SAP/IFSI MEETING 16-02-99 - VIEWGRAPHS

SPIRE - DPU Meeting Participants list IFSI 16 Feb. 99

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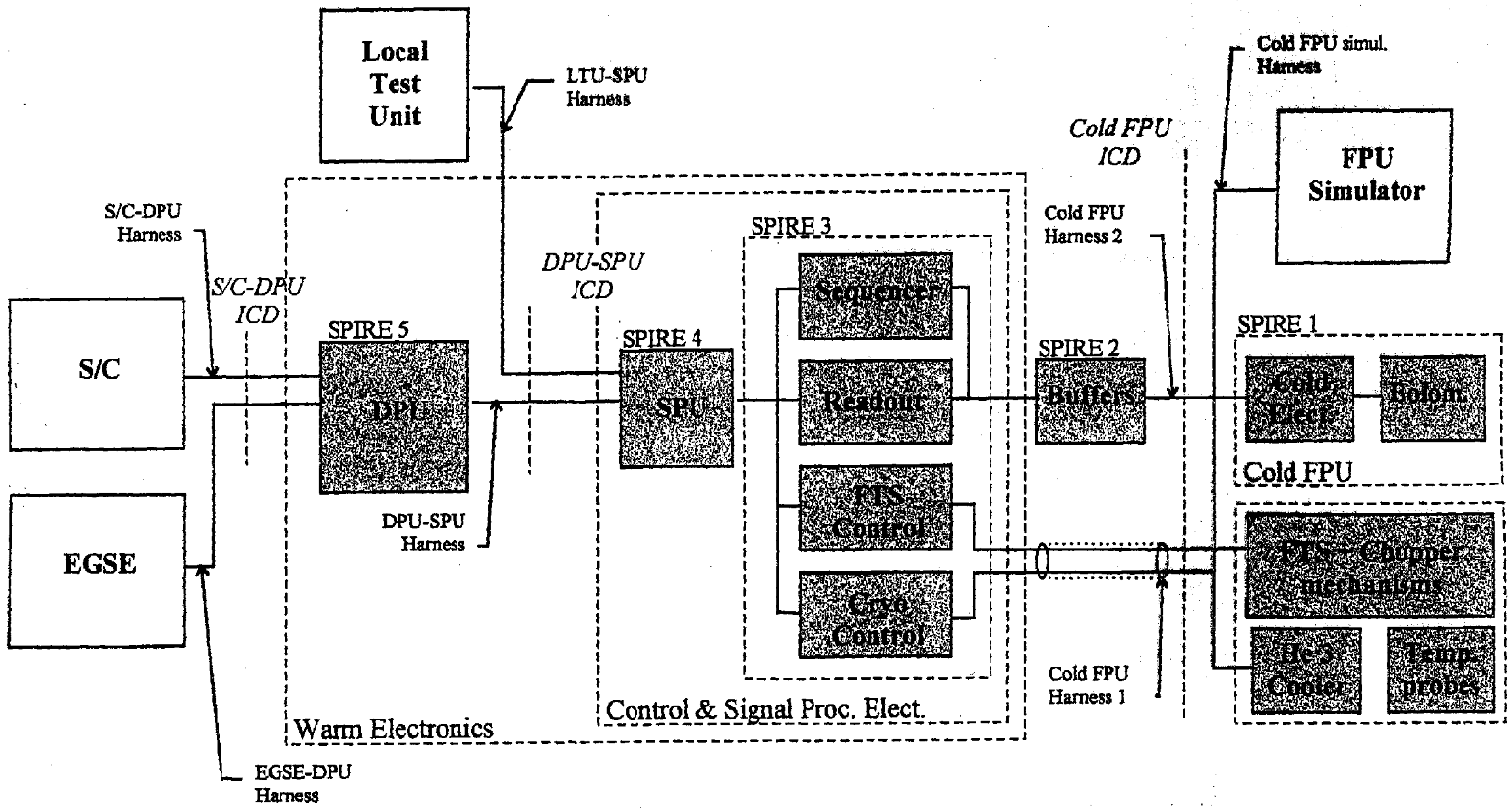
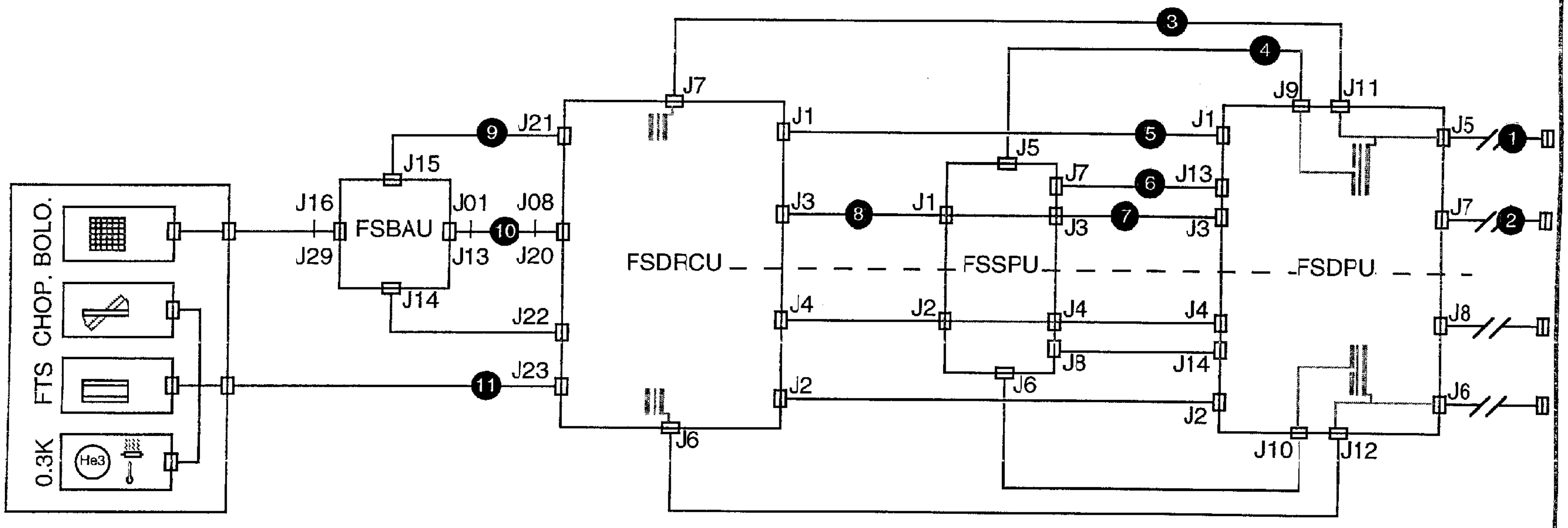
FIRST/SPIRE

