

WIDGETのステータスと 突発天体探査

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&

WIDGET Team

WIDGET@夜天光

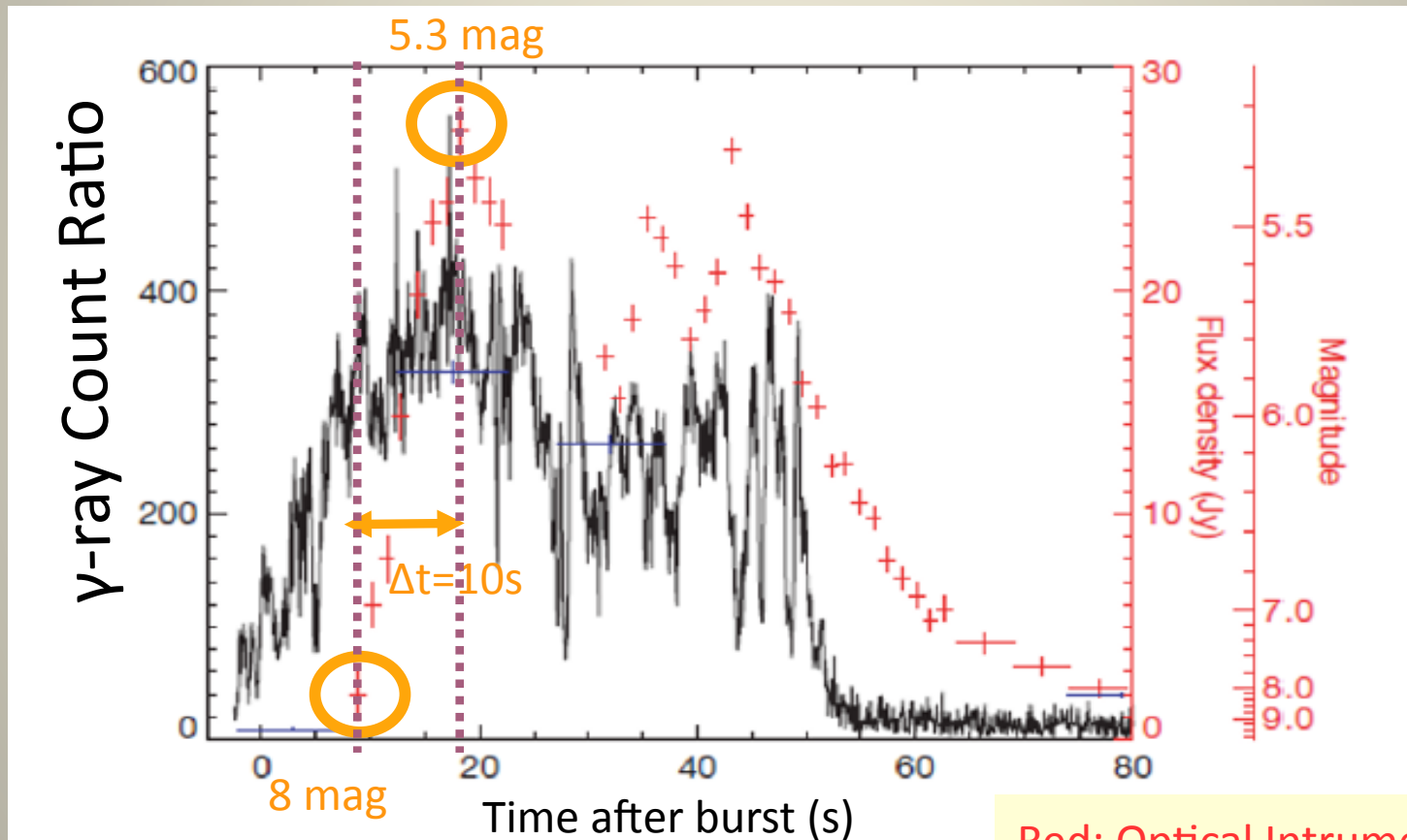
Instrumentation:

- CCD Camera: Apogee Alta U10
- Lens: Canon EOS EF50 F1.2
- Pixel size: $14\mu\text{m}$
- Image format: 2K*2K
- Field of View(total): $64^\circ \times 64^\circ$
- Mount: Takahashi NJP



