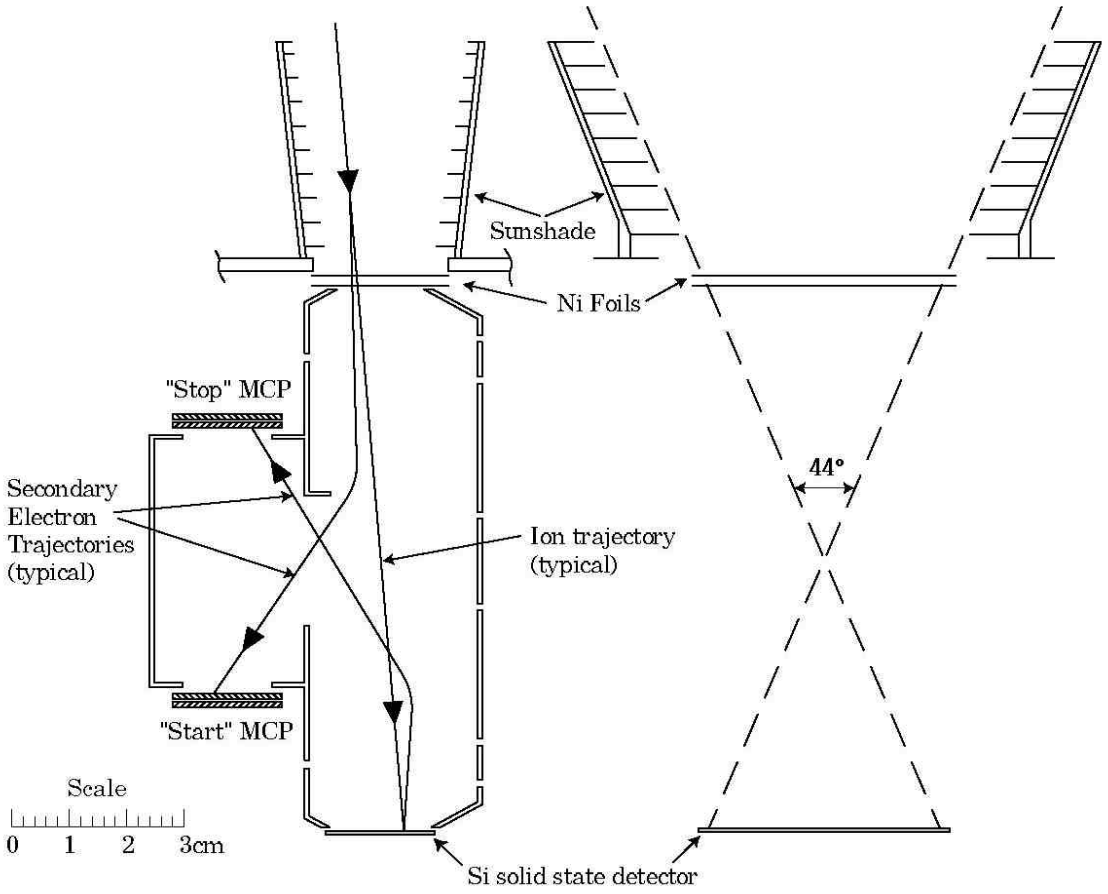
SUPRATHERMAL ION TELESCOPE

SIT

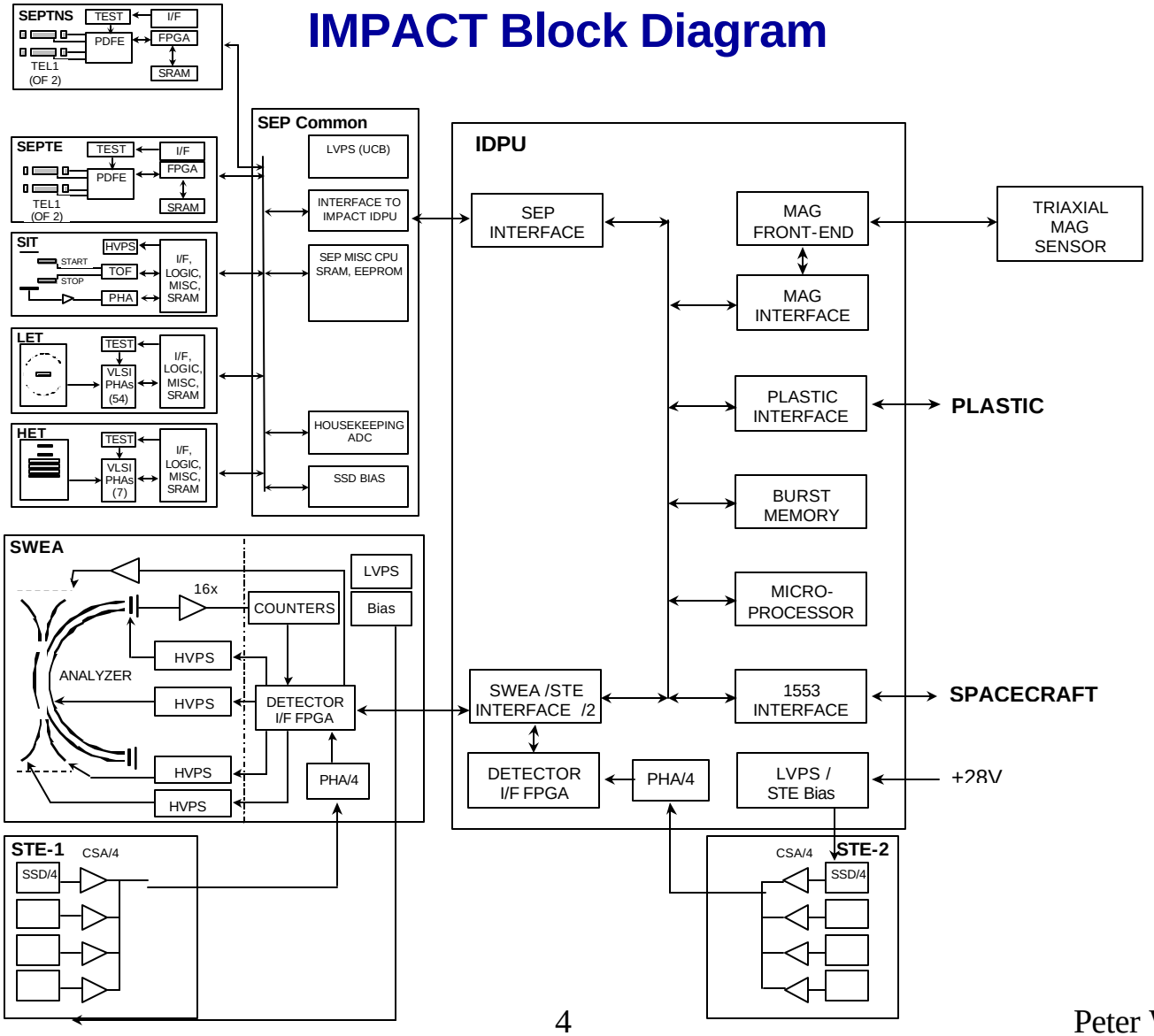
WHAT IS IT?

- **Charged Particle Measuring Instrument**
  - **He - Fe, 30 - 2000 keV/Nuc**
- **Single "Telescope" measures Time-of-Flight vs. Energy**
  - **TOF --> velocity**
  - **velocity and energy --> mass**
- **Solid State Silicon Detector - provides energy measurement**
  - **conventional surface barrier**
- **Microchannel plates - START and STOP signals from secondary electrons**
  - **chevron pairs, ~1000v bias per plate**
- **Thin entrance foils - 1000Å Ni (each foil)**

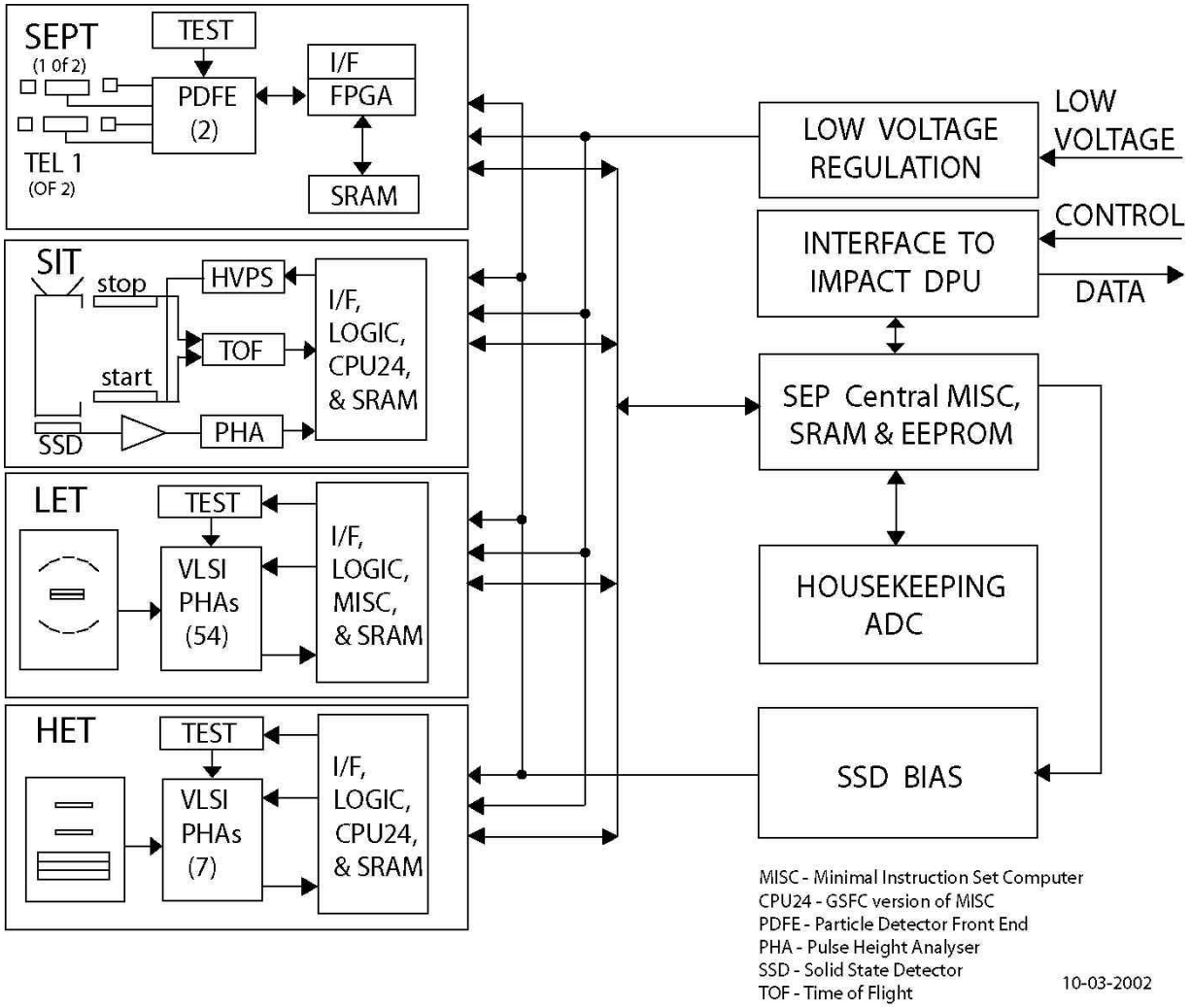
Suprathermal Ion Telescope (SIT)



IMPACT Block Diagram



SEP Block Diagram

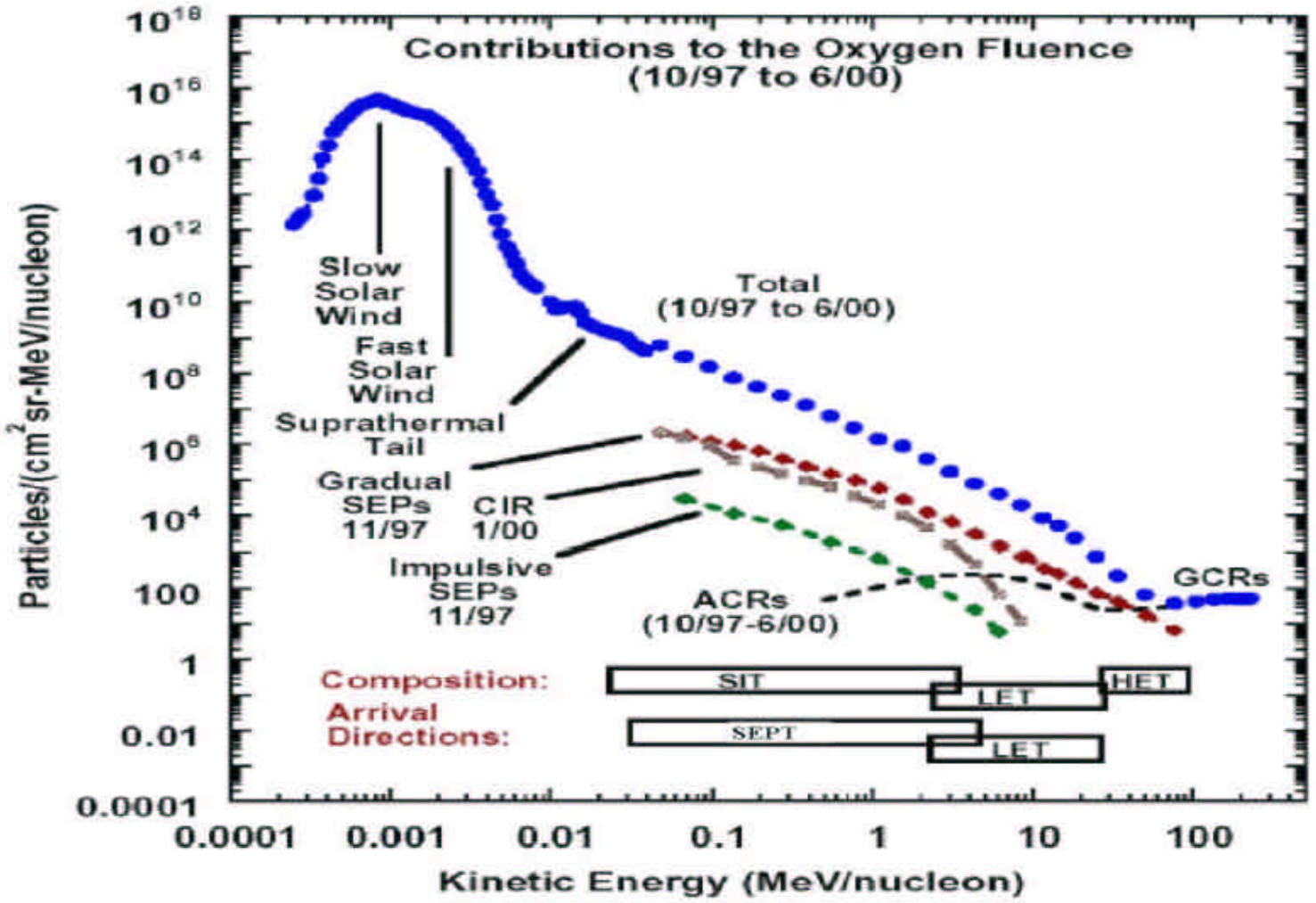


Science Requirements

• Level 1 science requirements (also called science measurements) are flowed down to the Instruments in the Mission Requirements Document (460- RQMT- 0001).

Science Objectives	(Level 1 Requirements)	Instrument Requirement
Discover the mechanisms and sites of energetic particle acceleration in the low corona and the inter-planetary medium.	F. Characterize distribution functions for particles of interest with energies typical of solar energetic particle populations. G. Determine the location of particle acceleration in the low corona and through the interplanetary medium.	"IMPACT/SEP F,G Measure the intensity, composition,and energy spectra, and direction of energetic ions and electrons from two vantage points, including protons from 0.02 to 100 MeV,heavier ions from ~0. 03 to to 50MeV/ nuc, electrons from ~0. 02 to 6MeV, and 3He- rich solar particle events."

Science Requirements (cont.)



PERFORMANCE REQUIREMENTS

• From the Science Requirements was generated the IMPACT Performance Specification which lists the SIT Performance Requirements

3.4. *SIT Requirements*

Description	Goal	Requirement
FOV	17 x 44 degrees	17 x 44 degrees
Energy	30-2,000 keV/nuc He-Fe	30-2,000 keV/nuc He-Fe
Mass Resolution	0.85 AMU (^{16}O at 100keV/nuc)	0.85 AMU (^{4}He at 1MeV/ Nuc)
Energy Resolution	20keV FWHM	35keV FWHM @ 22C
Geometric Factor	0.4 cm^2 ster	0.4 cm^2 ster
Background	10^{-2} events/sec in quiet time	10^{-2} events/sec during vac test
Max Event Rate	1000 events/sec	1000 events/sec
Time Resolution	1 Minute	15 Minutes

From: IMPACTPerformanceSpec_F.doc
Version F – 2001-Sep-07

APPLICABLE DOCUMENTS

- Phase A Study for the IMPACT Investigation on STEREO, Volume 1: Tech. Sect., dated July, 2000
- STEREO Mission Requirements Document
- STEREO EMI/EMC Control Plan, JHU/APL 7381-9030
- STEREO Contamination Control Plan, JHU/APL 7381-9040
- STEREO Environments Definition, Observatory, Component and Instrument & Test Requirements Document, JHU/APL 7381-9003
- STEREO IMPACT Interface Control Document, JHU/APL 7381-9011
- STEREO Mission Risk Management Plan
- STEREO IMPACT Performance Assurance Implementation Plan (PAIP)
- STEREO IMPACT Configuration Management Plan
- SIT-SEP_Central Interface Control Document
- SIT Instrument Logic Interface Definition Document, UMd
- SIT Front-End Logic Specification, Rev.3
- SEP HET and SIT Flight Software Development Plan, GSFC
- SIT CPU24 Flight Software Requirements
- Design Considerations for the STEREO/IMPACT/SEP/SIT
- CPU24 MISC Microprocessor Users Manual
- SEP Sensor Suite Commanding and Users Manual, STEREO-CIT-007.A

INTERFACES TO S/C

- **MECHANICAL – managed by Sandy Shuman at GSFC**
  - **Dwg 2053410 (GSFC) ICD SEP/SIT Instrument Stereo Ahead S/C**
  - **Dwg 2053440 (GSFC) ICD SEP/SIT Instrument Stereo Behind S/C**
- **THERMAL – handled by John Hawk at GSFC**
- **PURGE – 5 liters/hour, restrictor in SIT telescope**
- **“PYRO” – TiNi actuator to unlach SIT acoustic cover after launch.**

INTERFACES TO SUITE

- **All electrical interfaces are to SEP Central except “Pyro”**
  - **POWER**
  - **DATA**
- **Interface document “SIT-SEP Central ICD”**

