

Warsaw Polytechnics
Institute of Electronic Systems
PERG Group

The π of the sky project - software

Michał Jegier
Part of M.D. Thesis

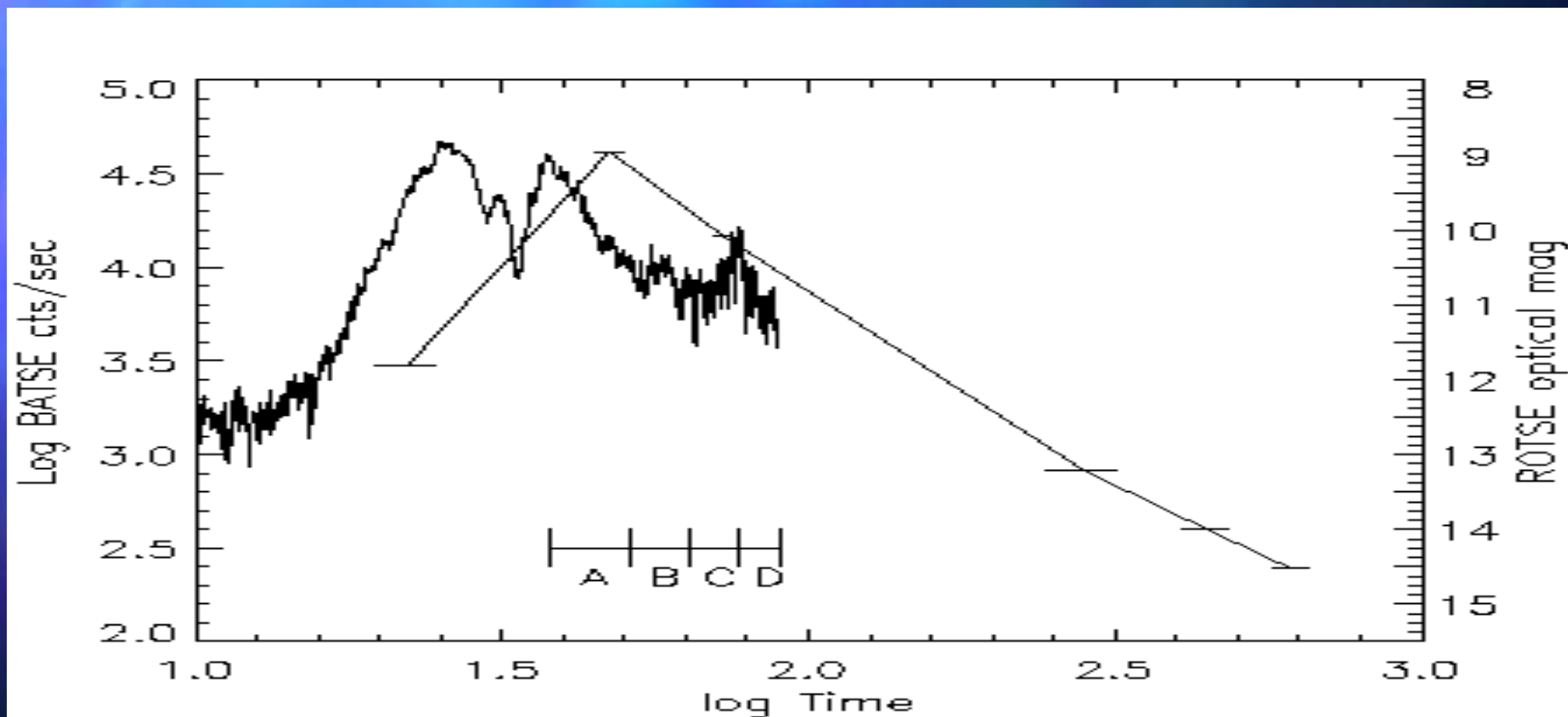
supervised by:

Krzysztof Poźniak, Ph. D. Institute of Electronic Systems

Grzegorz Wrochna, Ph. D. Institute for Nuclear Studies

What are Gamma Ray Bursts (GRBs)?

- GRBs are very short flashes of Gamma radiation, coming from random directions
- Orphan optical bursts are believed to follow every GRB



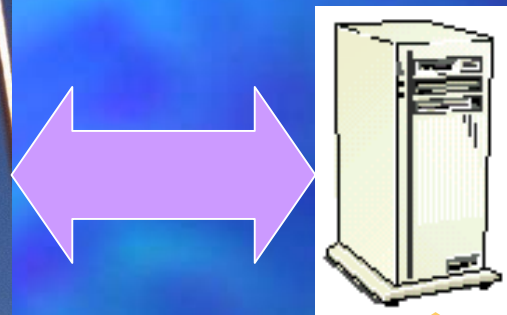
The only case of registered optical flash associated with GRB.
What are the qualities of others?