WIDGETのねらい

Prompt GRB flash

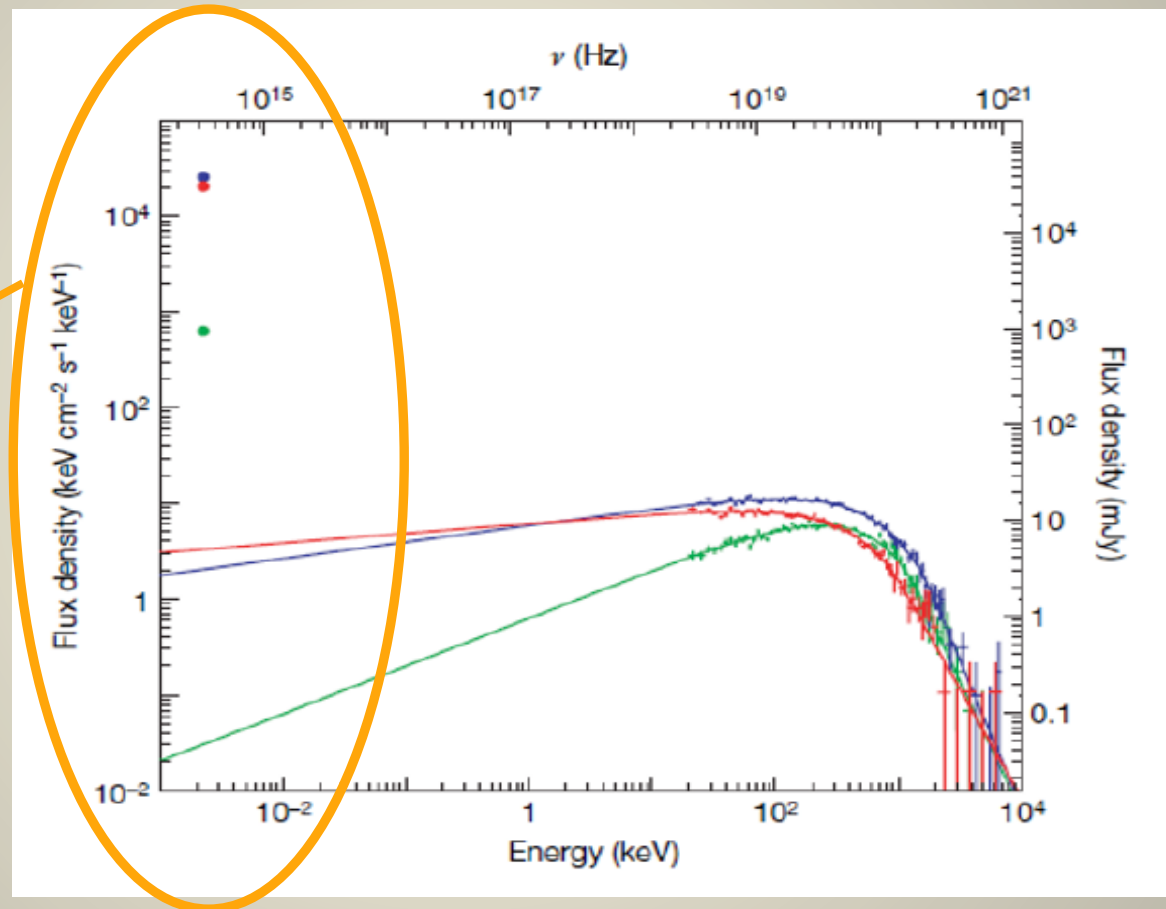


1. Peak brightness is 5.3 mag
2. 2.7 mag variation with the time interval 10s

Red: Optical Instrument
Black: γ-ray Satellite

WIDGETのねらい

GRB 080319B



10⁴ times larger than the extrapolation of the γ -ray spectrum

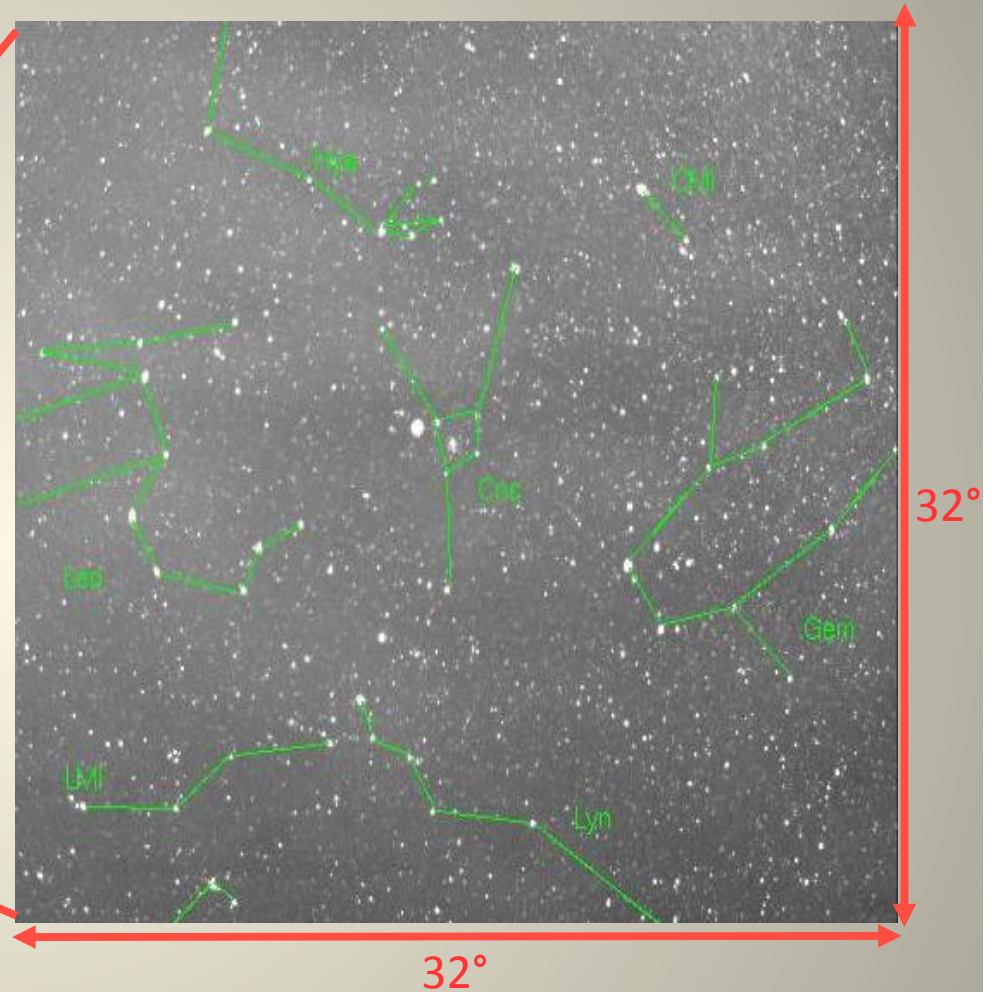
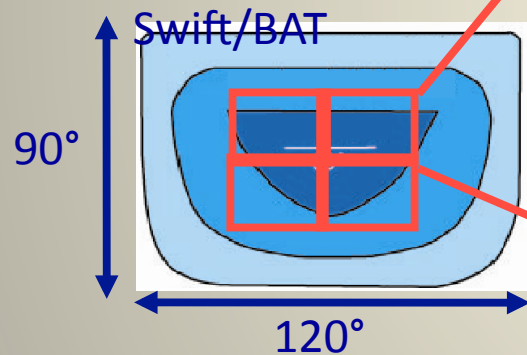
Flux density in 10s with 3 time interval at T0 + 3s, T0 + 17s and T0 + 32s.

