Brazilian Tunable Filter Imager (BTFI)
Preliminary Design Review (PDR)
CCCP
EMCCD Detector Controller

Denis Andrade – Keith Taylor (IAG)
Dani Guzman (AstroInventions)

Version 1.0

USP-IAG Universidade de São Paulo

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BTFI Detectors

- 2 EMCCD (L3CCD) from E2V
- Will use new 1600 x 1600 full-frame devices
- Characteristics studied for CoDR:
  - Clock Induced Charge (CIC) predominant noise source
  - Inversion / Non-inversion operation affect dark current and CIC
- Stringent requirements for the detector controller

Controller Requirements

- Multiplication register: requires a high voltage clock. Sinusoidal waveform, if available
- Photon counting mode requires very fast readout speed, 10-20 times a normal CCD
  - Avoids factor of 2 QE hit
- Amplification mode also requires fast reads
  - Suffers QE/2 loss but avoid saturation
- CIC noise demands very clean clock waveforms
- Convention read-outs also supported

Controller Alternatives

- SDSU-III (Leach) popular controller, adding a high voltage board from ATC (Edinburgh). Tested in ESO's ULTRASPEC
- Craig Mackay's EMCCD controller for Lucky Imaging – Only one controller deployed so far
- CCCP (Montreal)

Investigations pre/post CoDR

- Based on:
  - Tullock (ING) data, using SDSU
  - ATC data, using SDSU
  - E2V data
  - CCCP preliminary data
- SDSU results: EMCCD noise was higher than E2V claims
- Mackay's controller uses trapezoidal waveforms, as SDSU does. It is expected to achieve similar performance
- CCCP showed better, promising results. The only one using HV sinusoidal waveform (among other features)
- Science requirements were more stringent than what SDSU could achieve

CCCP Advantages

- Sinusoidal HV clock, optimal for CIC noise
- Rest of the clocks can have arbitrary waveforms; also better for CIC – this is a step ahead respect to competition
- It is specially designed for EMCCD, with high speed photon counting and amplification mode in mind
- The electronic design is clean and simple
- Compact form factor
- Available from close collaborators (Montreal) with a good level of support
- It is less expensive from a hardware perspective for BTFI
- Achieves BTFI SNR requirements

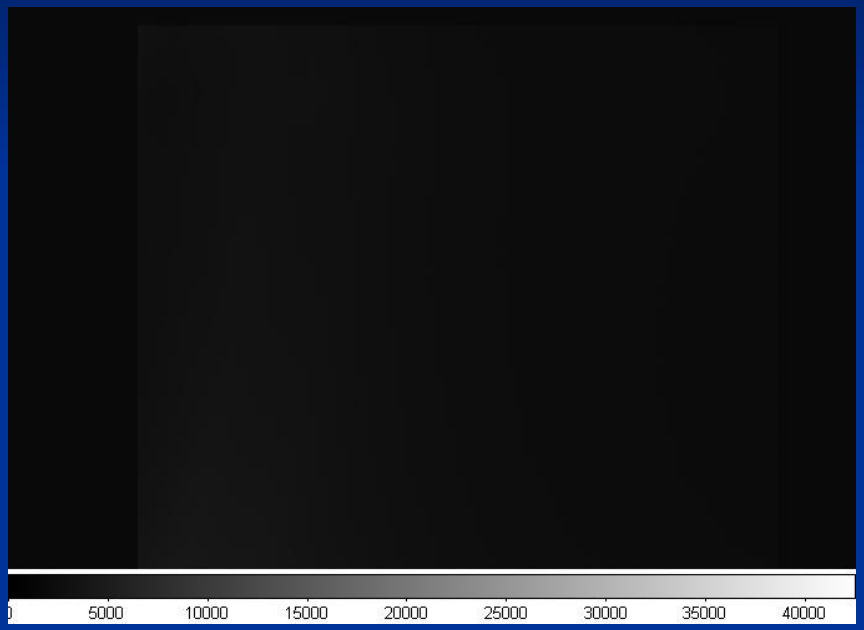
CCCP Disadvantages

- Still in development
- Communication link not proved
- Very new product – potential problems yet to be found
- Limited usage experience, only from the developer
- Not tested in an observatory environment

