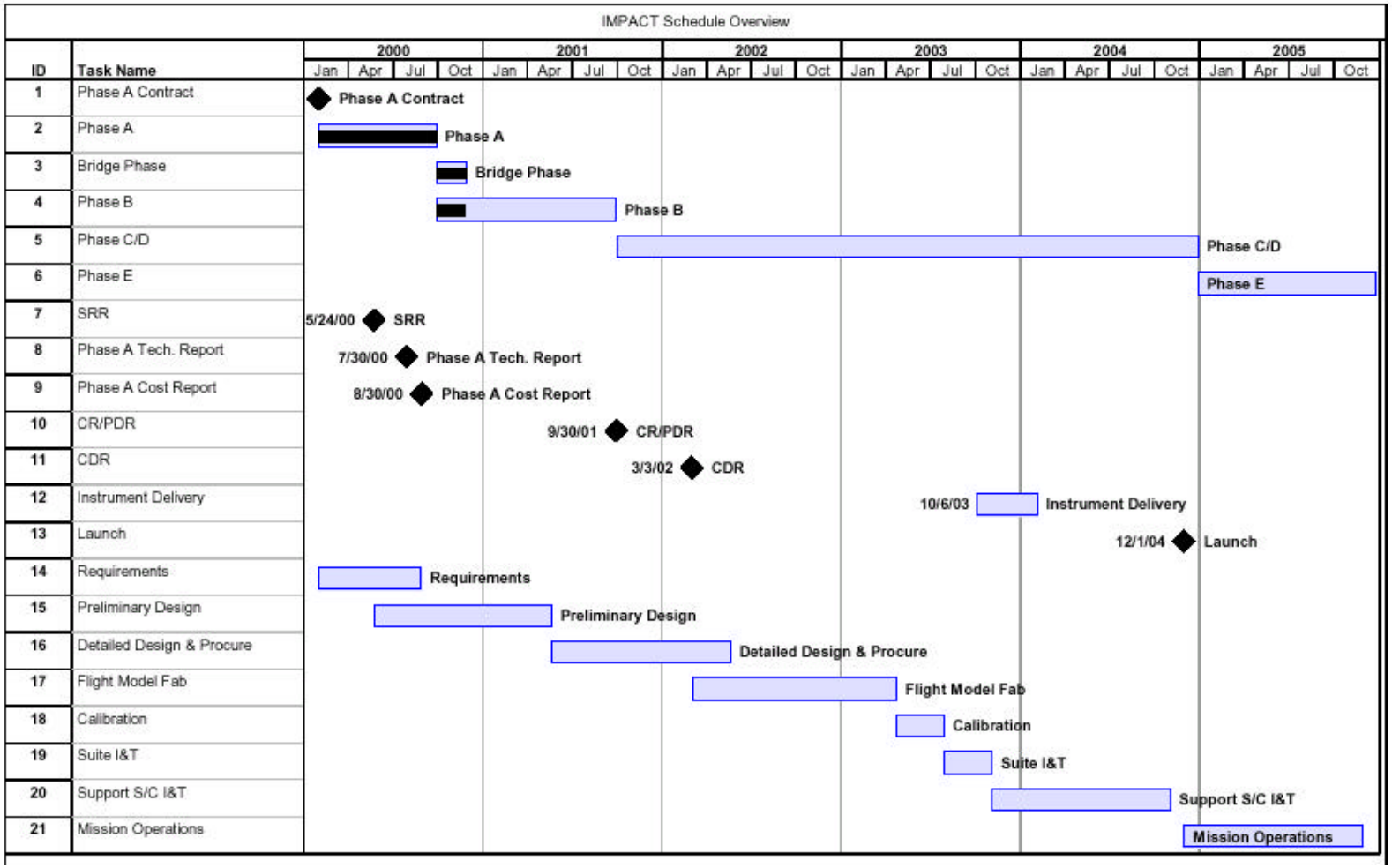
STEREO IMPACT Programmatics

IMPACT Team Meeting 12/2000

New Schedule

- The Phase B has been stretched by 4 months, through September 2001.
- Instrument delivery has been slipped 4 months
- Launch has been slipped 6 months
- New schedules are needed per institution to match the new project schedule (like those in the Phase A Report)
  - These schedules need to be updated monthly

