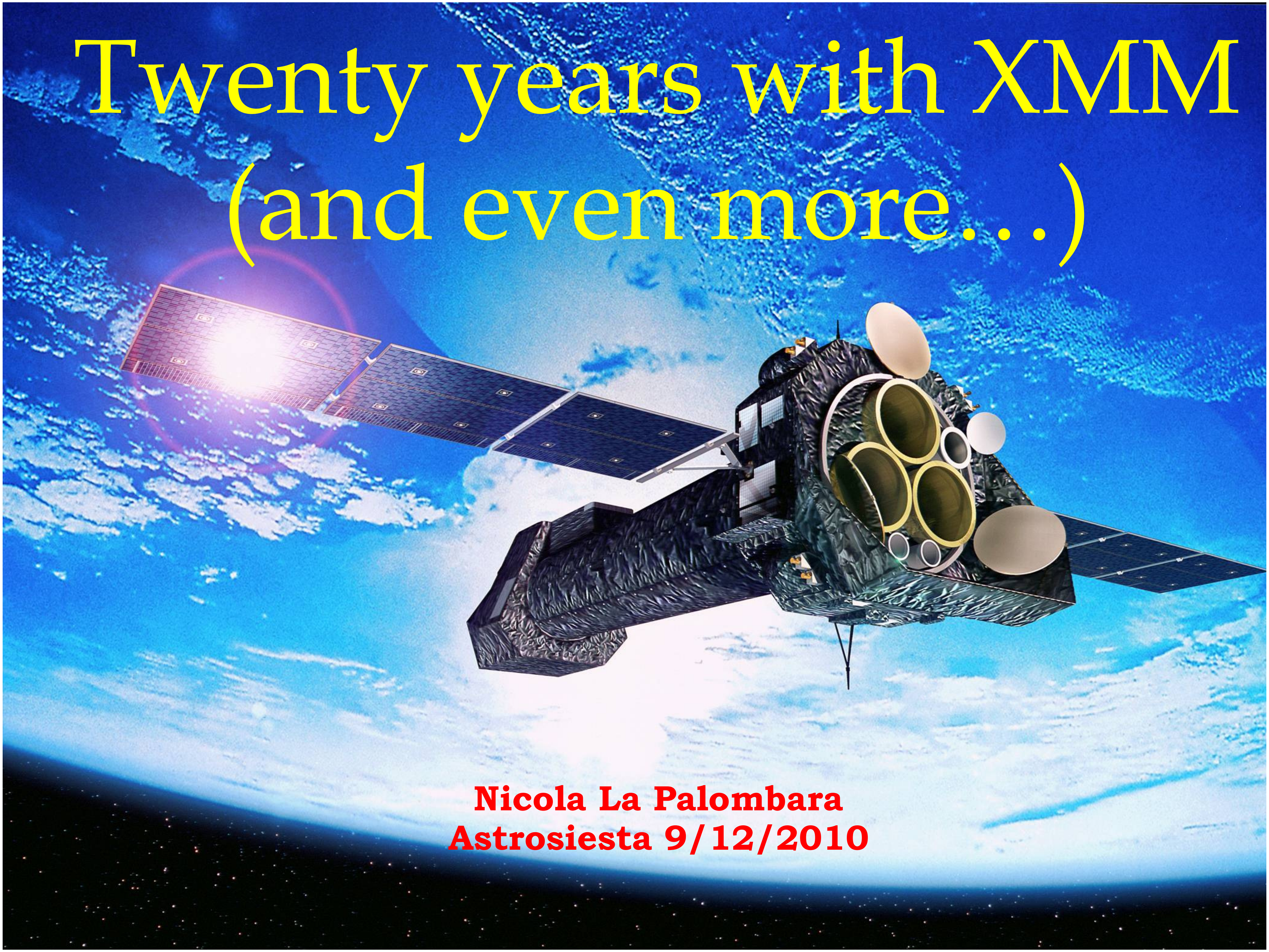
Twenty years with XMM (and even more…)



Nicola La Palombara

Astrosiesta 9/12/2010

The beginning: birth of an idea

90 J A M BLEEKER

The prime design drivers for a high throughput spectroscopy mission can, therefore, be summarised as:

= Energy dynamic range: 0.2-10 keV, covering the bulk of the emission in the X-ray band

throughput optimised for the 2-8 keV band:

* $A_{eff} \geqq 10.000\ cm^2$ at 2 keV

* $A_{eff} \geqq 5.000\ cm^2$ at 8 keV

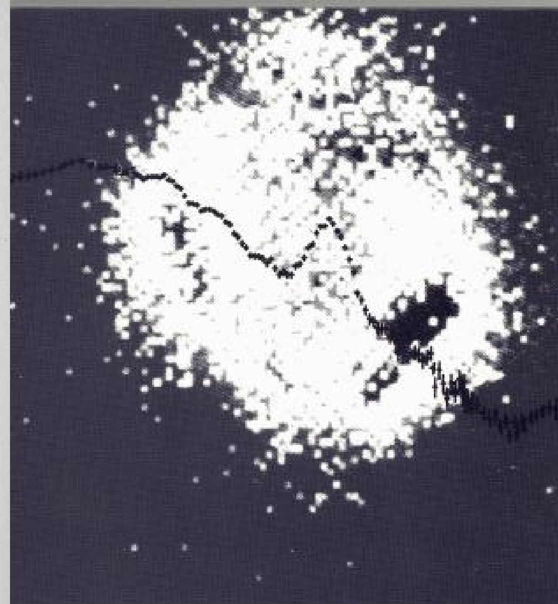
= Angular resolution: requirement $\leqq$ 30 arcsec HPW at 7 keV

design goal 10-20 arcsec HPW at 7 keV

This provides a dramatic increase of collecting power over the AXAF mission of about 10 at 2 keV and 30 at 8 keV at the expense of angular resolving power.

esa SP-239

An ESA Workshop on a Cosmic X-Ray Spectroscopy Mission



A Cornerstone of the ESA Long-term Space Science Programme

Lyngby, Denmark
24 – 26 June 1985

esa
european space agency

From the dreams…

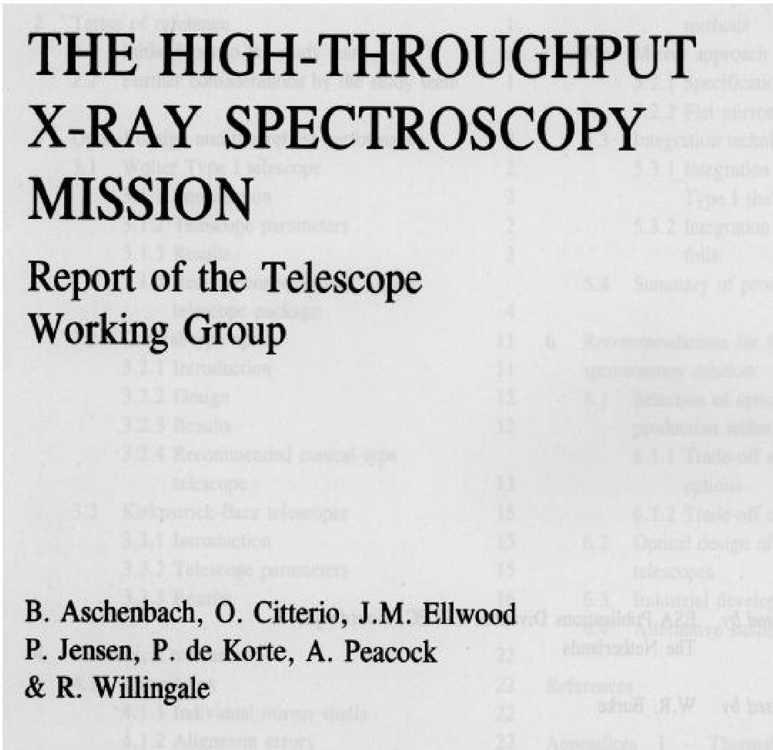
1. INTRODUCTION

The assesment study of the X-ray Multi-Mirror mission (ref.1) defines two types of telescope, i.e.:

- Low-energy (LE) telescopes with a good spatial resolution (10 arc sec H.P.W.) and with an energy coverage from 0.1 to 2.5 KeV.
- High-energy (HE) telescopes with a large collecting area (~2000 cm^2 per module) combined to a moderate spatial resolution (30 arc sec) and an energy coverage of 0.1-10 KeV.

In the present concept one foresees 12 LE-telescopes with a total effective area of 5500 cm^2 and 7 HE-telescopes with a total effective area of 13.000 cm^2 up to 2 KeV and still 10.000 cm^2 at 6 KeV.

…to the awakening:


THE HIGH-THROUGHPUT X-RAY SPECTROSCOPY MISSION

Report of the Telescope Working Group

B. Aschenbach, O. Citterio, J.M. Ellwood P. Jensen, P. de Korte, A. Peacock & R. Willingale

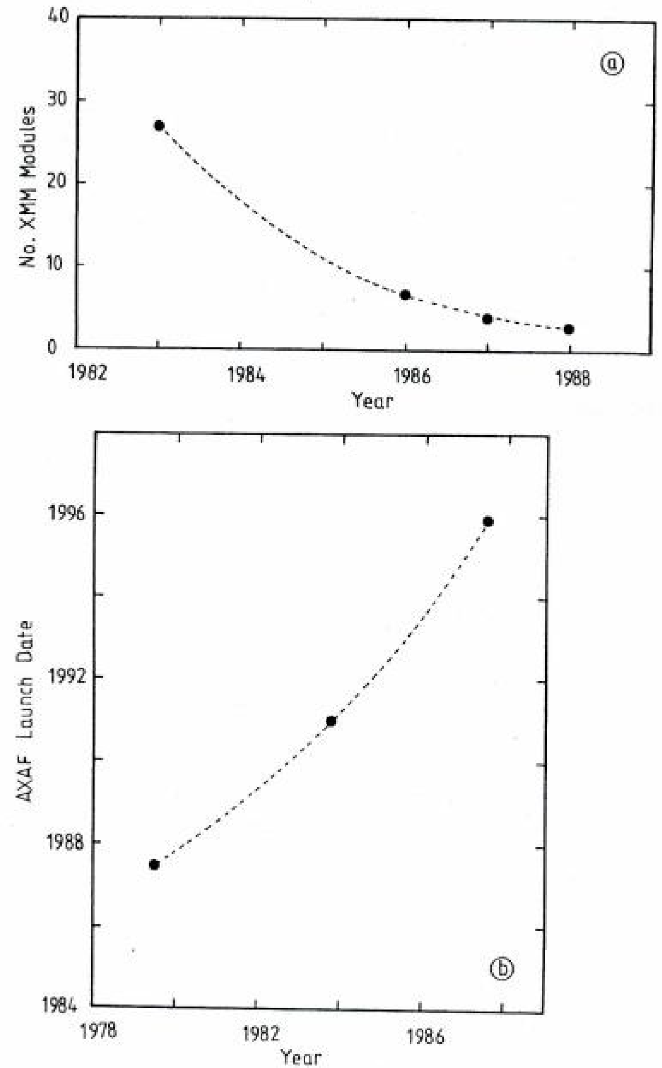
Telescope Working Group, February 1987:

"The TWG recommends the use of <u>7 Wolter I telescopes</u>, each with a focal length of 8 m and an aperture diameter of 70 cm"

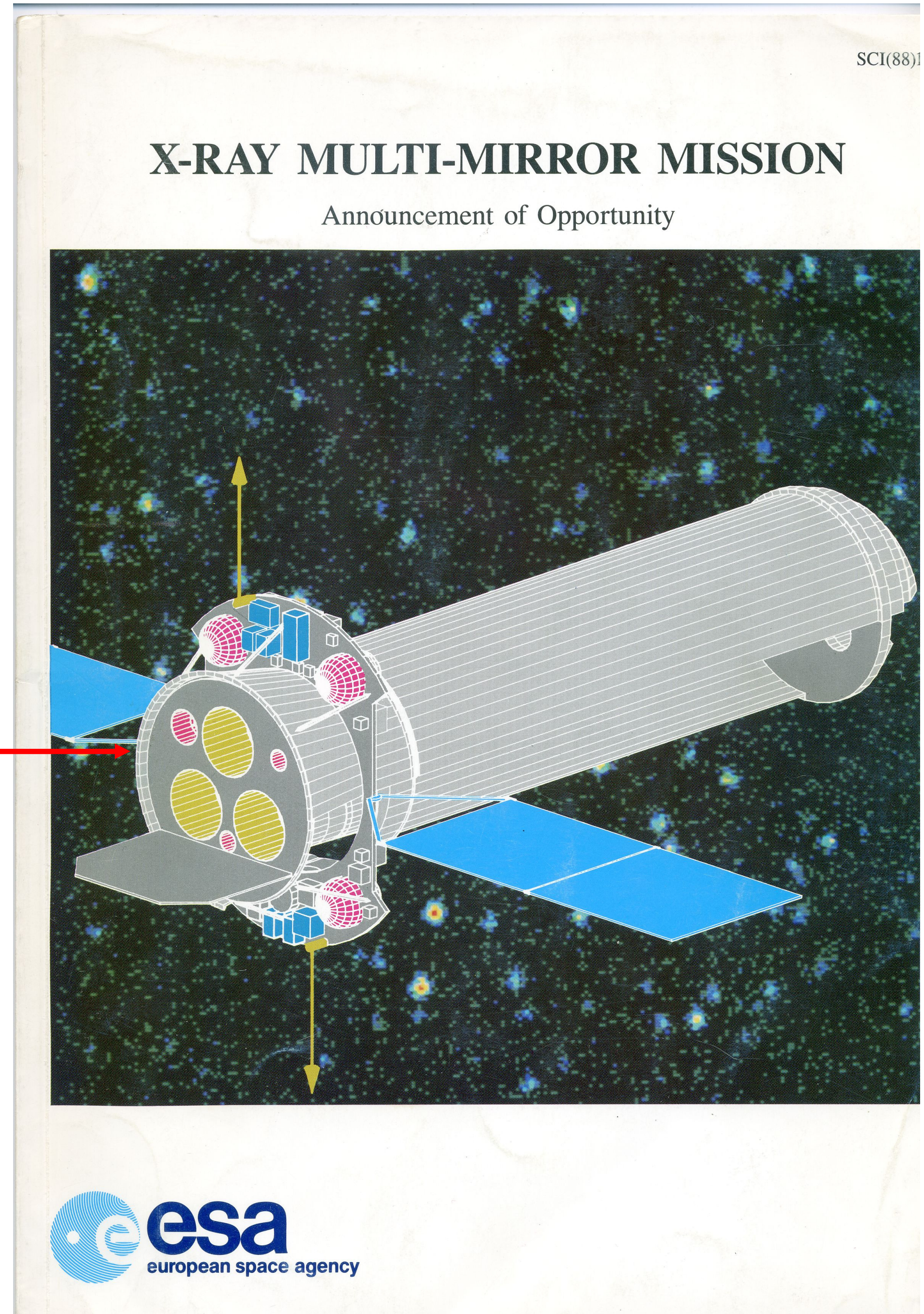
G.W Fraser: "X-ray detectors in Astronomy"

1.5 Post-Einstein: the modern era **31**

Fig. 1.14 X-ray astronomy in the real world. (a) Number of XMM mirror modules as a function of calendar time. The expected launch date for XMM is 1998. (b) Scheduled AXAF launch date versus time. The history of the '1.2 metre X-ray telescope' which eventually became AXAF actually begins in the 1960s (Tucker and Giacconi, 1985).