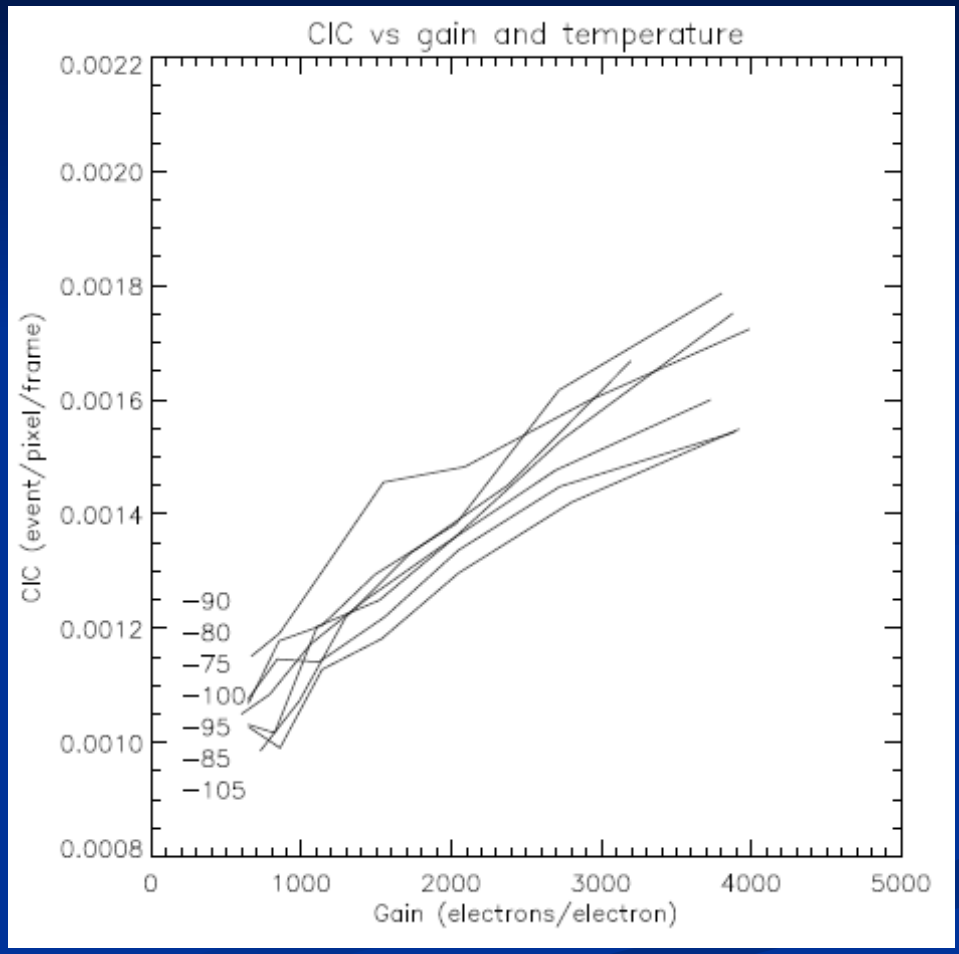
BTFI Contributions

- "Marseille Summit" Daigle-Guzman in Nov'08.
  - Validate design
  - Define modifications to make it "observatory viable"
  - Define communications interface
  - Define roadmap for version 2.0, with potential areas where IAG will make contributions
- PCB design of
  - communications board (CameraLink inteface)
  - Connector board
- Cable-less housing (CTIO's ArCon style)
- In summary, take CCCP and make it a detector controller ready for SOAR