Solution:

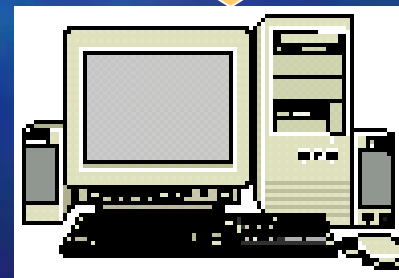
16 cameras coupled with computers, providing at least π stereoradians of viewangle, 1' sky resolution, ~ 5 sec. time resolution, online processing of incoming data



ROTSE's 'hedgehog'-like design



**Online processing
of data**



**Remote controlling
Via Internet**

Software

- Complete automation of retrieving and processing pictures to increase detection rate of orphan optical flashes
- processing must be performed online due to large stream of data (125MB/cycle) that cannot be stored
- Increase of sensitivity
- Recognition of optical flashes
- Interaction with triggers from GCN network (receiving and sending triggers)
- Controlling hardware via Internet

USB Driver for Linux

❖ Low level driver for kernel 2.6 – tested & debugged features:

- Direct Memory Access using sg-lists
- Direct Memory Access using user_map_pages
- Specific sequence of loading and unloading drivers
- Timing requirements for commands
- Use of Vendor commands for Cypress EZ-FX protocol
- Watchdog refresh, using kernel timers
- Overriding timeouts
- New commands for camera

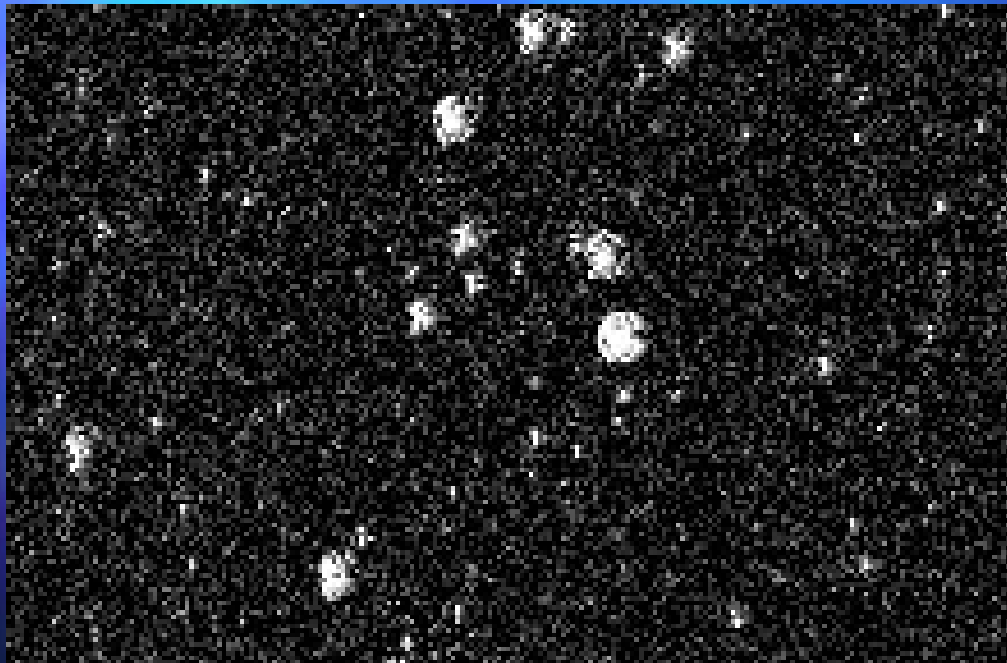
❖ High level driver wrapper providing functionality

New commands for Camera:

| Command | Description | Comments |
|------------------------------|------------------------------|--|
| 0xFD | „Artificial” RESET | EZ-FX2 does not provide normal reset |
| 0xFC | Watchdog refresh | Refreshes watchdog in camera so that it does not reset |
| 0xDD | Download firmware to Altera | Provides possibility of updates |
| 0x0D | LNA gain control | |
| 0xEF | Get version of cam | |
| 0xE | lens heating | |
| Vendor – over control pipe 0 | Download firmware to Cypress | Provides possibility of updates |

Data compression for storage

- Lossless – Rice-Golomb codes; differential coding using linear predictors
 - ✓ The library was completely rewritten to be compatible both with Windows and Linux
- Statistics



Compression ratio: 2.094

% of not compressed pixels: 7 %

Rice protocol overhead: 13%

Better adjusted sets of
predictors: 5%

=> The size of the compressed file
can be 25 % smaller

Diagram of length of compression codes

White pixels \sim 29 bits, black pixels \sim 7.7 bits

- Linear Predictors

| | |
|---|---|
| A | B |
| C | D |

If $((A==B) \& (A==C))$

$$\text{Predictor_D} = (A+B+C)/3$$

| | |
|---|---|
| A | B |
| C | D |

If $((A \gg B) \& (A==C))$

$$\text{Predictor_D} = B$$

Predictors can be better adjusted eg. statistically to obtain smaller standard deviation of differential signal

- Lossy compression

- ✓ JPEG format is not well suitable because it deforms the objects of interest
 - ✓ Stars must be compressed losslessly
 - ✓ Background can be compressed in a lossy way, not stored at all, or stored as rough gradient

Plans

- Further development of data compression – losless and lossy
- Further development of USB driver
- Final preparation of thesis

Project deadline: February 2005

Thank you for your attention