IMPACT Overview - New Schedule



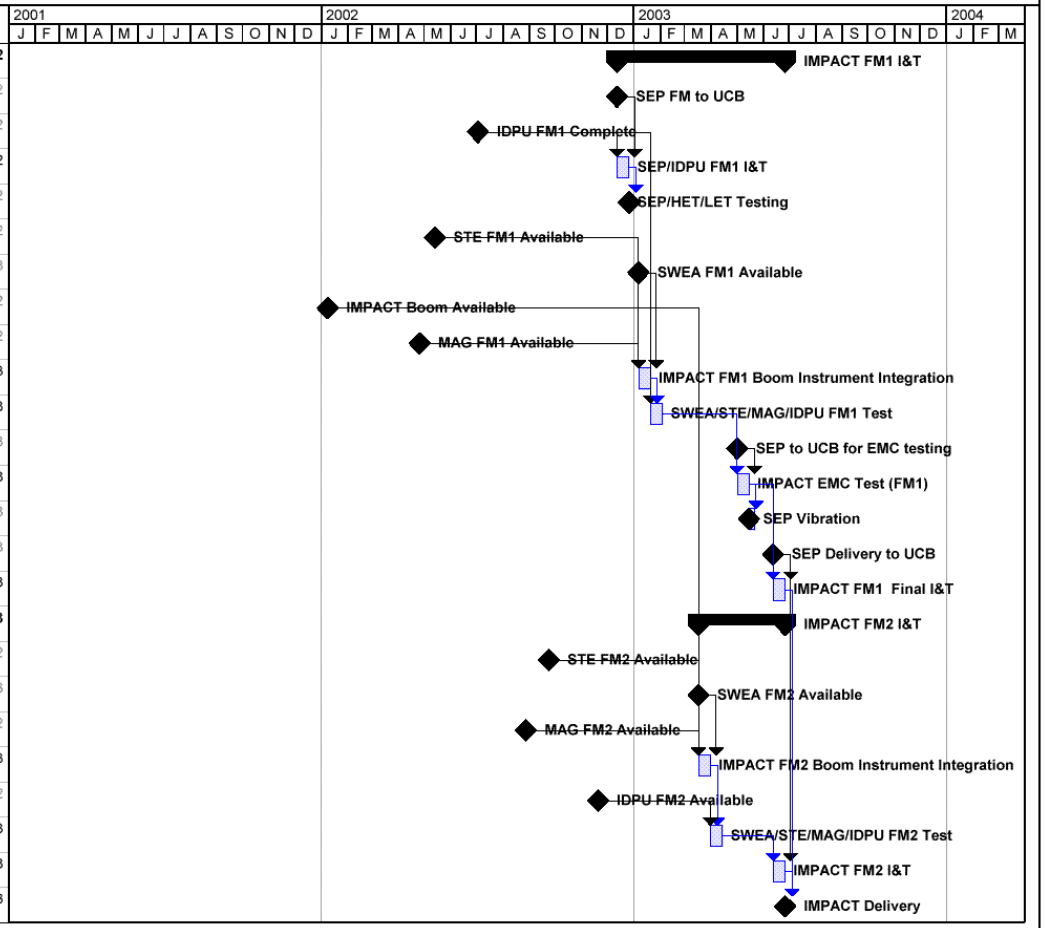
Suite I&T

- **Assumptions:**
  - **Instrument mostly calibrated individually, before integration, using IDPU and/or SEP simulators.**
  - **IDPU, MAG, SWEA, STE and BOOM Integrated, Vibrated, and Thermal Vac at UCB**
  - **SEP Integrated, Vibrated, and Thermal Vac at TBD**
  - **Entire Suite EMC tested together (early)**
- **Need to know for SOW: Are we doing one Proto Flight and one Flight, or two Proto Flight instruments? (effects level of testing on second unit)**

UCB Suite I&T Schedule (add 4 months)

IMPACT Suite Integration & Test (UCB)

ID	Task Name	Start
1	**IMPACT FM1 I&T**	**12/13/2002**
2	SEP FM to UCB	12/12/2002
3	IDPU FM1 Complete	7/3/2002
4	SEP/IDPU FM1 I&T	12/13/2002
5	SEP/HET/LET Testing	12/27/2002
6	STE FM1 Available	5/13/2002
7	SWEA FM1 Available	1/6/2003
8	IMPACT Boom Available	1/8/2002
9	MAG FM1 Available	4/25/2002
10	IMPACT FM1 Boom Instrument Inte	1/7/2003
11	SWEA/STE/MAG/IDPU FM1 Test	1/21/2003
12	SEP to UCB for EMC testing	5/1/2003
13	IMPACT EMC Test (FM1)	5/2/2003
14	SEP Vibration	5/16/2003
15	SEP Delivery to UCB	6/12/2003
16	IMPACT FM1 Final I&T	6/13/2003
17	**IMPACT FM2 I&T**	**3/18/2003**
18	STE FM2 Available	9/23/2002
19	SWEA FM2 Available	3/17/2003
20	MAG FM2 Available	8/28/2002
21	IMPACT FM2 Boom Instrument Inte	3/18/2003
22	IDPU FM2 Available	11/20/2002
23	SWEA/STE/MAG/IDPU FM2 Test	4/1/2003
24	IMPACT FM2 I&T	6/13/2003
25	IMPACT Delivery	6/26/2003