Formal proposal: June 1988 (3 telescopes)



One of the four "cornerstone" missions of the ESA science programme "Horizon 2000" (together with SOHO/Cluster, Rosetta and Herschel)

esa

european space agency
agence spatiale européenne

D.Sci/RMB/val/7258

Paris, 29 June 1988

Dear Madam, Dear Sir,

I invite the community to make proposals for involvement in the X-ray Multi-Mirror (XMM) mission.

This Announcement of Opportunity calls for proposals for

- Instruments/Principal Investigators
- Mission Scientists
- Telescope Scientist

within the X-ray Multi-mirror Mission project.

Proposals for Principal investigators and Mission Scientists can be accepted from individuals or Institutes within countries which participate in the ESA Science programme or the United States of America (under the Agreement of Reciprocity between ESA and NASA). Due to the potentially costly logistics of performing the telescope testing and calibration out of Europe, proposals for the role of Telescope Scientist will only be accepted from individuals or groups resident in an ESA member State.

This AO consists of the Announcement of Opportunity proper, together with three Annexes.

Annex A - The XMM Mission Report contains a description of the XMM mission, the spacecraft, model payload configurations and expected scientific performance.

Annex B - The Payload Requirements Document (EID Part A) describes in detail the services and resources provided to the user, management requirements are also included.

.../...

8-10, rue Mario-Nikis · 75738 Paris Cedex 15 · Tél. (33.1) 42.73.76.54 · Telex ESA 202746 · Télégr. Spaceurop Paris

Annex C - Technical and Programmatic Proposal Requirements (EID Part B)

This Annex provides a set of data sheets, in order to provide a detailed description of the proposed investigations and the required spacecraft resources. The completion of these sheets is mandatory for all proposers. The document is structured such that it will eventually become the Experiment Interface Document Part B.

Planning

The planning for the submission of proposals and the subsequence selection cycle is as follows.

Issue of the AO	July 1988
Letter of intent due	September 9, 1988
Submission of questions for briefing	September 9, 1988
Briefing Meeting	September 28/29, 1988
Proposals due	January 31, 1989
Clarification and Optimisation meetings	Feb/April 1989
Selection Completed	June 1989

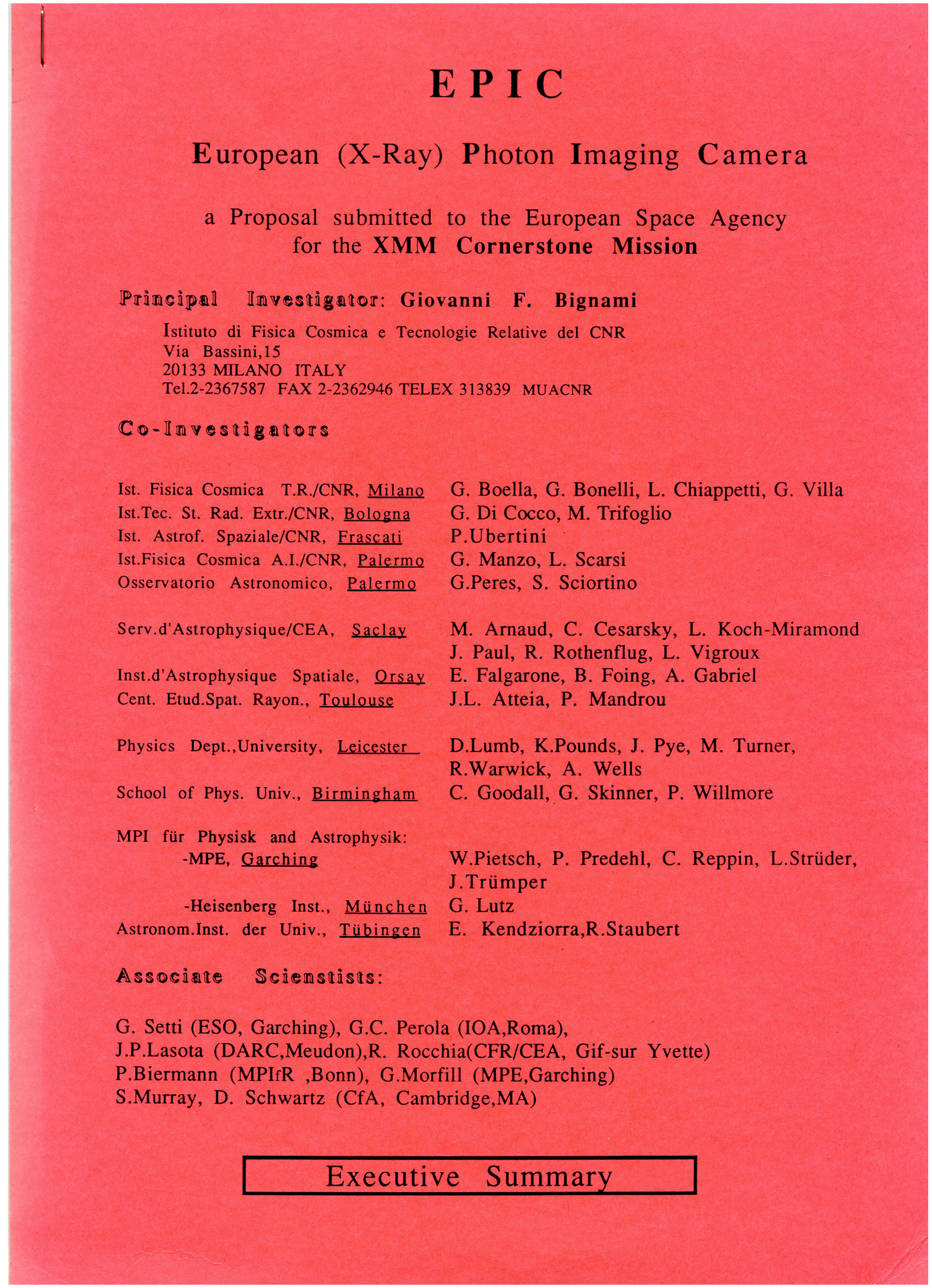
R.M. Bonnet
Director of Scientific Programme

Project timeline

The main features are:

- Selection of investigations .... June 1989
- Mirror Development Model Delivery .... Begin 1992
- Instrument Electro-Optical Breadboard Delivery Begin 1992
- Issue of AO for survey scientist 1992
- Commencement major funding 1992
- Spacecraft Phase C/D 1994-1997
- Instrument Qualification Model Delivery .... June 1994
- Instrument Flight Models Delivery .... Dec 1995
- Launch 1998

Proposal for the focal plane camera: "*EPIC*" European Photon Imaging Camera



EPIC

European (X-Ray) Photon Imaging Camera

a Proposal submitted to the European Space Agency
for the **XMM Cornerstone Mission**

Principal Investigator: Giovanni F. Bignami

Istituto di Fisica Cosmica e Tecnologie Relative del CNR
Via Bassini,15
20133 MILANO ITALY
Tel.2-2367587 FAX 2-2362946 TELEX 313839 MUACNR

Co-Investigators

Ist. Fisica Cosmica T.R./CNR, Milano	G. Boella, G. Bonelli, L. Chiappetti, G. Villa
Ist.Tec. St. Rad. Extr./CNR, Bologna	G. Di Cocco, M. Trifoglio
Ist. Astrof. Spaziale/CNR, Frascati	P.Ubertini
Ist.Fisica Cosmica A.I./CNR, Palermo	G. Manzo, L. Scarsi
Osservatorio Astronomico, Palermo	G.Peres, S. Sciortino
Serv.d'Astrophysique/CEA, Saclay	M. Arnaud, C. Cesarsky, L. Koch-Miramond J. Paul, R. Rothenflug, L. Vigroux
Inst.d'Astrophysique Spatiale, Orsay	E. Falgarone, B. Foing, A. Gabriel
Cent. Etud.Spat. Rayon., Toulouse	J.L. Atteia, P. Mandrou
Physics Dept.,University, Leicester	D.Lumb, K.Pounds, J. Pye, M. Turner, R.Warwick, A. Wells
School of Phys. Univ., Birmingham	C. Goodall, G. Skinner, P. Willmore
MPI für Physisk and Astrophysik: -MPE, Garching	W.Pietsch, P. Predehl, C. Reppin, L.Strüder, J.Trümper
-Heisenberg Inst., München	G. Lutz
Astronom.Inst. der Univ., Tübingen	E. Kendziorra,R.Staubert

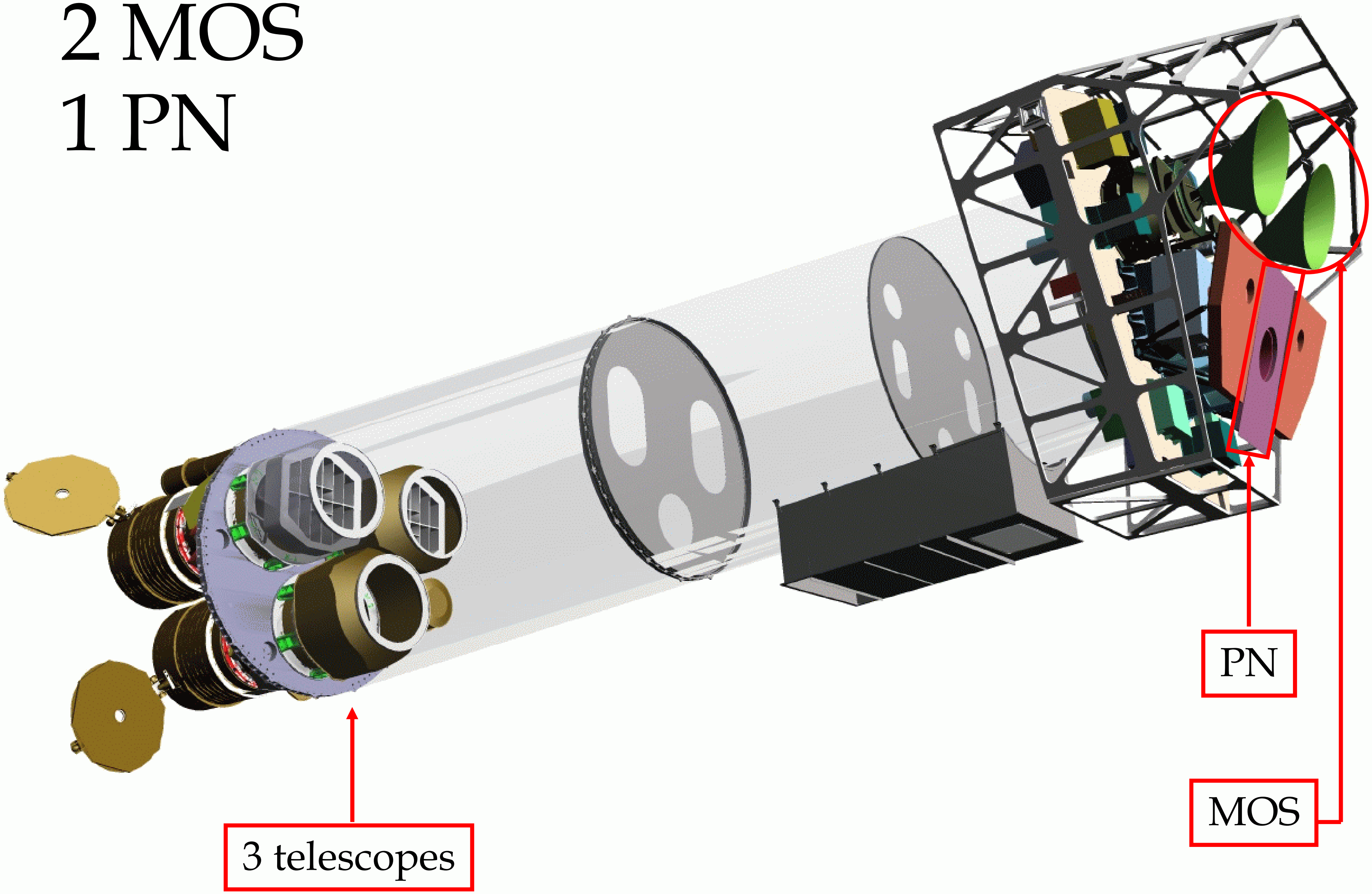
Associate Scienstists:

G. Setti (ESO, Garching), G.C. Perola (IOA,Roma),
J.P.Lasota (DARC,Meudon),R. Rocchia(CFR/CEA, Gif-sur Yvette)
P.Biermann (MPIfR ,Bonn), G.Morfill (MPE,Garching)
S.Murray, D. Schwartz (CfA, Cambridge,MA)

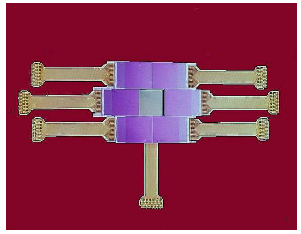
Executive Summary

Three focal plane cameras:

