CAL/OPS meetings

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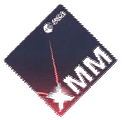
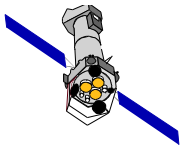
with input from the XMM FCT

menu

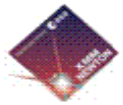
- spacecraft status & mission performance
- special events
- outlook

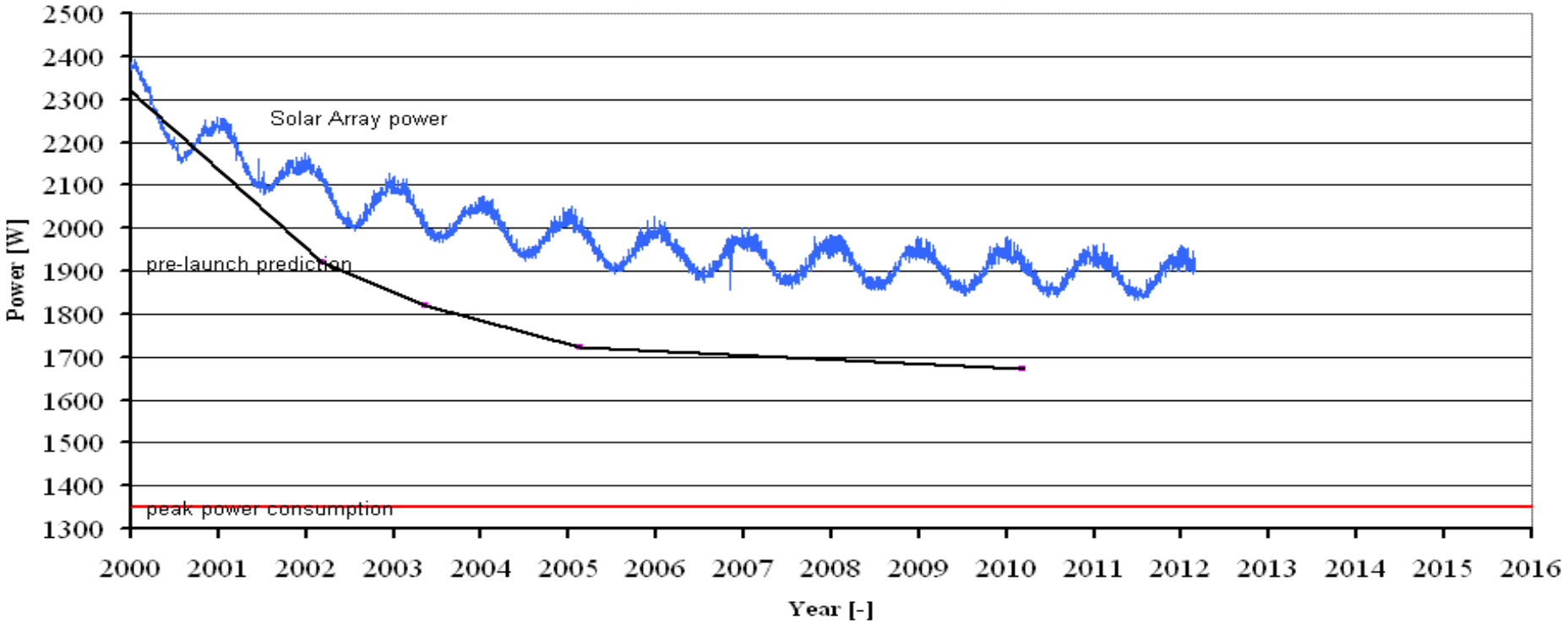




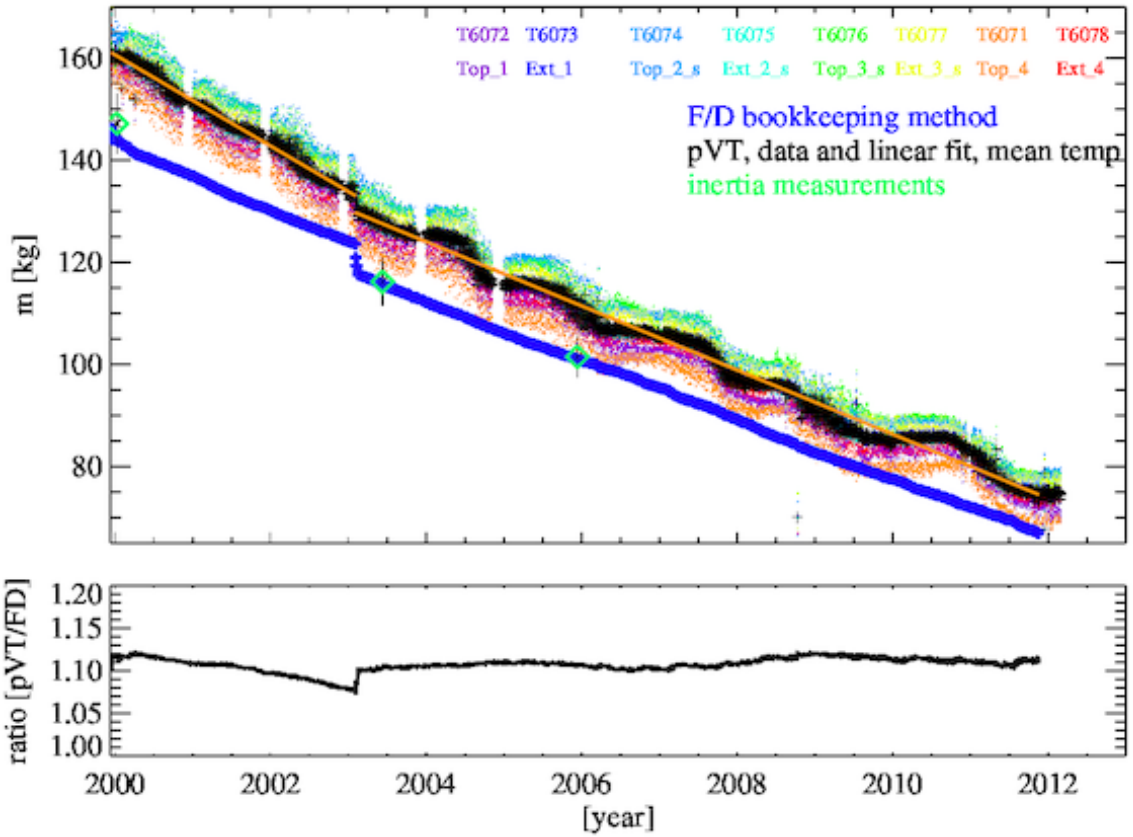
solar arrays

- power generation capabilities are normal
- no sign of unexpected degradation visible