Peer Review Schedule

- Three peer reviews scheduled before PDR
- Project will designate independent reviewers
- European Co-I attendance not required
  - Provide information to a US CoI to present
- Intended to be a working meetings not a dog and pony shows
  - Current design drawings rather than viewgraphs
- Scheduled by subsystem
  - May splinter to cover different disciplines (mechanical, electrical,…)
- Current Schedule:

To Be Reviewed	Where	When
Boom, STE, SWEA	Berkeley	2001/3/6
MAG, SEP (SIT, SEPT, LET, HET)	GSFC	2001/4/18
IDPU, Software, Ops, Data	Berkeley	2001/6/13

Funding

- The Phase B/C/D budget(the one in the Phase A report) is still being processed by Project.
- We have “provisional” phase B funding through February 2001 to cover the start of our Phase B efforts
- The existing contract will be funded for Phase B/C/D officially some time before the provisional funding runs out
- A new RFP will be issued shortly to respond to the new funding and schedule
- We will need new official budgets to respond to this RFP
- RFP will result in a contract modification

Phase B/C/D Statement Of Work

- Preliminary Phase B/C/D SOW has been provided by Project and distributed to NASA-funded Co-Is.
- There is a significant load of documentation required which Berkeley will need support from CoIs to generate:
  - Monthly progress reports starting Phase C/D
    - need a paragraph per institution covering accomplishments, resource status, problems, and risks
  - Monthly Financial reports (533) for NASA-funded institutions
  - Monthly Schedule update per institution or instrument
  - PDR, CDR, PER, PSR, and Peer Review presentations/support
  - PAIP, Software Development Plan, Data Processing Plan
  - Performance Specification, Verification Plan, Verification matrix
  - Instrument FMECA; Structural, Thermal analytical models
  - Configuration Controlled part/assembly drawings (not delivered)
  - Support for APL covering ICD, Saftey, Mission Ops, EMC, Contamination, I&T, FMECA, FTA, Verification Plans
  - Acceptance Data Package, Users Manual, Photographs, Final Report

IMPACT IDPU

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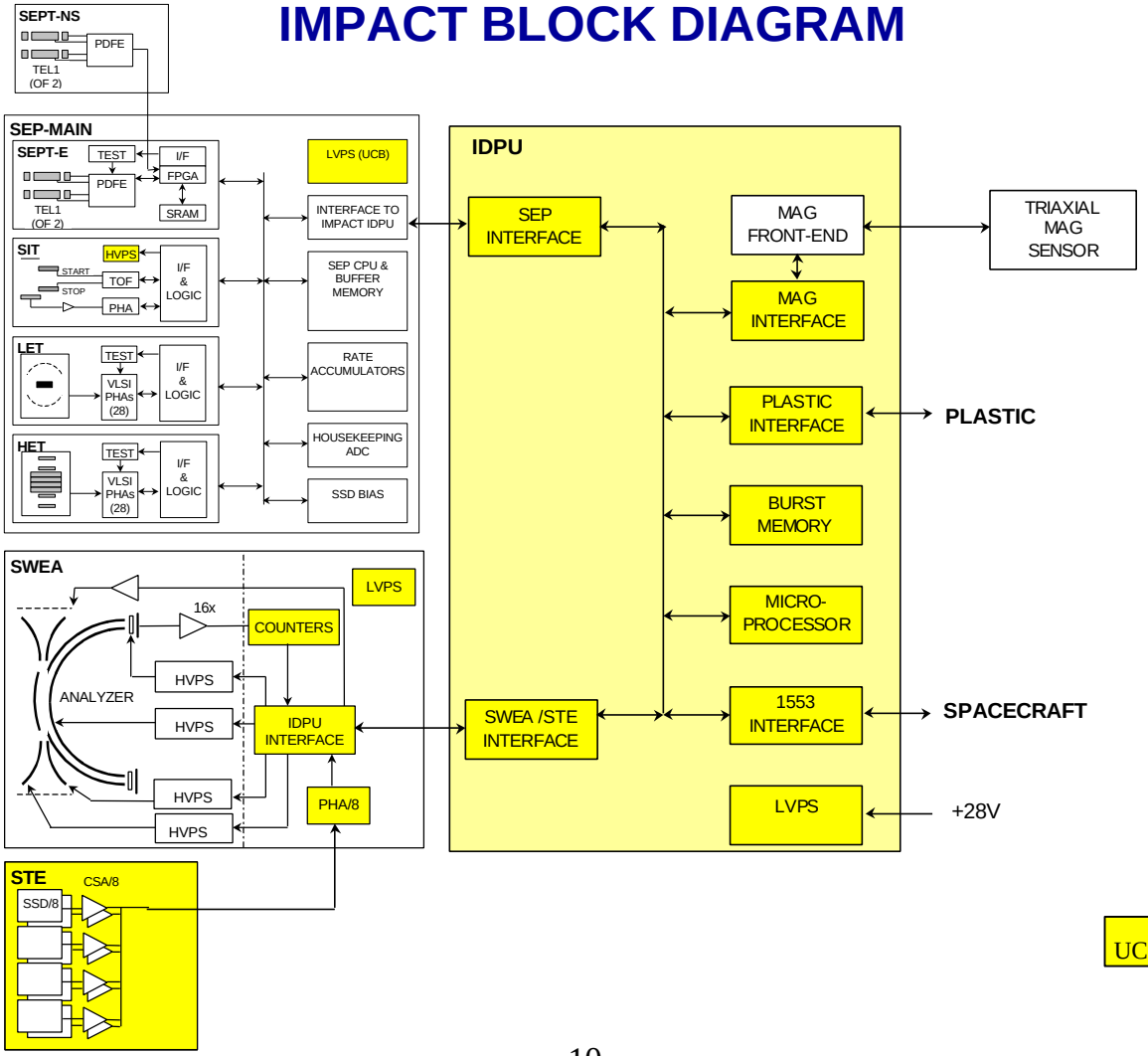
IMPACT BLOCK DIAGRAM



