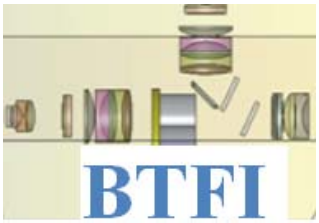


Brazilian Tunable Filter Imager (BTFI) Instrument Project

Preliminary Design Review (report)

IAG Universidade de Sao Paulo

2008 June 18 & 19

Review Panel:

Claude Carignan, LAE, Université de Montréal, Canada (chair)

Patricio Shurter, CTIO, Chile

Marco Bonati, CTIO, Chile (videoconf)

Participants:

- **Claudia Mendes de Oliveira (CMdO), IAG - USP, Brazil (PI)**
- **Keith Taylor (KT), IAG - USP, Brazil (Project Manager) (PM)**
- **Claude Carignan, LAE, Université de Montréal (chairman)**
- **Patricio Shurter, CTIO (reviewer)**
- **Marco Bonati, CTIO (videoconf) (reviewer)**
- **Peter Gray (PG), Atacama Engineering Consulting, Australia (remote) (reviewer)**
- **Gerarld Cecil (GC), University of North Carolina, USA (remote) (reviewer)**
- **Denis Andrade, INPE, Sao José dos Campos, Brazil**
- **Luiz Cavalcanti (LC), UNIFEI - Itajuba, Brazil (remote)**
- **Olivier Daigle, LAE, Université de Montréal (remote)**
- **Cesar de Oliveira, LNA – Itajuba, Brazil**
- **Ligia Souza de Oliveira, LNA – Itajubá, Brazil**
- **Fabricio Ferrari, Universidade Federal do Pampa, Bajé, Brazil**
- **Fernando Fontes, Athena Consultoria e Sistemas, Belo Horizonte, Brazil**
- **Jean-Luc Gach (LAM), Marseille, France (remote)**

- **René Laporte, INPE – Sao José dos Campos, Brazil**
- **Henri Plana, Universidade Estadual de Santa Cruz – Ilhéus, Brazil**
- **Bruno Quint (BQ), IAG - USP, Brazil**
- **Giseli Ramos (GR), IAG - USP, Brazil**
- **Francisco Javier Ramirez Fernandez, Poli – USP, Brazil**
- **Julian David Rodriguez Ramirez, Poli – USP, Brazil**
- **Reuven Opher, IAG - USP, Brazil**
- **Cesar Strauss, INPE – Sao José dos Campos, Brazil (remote)**

Preamble:

The BTFI instrument project will utilize three new technologies (Bragg Tunable Filter (iBTF), long-range Fabry Perot (FP) etalons & EMCCD detectors) for a versatile Ground Layer Adaptive Optics (GLAO) fed tunable filter imager for the Southern Astrophysical Research (SOAR) telescope. The goals of the PDR are:

1. Report on the project progress during the design phase and present the detailed design of the optics, mechanics, controls and software of the instrument.

2. At the time of the PDR, the majority of the design work should be completed and most technical choices should have been made.

3. The design should be essentially ready to proceed to the construction with sufficient detail to obtain accurate cost of materials and staff time estimates.

4. The PDR is an opportunity for external reviewers to critically examine the design and identify any shortcomings or changes that need to be made.

5. Are the team and project ready to go forward to the construction phase?

1. Introduction

During the first day, the following presentations were done to the review panel:

- Project Overview: science goals and budget management (CMdO)
- Optical design (KT)
- Opto-mechanical design (KT)
- Electronics and software instrument controls (Fernando & GR)
- iBTF prototype report (KT)
- Detector (KT, OD)
- System Modeling (BQ & KT)

The second day was devoted to the following topics:

- Etalon controller (LC & JLG)
- BTFI Emulator (Fernando)
- Data reduction (KT)
- Management (KT)

2. Answers to the CoDR report

2.1 Technical

- *It is recommended to sort out, as soon as possible, with the SOAR people the maximum weight that can have the BTFI, since this has a large impact on the mechanical design.*

    - Clearly, this question was not sorted out the way the CoDR committee would have liked. See below

- *It is recommended that the mechanical design takes well into account the two ports where the BTFI could be used (two modes: GLAO and SL).*

    - OK

- *It is recommended to sort out as soon as possible what will be the exact contribution of the company Photon etc in the iBTF module (From conceptual studies up to producing the whole module).*

    - This was not completely sorted out to the satisfaction of the committee. The agreement for the CCCP-v2 controller is related to the detector and not to the iBTF module.

