BTFI Instrument Requirements & Specifications			
Doc# BTFI_11.01_Requirements_v01			
2007-09-20			
CHANGE LOG *- Date Author Changes ID# Justification*			
20070213 - PMG Several revisons as instrument design as it existed Feb 2007 was developed. Old doc number was BTFI-00.00.00-02-LIS-A			
20070914 - PMG major revision of whole requirements list. Changed doc numbering system.			
20070918 - PMG added detector requirments from Dani Guzman			
20070920 - PMG added Software requirements from Giseli.			
This document is at present a WORKING DOCUMENT under-construction.			
It will be the single main reference document for the iBTF instrument project. It lists the technical requirements to achieve the desired operational and			
performance specifications. It will be updated regularly with approval and controlled versions each time a requirement or specification needs to be changed.			
The information should be used by all project staff as the single approved source to design and construct the instrument.			
Req ID#	***Name***	***Requirement***	***Comment***
REQ-00.00	**GENERAL**		
REQ-00.01	Instrument operating environment.	Instrument must be able to operate succesfully over: temperature range -5 to 25 degC, humidity range 0 to 80% relative humidity, telescope altitude 2701m above sea level.	
REQ-00.02	Telescope XYZ Cartesian Coordinate System	**Z axis** defined as parallel to the Telescope Optical Axis +ve upwards when telescope tube is vertical . **Y axis** is defined as the optical axis of Optical Nasmyth focus +ve direction as light travels. **X axis** direction defined as orthogonal to Y axis +ve running to RH side horzontally with the Nasmyth rotator in the 0 degree position.	
REQ-00.03	Instrument XYZ Cartesian Coordinate System	For the instrument the XYZ coordinate system with instrument in the park position with SAM horizonal to RH side looking at the Nasmyth focus. **Z axis** vertical beam emerging from SAM output, **Y axi**s running horizonally from the SAM axis outwards along the telescope ALT axis, **X axis** runs horizontally from SAM output to RH side.	
REQ-00.04	Instrument Mounting Location	Instrument will be designed to be used on the SAM (SOAR Adaptive Optics Module). As a backup option it may be mounted on the Nasmyth IR port using an adapter flange.	Previous version of Requirements document dated Feb 2007 had the additional requirement of mounting on the SOAR IR Nasmyth port to provide wide field uncorrected seeing. KT: I think we still need this as a back-up if either GLAO is inoperable or if we wish to share the telescope with SIFS/SAM configuration.
REQ-00.05	Instrument Telescope Operating Limits	Instrument will be useable for range of telescope ZD motion from 0 to 70 degree.	
REQ-00.06	Instrument Gravity Vector Range	Instrument mounting location on Optical Nasmyth will involve 360 degree gravity vector rotation about the Y axis direction with instrument rotator rotation. No rotation about X axis. Only telescope acceleration about Z axis as telescope moved in Azimuth.	
REQ-00.07	Instrument Power & Grounding	SOAR will provide the UPS power for thr instrument. The power at SOAR is 115 VAC 50 Hz. The instument must be capable of 50/60 Hz operation to allow repair/maintenance on Cerro Tololo. All instruments must be compatible with the TBD grounding strategy to be adopted by the Observatory. Linear rather than switching amplifiers are prefered to minimize pickup. Instrument electronics must be in the form of PXI/compactPCI cards which fit into a single 8-slot PXI chassis. This is described in http://www.natinst.com/pxi/pxispec10.html. This chassis will be insulated and cooled so that it emits < 50 Watts into the environment.	from SOAR Requirements document June 1998 & Interface of SAM with the SOAR telescope - Tokovinin - June 2005
REQ-10.00	**MANAGEMENT**		
REQ-20.00	**SCIENCE**		
REQ-21.01	Wavelength range	370nm > l > 900nm	Claudia 2007-09-10. Need 370nm lower limit because of 3727Å line.
