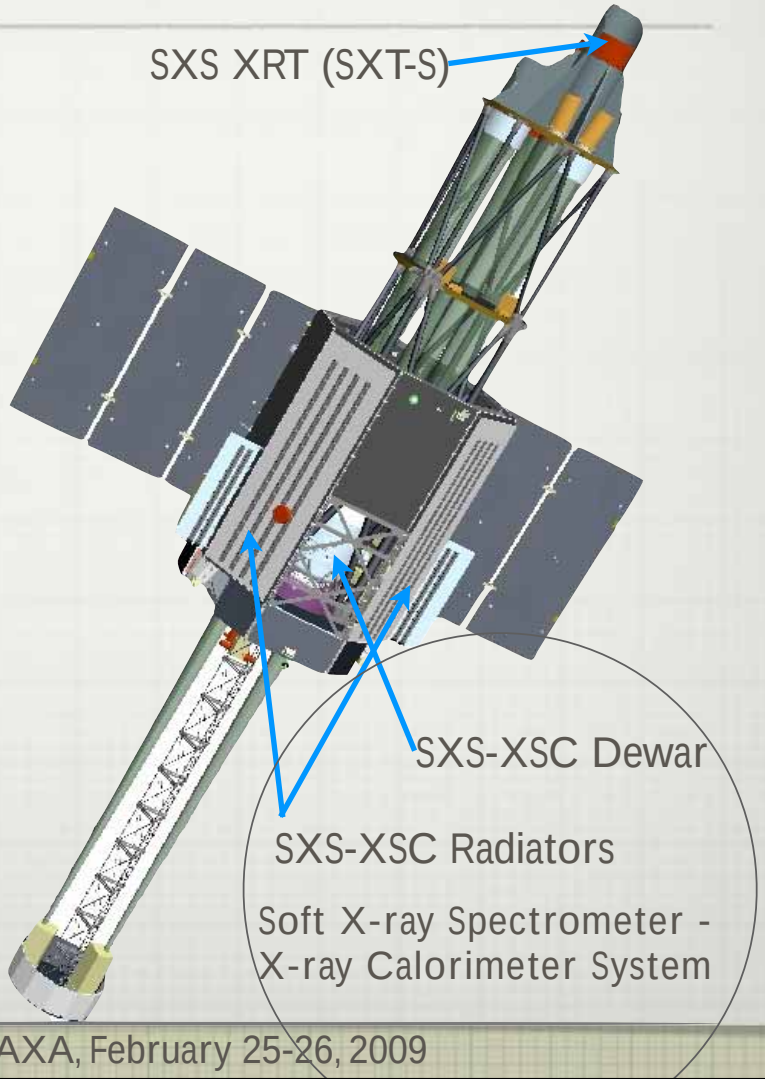
SXS (XCS)

K. Mitsuda for the SXS-XCS team

SXS

- **High resolution X-ray spectrometer using a microcalorimeter array**
- **High Energy resolution (FWHM<7eV) and modest imaging (6x6 or 8x8) capabilities**
- **Recovery of Suzaku XRS science with improved sensitivities - larger collecting area (& better energy resolution) - & improved reliability**



Astro-H SXS-XCS team

JAXA	High Energy Astrophy. , ISAS	K. Mitsuda, N.Y.Yamasaki, K. Shinozaki, Y.Takei, M.Tsujimoto,T. Dotani
	Ir/Submm Astrophy., ISAS	T. Nakagwa
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	SMILES group, ISAS	K. Kikuchi
Tokyo Metro. Univ.	Grad. School of Science	T. Ohashi,Y.Ishisaki,Y.Ezoe
Kanazawa Univ.	Grad. School of Natural Sci. & Tech.	R. Fujimoto, K. Sato
Riken	Cosmic Radiation Laboratory	K.Makishima,T.Mihara, M.Kawaharada, T.Tamagawa
Rikkyo Univ.	Grad. School of Science	S. Kitamoto
Saitama Univ.	Grad. School of Sci. & Eng.	M.Tashiro
National Inst. Material Science	Innovative Materials Eng. Lab.	T. Numazawa, K.Kamiya
Tsukuba Univ.	Grad. School of Systems & Info. Eng.	M. Murakami
(members are not complete..)		
NASA/Goddard Space Flight Center (GSFC)		R, Kelley, C.A. Kilbourne, F.S. Porter, P. Shirron, M. DiPirro
University of Wisconsin		D. McCammon
Yale University		A.E. Szymkowiak
NASA/AMES		A. Kashani
Netherlands Institute for Space Research (SRON)		J.-W. den Herder, C. P. de Vries, E. Costantini H.Aarts
Geneva University		S. Paltani, M. Pohl, F.Wildi

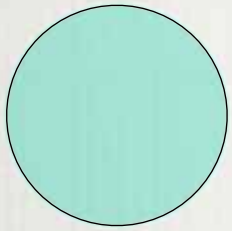
Participation to be decided.