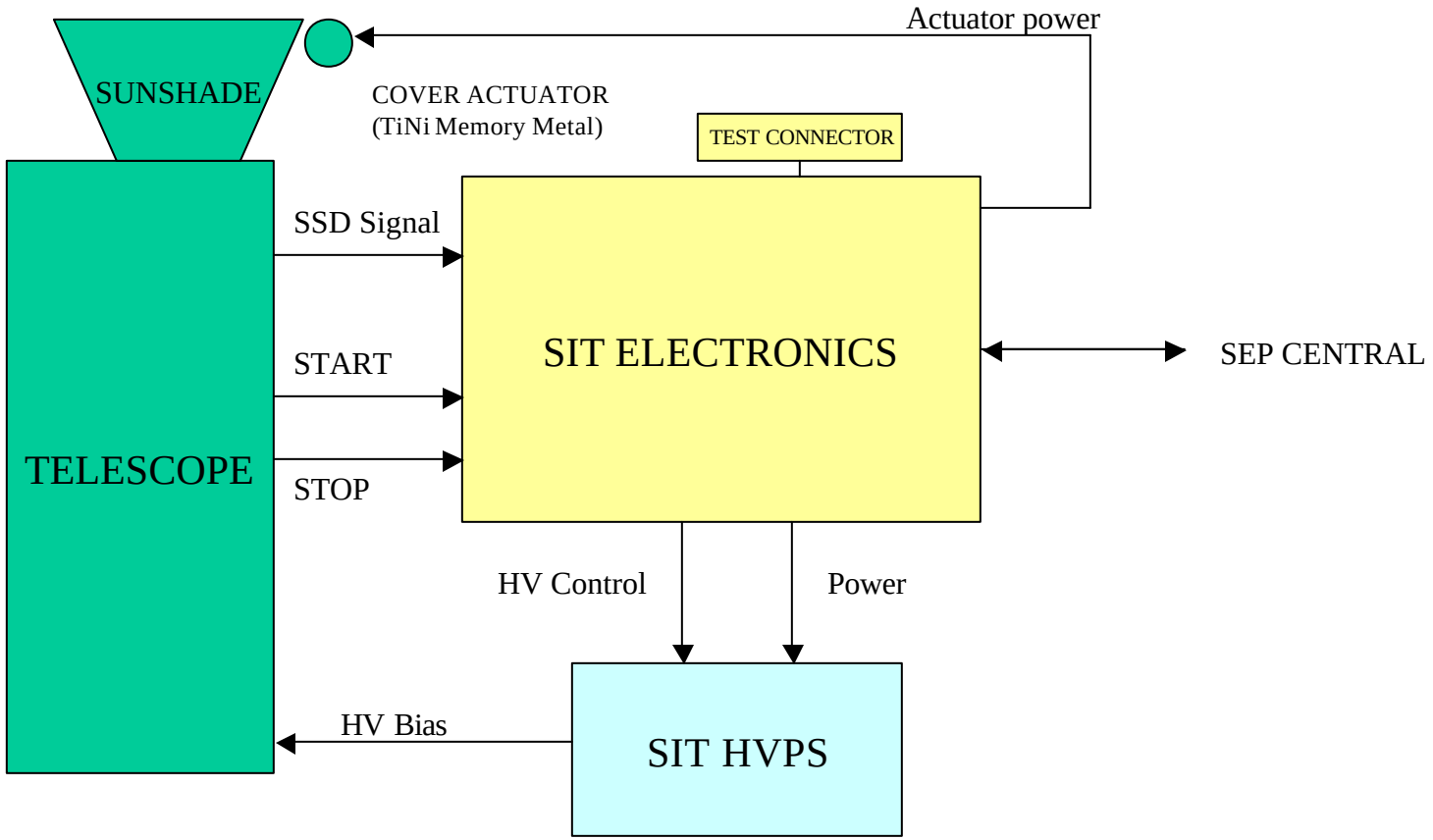
RESPONSIBILITIES - Who Does What? (Outline)

- **UNIVERSITY OF MARYLAND (UMd)**
  - Overall design
  - Supply SSDS and MCPs
  - SIT test, integration and calibration
- **MAX-PLANK-INSTITUT fuer AERONOMIE (MPAe)**
  - Supply tested TOF electronics
- **UNIVERSITY OF CALIFORNIA at BERKELY (UCB)**
  - Supply tested HVPS
- **GODDARD SPACE FLIGHT CENTER (GSFC)**
  - Supply mechanical designs and components (telescope, electronics boxes)
  - Assemble electronics boards and mechanical components
  - Logic design realization in Actel with MISC
  - Flight software

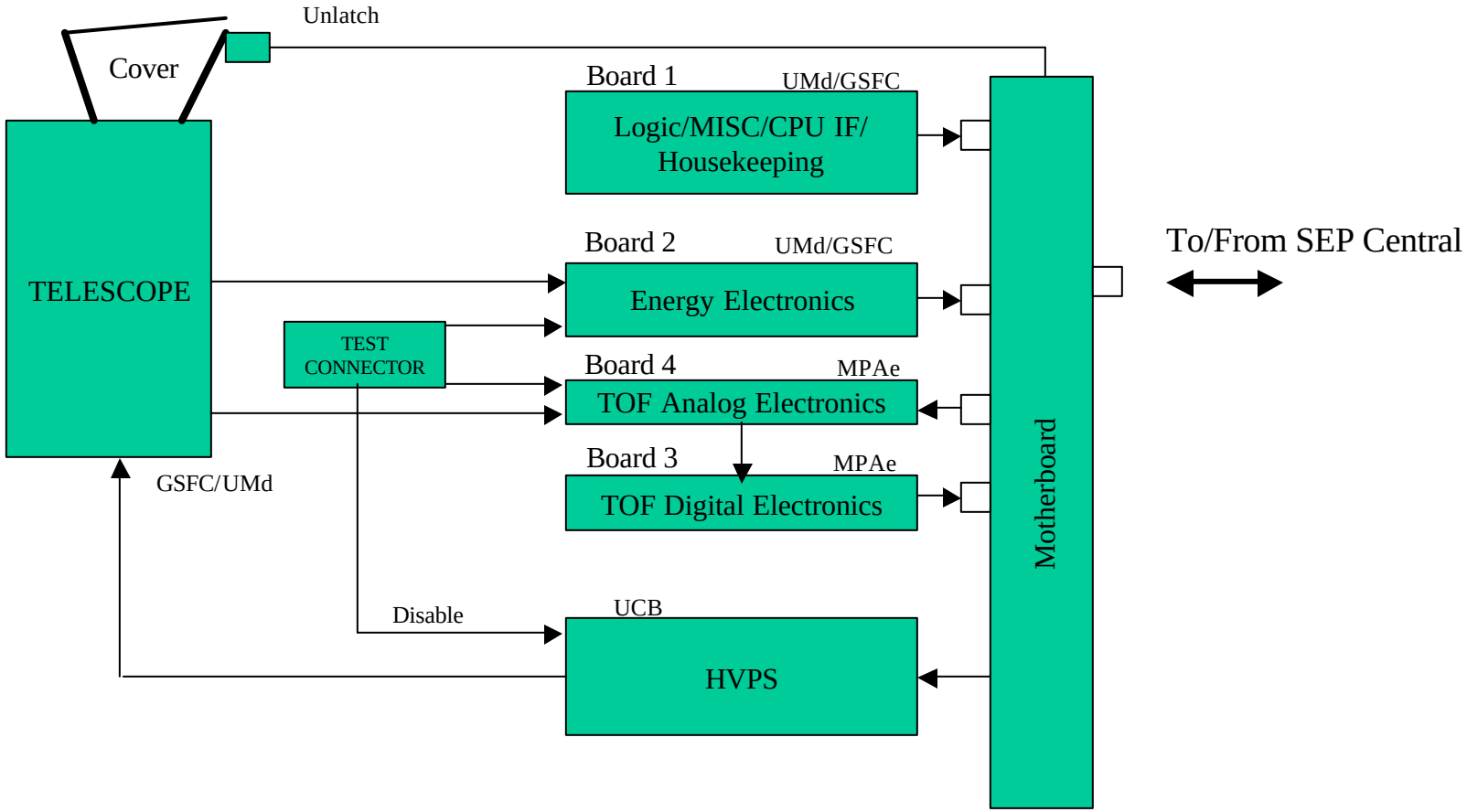
SIT SPECIFIC REVIEW HISTORY/ ACTION ITEM STATUS

- **SEP Peer Review**
  - **RFAs resolved**
- **PDR**
  - **RFAs resolved**
- **SIT Peer Reviews:**
  - **HET/SIT S/W Review – Aug 2002**
    - **Some items still being worked (Nov. 6, 2002)**
  - **SIT Door Review (Nov 15 2002)**

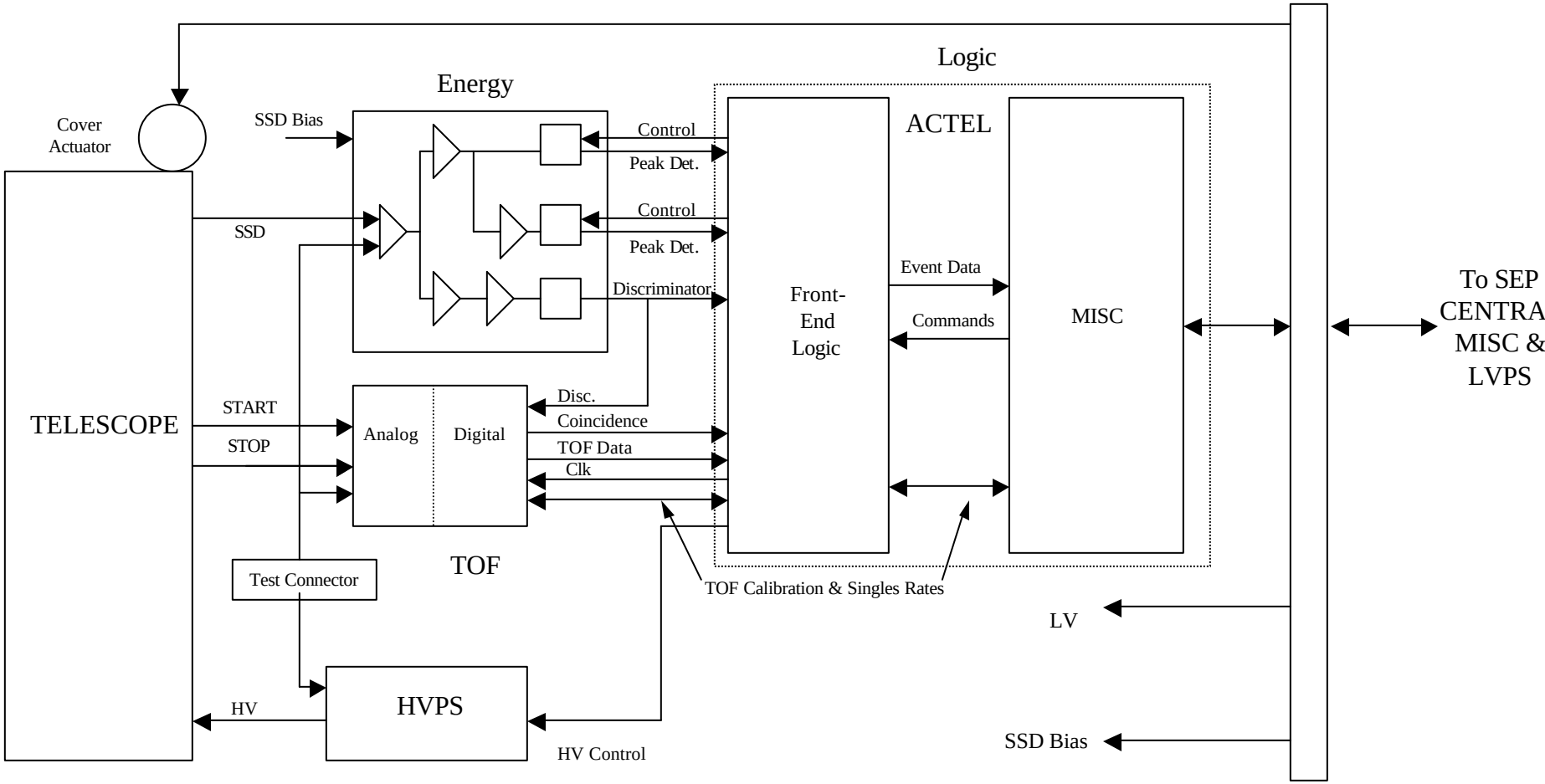
Instrument Description



SIT BOX-LEVEL BLOCK DIAGRAM



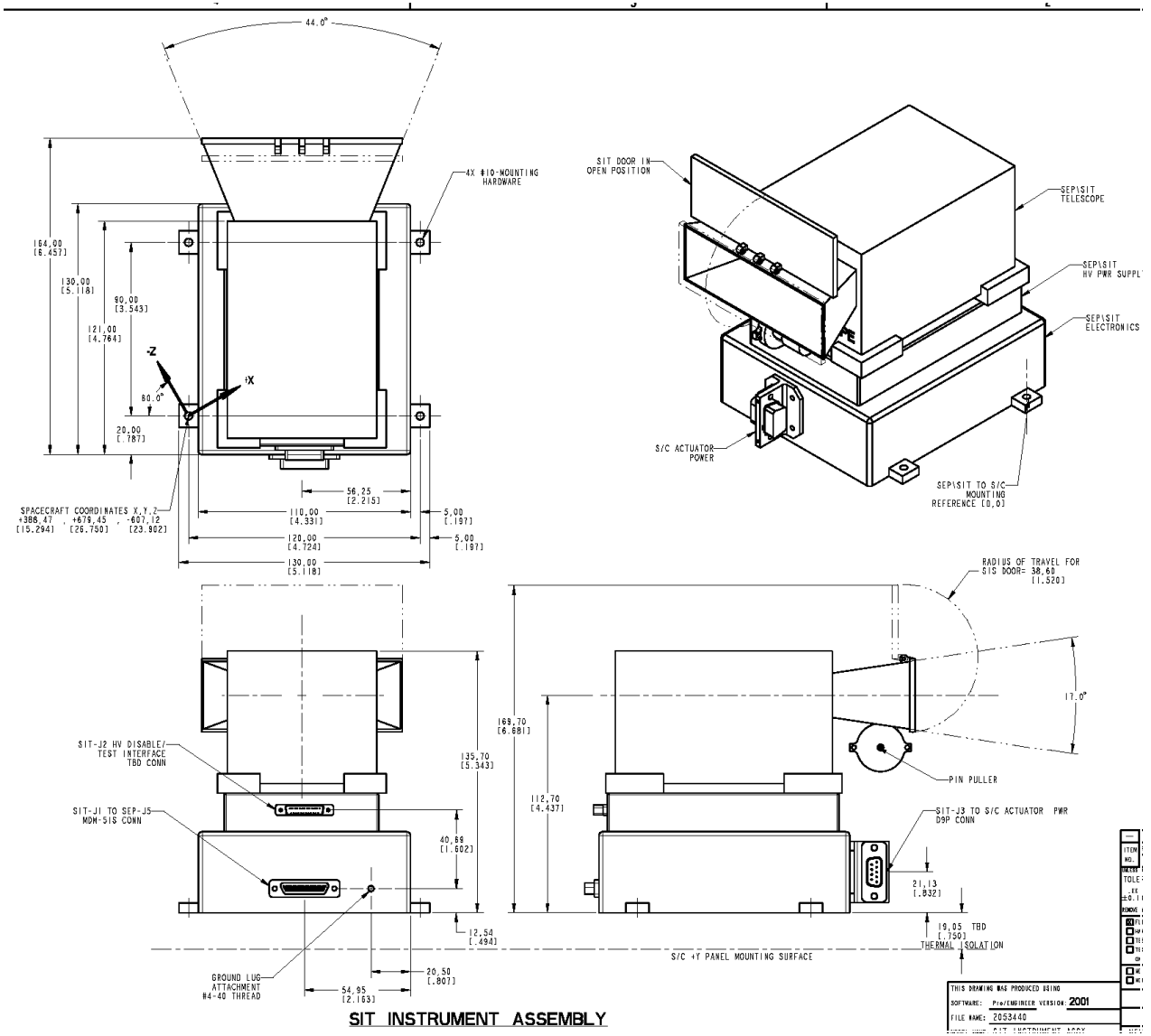
SIT BOARD-LEVEL BLOCK DIAGRAM



SIT FUNCTIONAL BLOCK DIAGRAM

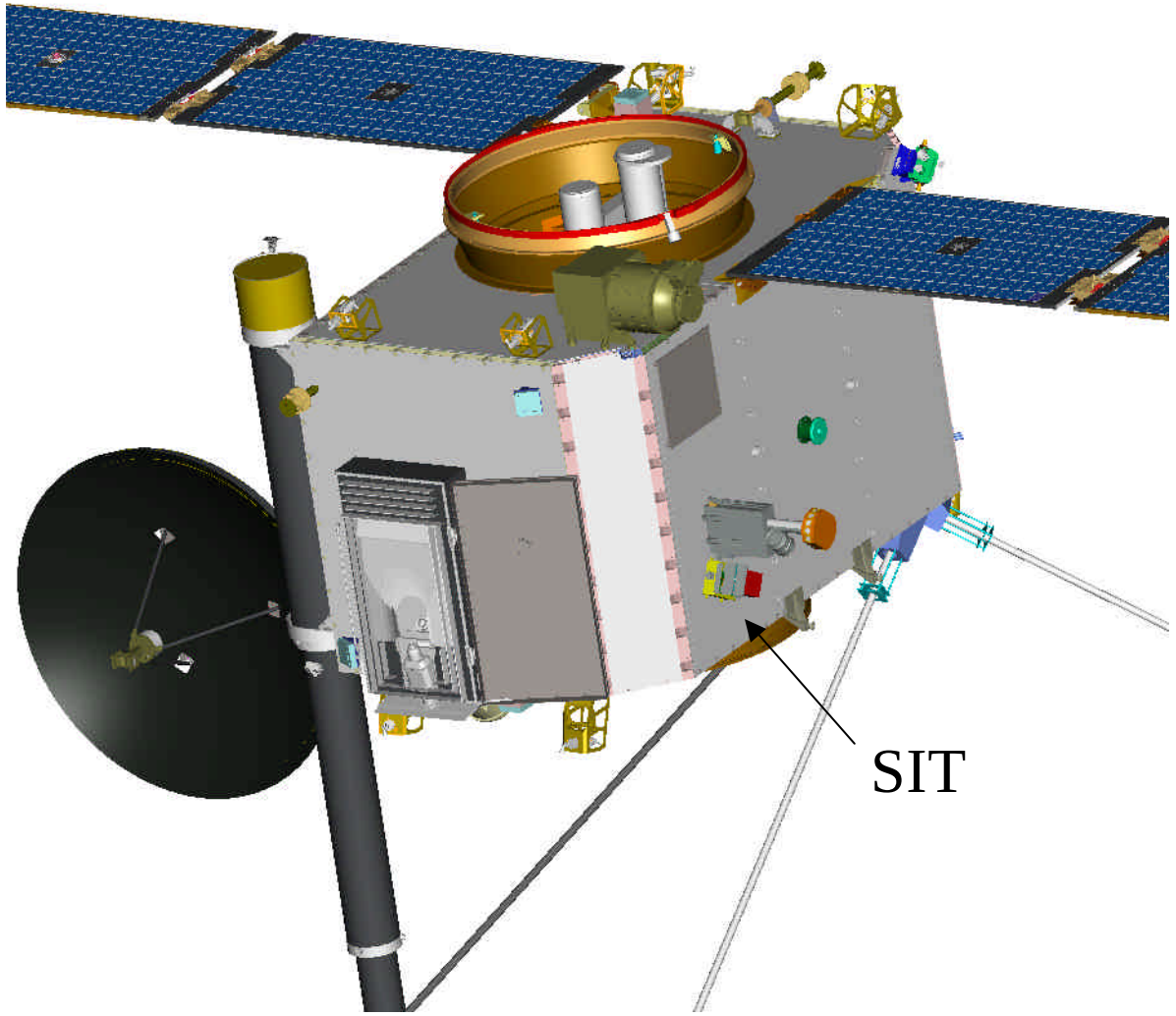
HERITAGE

- **Concept**
  - **TOF / Energy instrument for measuring supra-thermal energetic particles, very similar to STEP instrument on WIND/EPACT**
- **Telescope**
  - **Identical sensor elements and interior design to STEP instrument**
- **Energy Electronics**
  - **Similar design to STEP, realized in Amptek hybrids, which we have flown on SAMPEX, ACE and other missions.**
- **TOF Electronics**
  - **Analog electronics (amplifier, CFD) design was flown on STEP. Built for SIT by MPAe.**
  - **Digital electronics (time-digital converter) new design by TUB**
- **HVPS**
  - **Based on successful HESSI design at UCB**