- *It is recommended that the science (project vs resolution) should really be what decides the iBTF configuration (1 or 2 VPH, reflection vs transmission). Because it is a completely new technology, prototyping is highly suggested before building the finite module.*

    - OK

- *It is recommended to identify resources to do Finite Element Analysis (FEA) studies of the instrument structure and of the BTFI/SAM assembly.*

- While the resources may have been identified on the SOAR staff, clearly much more studies are necessary. See below.

- *It is recommended, before the next PDR, to continue gathering information on the two possible types of controllers (LAE or SDSU) that could be used for the EMCCD detectors. As much laboratory tests and simulations should be obtained for both types of controllers.*

  - OK

- *It is recommended that the software group add to the acquisition software data handling software and a window for on-line data reduction.*

  - OK

3.2 Management

- *It is recommended to hire a project manager (PM) as soon as possible. This could be a full-time job or at least 3 days/week.*

  - OK (Keith Taylor)

- *It is recommended, before the next PDR, to identify clearly all the sources of financing and of manpower, and this until the end of the project.*

  - While the situation is more clear, it seems that 200K$ are still missing.

- *It is recommended to hire a mechanical engineer and mechanical detailed designer as soon as possible.*

  - OK

- *It is recommended to identify, as soon as possible, the resources (workshop, manpower) to actually build the instrument and the location and schedule of the instrument integration.*

  - OK

- *It is recommended to clarify as soon as possible the participation of the LNA and of INPE into the BTFI project.*

  - OK

- *It is recommended to establish a strong communication link between the BTFI project group and the proper representative of the SOAR telescope and SAM*

team. Regular exchanges should happen from now on between the two groups.

- OK

- *It is recommended to make a few presentations on the BTFI at the next SPIE meeting on Astronomical Instrumentation, to be held next June in Marseille, to make the instrument well known to the international Astronomical community.*

    - Too bad the SPIE deadline was missed !!!

3. Review of the Different Project Components

3.1 Project Overview

Summary: The science drivers are well identified and the science case is strong. The advantages of the different modes of operation seem well understood: programs which need excellent spatial resolution (centers of AGNs, mergers, physics of HII regions) will benefit of the SAM's GLAO mode while the large-scale dynamical and abundance studies will mainly be using the seeing-limited (SL) mode.

Comments/suggestions:

- There are plenty of science drivers. Programs to be done in SL mode are well identified but this is less the case for the GLAO-fed mode. Applications on nearby objects are well documented (e.g.AGNs) but higher redshifts programs should be further developed.

- It is clear that the BTFI would benefit of becoming a facility instrument at SOAR but is still a visitor instrument, at present (should be discuss at the SOAR board).

- The causes of the increase of the budget since CoDR should be explained more clearly.

3.2 Optical Design

Summary: The optical design seems to be well under control. The project can probably proceed with the procurements once the cells fabrication and the acceptance tests issues are sorted out.

Comments/suggestions:

- The optical design calls for tight alignment specs. Was flexure taken into account? FEA would be necessary.

- It is not yet decided whether the optics will be procured alone or with their cells. Quotes should be asked for both and the decision should be taken according to the budget available, meaning that the optics should be bought in cells if money allows it.

- Who will do the acceptance tests for the optics? While manufacturers can be asked to quote with detailed test results, an independent check is always better. Who can do it (NOAO, …)? Those uncertainties on the acceptance tests should be cleared out.

3.3 iBTF prototyping

Summary: While the mechanical construction of the iBTF prototype was done following the CoDR request, the tests needed to validate the concept, which should have been done before the PDR, still have to be done.

Comments/suggestions:

- It was disappointing not to see any test results and more quantitative analysis of the iBTF prototype module. While it is great to have some hardware to show, the real reason to have built the prototype was to demonstrate that the necessary level of alignment, angular/position control and repeatability can be achieved by the mechanisms to make the tunable filter work as specified. At the least, it would have been good to see a test plan for what was going to be done with the prototype in the coming months.