fuel



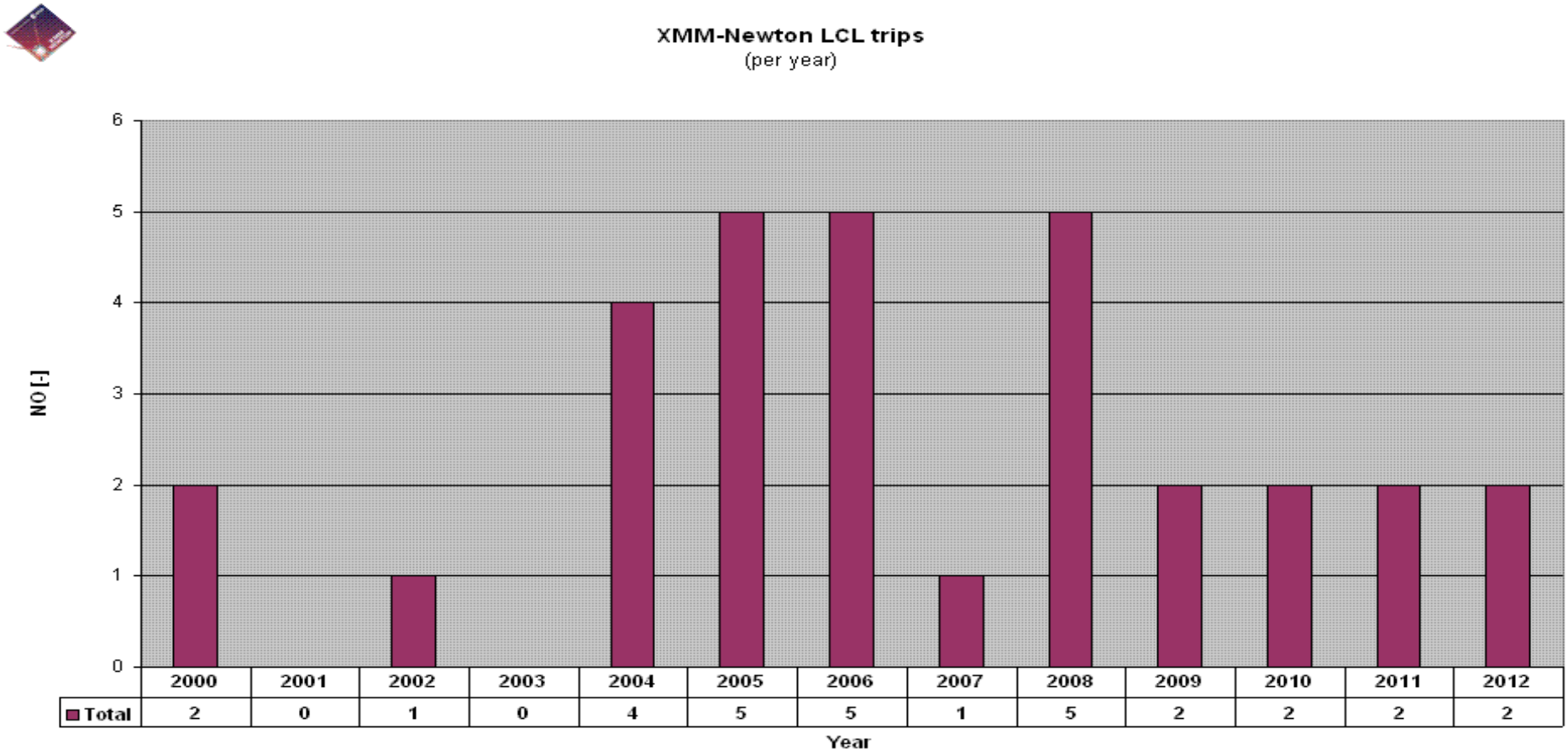
Remaining fuel	65. [kg]
Consumption last 12 month	6.2 [kg]
average fuel consumption (since 2003-03-01)	0.48 [kg/month]
residual lifetime in month	97 [-]
extrapolated milage	Feb. 2020

LCL statistics

2012:

•02-01-2012: HLCL 4.2A trip off (powers 2 heaters of the main branch of the EPIC and RGS electronics.)