CCCP Lab Results: CCD97

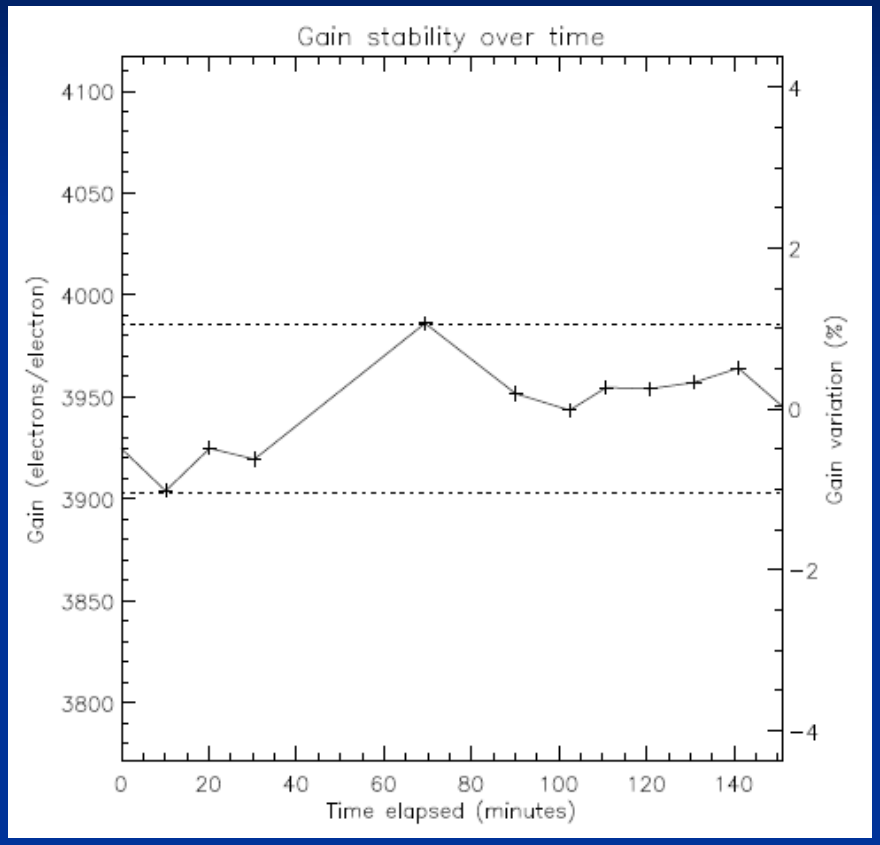


Lab bias frame – Extremely low noise

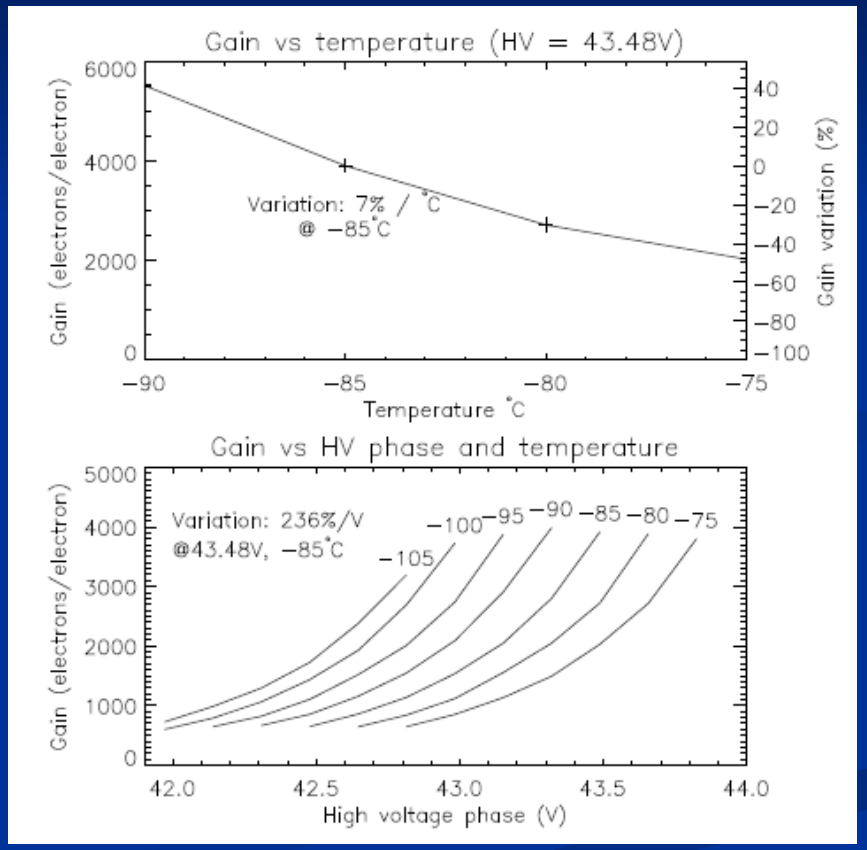


CIC
within 0.001 – 0.0018 events/pix/frame
at different temperatures

CCCP: Lab Results (CCD97)