- Prototyping needs to test the cancellation with the gratings before knowing that it really works (even if theoretically, it should work). This was one of the main purposes of the prototype.

- iBTF must be tested for image stability during the scans.

- iBTF must be tested at different gravity factors.

- Regarding the iBTF prototype anti-collision electronics, it is suggested to use Hall effect sensor and magnets. Manuel Martinez at CTIO has experience developing this.

- It may be premature to decide to use the actual prototype in the final instrument before more tests are done.

3.4 Opto-Mechanical Design

Summary: The opto-mechanical design is in a well advanced stage. However, further development should wait after the issues discussed below are resolved.

Comments/suggestions:

- ***(****Taken from the CoDR report****) Mass/Moment Limit -*** *The major technical interface issue is likely to be the maximum weight/moment that can be mounted on the SAM instrument. The current estimates vary between 60-300kgs. It is not clear if these numbers have been derived from a detailed analysis and what the consequences in technical performance or physical limits are. There does not appear to be a moment limit, however this may be important for a cantilevered instrument such as the BTFI because of the loads and deflections this may introduce on the SAM instrument. Knowing the limits to mass and moment will be important to define the possibilities of instrument configuration and structural design.*

- An FEA analysis and investigation needs to be completed to determine a sensible upper mass/moment limit for the instrument mounted on SAM **before proceeding much further with the detailed mechanical design work**. This should be done using a simple point mass load, no need to model SAM plus BTFI. Once this mass limit is determined, the BTFI mechanical design should use this as a firm requirement. Not having a believable clear mass limit means that the mechanical design is not taking into account the need to be careful about extra mass. One example is the large solid mounting plate used to mount BTFI to SAM.

- The FEA modeling of BTFI should be checked carefully against the optical and performance requirements, for both tilt and displacement. Also when an analysis is run, an attempt should be made to feedback the results to improve the design. For example the current design shows significant cantilever bending deflection of the top square frame that would be substantially reduced if a simple diagonal brace was used.

- Why not motorize the change of etalons and of filter wheels?

- The filter wheel flexure must be studied. Filters must be protected from belt debris.

- The interference of a truss with the instrument does not seem to be fully resolved (see CoDR report). Two solutions are still explored: 1- build a bent truss which would imply some BTFI modification or 2- cut the truss in two, one half being removed when BTFI is over SAM. This should be resolved before the CDR.

- We know that major efforts have already been made to minimize the weight, but can anything else be done to further reduce it? The structure may be overly stiff. Can it be lightened?

3.5 Detector

Summary: This part seems well under control. The first prototype of the controller was tested and the CCCP_v2 should be delivered during the summer. The 1600x1600 EMCCD chips have been ordered.

Comments/suggestions:

- Not much detail was given on the CCD enclosures: vacuum gauge, means of cooling (Cryo-tiger or LN2), shutters. This should definitely be all sorted out for the CDR. Final dewar drawings should be presented.

- There is a concern about the availability of spares and about the training of the personnel.

- One of the risks is that some crosstalk is seen among both controllers. Even when both controllers will be controlling different detector, on different dewars, since they will both be on the same instrument, there is always the risk of founding crosstalk. If this is the case, what would be the plan to minimize the problem? Sync. the controllers? Something else? There has been no mention about this at all.

- For CDR there should be clear data on the controller's performance: RON, CIC, glow, xtalk, etc, on actual, real data, not theoretical. These results may exist already, but they should be available for review.

3.6 Electronics & Software Instrument control

Summary: This is another part that seems well under control. The design of the control software is well developed. No real drawbacks were identified at time of the PDR.

Comments/suggestions:

- It appears absolutely necessary to use both the Linux and Windows (because of Visual Basic) operating systems.

- There is still a need to define a clear protocol for instruments communication.

- One of the concerns is the reliability of the Linux driver for the controller. Being a new controller/driver it is always unclear how easy would be to interface it and how robust the interface may be. We expect to have more "continuous hours" on the sky for CDR time, at least enough to show that it can work reliably for a reasonable long period of time, and also to show that the interface is easy enough to hook to.

3.7 Fabry-Perot etalon and FP controller

Summary: This appears to be the weak point in the different work packages. The characterization of the new Marseille etalon is far behind schedule and the controller design not very advanced. A hybrid design of the controller making use of the MC900 module of Fogale may be the way to go as an interim solution. The technical choices should be made by the time of the CDR.