SIT INSTRUMENT ASSEMBLY

SIT Location on Front S/C



Design Status

MAJOR DESIGN ELEMENTS

- **TELESCOPE**
  - **Telescope and sunshade**
  - **Acoustic cover and mechanism**
- **HVPS**
  - **Electronics**
  - **Housing**
- **ELECTRONICS BOX**
  - **Electronics**
  - **Housing**
- **GSE**
  - **Electrical**
  - **Mechanical**
- **THERMAL DESIGN**

TELESCOPE DESCRIPTION & STATUS

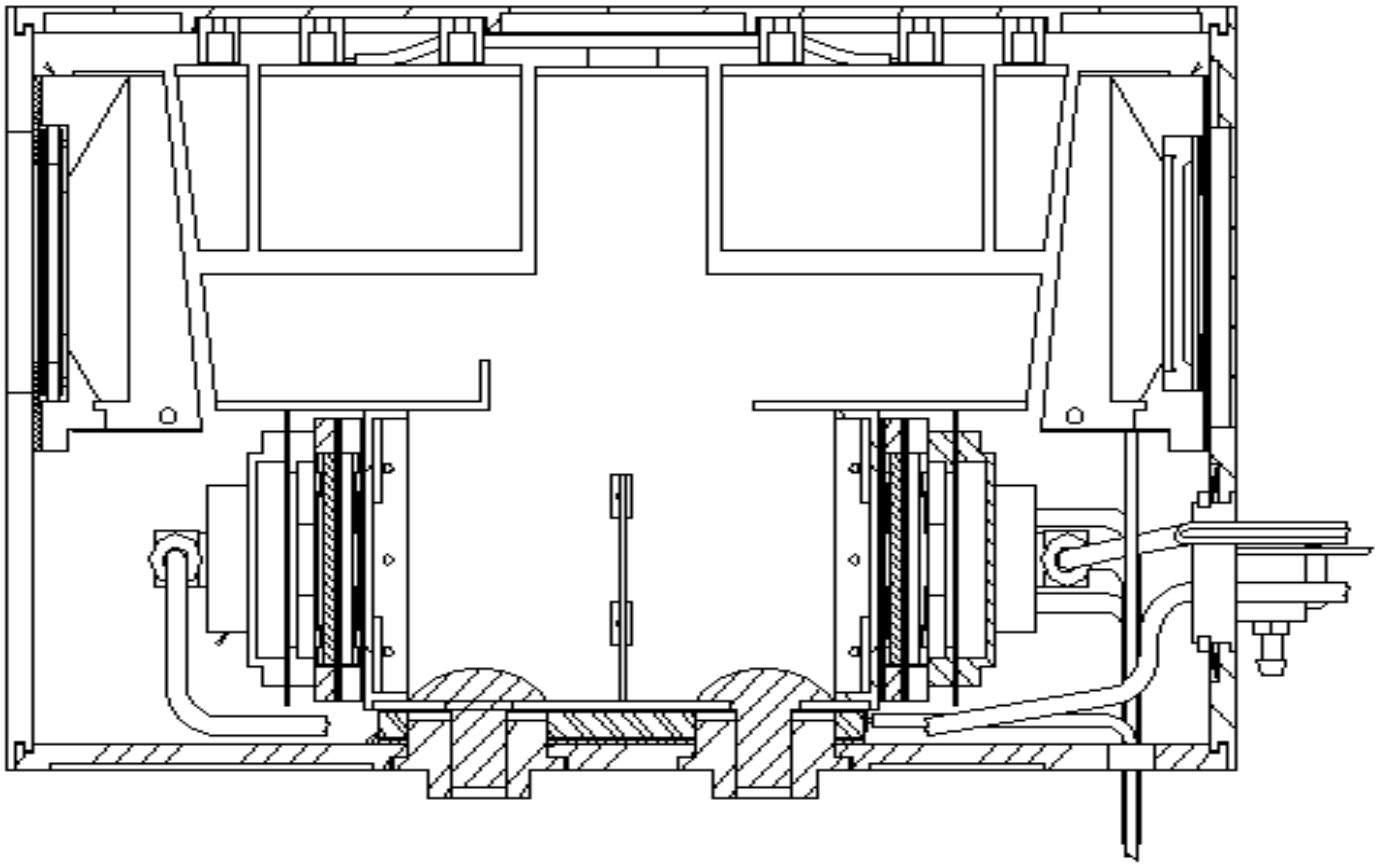
- **TELESCOPE**
  - **Heritage from WIND/EPACT/STEP**
  - **Modifications to mounting and sunshade**
  - **Prototype built from STEP spares exists and is working and being used in ETU testing at UMd**

- **Sunshade**
  - **Keeps solar UV out of telescope FOV**

- **Acoustic Cover and mechanism**
  - **Protects thin foils from damage and from launch acoustic environment**
  - **Spring mechanism to open, opens once after launch, quiescent thereafter**
  - **Unlatch mechanism – TiNi actuator**

- **Flight design Status – Internal designs complete and many components on hand. Modifications to telescope outer surfaces for mounting and sunshade/acoustic cover design to proceed after CDR.**

SIT Telescope Cross Section



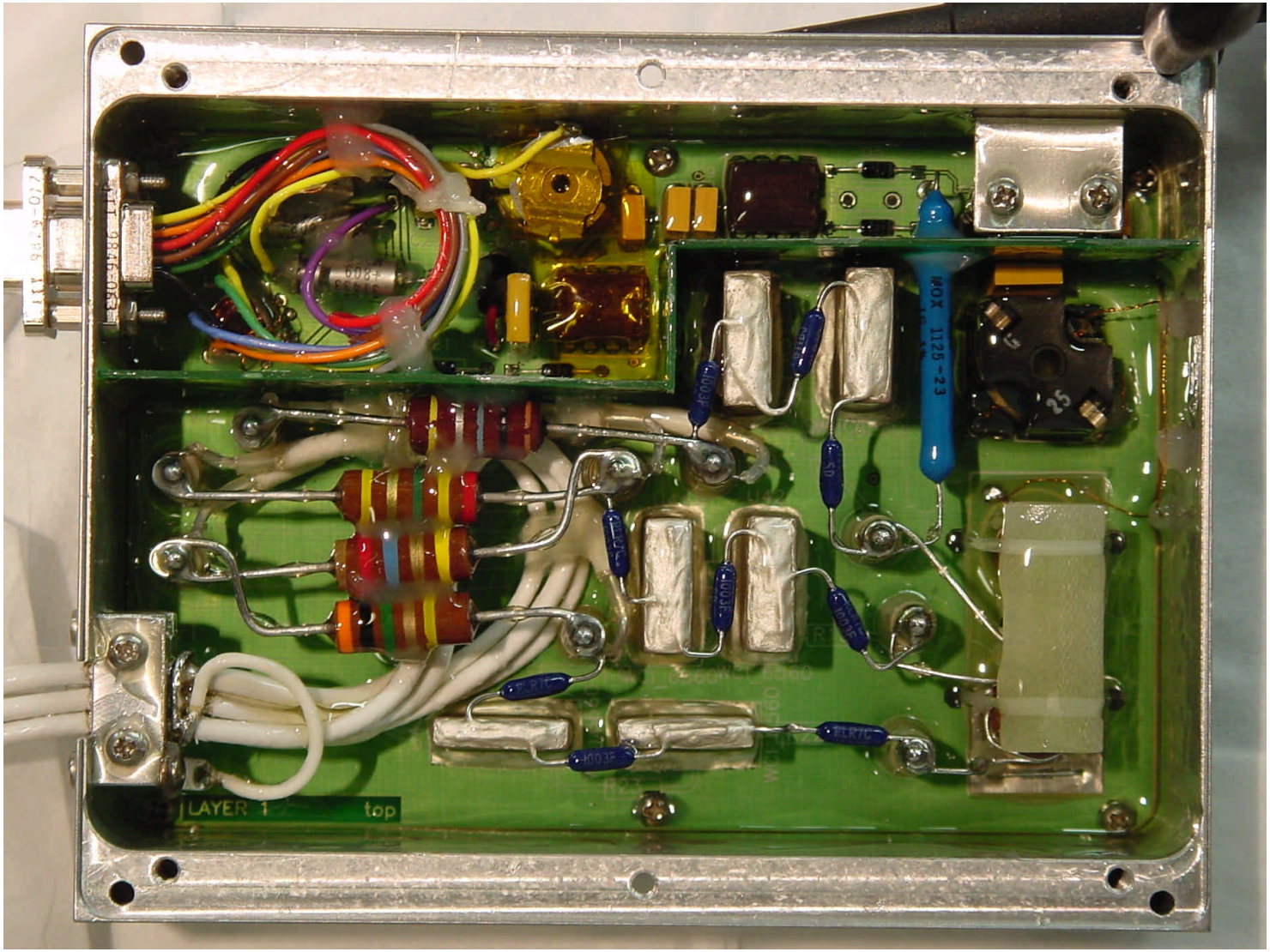
HVPS STATUS

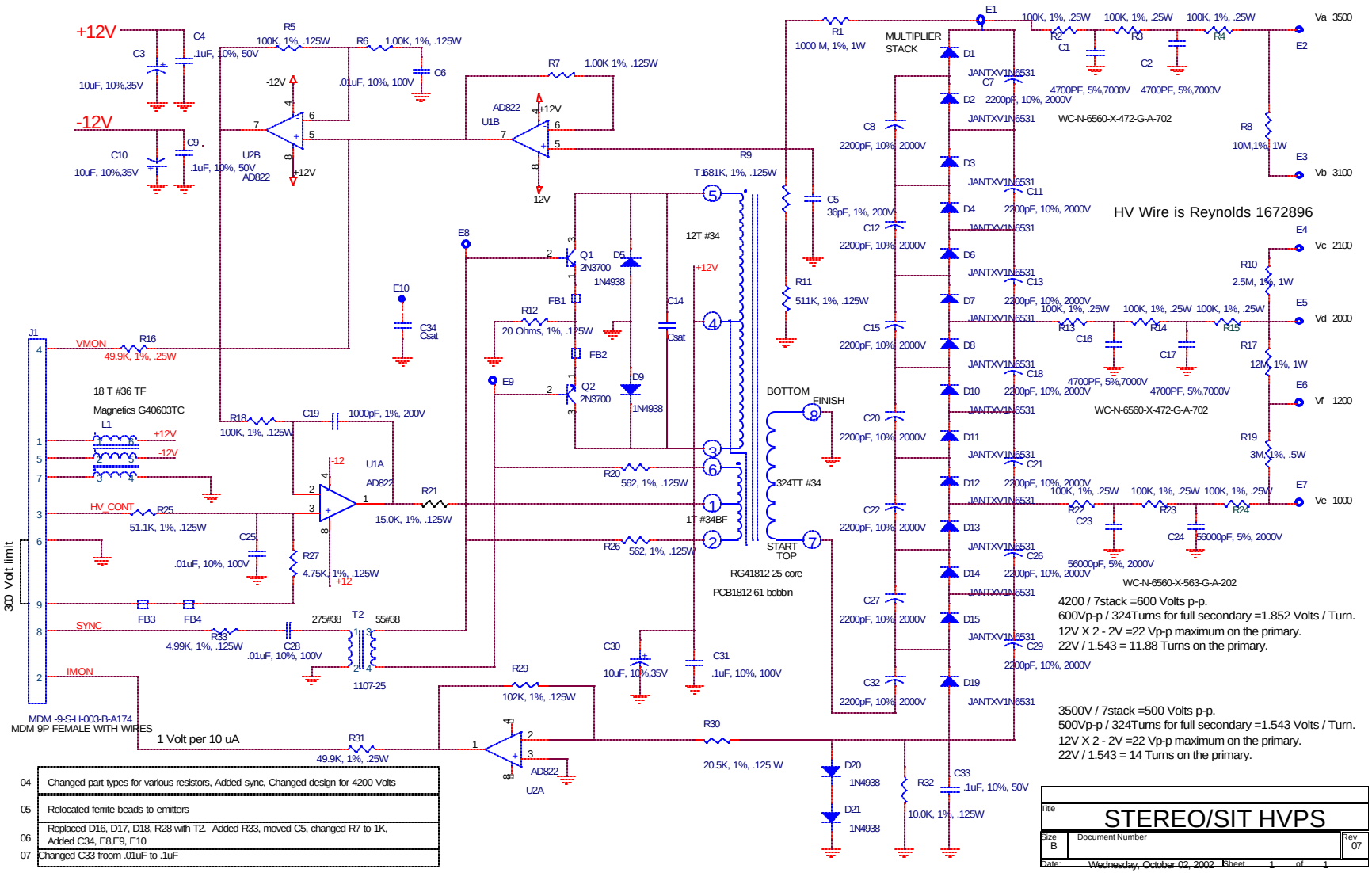
- **Housing**
  - **Preliminary design complete**
  - **ETU constructed**

- **Electronics**
  - **ETU Design complete**

  - **ETU completed and tested at UCB**
    - **currently under test at UMd**
    - **Some design changes may be required as result of testing**

TU HVPS




+12V
-12V
C4 .1uF, 10%, 50V
C3 10uF, 10%,35V
C10 10uF, 10%,35V
C9 .1uF, 10%, 50V
R5 100K, 1%, .125W
R6 1.00K, 1%, .125W
C6 .01uF, 10%, 100V
U2B AD822
R7 1.00K 1%, .125W
U1B AD822
R9 T1681K, 1%, .125W
R1 1000 M, 1%, 1W
MULTIPLIER STACK
E1
100K, 1%, .25W
100K, 1%, .25W
100K, 1%, .25W
Va 3500
E2
C1
C2
4700PF, 5%,7000V
4700PF, 5%,7000V
R8 10M,1%, 1W
E3
Vb 3100
D1 JANTXV1N6531
D2 JANTXV1N6531
D3 JANTXV1N6531
D4 JANTXV1N6531
D6 JANTXV1N6531
D7 JANTXV1N6531
D8 JANTXV1N6531
D10 JANTXV1N6531
D11 JANTXV1N6531
D12 JANTXV1N6531
D13 JANTXV1N6531
D14 JANTXV1N6531
D15 JANTXV1N6531
D19 JANTXV1N6531
C7 2200pF, 10%, 2000V
C8 2200pF, 10%, 2000V
C11 2200pF, 10%, 2000V
C12 2200pF, 10%, 2000V
C13 2200pF, 10%, 2000V
C15 2200pF, 10%, 2000V
C18 2200pF, 10%, 2000V
C20 2200pF, 10%, 2000V
C21 2200pF, 10%, 2000V
C22 2200pF, 10%, 2000V
C26 2200pF, 10%, 2000V
C27 2200pF, 10%, 2000V
C29 2200pF, 10%, 2000V
C32 2200pF, 10%, 2000V
WC-N-6560-X-472-G-A-702
WC-N-6560-X-563-G-A-202
HV Wire is Reynolds 1672896
E4
Vc 2100
R10 2.5M, 1%, 1W
E5
Vd 2000
R13 100K, 1%, .25W
R14 100K, 1%, .25W
R15 100K, 1%, .25W
C16
C17
4700PF, 5%,7000V
4700PF, 5%,7000V
R17 12M, 1%, 1W
E6
Vf 1200
R19 3M, 1%, .5W
E7
Ve 1000
R22 100K, 1%, .25W
R23 100K, 1%, .25W
R24 100K, 1%, .25W
C23
C24 56000pF, 5%, 2000V
56000pF, 5%, 2000V
E8
E9
E10
Q1 2N3700
Q2 2N3700
D5 1N4938
D9 1N4938
FB1
FB2
R12 20 Ohms, 1%, .125W
C14 Csat
C34 Csat
12T #34
+12V
R11 511K, 1%, .125W
C5 36pF, 1%, 200V
BOTTOM FINISH
324TT #34
1T #34BF
START TOP
RG41812-25 core
PCB1812-61 bobbin
R20 562, 1%, .125W
R26 562, 1%, .125W
J1
VMON
R16 49.9K, 1%, .25W
18 T #36 TF
Magnetics G40603TC
L1
+12V
-12V
R18 100K, 1%, .125W
C19 1000pF, 1%, 200V
U1A AD822
R21 15.0K, 1%, .125W
HV_CONT
R25 51.1K, 1%, .125W
C25 .01uF, 10%, 100V
R27 4.75K, 1%, .125W
300 Volt limit
FB3
FB4
SYNC
R33 4.99K, 1%, .125W
C28 .01uF, 10%, 100V
T2
275#38
55#38
1107-25
IMON
MDM -9-S-H-003-B-A174
MDM 9P FEMALE WITH WIRES
1 Volt per 10 uA
R31 49.9K, 1%, .25W
U2A AD822
R29 102K, 1%, .125W
C30 10uF, 10%,35V
C31 .1uF, 10%, 100V
R30 20.5K, 1%, .125 W
D20 1N4938
D21 1N4938
R32 10.0K, 1%, .125W
C33 .1uF, 10%, 50V
4200 / 7stack =600 Volts p-p.
600Vp-p / 324Turns for full secondary =1.852 Volts / Turn.
12V X 2 - 2V =22 Vp-p maximum on the primary.
22V / 1.543 = 11.88 Turns on the primary.
3500V / 7stack =500 Volts p-p.
500Vp-p / 324Turns for full secondary =1.543 Volts / Turn.
12V X 2 - 2V =22 Vp-p maximum on the primary.
22V / 1.543 = 14 Turns on the primary.
04 Changed part types for various resistors, Added sync, Changed design for 4200 Volts
05 Relocated ferrite beads to emitters
06 Replaced D16, D17, D18, R28 with T2. Added R33, moved C5, changed R7 to 1K, Added C34, E8,E9, E10
07 Changed C33 froom .01uF to .1uF
Title
STEREO/SIT HVPS
Size B
Document Number
Rev 07
Date: Wednesday, October 02, 2002
Sheet 1 of 1