→They are from the same physical region, but different spectral component

3. WIDGET Daily Operation

- Pointing Strategy:

- Swift/BAT FOV
- Zenith direction
- GRB originate



- Daily Operation:

- 1 frame/10s → exposure time: 5s, read-out time:5s
- Daily-check movie

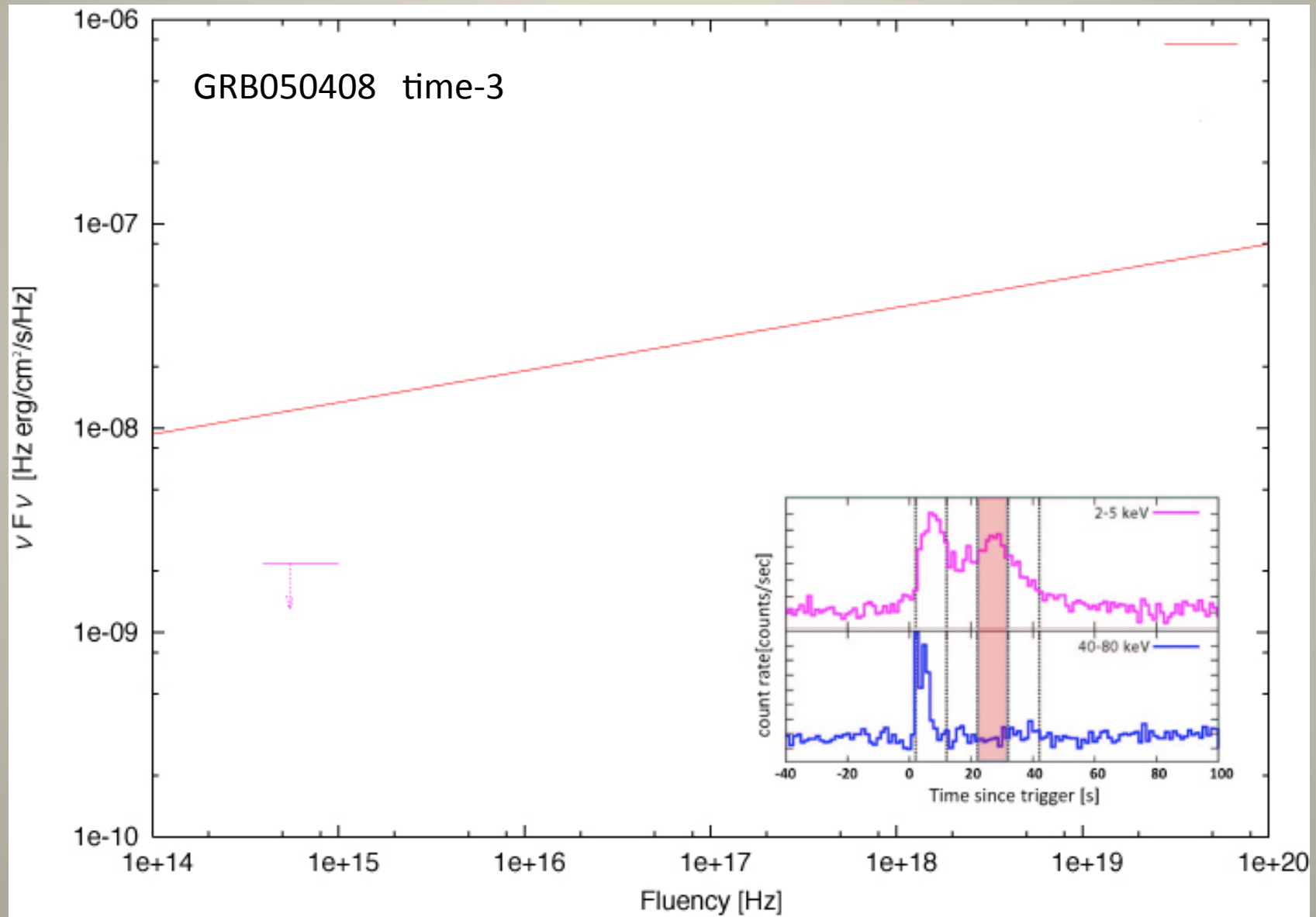
ステータス

- (1)カメラ1台で稼働中
- (2)システム開発とGRB観測をあわせて論文投稿
- (3)自動位置測定スクリプト完成
- (4)突発天体探査パイプライン完成
自動化スクリプトを作成中

