COS
Monthly Status Review
May 22, 2002
Ball

Agenda

Progress Summary Since Last Monthly	J. Andrews
Ground Calibration Planning	J. Andrews
Cal/FF Subsystem Assembly	J. Andrews
COS I&T Preparation & Support	J. Andrews
UCB FUV Detector Programmatic Status	J. Andrews
UCB FUV Detector Technical Status	O. Siegmund
Schedules	J. Andrews
Descope Report	J. Andrews
Upcoming Events/Activities	J. Andrews
CU Issues & Resolution Plan	J. Andrews
STScI Presentation	K. Sembach
BATC Presentation	R. Higgins
Financial Splinter	GSFC/Ball/CU

Progress Summary Since Last Monthly (4/2/02)

- Continued FUV-01 recovery from QE grid failure.
- Started Cal/FF subsystem I&T.
- Commenced detail ground calibration planning.
- Began SMOV performance verification planning (OP-03).

Ground Calibration Planning

- Detailed planning of calibration planning is starting.
- AV-03 (released) defines requirements.
- Identification of facilities/resources for sensitivity calibration is done (Ebbets).
- Identification of facilities/resources for resolution calibration is starting (Green).

COS Calibration System Integration Status

- Preliminary alignment completed on schedule.
- Shim thickness and wedge have been determined for ellipse and beam splitter. Shims are being ground.
- Final alignment and installation of beam splitters and ellipse will be completed this week.
- First light through calibration subsystem expected Tuesday 5/28/02.

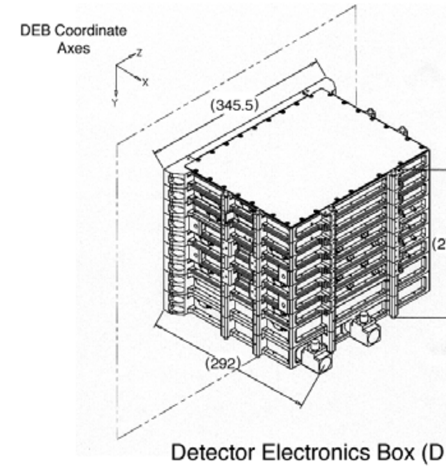
Calibration platform with lamps and ellipse in nominal positions. GSE mounting fixture and fold mirror visible.

COS I&T Preparation and Support

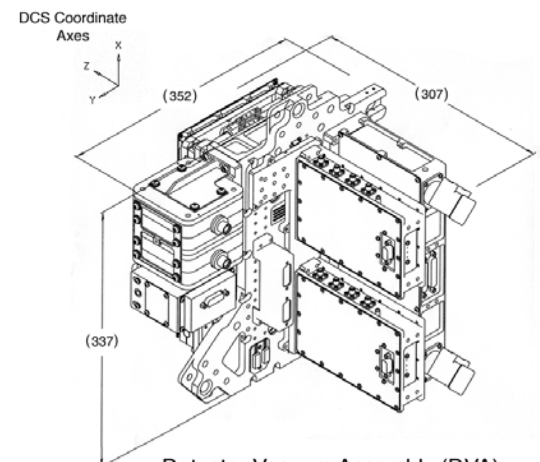
- CU's support of COS I&T at Ball continues and will ramp-up further in June as S. Beland joins K. Brownsberger to support FSW/OPS activities.
- CU/Ball/UCB/GSFC met again on 5/21 to discuss I&T planning and staffing for all future activities at Ball and GSFC.
- GROVER was returned it to GSFC for reconditioning into CAOS last month.

Overview of FUV Detector Assemblies

- **DEB** - (**D**etector **E**lectronics **B**ox)
  - **DCE** (**D**etector **C**ontrol **E**lectronics))
  - **TDCs** (**T**ime**-to-D**igital **C**onverters)
  - **HVPS** (**H**igh **V**oltage **P**ower **S**upply)
  - **LVPC**(**L**ow **V**oltage **P**ower **C**onverter)
- **DVA** - (**D**etector **V**acuum **A**ssembly)
  - **VHA** (**V**acuum **H**ousing **A**ssembly)
    - Detector Door Mechanism
    - Ion Pump Assembly
  - **DBA** (**D**etector **B**ackplate **A**ssembly)
    - **Amplifiers**
    - **HVFM (H**igh **V**oltage **F**ilter **M**odule)



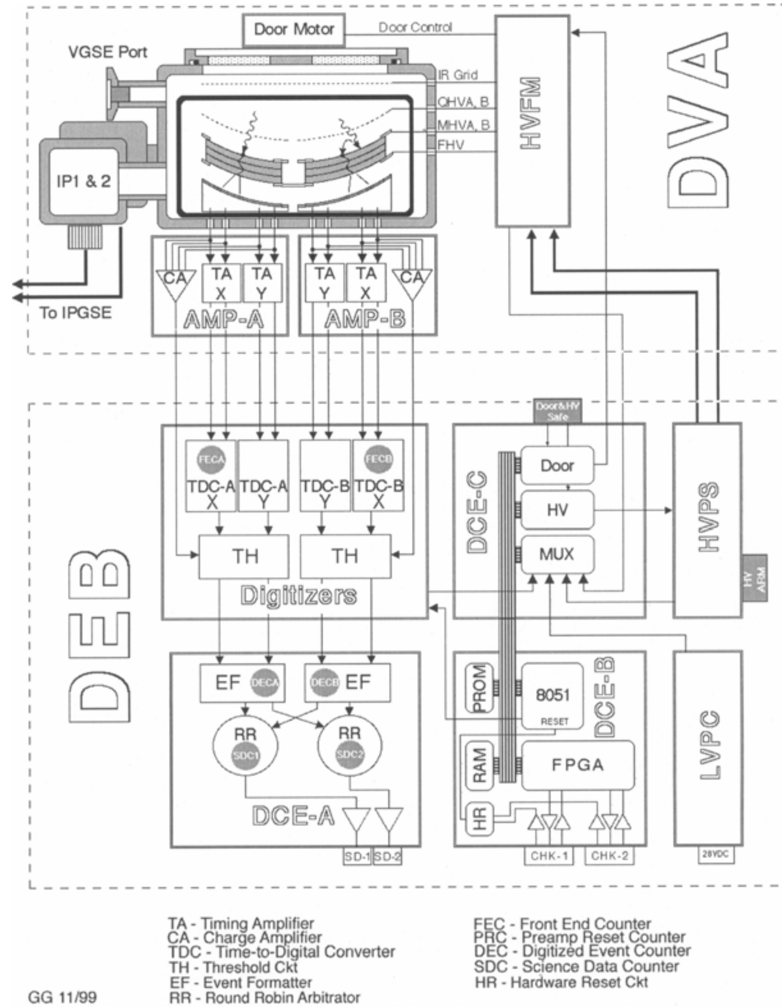
Detector Electronics Box (DEB)



Detector Vacuum Assembly (DVA)

FUV Detector Subsystem Block Diagram

- UCB is under contract to deliver 1 flight FUV detector subsystem (FUV-01) and 1 flight-spare detector subsystem (FUV-02).