Electronics Block Diagram



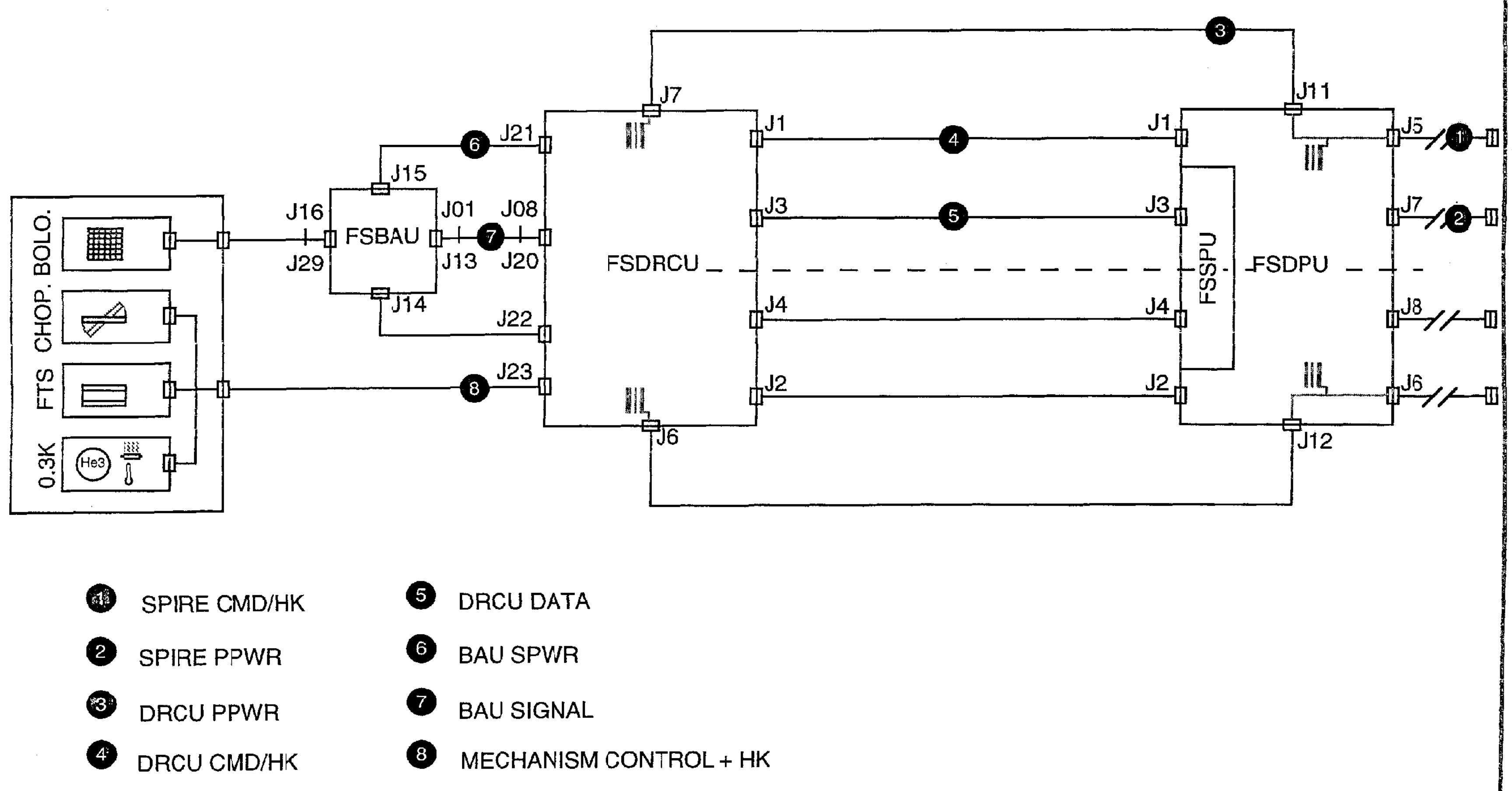
27/7/98

SPIRE ELECTRICAL CONFIGURATION
SPU H/W & S/W OPTION



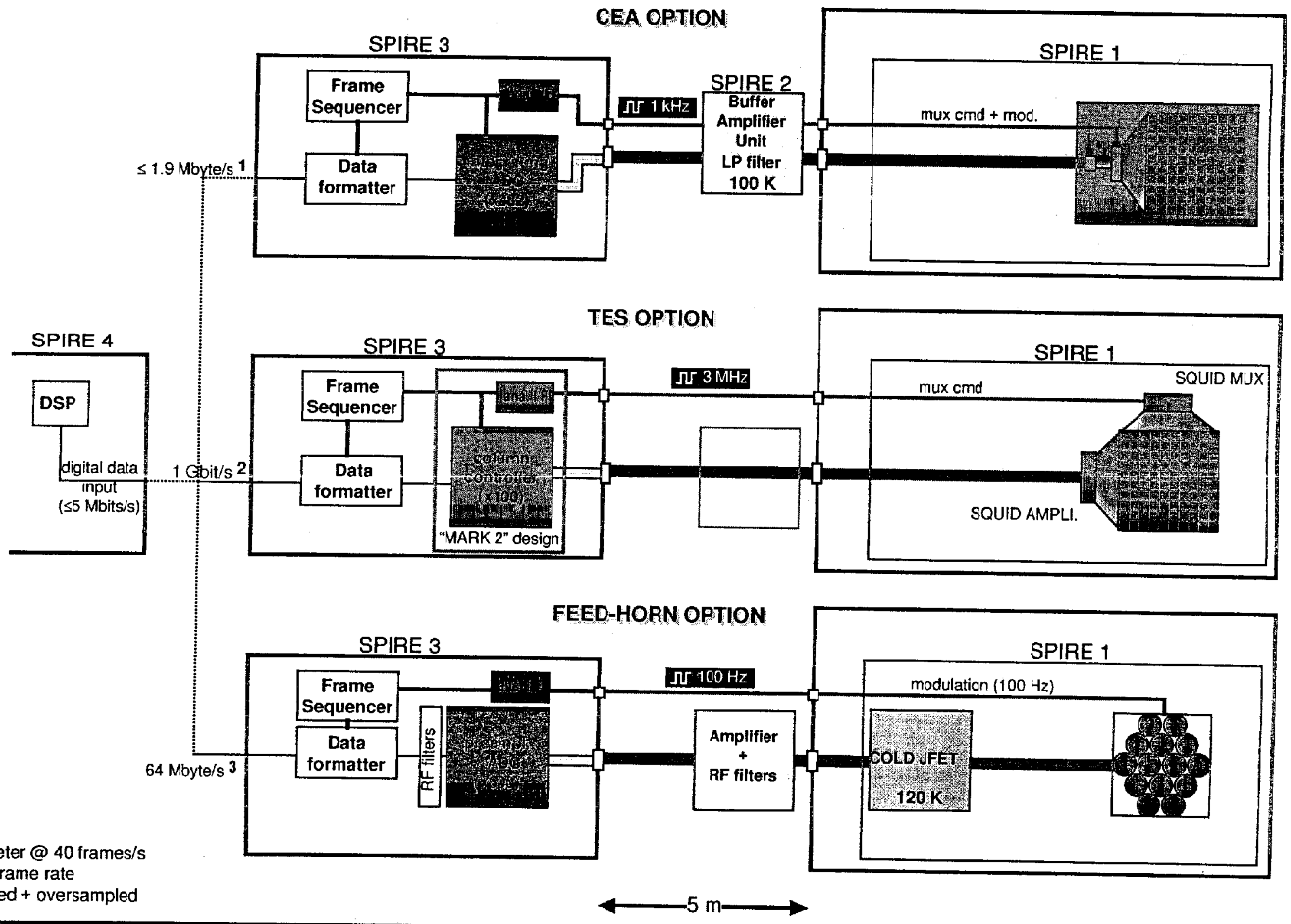
1 SPIRE CMD/HK
2 SPIRE PPWR
3 DRCU PPWR
4 SPU SPWR
5 DRCU CMD/HK
6 SPU CMD/HK
7 SPU DATA
8 DRCU DATA
9 BAU SPWR
10 BAU SIGNAL
11 MECHANISM CONTROL + HK

SPIRE ELECTRICAL CONFIGURATION
SPU S/W ONLY OPTION



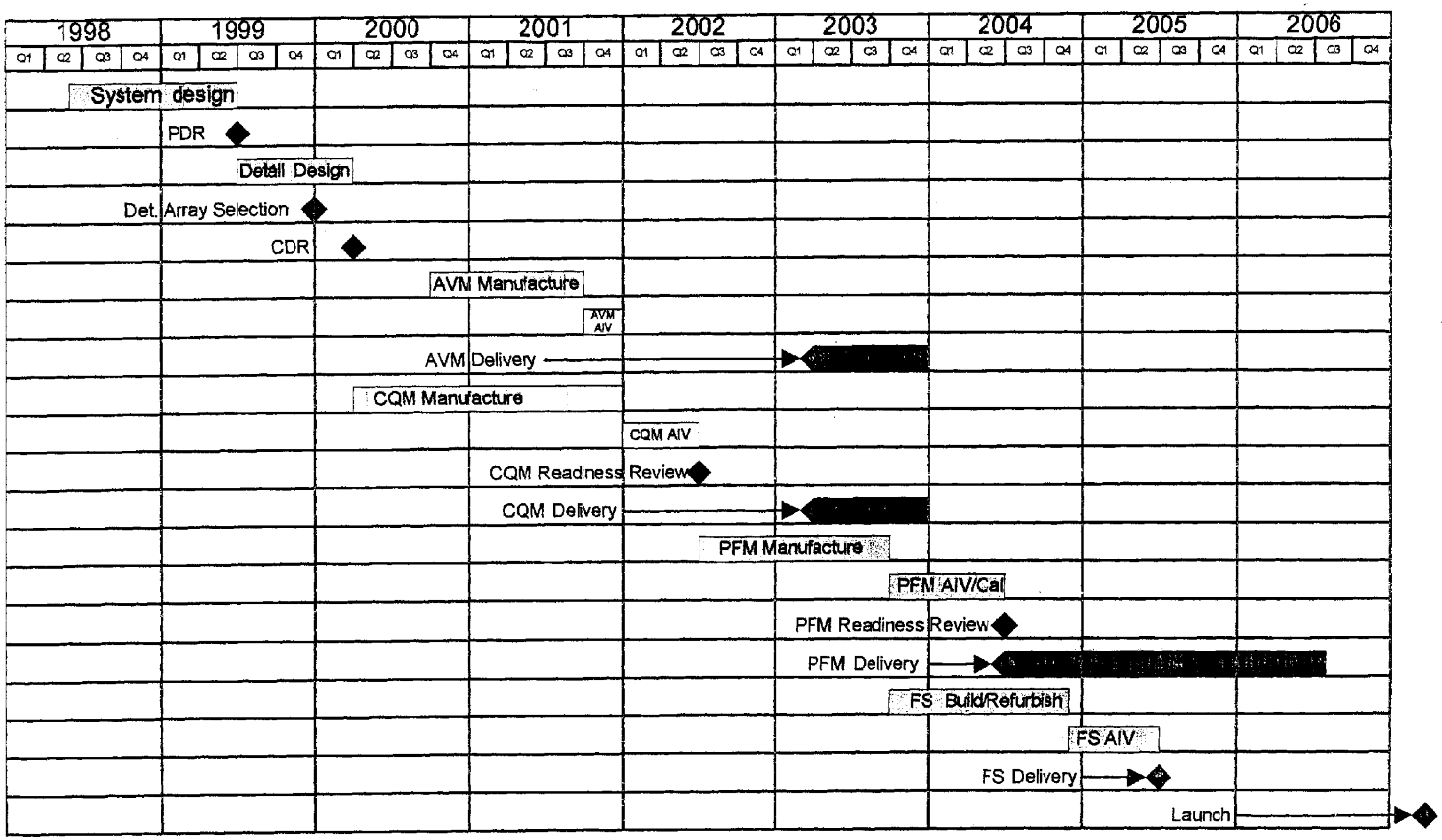
FIRST / SPIRE — ELECTRONICS SYSTEM DESIGNS vs ARRAY OPTIONS