REQ-21.02	Field of View on Sky	≥ 3 arcmin	From KT CoDR Instr Overview talk 24 Sept 2007
REQ-21.03	Spatial Resolution on sky	≤ 0.12 arcsec sampling, resolution ≤ 0.24 arcsec	From KT CoDR Instr Overview talk 24 Sept 2007
REQ-21.04	Tunable Filter iBTF λ Resolutions	20 <R < 5,500 (Goal), 20 <R < 3,000 (Acceptable)	From KT CoDR Instr Overview talk 24 Sept 2007
REQ-21.05	Use with Two Fabry-Perot Etalons	Ability to observe with either one or two FP etalons in series. FP1 in the diverging beam before the collimator. FP2 in the collimated beam.	
REQ-21.06	Fabry-Perot FP1 + Filter λ Resolution	250 < R < 25,000	From KT CoDR Instr Overview talk 24 Sept 2007
REQ-21.07	Fabry-Perot FP1 + FP2 + Filter λ Resolution	16,000 < R < 40,000	From KT CoDR Instr Overview talk 24 Sept 2007
REQ-21.08	Simultaneous Observation	Ability to observe simulatneously in both FP and iBTF channels with separate identical detectors. Either channel can also be used independently. Possible to image (WHITE) directly onto either detector	
REQ-21.09	Modes of Operation	At least four modes of operation: (1) iBTF & WHITE, (2) iBTF & FP2, (3) WHITE & FP2, (4) FP1+FP2 & WHITE	Claudia 2007-09-10.
REQ-21.10	Instrument Efficiency	must be able to reach 10^{-17} ergs/sec/cm^2/arcsec^2 in 2.5 hour exposure for a S/N ratio = 2 for 1 arcsec seeing.	Claudia 2007-09-10.
REQ-21.11	Overall Average Throughput (SOAR+SAM+Instr+Detect)	≥ 10%	Claudia 2007-09-10.
REQ-21.12	Instrumental Average Throughput	≥ 40%	From KT CoDR Instr Overview talk 24 Sept 2007
REQ-21.13	Detector Average Efficiency	≥ 60%	From KT CoDR Instr Overview talk 24 Sept 2007
REQ-21.14	Instrument Stability	Instrument stability should be stable enough to permit a 1hr observation without requiring realignment or calibration. Long term stability sufficient to not need for major recalibration ≤ every 2 days.	PG 20070919
REQ-21.15	Output data	Require the output images in data cubes.	
REQ-21.16	SOAR Instrument Status	For the first year of operation would be a Visitor Instrument with technical and operational support provided by the instrument. After this period the instrument would become a SOAR instrument supported by observatory staff.	Claudia 2007-09-10.
REQ-30.00	**OPTICS**		
REQ-30.01	Telescope diameter	4.1m.	
REQ-30.02	Input f-ratio	f/16.5	

REQ-30.03	Field of View	ON AO corrected SAM port unvignetted Field of View is 4.1arcmin diameter or equiv 3.0arcmin square.	
REQ-30.04	Optics Wavelength Range	Coated optics should have transmit over wavelength range 390- 900nm with >10% of peak throughput. Image quality specification is for wavelength range 390- 900nm.	20070920 After discussion with KT and Clauidia raised blue limit t0 390nm and lowered red limit to 900nm.
REQ-30.05	Instrument focal plane	The nominal focal position of SAM is 250mm behind the ISB °ange (or 100mm behind the nominal focus for other instruments, M2 shift 1mm).	From SOAR_SAM ICD , Tokovinin, June 2005
REQ-30.07	Plate scale	Nasmyth platescale 330.53 micron/arcsec (3.025 arcsec/mm) (assumes SAM provides 1:1 image transfer TBC)	
REQ-33.01	Fold Mirrors - Collimator	Two Fold mirrors beforer collimator to shorten distance to collimator by 250mm. Second fold mirror after iBTF to reflect diffracted light from iBTF into orthogonal iBTF Camera. All mirrors to be front surface, protected high reflectance multi-layer coating.	Note that use of high reflectance coating limit performance for l<390nm
REQ-34.01	Pupil size	50mm	
REQ-34.01	Length of collimated space	>0.5m. Current design has 580mm.	KT: A new value has to be defined once we've baselined the iBTF configuration.