FUV Detector Verification Testing Summary

Unit	Functional Testing	Performance Testing	EMI/EMC	Sine Burst	Random Vibe	Thermal-Vac	Contamination Certification
FUV-01 DVA	C	C	@SS	A - C	A - C	@SS	@SS
FUV-01 DEB	C	C	@SS	Q - C	Q - C	@SS	@SS
FUV-01 SS	C	C	C	@Comp	@Comp	6-cycles	C
FUV-02 DVA	C	C	N/R	Q - P	Q - P	@SS	@SS
FUV-02 DEB	C	C	N/R	Q - P	Q - P	@SS	@SS
FUV-02 SS	P	P	N/R	@Comp	@Comp	8-cycles	P
DVA Surrogate (1)	C	N/R	N/R	C	C	N/R	N/R
DVA Surrogate (2)	P	N/R	N/R	P	P	P	N/R

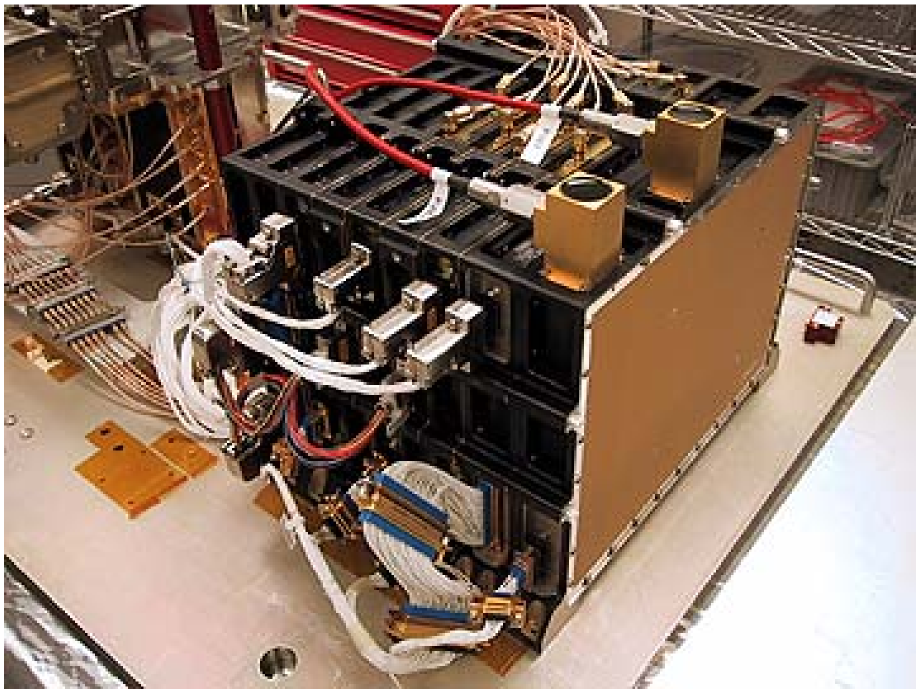
C	Complete
@SS	At Subsystem
A	Acceptance Levels
Q	Qualification Levels
N/R	Not Required
P	Planned
(1)	Old Door Mechanism
(2)	New Door Mechanism

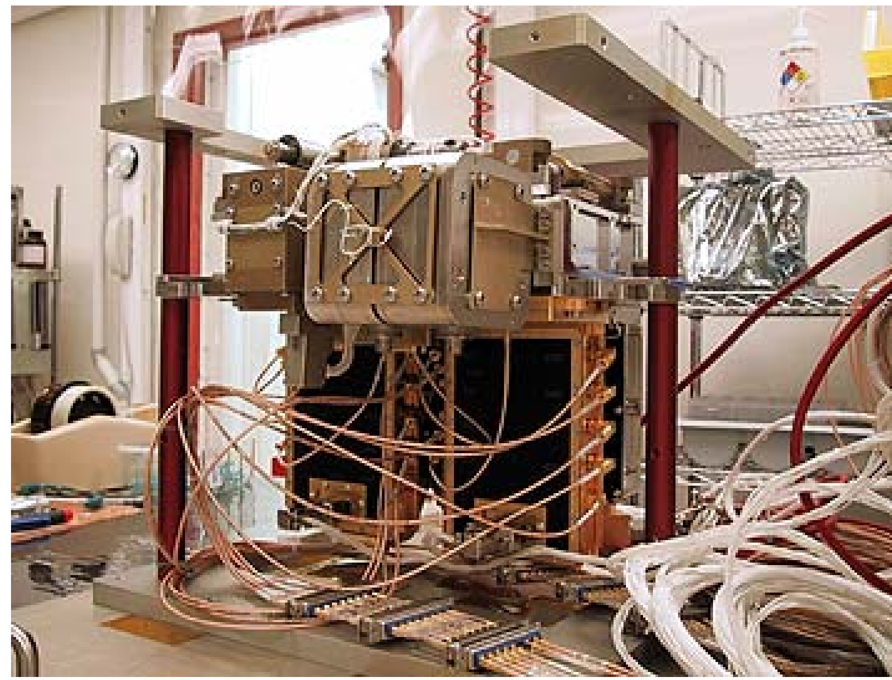
- FUV-01 DVA has now seen acceptance level vibe 2x.
- A single-axis workmanship vibe on FUV-01 DVA was completed after the door mechanism was repaired in early March.
- A single, z-axis acceptance level vibe on FUV-01 DVA is planned upon installation of new grids.

ID	Task Name	% Complete	Duration	2002–2003 (S O N D J F M A M J J A S O N D J F)
1	QE GRID RETRO-FIT OF FUV#1	41%	108 days	
2	**Initial Problem Diagnosis**	**100%**	**15.5 days**	
16	**Test & Qualify New Grids**	**100%**	**32 days**	
28	**Life Test of Qual Grid Assembly (Pending Hardware Availability)**	**7%**	**18 days**	
29	Repair of Stork-Veeco grid	100%	2 days	5/14 – 5/15
30	Thermal cycling of qualification grids	0%	5 edays	5/15 – 5/20
31	Visual inspection & field emission tests of grid (when F.E. detector available	0%	1 day	5/21 – 5/21
32	Vibration Life test No. 1 of qualification grid at AMES (need ETU DVA)	0%	2 days	5/22 – 5/23
33	Visual inspection & field emission tests of life test grid (when F.E. detector a	0%	1 day	5/24 – 5/24
34	Vibration Life Test No. 2 of qualification grid at AMES (need ETU DVA)	0%	2 days	5/27 – 5/28
35	Visual Inspection & Field emission test of life test grid	0%	1 day	5/29 – 5/29
36	Repeat Thermal Qual of Replaced Grid	0%	2 days	5/30 – 5/31
37	Visual Inspection & Field Emission Test of life test grid	0%	1 day	6/1 – 6/1
38	Qual vibe of qual/life-test grid	0%	1 day	6/3 – 6/3
39	Visual Inspection & Field Emission Test of life test grid	0%	1 day	6/4 – 6/4
40	Life test of Grid Design Completed	0%	0 days	6/4
41	**Assembly & Test of Flight Grid Assembly**	**20%**	**10 days**	
42	Fabricate and epoxy cure FUV#1 & FUV#2 grids (UCB personnel)	100%	2 days	5/14 – 5/15
43	Optical inspection & Field Emission Test of FUV#1 grid (need F.E. detector)	0%	1 day	5/16 – 5/16
44	Thermal qualification of FUV#1 grid	0%	3 days	5/17 – 5/20
45	Inspect and field emission test of FUV#1 grid (need F.E. detector))	0%	1 day	5/21 – 5/21
46	Qualification shake test of FUV#1 grid at AMES (need ETU DVA)	0%	1 day	5/22 – 5/22
47	Inspect and field emission test of FUV#1 grid (need F.E. detector)	0%	2 days	5/23 – 5/24
48	**Reassembly & Test of Flight FUV-01 Detector**	**0%**	**50 days**	
49	Complete FUV-01 QE Tests	0%	4 days	5/20 – 5/23
50	Open FUV#1 and Install qualified QE grid	0%	3 days	5/28 – 5/30
51	Install FUV#1 in QE test chamber	0%	1 day	5/31 – 5/31
52	Detector #1 functional test with flight DEB	0%	1 day	6/3 – 6/3
53	QE check of FUV#1 detector	0%	2 days	6/4 – 6/5
54	Pre-vibration functional testing	0%	1 day	6/6 – 6/6
55	FUV#1 vibration test at Lockheed	0%	3 days	6/7 – 6/11
56	Post vibration function tests in QE chamber	0%	2 days	6/12 – 6/13
57	Install FUV#1 system in cal chamber + set-up scrub	0%	2 days	6/14 – 6/15
58	Mini-Scrub of FUV#1 plates in Calib chamber	0%	6 edays	6/17 – 6/23
59	Final QE calibration of FUV#1	0%	4 days	6/24 – 6/27
60	Final System Functional testing	0%	3 days	6/28 – 6/30
61	Pack detector for shipment	0%	1 day	7/1 – 7/1
62	Ship FUV01 detector system to UCo	0%	2 days	7/2 – 7/3
63	Install detector system into UCo T-V chamber	0%	1 day	7/8 – 7/8
64	Pre-pump down functional testing	0%	1 eday	7/9 – 7/10
65	Completion of FUV#1 System T-V tests	0%	4 edays	7/11 – 7/15
66	FUV#1 System cleanliness certification	0%	1 day	7/16 – 7/16
67	Remove flight system and pack	0%	1 day	7/17 – 7/17
68	FUV#1 system ready for BATC	0%	0 days	7/17