cea /SAp
12/02/99



1 : Photometer @ 40 frames/s
2 : 10 kHz frame rate
3 : modulated + oversampled

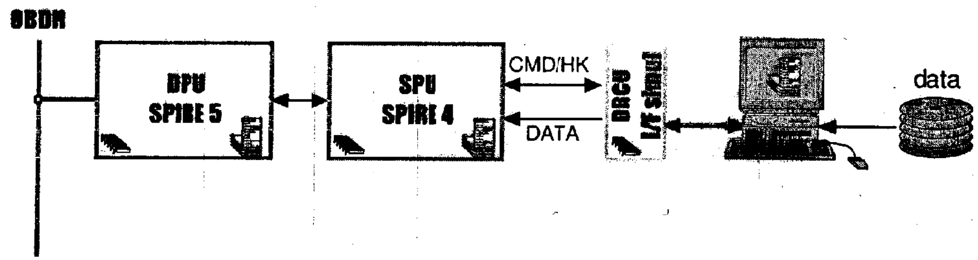
SPIRE Instrument Development Schedule



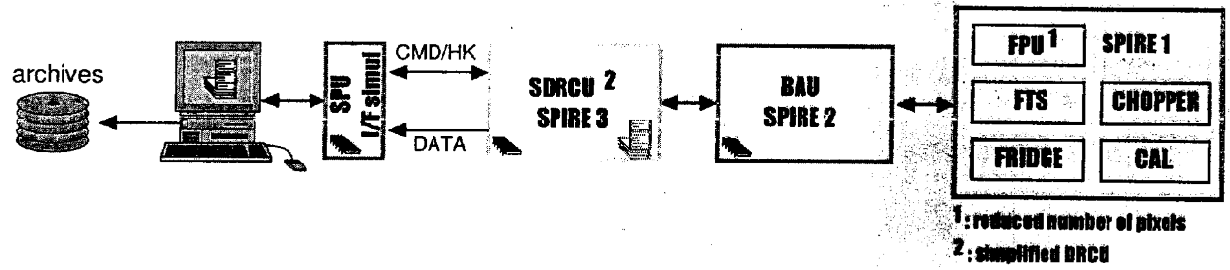
29th July 1998

SPIRE ELECTRONICS SYSTEM
MODEL DESCRIPTIONS

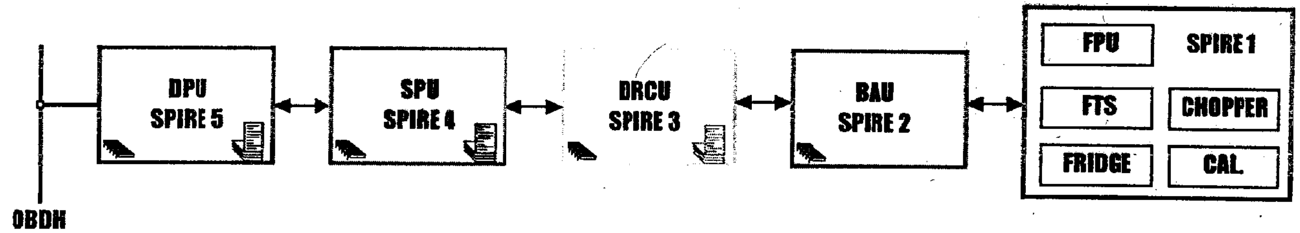
AVM : test S/C hardware/software interfaces



CQM : mechanical, thermal & EMC tests



PFM



Italian Contribution to FIRST

- The Scientific Committee of the Italian Space Agency (ASI) at the end of October has positively evaluated the participation to the following tasks of FIRST:
  - Development of DPU's for the 3 instruments (IFSI)
  - Contribution to the HIFI back-end (CAISMI)
  - PACS frequency calibration (LENS)
  - Contribution to the ICC's of the 3 instruments (Padova Observatory).
- For the present year (end 1998 - beginning 1999) a budget of ~230 Keuro (450 MLt) has been allocated. Most (~ 70 %) of the budget will be dedicated to DPU's development.
- ASI has given to FIRST the second priority (after Planck's LFI) among the long term programmes.

SPIRE Cost Breakdown

Table 1 H/W+S/W

YEAR	Institute		Extra		Funding Agency			Total	
	Manpower		Manpower		Industry	Other	Total		
	My	Costs	My	Cost	Costs	Costs	Costs	My	KEURO
1998	1.5	114			63.0	7	70	1.5	184
1999	4.0	304	1	33	102.0	15	150	5.0	454
2000	4.0	304	1	33	237.0	30	300	5.0	604
2001	4.0	304	1	33	246.0	31	310	5.0	614
2002	6.0	456	1	33	426.0	51	510	7.0	966
2003	6.0	456	1	33	201.0	26	260	7.0	716
2004	4.0	304	1	33	102.0	15	150	5.0	454
2005	4.0	304	1	33	102.0	15	150	5.0	454
2006	1.0	76	1	33	12.0	5	50	2.0	126
2007	1.0	76	1	33	12.0	5	50	2.0	126
Total	**35.5**	**2698.0**	**9.0**	**297.0**	**1503.0**	**200.0**	**2000.0**	**44.5**	**4698.0**

Table 2 ICC

YEAR	Institute		Extra		Funding Agency			Total	
	Manpower		Manpower		Industry	Other	Total		
	My	Costs	My	Cost	Costs	Costs	Costs	My	KEURO
1998									
1999	1.0	76	0.6	37.8		4.2	42.0	1.6	118.0
2000	1.0	76	0.6	25.0		4.2	42.0	1.6	118.0
2001	1.0	76	0.8	33.3		5.6	56.0	1.8	132.0
2002	1.0	76	1.0	41.7		7.0	70.0	2.0	146.0
2003	1.0	76	1.0	63.0		7.0	70.0	2.0	146.0
2004	1.0	76	1.0	63.0		7.0	70.0	2.0	146.0
2005	1.0	76	1.0	63.0		7.0	70.0	2.0	146.0
2006	1.0	76	1.0	63.0		7.0	70.0	2.0	146.0
2007	1.0	76	1.0	63.0		7.0	70.0	2.0	146.0
2008	1.0	76	1.0	63.0		7.0	70.0	2.0	146.0
2009	1.0	76	1.0	63.0		7.0	70.0	2.0	146.0
2010			2.0	126.0		14.0	140.0	2.0	140.0
Total to 2006	**8.0**	**608.0**	**7.0**	**389.8**		**49.0**	**490.0**	**15.0**	**1098.0**
Total to 2010	**11.0**	**836.0**	**12.0**	**704.8**		**84.0**	**840.0**	**23.0**	**1676.0**

Table 3 H/W+S/W+ICC

YEAR	Institute		Extra		Funding Agency			Total	
	Manpower		Manpower		Industry	Other	Total		
	My	Costs	My	Cost	Costs	Costs	Costs	My	KEURO
1998	1.5	114.0			63.0	7.0	70.0	1.5	184.0
1999	5.0	380.0	1.6	70.8	102.0	19.2	192.0	6.6	572.0
2000	5.0	380.0	1.6	58.0	237.0	34.2	342.0	6.6	722.0
2001	5.0	380.0	1.8	66.3	246.0	36.6	366.0	6.8	746.0
2002	7.0	532.0	2.0	74.7	426.0	58.0	580.0	9.0	1112.0
2003	7.0	532.0	2.0	96.0	201.0	33.0	330.0	9.0	862.0
2004	5.0	380.0	2.0	96.0	102.0	22.0	220.0	7.0	600.0
2005	5.0	380.0	2.0	96.0	102.0	22.0	220.0	7.0	600.0
2006	2.0	152.0	2.0	96.0	12.0	12.0	120.0	4.0	272.0
2007	2.0	152	2.0	96.0	12.0	12.0	120.0	2	272.0
2008	1.0	76	1.0	63.0		7.0	70.0	2	146.0
2009	1.0	76	1	63.0		7.0	70	2	146
2010			2	126.0		14.0	140	2	140
Total to 2006	**42.5**	**3230.0**	**15.0**	**653.8**	**1491.0**	**244.0**	**2440.0**	**57.5**	**5670.0**
Total to 2010	**46.5**	**3534.0**	**21.0**	**1001.8**	**1503.0**	**284.0**	**2840.0**	**65.5**	**6374.0**

15 Jan. '99

IFSI notes:

1 - One My averaged to 76 Keuro for CNR manpower
2.- One My averaged to 33 KEURO for Agency funded manpower
3 - Funding agency other costs are for CNR overhead (10%)
4.- One ICC My averaged to 70 KEURO for Agency funded manpower
5 - Launch date spring 2007