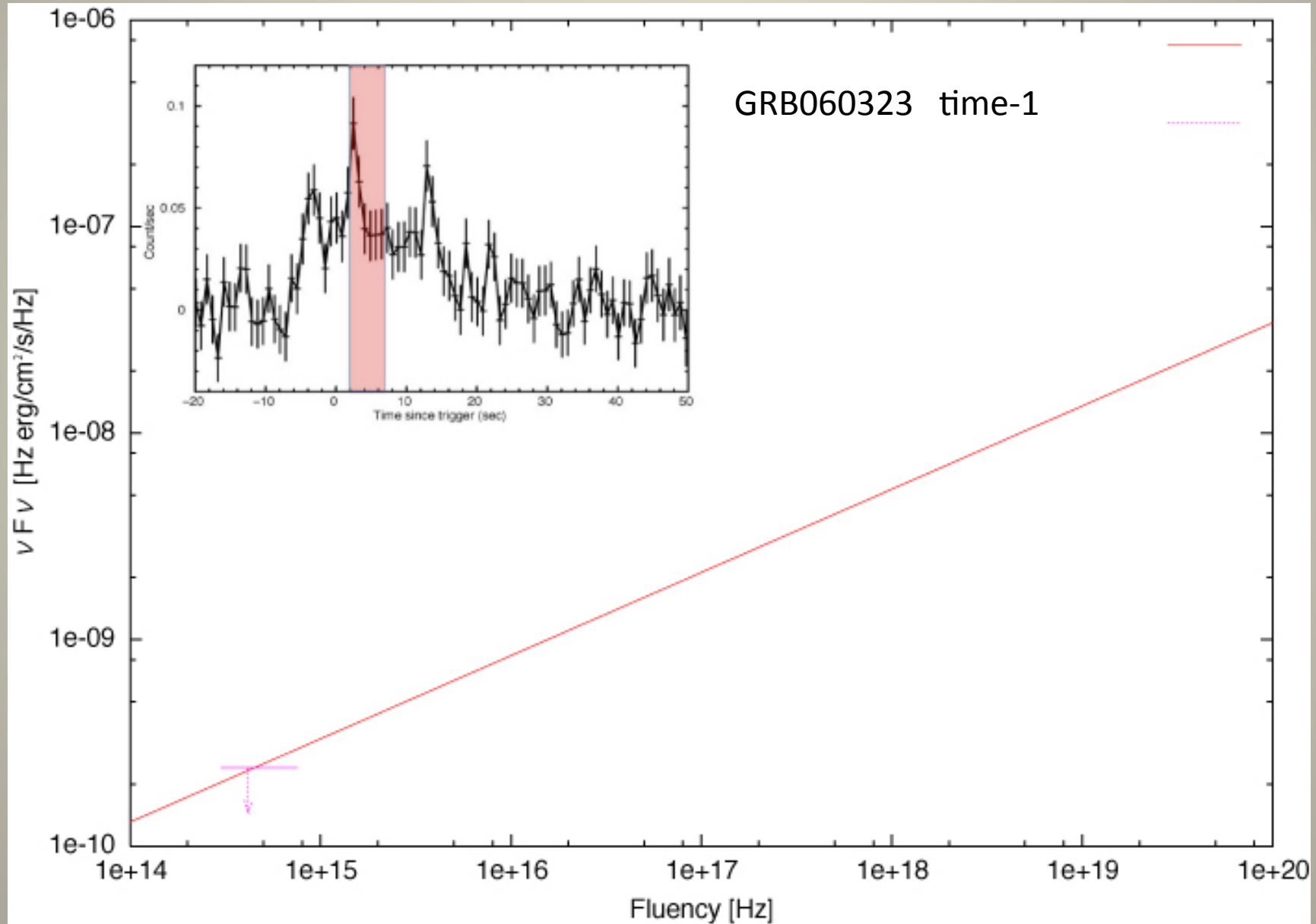
(2) システム開発とGRB観測

- 11 GRBsで γ 線と同期観測
- 11 GRBsでは明るい閃光無し
- γ 線に先行する可視光放射も無し
(Yamazaki 2009 predicted precursor)
- 2 GRBsの時間分割SEDで放射モデルに制限
同一のシンクロトロン放射+自己吸収

GRB:時間分割 10秒毎-SED①



GRB:時間分割 10秒毎-SED②

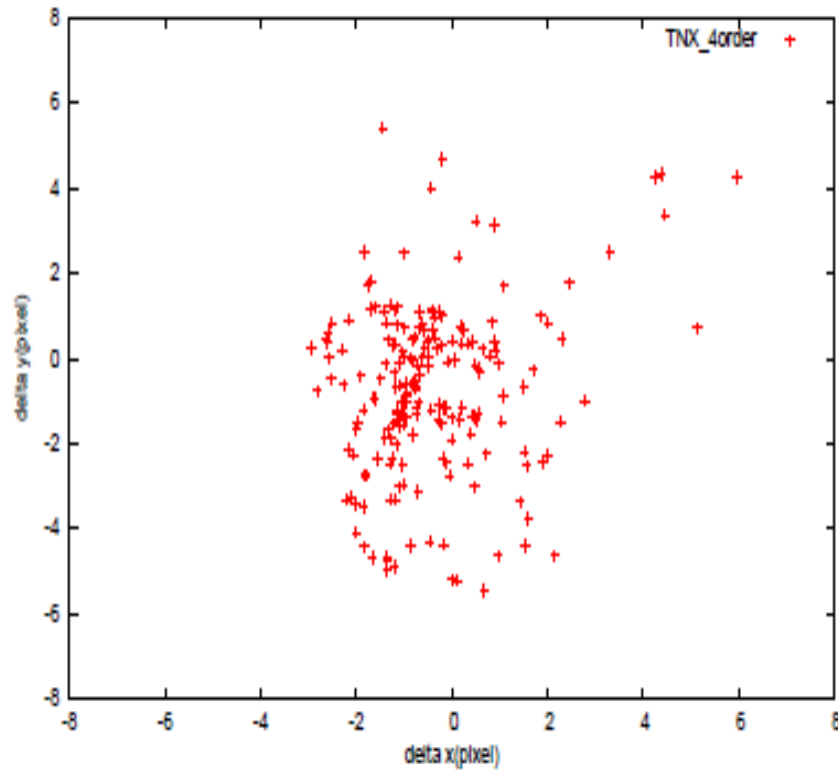


(3) 自動位置測定(distortion補正込み)