COS FUV Detector Systems

- Detector DEB
- Detector Head

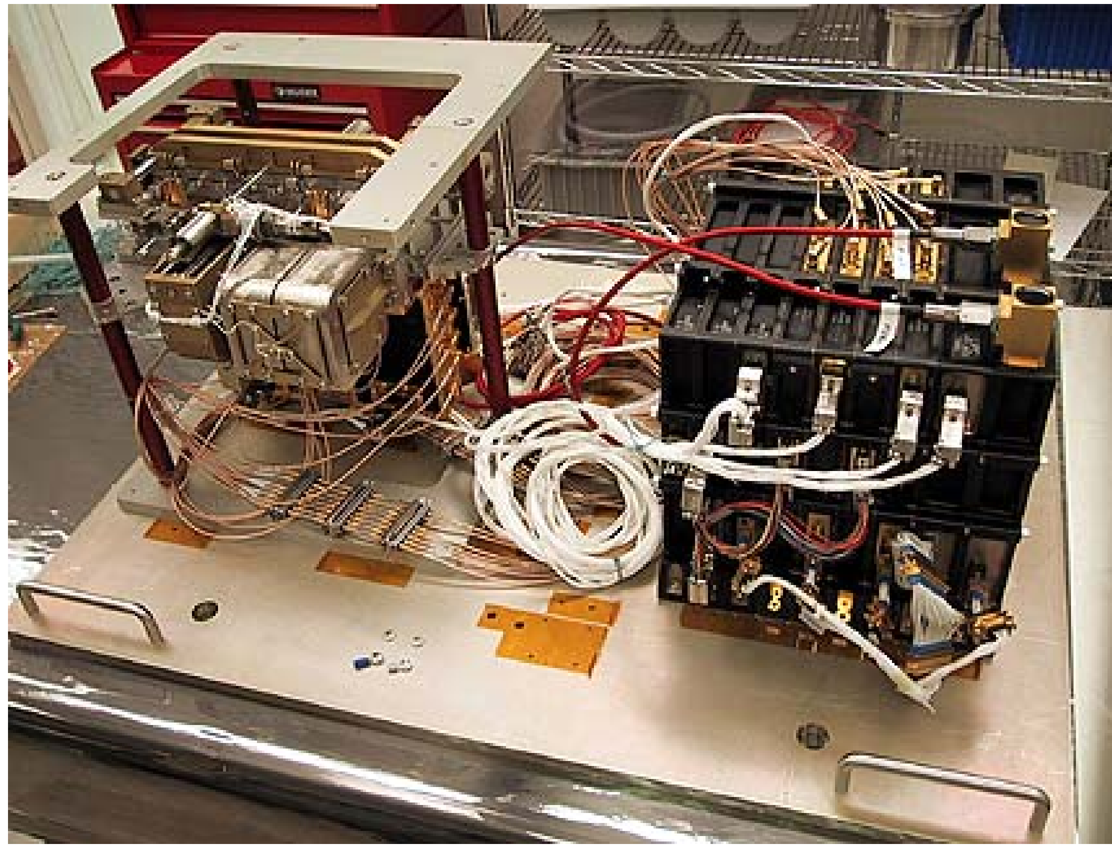




Flight FUV01 Detector System

Detector upper door & mechanism re-worked at UCB in collaboration with Swales, CU & GSFC.

FUV01 door motor and HOP subassy rebuilt and tested at UCB successfully on ETU. Door reassembled and tested successfully at CU before and after vibration at Ball.



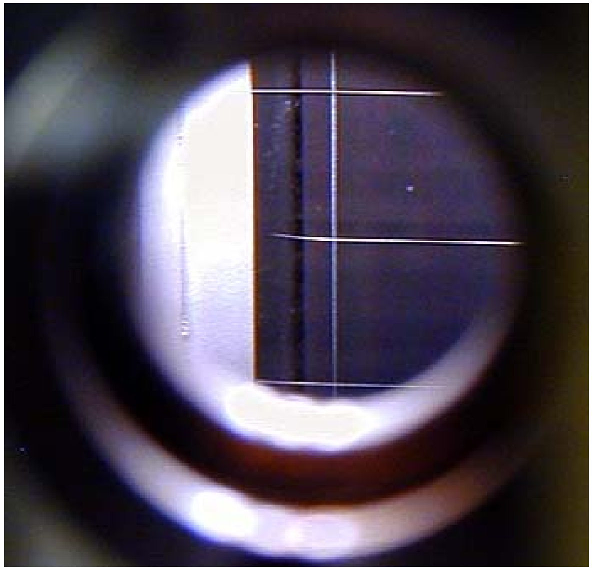
FUV Door Problem Recap

- FUV01 Door Reassembled & Tested Successfully
  - **FUV01 shafts, flags, cogs, clamshells, motor, modified & rebuilt**
  - **Installed FUV01 motor sub assembly onto ETU DVA**
  - **Bench tested, door open/close with motor, HOP firing, relatch, - OK**
  - **Installed in thermal vac tank and tested**
    - **door open/close with motor, HOP firing, relatch, at ambient/cold/hot -OK**
  - **Vibrated to qualification levels at Lockheed -OK**
  - **Re-installed in thermal vacuum tank and tested**
    - **door open/close with motor, HOP firing, relatch, at ambient/cold/hot -OK**
  - **Removed FUV01 motor assy and returned to CU, installed on FUV01**
  - **Vacuum tested door systems operation successfully at vacuum**
  - **Vibrated in Z axis to acceptance levels at Ball**
  - **Returned to CU and verified door operation successfully at vacuum**
  - **Found high field emission due to broken grid wire**

FUV01 Grid Wire Problem

- FUV01 Grid wire broke on last acceptance vibration at Ball
  - Intense field emission observed on "B" side only when grid bias on
  - Inspection through window shows one wire has broken & bent towards MCP's
  - FUV01 brought back to UCB for analysis and correction
  - Working closely with GSFC and CU to expedite solution