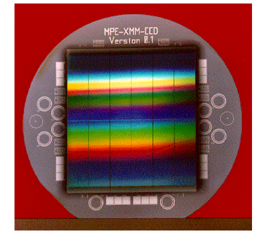
2 MOS
1 PN

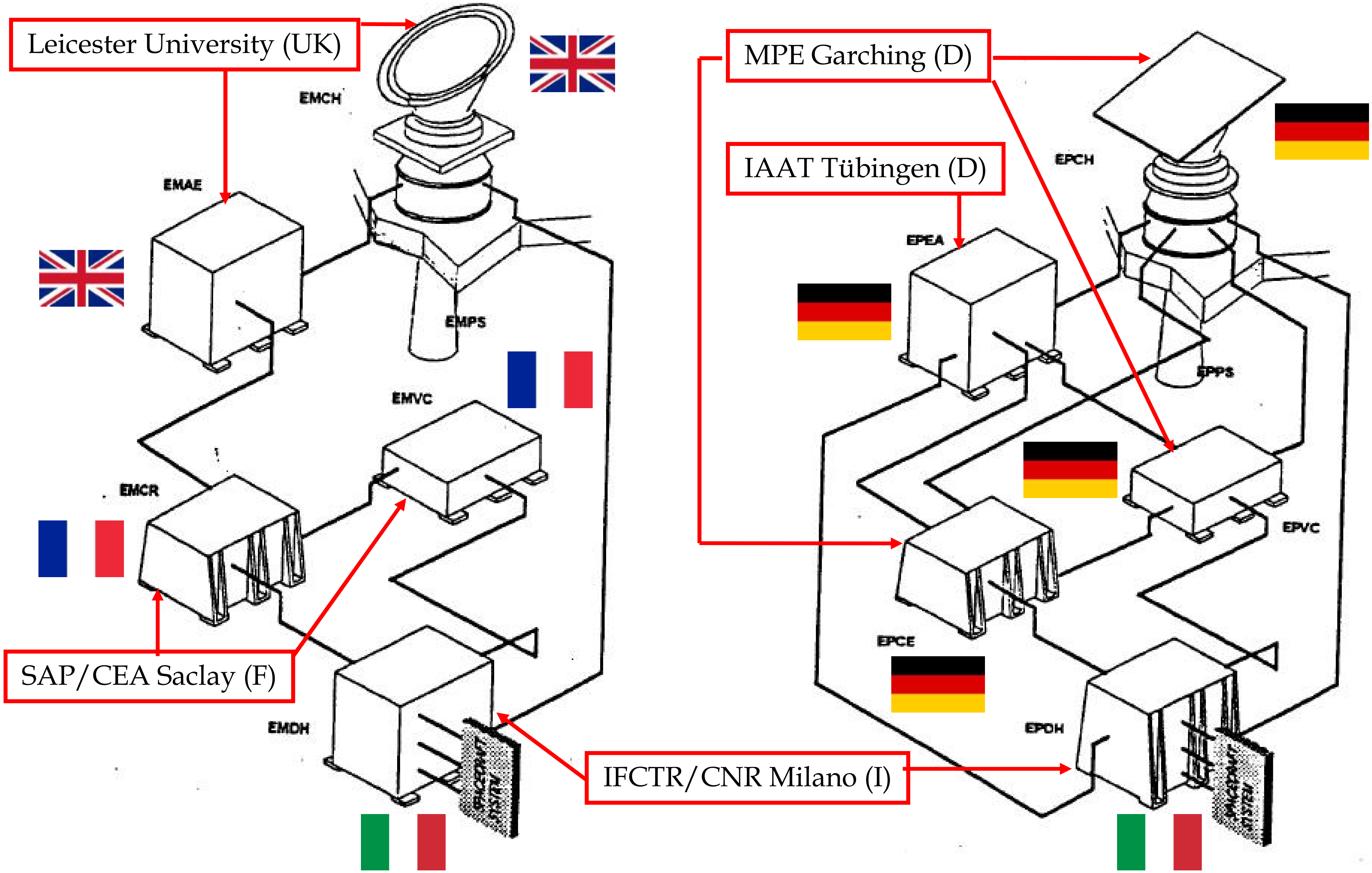


MOS

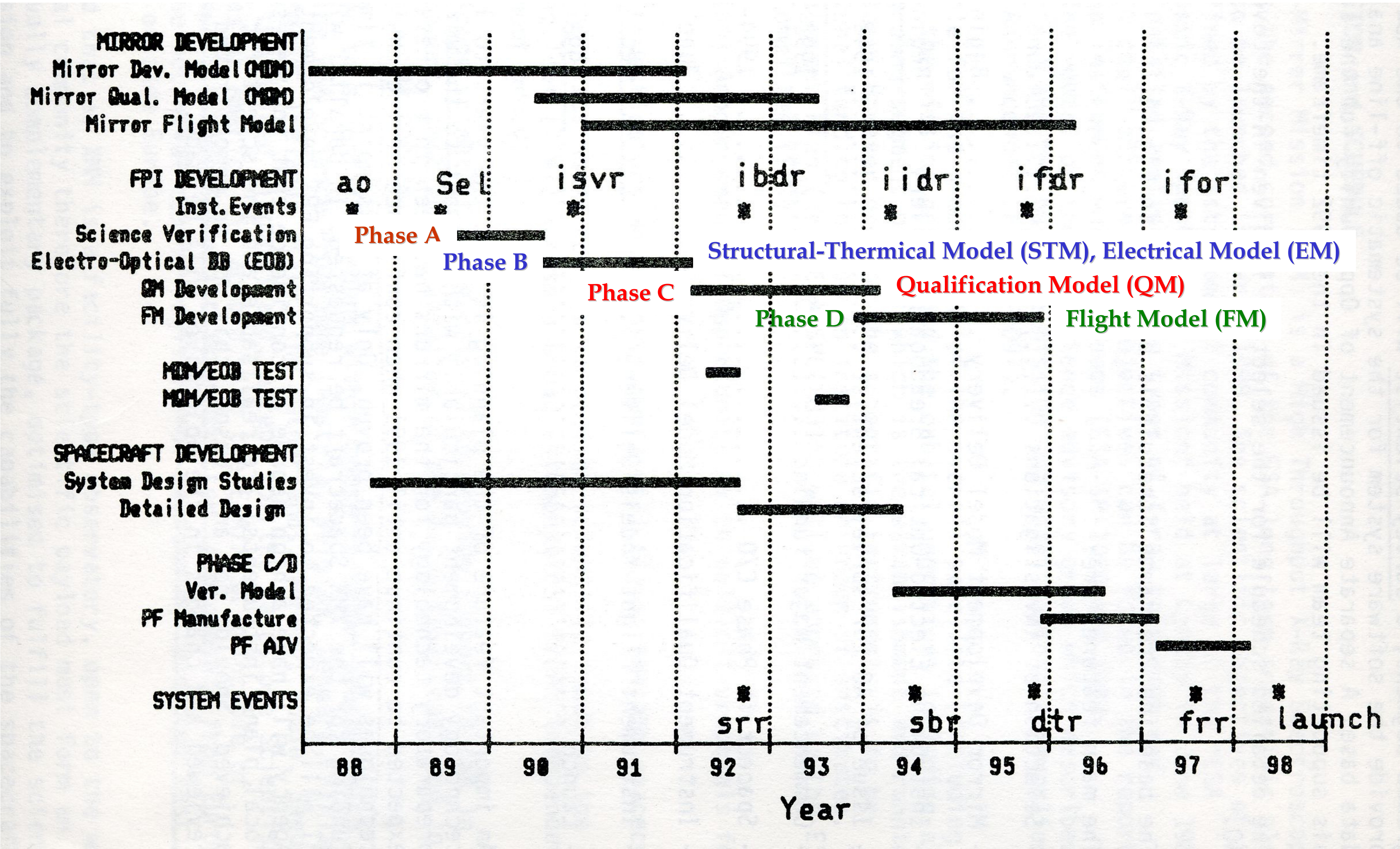


PN




Leicester University (UK)
EMCH
EMAE
EMPS
EMVC
EMCR
SAP/CEA Saclay (F)
EMDH
SPACECRAFT SYSTEM
IFCTR/CNR Milano (I)
MPE Garching (D)
IAAT Tübingen (D)
EPCH
EPEA
EPPS
EPVC
EPCE
EPDH
SPACECRAFT SYSTEM

From the “model philosophy” to the project phases:



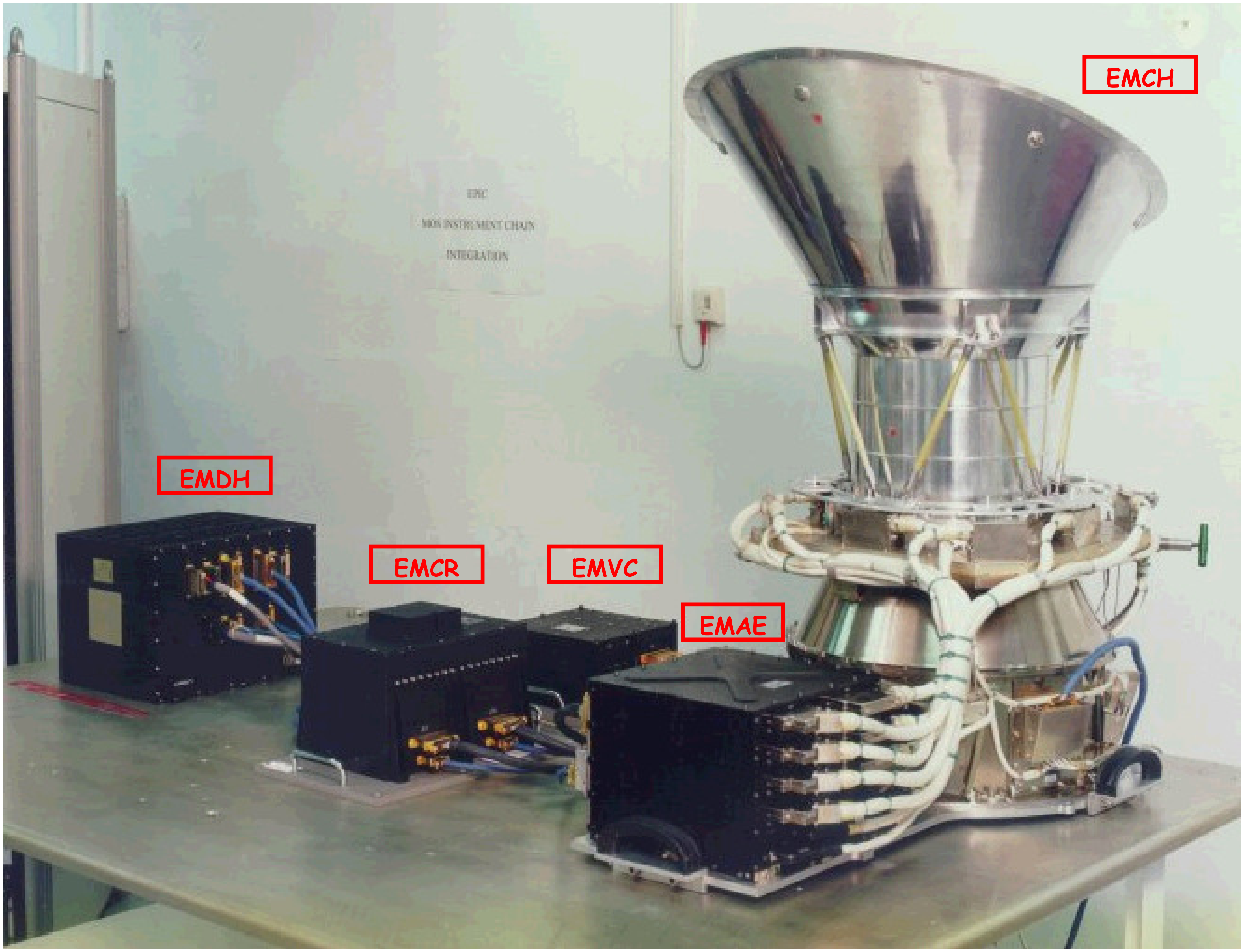
Need to coordinate the project

↓

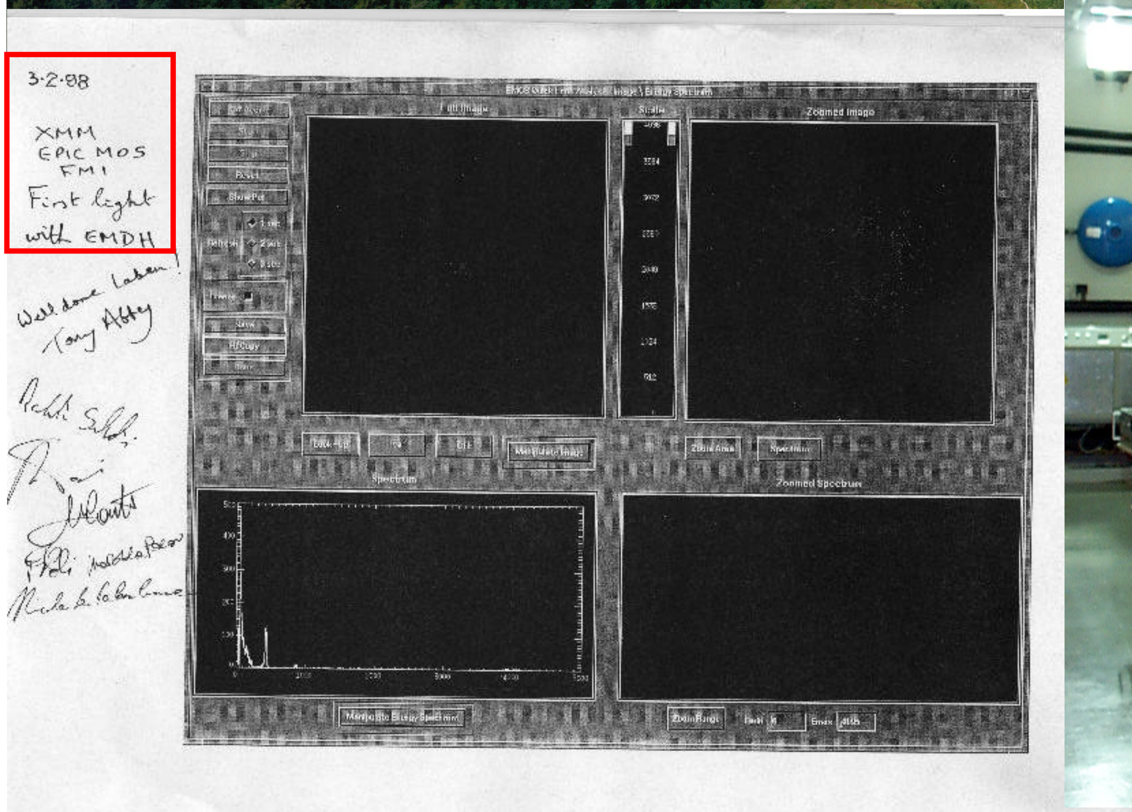
Establishment of the '*EPIC System Team*' at IFCTR/CNR