画像全面(32°x32°)にたいして、自動的に位置測定

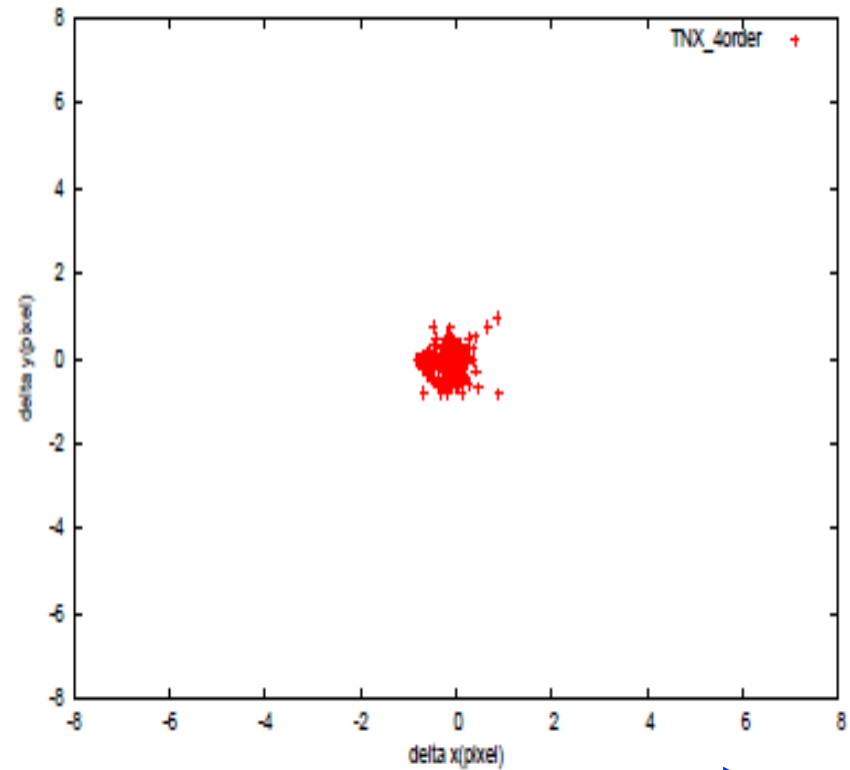
(2) Rough Astrometry

TNX function in imwcs 4 order



(4) Accurate astrometry

TNX function in IRAF 4 order



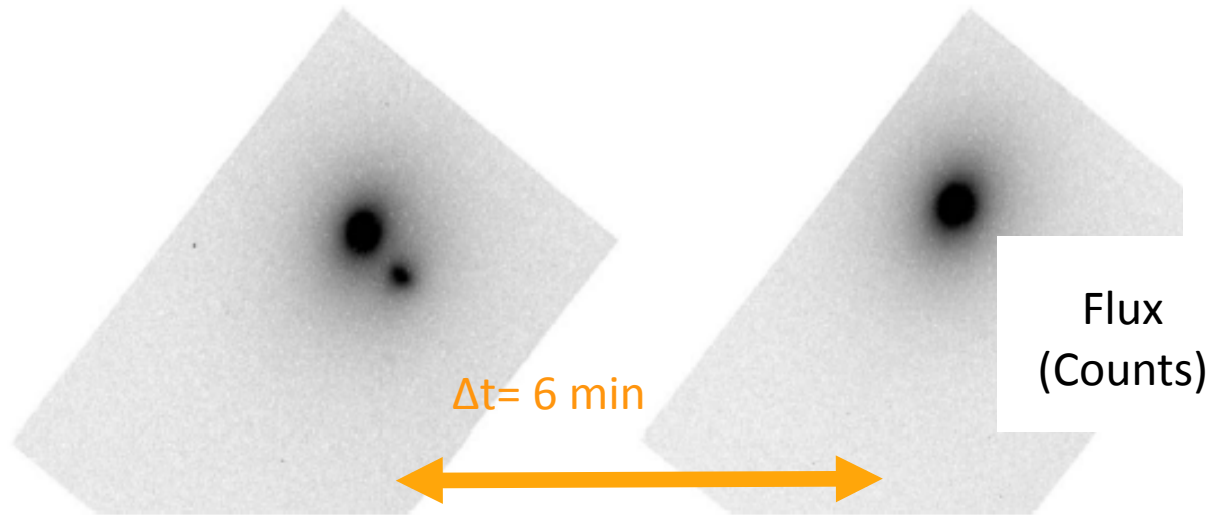
Δx [pixel]