Grid wire through window



Grid wire from side angle

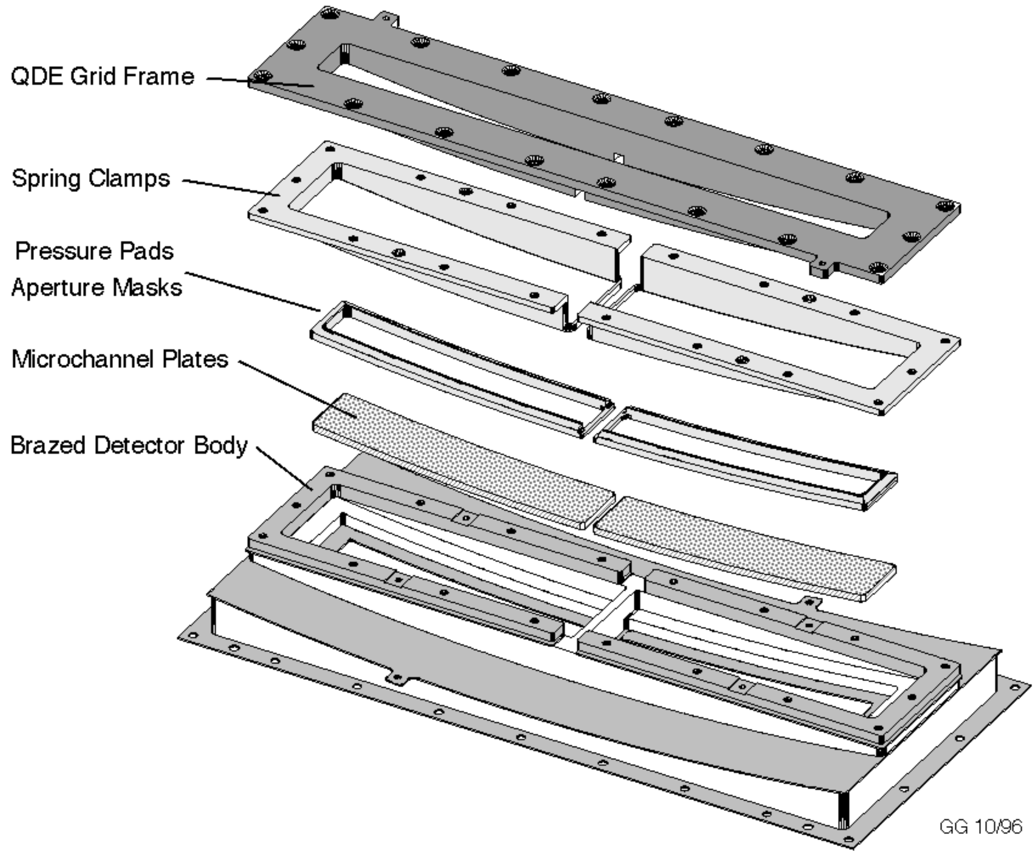
Grid wire attachment point

FUV01 Grid Design

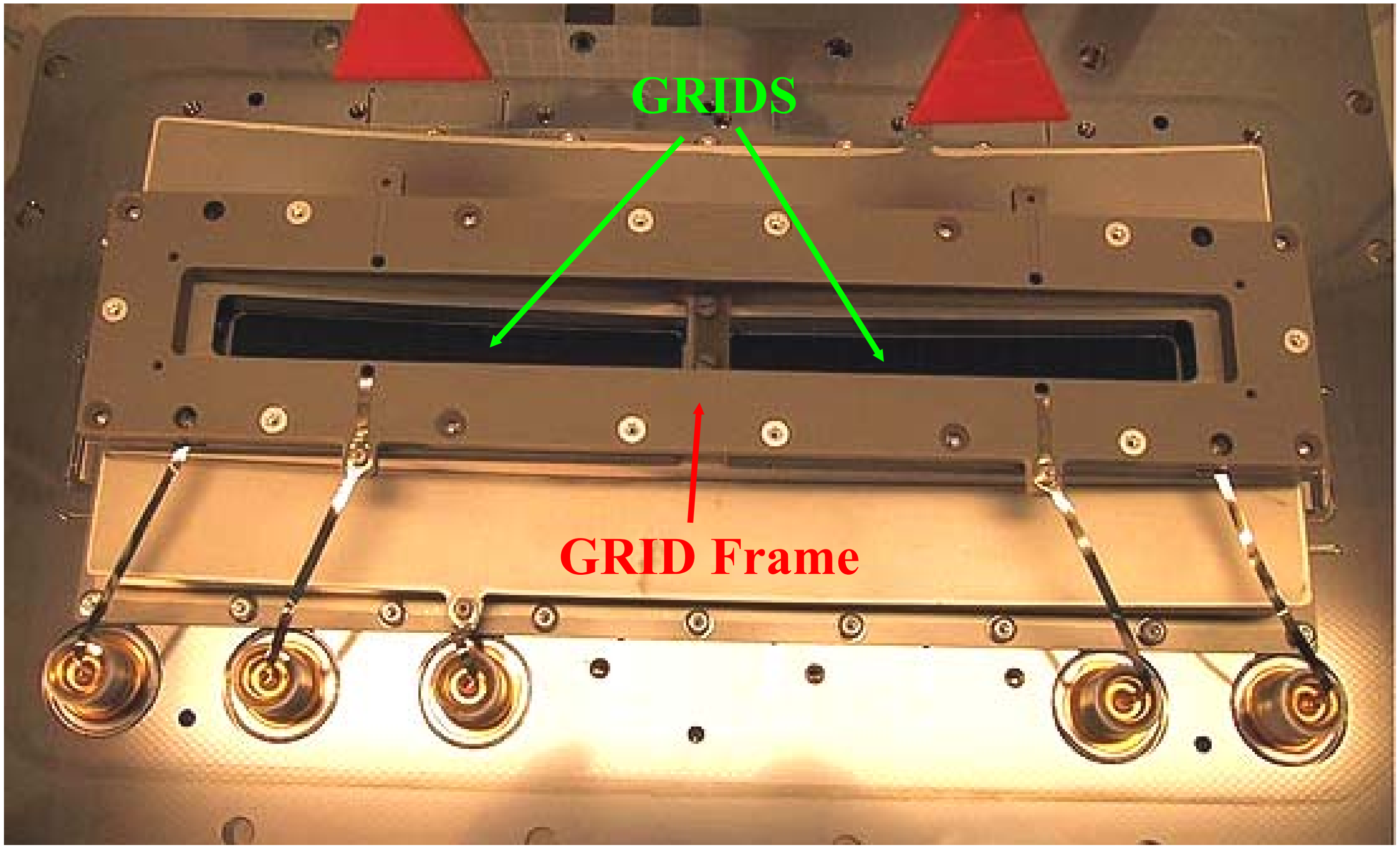
FUV01 QE Grid

- Mounts to top of detector
- Frame is PEEK insulator
- Grids are electroformed Ni
- One grid on each segment
- Used to enhance QE by 30%
- -1500v bias to MCP
- Bias can be turned off
- Ramps with MCP HV

- Can be removed or installed without disturbing MCP's
- Access by removing DBA & magnetic shield from VHA



FUV01 Grid Frame Assembly



FUV01 Grid is held on detector with 10 screws

FUV01 Grid Wire Design

<u>FUV01</u>

Mesh made by Buckbee-Mears.

Grids selected by optical inspection.

Nodules & wire breaks rejected.