Comments/suggestions:

- As you move toward CDR and are optimizing etalon and VPH performances, assess the impact on photometric accuracy of polarized targets (e.g. proto-stellar) by field rotation on SOAR M3, oblique reflection in the iBTF and gratings.

- At CDR, quantify the contribution factors to the etalon performance in astronomer terminology, including coatings and residual controller errors.

- The SOAR facility calibration unit will be available. At CDR, summarize the expected accuracy from this for the various calibrations, and provide supplementary means to calibrate those that it does not, to attain science goals.

3.8 Emulator and data reduction

Summary: This looks like a very valuable tool.

Comments/suggestions:

- The emulator should be developed to become a tutorial for future observers.

- What about flux calibration? Every effort should be made to flux calibrate everything.

3.9 Management

Summary: The situation is better now that an official PM was chosen. The main concerns are about timescales. The discussion with SOAR, which was a concern at time of CoDR seems to be resolved.

Comments/suggestions:

- Is the 6 months fabrication realistic? We think the manufacturing and integration schedule is too optimistic. It is encouraging that the team managed to fabricate and assemble the iBTF prototype so efficiently. However, there should be some caution in extrapolating this success to the full instrument which has many more parts that need to be procured and made to fit. There should be some "lesson learned" from the SAM and LGS project where they may have had an equally optimistic approach to the schedule.

- For the first two years, the BTFI will be on another port and thus will only be available in SL mode. This may be good for the commissioning phase to do it separately from SAM but the instrument will loose most of its specificity. In most cases, it will be inferior to the 3DNTT because of its relatively small field (3’ x 3’ vs 17’ x 17’). Its only advantage may be its lower spectral resolution in iBTF mode. Clearly, the BTFI team should consult with the 3DNTT team to concentrate the projects that don’t need a large field or need low spectral resolution on the SOAR and those that need a large field on the NTT.

- What is the answer on the possible 6 arcmin field in SL-mode?

4.0 Recommendations

4.1 Technical

1. **Weight issue: this needs to be resolved. No further design studies should be done before the proper FEA analysis of flexures are done and the effects on SAM well known. (high risk)**

2. **The timescale for the availability of the new Marseille etalon and on the development of the FP controller seems to be the highest risk concern. A clear plan should be presented at time of CDR. (high risk)**

3. **Proper tests using the iBTF prototype should be carried out as soon as possible to validate properly the whole concept and to be able to decide whether to use the prototype in the final instrument. (medium risk)**

4. **The question of the acceptance tests for the optics should be resolved. (low risk)**

5. **A clear procedure for flux calibration of all the data should be developed. (suggestion)**

4.2 Management

1. **The fabrication and integration schedules should be revised since they both appear too optimistic. Revised schedules should be presented at the CDR. (high risk)**

2. **For the first two years of operation in SL-mode, consultations should be done with the 3DNTT team to optimize the scientific programs done on the 2 instruments. (suggestion)**

5.0 Concluding Remarks

The goals of the PDR are:

- *Report on the project progress during the design phase and present the detailed design of the optics, mechanics, controls and software of the instrument.*

OK

- *At the time of the PDR, the majority of the design work should be completed and most technical choices should have been made.*

Some technical choices still have to be done:

1. **LN2 vs Cryo-tiger for cooling**
2. **Optical components ordered with barrels or not**
3. **Who will perform the acceptance tests of the optics?**
4. **Type of FP controller**

- *The design should be essentially ready to proceed to the construction with sufficient detail to obtain accurate cost of materials and staff time estimates.*

OK

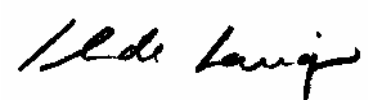
- *The PDR is an opportunity for external reviewers to critically examine the design and identify any shortcomings or changes that need to be made.*

Two high risks issues to be resolved:

1. **Availability of the new Marseille etalons & FP controller.**
2. **FEA analysis to determine maximum weight permitted for the BTFI and its effect on SAM.**

- *Are the team and project ready to go forward to the construction phase?*

1. **Yes, once the two points above are resolved.**
2. **The fabrication and integration schedules should be revised.**



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Claude Carignan, chairman
For the Preliminary Design Review Committee

July 24, 2008.