1st Astro-H SWG meeting, ISAS/JAXA, February 25-26, 2009

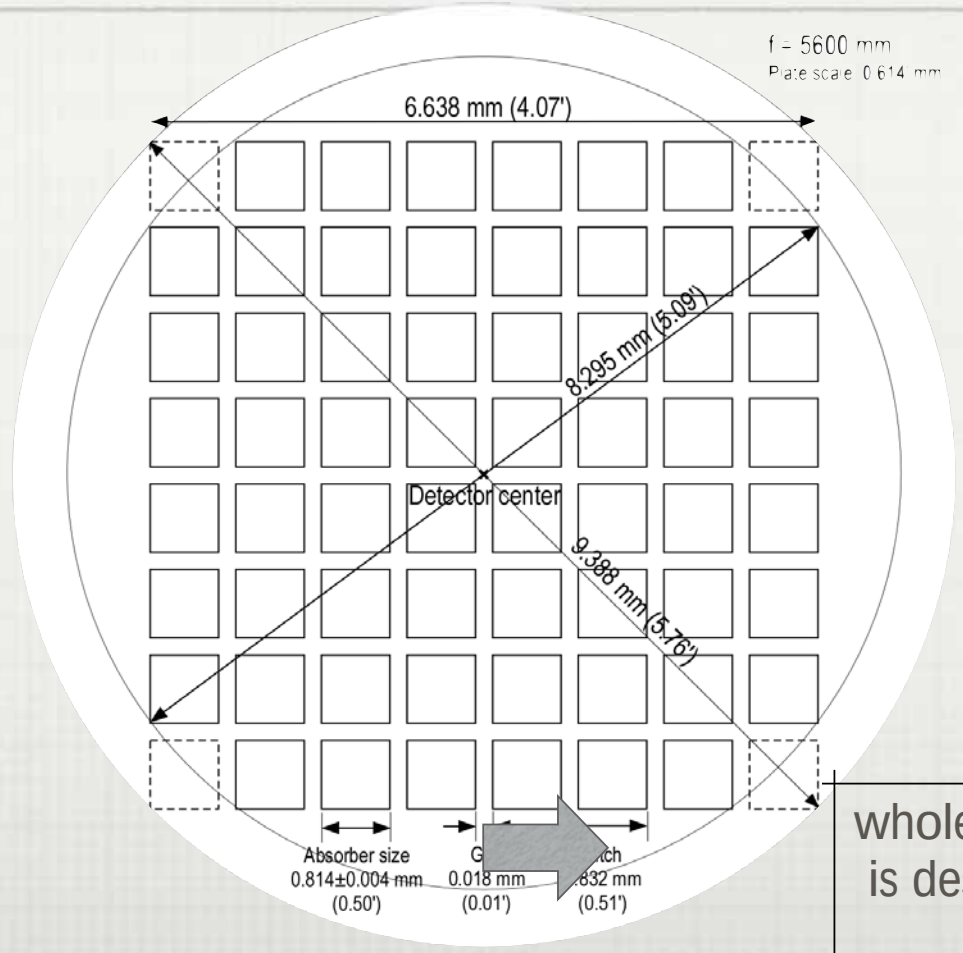
SXS baseline and goal designs

	Baseline	Goal	XRS
Pixel size	814μm□		624μm□
Array format	6 x 6 (32 pixel readout)	8 x 8 (64 pixel readout)	6 x 6 (32 pixel readout)
(FOV)	3.0' x 3.0'	4.1' x 4.1'	2.9' x 2.9'
Effective area@1keV	190 cm^2		136 cm^2
Effective area@7keV	225 cm^2		132 cm^2
Energy Resolution	7 eV	4 eV	(12 eV) 7 eV
Lifetime	3 years	> 5 years	(>2 years)

