst!

- Science result :**No Optical Flash of GRB030329**
  Obtain Color (BGR) Data← to be analyzing
- Outreach result :

"First afterglow photograph" taken by armature

- Observational suggestion:

  the photograph (and video) data just after burst restrict hardly the existence of optical flash.

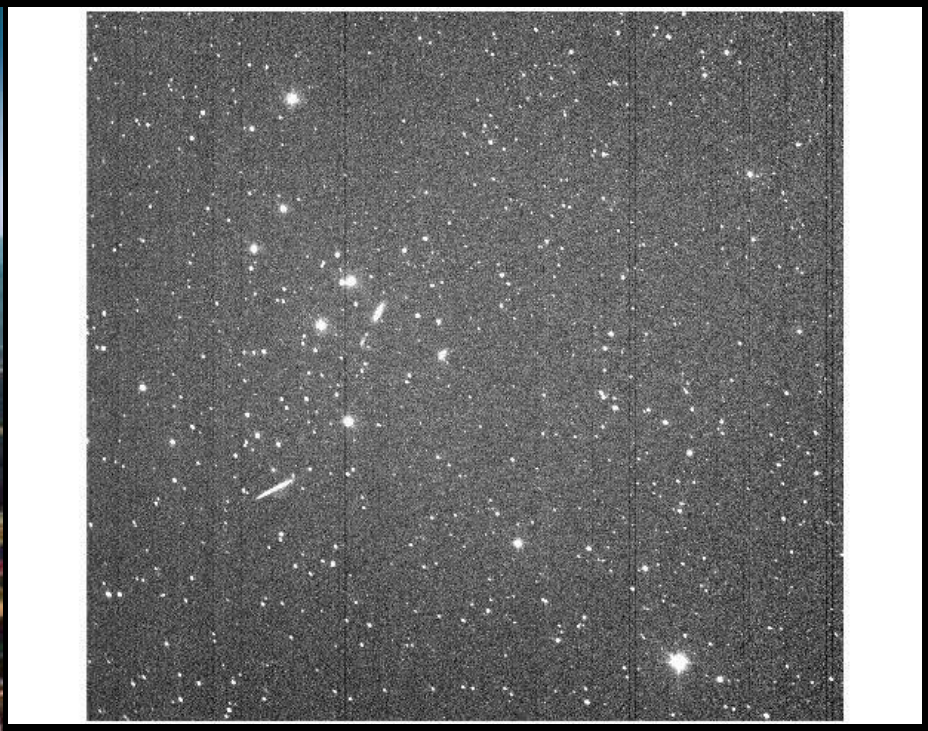
→TOTO investigate the existence of optical flash

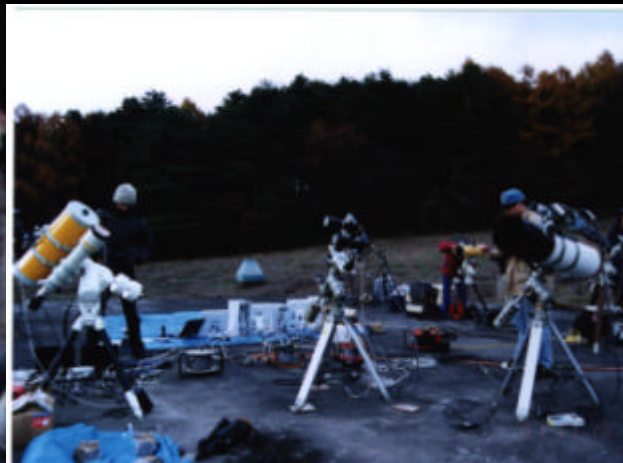
Comment

- HETE
- Swift →機上で光学観測可能➔光学残光の観測は機上でできる 紫外）
- しかし、**光学望遠鏡を向けるのに数分の時間➔光学閃光はTOTO**
- 残光観測は多波長 近赤外線）
- ガンマ線視野を随時変更➔Groundでの観測では方向を常に制御

- TOTO　　現在：
- 解析法の確立へ➔限界等級を2等星以上向上
- ビデオキャプチャーの遠隔操作
- Testbed-0 ビデオ2台＋ラプスビデ　(12mm2台・限界等級7-9等星）
- Testbed-1 ビデオ4台＋ラプスビデオ (25mm4台・限界等級8-10等星）
- TOTO　　近い将来：
- Testbad-2 ビデオ4台＋PC キャプチャー＋ネット制御 ➔ 明野観測所の理研or 東工大望遠鏡にビギーバックしたい

AKENO Observatory





“First afterglow photograph” taken by armature