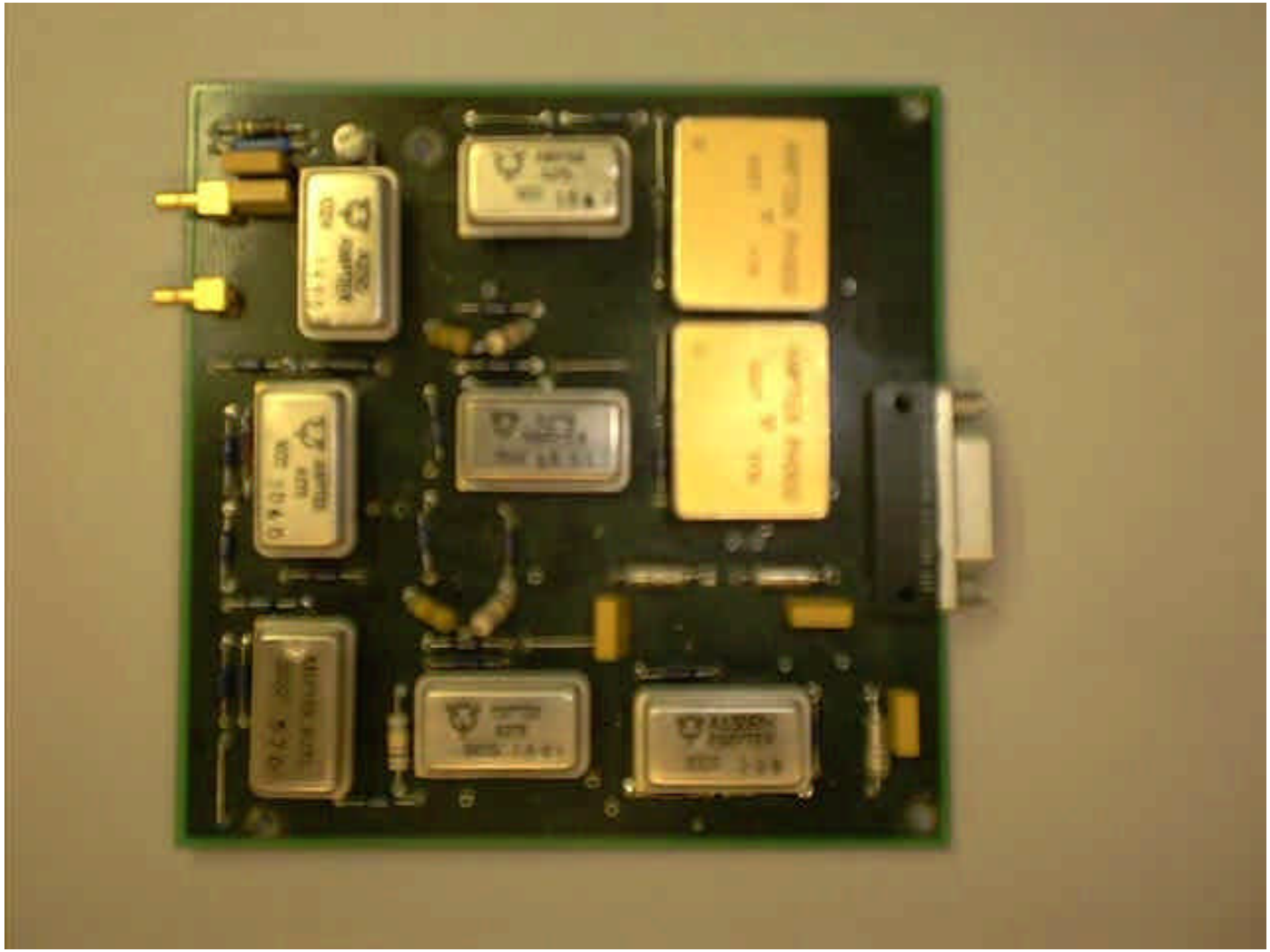
ELECTRONICS BOX STATUS

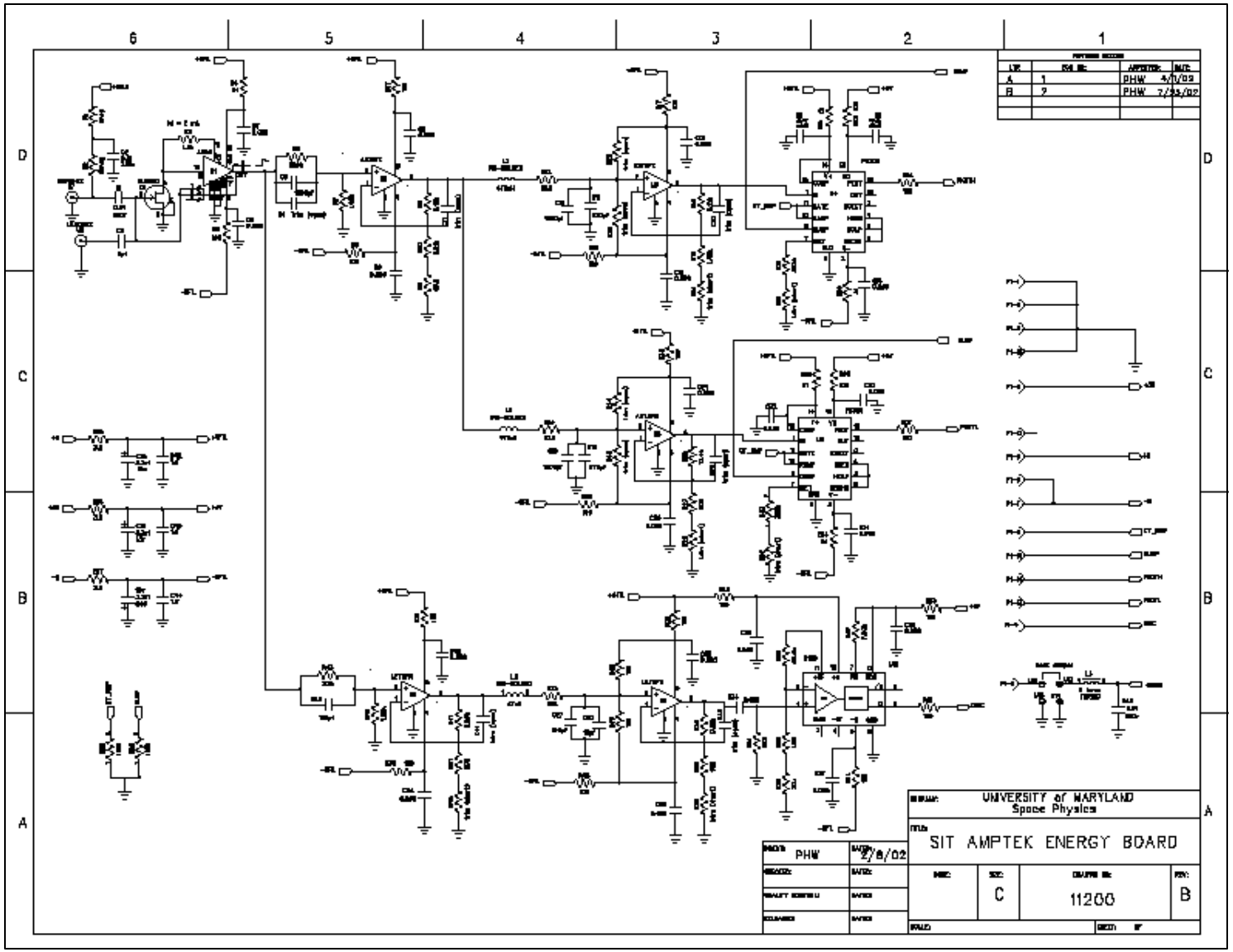
- Housing
  - Preliminary design complete
  - Design to be finalized after CDR
- Electronics
  - Energy Board
  - TOF System
    - Analog Board
    - Digital Board
  - Logic Board
    - Front-End Logic
    - MISC
    - Flight Software
    - Housekeeping/Heater Control
  - Mother Board

ELECTRONICS BOX ELECTRONICS STATUS

- **Energy System**
  - **Design complete**
  - **Prototype built and tested at UMd**
  - **Flight layout performed, will build up ETU**

Prototype Energy Board

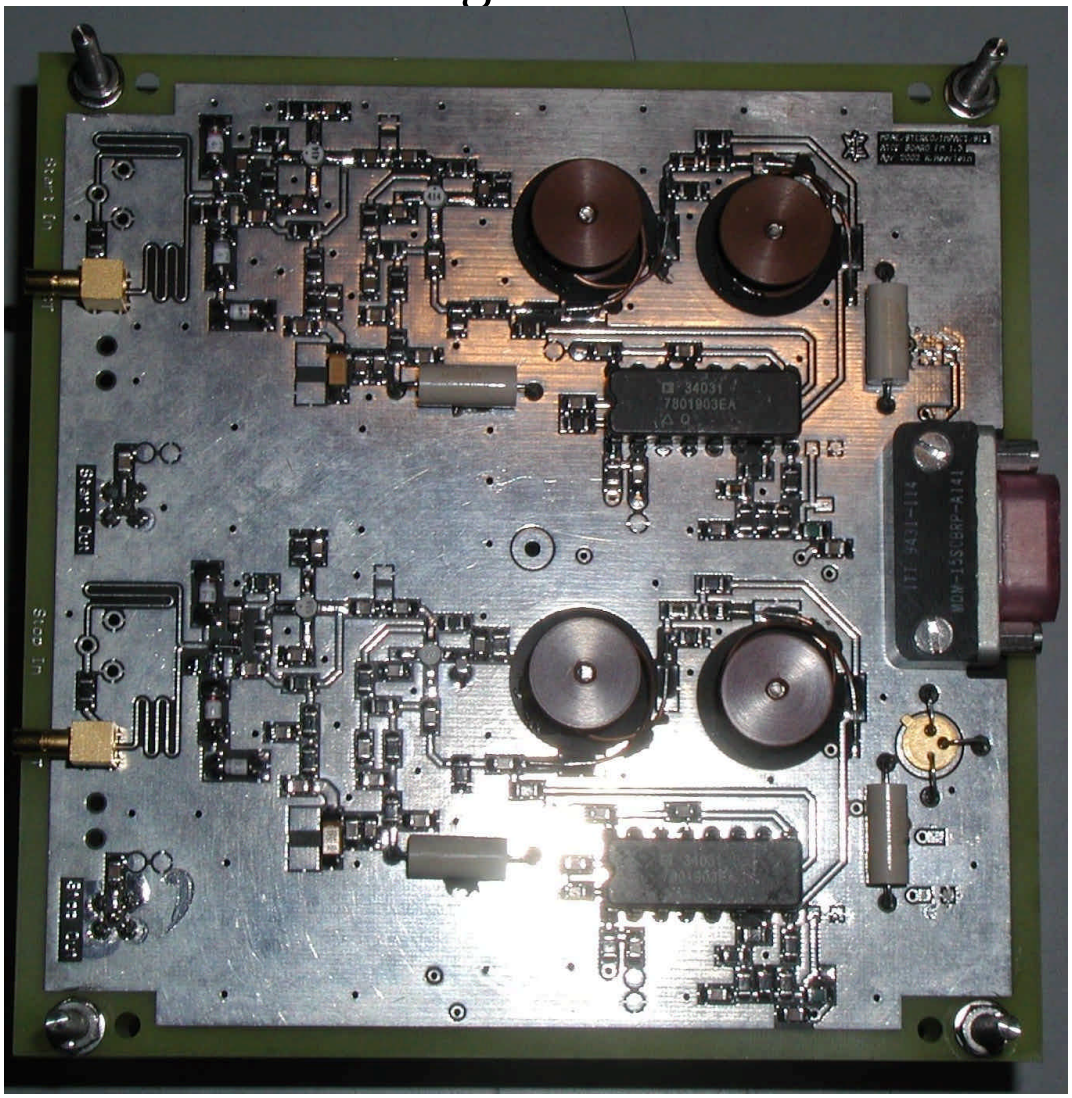



UNIVERSITY of MARYLAND
Space Physics
SIT AMPTEK ENERGY BOARD
11200
C
B
PHW

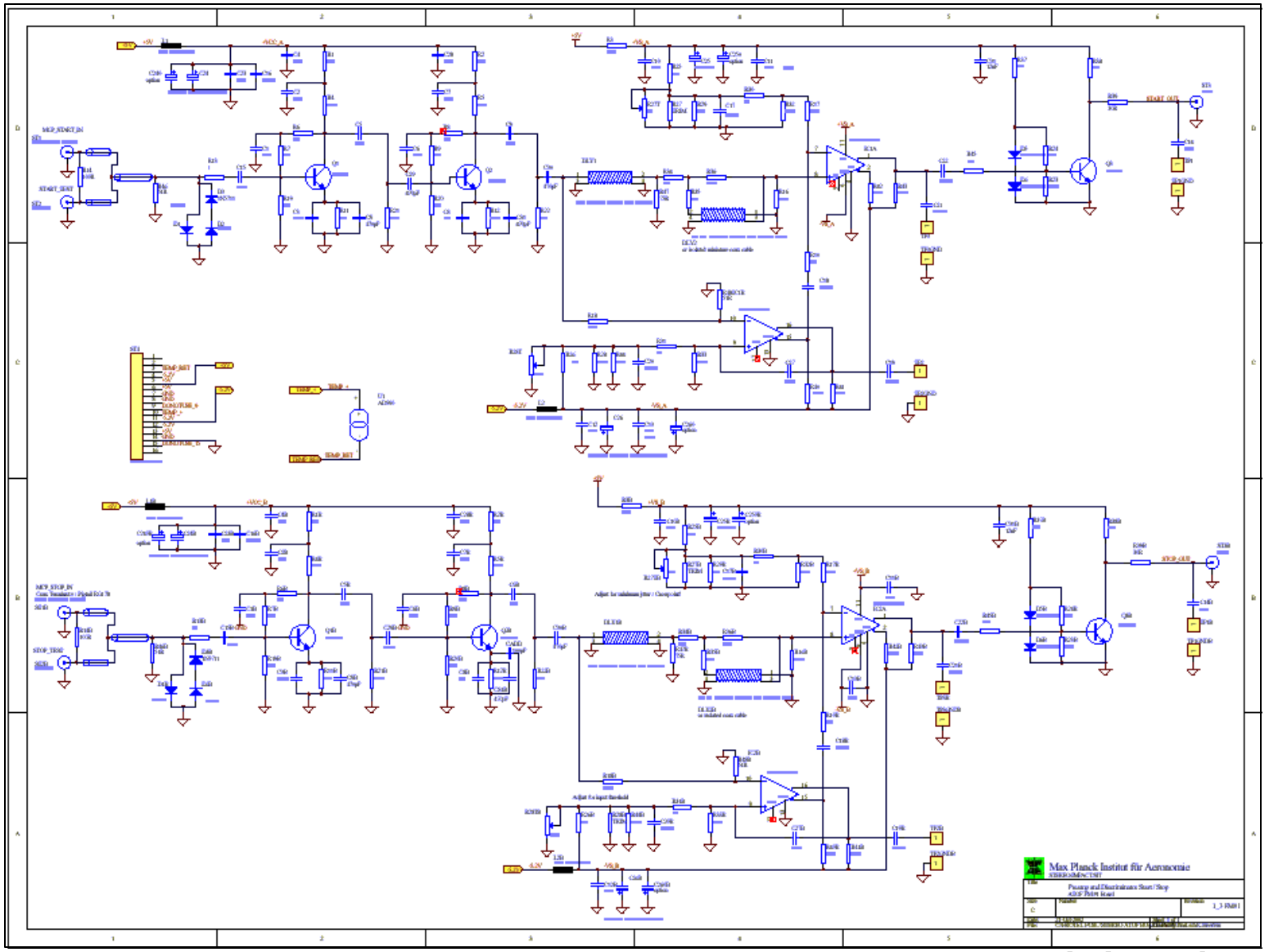
ELECTRONICS BOX ELECTRONICS STATUS - cont.

- **TOF System**
  - **Two generations of prototype TOF boards built at MPAe and the Technical University of Braunschweig (TUB) and tested at UMd**
  - **design complete**
  - **Proto-flight board set built and tested at MPAe, delivered to UMd**