FOV



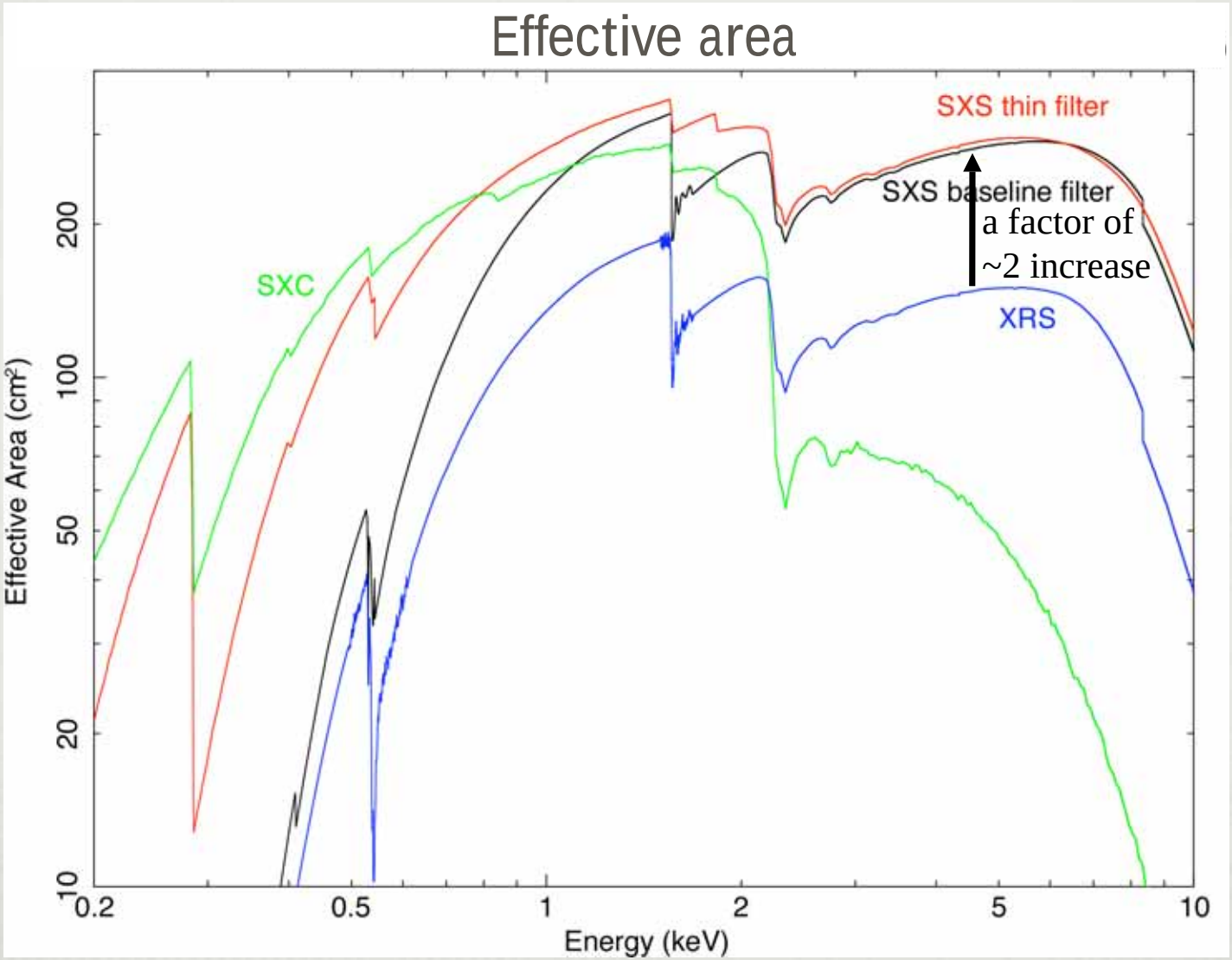
Telescope HPD ~ 1.3’