- technical support to the instrument PI
- system level integration (AIV) → definition of the interfaces, both internal (between single instrument units) and external (with the spacecraft)
- system-level management of technical (QA, HW/SW configuration, documentation) and programmatic issues (→ respect of the time schedule…)
- interface with ESA Project Office and production of required *deliverable* items (reference documents, TC&TM database, command procedures, …)

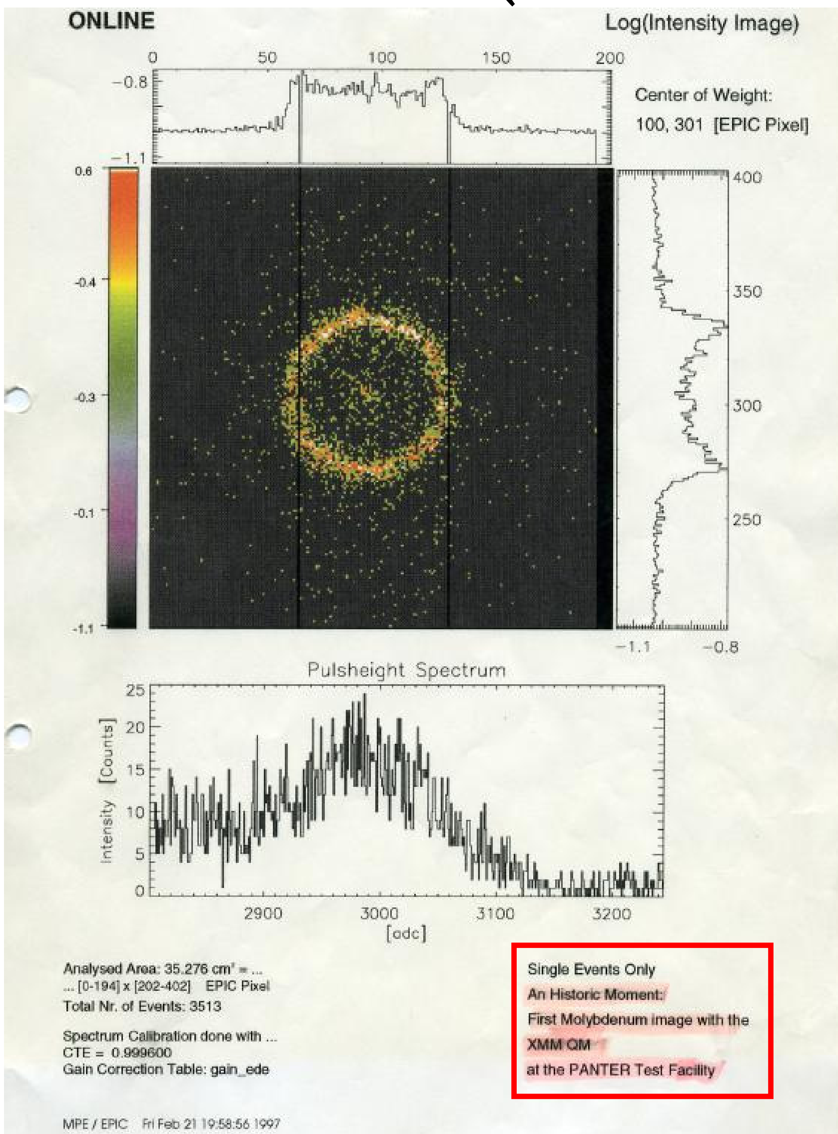
System-level Integration at LABEN–1996/8



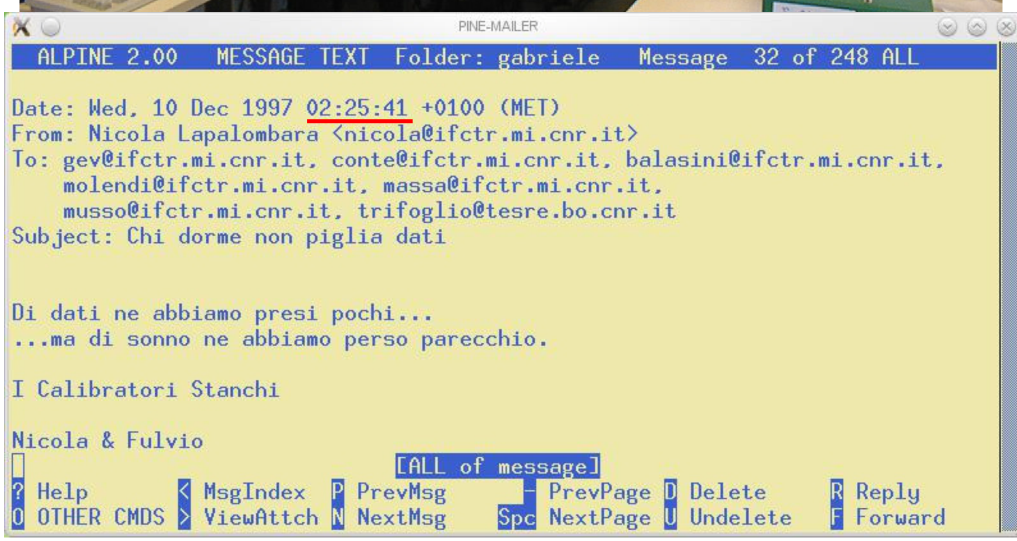
Calibrations at the MPE Panter Facility (Munich) 1997-8



Calibrations at the MPE Panter Facility (Munich) 1997-8



Calibrations at the IAS synchrotron of Orsay 1997/8 (*Football World Cup Championship*…)



PINE-MAILER

ALPINE 2.00 MESSAGE TEXT Folder: gabriele Message 32 of 248 ALL

Date: Wed, 10 Dec 1997 02:25:41 +0100 (MET)
From: Nicola Lapalombara <nicola@ifctr.mi.cnr.it>
To: gev@ifctr.mi.cnr.it, conte@ifctr.mi.cnr.it, balasini@ifctr.mi.cnr.it,
molendi@ifctr.mi.cnr.it, massa@ifctr.mi.cnr.it,
musso@ifctr.mi.cnr.it, trifoglio@tesre.bo.cnr.it
Subject: Chi dorme non piglia dati

Di dati ne abbiamo presi pochi...
...ma di sonno ne abbiamo perso parecchio.

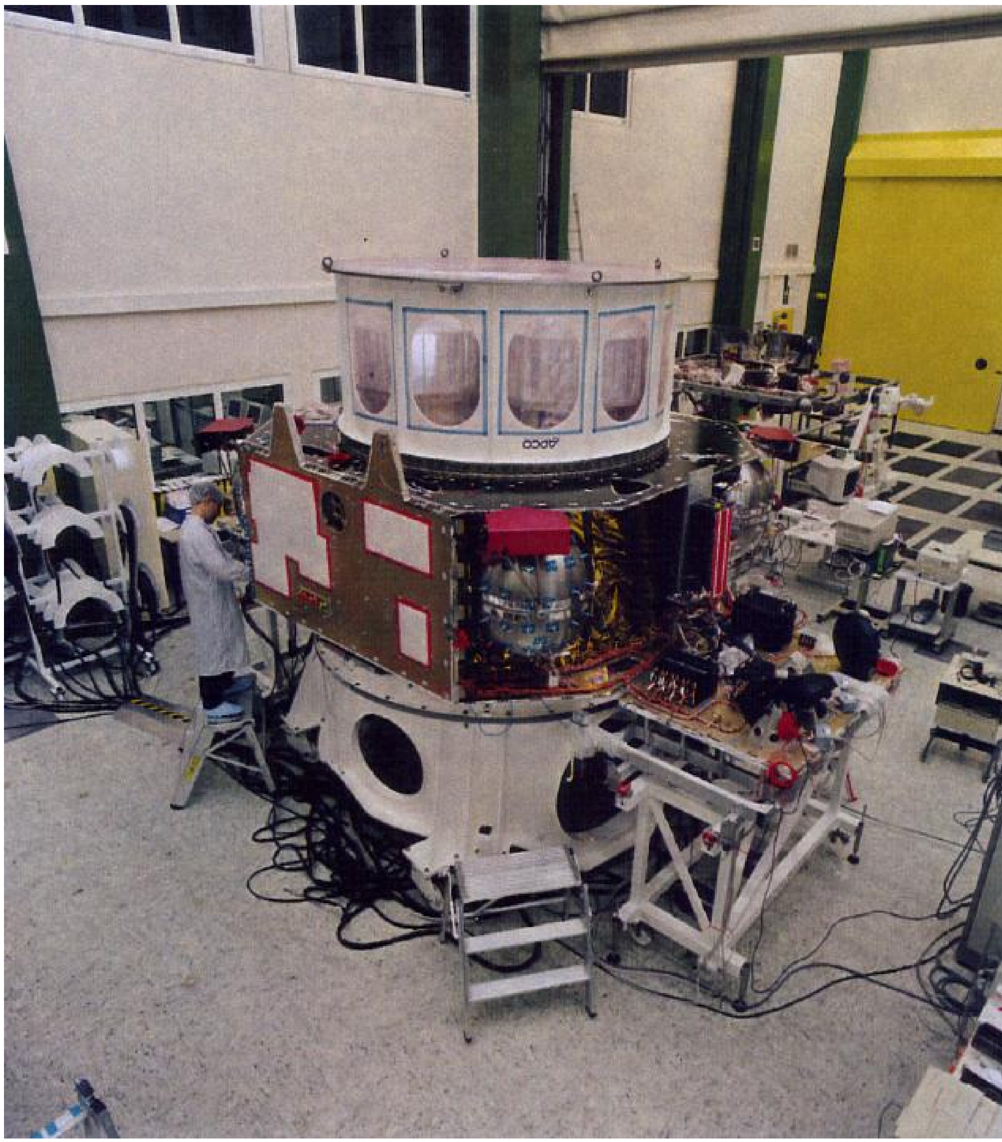
I Calibratori Stanchi

Nicola & Fulvio

[ALL of message]

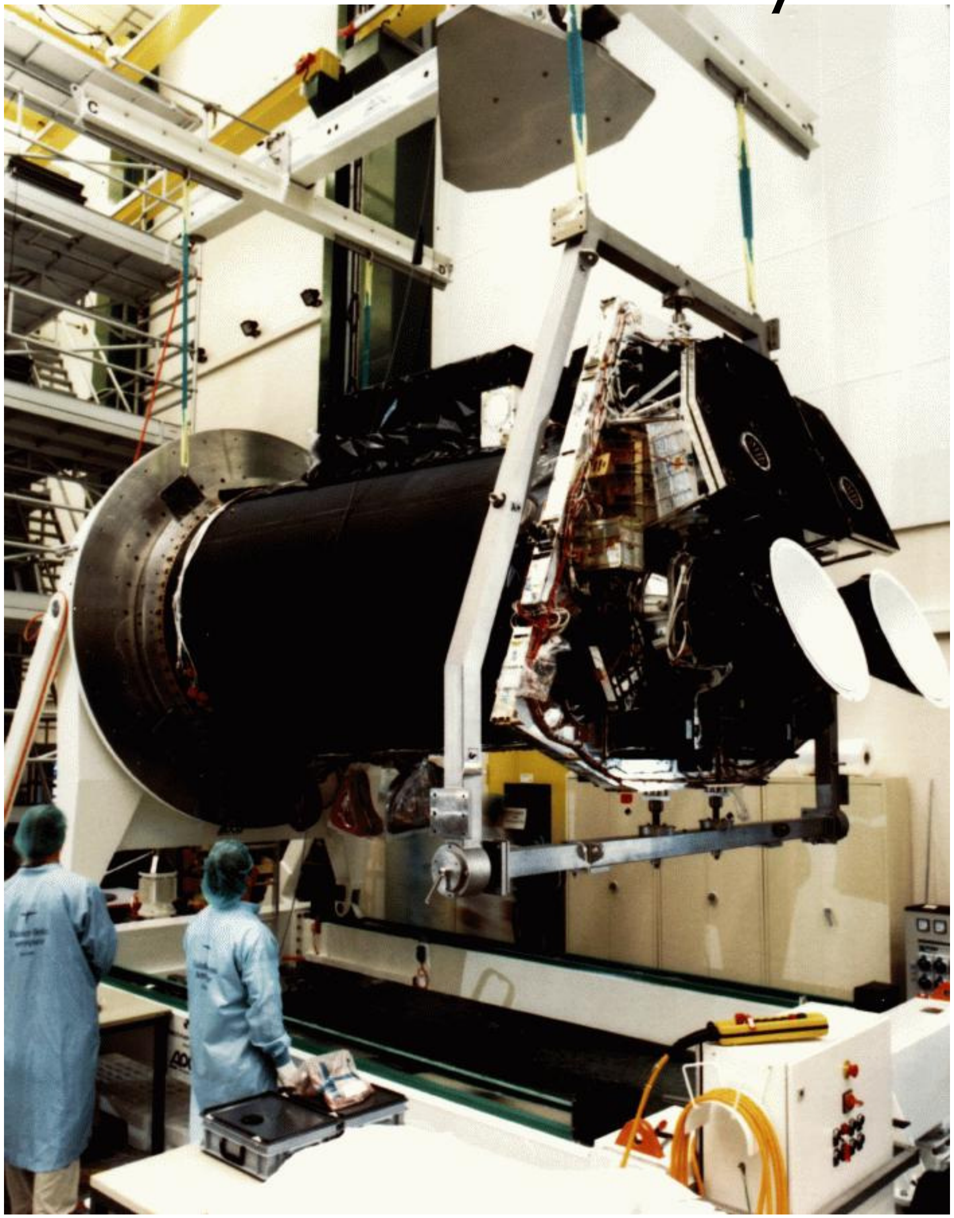
? Help   < MsgIndex   P PrevMsg   - PrevPage   D Delete   R Reply
O OTHER CMDS   > ViewAttch   N NextMsg   Spc NextPage   U Undelete   F Forward