IFSI SPIRE-DPU subsystem team organisation

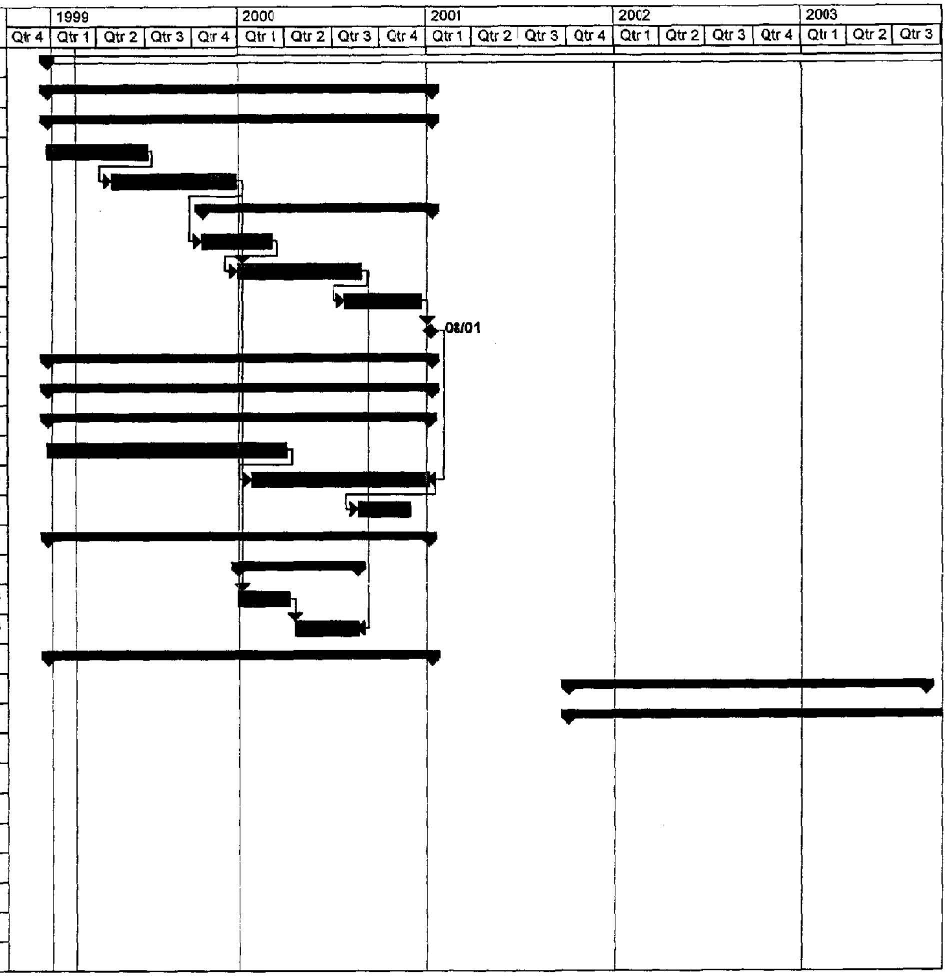
CNR-ASI responsible: G. Tofani (Arcetri, Firenze)

- Responsible - R. Orfei — Renato.Orfei@ifsi.rm.cnr.it
- PM - P. Cerulli-Irelli — Riccardo.Cerulli@ifsi.rm.cnr.it
- PA, AIV - R. Orfei — Renato.Orfei@ifsi.rm.cnr.it
- Science - P. Saraceno (Co-I) — Paolo.Saraceno@ifsi.rm.cnr.it
  A. Di Giorgio — Anna.DiGiorgio@ifsi.rm.cnr.it
  L. Spinoglio — Luigi.Spinoglio@ifsi.rm.cnr.it
- H/W Des. - Cerulli, Orfei, G. Chionchio
- S/W Des. - Cerulli, A. Di Giorgio, TBD
- Mech. Des. - P. Baldetti — Paolo.Baldetti@ifsi.rm.cnr.it
  A. Morbidini

DPU Status report

- **S/C Interfaces**: waiting for ESA documentation. During the next commonality meeting, a formal request to specify the S/C interfaces will be presented.
- **Subsystem interfaces**: present baseline based on low speed serial bus proposed by B. Van Leuwen (HIFI) and SCMS 332 for high speed.
- **On Board S/W**: general structure designed. Simulation program for TLC management developped .
- **Funds Status**: 1998 (and partly 1999) funds allocated (~230 K ECU).
- Need for quick decision about industry contract.

ID	WBS	Task Name	Duration
0	0	**SPIRE_WP**	**1636 day**
1	1	**AVM**	**108 wks**
2	**FSBA0**	**Computer**	**108 wks**
3	FPBA0A100	Specifications	28 wks
4	FPBA0A200	Design	35 wks
5	**FPBA0A300**	**Manufacturing**	**65 wks**
6	FPBA0A310	Procurement	20 wks
7	FPBA0A320	Assembly	35 wks
8	FPBA0A330	Test	22 wks
9	FPBA0A340	Delivery	1 wk
10	**FSBA1**	**S/C I/F**	**108 wks**
18	**FSBA2**	**Subsys. I/F**	**108 wks**
26	**FSBA3**	**OBS**	**107 wks**
27	FPBA3A100	Specifications	67 wks
28	FPBA3A200	Coce	50 wks
29	FPBA3A300	Documentation	15 wks
30	**FSBA4**	**Health Auton. Funct.**	**107 wks**
34	**FSBA5**	**Housing**	**34 wks**
35	FPBA5A100	Design	15 wks
36	FPBA5A200	Manufacturing	13 wks
37	2	**EM SAP Saclay unit**	**108 wks**
73	3	**PFM**	**100.2 wks**
100	4	**FS**	**182.2 wks**



MODEL PHILOSOPHY

The following models will be produced:

- AVM: Avionic Model, commercial grade components, electrically and software representative of the following models
- EM SAP unit: Engineering Model, commercial grade components, electrically and software representative of the following models
- PFM: Flight Model with full flight level components
- FS: Flight Spare boards

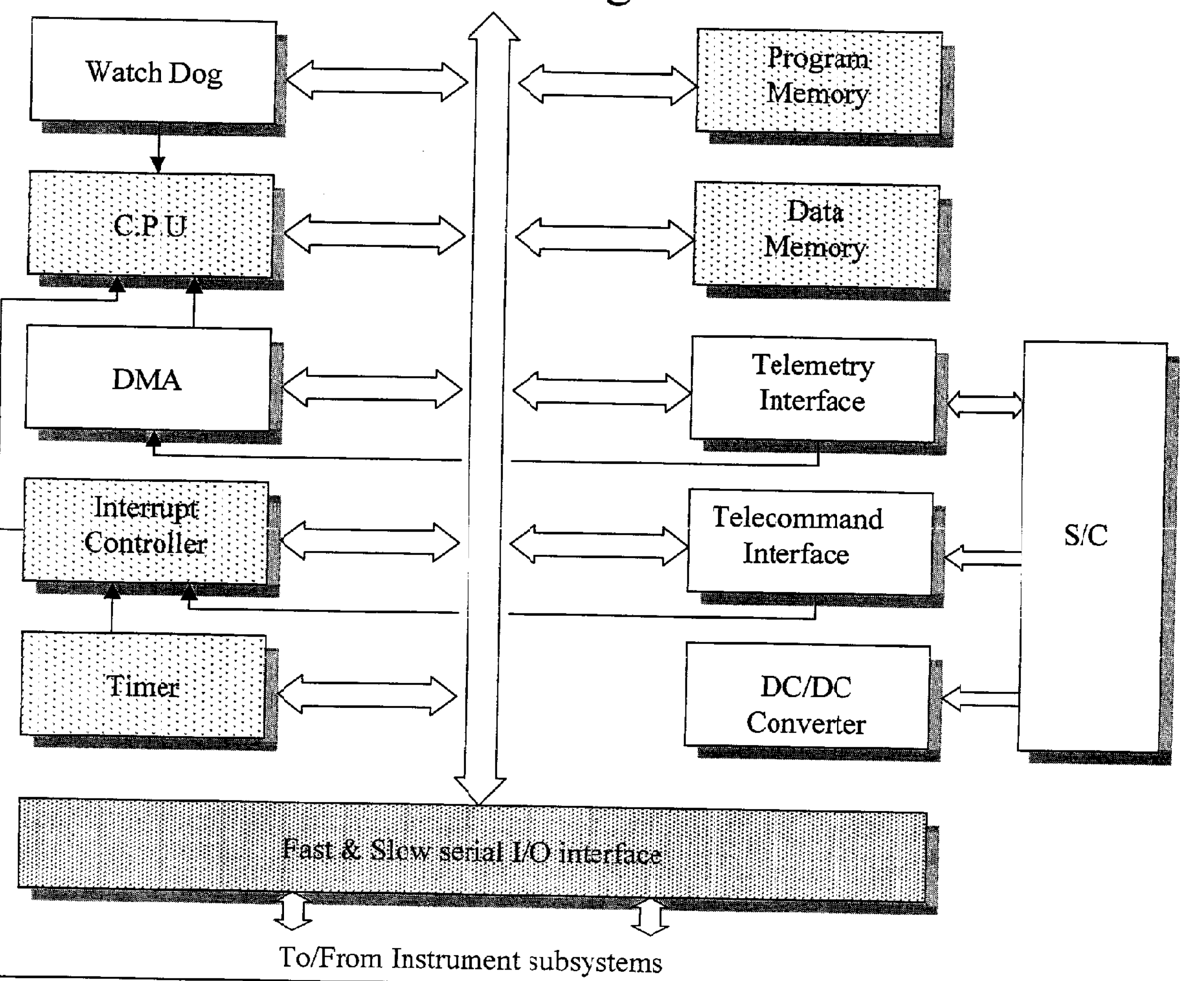
Will qualify our DPU by qualifying DPUs for other instruments (Provided they are the same !