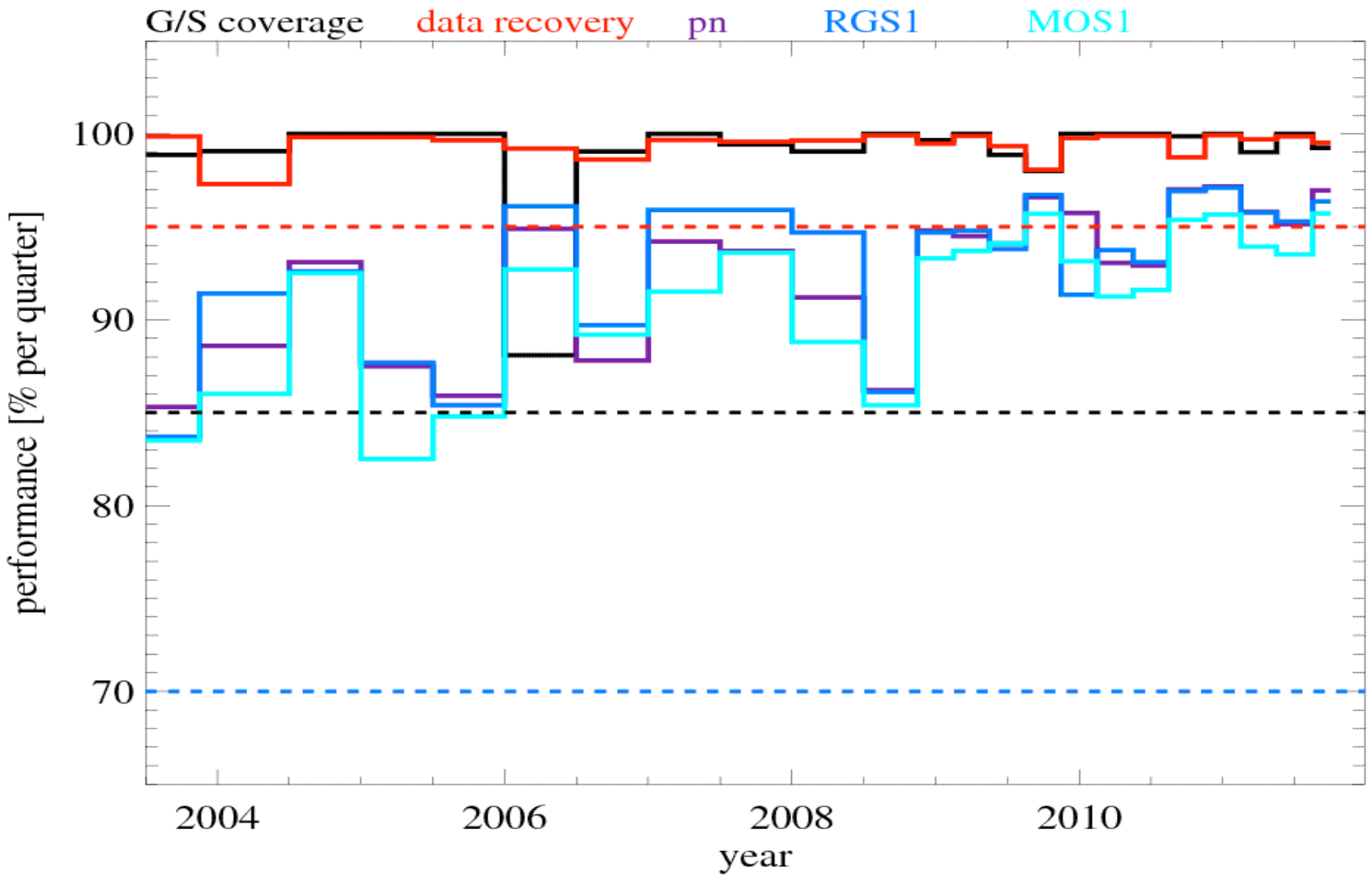
•2012-01-25: HLCL STA PAN B trip off (powers redundant IMU/RW heaters)



spacecraft/mission status

Money	Funded until next extension request	End 2012/14 in 2012→2016
Fuel	remaining Use per year Mileage left	65 kg 6 kg →2020
Solar array power	Maximum required Current margin Margin end of 2018	1350 W 545 W 350 W
Battery	According to UHB	15+ y
Gyros/(IMUs)	Usage	< 20 %
Reaction wheels	Usage	< 44 %
RF switches **Transponder switches**	Usage	Stuck at one position Back up not used instead transponders are switched TX A LCL switches 584 TX B LCL switches 595(Qualified to 25000)