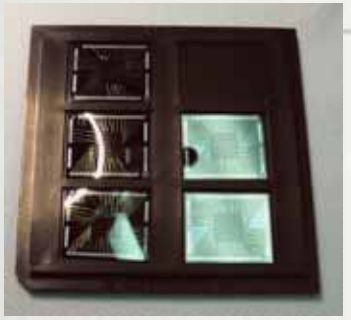
+ 4 cal pixels

whole the SXS system is designed to handle 8x8 array

Effective area



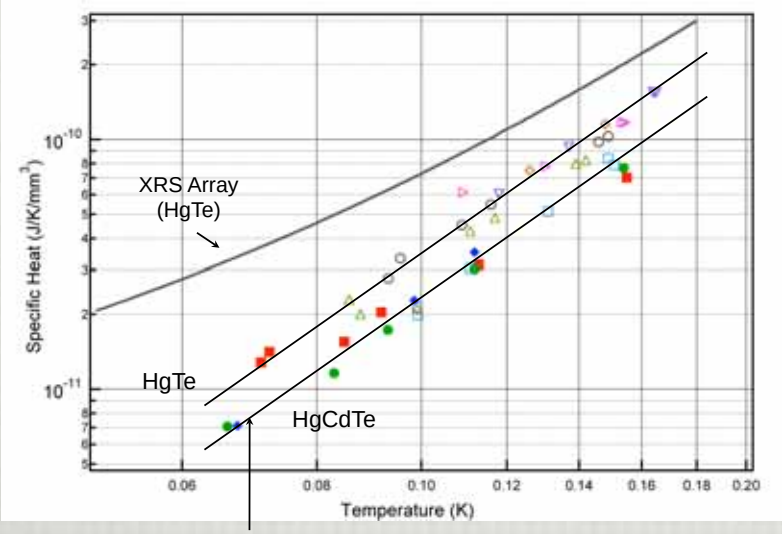
Detection: Detector



Existing XRS spare arrays
6x6, 830 μm pitch

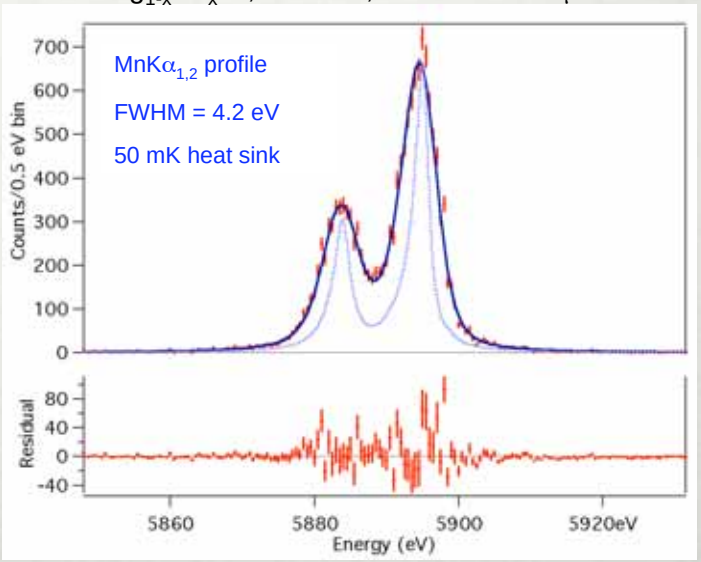
Improvement in energy resolution at laboratory level

Achieved Lower Heat Capacity

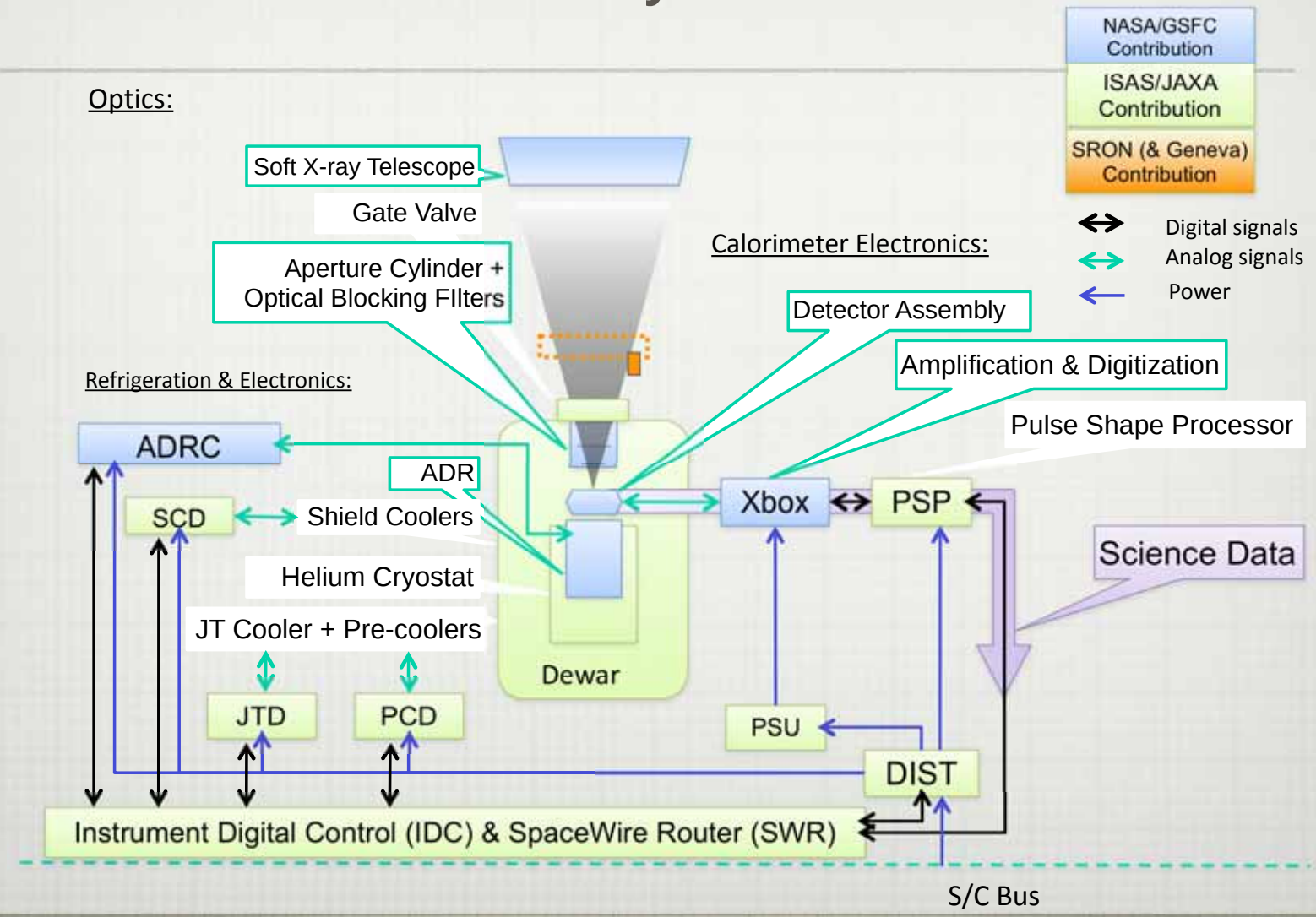


4 times lower than XRS.