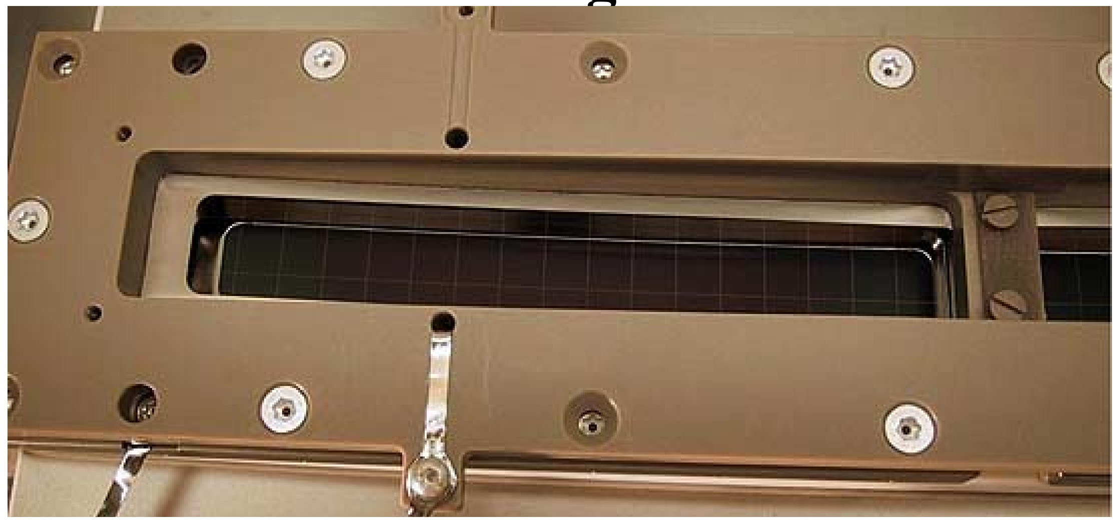
Thickness 12 ±6µm.

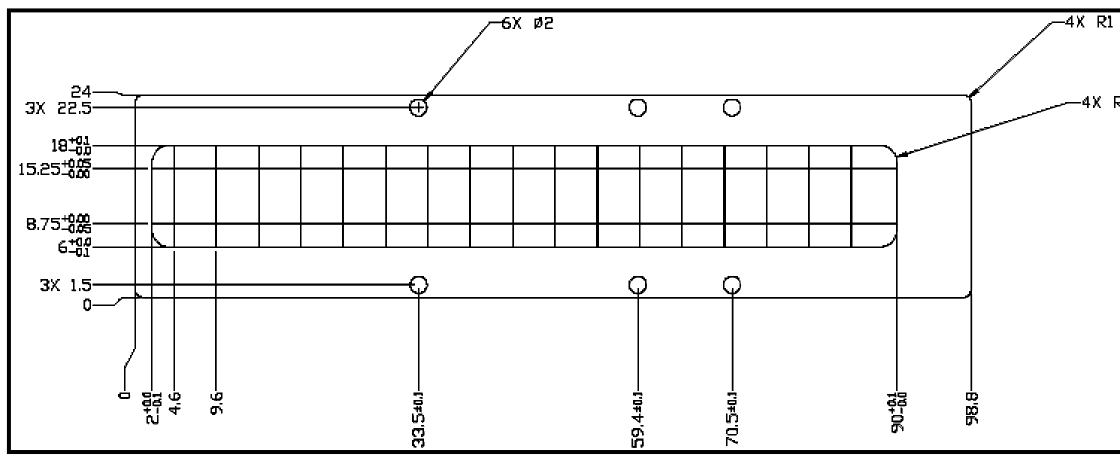
Wires 25 ±10µm.

Wires on 5mm pitch.

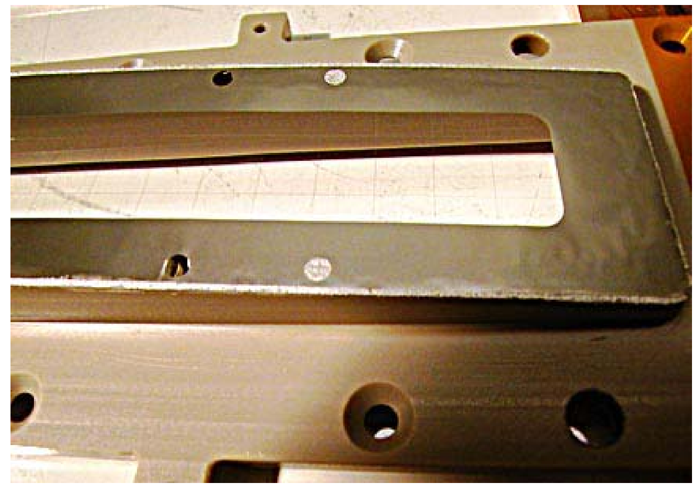
Glued to frame with silver epoxy.

Cured at elevated temperature (60°C)





FUV01 Grid After Epoxy Cure



Grid was selected by optical inspection.
Epoxy to frame & smooth out.
Placed in oven to cure.
Re-inspected post cure.
Slightly slack at room temp.

Procedures and inspections recently reviewed by GSFC representative.

9 grids & 4 frames remained after FUV01 grid fabrication,
3 grids rejected, 6 OK.
Thickness 6µm to 10µm, wires ~15µm wide.

Successful Grids on Other Missions

- EUVE - various shapes, all 70 wires/inch, sizes up to 60mm
- SOHO - UVCS & SUMER smaller all 70 wires/inch
- FUSE - similar to COS size, but finer mesh, 25 wires/inch
- Orfeus - similar to COS, but one segment & finer mesh
- ALEXIS - annular mesh, 70 wires/inch
- Many sounding rockets (30+ flights)

- FUSE grid is the most similar to COS
- FUV01 grids have undergone two full acceptance vibrations and one Z axis acceptance vibration, plus thermal vac soaks (+50, -20°C) and four cycles (0 - 40°C).

Tests and Models of Grid Wire Problem

Had 6 grids left over from FUV01 grid frame fabrication/inspection/selection.

20 new grids received from Buckbee-Mears to original design (15µm wide, 6µm thick)

40 new grids received from Stork-Veco,with thicker/wider wires (35µm wide, 12µm thick)

Original Buckbee Mears Grid Tests.

Made 3 grid assemblies with natural PEEK frames, 1 with reject grids as a trial
Two with flight grids, one epoxy cured at 40°C, and one with room temp cure
Both subjected to 3 thermal cycles, -25°C to +55°C, wires broke on 1 room temp grid
40°C cure vibrated at qualification levels on ETU detector, wires broke on one side

Further Analysis and Tests.

Pull tests on original and new batch grid material done at GSFC (Ben Reed).

Epoxy mix cure tests and glass transition tests done at GSFC (Ben Reed)

GSFC grid simulation (Bart Drake) indicates thermal grid to frame CTE mismatch problem.

Shock tested COS ETU DVA with HOP at AMES, shows ~40G rms at DVA - not a problem

Electric field strength model shows only 1G force with QE grid field on - not a problem

Basic vibration model indications OK provided grids have not yielded, or excessive slack.

Tests and Models of Grid Wire Problem - materials tests

Specimen Id.	Gage Length (in)	Specimen Width (in)	Specimen Thickness (in)	Failure Load (lbs)	Tensile Strength (ksi)	Yield Strength (ksi)	Elongation (%)
1	.75	0.234	0.00025	6.04	108.3	74.7	2.8
2	.75			5.89	105.6	73.3	2.8
3	.5			5.93	106.3	74.2	3.8
4	.5			5.62	100.8	76.9	2.4
5	.5			5.48	98.2	72.2	2.7
6	.5			5.73	102.7	73.6	3.0
AVERAGE				5.78	103.6	74.2	2.9

Table 1. Individual Test Results.