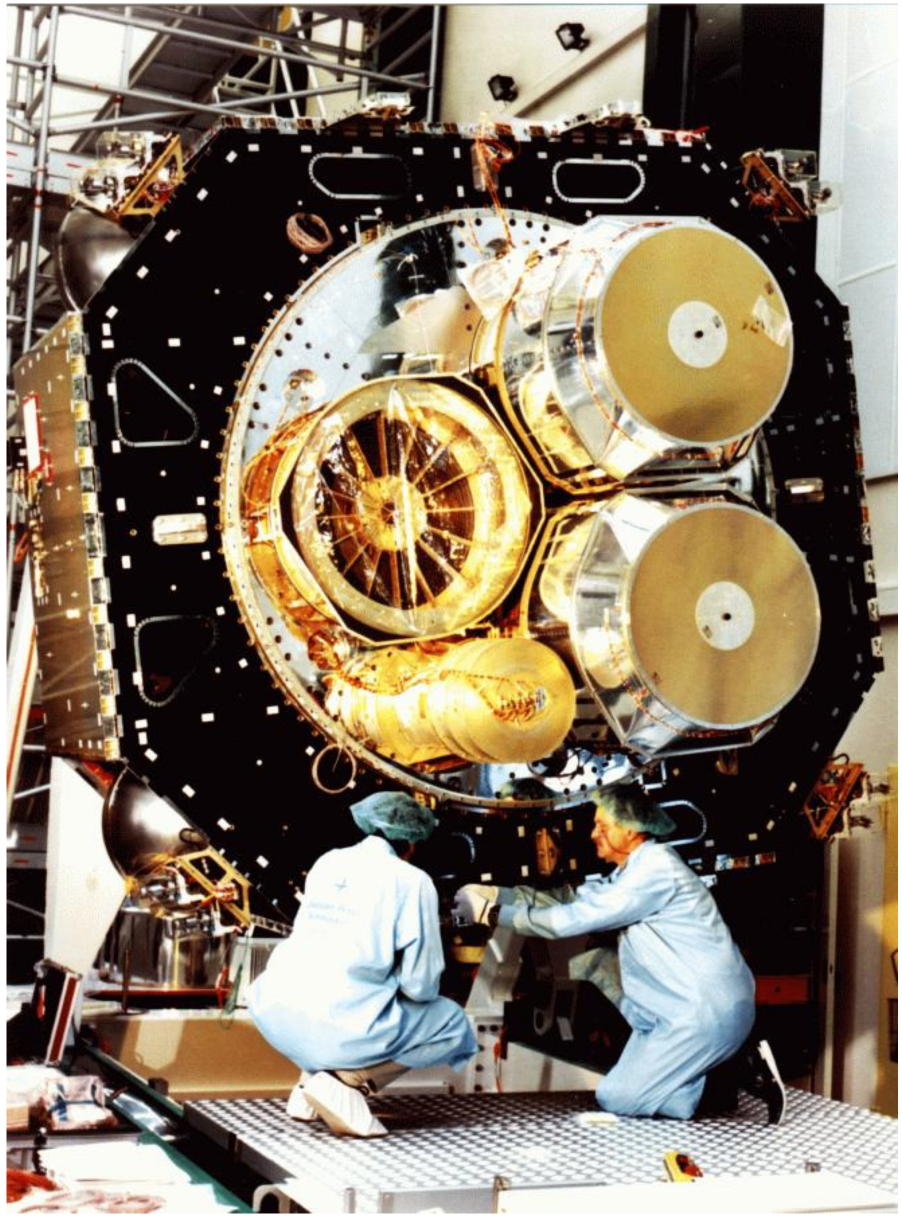
Satellite integration at DASA/Dornier Friedrichschafen (D) – 1998/9



FM mirrors delivered at ESA/ESTEC on 5/12/1998 (*Sinterklaas* in NL)

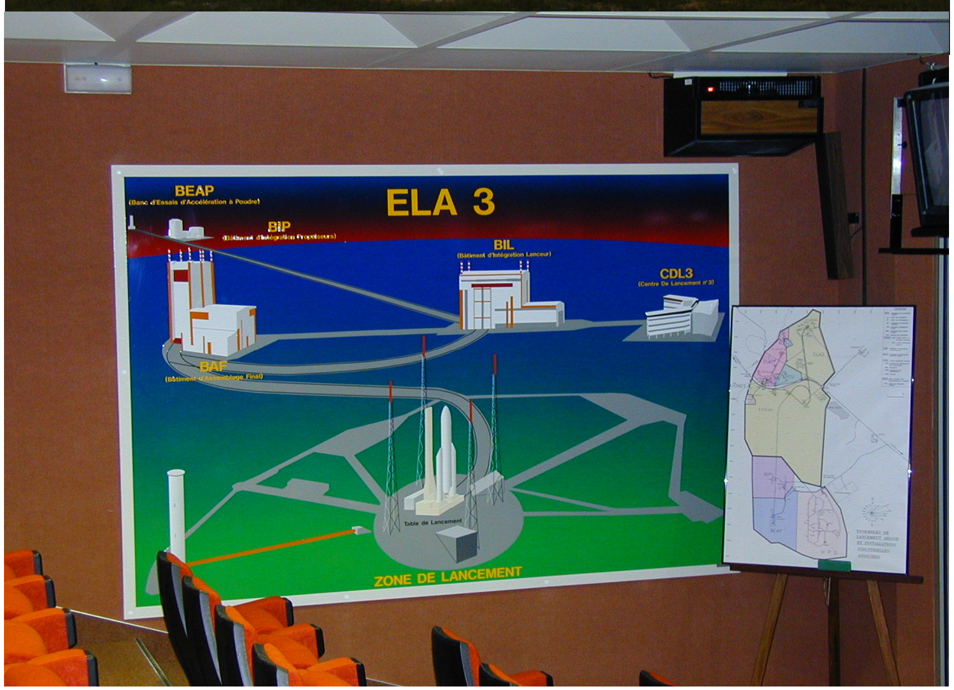
Satellite integration at ESTEC and TBTV/SVT tests - 1999





Satellite integration at ESTEC and TBTV/SVT tests - 1999

September – December 1999: Launch Campaign at Kourou – French Guyana



The "Big One"

L'erreur de programmation qui a coûté 370 millions de dollars

Lancio-disastro del razzo europeo in Guyana: 13 mila miliardi di lire e 10 anni di lavoro in fumo dopo 66 secondi

Il volo di Ariane è durato un minuto

Berlinguer: ma indietro non si torna, abbiamo già sbagliato per chimica e nucleare

DAL NOSTRO INVIATO

KOUROU (Guyana Francese) — Sessantasei secondi di volo, una fiammata luminosa e una raffica di scoppi col botto finale. Così si è concluso il primo lancio del razzo Ariane-5, orgoglio della tecnologia spaziale europea. Nella postazione avanzata, a tre chilometri dalla torre dalla quale seguivamo la partenza, è scattata subito la corsa verso le maschere antigas per evitare i fumi venefici della grande nube sprigionata dallo scoppio. Qualcuno gridava di restare calmi finché tutti ammutoliti e rinchiusi in un bus si è fatto ritorno al centro di controllo dove erano stati nel frattempo spenti gli impianti di condizionamento per impedire l'eventuale aspirazione dell'aria avvelenata.

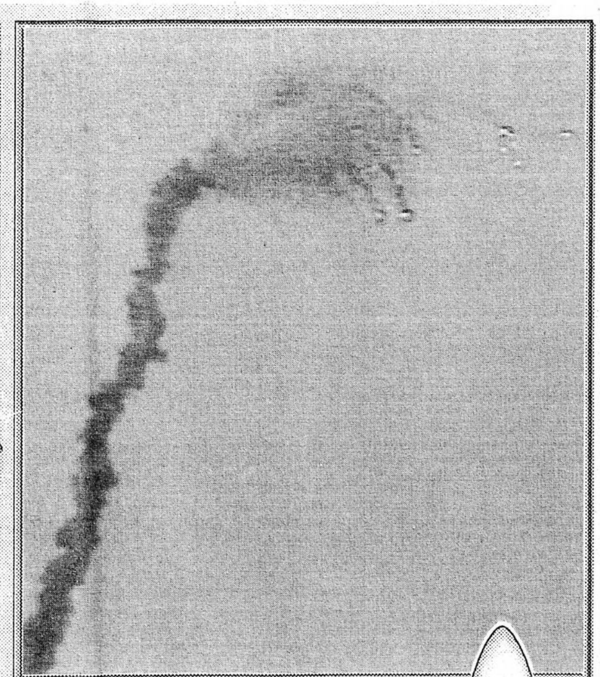
La nuvola, generata dalle 400 tonnellate di propellenti, spinta dai venti, lambiva le coste della Guyana francese dove, quasi a cavallo dell'Equatore, si trova la base spaziale europea. Per fortuna si allontanava verso l'Oceano, distante solo qualche chilometro. Immediatamente venivano attivate le misure di sicurezza anche presso le popolazioni dei due villaggi di Sinnamary e Kouroru adiacenti la base ma — secondo il prefetto della Guyana — nessuna conseguenza negativa era provocata dall'imponente massa dei gas inquinanti che nelle ore seguenti si è dispersa sull'Atlantico.

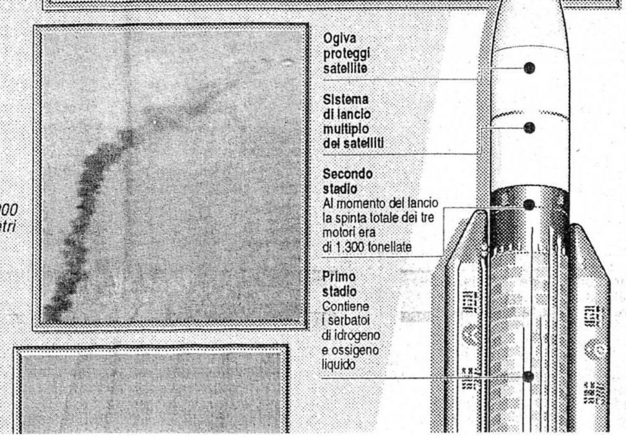
Ariane-5 si sollevava dalla rampa di lancio alle 9.35 locali, con un'ora di ritardo a causa delle nuvole che ricoprivano la zona e che avrebbero impedito di seguire con i telescopi il comportamento del razzo al suo primo volo. Tutto era filato liscio nel conto alla rovescia. Il nuovo razzo dell'agenzia spaziale europea Esa aveva richiesto quasi 7 tonnellate sull'orbita geostazionaria a 36 mila chilometri d'altezza dove lavorano i satelliti per le telecomunicazioni, era destinato a sostituire l'attuale e meno potente Ariane-4 in servizio dal 1979. Con un compito molto importante: quello di permettere all'Europa di mantenere il controllo del 60 per cento del mercato del trasporto spaziale mondiale che ha conquistato. E, siccome i satelliti per le telecomunicazioni continuano a crescere di peso, bisognava costruire un razzo più potente come appunto Ariane-5 che tenesse testa ai concorrenti americani, russi e cinesi anch'essi ormai protagonisti.

A tal fine si erano mobilitate le nazioni europee che ora devono affrontare l'inaspettato fallimento. Secondo l'esame dei primi dati la causa sembra essere legata al cattivo funzionamento del «cervello» del razzo costruito dalla francese Matra, dal quale sarebbero partiti ordini anomali che hanno portato alla distruzione del razzo. Ma che cosa sia veramente accaduto lo dovrà spiegare la commissione d'inchiesta istituita dal direttore generale dell'Esa, Jean-Marie Luton, e che consegnerà il suo responso entro il 15 luglio.

«Il programma continua» hanno ricordato sia lo stesso Luton, sia il ministro francese delle Poste e dello spazio François Fillon. «Non bisogna dimenticare che si trattava di un volo di collaudo — ha aggiunto Michel Mignot, direttore della base spaziale — e quindi soggetto ad alti rischi sia pure calcolati».

«Le prove delle diverse parti a terra erano state numerose ed accurate, tanto che il motore Vulcano aveva già funzionato per l'equivalente di 150 missioni nello spazio», ricorda Carlo Dana, responsabile in Esa della





L'INTERVISTA

Il ministro: responsabilità soprattutto dei francesi

Tre mesi fa il Tethered che strappa il guinzaglio e si perde nel vuoto siderale. Ieri i fuochi d'artificio di Ariane nel mare della Guyana francese. Dieci anni di ricerche, miliardi di dollari andati in fumo. Quattro satelliti scientifici distrutti. E i responsabili del progetto europeo che giurano: non cambia nulla, andiamo avanti lo stesso. Ne vale davvero la pena? «Piano, piano — risponde Luigi Berlinguer —. Io sono contrario a prendere decisioni affrettate, sull'onda delle emozioni popolari. È un errore che abbiamo già compiuto almeno due volte in passato, per la chimica e per il nucleare. E l'aerospaziale è un settore strategico, destinato ad avere un ruolo trainante nei prossimi anni, anche nella creazione di nuovi posti di lavoro».

Il futuro dell'industria delle telecomunicazioni è strettamente legato allo sviluppo dei satelliti, spiega il pluriministro, che parla qui nella sua veste di titolare della ricerca scientifica. «L'Italia è la quarta potenza del mondo nello spazio, ma molto indietro nel campo delle telecomunicazioni. Bisogna unire gli sforzi a livello europeo. Finora, per lanciare i satelliti della nuova generazione, che pesano fino a otto tonnellate, non si poteva fare a meno dei vettori americani. Ariane ha una capacità di sette tonnellate, vicina dunque alla soglia critica».

Peccato che abbia fatto cilecca.

«Vede, di fallimenti e di esplosioni è disseminata la storia dei lanci spaziali. E poi, in questo caso, il razzo pare sia scoppiato per decisione dei tecnici. Stando alle informazioni in nostro possesso, qualcosa non ha funzionato nel dispositivo di mira del pilotaggio, per cui si è temuto che Ariane potesse precipitare in una zona abitata».

Così invece, per fortuna, nessuna vittima. Ma chi sono i responsabili del disastro? E quanto ci ha rimesso l'Italia?

«Il progetto era stato coordinato dalla società "Arianespace", a maggioranza francese. E il lancio è avvenuto sotto l'egida del Cnes, l'agenzia spaziale del governo di Parigi. Quanto all'Italia, uno dei motori del razzo era di fabbricazione Fiat, e ha funzionato benissimo. La nostra partecipazione al progetto ammonta a 1460 miliardi, pari al 15% del costo complessivo. Ma include anche il prossimo lancio».