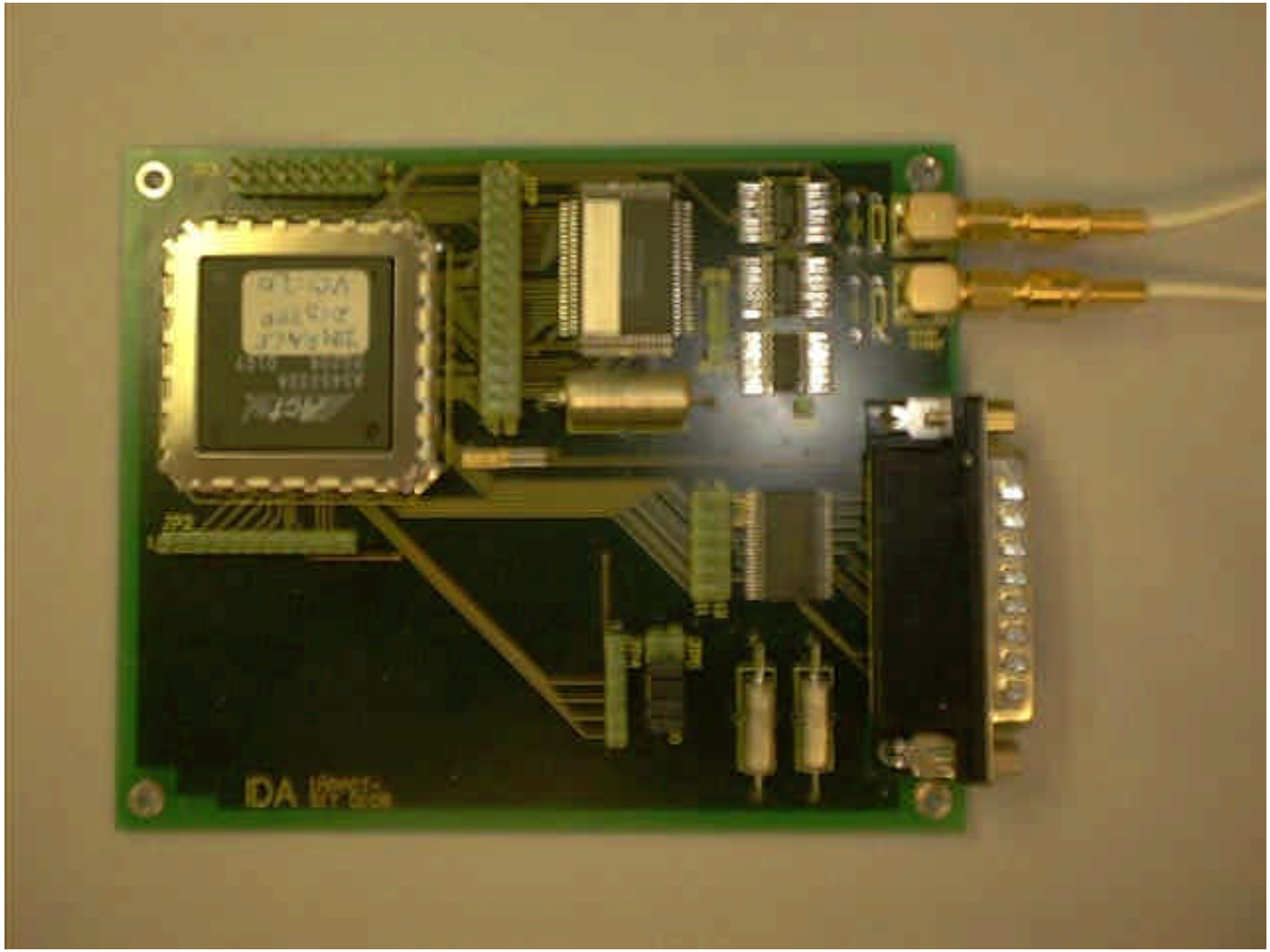
Proto/FlightATOF Board



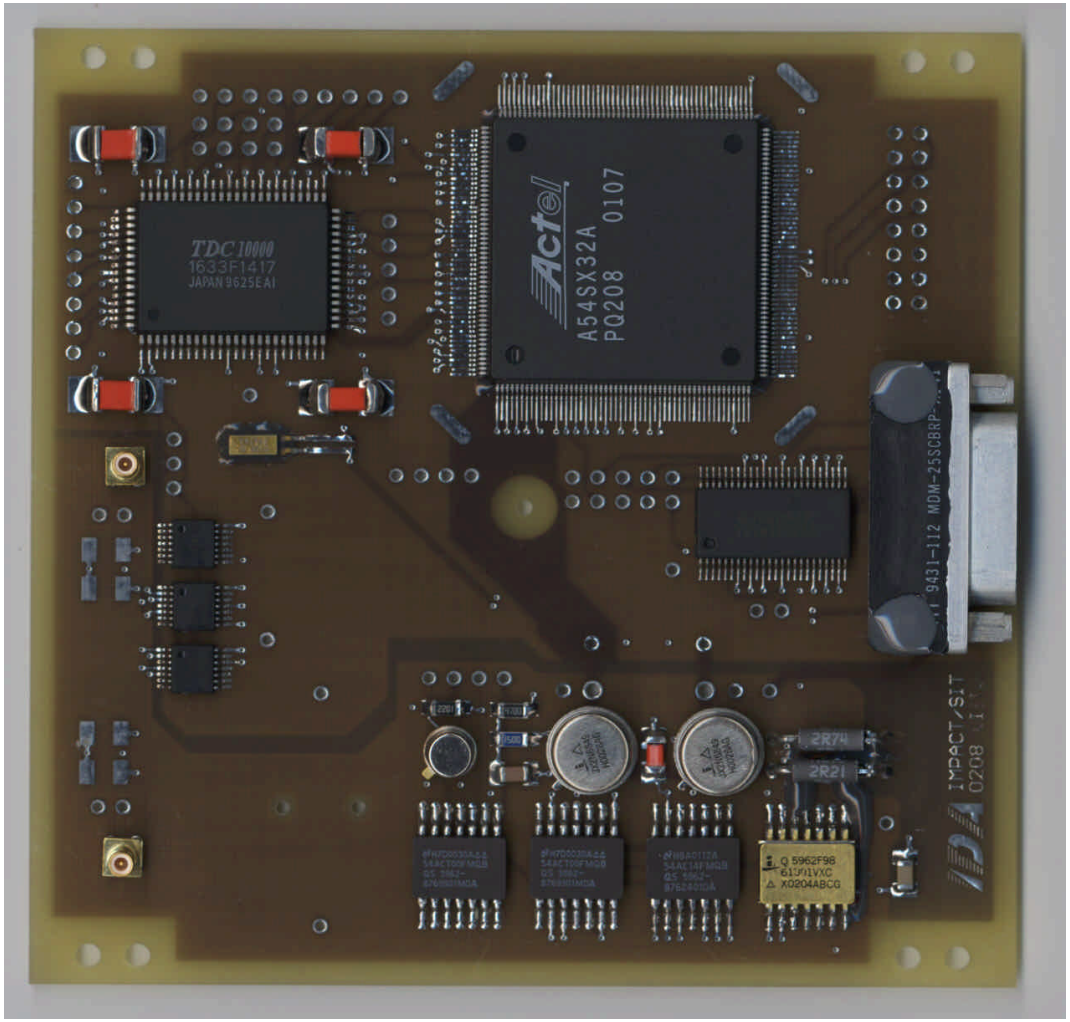
Schematic of ATOF board



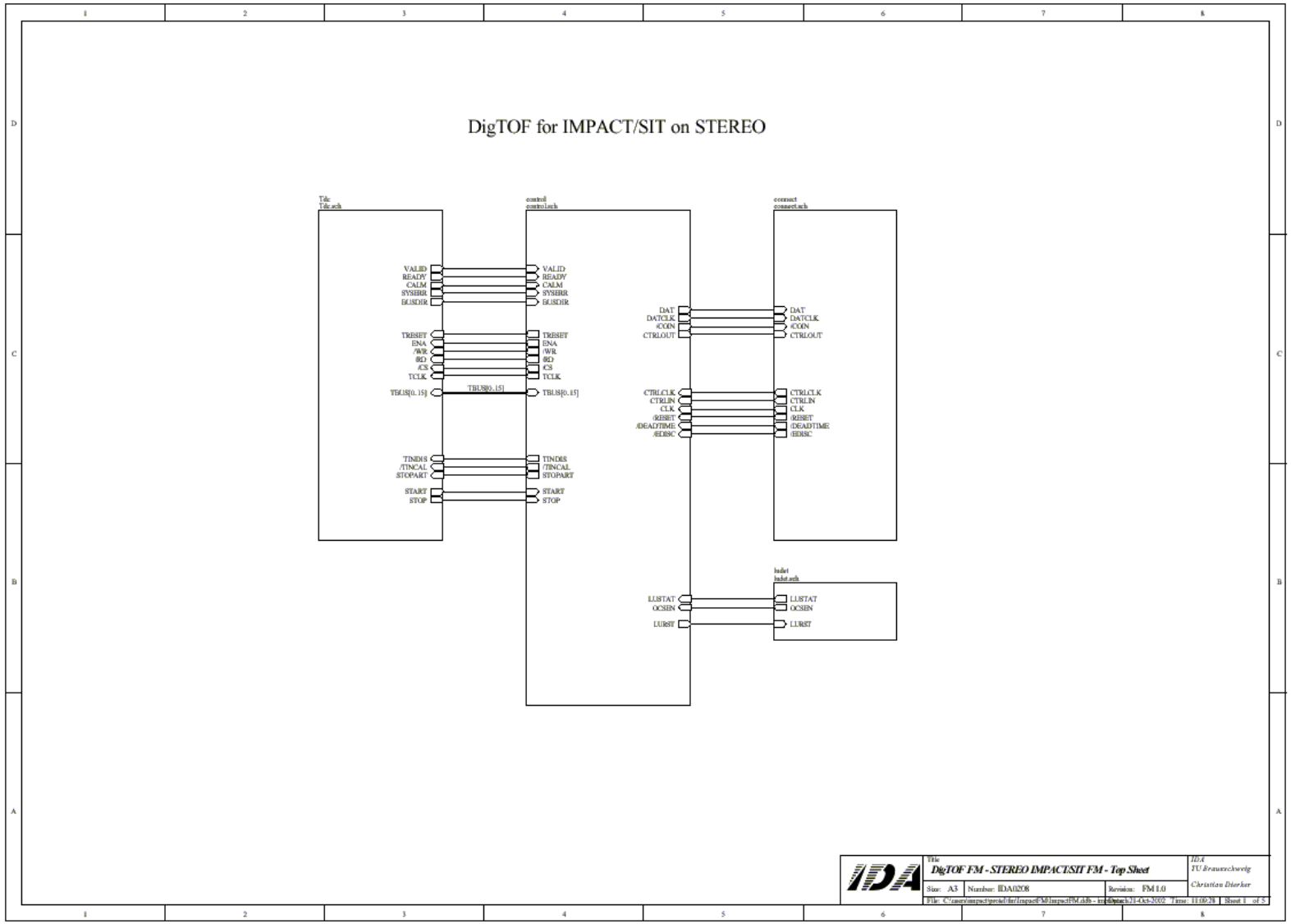
Prototype DTOF Board



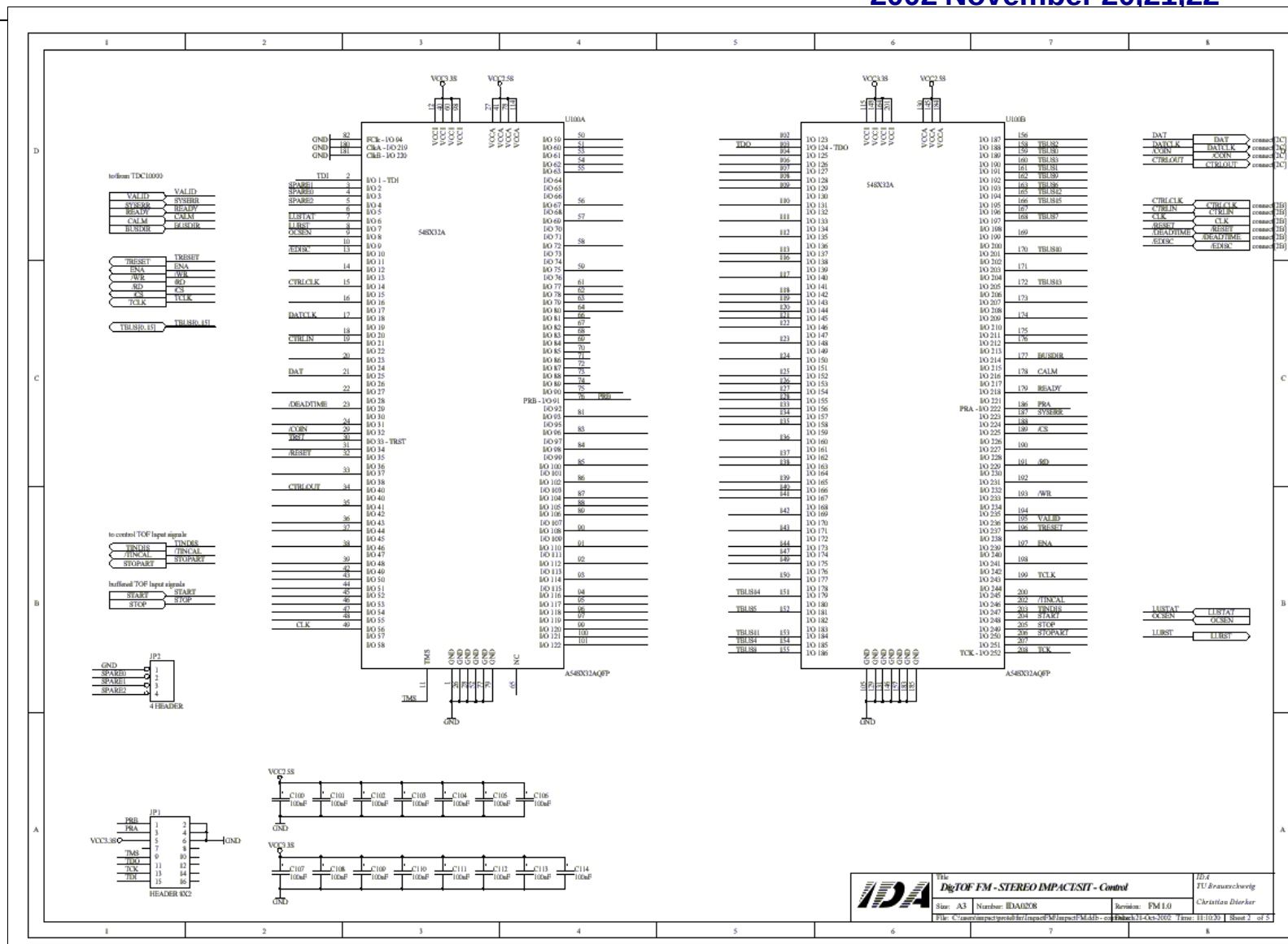
Proto-Flight DTOF board



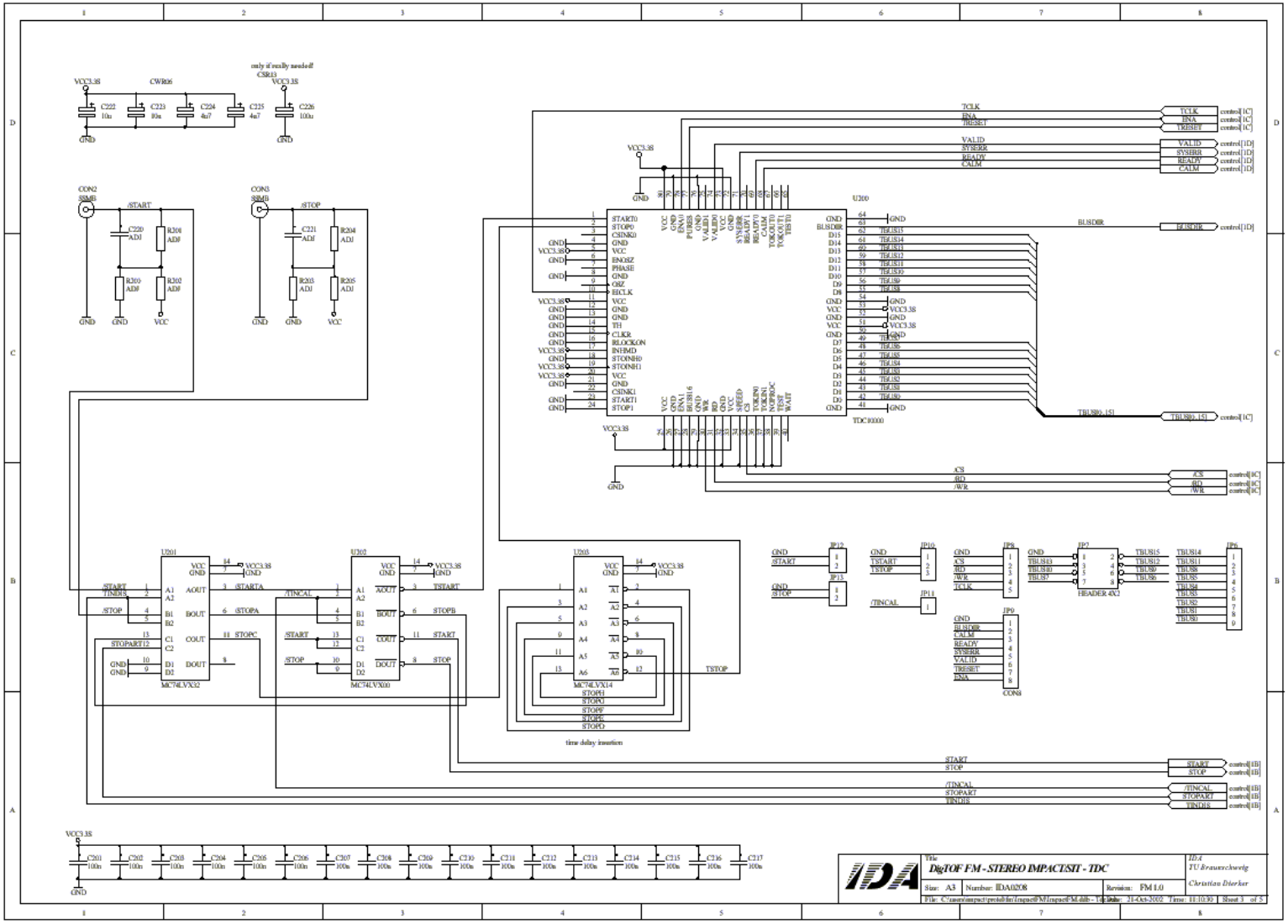
Schematic of DTOF board
1 of 5



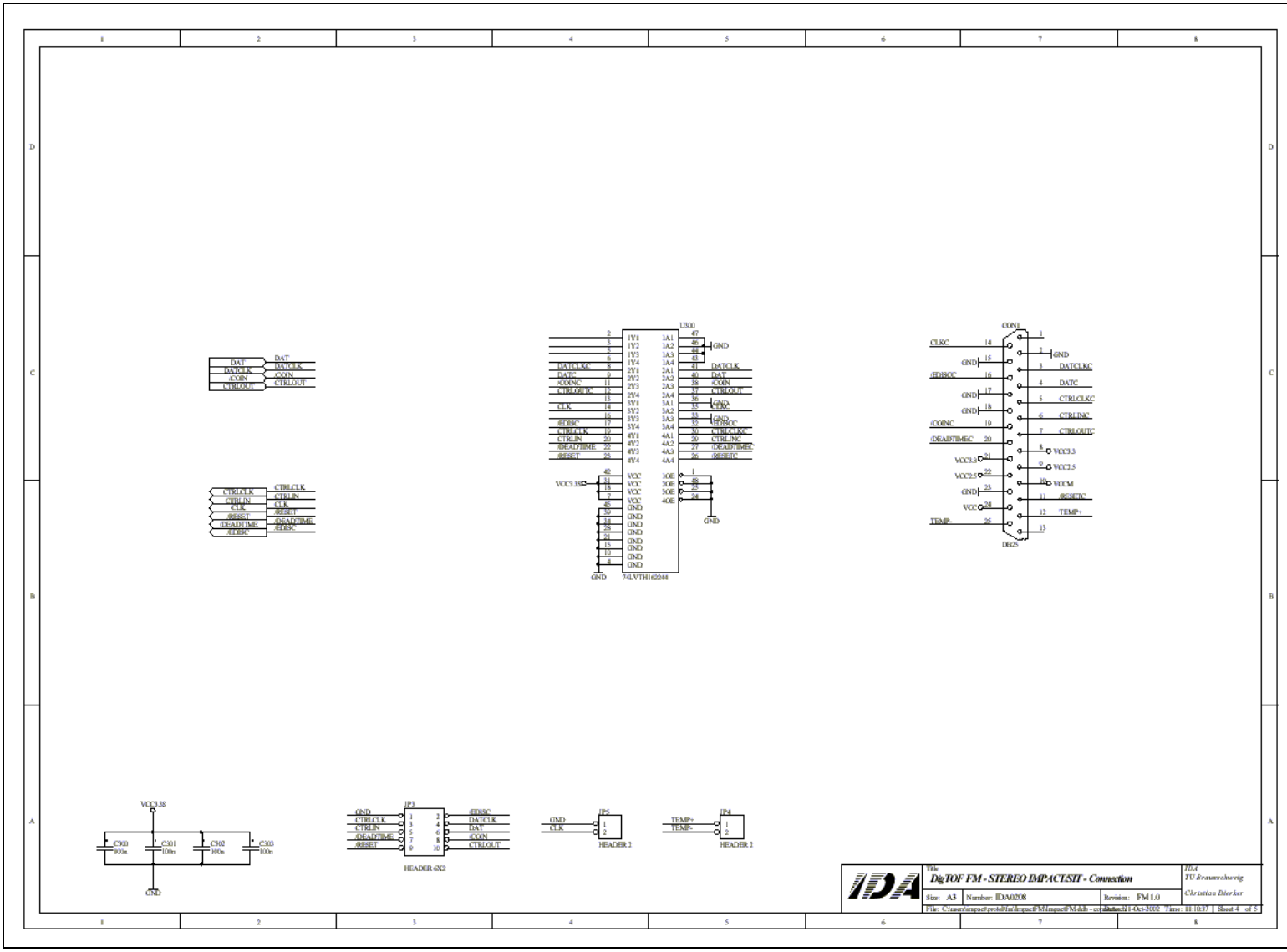
Schematic of DTOF board
2 of 5



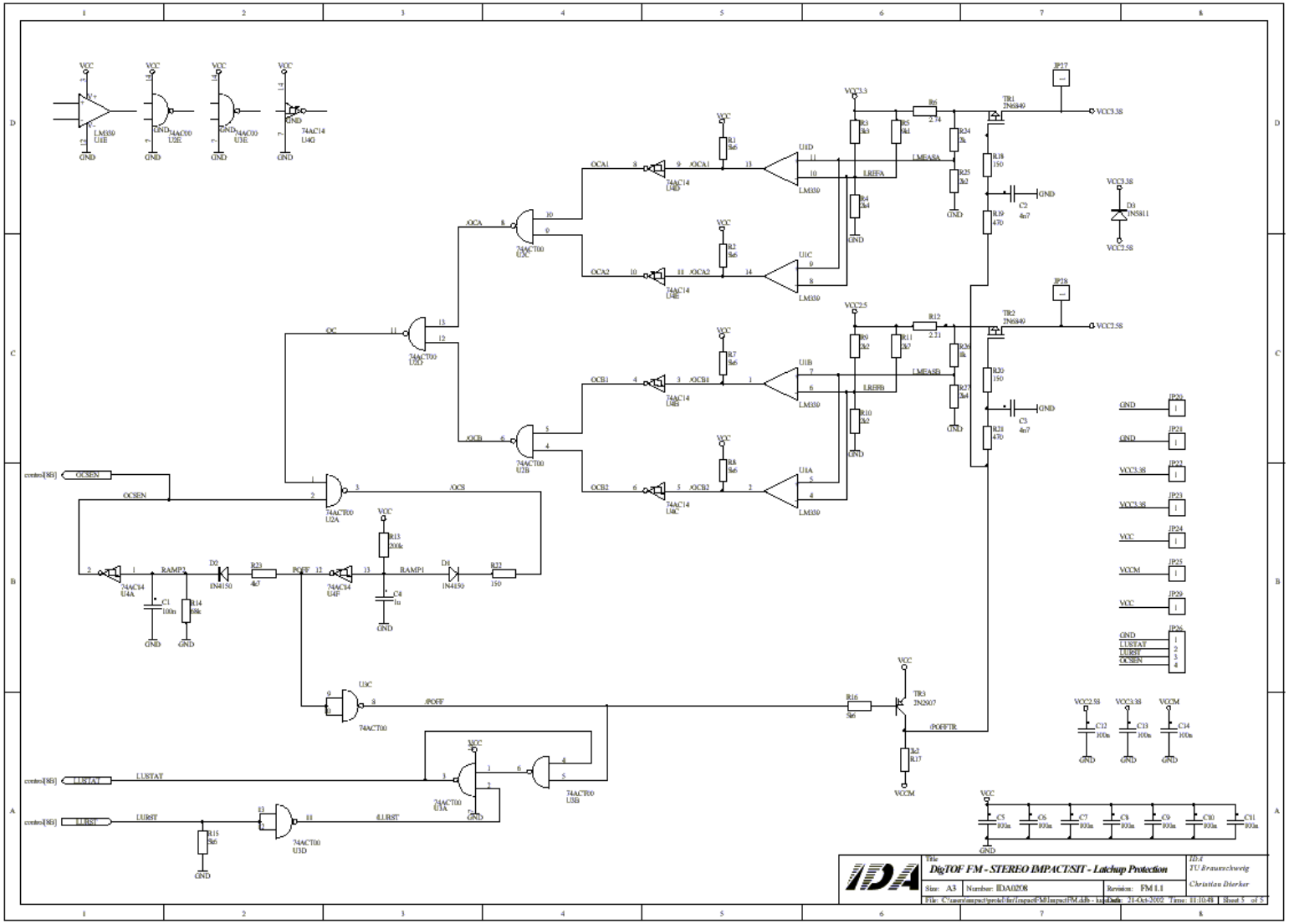
chematic of
DTOF board
3 of 5

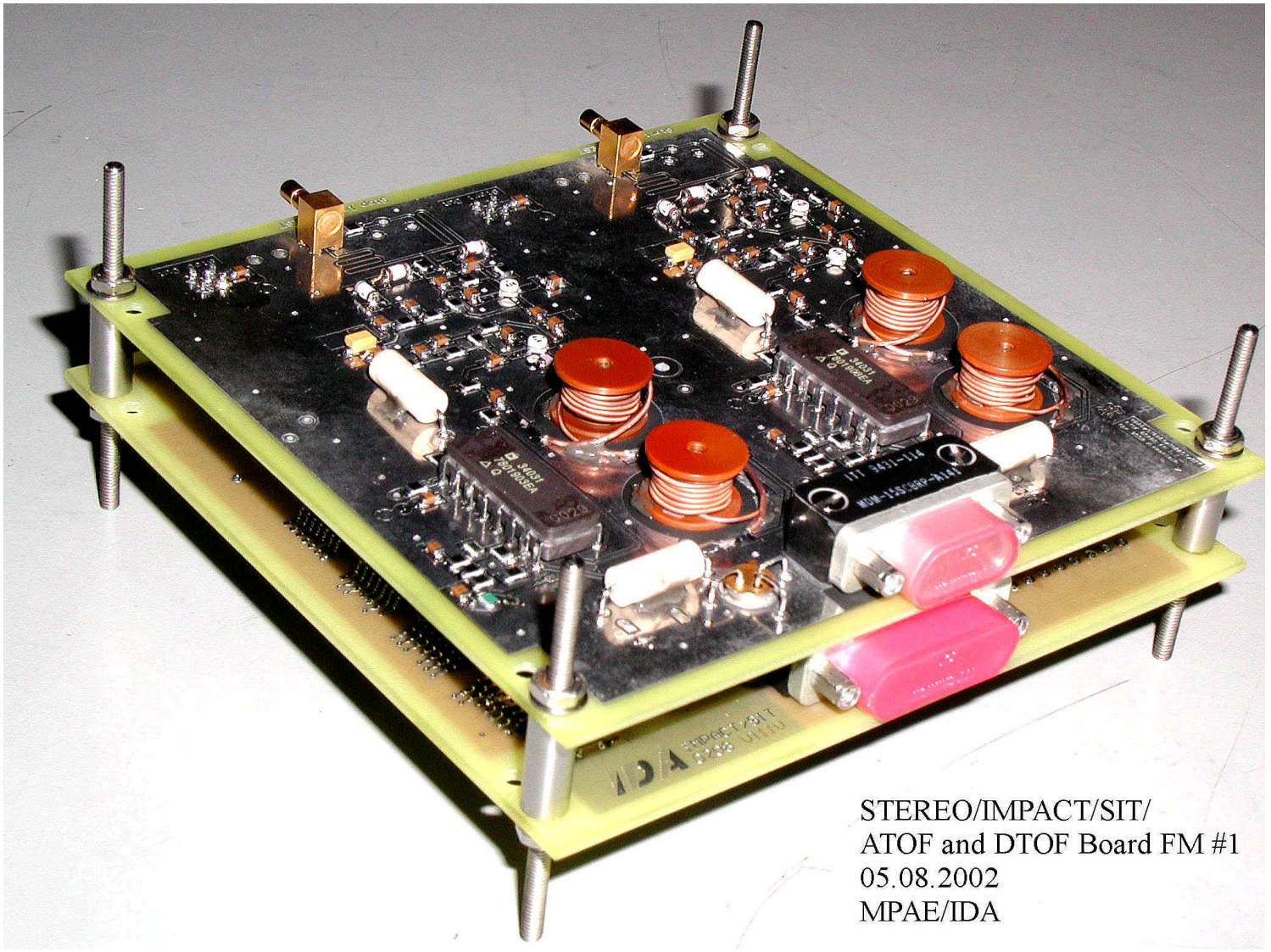


Schematic of DTOF board
4 of 5



Schematic of DTOF board
5 of 5




STEREO/IMPACT/SIT/
ATOF and DTOF Board FM #1
05.08.2002
MPAE/IDA