WORKING GROUP MEMBERS

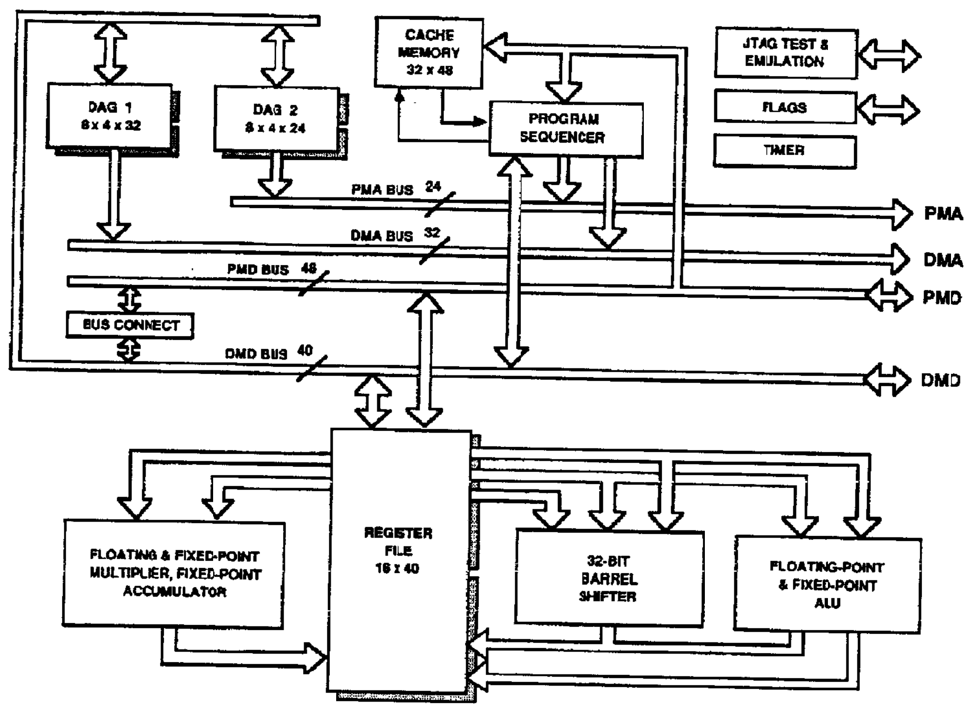
10.02.1999

WG #	ESA Chair	ESA Secretary	Planck HFI	Planck LFI	FIRST HIFI	FIRST PACS	FIRST SPIRE	Cross Instrument Support
SC	T. Passvogel	P. Estaria	J. Charra	C. Butler	H. Aarts	O. Bauer	K. King	
1/2	F. Vandenbussche	H. Schaap	R. Pons J.L. Beney	NN	D. Beintema	E. Renotte	V. Mauguen M. Carter	R. Orfei R. Cerulli J.H. Herreros
3	A. Heras	No permanent Secretary	R. Gispert F. Couchot	C. Butler	P. Roelfsema	O. Bauer E. Wiezorrek	T. Dimbylow R. Gastaud	P. Estaria A. di Giorgio
4	F. Vandenbussche	P. Estaria	J. Charra F. Couchot	C. Butler TBD (Laben)	P. Roelfsema	H. Feuchtgruber	D. Pike NN (Sap)	R. Cerulli
5	P. Estaria	H. Schaap	R. Gispert F. Pajot	TBD (Laben)	P. Roelfsema S. Pezzuto	H. Feuchtgruber	NN	
6	P. Claes	NN (G. Pilbratt J. Tauber K. Bennet)	R. Gispert	F. Pasian	P. Roelfsema	O. Bauer R. Huygen	T. Dimbylow N. Todd	P. Estaria P. Andreani