IDPU Mechanical Design

- 15x19cm board size
- Four Boards:
  - Processor / Burst Memory
  - Interface
    - Mag (Digital)
    - SEP
    - PLASTIC
    - SWEA/STE
    - Spacecraft (1553)
  - MAG Analog (GSFC)
  - IDPU LVPS (plus GSFC-provided MAG Heater circuit)
- Mounted inside bus, thermally coupled to spacecraft deck

IDPU Electrical Design

- 16-bit (0.5W) Processor (UTMC 80CRH196)
- Burst Memory (2Mbytes)
- EEPROM?
- 1553 Spacecraft Interface - UTMC Summit ?
- FPGA - Actel 54RXSX32?
- Four Identical Serial Interfaces
  - SEP, SWEA/STE, MAG, PLASTIC
  - Provides commanding, telemetry, and timing
  - No handshaking provided in hardware; sender transmits data in blocks
  - Described in preliminary interface document
  - Common UCB-provided IDPU Simulator GSE
  - Drive Circuit Breadboarded, good for >8m over three small coax
  - Next level interface to be negotiated; data block formats, data flow rates and control, etc.

IDPU Software Design

- All IDPU Flight Software to be programmed at Berkeley
- Instrument Processing Requirements (preliminary) to be provided to Berkeley by 4/2001
  - SEP - Tycho or designate
  - SWEA, STE - Larson
  - Burst System - Larson (+Bale for SWAVES I/F)
  - MAG - Acuna
  - PLASTIC - UNH
- Requirements to include:
  - Instrument Control Requirements (anything more than setting mode words via ground command to be detailed)
  - Data Collection Requirements (how much, how often)
  - Data Compression Requirements (algorithim, how often)
  - Telemetry Products description
  - Burst Telemetry Products description
  - Memory Requirements (RAM and look-up tables)

LVPS

- **UCB is building 4 LVPS (x2)**
  - **IDPU (+MAG) 3.6 W +3.3, +5D, +/-12V**
  - **SEP 3.5 W +3.3, +5D, +/-5, +/-12V**
  - **SWEA/STE 1.3 W +3.3, +5D, +/-5, +/-12V, +28V**
  - **PLASTIC 3.7 W +5, -5, +12V**

Verify These

- **Common design and layout**
  - **Vary turns ratios and parts loading to accommodate different voltage requirements**
  - **SWEA/STE may have different layout due to lower power requirement and form factor constraints**
- **Meets SWAVES EMI/EMC guidelines**
- **Provided in a box to provide shielding**
- **Approximately 200g, 2cm x 10cm x 10cm (TBR)**
- **Approximately 80% efficient (except 3.3V)**

IDPU Simulator GSE

- Simulates IDPU serial interface to instruments (incl. PLASTIC)
- Developed at UCB
- PC-based system with custom I/O to simulate serial I/F
- LabWindows CVI-based software
- Delivered with baseline services:
  - Command interpreter& scripting user interface
  - Raw and statistical engineering displays
- Science displays to be provided by the Instrument team
  - Separate program running on same or another computer
  - Data provided over socket connection to UCB control software