REQ-35.01	Image quality	final image quality at detector focal plane >80% ensquared within 2 detector pixels (see REQ-20.00.00-03) over operating wavelength range (see REQ-30.04).	
REQ-35.02	Image scale (camera FP)	Two identical cameras 0.12arcsec/pixel (f/6.7camera),. One for iBTF path and one for FP path.	From KT on 13 September 2007
REQ-35.03	Number of cameras	Total two lens cameras required. One "FP Camera" straight-through "zeroth-order" for Fabry-Perot#2 path. Second "iBTF Camera orthogonal with 90degree	
REQ-36.01	Interference filters	Pupil plane fileter wheel, Quantity ~10, clear diameter 75mm	
REQ-40.00	**IBTF**		
REQ-41.01	iBTF VPH Grating Mounting & Alignment	The iBTF VPH gratings moutings will allow by shimming a yaw rotation adjustment +-5degrees and pitch-roll tilt +-1deg.	
REQ-43.01	VPH Coordinate System	For purposes of angular adjustment and alignment of VPH gratings the following rotation orientations are defined. PITCH is rotation about axis parallel to grating rulings, ROLL is rotation about axis orthogonal to the rulings in the plane of the grating surface, YAW is rotation about an axis normal to the grating surface.	
REQ-50.00	**FABRY-PEROT**		
REQ-50.01	Fabry-Perot Etalon Modules	Two separate Fabry-Perot modulesused in series. First **FP#1** located at the instrument entrance immediately behind the Field Lens in the diverging f/16.5 beam. Second **FP#2** in the collimated space after the iBTF. Planned to have both FPs the same and interchangeable.	
REQ-51.01	Fabry-Perot Etalons	**SESO Fabry-Perot Etalons**. Identical to those use don 3DNTT instrument. BTFI will purchase two? And borrow others from the NTT . The mechanical design for the Fabry-Perot was also provided by SESO. This is available at LAM and it was also sent to the Mechanical Engineering group in Meudon for building the parts.	Information from Minutes of the meeting on Jul 24th/2007.
REQ-51.02	Fabry-Perot Etalon Mechanical Mounting	The design of the Fabry-Perot modules shall be copied from that of the 3DNTT instrument and will be interchangeable without major realignment.	
REQ-55.01	FP Control Electronics	Custom built etalon control electronics. Based on design from LAM group in Marseille. The Marseille etalon controller is designed by Jean-Luc and will be put together by a private company and by Olivier Boissin.	Information from Minutes of the meeting on Jul 24th/2007.
REQ-60.00	**STRUCTURE & MECHANISM**		
REQ-60.01	Instrument Rotator	None required. Mounted only on SAM port. If BTFI is mounted in its backup location on the Nasmyth IR port it will utilise the existing instrument rotator.	.
REQ-60.02	Instrument Guider	None required. Mounted only on SAM port. If BTFI is mounted in its backup location on the Nasmyth IR port it will utilise the existing instrument guider	KT: NB: No OIWFS - is this OK?
REQ-61.01	Maximum instrument weight	<380kgs	(including local instrument control system), we can quote Steve as saying that the 100kg limit was not firm. PG I have specified a 380kg upper limit based on a guesstimate of what the instrument could weigh if a lightweight mass-efficient design is used.
REQ-61.02	Maximum instrument dimensions	must be contained within a swept radius of ~1.9m from centre of Instrument Support Box (ISB)	KT: Supllementary details supplied by Scherter (SOAR)
REQ-62.01	Focal Plane Aperture Slide	Four position manual slide. Diameter aperture masks 85mm. First aperture mask matrix 100 micron pinholes on 10mm pitch for distortion mapping. Second aperture mask 4 holes 1mm dia on 50mm dia circle for image plane paralelllism test. Third clear position.	Email from Keith Taylor 20070914. KT: Maybe a 4th position for a focal-plane filter - sorry! Also, the whole question of "manual" mechanisms is not clear to me - let's discuss.