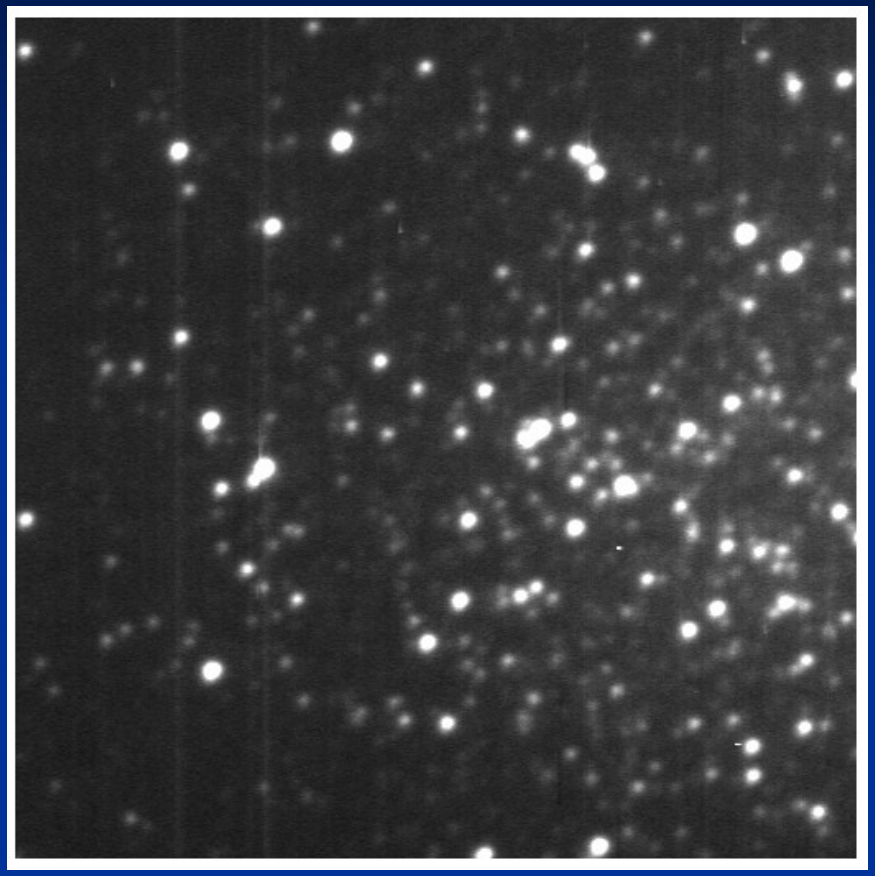


Temperature stability +/- 0.3 °C

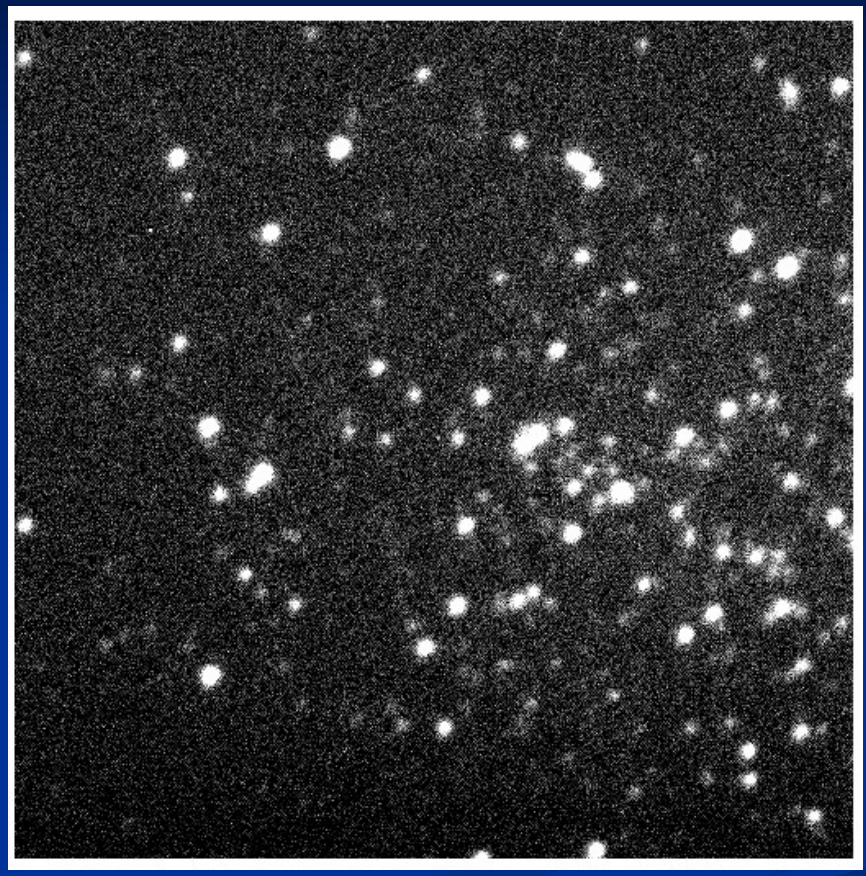


Consistent results varying parameters

CCCP On-Sky Results



M13 imaged In Photon Counting mode. The image is the sum of 9000 images of 1/30 second each (total of 300 seconds)