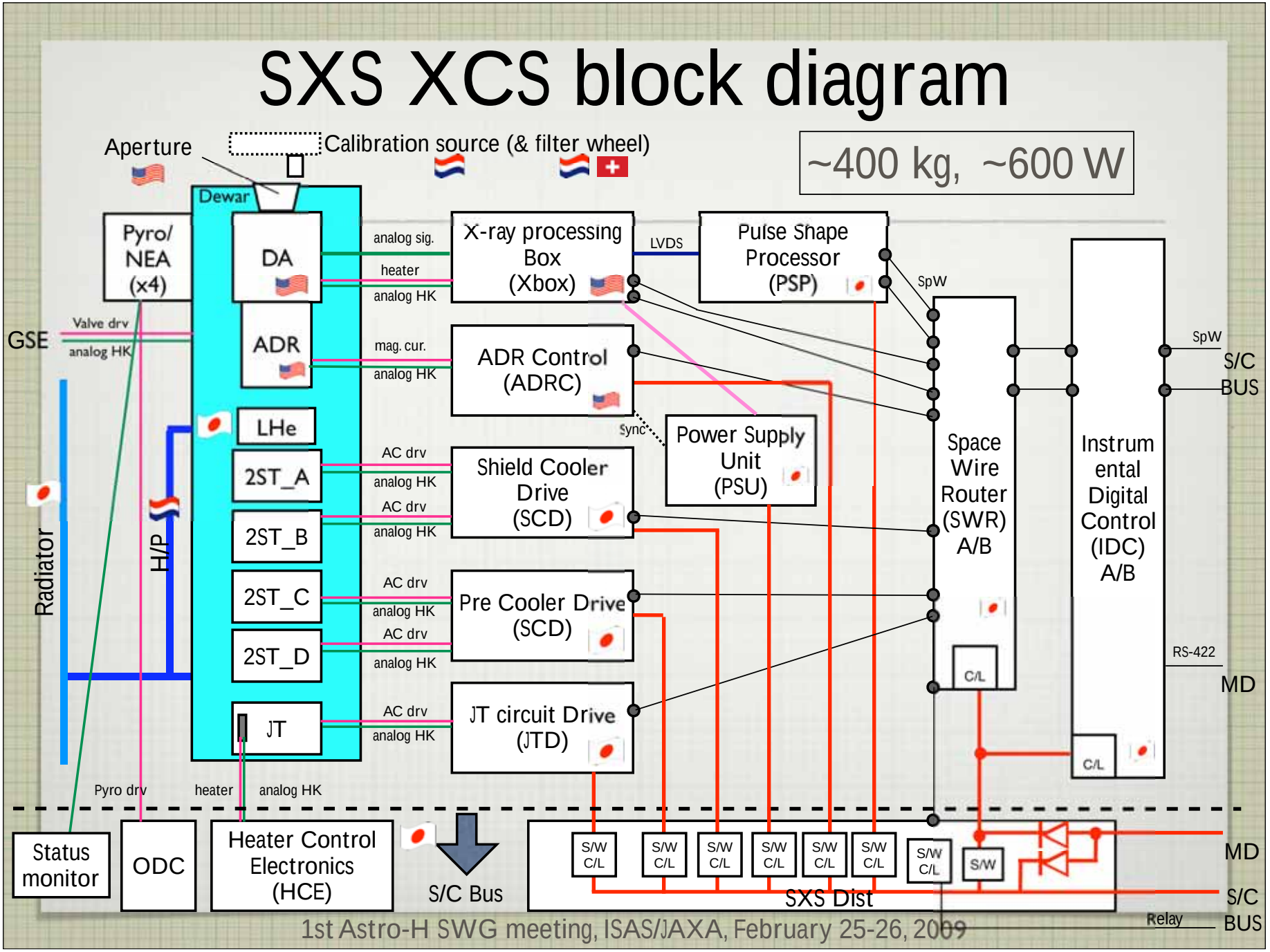
$Hg_{1-x}Cd_xTe$, x = 0.16, 790 × 790 × 6 μm



SXS system


NASA/GSFC Contribution
ISAS/JAXA Contribution
SRON (& Geneva) Contribution
Digital signals
Analog signals
Power
Optics:
Soft X-ray Telescope
Gate Valve
Aperture Cylinder + Optical Blocking FIlters
Calorimeter Electronics:
Detector Assembly
Amplification & Digitization
Pulse Shape Processor
Refrigeration & Electronics:
ADRC
ADR
SCD
Shield Coolers
Helium Cryostat
JT Cooler + Pre-coolers
Dewar
Xbox
PSP
Science Data
JTD
PCD
PSU
DIST
Instrument Digital Control (IDC) & SpaceWire Router (SWR)
S/C Bus