REQ-62.02	SIFS Pickoff Mirror	Possible provision for small pickoff mirror on Focal Plane Aperture Slide. SIFS fibre bundle input would need to be removed from SIFS input assembly. Could utilise BTFI for acquistion and guiding. Enables simultaneous FP/iBTF imaging and IFU 2D spectroscopy.	TBC. Tentative discussion with KT 20070913. KT: Interesting thought - let's talk to the SIFS folks.
REQ-62.03	FP#1 Etalon Exchange Mechanism	Three position manual slide with manual lock. Clear, Etalon in-Beam and Etalon-Load positions. Ability to easily access the load position from outside the instrument during the night.	
REQ-62.04	FP#1 Etalon Tilt	Manual adjustment of etalon tilt. One axis. 0-5deg range, ±0.5deg accuracy.	
REQ-62.05	FP#1 Etalon Inspection Port	Ability to inspect visually the etalon in the load position. Monochromatic flat field light source, manually switched. Ability to manually adhjust LAM etalon control lerwhile observing etalon inspection port visually.	
REQ-63.01	Fold mirror supports	See also REQ-33.01. Above collimator, two mirrors in a paired configuartion for folding optical path to keep instrument with space envelope. One mirror above iBTF Camera to fold beam from iBTF before entering camera. All mountings can be fixed and aligned once wiht shimming if necessary.	
REQ-64.01	Collimator Optics Mounting	Collimator optics mounted together in cylindrical tube assembly. Optical axis concentric and parallel with mechanical tube axis to ±0.1mm	

REQ-64.02	Collimator Mechanical Mouting	A fixed rigid mechanical support will be used to mount and align the collimator optics tube sub-assembly. Alignment will be achieved by mechanical precision. No displacement or angualr adjustment will be required.	KT: Optical tolerancing study required to define all alignment tolerances
REQ-65.01	iBTF Exchange Mechanism	The iBTF VPH gratings will be mounted and prealigned in individual metal frames (see REQ-41.01). The metal frames will be able to be manually removed and replaced during the night from outside the instrument. A system of precision reference surfaces will allow the VPH gratings cells to repeat their alignment to ±0.1 degree pitch-roll and ±0.5degree yaw.	KT: We need to confirm VPHG alignment tolerances before CoDR
REQ-65.02	iBTF VPH Grating Mounting & Alignment	See REQ-41.01	
REQ-65.03	iBTF VPH Configuration	A pair of VPH gratings will be used in a configuration to achieve the iBTF dispersion cancellation. The first **VPH1** is mounted on-axis. The second **VPH2** is displaced from the instrument axis, by an distance defined by mechanical analysis.	
REQ-65.04	iBTF VPH1 Tilt Mechanisms	VPH1 needs to be tilted about the PITCH axis over a range 25-45 degrees with an accuracy of ±0.1degrees. The tilt motion needs to have motor control and encoding to enable remote operation. It will be moved to setup an observation but will be held fixed during an expose/read cycle.	KT: Need to confirm tolerances
REQ-65.05	iBTF VPH2 Tilt & Displacement Mechanisms	VPH2 needs to be tilted about the PITCH axis over a range 25-45 degrees with an accuracy of ±0.1degrees. VPH2 also needs to be able to translate in the Y direction over a range 0-125mm with a positioning accuracy ±0.5mm. The tilt and displacement motions need to have closed-loop motion control and encoding to enable remote operation. It will be moved to setup an observation but will be held fixed during an exposure.	
REQ-66.01	Pupil Plane Aperture Slide	Two position manual slide. Diameter aperture masks 85mm. Clear position or aperture mask aperture mask with 4 holes 2mm dia on 40mm dia circle. Ability to select one hole at a time by computer controlled rotational mask.	