ELECTRONICS BOX ELECTRONICS STATUS - cont.

- **LOGIC Board**
  - **Front-End Logic**
    - **breadboarded at UMd using Xilinx prototyping boards**
    - **implemented on Actel at GSFC**
    - **ETU to be built at UMd**
  - **MISC**
    - **Same as HET MISC**
    - **implemented in Actel at GSFC and under test there**
    - **will be put on same Actel as front-end logic**
  - **Flight S/W**
    - **based on HET**
    - **under development at GSFC**
  - **Housekeeping**

Block Diagram of Logic Board

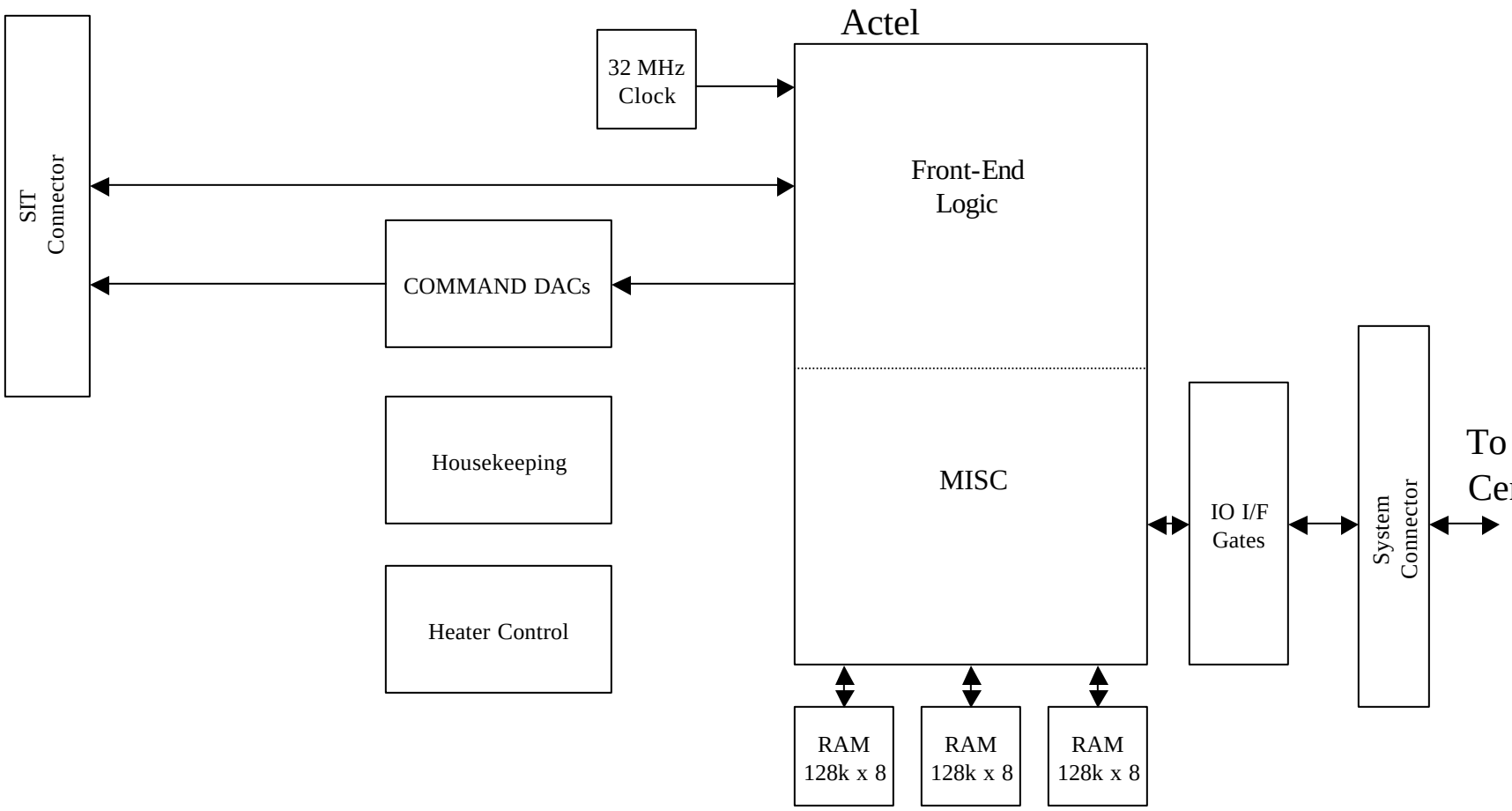
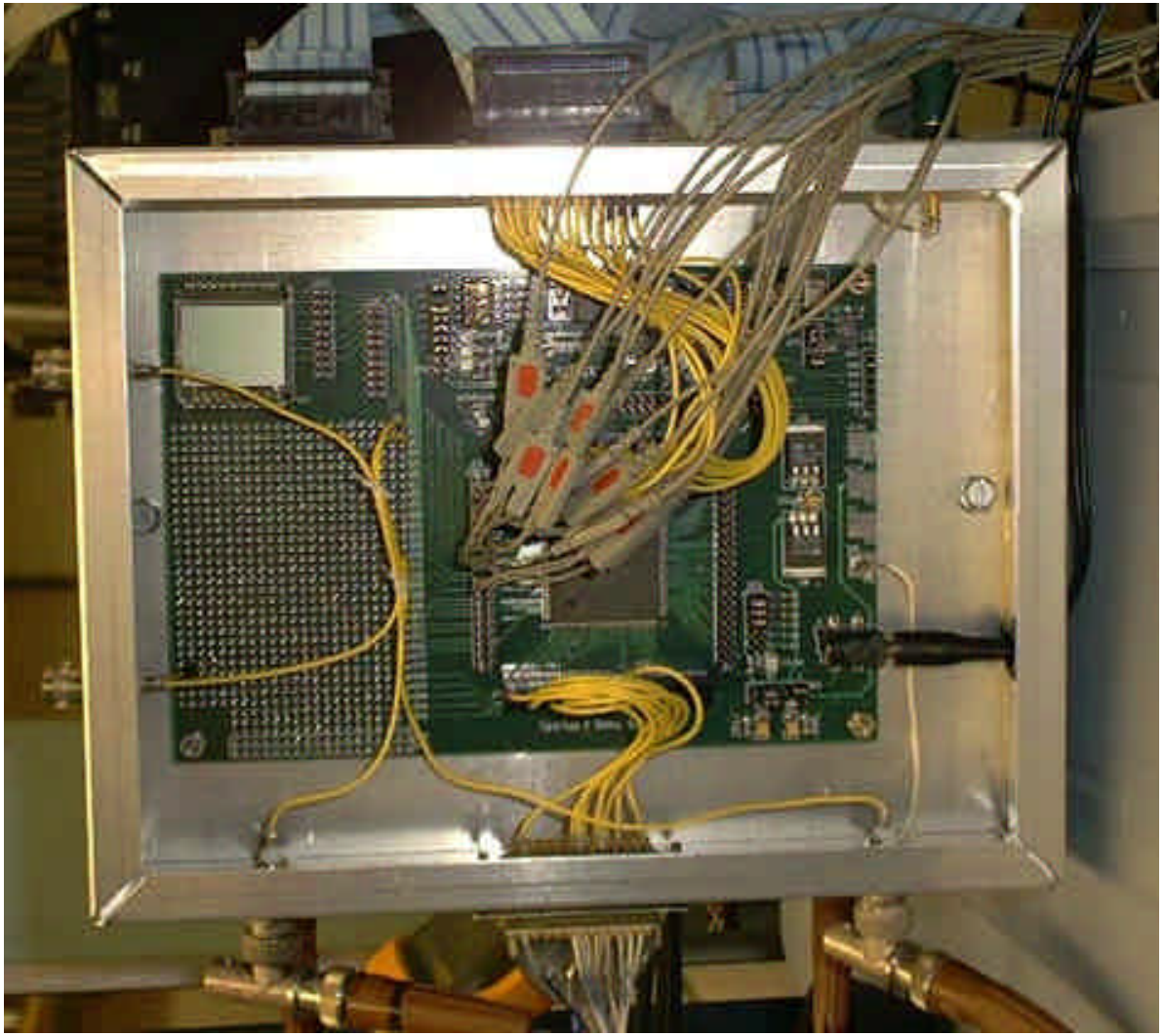
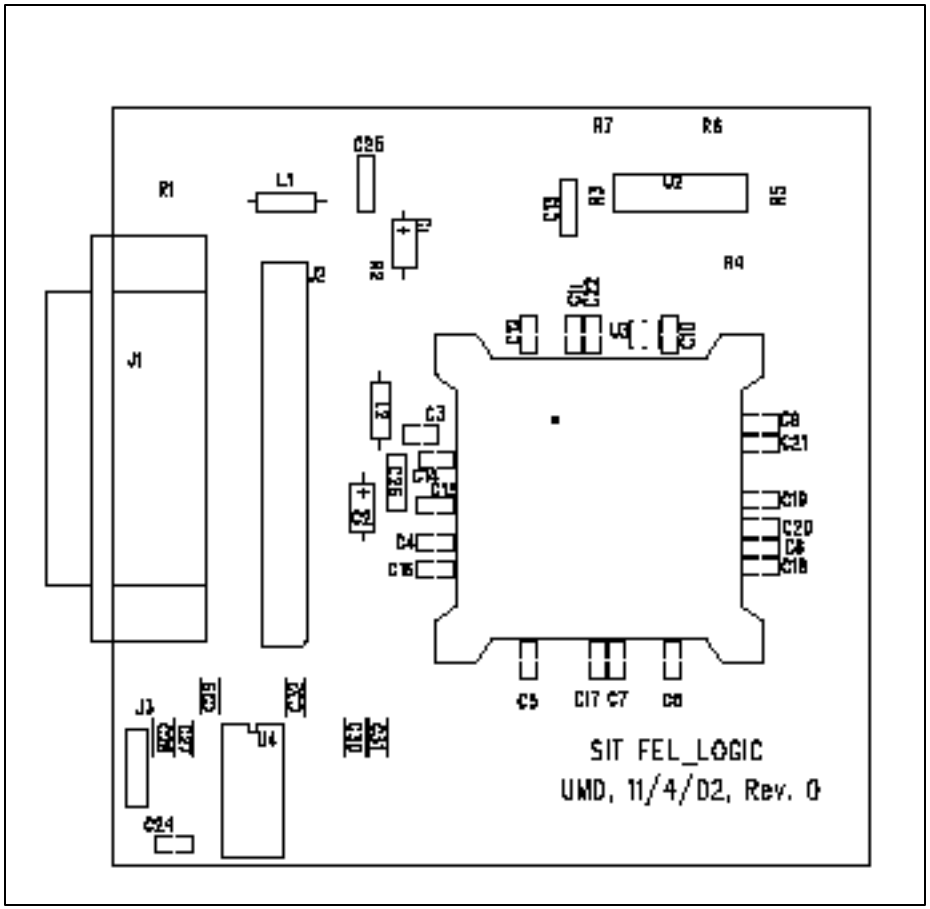
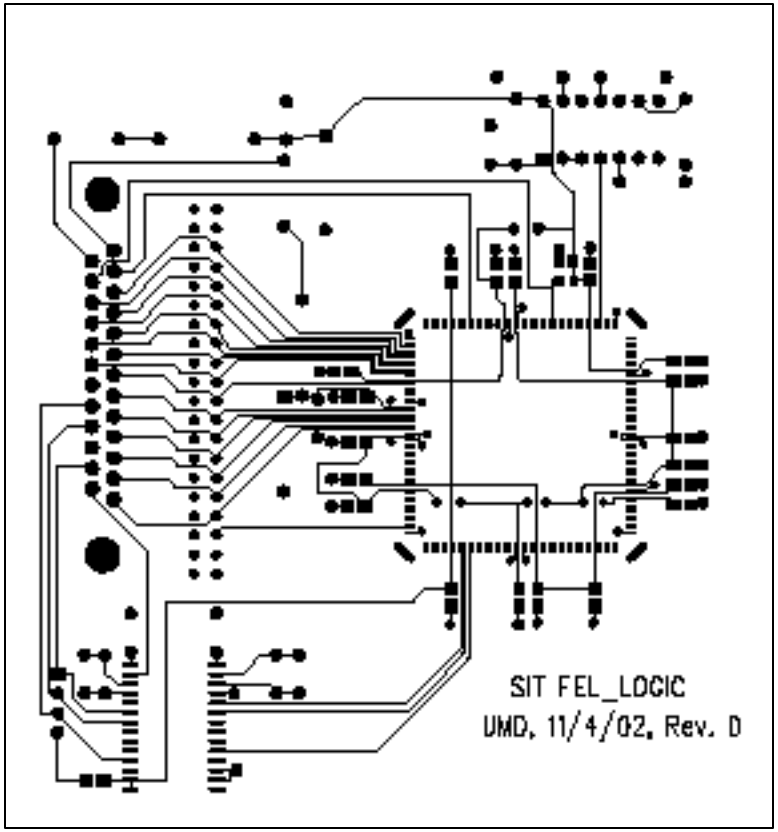