Specimen Id.	Manufacturer & Serial #	Grid Thickness (in)	Testing Condition	Failure Load (lbs)	Tensile Strength (ksi)	Yield Strength (ksi)	Elongation (%)
1	Stork Veco S/N 048	0.0006	As Received	32.1	228.6	179.9	**
2				29.9	213.0	166.0	5.6
3				28.4	202.3	165.3	4.9
4			Annealed	*	---	---	---
5				*	---	---	---
6				1.9	13.5	12.0	1.7
7	Stork Veco S/N 057	0.0006	As Received	31.7	225.8	165.9	6.1
8				31.9	227.2	174.3	5.9
9				28.4	202.3	165.3	4.9
10			Annealed	1.9	13.5	12.3	1.1
11				2.0	14.2	13.0	1.2
12				2.1	15.0	13.4	1.4
13	Buckbee Mears S/N 033	0.00035	As Received	5.4	65.9	53.1	3.4
14				5.0	61.0	49.6	2.4
15				5.6	68.4	53.5	4.8
16			Annealed	1.3	15.9	8.8	9.8
17				1.3	15.9	8.6	9.4
18				1.4	17.1	8.8	11.6

Original Buckbee-Mears meshes

(Epoxy, glass transition point is >50°C for all cure temps)

New meshes

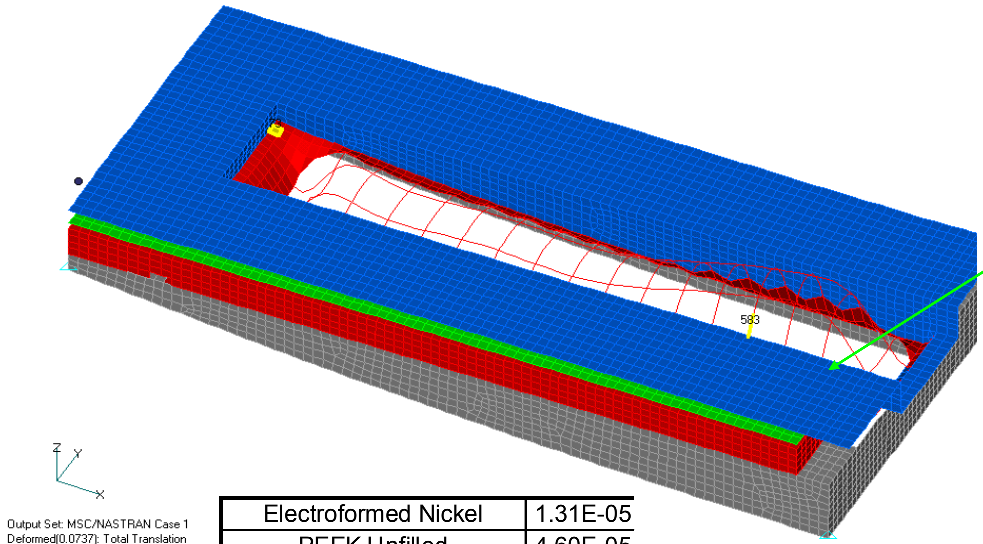
New Buckbee-Mears are weaker than originals

Stork-Veco are twice the strength and elongation of original Buckbee-Mears mesh

Tests and Models of Grid Wire Problem - Grid model

PEEK	Grid Part	Stress (psi)	M.S. Yield (%)	M.S. Ultimate (%)
Unfilled	Wire	125382	-52.69	-33.87
Unfilled	Annulus	48604	22.05	70.60
30% Filled	Wire	48986	21.10	69.27
30% Filled	Annulus	17769	233.84	366.66

Using original Buckbee-Mears mesh data, assumes room temp cure, +35°C temp excursion with grid mounted to brazed body



Model of original configuration predicts wire break close to that seen

Model indicates a 30% glass filled PEEK frame with a room temp cure and original Buckbee-Mears mesh will solve problem

- new Stork-Veco meshes would be even better

Electroformed Nickel	1.31E-05
PEEK Unfilled	4.60E-05
PEEK (30% Glass Filled)	2.16E-05
304 Stainless Steel	9.60E-06

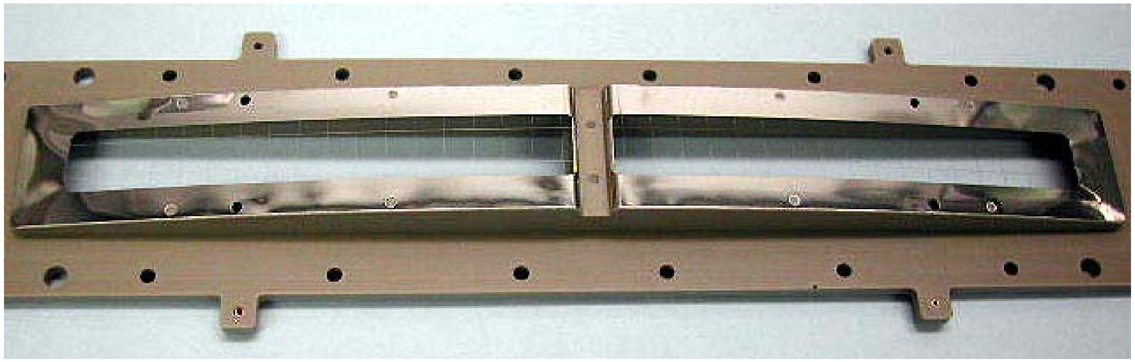
CTE

Plan for Grid Solution and Verification

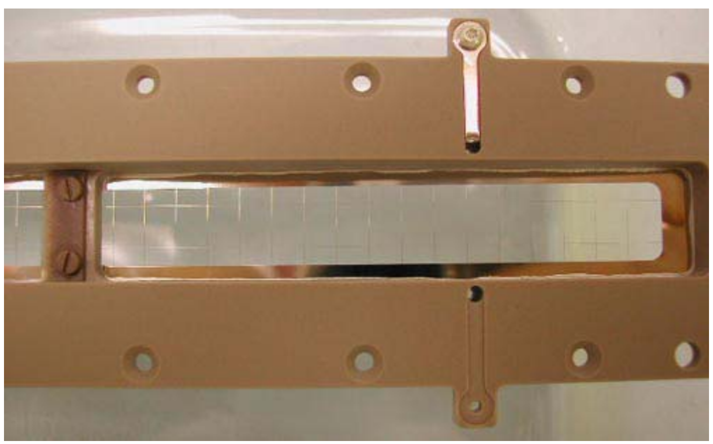
Use New Grids on 30% Glass Filled PEEK Frames, Qualification and Lifetest

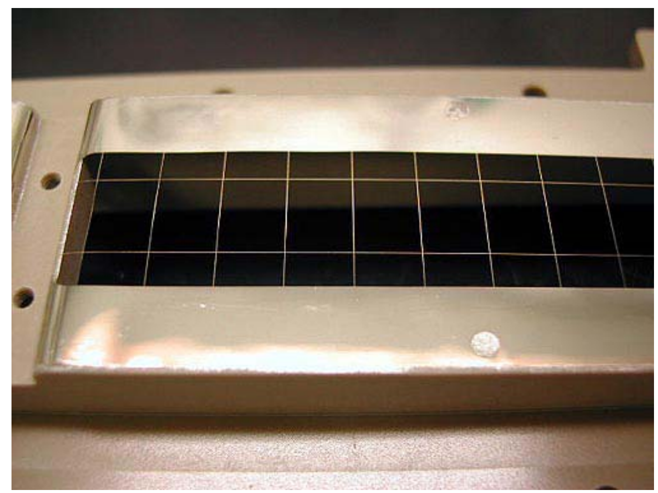
Had 3 vendors fabricate 30% Glass Filled PEEK frames, received 4 from J3
Have 4 more ordered from J3, other vendor frames were warped.
Made 2 test grid assemblies in 30% Glass Filled PEEK frames, one of each grid type
Epoxy cured at room temp to avoid wire slackness that occurs with hot cure.
Thorough grid microscopic examination, then field emission tested on a detector
Both subjected a set of thermal cycles, -25°C to +50°C, with no visual grid damage
Field emission tested both on a detector, Stork-Veco OK,
Buckbee-Mears assembly field emitted on both grids - cannot fix or use this option
Proceeded to qual vibration with Stork-Veco assembly (broke 2 wires in handling!)
However - had no field emission even with broken wires - proceeded to vibrate
No damage and no field emission after qualification level vibration
Replaced broken mesh and proceeded to do lifetesting
Field emission tested - OK, then was placed into another set of thermal cycles
Expect to finish 2nd thermal cycle tests at end of this week then vibrate again