(4) 突発天体探査

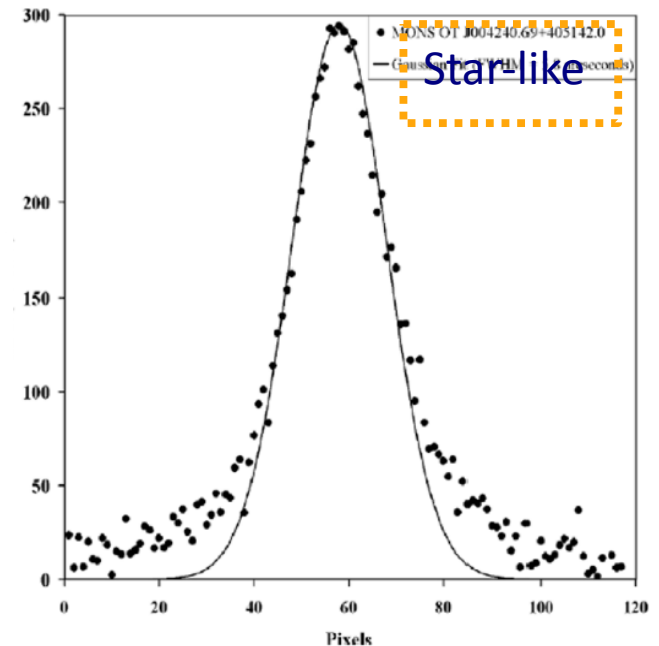
- 目的: 激しく短い変動の突発天体の探査
(e.g. 10秒間で1~2等級の変動)

全く新しい未知の天体の可能性大

MONS OT J004240.69+405142.0

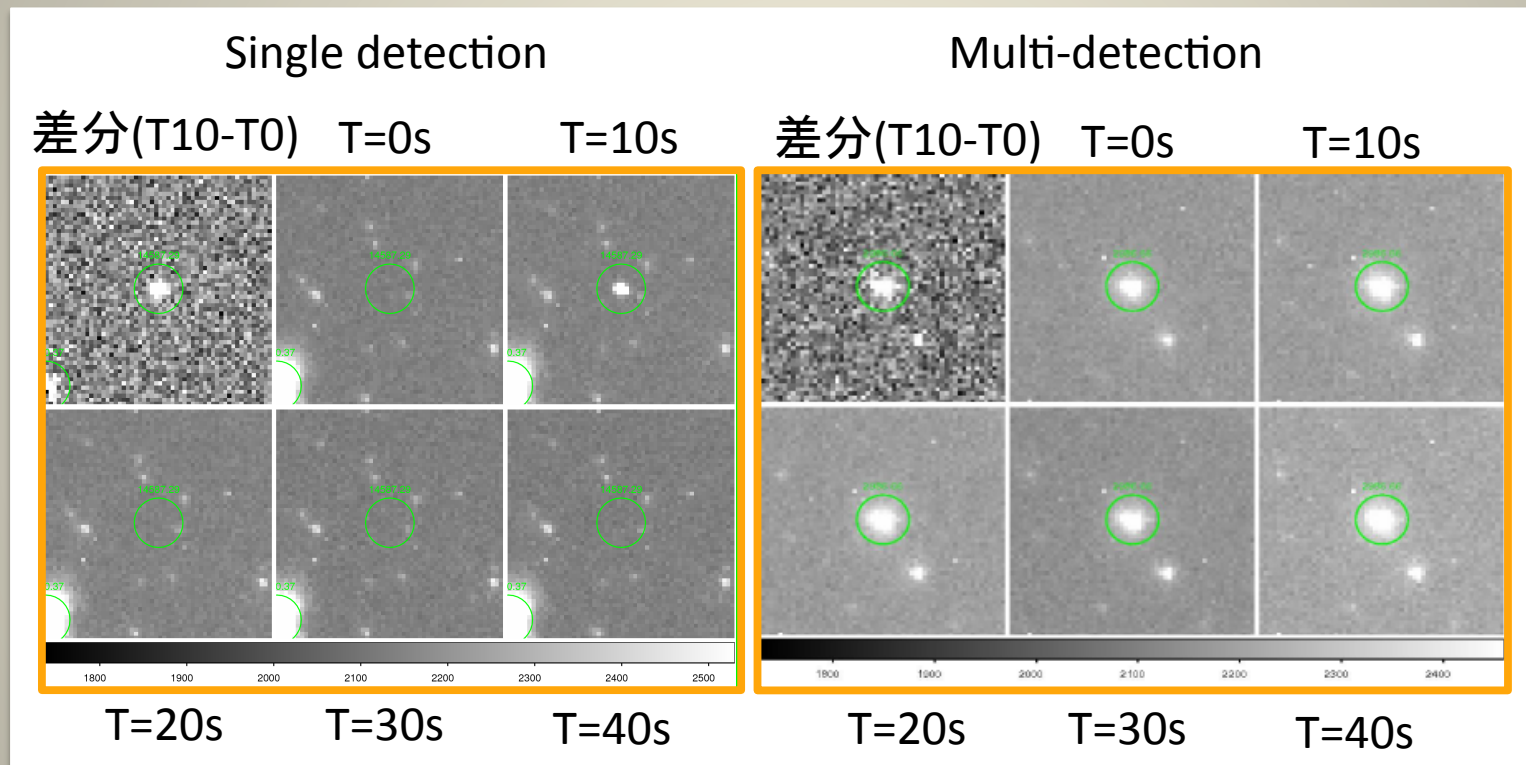


Marcos et al., 2009



(4) 突発天体探査パイプライン

- 単純な画像引き算 (Under sampling)



- ノイズ落とし (5つのフィルター)

(4) 突発天体探査パイプライン

- 単純な画像引き算 (Under sampling)