Nessun ripensamento, allora?

«Nel modo più assoluto. Un danno l'abbiamo avuto, ma ritirarci a questo punto sarebbe un suicidio. Significherebbe il nostro isolamento dall'Europa, una caduta verticale nella competitività delle nostre industrie».

E l'Agenzia Spaziale Italiana? Il suo predecessore aveva cercato di rilanciarla, dopo gli scandali e le polemiche degli anni scorsi. Lei come intende muoversi?

«L'Asi è uno dei punti di sutura più delicati tra imprese e stato, ma non è finora riuscita a trovare un corretto equilibrio di gestione. Io voglio riesaminare radicalmente tutta la nostra politica in questo settore».

Riccardo Chiaberge

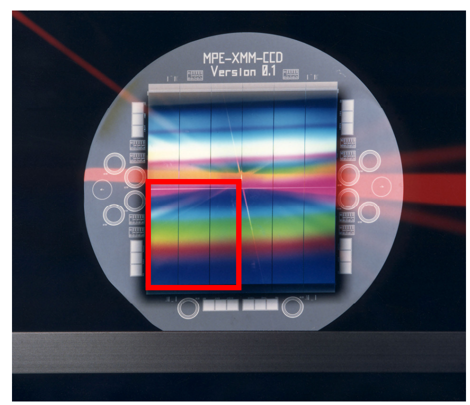
Integration of Ariane 504 for XMM launch


esa

The instrument team

Increasing pre-launch problems…

- GSE not ready (useless Quick-look analysis)
- Leakage in the MOS FM2 camera-head (=> swap in August 1999)
- Uncertainties about the Ariane V vibration figures
- *Millennium bug* => launch in December and parking in space
- Short-circuit in 1 of the 4 quadrants of the PN camera



The last straw:

anomaly - Thunderbird

Subject: anomaly
From: Martin C. Weisskopf <martin@smoker.msfc.nasa.gov>
Date: 9/14/1999 4:39 PM
To: rlaine@estec.esa.nl, fjansen@estsa2.estec.esa.nl, Brinkman - Bert <A.C.Brinkman@sron.nl>, mjt@leicester.ac.uk
Cc: Tananbaum - Harvey <ht@cfa.harvard.edu>, Mushotzky - Richard <mushotzky@lheavx.gsfc.nasa.gov>,

Dear colleague.

In the spirit of cooperation I am sending you this e-mail. We have an unexplained anomaly with a subset of the CCDs aboard Chandra - the front-illuminated devices. If you desire a briefing on this subject I would be able to discuss this with you at 8:00 am tomorrow (my time - Central time zone USA)) so that you might assess the implications for your mission. If so, please inform me of a number you can be reached at. Perhaps you might wish to arrange a conference call including other members of your team that you feel appropriate to this discussion. If so, please let me know and I will provide you with a list of numbers to include from this side.

We would appreciate your not discussing these matters with the press as we are in the process of trying to understand the problem.

Martin C. Weisskopf
Chandra Project Scientist

The soft-protons problem

PINE-MAILER

PINE 4.64 MESSAGE TEXT Folder: INBOX Message 96 of 96 46%

Mime-Version: 1.0
X-Sender: mjlt@ltsun0.star.le.ac.uk
Date: Mon, 8 Nov 1999 13:21:50 +0100
To: Gabriele Villa <gev@ifctr.mi.cnr.it>,
Reppin Claus <clr@mpehp1.mpe-garching.mpg.de>,
Philippe ferrando <pferrando@cea.fr>,
Turner Martin <mjlt@star.le.ac.uk>
From: M Turner <mjlt@star.le.ac.uk>
Subject: EPIC and Protons

Dear Colleagues,

This is to update you on the EPIC proton saga. Basically we are ok. I will detail the reasons and history below.

At the FAR it became clear to me that there was a significant risk to EPIC MOS from solar flare protons. It was already determined that the RGS was ok, and that the PN is not sensitive to soft protons (caveat-dmage to the implant by soft protons TBD). The quoted solar flare fluence was dangerously close to giving EPIC MOS about 3 months life. Since then I have been carefully over the figures, and conducted a battle with ESTEC over their bland assumption that everything was ok. I have now checked all the figures, and the bottom line is that with conservative assumptions and judicious use of the closed positon we can guarantee 5 years for epic mos at the cost of an average 10% loss of observation time.

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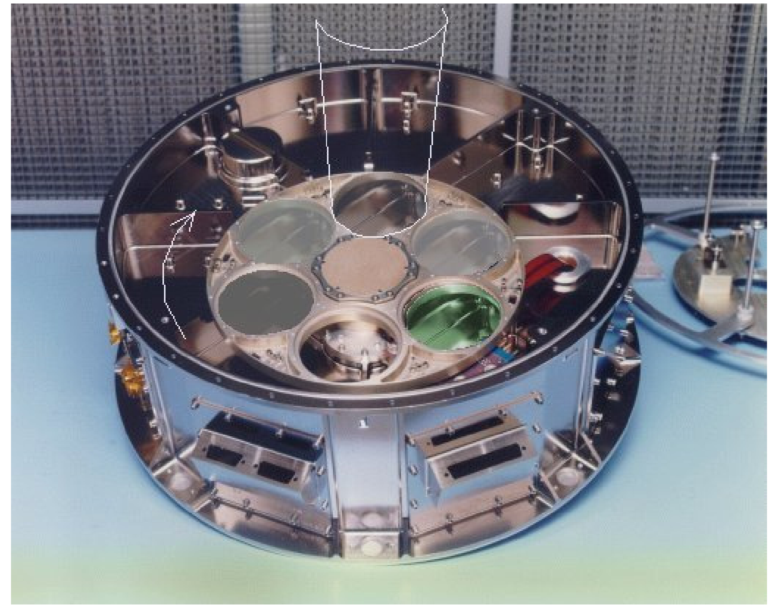
O OTHER CMDS | > ViewAttch | N NextMsg | Spc NextPage | U Undelete | F Forward

Proposed solution



The formula determining the actual instrument lifetime considering both the soft-solar flare protons and the 'regular' mission dose is :

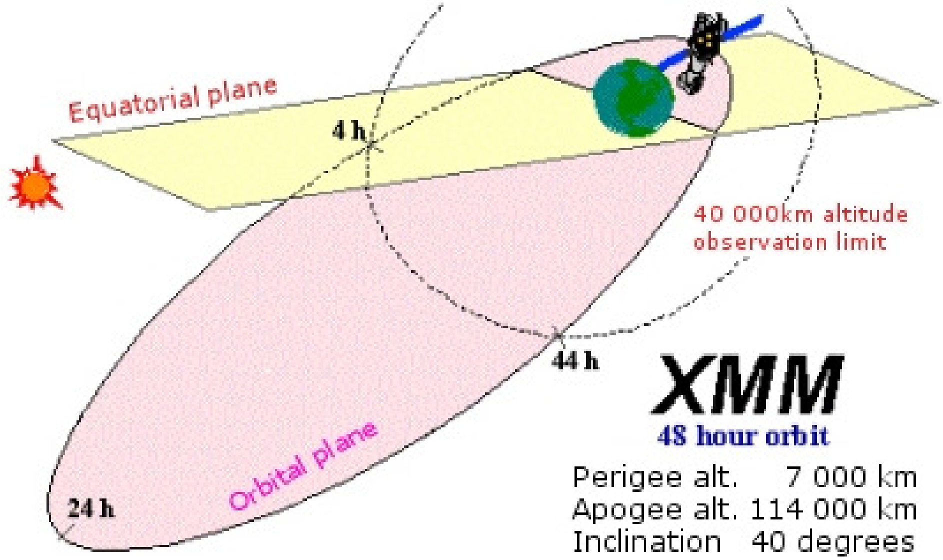
$$Lifetime = 10yrs \frac{1}{1+\frac{Factual}{10^{6}\, p+/cm**2}}$$

Based on all this, we agree that EPIC-MOS can safely be launched provided that the filter wheel be closed for ALL major solar flares (actual level TBD).

Fred Jansen
XMM Project Scientist

Martin Turner
EPIC PI

10 December 1999: a perfect launch!



The door opening
ESOC – 11/1/2000

PINE-MAILER

ALPINE 2.00 MESSAGE TEXT Message 13 of 20 73%

From: Nicola La Palombara <nicola@ifctr.mi.cnr.it>
To: Gabriele Villa <gev@ifctr.mi.cnr.it>, Massimo Conte <conte@ifctr.mi.cnr.it>,
Silvano Molendi <silvano@ifctr.mi.cnr.it>,
Simona Ghizzardi <simona@ifctr.mi.cnr.it>,
Stefano Vercellone <stefano@ifctr.mi.cnr.it>,
Massimo Trifoglio <trifoglio@tesre.bo.cnr.it>,
Fulvio Gianotti <gianotti@tesre.bo.cnr.it>,
Carlo Musso <musso@asi.it>,
dicocco@tesre.bo.cnr.it
Subject: Ci siamo!

EPICi colleghi,

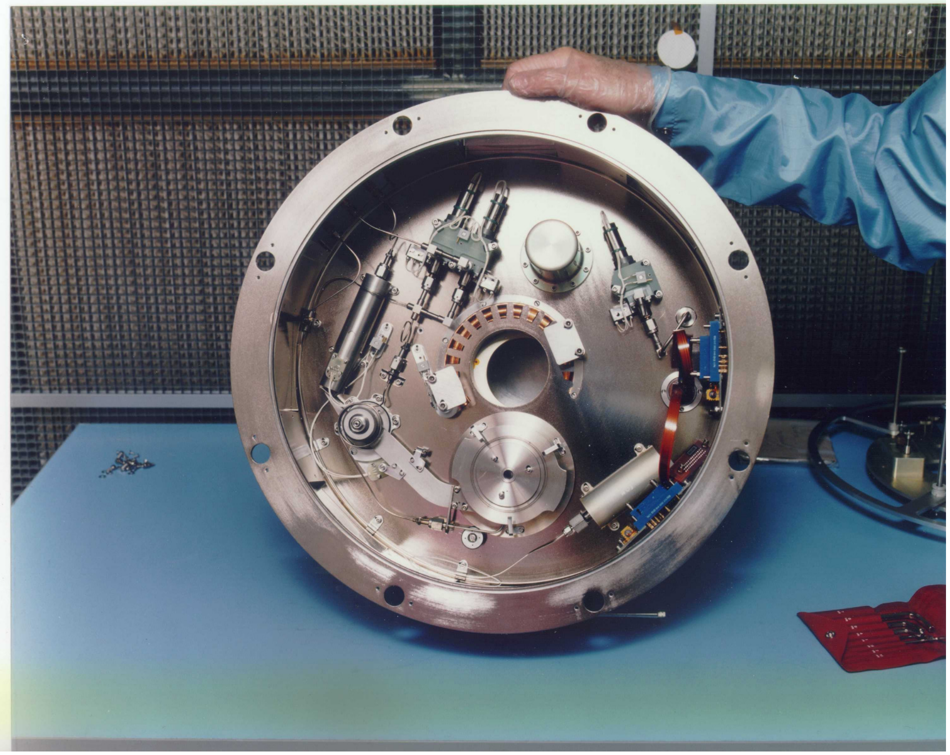
tra mezz'ora (17.00) inizieranno le operazioni per l'apertura delle Door.
Si partira' con il MOS1 e, poi, ad intervalli di circa 1h 30m, si passera'
al PN ed al MOS2. Incrociate le dita, fate tutti gli scongiuri del caso
(presentabili e non...) e speriamo in bene.

Per il momento e' tutto: non ci resta che aspettare...