DPU block diagram

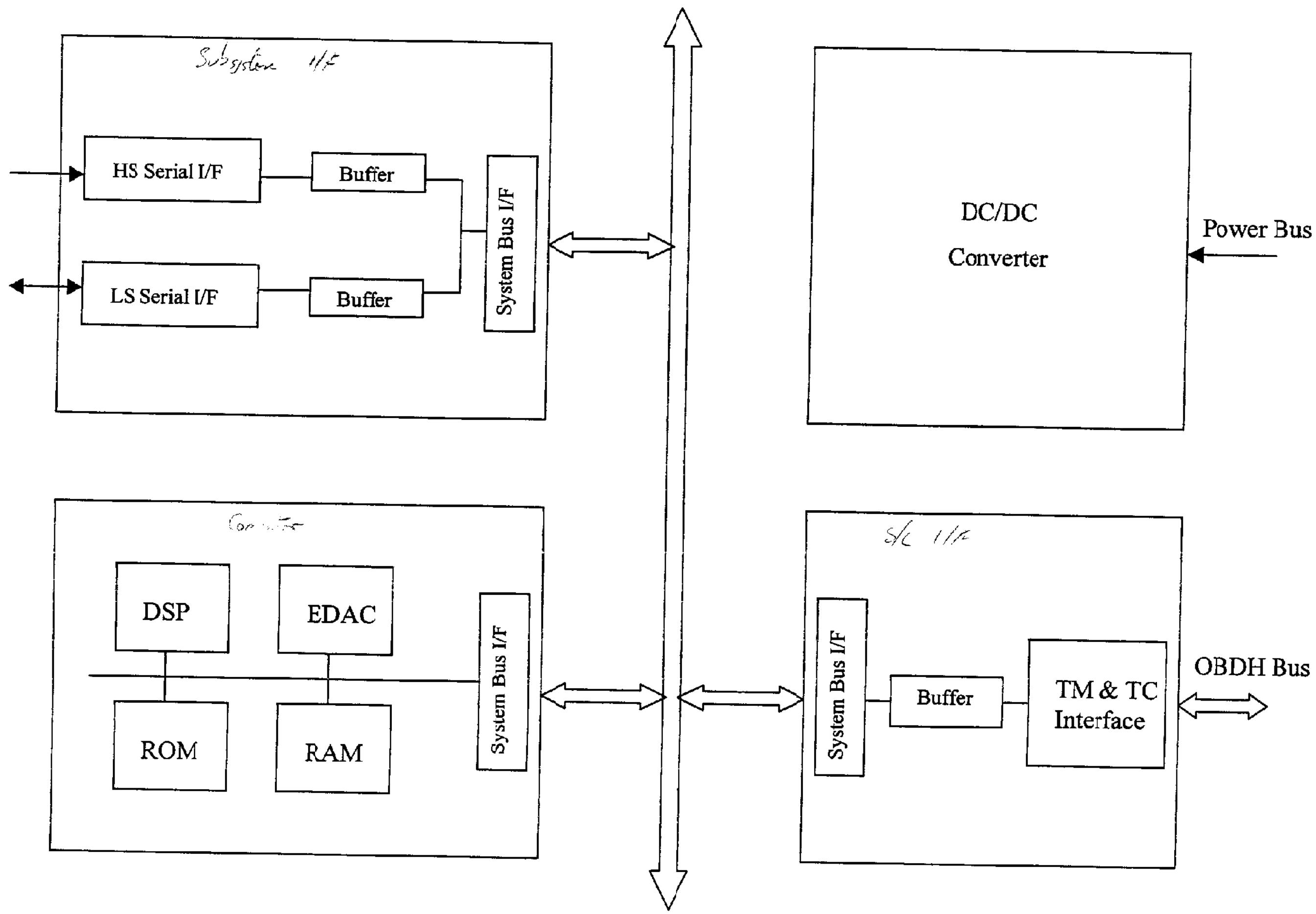


TSC21020E block diagram

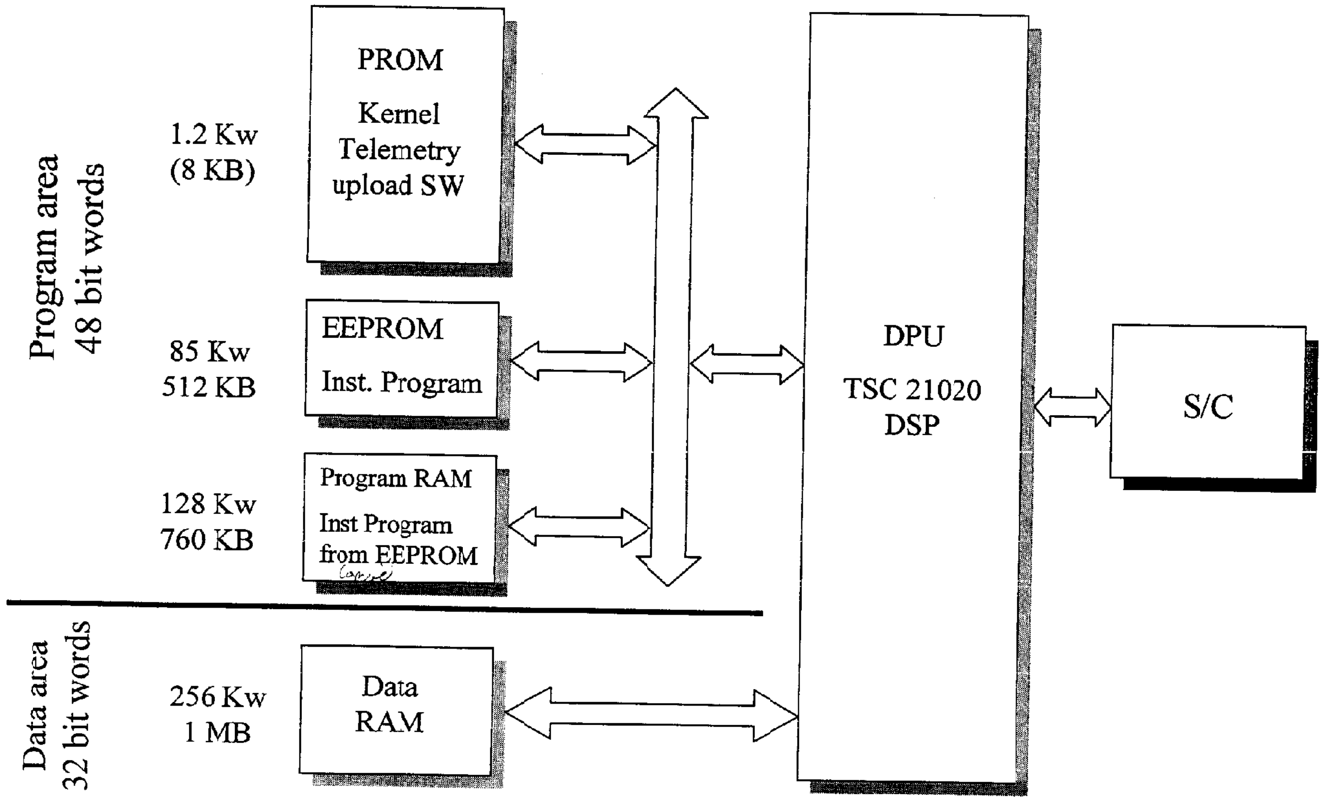


Prog Bus => 48 bit
Data Bus => 32 bit

4 ext. interrupt lines
16 Mw Prog & 4 Gw Data RAM
Internal 32 bit down counter timer


Subsystem I/F
HS Serial I/F
Buffer
LS Serial I/F
Buffer
System Bus I/F
Computer
DSP
EDAC
ROM
RAM
System Bus I/F
DC/DC
Converter
Power Bus
S/C I/F
System Bus I/F
Buffer
TM & TC
Interface
OBDH Bus

Memory organisation



Interfaces

Present design is based on serial interfaces in order to minimise interconnecting wiring and in agreement with requirements with the other two FIRST instruments. From the noise point of view the reduced number of wires requires a balanced RS-422 interface:

- One high speed data link based on IEEE Std 1355-1995.
- One synchronous serial bidirectional bus. This bus is common for all subsystems and handles commands and HK up to a speed of ~ 100 Kbit/s.

High speed interface

- SPU suggests the use of SMCS 332 .
- This is based on IEEE Std 1355-1995 links (DS-LinkTM):
  - 3 serial communication links on chip (196 pin CQFP package)
  - Up to 200 Mbit/s transfer rate
  - Rad tolerant version (50 Krad) available from Temic/MHS
  - http://www.omimo.be/new/companies/dasa_001.htm
- Can be a simpler monodirectional synchronous serial I/F (HIFI suggestion)

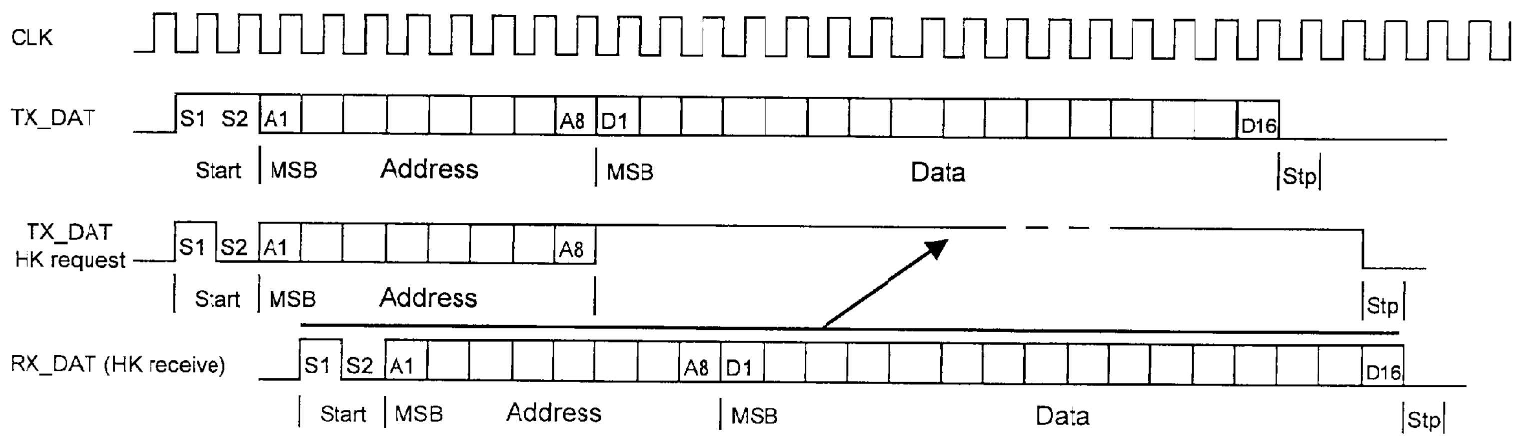
Low speed interface

HIFI proposal adopted and shown (SPIRE ?).

All data transactions with the addressed subsystem (addr. In TX_DAT), are initiated by DPU.
DPU will send data to all subsystems using one serial data line TX_DAT and can send both commands and HK requests via this line.
Subsystems will send responses via RX_DAT line.

A **command** is made of 2 start bit, 8 address bit, 16 data bit and 1 stop bit.
HK request is made of 2 start bit and 8 address bit. After transmission of these 10 bit, the TX_DAT line shall stay high untill the corresponding HK response has been received. Then 1 stop bit will follow.
A **HK response** shall consist of 2 start bit, 8 address bit, 16 data bit and 1 stop bit

The figure shows the proposed HW protocol. Clock rate ~ 100KHz



Operating system

We are evaluating the possibility of using the EONIC "Virtuoso" Multi-level architecture operating system. The O.S. can be customised resulting in minimal memory use of 200 w to an average use of 2 - 3 K words

Level 1: ISR0 level

Hardware level interrupt processing.

Level 2: ISR1 level

Prioritised and nested interrupt handling even on processors that do not support nested interrupts in hardware.

Level 3: The nanokernel level

Processes with a reduced context are scheduled in a prioritised round-robin fashion.

Level 4: The microkernel level

This is the standard C level with over 85 kernel services. It is fully pre-emptive, priority driven, and provides a high level framework for building applications.

Commands

Memory load commands are used to send single instructions to the instrument or to command pre-defined sequences of operations.

A **command** is constituted by a variable number of **telecommand** words: it is formed by the description of the action to be carried-out followed by the definition of the parameters needed for that action.