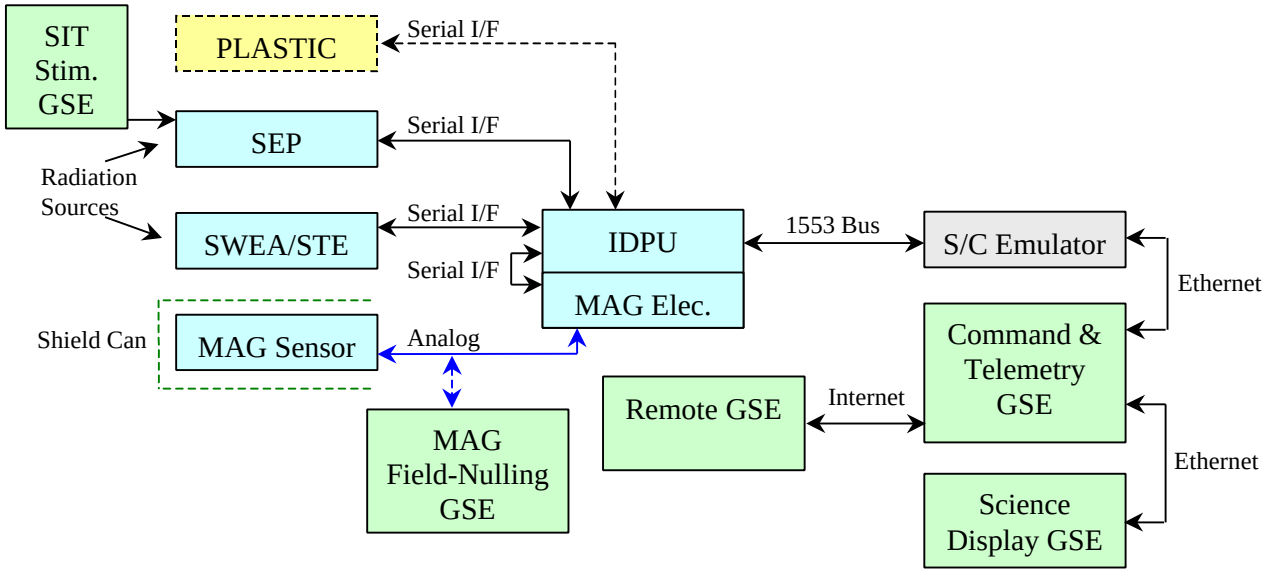
Command & Telemetry GSE

- Developed at UCB
- Works with Spacecraft Emulator at suite I&T level
- Works with MOC at Spacecraft I&T level
- Works with SSC at Mission Ops level
  - A common network interface for these three environments is highly advantageous and has been assumed in development plans
- Runs commands and command scripts
  - STOL-like language
- Remote commanding & display via secure internet connection
- Displays housekeeping and instrument status information with limit-checking/alarms
- Decommutates and passes on packets to Science Display GSE and/or remote C&T GSE via network