SXS XCS block diagram



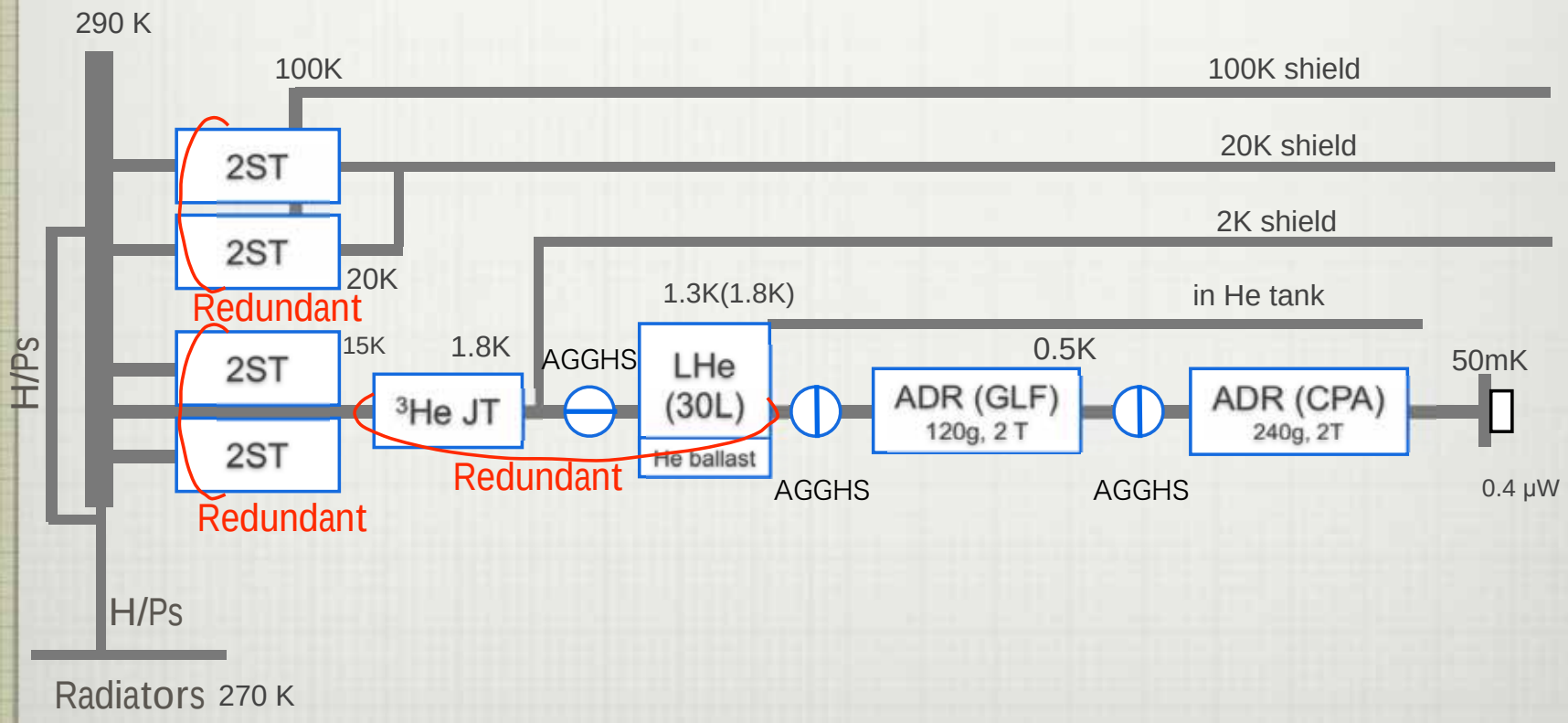
Requirements on cooling system

	Requirement	Goal
Temperature @detector interface	47 mK	47 mK
Stability	1μK rms in 20s -10mim	0.5 μK rms
Lifetime	3 years	5 years
Heat load from detector (FEA)	0.4μW @47mK	0.6μW @47mK
	0.3mW @1.3K (He)*	
	15mW @32K (IVCS)	