Each command is formed with a variable number of 16 bit words having the following general structure:

1. a Header describing the Command function;
2. the number of words to follow;
3. the new values of the parameters, if any;

Types of commands

There are two main categories of commands:

- Standard Commands
- Time tagged Commands **T**

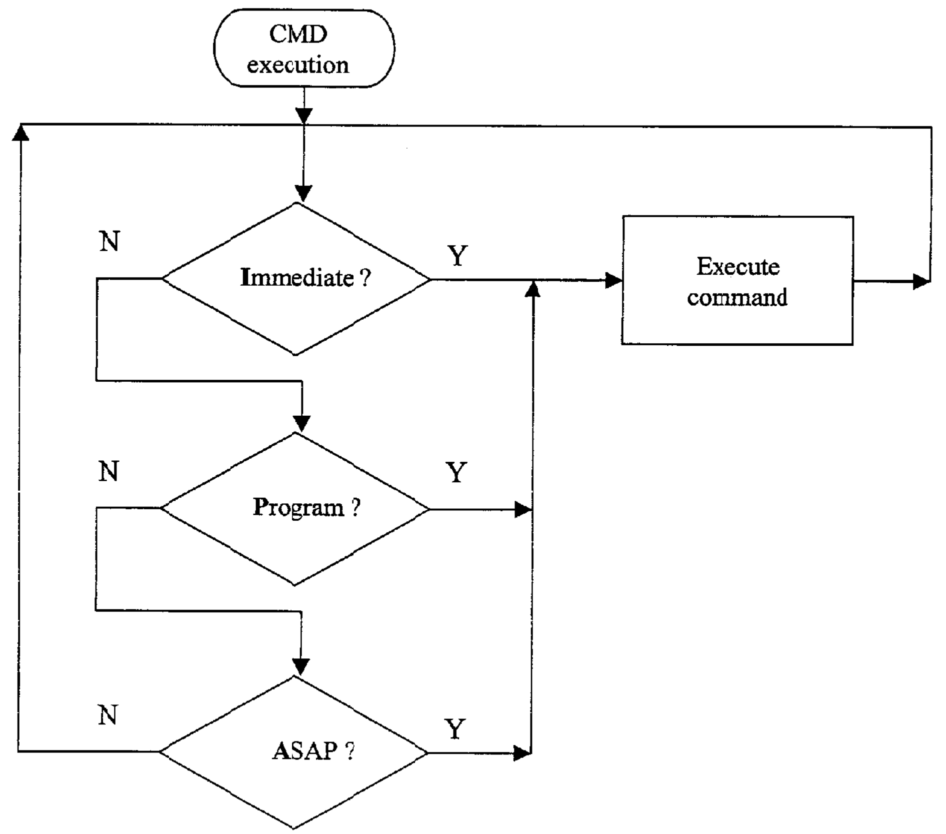
The time tagged commands are standard commands that will be executed at a specified time.

There are 3 types of standard commands, defining the execution priority from high to low, stored in different circular buffers.

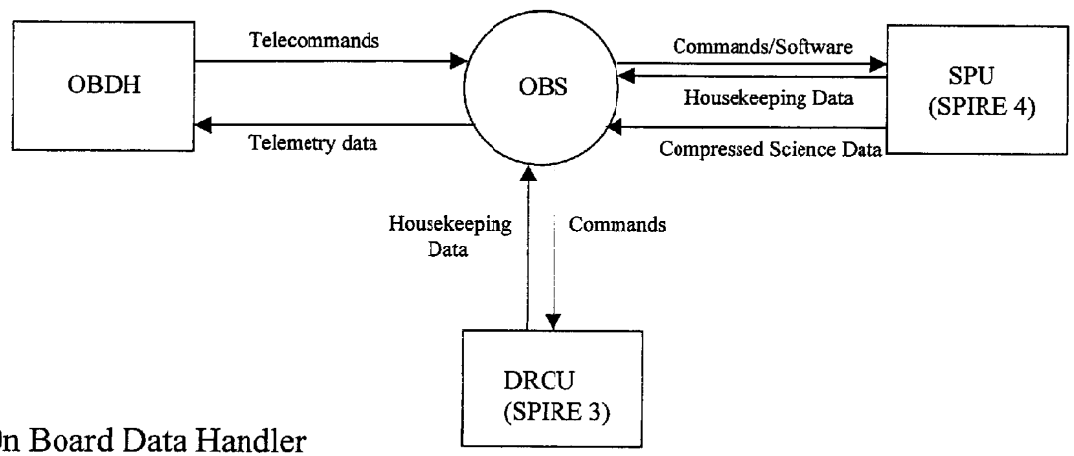
- Immediate commands **I**
- Program commands **P**
- ASAP commands **A**

Generally each command can belong to each of the 3 types.
Immediate commands are executed at the end of the current command execution phase.
Program commands, are standard commands executed as a sequence. The sequence (i.e. the program) starts when a **I** or **A** RUN command is executed. A few commands are permitted only as **P** commands (instructions) defining elementary programming language statements (i.e. for loop, if statements, setting of program variables etc).
ASAP commands are executed when no other command type is present.

Commands will range from a simple subsystem parameter change, to a complex macro defining a measurement routine.

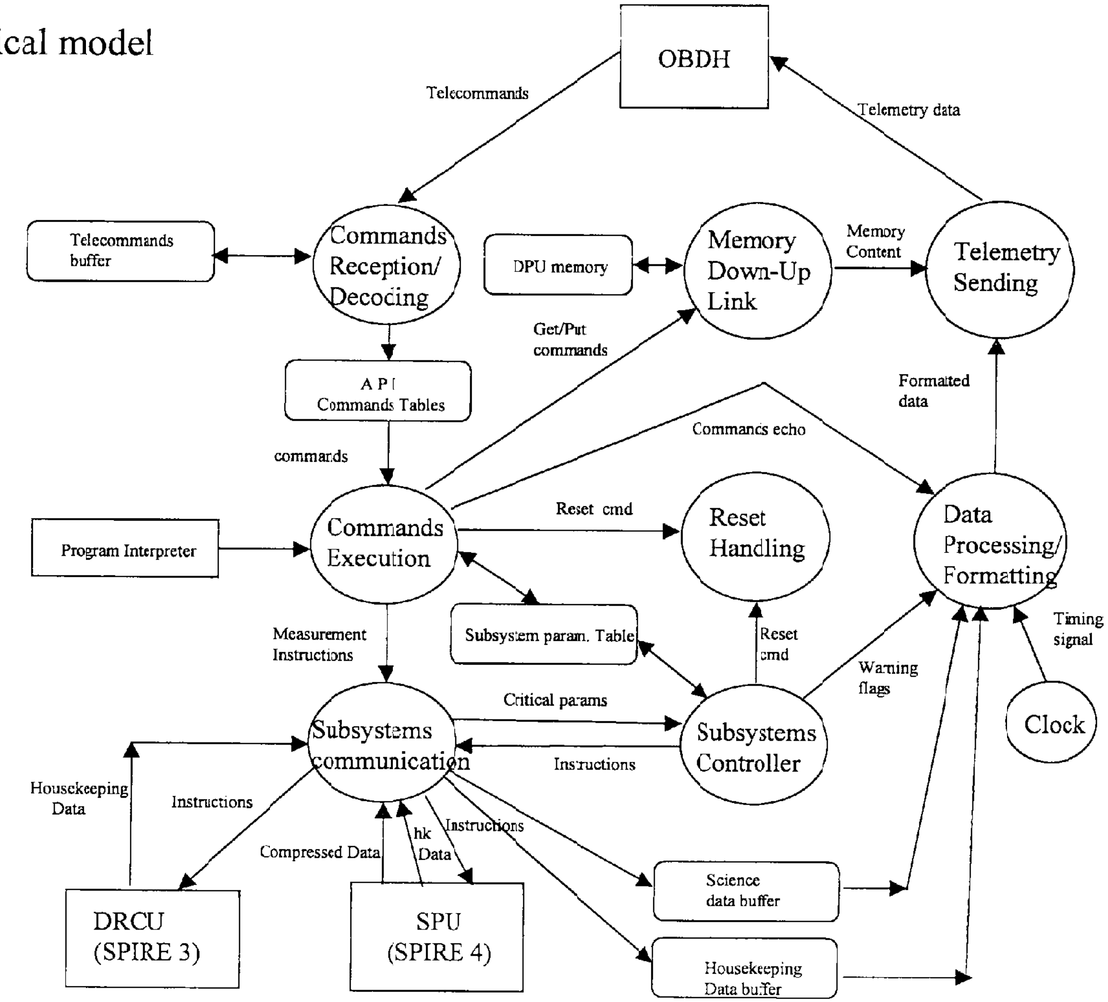

CMD
execution
Immediate ?
Program ?
ASAP ?
N
N
N
Y
Y
Y
Execute
command

SPIRE On Board Software
Context Diagram



OBDH On Board Data Handler
OBS On Board Software
SPU Signal Processing Unit
DRCU Detector Read-out & Control Unit

SPIRE OBS - Logical model



Functional decomposition

Based on the functional description contained in the SPIRE Scientific and Technical Plan, the following main functional components have been individuated for the SPIRE OBS:

1. Commands Reception/Decoding :

- Receives the telecommands from OBDH and stores them sequentially in the Telecommands Buffer (a cyclic buffer necessary to store all the telecommands as soon as they are received, until they are examined for their decoding and execution);
- Reads the Telecommand buffer, executes a first level analysis, and moves the telecommands to the three Commands Tables (one per execution priority: I, P, A), which contain the received commands sequentially, as they were transmitted.

2. Commands Execution :

- Reads from the Commands Tables the commands to be executed, according to their priority;
- Interprets the Commands according to given algorithms;
- If requested, it passes the RESET command to the *Reset Handling* component;
- Updates the Subsystems Parameters Table(s), which is used for the actual execution of the measurement;
- Sends the relevant sequence of digital commands (Measurement Instructions) to the *Subsystem Communication* component;
- If requested, it passes the memory reading/writing commands to the to the *Memory Down-Up link* component.