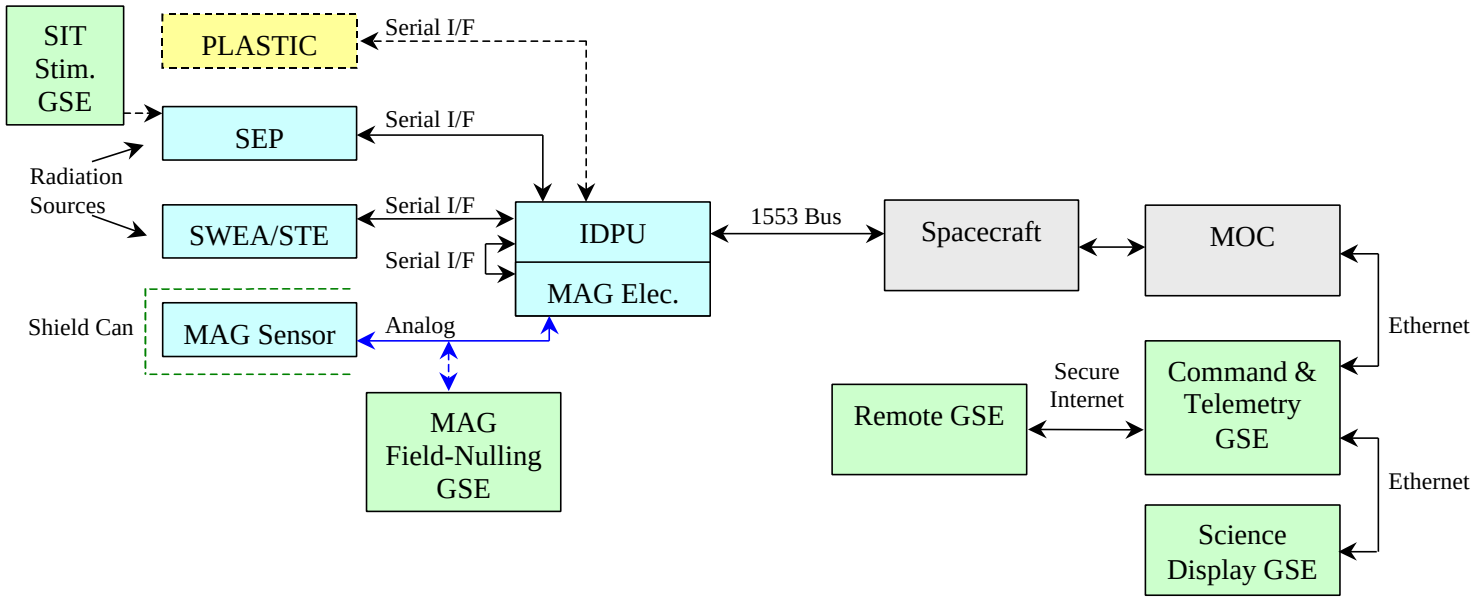
Science Display GSE

- Decodes and Displays science data from instruments
- Provides adequate information to determine the health and functionality of the instrument in the I&T, Commissioning, and mission environment
- Receives telemetry packets forwarded by Command & Telemetry GSE at the suite, spacecraft, and mission level via the network
- Developed by the instrument builder and UCB.
  - Instrument teams to develop Instrument science display GSE
- Runs on a second workstation (PC) in order to provide more display space, separate science and engineering functions, and improve the reliability of the C&T system.

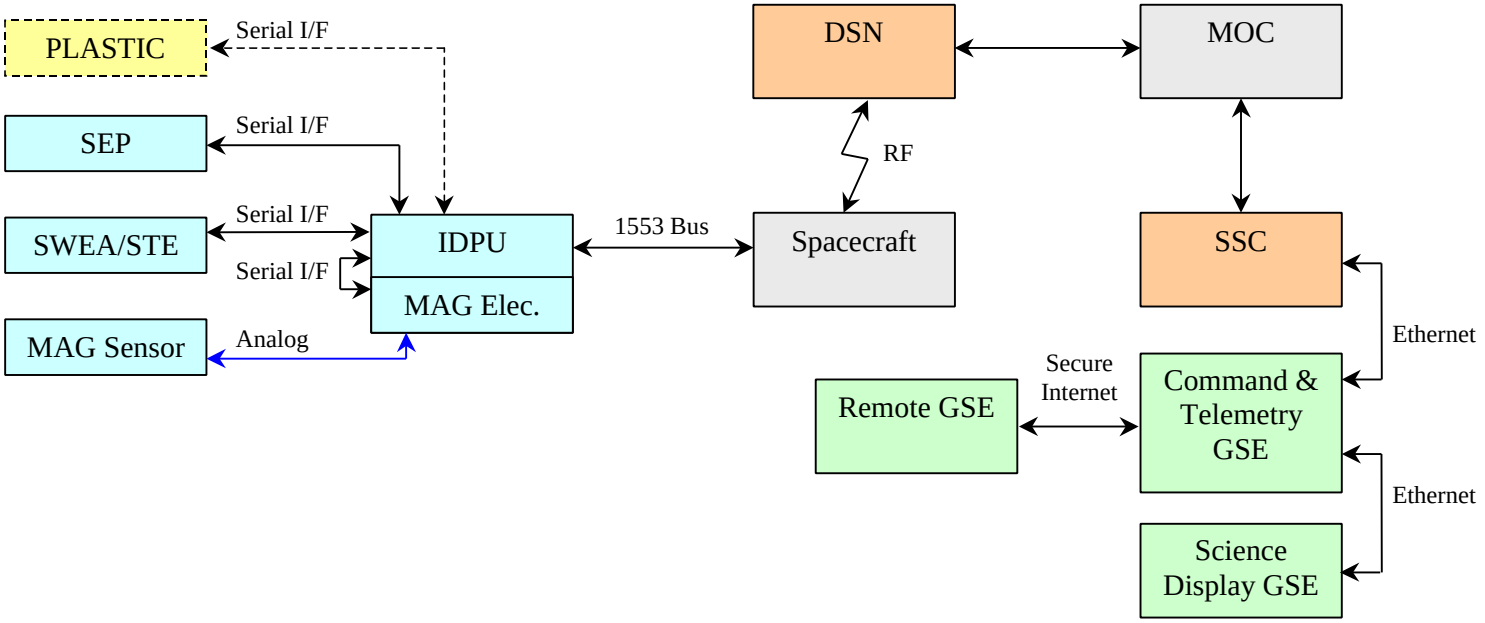
IMPACT Suite Integration GSE Configuration (at UCB)



IMPACT Spacecraft Integration GSE Configuration



IMPACT Mission Operations GSE Configuration



IMPACT ICD & Resources

IMPACT Team Meeting 12/2000

ICD Issues

- A preliminary draft of the Spacecraft to IMPACT ICD has been released
- This document is currently considered ITAR-controlled by APL
- I will take the lead in working the ICD; pass any issues you have with it on to me
- I will request any information I require for the ICD from the CESR SWEA team
- Tycho or his (US) designate will request any information required from the non-US SEP team members for the ICD.
- This document will be signed off a few months before PDR.