Photo of Breadboard Front-End Logic

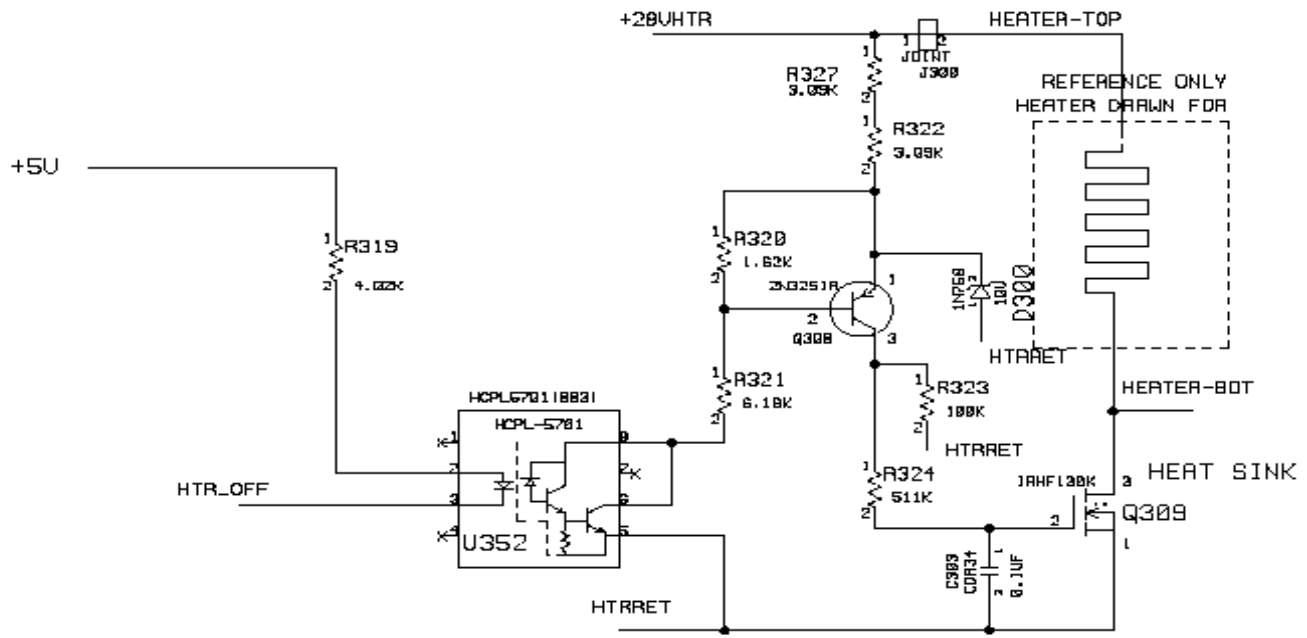


Prototype Front-End Logic Board – in Progress





Schematic of Heater Control



SCHEMATIC, HEATER SWITCH CIRCUIT
8/29/2002

ELECTRONICS BOX ELECTRONICS STATUS - cont.

- **Mother Board**
  - **size and shape defined**
  - **Connectors defined**
  - **not yet laid out**

GSE STATUS

- **Electronic GSE**
  - **GSE LVPS - built and tested**
  - **Test Pulser - in design**
  - **Instrument-Level Test S/W**
    - **will use same system as HET**
    - **in development at GSFC**

- **Mechanical GSE**
  - **Shake fixture - not yet implemented**
  - **Carrying case - not yet implemented**

STATUS SUMMARY and REMAINING TASKS

- **ELECTRONICS**
  - **Energy – assemble/test ETU**
  - **TOF – ready**
  - **Logic**
    - **Finish test of ETU front end logic**
    - **Integrate front-end logic with MISC and layout and test**
    - **Complete HK and Command DAC design**
  - **HVPS – revise ETU based on current test results and retest**
  - **Motherboard – layout**

- **MECHANICAL**
  - **Finalize telescope housing design, sunshade and acoustic cover**
  - **Finalize HVPS box design**
  - **Finalize electronics box design**

- **GSE – build Test Pulser**

PARTS/MATERIALS STATUS

- **Detector Elements**
  - **SSDs - on order 6/02, expected 11/02**
  - **MCPs - on order 9/02, expected 1/03**
  - **foils – meshes in house, foils to be ordered 12/02**

- **Parts Lists**

Parts lists exist for:

Energy

TOF

HVPS

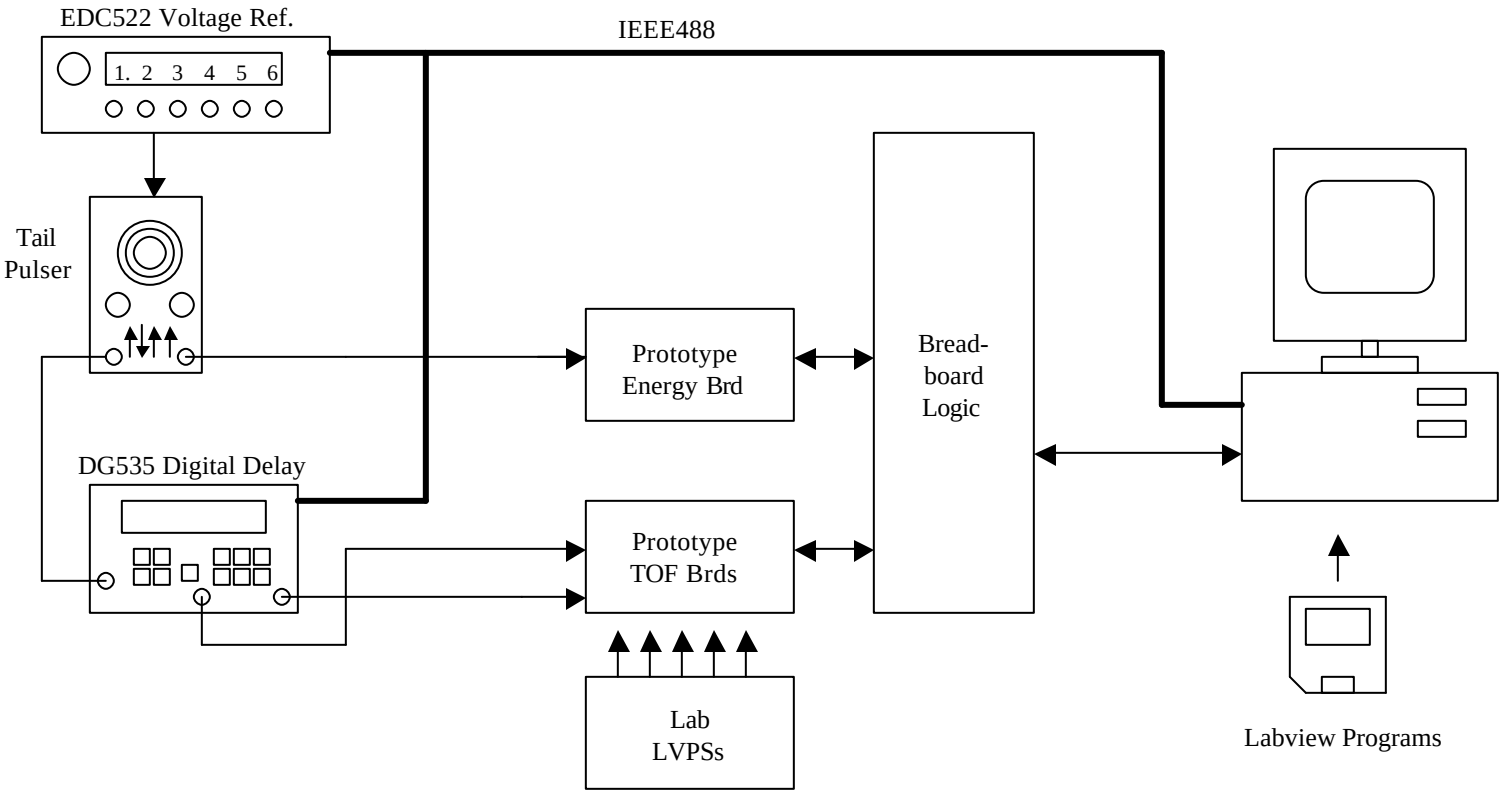
Partial list exists for:

Logic board

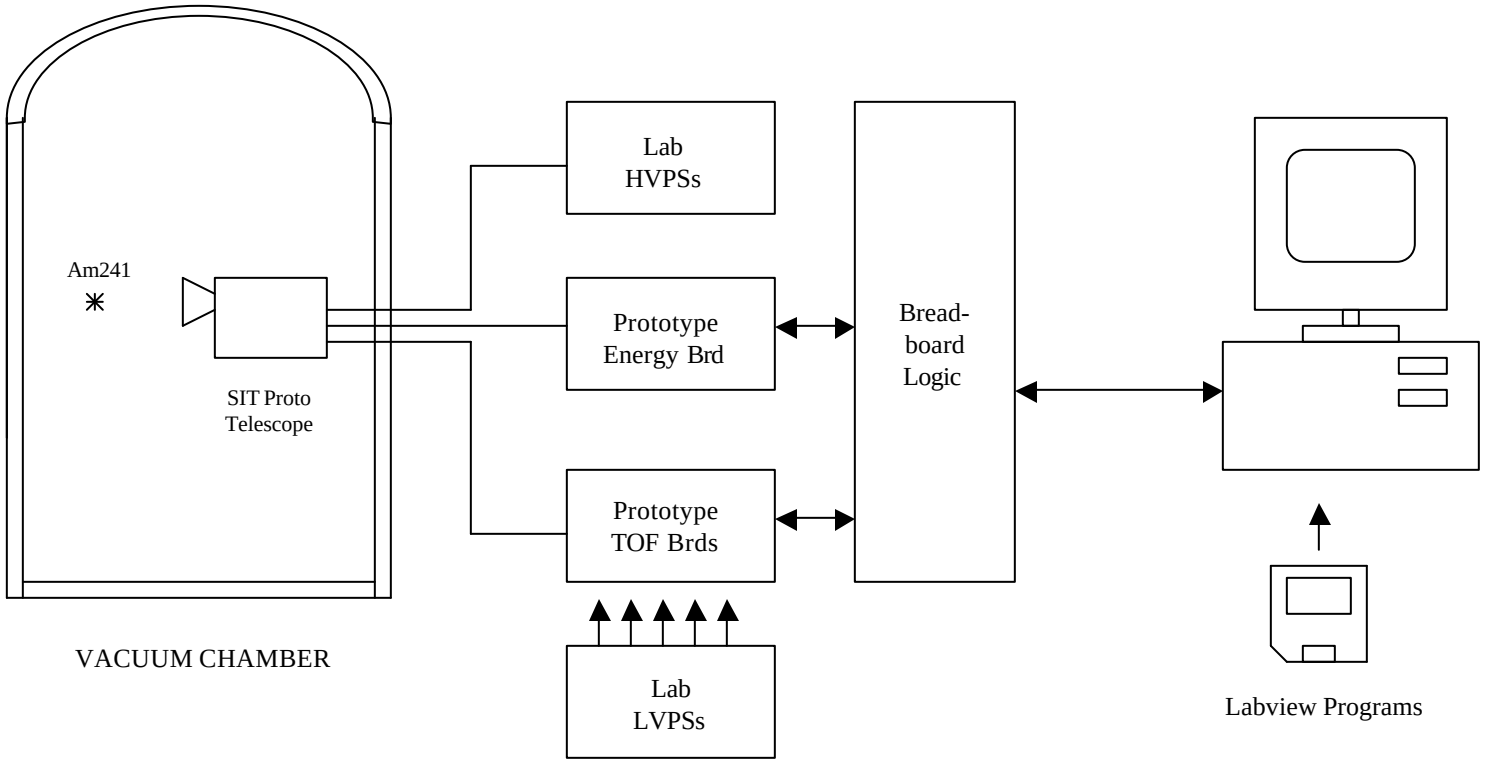
PERFORMANCE TESTING – at UMd

- **Environment Test**
  - **Prototype Energy System**
    - **thermal (-40 to +50C)**
    - **voltage margin (+/- 10%)**
  - **Proto-flight TOF**
    - **thermal**
    - **voltage margin**

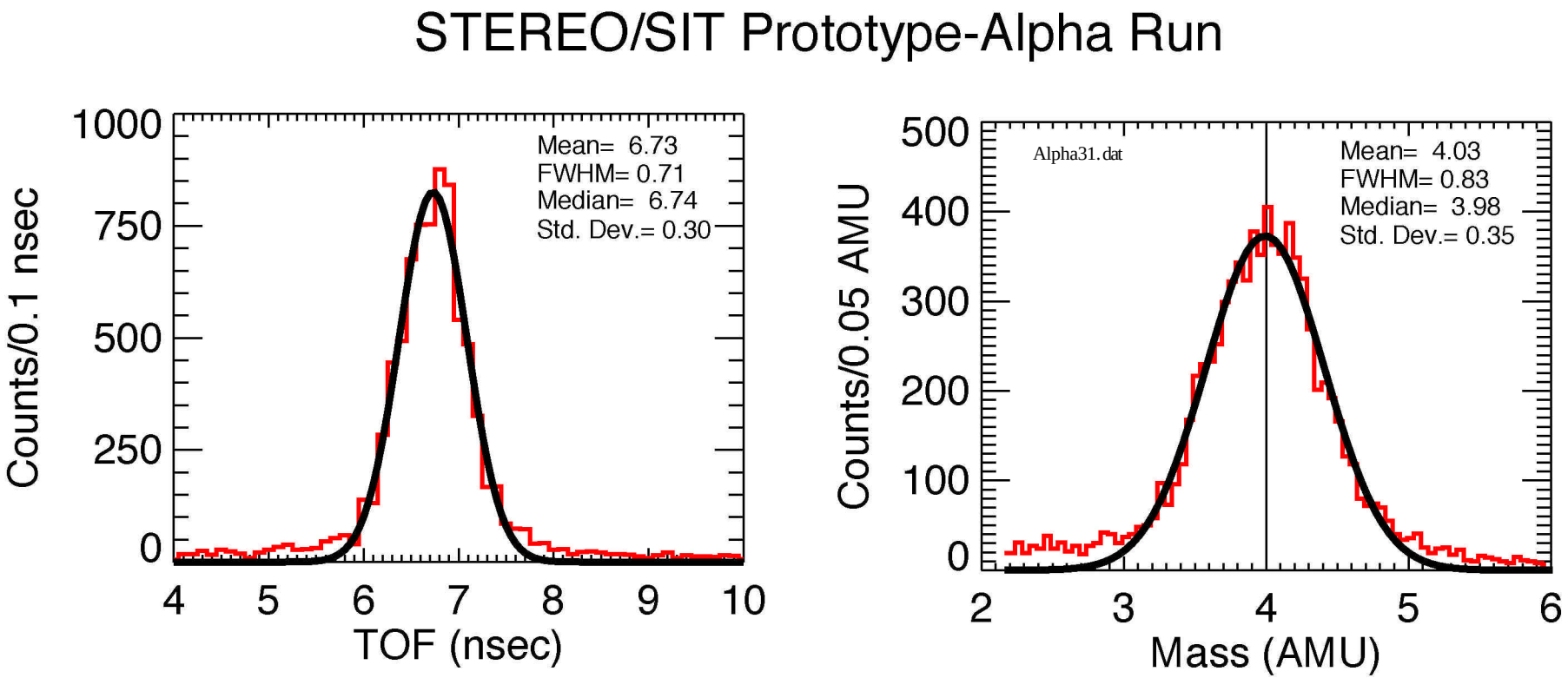
- **Functional Test**
  - **Bench Calibration of prototype energy and TOF systems**
  - **alpha Test with prototype telescope, energy and TOF systems**