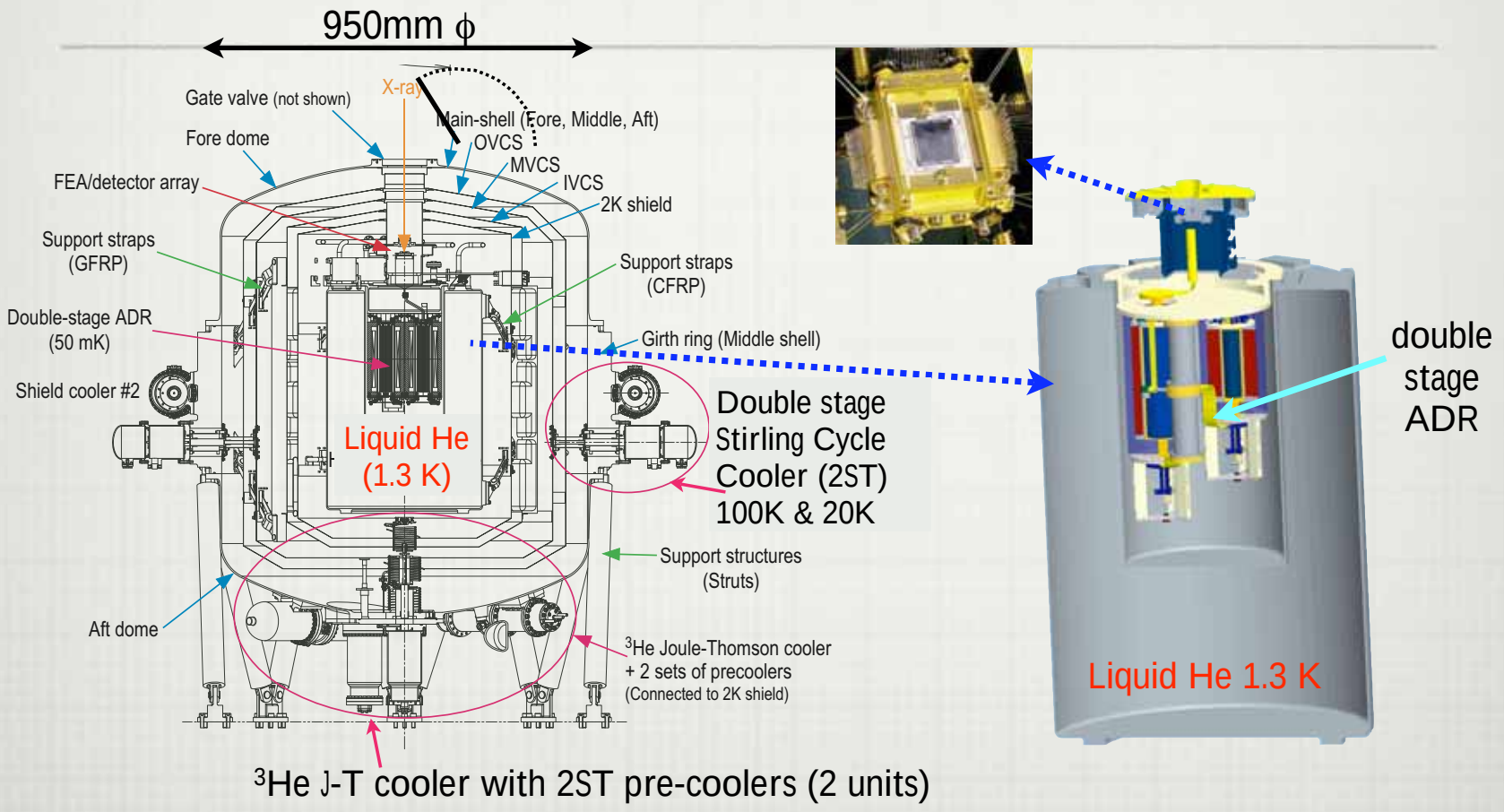
FEA = detector Front-End Assembly

* Dependent on IVCS temperature

Cooling system: Cooling chain



Cooling system: Dewar



Dewar~ 250kg, Cooler drive electronics: 50kg

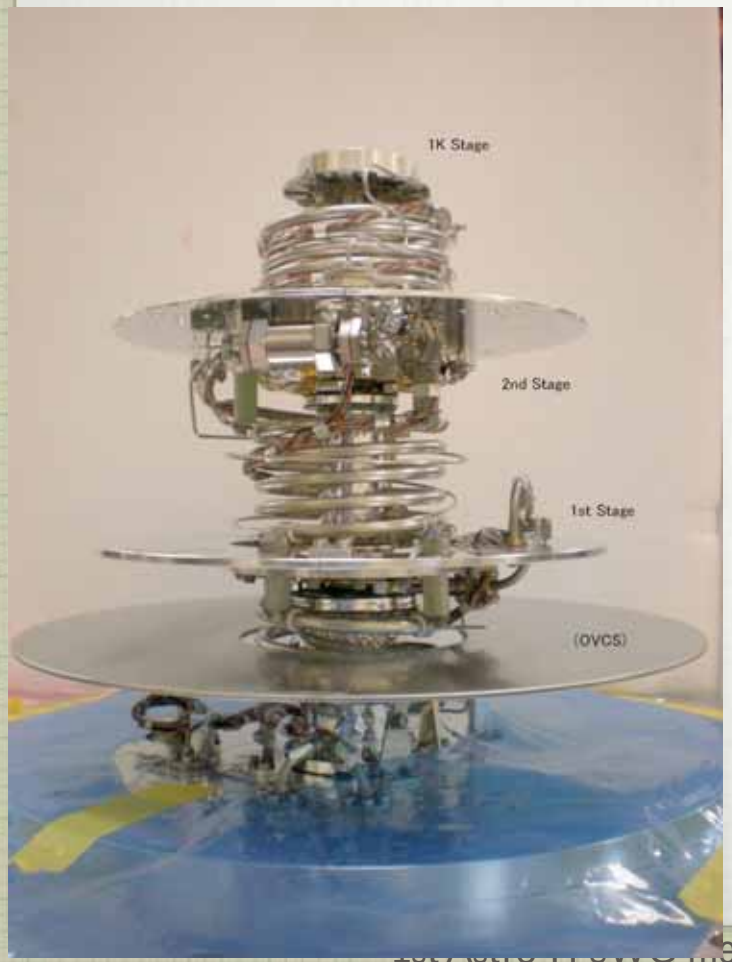
Cooling system: LHe expected life

	Case	Cooler Power (W)	Heat load to He tank (mW)	Lifetime of LHe (years)
1	Normal	Shield cooler 50x2 Precooler 50x2 JT 90	0.53 (0.3 from FEA)	5.7^{+}
2	Failure of one shield cooler	Shield cooler 90x1 Precooler 50x2 JT 90	0.83 (0.6 from FEA)	3.6^{+}
3	Failure of JT compressor	Shield cooler 90x2 Precooler 50x2 JT 0	0.96 (0.1 from FEA)	3.1
4	Failure of one JT precooler	Shield cooler 90x2 Precooler 90x1 JT 0	0.99 (0.1 from FEA)	3.0

+ Observation continues as far as ^{3}He JT cooler works

Astro-H EM ^{3}He JT cooler

design lifetime ≥ 5years



Lifetime test started on February 23 with the EM 2ST precooler at JAXA Tsukuba campus.

Contribution from Europe

- **Loop heat pipes: seem to be mandatory for ground operations**
  - **A sample heat pipe will be tested by the JAXA thermal engineering group with SRON's support.**
- **External calibration source(s) which can be turned on/off in orbit: mandatory for in-orbit calibrations**