REQ-66.02	FP#2 Etalon Exchange Mechanism	Three position manual slide with manual lock. Clear, Etalon in-Beam and Etalon-Load positions. Ability to easily access the load position from outside the instrument during the night.	
REQ-66.03	FP#2 Etalon Tilt	Manual adjustment of etalon tilt. One axis. 0-5deg range, ±0.5deg accuracy.	
REQ-66.04	FP#2 Etalon Inspection Port	Ability to inspect visually the etalon in the load position. Monochromatic flat field light source, manually switched. Ability to manually adhjust LAM etalon control lerwhile observing etalon inspection port visually.	
REQ-67.01	Pupil Plane Filter Slide	A manual six position filter slide will be provided in the pupil space immediately after the FP#2 slide. Filter slide to have one clear position and five filter position. Positioning accuracy ±0.5mm. Filters should be easily removed and realigned during the night from outside the instrument. A set of metal filter holder should be used with sufficient filter holders available for all filters see REQ-36.01	
REQ-67.02	Pupil Plane Filter Tilt	A mechanism should be provided to allow the pupil plane filter to be tilted by 0-15deg by means of a manual micrometer adjuster.	
REQ-68.01	Camera Types	as for REQ-35.03 there are two separate cameras of identical design. The first is the FP Camera. The second is the iBTF Camera.	
REQ-68.02	Camera Optics Mounting	Camera optics mounted together in cylindrical tube assembly. Optical axis concentric and parallel with mechanical tube axis to ±0.1mm. Identical design and mounting should be used for both FP and iBTF Cameras. They should be interchnageable.	
REQ-68.03	Camera Mechanical Mouting	A fixed rigid mechanical support will be used to mount and align the camera optics tube sub-assembly. Alignment will be achieved by mechanical precision. No displacement or angualr adjustment will be required. An identical design should be used for both Camera mountings.	KT: Optical tolerancing study required to define all alignment tolerances
REQ-68.04	Camera Shutter	Two mechanical shutter assemblies required, one for each camera. Commercial component. Minimum exposure time 10msec. Accuracy exposure time ±10% Msec. Open-Close state indication.	
REQ-70.00	**DETECTOR SYSTEM**		
REQ-70.01	Cryogenic Cooling	LN2 in at least 30-hour holdtime dewars will be used for optical CCD's.	from SOAR Requirements document June 1998.
REQ-70.02	Number of Detector Systems	Two separate CCD Detector Systems. One for the FP Camera. Second for iBTF. Identical systems which can be run independently	
REQ-72.01	Detector Type & Format	L3CCD/EMCCD Type. E2V Technologies EMCCD# CCD207-40. 1600x1600 pixels. Full-Frame. Back-thiined. 16micron pixels.	Letter Paul Jorden 14 Mar 2006 and Email Paul Jorden E2V Sep 13, 2007
REQ-72.02	Detector Pixels	>15 micron (CCD207-40 has 16 microns)	
REQ-73.01	Camera Head	Detector must be installed in a vacuum sealed chamber, cooled through contact with LN2 can; with window to expose detector to science beam and provisions in terms of connectors for running detector signals and temperature control. Camera head must be integrated mechanically with controller housing	from Dani Guzman 17 Sept 2007
REQ-73.02	Camera Head Cabling	Internal cabling in the camera head must assure a low thermal conduction and high electrical conduction, in order to omply with REQ-70.01. Flex-circuit technology or similar must be used	from Dani Guzman 17 Sept 2007
REQ-73.03	Camera Head Temperature control	detector temperature control must be assured using sensor(s) and actuator(s) at the detector mount, as close as possible to the detector, in order to obtain an accurate temperature measurement. Cabling for this purpose must run independent of other detector cabling, in order to reduce pick up noise and interference from clock signals	from Dani Guzman 17 Sept 2007
REQ-77.01	Detector Controller	Copy of a proven design being used with L3 CCDs. Choice to be made between a modified SDSU controller by Derek Ives ATC and Simon Tulloch, La Palma OR an EMCCD Controller developed by Olivier Daigle at Montreal.	