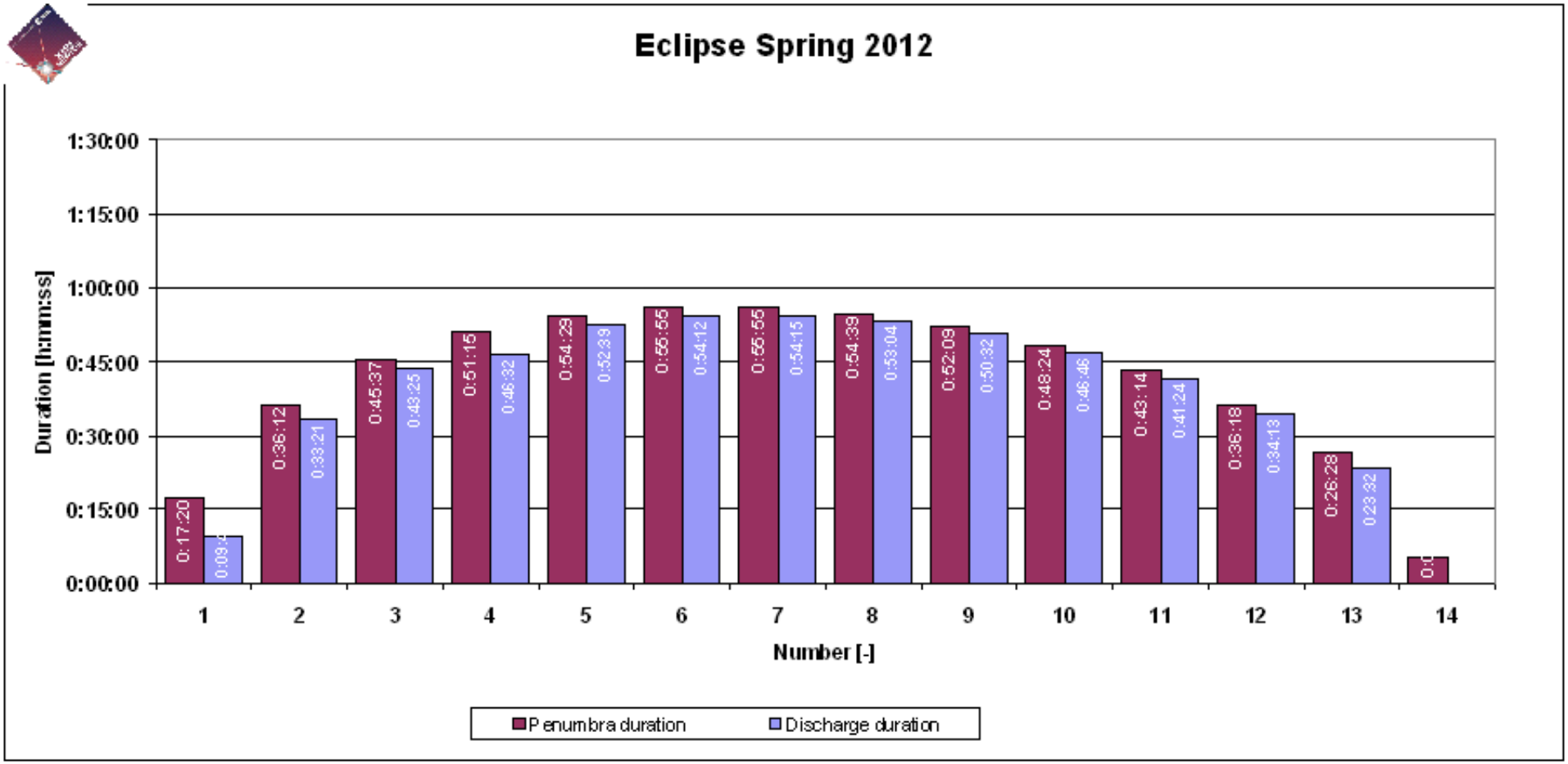
mission performance



eclipse winter/spring 2011/2

- 15/12-10/01
- max. discharge duration: 0h55m55s
- Max. Depth of Discharge: 17.2 % (100%=35Ah)