Flight Grid Solution



Stork-Veco mesh on 30% glass filled PEEK frame





Plan for Grid Solution and Verification

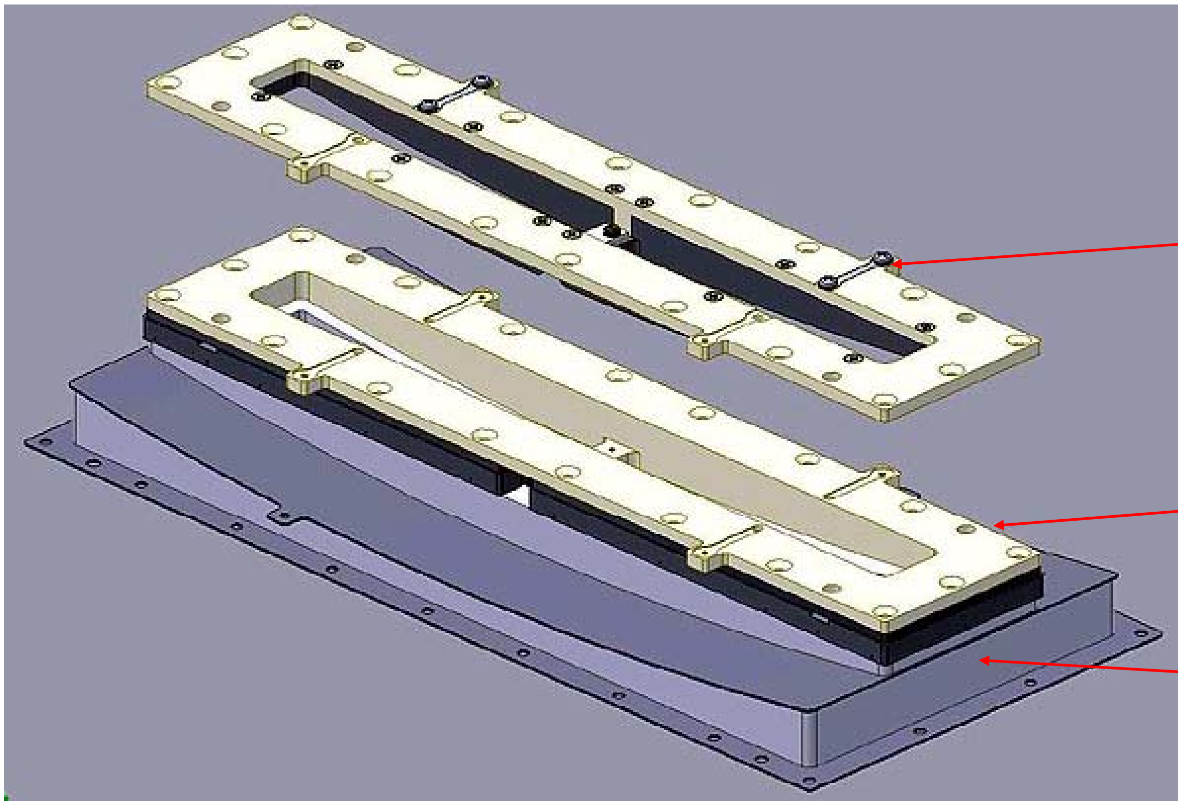
Flight Grids on 30% Glass Filled PEEK Frames

Made 2 flight grid assemblies on 30% Glass Filled PEEK frames, Stork-Veco mesh
Epoxy cured at room temp, thorough grid microscopic examination
Both field emission tested on a detector successfully
One due to finish a set of thermal cycles, -25°C to +50°C, Monday 20th
Then inspection and field emission test
Vibration test planned today for first assembly
Then inspection and field emission test
If successful then ready to install on FUV01 next week

2nd assembly in a set of thermal cycles, -25°C to +50°C, to finish end of this week
Then inspection and field emission test
Vibration acceptance test
Then inspection and field emission test

Grid, Backup Solution

- **Change grid frame mesh mount protrusions to stainless steel**
  - **Matches grid thermal expansion/shrinkage**
  - **Allows each grid to be made on a separate sub-assembly**