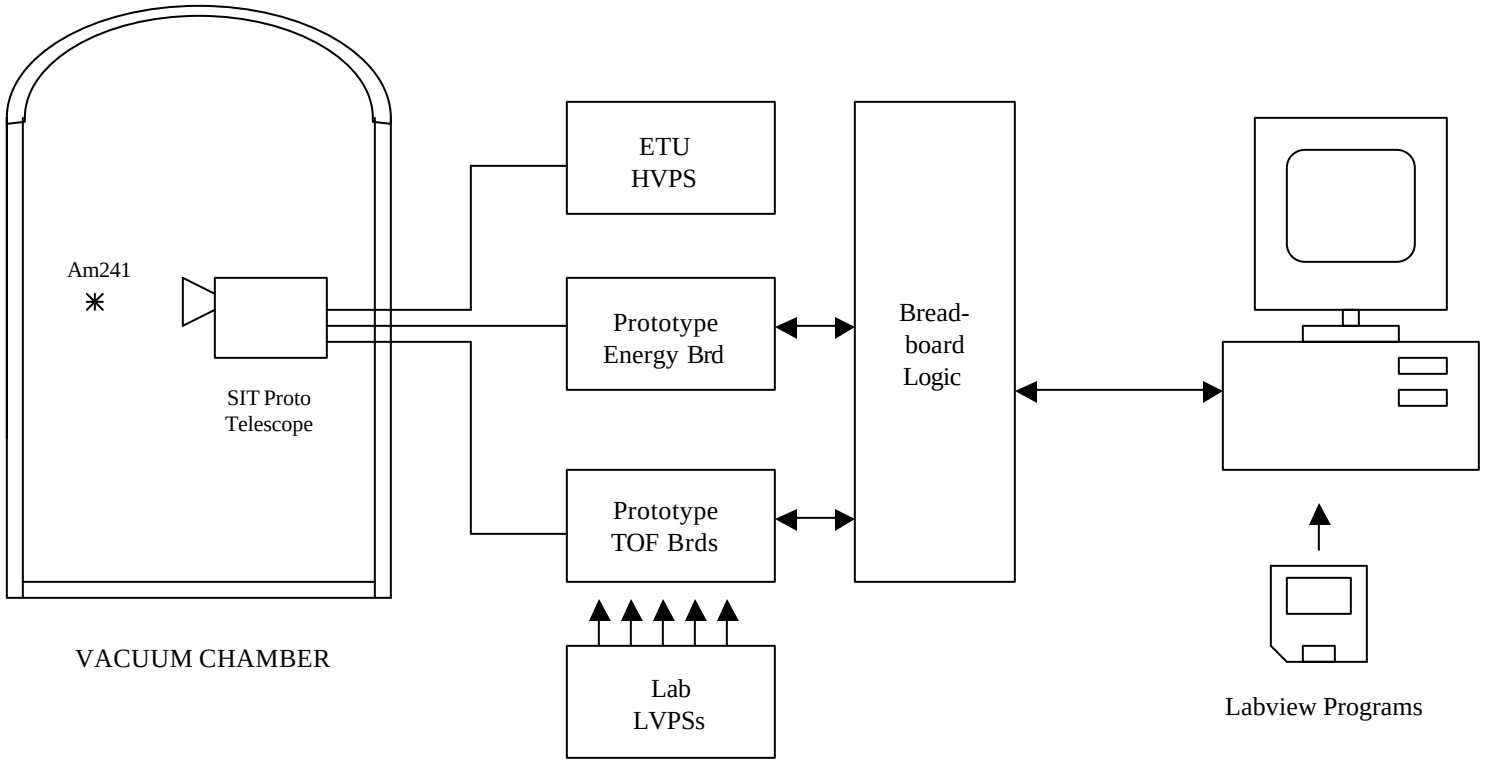


SIT PROTOTYPE TESTING - Bench Calibration

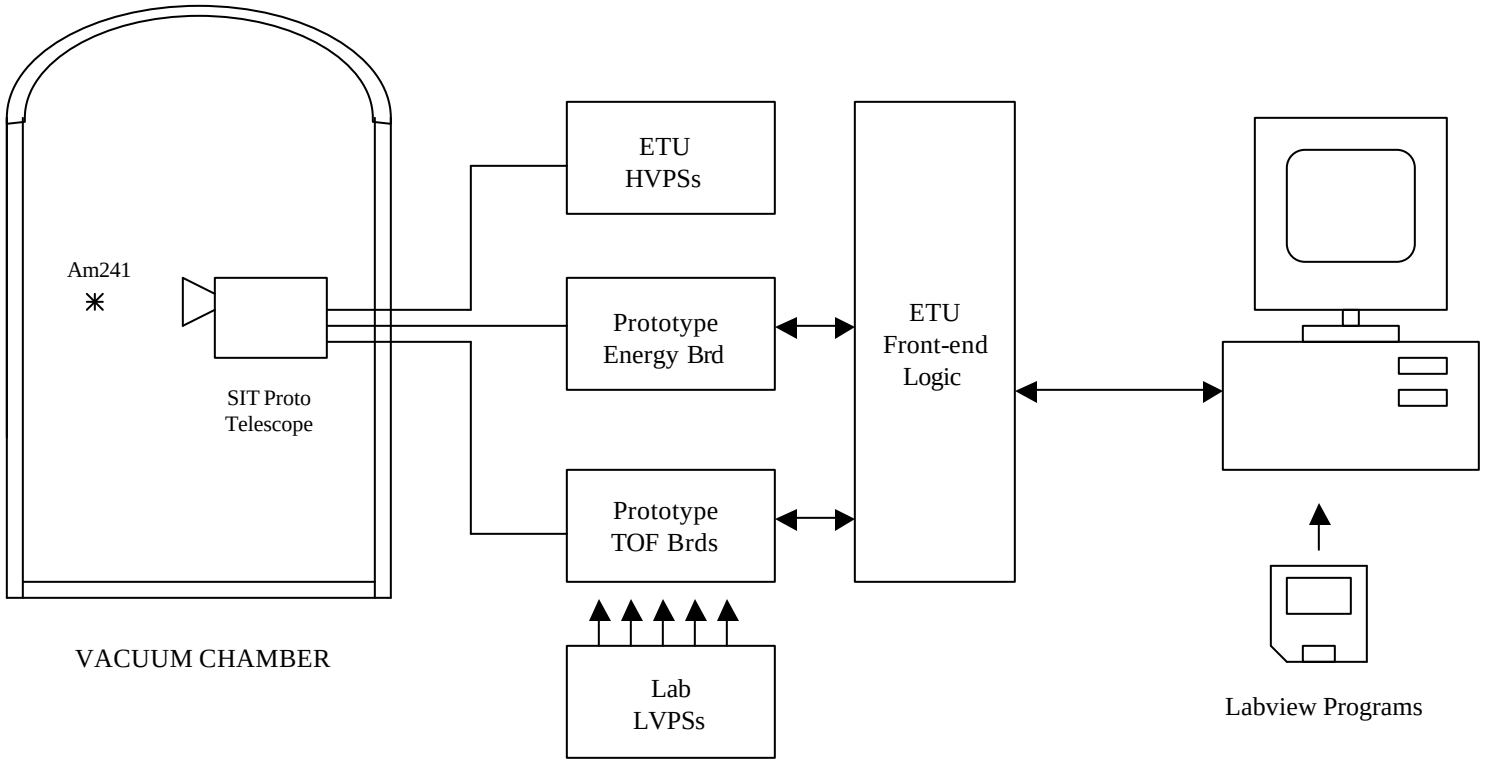


SIT PROTOTYPE TESTING - alpha test


STEREO/SIT Prototype-Alpha Run
Counts/0.1 nsec
1000
750
500
250
0
4
5
6
7
8
9
10
TOF (nsec)
Mean= 6.73
FWHM= 0.71
Median= 6.74
Std. Dev.= 0.30
Counts/0.05 AMU
500
400
300
200
100
0
2
3
4
5
6
Mass (AMU)
Alpha31.dat
Mean= 4.03
FWHM= 0.83
Median= 3.98
Std. Dev.= 0.35



SIT PROTOTYPE TESTING – HVPS Testing (in Progress)



SIT PROTOTYPE TESTING – Logic testing (in Progress)

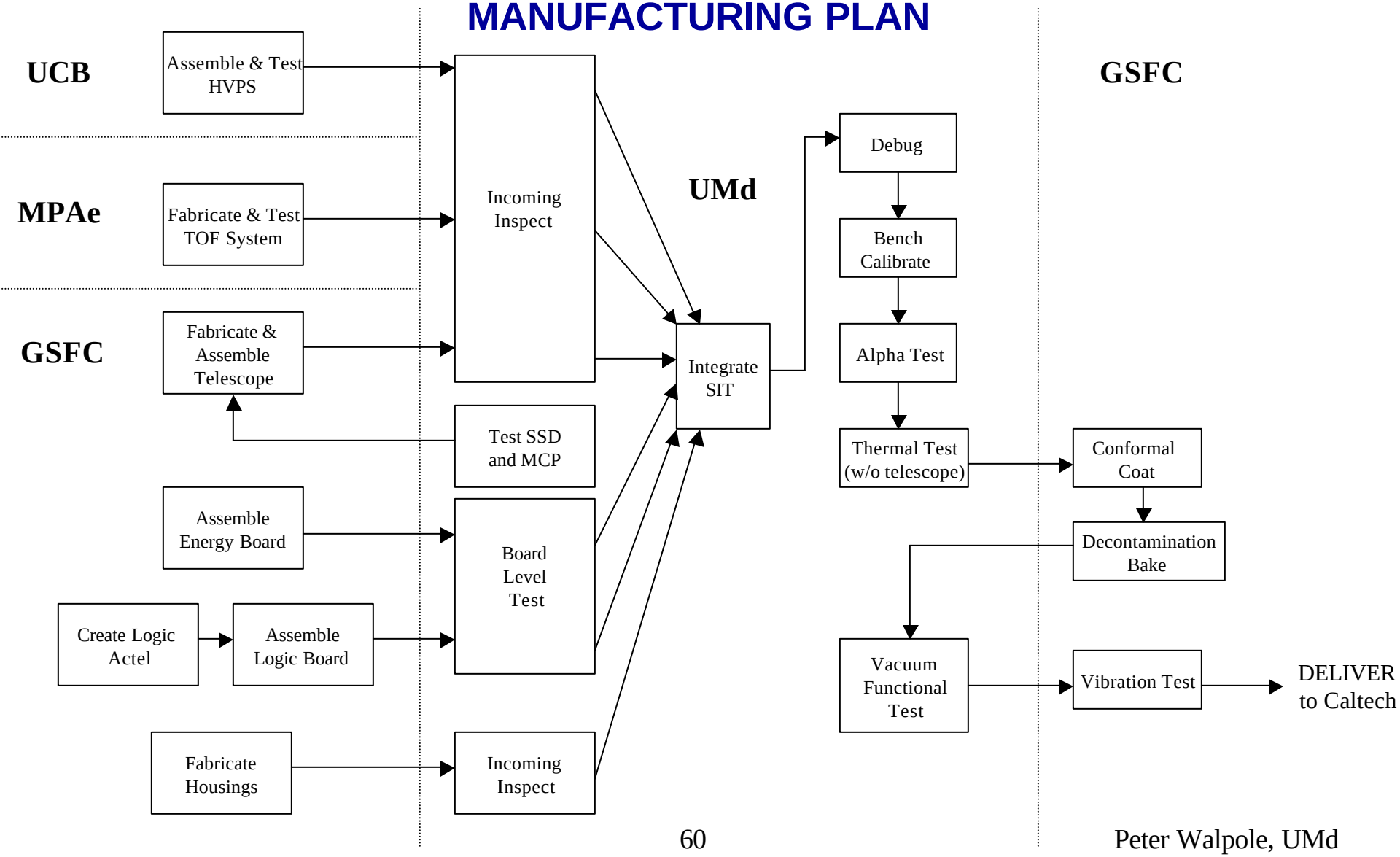
IMPACT TOP RISKS

No.	Risk Item	Score	Mitigation	Mitigation Schedule						
				PDR	EM Test	CDR	Sub-system Test	System Test	Env test	Early Orbit Test
UCB_5	IMPACT boom is a new design. Failure could affect Imager pointing requirements as well as boom-mounted instruments.	MEDIUM	Design for reliability. Early prototype testing. Adequate force margins.	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW
UCB_4	The IDPU is a single point failure mechanisim for the IMPACT suite and PLASTIC	MEDIUM	IDPU is a simple, reliable system. Extra attention will be paid to ensuring its reliability, minimizing the risk of fault propagation. Early prototype testing	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM
UCB_23	Non-standard parts qualification failure could impact delivery schedule	MEDIUM	Early parts selection and screening	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW	LOW
UCB_27	Actel timing differences between flight & ETU parts may cause failures late in testing impacting delivery schedule	MEDIUM	Do FM Thermal Vac early to allow time for finding and fixing timing problems; for designs on the critical path, consider installing a flight Actel in the ETU & thermal cycle.	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW
UCB_11	Stringent EMI requirements may delay schedule if testing fails	MEDIUM	Careful design, ETU power converter testing, early system testing	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW
UCB_28	Thermal limitations of detectors result in a low bakeout temperature which might require a very long bakeout impacting delivery schedule	MEDIUM	Bakeout subsystems prior to detector integration to reduce time of instrument-level bakeout; early bakeout	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW
UCB_19	Concern about fragility of ITO surfaces required to meet ESC requirements; failure will impact SWEA science	MEDIUM	Replace ITO with more robust solution where possible; test ITO surfaces during I&T and replace when required	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW
UCB_10	Complex Interlocking IMPACT schedule increases risk of late delivery to spacecraft	MEDIUM	Detailed fully integrated schedule developed and maintained with Project support. Monthly tracking of status.	MEDIUM	MEDIUM	MEDIUM	MEDIUM	LOW	LOW	LOW
UCB_21	PHASIC Custom VLSI used in SEP may has schedule and cost risk	LOW	Early development to prove design; use Amptek in place of VLSI in SIT (stll use VLSI in HET, LET); first run looks good, but a second run will be required	MEDIUM	LOW	LOW	LOW	LOW	LOW	LOW
UCB_18	LET Detectors from a new manufacturer	LOW	Backup L1 detectors; low risk, meet requirements; Decision point 1/2003	MEDIUM	LOW	LOW	LOW	LOW	LOW	LOW

RISKS – Impact on SIT

- **UCB-13 IMPACT Team is Thin**
  - **One engineer at UMd for SIT**
- **UCB-21 – Custom Hybrid use on SEP**
  - **SIT has migrated away from using the custom hybrid and is using an Amptek based design instead. (Special circumstances of SIT make this possible)**
- **UCB-1 – ITAR Restrictions limit communication**
  - **We have active collaboration with MPAe but ITAR issues have been resolved with help from GSFC office.**

MANUFACTURING PLAN



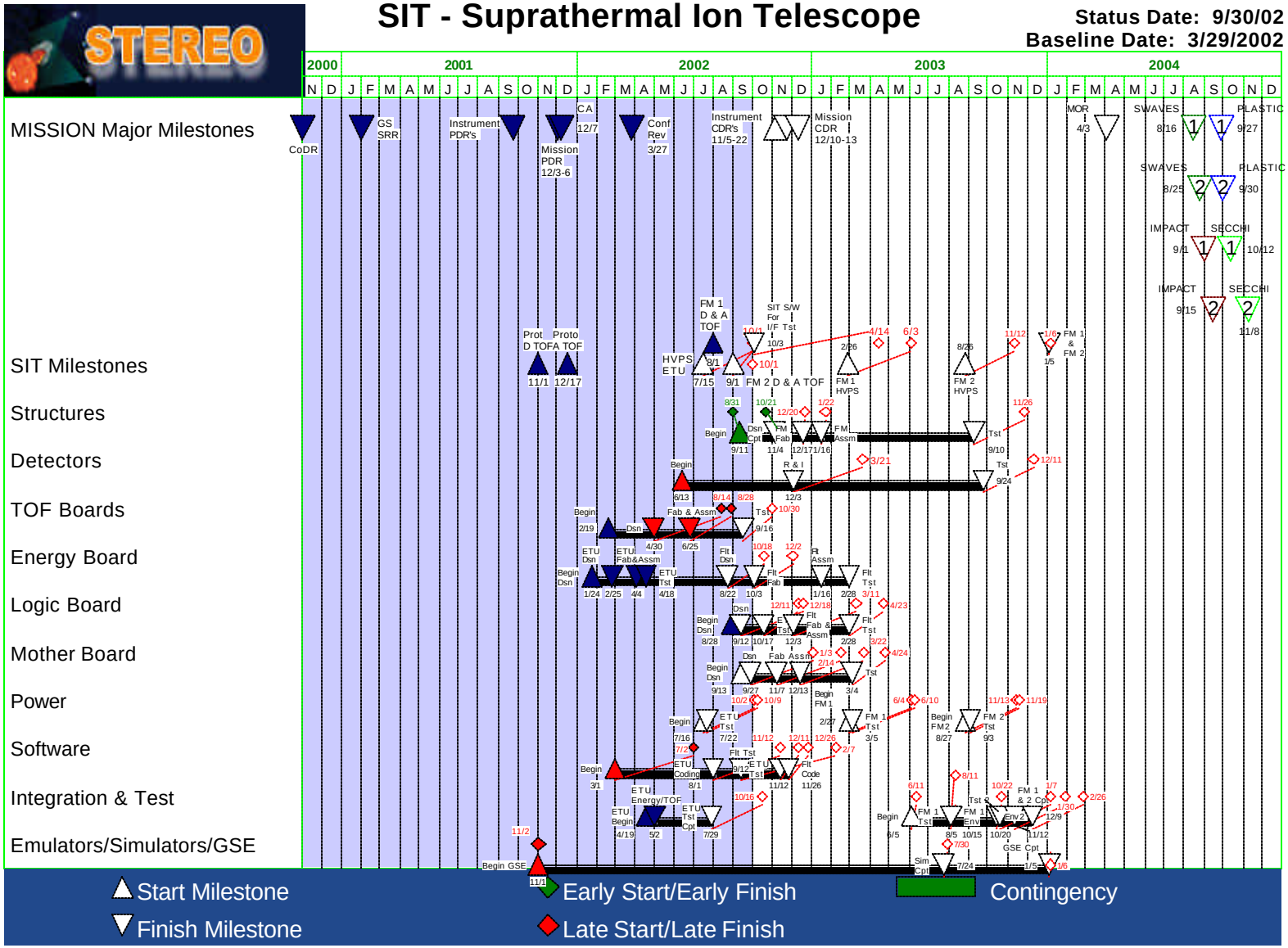
SIT Verification Matrix

			Verification Matrix for STEREO/IMPACT/SEP/SIT																		Revision Date: 2002/11/8
																					Revision Number: 2
	Hardware Description	Tests																			
Level of Assembly	Item	Vacuum	Alphas	Elect. test, rm. Temp	Bench Calibration	Elect. Test, hot	Elect. Test, cold	Vibration, Sinusoidal	Vibration, Random	Self Shock	Acoustics	Thermal Vacuum	Voltage margins	Thermal cycle	Thermal balance	Life Test	EMC/EMI	Magnetics	Beam Calibration	Bakeout	Contamination	Comments
C	Detectors, F		X									X										
C	Foils PT										X											
C	Telescope PF,F	X	X																		X	
C	Energy board, EM			X		X	X						X									
C	Energy board, F			X																	X	
C	TOF Board, EM			X		X	X						X									
C	TOF Board, F			X																	X	
C	HVPS EM			X		X	X						X									
C	HVPS F			X																	X	
I	Instrument W/O Telescope																			X		
I	Instrument, PF	X	X	X	X	X	X	X	X	X		X	X	X	X	X	H	X	X	X	X	Protoflight levels
I	Instrument, F	X	X	X	X	X	X	X	X	X		X	X	X		X	H	X	X	X	X	Acceptance levels

Legend:			
	Level of Assembly	Unit Type	X = Test required
			A = Analysis
	C = Component	BB Breadboard	H = at a higher level
	I = Instrument	EM Engineering Model	
		PT Prototype	
		PF Protoflight	
		F = Flight	

SIT - Suprathermal Ion Telescope

Status Date: 9/30/02
Baseline Date: 3/29/2002



SCHEDULE HIGHLIGHTS

- **Electronics Fabrication/test** — **now thru 6/03**
- **Flight Housings Design/Fab** — **now thru 6/03**
- **Flight Telescope Design/Fab** — **now thru 6/03**
- **ETU test at Caltech** — **5/03**
- **FM1 SIT Integration** — **6/03**
- **FM1 Debug/Functional Test** — **6/03 - 10/03**
- **FM2 SIT Integration** — **10/03**
- **FM2 Debug/Functional Test** — **10/02 - 12/03**
- **Conformal Coat** — **12/03**
- **Bakeout** — **12/03**
- **Vibration Test** — **12/03**
- **Delivery to Caltech** — **1/04**

TRANSPORTATION

- **Instrument Level**
  - **Carrying case - shock mount, cleanliness**
  - **hand carry (haven't done this since 9/11/01, problems?)**
  - **Purge not required during transport at instrument level**
  - **no other known concerns**
- **Suite Level**
- **S/C Level**

OPEN ISSUES/CONCERNS