Year/Month	Frame No.	Total Detection
2009/01	755	4671
2009/02	3033	13904
2009/03	2985	24676
2009/06	2049	11247
2009/07	2374	6499
2009/12	2099	34403
all	13295	95400

多くは、明るい星のフラクチュエーション、移動天体など

- ノイズ落とし (5つのフィルター)

(4)ノイズ落とし

- (1) Count value filtering (差分画像にたいして)
- (2) Number detection filtering (5フレーム)
- (3) Elongation filtering (元画像にたいして)
- (4) Flux filtering (元画像にたいして)
- (5) Light curve checking

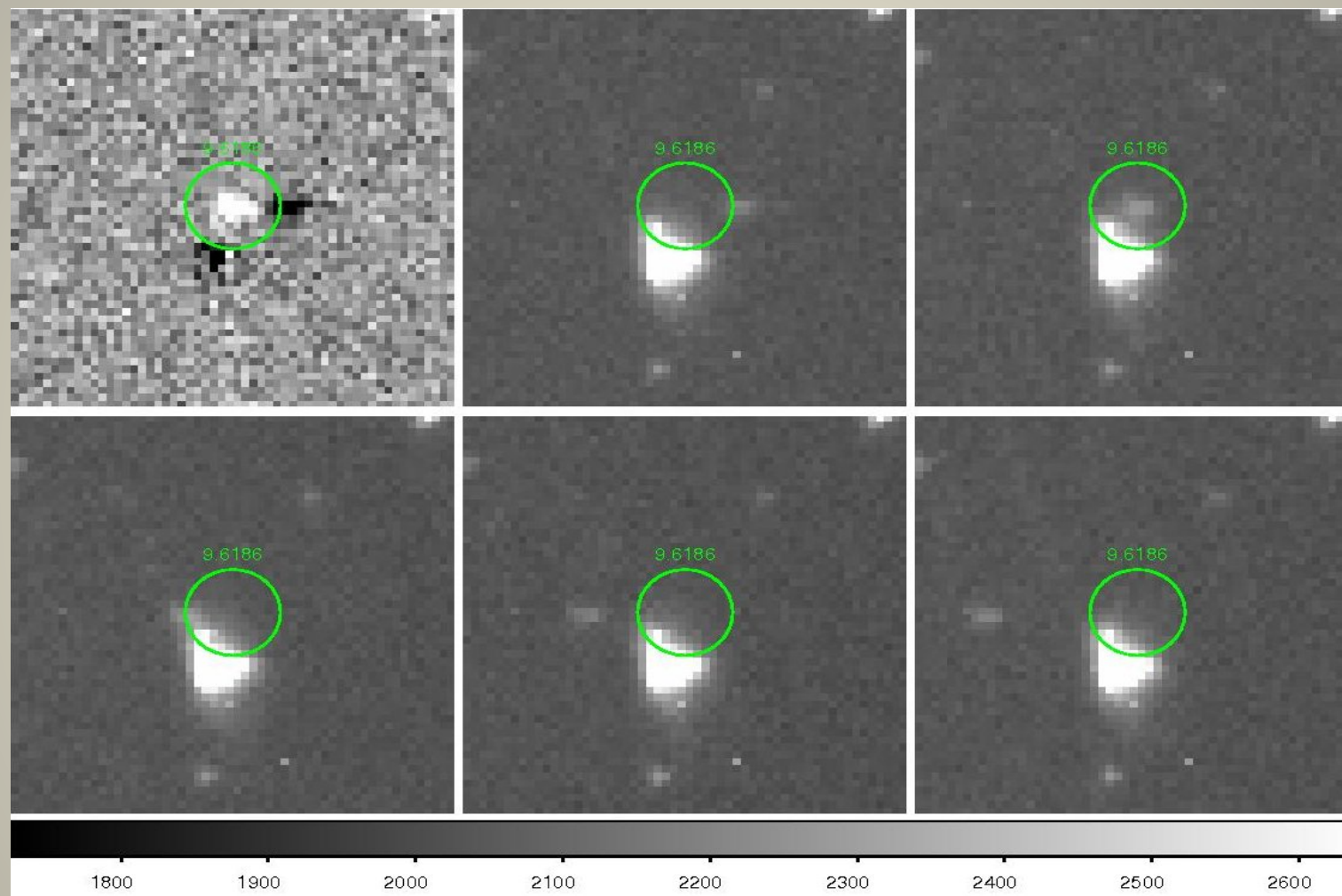
4.2 Filtering for noise rejection

パイプラインの適用

- Data: 2009/03/17 (totally 66 frames)
- Number of picked up objects: 3795 source
 - (1) Count value filtering: 2993 picked up
 - (2) Number detection filtering:
 - single detection: 231 sources
 - multiple detection: 2762 sources
 - (3) Elongation filtering:
 - $a/b > 3$: 8 sources **Only 8 fast moving objects**
 - $a/b < 3$: 2754 sources
 - (4) Flux filtering:
 - > 10000 : 2706 sources **Well rejected number of fluctuations**
 - < 10000 : 48 sources
 - (5) Light Curve checking:
 - other : 48 (small variation and bright star fluctuation)
 - small variation: 7
 - bright star: 23
 - real candidates: 18

5. Discussion : origin of real candidates

All 18 objects are slow moving objects by manual extraction.



Possible improvements of the pipeline

Number detection filtering (current matching radius is 4pixel.)