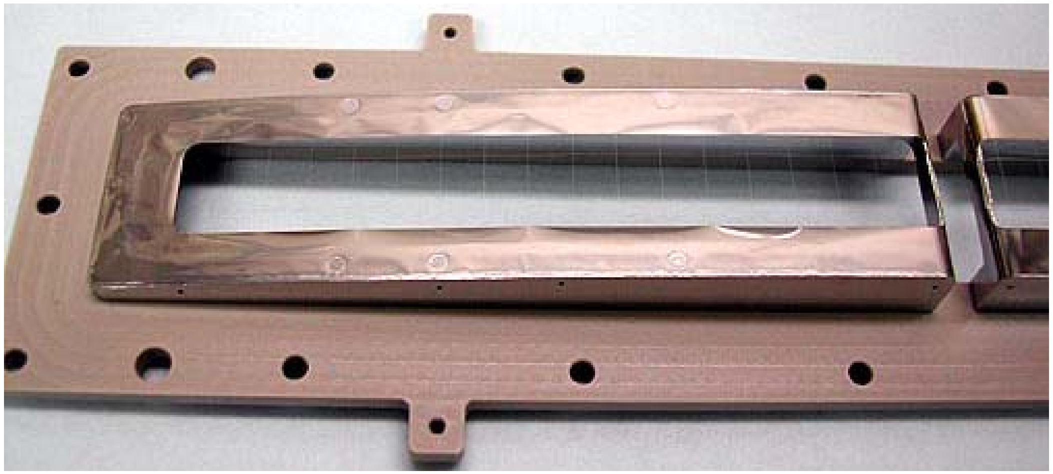


New metal frames on 30% glass filled PEEK flat carrier design

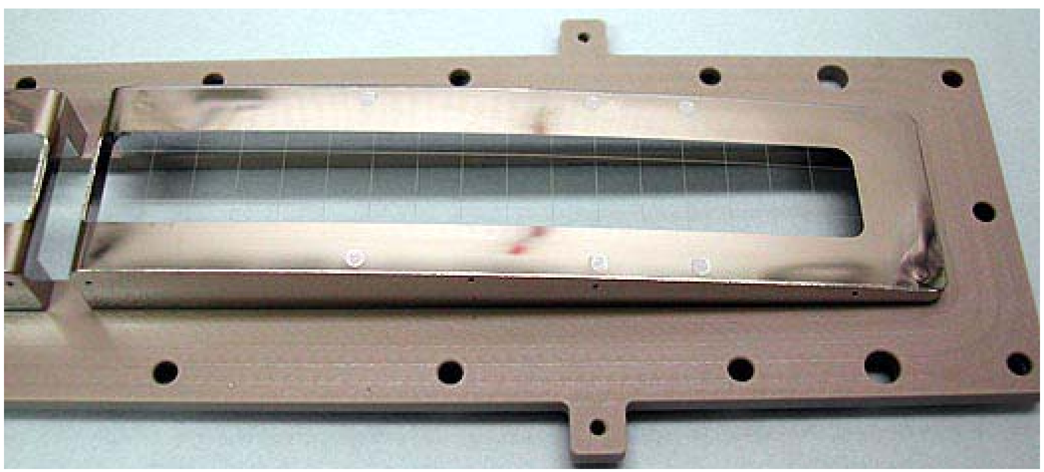
Original frame design solid PEEK

Brazed body assembly

Grid Backup Solution



Buckbee-Mears mesh on metal frame



Stork-Veco mesh on metal frame

Carrier is incorrect
Salvaged from PEEK frame fabrication efforts

Grid Backup Solution

Will field emission test initial assembly this week

30% glass filled PEEK carriers on order from J3

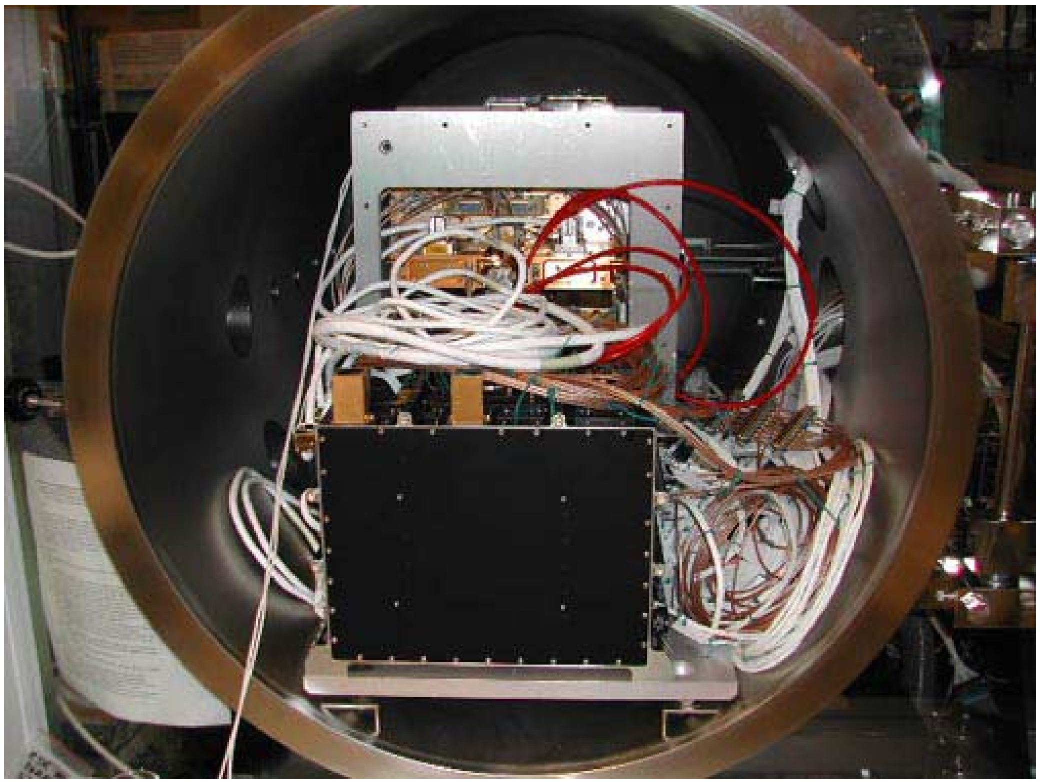
Will do thermal cycles, and vibration when PEEK carriers arrive

Proceed with tasks on this option only when it does not affect the progress of the prime solution option.

FUV01 Detector Status

Have installed entire FUV01 detector into our QE tank

Will do functional tests and QE check (grid voltage off) this week



FUV01 detector and electronics inside the QE tank

FUV01 Grid replacement - near term tasks

Post thermal cycle test inspection and field emission test of new grid assembly

Acceptance vibration test of new grid assembly

Post vibration test inspection and field emission test of new grid assembly

Preparation for removal of old and installation of new FUV01 QE grid

Functional test of FUV01 in QE tank

Retrofit and Commissioning steps for FUV01

Replace broken FUV01 grid frame - scheduled for next week

Full set of detector functional tests

Acceptance vibration test

Re-scrub detector and functional test

Check of detector QE performance

Ship to CU --- Thermal vacuum test

Deliver to Ball

UCB FUV02, Flight Backup Detector, Status

- **DEB -** All boards have been cleaned, coated, staked, and vacuum baked.
- **Harnesses -** Cleaned and vacuum baked/certified.
- **DBA -** Built up and integrated with VHA, at UCB.
- **Vacuum Housing Assembly**
  - Successfully completed alignment tests at Ball.
  - Door assembly at UCB awaiting re-assembly with modified parts
- **Brazed Body Assembly**.
  - BBA currently in safe vacuum storage awaiting final FUV02 buildup.
- **ETU DEB -** ETU DEB delivered to Ball mid August.

UCB FUV02, Flight Backup Detector, Next Actions

- Complete FUV02 assembly and test sequence
- Complete FUV02 door pre-assembly preparations at UCB
- Re-assemble FUV02 door assembly at UCB and test
- Proceed with final FUV02 buildup, test, & scrub.
- FUV02 environmental testing (vibration and thermal vacuum).

COS Schedule for CU/UCB

Task	Status
CALCOS Software Development	On-going.
Cal/FF SS Optical Integration	On-going: complete by early June.
FUV-01 Grid Rework Activities	Ongoing. Earliest delivery by 7/17.
Complete FUV-02	Deliver ~9/18/02.

COS Descope Issues (No Changes Since Last MSR)

- The COS IDT has been asked to develop and track a descope plan which, if implemented, can be used to control future cost growth and/or schedule difficulties.
- At the beginning of the COS development effort, late CY97 and early CY98, we prepared and presented several descope options. At that time we descoped the following:
  - Reduced the MEB SRAM buffer memory
  - Fewer NUV/FVU optics/grating spares
  - No parallel technology path for NUV gratings
  - Reduced I&T/calibration effort
  - Baselined environmentals at GSFC

COS Descope Tracking List

Candidate De-Scope	Trigger Date	Resource Saved*	Impacts
Eliminate FUV Detector detailed resolution tests	**Implemented**	2 weeks	Knowledge of detector
Eliminate FUV Detector detailed QE tests	**Implemented**	2 weeks	Knowledge of detector
Eliminate FUV Detector deep FF tests	**Implemented**	3 weeks	Knowledge of detector
Make DCE Op Code non-uploadable	**Too late**	---	Higher risk, Ops
Early transition of FSW to Code 582	**Too late**	$	Ops
Remove Redundant Cal/FF Elements	**Too late**	$,t	Higher risk, Ops
Remove/reduce memory	**Too late**	---	Ops
Remove NUV gratings from OSM2	**Too late**	$,t	Degraded science
Drop NUV channel	TBD	$$$,tt	Degraded science
Remove NCM3 optics	**Too late**	$,t	Degraded science, Ops
Eliminate Aperture Mechanism	TBD	$,t	Ops, Obs. Efficiency, higher risk
Drop all Accum mode processing w/ Doppler	**Too late**	$,t	Degraded science
Drop spare FUV detector	**Too late**	$,t	Higher risk
Drop OSM1 capability (don't cover λ gap)	**Too late**	---	Degraded science
Reduce S/N requirement to 30 (no FF lamp)	TBD	$,t	Degraded science
Relax NUV resolution requirements below 20k	**Too late**	$,t	Degraded science
Remove on-orbit change-out capability	**Too late**	$,t	Higher risk
Drop dispersed light TA	**Too late**	$,t	Ops
No Ion Gauge	TBD	$,t	Higher risk, Ops
No external shutter	**Too late**	$,t	Ops
Change MSRs to QSRs	TBD	$	Save trees
Eliminate Mechanism Lifetime tests	TBD	$$	Higher risk
Reduce CDRLs	TBD	$	Unknown
Drop G140L blazed effort	**Implemented**	$,t	Missed opportunity for improved science
Reduce G160M image testing	**Too late**	$,t	Higher risk

*The IPT has not yet done a detailed analysis to quantify actual $ or time to be saved.

Upcoming Events/Activities

- Complete life-time testing of QE grid assy.
- Install new grids in FUV-01 and commence re-test.
- Complete Cal/FF S.S. Assembly at CU.
- Continue I&T support activities.
- Continue ground calibration planning.

Issues

- None