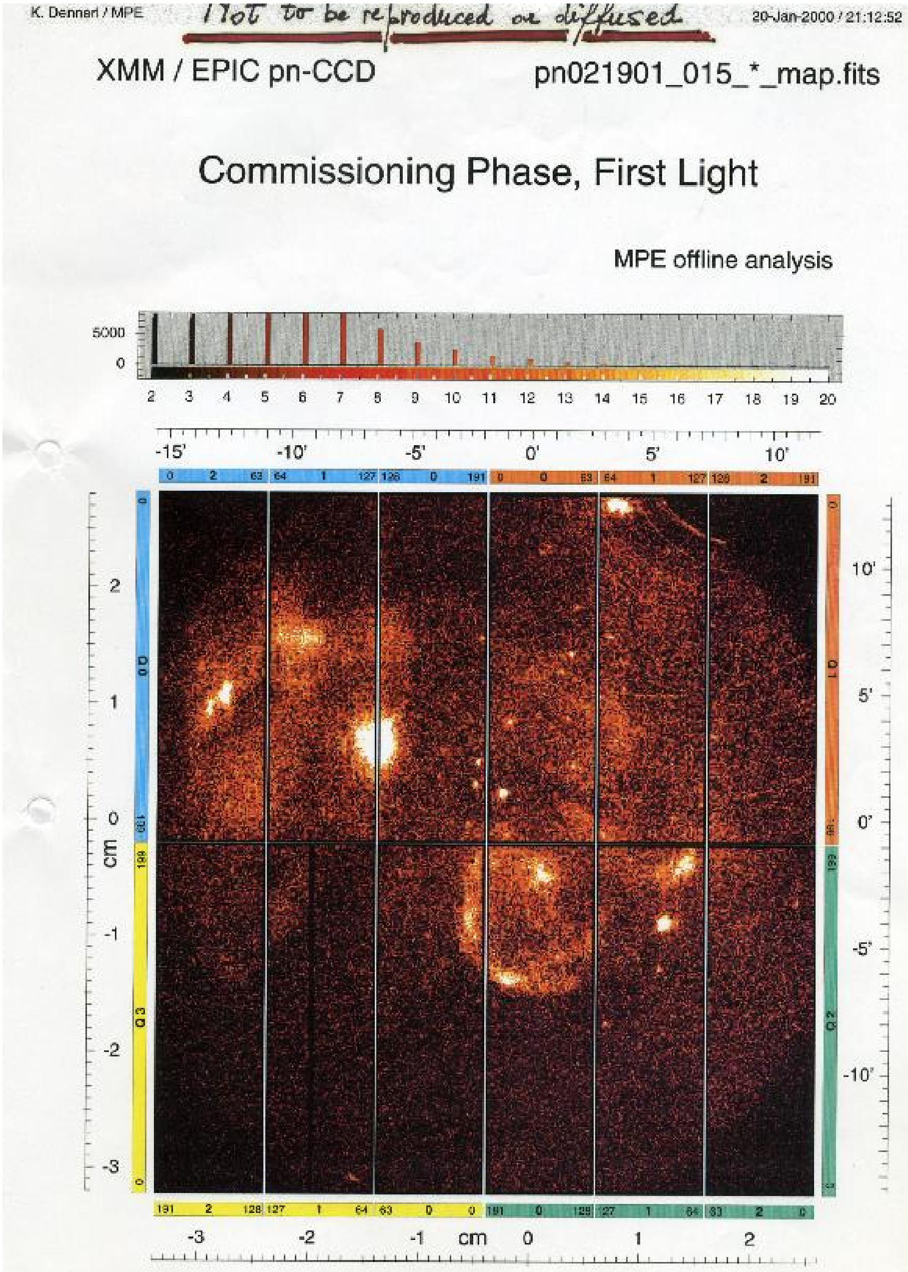
Ciao

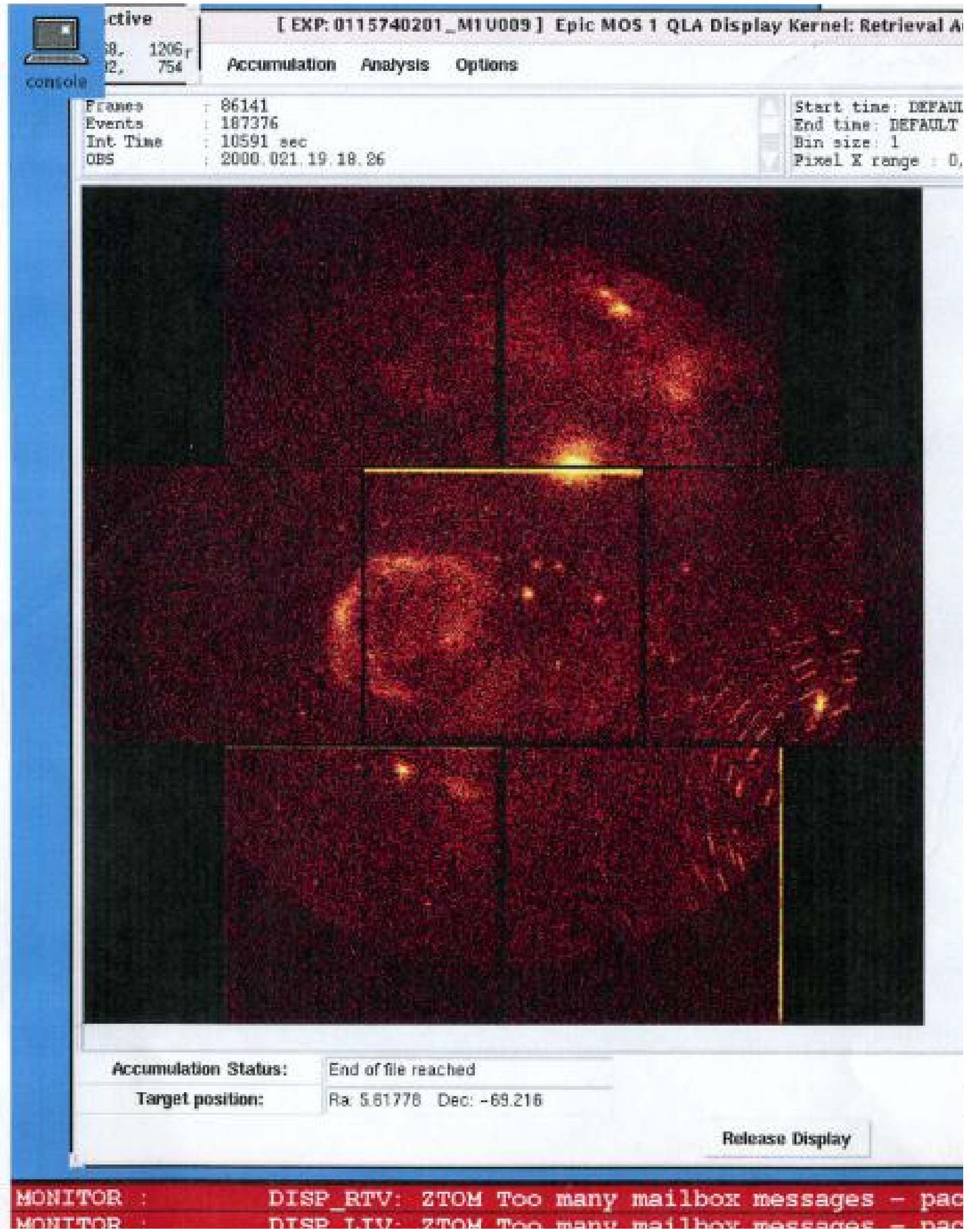
Nicola

? Help < MsgInd P PrevMsg - Prev D Delete R Reply
O OTHER > ViewAt N NextMsg Spc Next U Undele F Forward



The first light – 20 January 2000





Commissioning Phase (Jan-Mar 2000): main results

- **b) Instrument Commissioning**
  - Switch-on OK
  - Functional check-out OK
  - Opening of internal doors OK
  - Decontamination activities:
    - not required for CP (to be executed end of CP)
  - Filter integrity check
    - wrong pointing
    - MOS noise high, p-n offset
    - Used filters do not show any evident problem
    - OM filter check performed with ENG4 instead that imaging
  - CCD functional check
    - on ground short of p-n CCD1 Q2 have disappeared
    - noise on some MOS CCD
    - Failure in driving electronic for RGS2 CCD4
    - OM detector OK
  - Functional verification on sources and cal source
    - EPIC p-n Modes
      - All modes exercised
      - Modified TC sequences
      - poor MIP rejection
      - Offset calculation not optimal
      - Too high TM rate
    - EPIC MOS Modes
      - All Modes exercised
      - TC sequences optimized
      - Small window & timing out of target
      - MOS2 cal source too strong
      - test disrupted by TC's with zero's

- **d) S/C performance (mainly pointing)**
  - Excellent pointing stability when stars are not lost from Star Tracker
  - limited experience on thermo-elastic distortion due to rather constant SAA
  - Start tracker offset correction as from yesterday night
  - preliminary instrument boresite in line with ground mesurements
- **e) Effects of Radiation environment**
  - In general underestimated on all instruments
  - p-n on board MIP rejection insufficient
  - OM memory SEU and DEU
  - high number of cosmic rays has required new thresholds setting on RGS
  - residual events after pattern recognition on MOS higher
  - noise problem on MOS CCD's ?
  - RAD MON correlation with particle flux through mirrors somewhat ambiguous
  - RAD MOM warning thresholds lowered by a factor 10
  - No significant degradation of RGS and EPIC CCDs

- Instruments (general): the main finding from all instrument teams is that the particle background rate is a factor 2 to 3 higher than expected. This questions the validity of pre-launch predictions. Another important finding is that there are no signs of a significant degradation of the CCD CTE beyond specifications for any of the instruments so far. However, the relatively short period of time over which the CTE was measured restricts the accuracy of the CTE degradation evaluation. It is thus important to continue monitoring the CTE degradation carefully. Finally, several instrument anomalies have been uncovered which need to be properly documented, formally recorded and put under configuration control in the NCR database. Instrument teams are requested to raise NCR (Non Conformance Report) as appropriate.

Commissioning Phase: SW debugging

NCR	Title	System	Status
1	Corrupted VC7 data	RM	Closed: use as is
3	Filter wheel movement HK telemetry delayed	MOS	Closed (Fabio e-mail on 2000/05/10), EMDH SW I.I delivered on July 3rd 2001
5	Inconsistent imaging correction	PN	Closed
6	Time Info first word set to 0xFFFF	PN	Closed
7	Command rejected	PN	Closed (Fabio e-mail on 2000/05/10)
9	Command rejected	MOS	Closed (Fabio e-mail on 2000/05/10) , EMDH SW I.I delivered on July 3rd 2001
11	Insufficient MIP reduction	PN	Closed
12	Low energy noise due to wrong offset	PN	Closed
13	FIFO overflow causes data corruption	MOS	Closed, EMDH SW I.I delivered on July 3rd 2001
14	TM Headers and trailers do no match	MOS	Closed (Fabio e-mail on 2000/05/10), EMDH SW I.I delivered on July 3rd 2001
15	Bright pixel tables not operating correctly	MOS	Closed (Paul e-mail on 2000/04/07)
16	EPIC Radiation Monitor has a processor reset occasionally	RM	Closed: use as is
17	Noise in MOS cameras	MOS	Closed: use as is
18	MOS Timing mode not working correctly	MOS	Closed (Fabio e-mail on 2000/05/10)
31	MOS Timing mode: cosmic ray rejection incorrect	MOS	Closed (Philippe e-mail on 2000/04/27)
38	XMM TM outage and Instrument Safety	MOS&PN	Closed
39	EPEA quadrants do not always respond to TCs when in observation mode	PN	Closed: use as is
40	Discarded lines packets are not correctly segmented.	PN	Closed: will be fixed on-ground (XSCX v12)
42	MOS 2 buffer manager / counting mode failure	MOS	Open (new EMDH SW under test)
43	MOS 2 timing mode exposure with regular noise pattern	MOS	Open
75	Failure to reset EPEA on-board time counter for Q2	PN	Open
83	Operating heater autonomous switch-off	PN	Open
87	QO stopped working (wrong CKS)	PN	Open

- closure of open NCRs
- request for SW improvements

esa

XMM-Newton SOC

Engineering Change Request # 3

System	Subsystem	Status
EPIC-PN		Closed

Category	Manufacturer	Originator Reference
MAJOR	SOC	n.a.

Title

TC watchdog function to close the FW

Description

R1 S/W shall monitor the arrival of TCs to the instrument. In case TCs are not received for a period longer than a programmable number of seconds, the instrument shall close the Filter Wheel ,unless the PN mode is already Safe.

R2 A new TC (5.3) shall be implemented in order to activate/ deactivate the above function, furthermore the timeout shall be programmable to satisfy the various mission constraints.

R3 After the bootstrap the function shall be disabled.

R4 The following new information shall be added in the main H/K TLM Packet using spare fields:
The content of the parameter included in the TC (see above) used to enable/disable the function (0 after bootstrap)
The current value of the internal counter used to implement the function

R5 In case of timeout expiration after the instrument safing the function will be automatically disabled

R6 In case the timeout expires but the instrument is already in a valid Safe Stand-by mode no action will be undertaken.

R7 It shall be possible to send the Test Command in all modes.

esa

XMM-Newton SOC

Engineering Change Request # 7

System	Subsystem	Status
EPIC-MOS	EMCR-EMDH	Open

Category	Manufacturer	Originator Reference
MINOR	n.a.	n.a.

Title

Increase of number of bad pixel in the uploaded tables

Description

The current maximum number of bad pixel storable on board by the EMDH is 50

pixels per CCD. With the latest version (v5) some CCDs are getting close to

this limit, for instance 48 for MOS2 CCD1 already !
Looking ahead at the potential future pixel "candidates" to be masked from the SOC MOS bad pixel monitoring, would lead to go over the 50 limit for a few CCDs in a few months.

Justification for the change

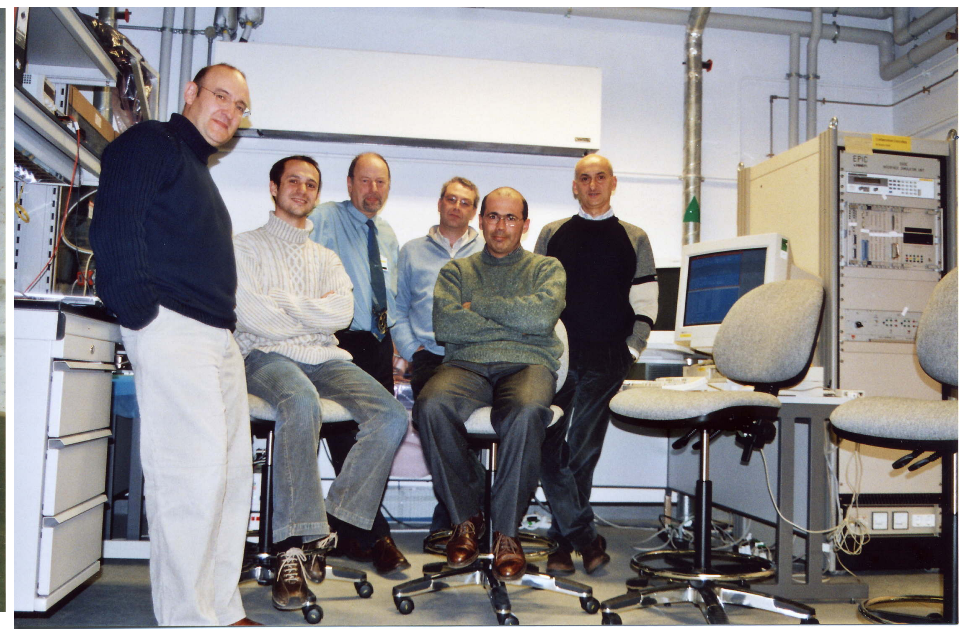
To mask hot pixels on board, to avoid loading the MOS TM bandwidth by flase events and decrease the size of the event files.