→ Automated TT generation now fully operational



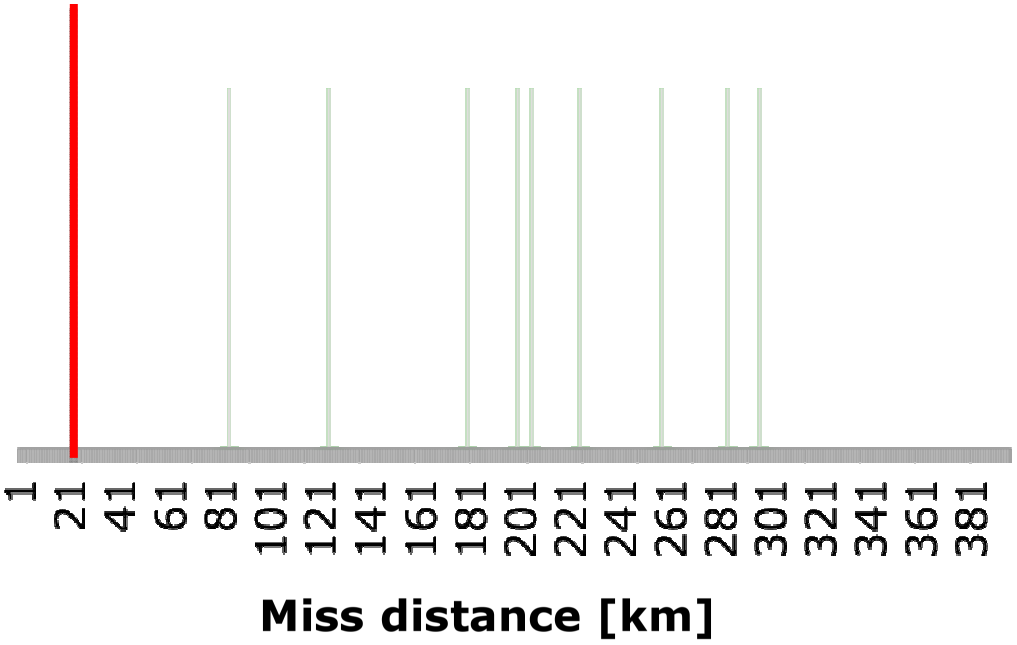
special events

- **Collision avoidance** in place (November 2011 – March 2012)
- Reaction wheel **cage instability**:
  - XMM_SC-72, 2011-08-16, Reaction Wheel 1 unexpected increase in torque and current during stable pointing
  - Switch of reaction wheel configuration from 1-2-3 to 2-3-4 in December 2011
- **4WD project**
  - Wheel4 tested up to 3750 rpm in July
- **MCS migration**
- **Fuel migration**