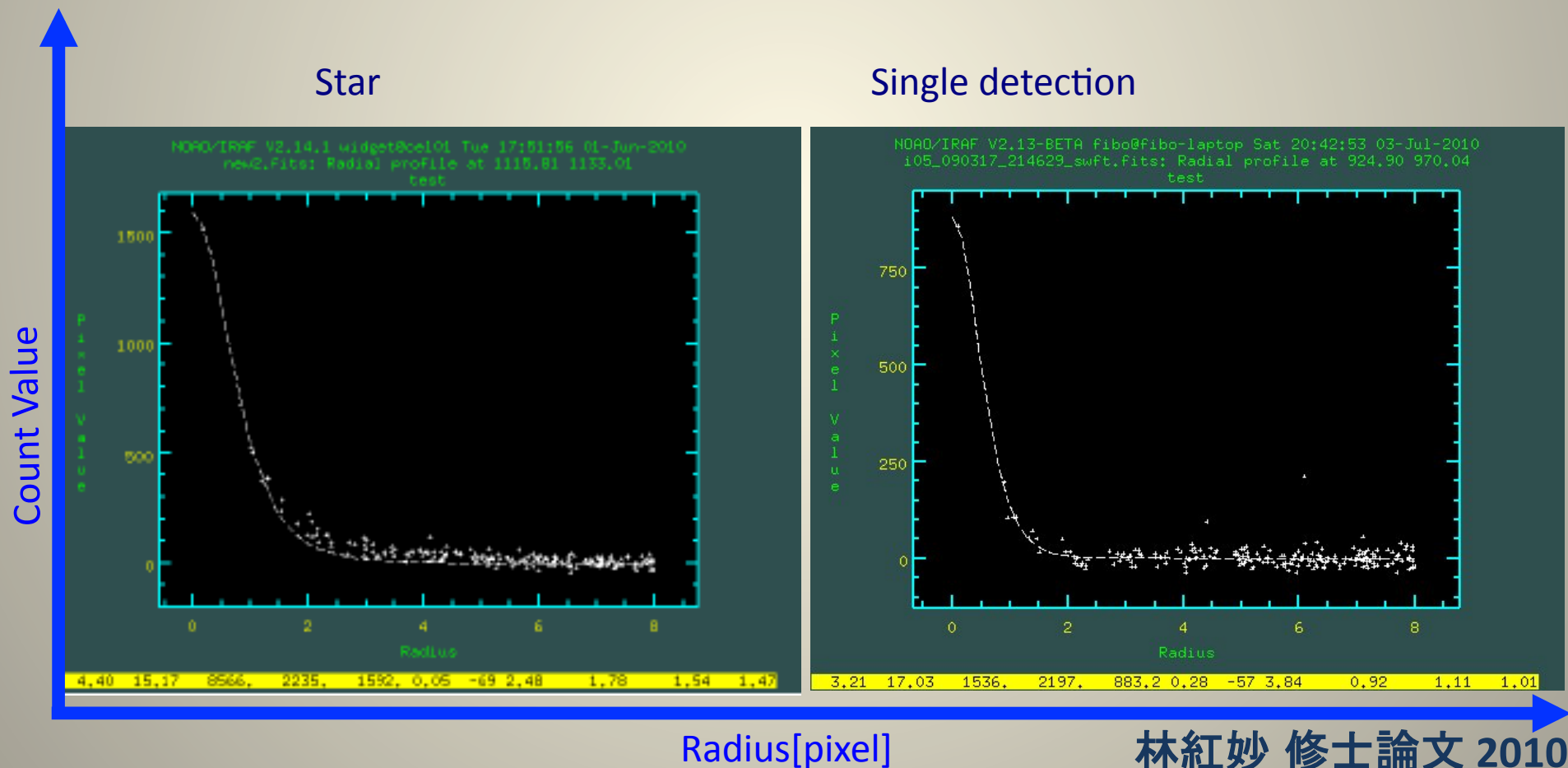
Evaluating with WIDGET tracking accuracy, we may be able to set much smaller radius.

林紅妙 修士論文 2010

5. Discussion : Origin of Single detections

The features:

- Radial Profile : similar to stars on the WIDGET image
- The number ratio : 0.85 ± 0.26 sources / cm^2/min



5. Discussion: Origin of single detections **spot type cosmic rays ?**

Spot type cosmic rays:

- ionizing radiation interact with Silicon (CCD)
- cause: secondary meson decay (muons)
- incident angle: 90° (localized event)
- psf: 1 or 2 pixel \rightarrow consistent with WIDGET image
- The rate of cosmic ray research by Lawrence Berkeley National Laboratory
 - CCD thickness 200-300 μm
 - Long dark images of UCO/Lick and NOAO CCD Laboratories \rightarrow The number density $\sim 0.87 \pm 0.08 \text{ \#/cm}^2/\text{min}$

Consistent

5. Discussion: Origin of single detections **spot type cosmic rays ?**

For more simple extraction,

● Additional testing (threshold=1000) :

→ Clear data	0.85 #/cm ² /min
→ Cloudy data	1.07 #/cm ² /min
→ Roof-covered data	1.15 #/cm ² /min

All number ratio are consistent.



Single Detections have low potential to
be a new real transient

まとめ

- ¼スケールで稼働中
- 1st論文を投稿
- 自動位置測定パイプライン完成
- 突発天体探査パイプライン完成

今後

- カメラ4台体制の復旧
 - 突発天体探査(2年分データ ~5TB)
 - Real-time transient trigger
 - 3-layer CMOSカメラ(同時3色)のテスト
- New GRB mission SVOM(2014~)に向けて