- **Filter wheel: Low energy cut and/or neutral density filters for bright (~>50 mCrab sources) sources & radio active sources for backup**

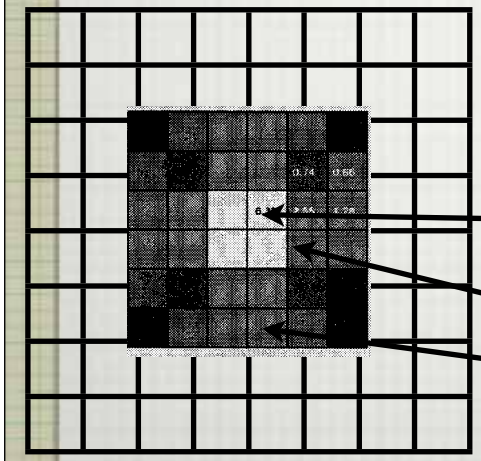
to be decided.

SXS SWG related issues

- **Filter wheel**
  - **Necessity of filter wheel**
  - **Number and kinds of filters**
    - **100 μm Be**
    - **10 % Neutral density**
    - **..**

Filter wheel

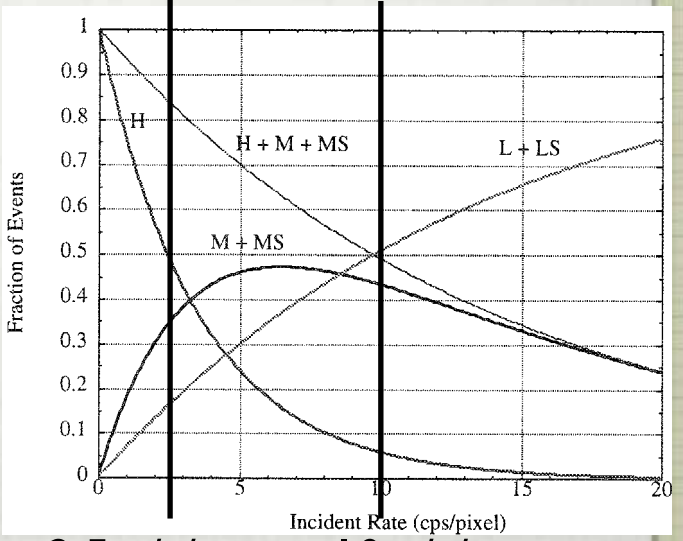
- Necessary to observer bright (~> 50 mCrab) sources efficiently.
- Estimations for sources with different spectra: by Kaastra.



Crab count rate

Pixel	Raw	300μm Be
whole array	2260	765
Center	176	59
2nd fm cent	70	24
3rd fm cent	35	12

Hi res > 50% Hi+M res > 50%



*Count distribution was scaled from Suzaku XRS/XRT

2.5 c/s/pix 10 c/s/pix

Reliability

- Root causes of the problem in Suzaku XRS
  - Inadequate communication of requirements (in particular early phase of development) and inadequate insight between organizations
- Better communications inside team
  - Sharing detailed information, frequent communication
- Participation in higher level reviews
  - Joint Systems Engineering Team
- More clear-cut boundary between J-US
- Redundant system