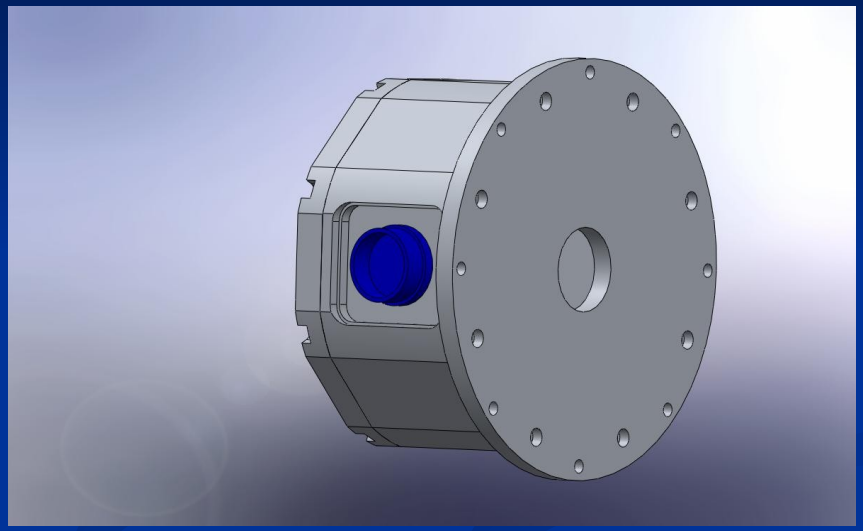
M13 made of 20 images of 15 seconds each, in conventional mode (no gain)

CCCP Current Status

- Version 2.0 ready in July (Montreal)
- BTFI Science cameras interface designed and built at INPE (prototype ready for Sept'08):
  - Connector interface board to cryostat
  - Mechanical housing w/o umbilical cables
- First integration of the prototype with BTFI's Test Dewar in September '08 at IAG
- Production version of CCCP for science cameras available in Q1-2009

CCCP-Test Dewar Integration

- Defined as key aspect of BTFI detector program
- Testing of CCCP v2 for first time
- Integration with detector software (ArcView)
- Will run CCD97, 5122 EMCCD (on loan from Montreal)



AstroInventions' Test Dewar Concept

- Integration of mechanical housing with cryostat and controller
- Get BTFI team ready to undertake the next job, with science detectors
- Gain experience running and characterizing EMCCD

Detector Program Schedule I

- Test Dewar Integration (Sept 2008):
  - Montreal: Deliver 1 set of CCCP boards (July 08)
  - IAG:
    - CCCP's connector board under design (June 08)
    - CCCP's power supply under design (June 08)
    - CCCP electronic tests (July 08)
    - CCCP / ArcView integration (July, August 08)
  - INPE:
    - Design/fabrication CCCP housing (July 08)
  - AstroInventions:
    - Vacuum & cold tests of the dewar in July 08
    - Cold tests with CCD97 mechanical sample in August 08

Detector Program Schedule II

- Science cameras parts:
  - Montreal: Deliver 2 sets of CCCP boards: Q1-2009
  - IAG: Produce boards and housings for 2 science cameras: October – December 08
  - AstroInventions: design and fabrication of 2 science cameras: October 08 – January 09
- Science cameras integration:
  - Both cameras will be integrated at IAG in Q1 or Q2 of 2009

Prospects with CCCP beyond BTFI

- BTFI's test dewar will stay at IAG
- Dedicated system to test EMCCDs and software
- Platform for detector characterization, in parallel with BTFI science cameras
- Fresh grass for graduate students!

BTFI Detector Team

- Denis Andrade (IAG)
- Javier Ramirez (USP)
- Cesar Strauss (INPE)
- Giseli Ramos (IAG)
- Fernando Fontes (IAG)
- Dani Guzman (AstroInventions)