Resource Allocations

- **Mass, Power, and Telemetry are controlled by Project; any requests for changes must be submitted to them.**
- **I will coordinate any such change requests; any requests should pass through me so I can keep track of the.**
- **Requests must include reason for the increase and impact if it is not allowed**
- **This project does not have large resource reserves; do not expect to get what you ask for.**

Current Allocations

Stereo Instrument Resource Estimates					16-Aug-2000							
Instrument	**Mass, kg**	**Power, W**	**Volume, cc**	**bps**	**Notes**							
SEP:												
SEPTE	0.46	0.52	218	120	Mueller-Mellin 7-July-00 e-mail							
SIT	0.93	0.66	619	240	May IMPACT meeting							
LET	0.51	0.18	424	320	May IMPACT meeting							
HET	0.70	0.07	206	120	May IMPACT meeting; 700g for compromise HET							
SEP Common Elec.	1.49	0.85	3000		May IMPACT meeting; assume 150g for bias supply							
SEP LVPS	0.20	0.70			Efficiency	80%						
SEP Total	4.29	2.99		800								
SEPT-NS	0.44	0.52			Mueller-Mellin 7-July-00 e-mail							
SEP-NS Bracket	0.27				APL Estimate, 8/2000							
SEP Bracket	1.00				Tycho's July estimate (APL=0.76)			(9/00, APL says L=0.8/T=0.5)				
SEP Blankets	0.10				Project Allocation 7/2000							
SWEA (CESR)	1.21	0.54	1000	394								
SWEA/STE I/F	0.30	0.30	500		SWEA/STE I/F and LVPS included in SWEA unit; includes SWEA baseplate							
SWEA/STE LVPS	0.20	0.26			Efficiency	80%						
STE	0.35	0.20	600	64								
MAG Sensor	0.25		500	154	8Hz, 6-bit deltas, with a full sample every 4 seconds							
Boom	0.35											
Boom Totals	2.66	1.30	2600	612								
IDPU:												
Mag Card	0.30	0.38										
DPU Card	0.30	0.80										
Interface (on DPU card)		1.70			1553 I/F	1.5	W	(Plus conversion)				
IDPU LVPS	0.20	0.72			Efficiency	80%						
Mag Heater Control	0.07											
BOX	0.87		1920									
IDPU Total:	1.73	3.60	1920	164				IDPU:	Packet Header	50		
								bps	Packet Collect Time	50		
Burst Telemetry				524					Housekeeping	32		
Harness	0.63				Excludes Astromast portion				Playback Beacon	32		
SWEA/STE/MAG Blanket	0.10				Project Allocation, 7/2000							
TOTAL	11.21	8.41	4520	2100	no margin							
Project Allocations, 9/200	11.00	8.41		2100	+12kg for Astromast							
Project Allocations, 7/200	10.30	7.06		2100								
Proposal Allocations -SW	8.29	5.56		500								

IMPACT Parts

IMPACT Team Meeting 12/2000

Common Buy Parts

- There is still no Project Common Parts buy
- There has been no significant progress on an Instrument common parts buy since the last meeting (some interest, no urgency)
- The most likely components for a common buy are Actels and Memories, though issues such as voltage (5 or 3.3V), size, and speed may become a problem

Parts and QA

- Project is working on a new Instrument Mission Assurance Requirements Document (an early combined bus/instrument MAR was rejected)
- It is expected to require Grade 2 parts
- For parts that need to be up-screened, the difference between screening to Grade 2 vs Garde 3 is not a large cost; either way it is on the order of $5K per part type (lot), excluding radiation testing.
- The big difference is in what parts are acceptable without screening. Manufacturers high Rel and non-JAN parts need screening for Grade 2 applications.
- Project promises to be “reasonable” about parts, but on a case-by-case basis.
- It is expected that NSPARs will not be required; parts will be approved based on a parts list and discussions as required.
- How much of this is imposed on non-NASA funded hardware is TBD.

Data Rates and Formats

IMPACT Team Meeting 12/2000

Data Rates

- **Project has approved a significant increase in the IMPACT telemetry rate over the proposal level (from 500 to 2100 bps)**
  - **It is expected that this increase will decrease data compression complexity and reduce I&T test times.**
- **Data Rates by instrument were presented in the ICD/Resources section, and in the following table.**