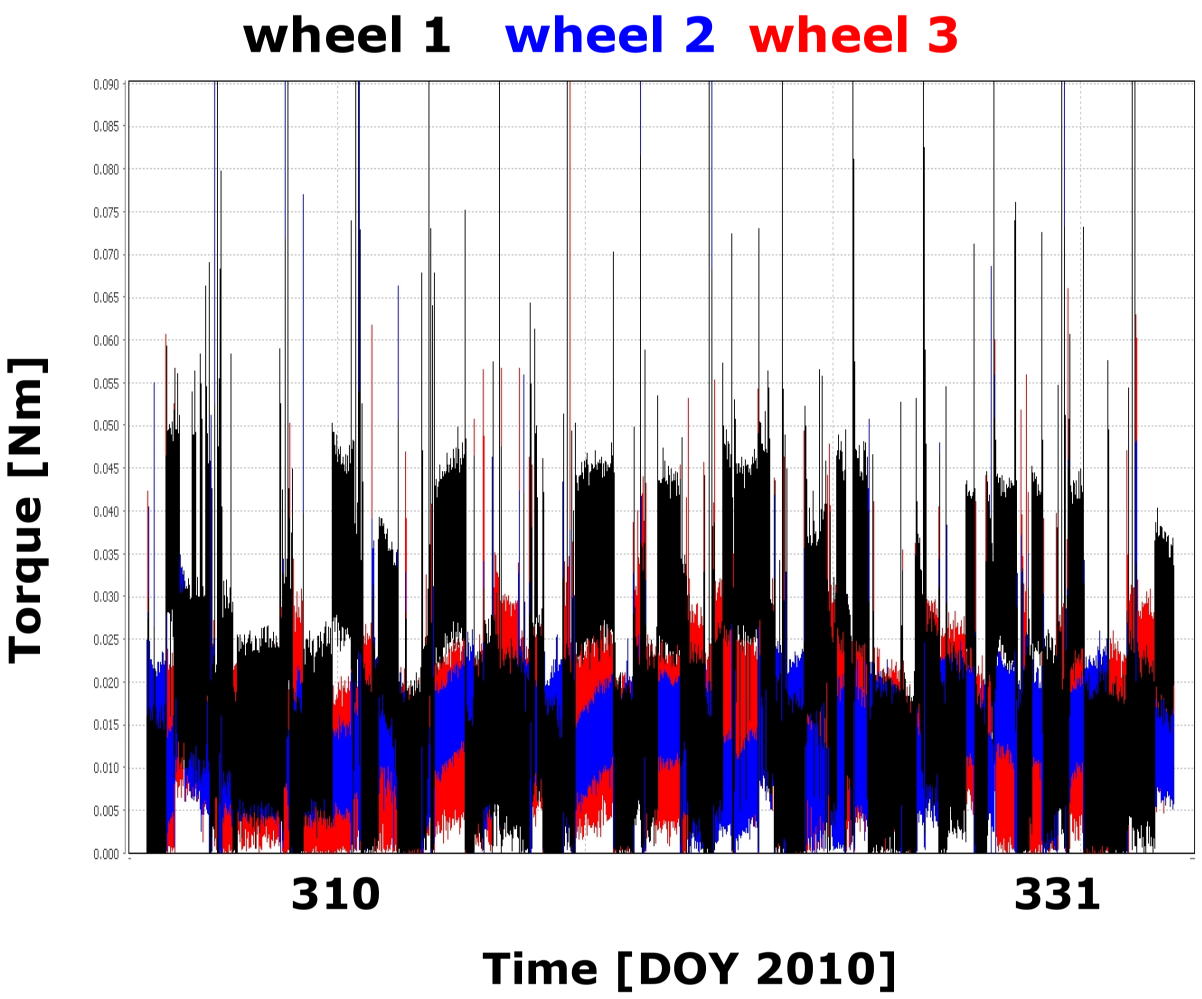
collision avoidance

- XMM orbit crossing GEO for a period of ~ 5 month
- Conjunction monitoring in place and procedure for collision avoidance maneuver

- Detected conjunctions (Screening Volume: 300km x 300km x 300km): 9
- No need for maneuver so far (below 20 km)
- Objects: Rocket bodies (3), Rocket body deb. (3), Spacecraft (3)



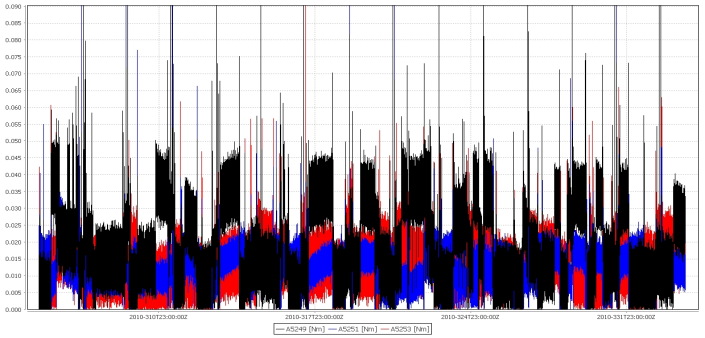
cage instability: symptoms



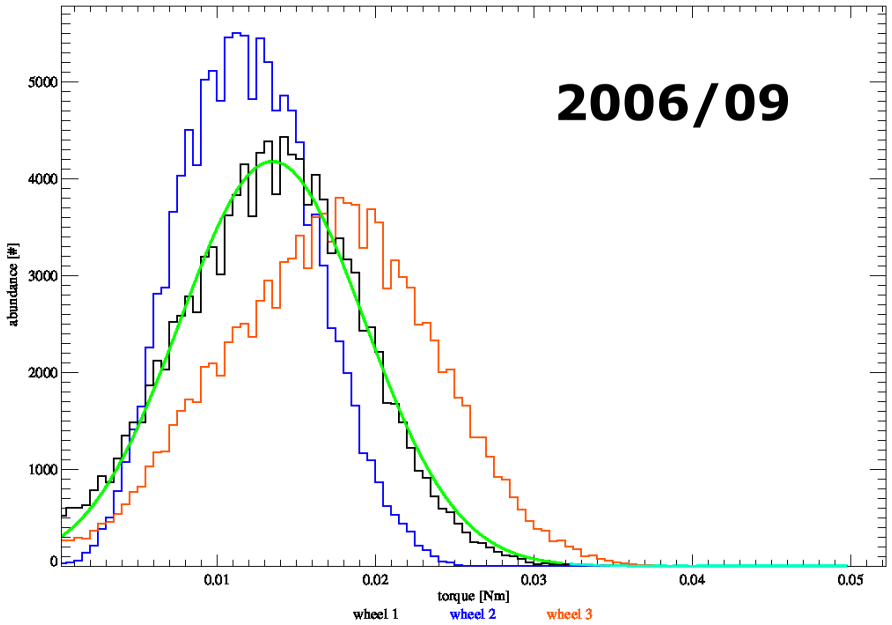
- RW1 commanded torque and RWDE1 current sometimes during stable pointing suffers a jump
- The reason for these jumps is most probably a sudden increment of the bearing friction level.
- Well known phenomena with bearings running in marginally lubricated regimes
- Chaotic vibration of cage
- Caused by too much or too little oil (late in the mission can only be due to reduction in oil quantity)
- Vibration causes increased friction, causes bearing to run hotter, oil gets thinner and gets ejected from bearing as micro droplets, oil runs hotter, oil starts to degrade, lighter fats boil off, oil runs hotter, oil degrades further, oil runs hotter, more complex fats boil off, bearing runs hotter, bearing fails