Impact

increasing the the number of bad pixels to be masked to slow the on-board processing time of the EMDH (to be investigated)

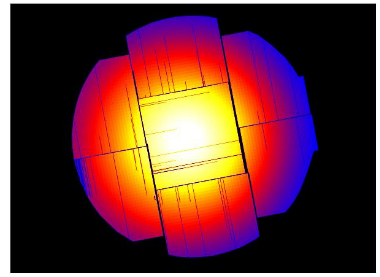
SW changes up to 2004

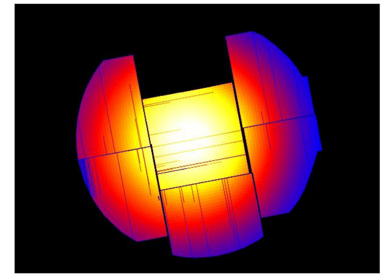
Demanding test-sessions and calibration meetings



Major events during the routine phase

• Micrometeorite impacts: Revolutions 107 (MOS2), 158 (PN), 325 (MOS1), 961 (loss of CCD6 MOS1)





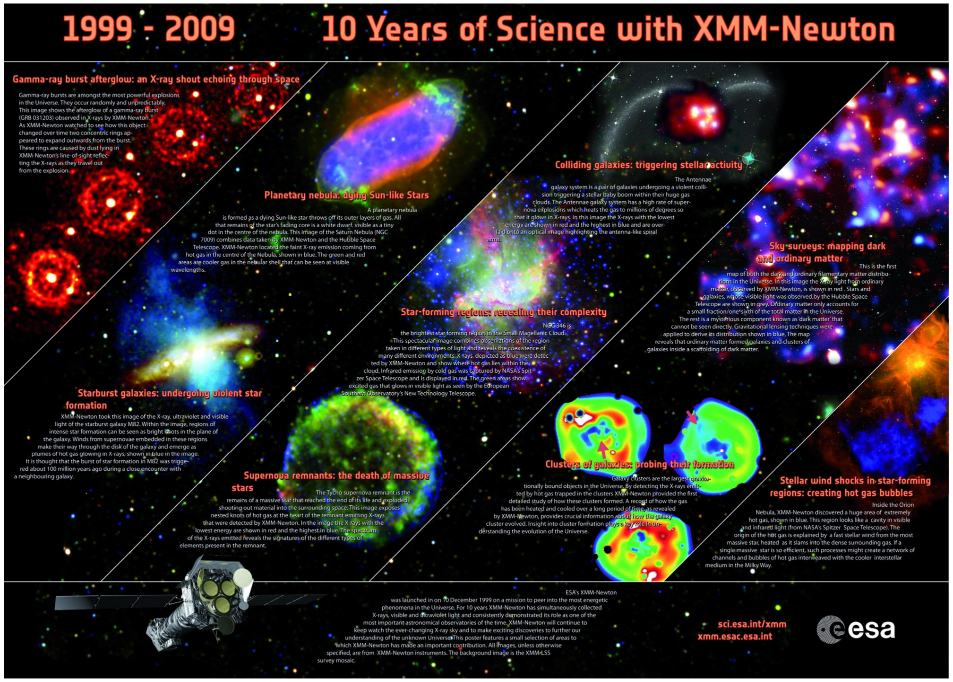
Science Programme Review Team Report 2006:

> The SPRT recommends, having considered the financial position of the Programme in detail, that before launching a Call for Mission Proposals, 200 million€, as a minimum, be taken out of the present suite of commitments.

• Joint management of XMM-Newton and Integral since 2008 to save money => various impacts and several risks

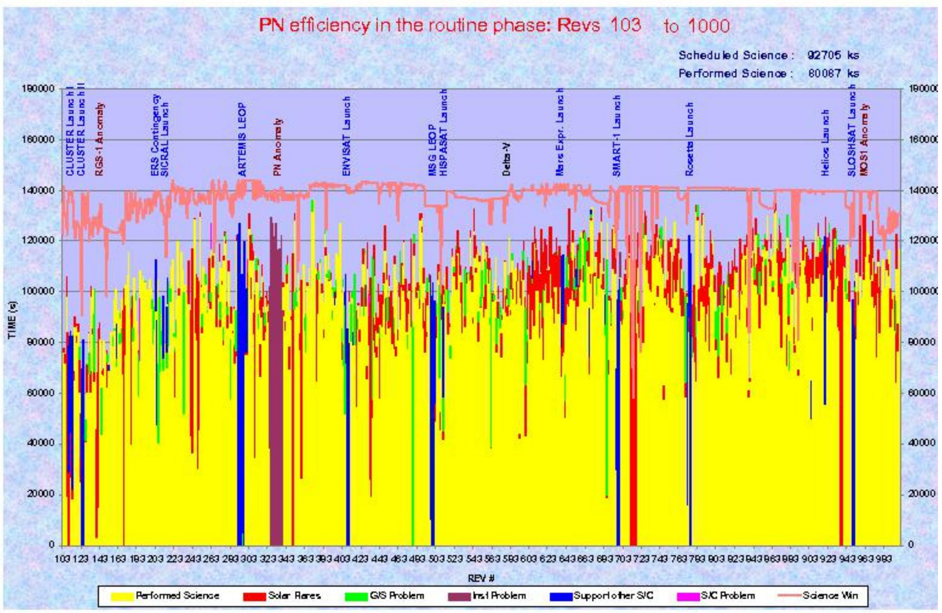
• 18 October 2008: contact lost from ground, due to a failure in the on-board Radio Frequency (RF) switch => communication re-established after 4 days

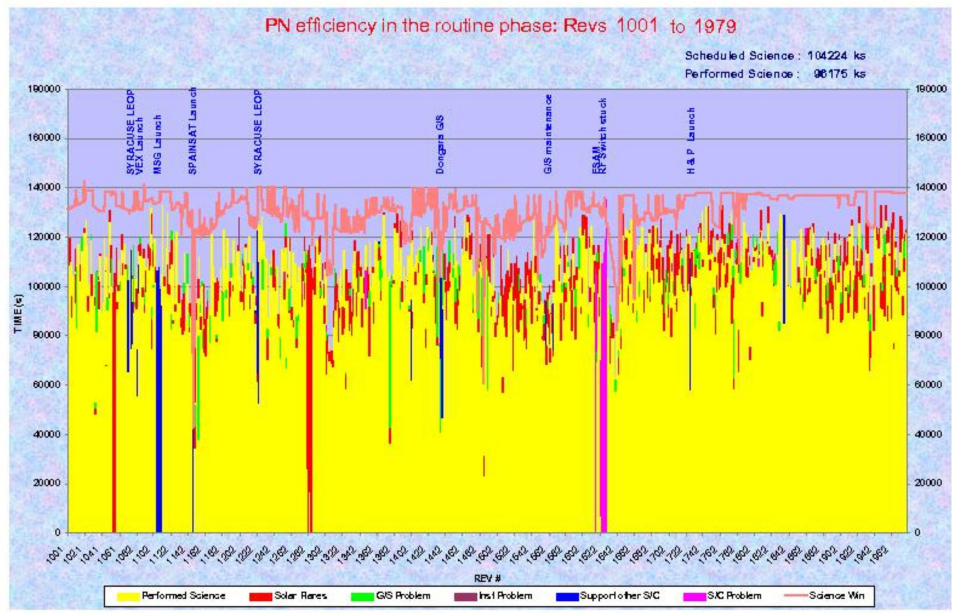
ESAC, 10 December 2009: XMM 10th Anniversary



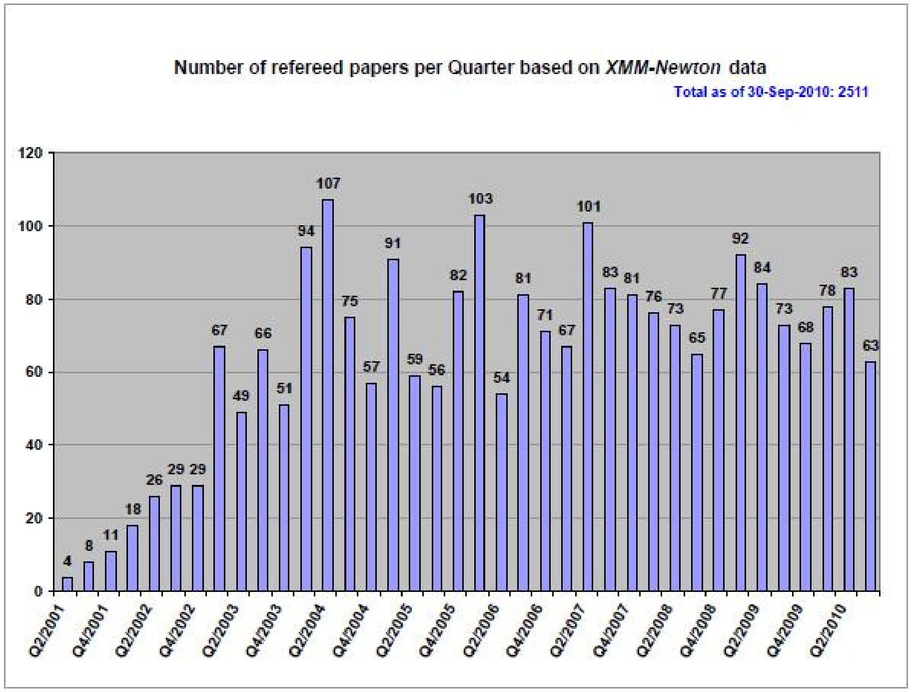
Data Processing and Distribution status as of 30-Sep-2010

Total number of Planned Observations in Routine Phase (revs 0103-1979)	8357
Total number of Performed Observations in Routine Phase	7974
Total number of Observation Data Files generated	7829
Total number of Pipeline/Data Products sets generated and distributed	7749





Science with XMM-Newton



- AO10: 491 proposals
90 Ms of required science time
=> over-subscription factor = 6.2

- At IASF-Milano:
12 degree thesis
9 PhD thesis

Vol 462|24/31 December 2009|doi:10.1038/nature08690 nature

REVIEWS

The first decade of science with Chandra and XMM-Newton

Maria Santos-Lleo[1], Norbert Schartel[1], Harvey Tananbaum[2], Wallace Tucker[2] & Martin C. Weisskopf[3]

NASA's Chandra X-ray Observatory and the ESA's X-ray Multi-Mirror Mission (XMM-Newton) made their first observations ten years ago. The complementary capabilities of these observatories allow us to make high-resolution images and precisely measure the energy of cosmic X-rays. Less than 50 years after the first detection of an extrasolar X-ray source, these observatories have achieved an increase in sensitivity comparable to going from naked-eye observations to the most powerful optical telescopes over the past 400 years. We highlight some of the many discoveries made by Chandra and XMM-Newton that have transformed twenty-first century astronomy.

Typically, cosmic X-rays are produced in extreme conditions— from intense gravitational and magnetic fields around neutron stars and black holes, to intergalactic shocks in clusters of galaxies. Chandra[1] and XMM-Newton[2] have probed the space-time geometry around black holes, unveiled the importance of accreting supermassive black holes in the evolution of the most massive galaxies, demonstrated in a unique manner that dark matter exists, and confirmed the existence of dark energy. They have also tracked the production and dispersal of heavy elements by supernovae and measured the magnitude and rate of flaring of young Sun-like stars. Table 1 gives a subjective and by-no-means complete list of significant discoveries made using these observatories.

With an order-of-magnitude or more improvement in spectral and spatial resolution and sensitivity, Chandra and XMM-Newton have shed light on known problems, as well as opened new areas of research. These observatories have clarified the nature of X-ray radiation from comets[3], collected a wealth of data on the nature of X-ray emission from stars of all ages[4,5], and used spectra and images of supernova shock waves to confirm the basic gas dynamical model[6,7] of these objects. They have resolved into discrete point sources the diffuse emission from the plane of the Galaxy[8], as well as the diffuse extragalactic X-ray background[9]. They have discovered hundreds of supermassive black holes at the centres of galaxies and for many of those obtained high-resolution spectra that have

Table 1 | A sample of discoveries made using the Chandra and XMM-Newton observatories

Topic	Discovery
Comets	Established charge-exchange as mechanism for X-ray emission.
Individual stars	Measured densities, temperatures and composition of hot plasmas, testing models for stellar evolution, X-ray emission from stellar coronae, and stellar winds.
Star formation and star-forming regions	Discovered X-ray emission from gas accreting onto stellar surfaces and influenced by magnetic fields; detected giant flares from young stars, with implications for planet formation.
Supernovae	Established that Kepler's supernova was a thermonuclear event.
Supernova remnants (SNRs)	Discovered a central compact object in the Cas A SNR and traced the distribution of elements indicating turbulent mixing along with an aspherical explosion. Imaged forward and reverse shock waves in several SNR, with implications for the acceleration of cosmic rays.
Pulsar wind nebulae	Resolved jets and rings of relativistic particles produced by young neutron stars.
Black hole accretion processes	Provided evidence for rotation of space-time around black holes; measured the efficiency of the accretion process; and detected jets and winds produced by black holes.
Galactic Centre	Measured the flaring of central black hole and resolved the galactic ridge emission into individual sources.
Starburst galaxies	Discovered evidence for enrichment of the interstellar medium and the intergalactic medium by starbursts.
Supermassive black holes and active galactic nuclei (AGNs)	Resolved the X-ray background radiation into discrete sources, mostly supermassive black holes; traced the history of supermassive black hole growth over cosmic timescales.
Active galactic nuclei feedback in galaxies and clusters of galaxies	Discovered evidence for heating of hot gas in galaxies and clusters by outbursts produced by supermassive black holes, supporting the concept that supermassive black holes can regulate the growth of galaxies.
Dark matter	Determined the amount of dark matter in galaxy clusters and, by extension, the Universe; observed the separation of dark matter from normal matter in the Bullet Cluster, demonstrating that alternative theories of gravity are very unlikely to explain the evidence for dark matter.
Dark energy	Observed galaxy clusters to generate two independent measurements of the accelerated expansion of the Universe.

[1]XMM-Newton Science Operations Centre, European Space Agency, Villanueva de la Cañada, 28691 Madrid, Spain. [2]Chandra X-ray Center, Smithsonian Astrophysical Observatory, Cambridge, Massachusetts 02138, USA. [3]Space Science Office, NASA Marshall Space Flight Center, Huntsville, Alabama 35812, USA.

XMM current status

XMM-Newton Latest	
Revolution	2014
Refereed Papers	2584

• <u>All instrument units working on the primary redundancy</u>

Fuel	remaining Use per year Mileage left	76 kg 6 kg →2019
Solar array power	Maximum required Current margin Margin end of 2018	1350 W 550 W 350 W
Battery	According to UHB	15+ y

Remaining fuel	76. [kg]
Consumption last 12 month	5.1 [kg]
average fuel consumption (since 2003-03-01)	0.48 [kg/month]
residual lifetime in month	118 [-]
extrapolated milage	Sept 2019

M. Kirsch, XMM-Newton European Space Operations Center Page 4

• ASI funding of 240 k€ for the three-years period 2010-2012

• Further mission extension: "At their 130th meeting on 18/19 November 2010 ESA's Science Programme Committee approved an extension of XMM-Newton operations until **31 December 2012**. They also approved an indicative extension until **31 December 2014**, subject to a mid-term review in 2012 on the regular two-year cycle."

See you in 2014!