REQ-77.02	Dual Readout Modes	Ability to operate in either photon counting regime and the more conventional integration regime.	

REQ.-77.03	Detector Controller Cabling	Cabling between camera head hermetic connectors and controller electronic boards must be implemented internally to the controller housing, routing to achieve minimum cable length possible	from Dani Guzman 17 Sept 2007
REQ-80.00	**SOFTWARE**		
REQ-80.01	Package to the control system software	ArcVIEW will be used. We will optimize the code and code the necessary modules.	
REQ-82.01	Manager and router of commands (server)	The ArcVIEW server will provide the required functionality. It will handle all the incoming command and forwards it to the correct module. Also sends the received responses to the client.	
REQ-82.02	Basic and general commands for the instrument	The ArcVIEW server has these general commands (init, get status, set [configuration], etc)	
REQ-83.01	General Purpose and Utility modules	The General Purpose Modules have general functionality and the Utility are modules that make specialized functions (such a data processing)	
REQ-83.02	Communication Protocol	A ArcVIEW module will provide the protocol (TCP/IP) and tools for the client, server and modules communicate with other parts of the system	
REQ-84.01	Hardware Modules	ArcVIEW Modules that controls specific hardware (camera controller, FP, etc)	
REQ-85.01	Client interface	ArcVIEW will provide the necessary to design a client connection within a graphical interface.	
REQ-85.03	Status information	shows: - the status of the detector; - the status of the connection to the server; - the current L3CCD mode operation; - the parameters entered for the current data cube; - coordinates: the coordinates will come from the TCS (right ascension, UTC, airmass, etc); - progress of exposure, readout and writer; - temperature and pressure.	
REQ-85.04	Operations	- selection of the L3CCD mode operation; - picture parameters; - take exposure; - stop exposure and save; - stop exposure and discard;	
REQ-85.05	Engineering Graphical Interface	This interface should show: - Current Setup: current setup information (location of the temperature sensors, number and location of detectors, positioning of the Fabry-Perot etalon and angle of VPH) - View Log file of everything happening on the instrument - Readings from temperature sensors in the cameras - A field to enter low level commands	
REQ-86.01	Data Reduction Pipeline	The BTFI data is intrinsically 3D. This requires both quick-look single-frame data to be viewed on-line and after-the-cube pipeline data reduction for during-the-night data assessment. The pipeline has also to be engineered so that it can be used for calibration and alignment purposes both for the FPs and iBTF.	KT 15 Sept 2007. Note from Claudia's meeting Jul 24th/2007Philippe informed that a quick-look tool already exists with ADHOC and that a new program inside IDL has been recently written which does everything in an automatic way. I have seen this program in IDL working and it is very impressive. The reduction of a datacube can be done in a few minutes with a user friendly interface. It is still necessary to fix the format the data will be in (FITS or something else, for 3D NTT).
REQ-86.02	Real Time Quick look	During the observation, the ICS must show the option to show or not show in real-time the acquisition of data cube	
REQ-87.01	Data Archiving	SOAR should archive all raw data and calibration frames, as well as the reduced-data products delivered by the operations team. We should at a minimum provide a means of recalling such data on an occasional basis (e.g. when the first distribution is accidently lost or destroyed.) However, the intent is not to provide a full retrieval archive at the level provided by e.g. HST or Gemini.	from SOAR Requirements document June 1998
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REQ-87.02	Data cube in FITS format	The FITS is a robust format that can fill the requirements of the data cube	
REQ-87.03	FITS Headers	The header must be the most complete possible, with the principal parameters of the observation, such as coordinates x, y and time tag of the event in each frame, scanning wavelength, name of the object, etc.	
REQ-90.00	**INTEGRATION, TEST & OPERATIONS**		
REQ-95.01	Nighttime science operations support	Will require an experience FP/iBTF science observer present during every BTFI run.	
REQ-96.01	Nighttime technical operations support	An experience technical person will need to be present during nights when the FP/iBTF are swapped to assist with alignment and calibration..	