Functional decomposition

3. Subsystems Communication:

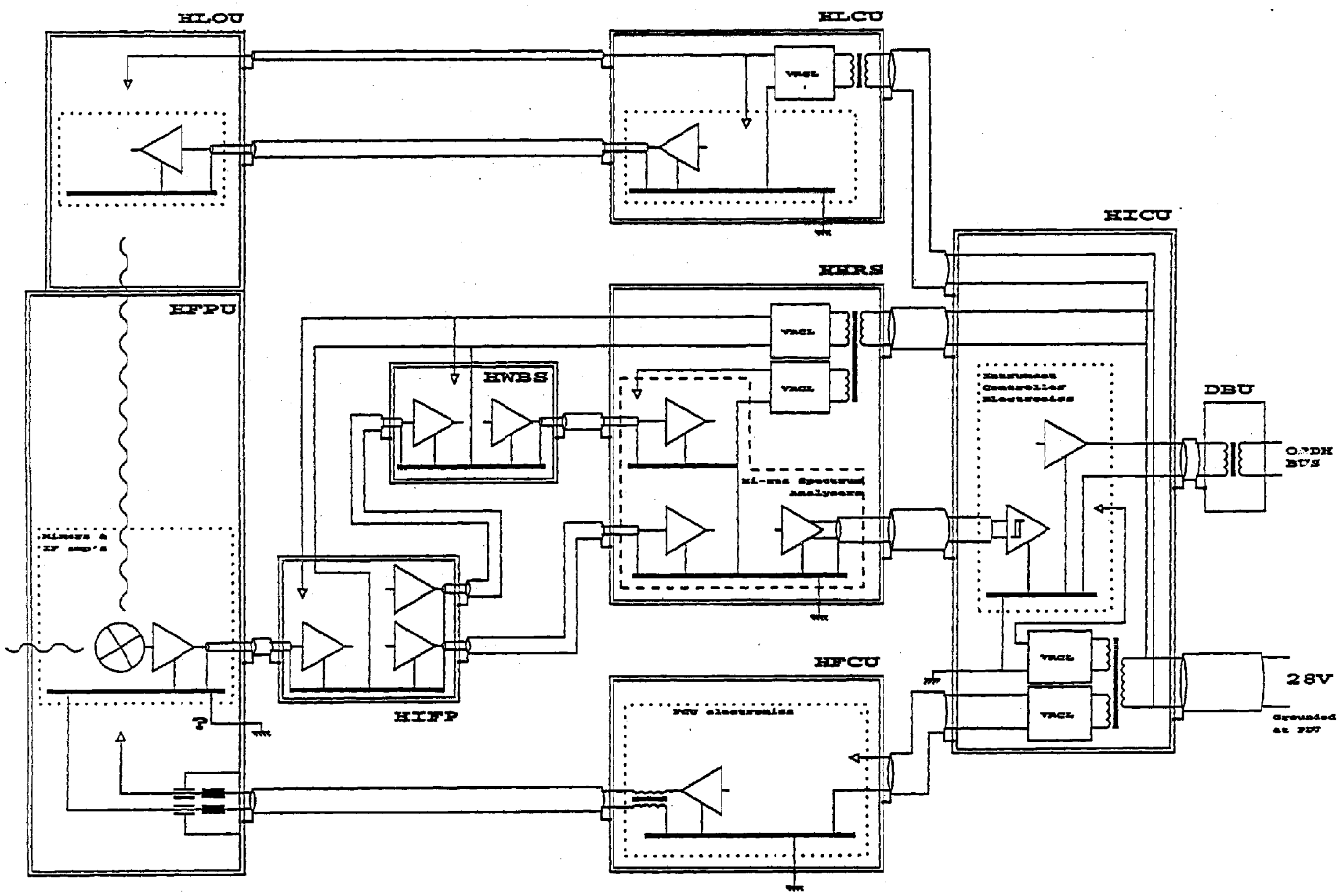
- It interfaces the instrument subsystems, by sending the measurement instructions, and getting the Housekeeping information from all the subsystems and the compressed science data from the SPU;
- Updates the Science Data Buffer and the Housekeeping Data Buffer;
- Sends the subsystems critical parameters to the *Subsystems Controller* component;
- Receives from the *Subsystems Controller* component the instructions generated after the analysis of the critical parameters and sends them to the subsystems (autonomy functions);
- Sends S/W modules to SPU.

4. Subsystems Controller:

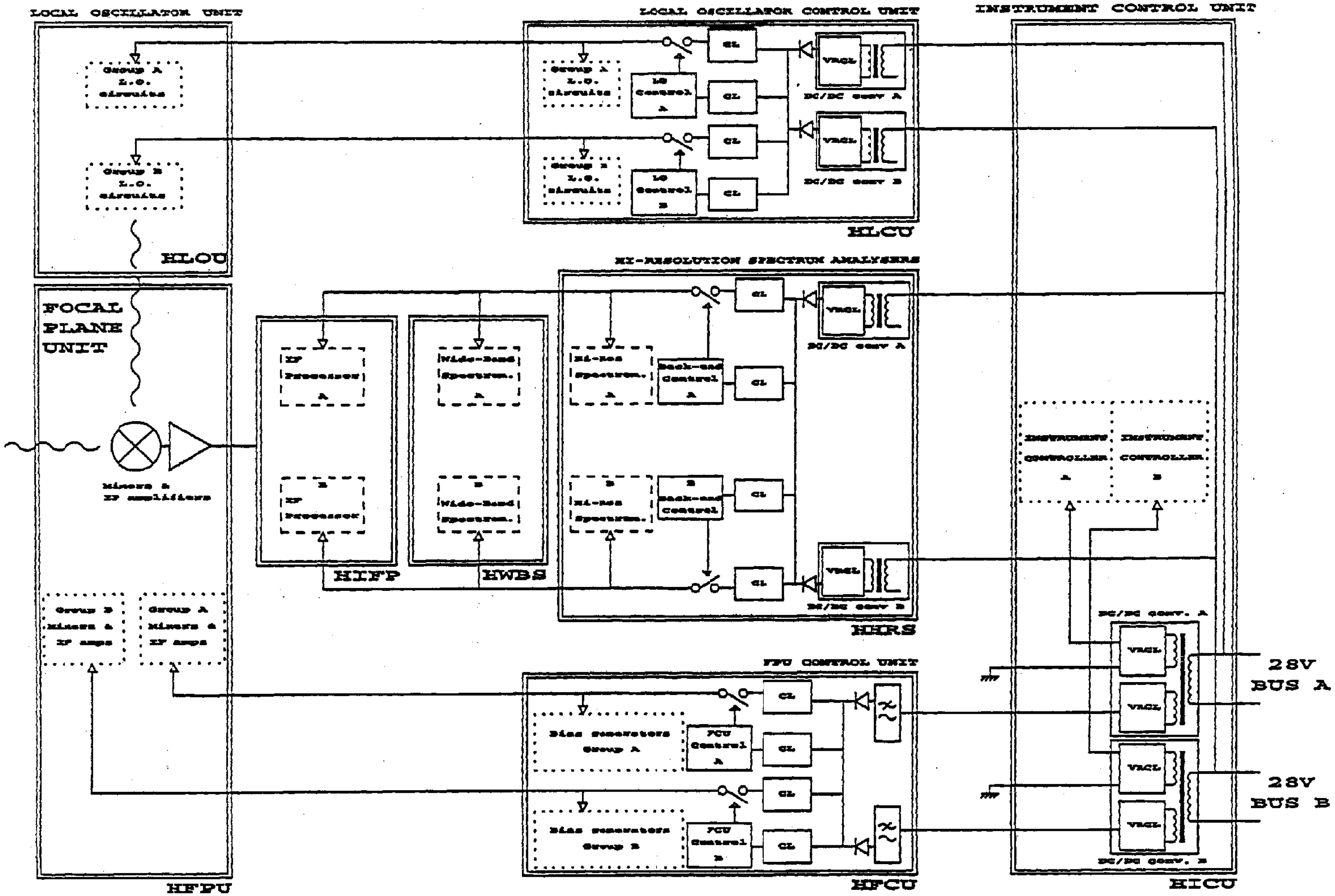
- Receives from the *Subsystems Communication* component the values of the critical parameters;
- Checks the parameters and flags the abnormalities; the warning flags are sent to the *Data Processing/Formatting* component to be included in the Telemetry data;
- In case of autonomous operation, it may take action to switch off parts of the instrument, by sending an appropriate set of instructions to the *Subsystem Communication* component.

Required resources

- 2 X 28V power lines: normal and redundant
- 10 W (TBC) for DPU (including 70% DC/DC efficiency)
- telemetry rate of ~ 140 kBit/sec (TBC)
- telecommand rate of ~ 750 Bit/sec (TBC)
- Dimensions as in the other 2 instruments (240 x 210 x 194 mm^3) in order to fit double europe standard boards.
- mass of 7 kg (TBC)



GROUNDING DIAGRAM HIFI



POWER DISTRIBUTION DIAGRAM HIFI

File HIFI_PWR2 9/3/98

Integration and test plans

- We will build subsystems simulators and S/C simulator to carry out in-house tests.
- DPU will be first integrated with the EGSE, then with the other subsystems.
- Environmental test:
  - Thermal vacuum can be done at unit level, but an integrated instrument test is preferred
  - Vibration can be done at unit level.
  - EMC-EMI should be done with the other subsystems to have meaningful results