IMPACT Science Summary

Table A.1 IMPACT Summary

Experiment	Instrument	Measurement	Energy or Mag. field range	Mass (kg)	Power (w)	Data Rate (bps)	Time Res.	Instrument provider
SW	STE	Electron flux and anistropy	2-100 keV	0.35	0.20	64	16 s	UCB (Lin)
	SWEA	3D electron distrib., core & halo density, temp. & anisotropy	~0-3 keV	1.71	1.10	394	3D=1 min 2D=8s Mom.=2s	CESR (Sauvaud) + UCB (Lin)
MAG	MAG	Vector field	$\pm$500nT, $\pm$65536 nT	0.25	0.0	154	1/8 s	GSFC (Acuna)
SEP	SIT	He to Fe ions	0.03-2 MeV/nuc	0.93	0.66	240	30 s	U. of Md. (Mason) + MPAE (Korth) +UCB (Curtis)
		^{3}He	0.15-0.25 MeV/nuc				30 s	
	SEPT	Diff. electron flux	20-400 keV	0.90	1.04	120	1 min	U. of Kiel (Mueller-Mellin) + ESTEC (Sanderson)
		Diff. proton flux	20-7000 keV				1 min	
		Anistropies of e,p	As above				15 min	
	LET	Ion mass 2-28 & anisotropy	1.5-40 MeV/nuc	0.51	0.18	320	1-15 min.	GSFC (von Rosenvinge) + Caltech (Mewaldt) + JPL (Wiedenbeck)
		^{3}He ions flux & anistropy	1.5-1.6 MeV/nuc				15 min.	
		H ions flux & anistropy	1.5-3.5 MeV				1-15 min.	
	HET	Electrons flux & anistropy	1-8 MeV	0.70	0.07	120	1-15 min.	Caltech (Mewaldt) + GSFC (von Rosenvinge) + JPL (Wiedenbeck)
		H	13-100 MeV				1-15 min.	
		He	13-100 MeV				1-15 min.	
		^{3}He	15-60 MeV/nuc				15 min	
	SEP Common	----	----	1.69	1.55	----	----	Caltech (Mewaldt) + GSFC (von Rosenvinge)
IMPACT Common	IDPU (+Mag Analog)	----	----	1.73	3.60	164 +524 Burst	----	UCB (Curtis)

Beacon Telemetry

- Beacon mode telemetry has also been increased over the proposal level
- There is a proposal to eliminate beacon mode to save $
  - Saves $ by reducing power requirements on the bus (smaller solar arrays)
  - There does not seem to be a strong proponent of Beacon Mode
  - HQ will need to decide on this descope from the baseline

IMPACT / PLASTIC Beacon Telemetry Allocation

STEREO IMPACT & PLASTIC Beacon Mode Telemetry										
2000-5-22, REV2										
		16-bit								
Instrument	**Measurement**	**Quantities**	**Time Res, sec**	**bps**		**Proposal**				
SEP-SIT	He, 2E	2	60	0.53		0.53				
	CNO, 2E	2	60	0.53		0.53				
	Fe, 2E	2	60	0.53		0.53				
SEP-SEPT	Electrons, 3E	3	60	0.80		0.80				
	Ions, 3E	3	60	0.80		0.80				
SEP-LET	Protons, 1E	1	60	0.27		0.27	3Z/E bands			
	He, 1E	1	60	0.27		0.27				
	CNO, 2E	2	60	0.53		0.27				
	Fe, 2E	2	60	0.53						
SEP-HET	Electrons, 1E	1	60	0.27		0.27	3Z/E bands			
	Protons, 3E	3	60	0.80		0.27				
	He, 1E	1	60	0.27		0.27			Total SEP	6.13
MAG	1 Vector	3	60	0.80		0.80			Total PLAS	10.93
STE	2 directions, 3E	6	60	1.60		0.80	1 direction			
SWEA	Moments	30	60	8.00		0.80	3E fluxes			
PLASTIC	SW Proton Moments	5	60	1.33		0.83	10->16 bits/sample			
	SW Alpha Density	1	60	0.27		0.17	10->16 bits/sample			
	SW Charge State	5	60	1.33		0.17	was 5 minute & 10->16 bits			
	Suprathermal, 2E/Q*3Z*5A	30	60	8.00		1.00	was 5 minute & 10->16 bits			
Instrument Status		2	60	0.53		0.40	PLASTIC+IMPACT			
Packet Overhead		6	60	1.60			1 minute/packet			
				29.60		9.77				
One packet (242 bytes) per minute				32.27	bps				Spare	2.67

Telemetry Formats

- All data must be formatted into 242-byte CCSDS telemetry packets
- Bitrate allocation has some flexibility
- My baseline plan is to build one packet format for each telemetry product
  - Advantages:
    - Modular telemetry formatting: independence between Suite instruments for setting sample rates, selecting what packet types to send, etc.
    - Ease of ground data distribution, and processing
    - Simplifies on-board software (less interaction between instruments)
  - Disadvantages:
    - Low rate packets come out infrequently, slowing down testing
      - Can get around this by increasing the rate of a selected packet type at the expense of Burst telemetry
    - Fixed size can be inconvenient for some telemetry types (a mixed instrument format could overcome this)