cage instability: analysis

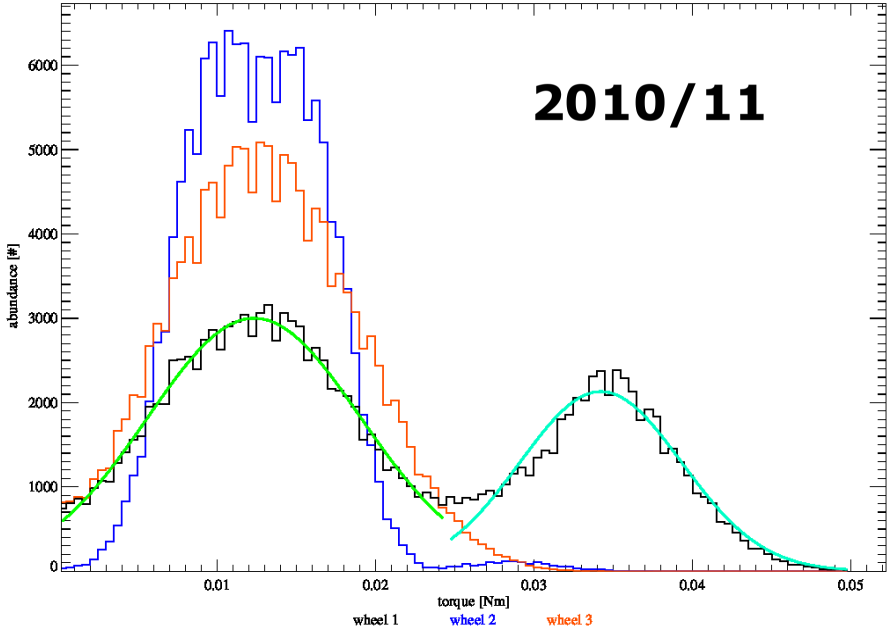
- Screen data for non slew and non RWB times
- Produce monthly histograms of commanded torque
- First peak shows nominal torque distribution
- If there is second peak, this shows cage instability
- Height/integral of second peak gives indication of amount of caging
- Difference of peak position between 1st and 2nd peak gives strength of caging



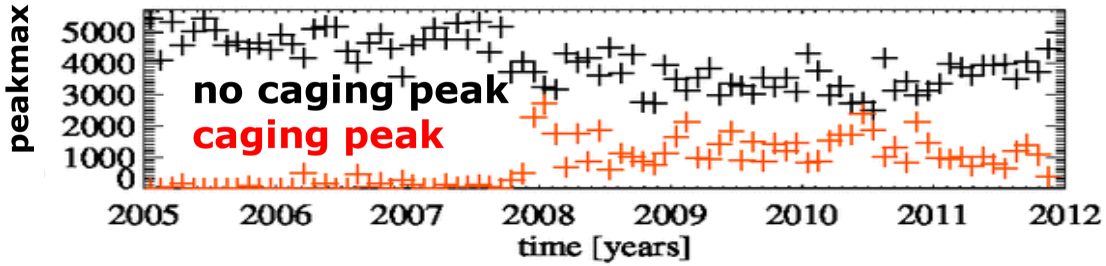
no cage instability

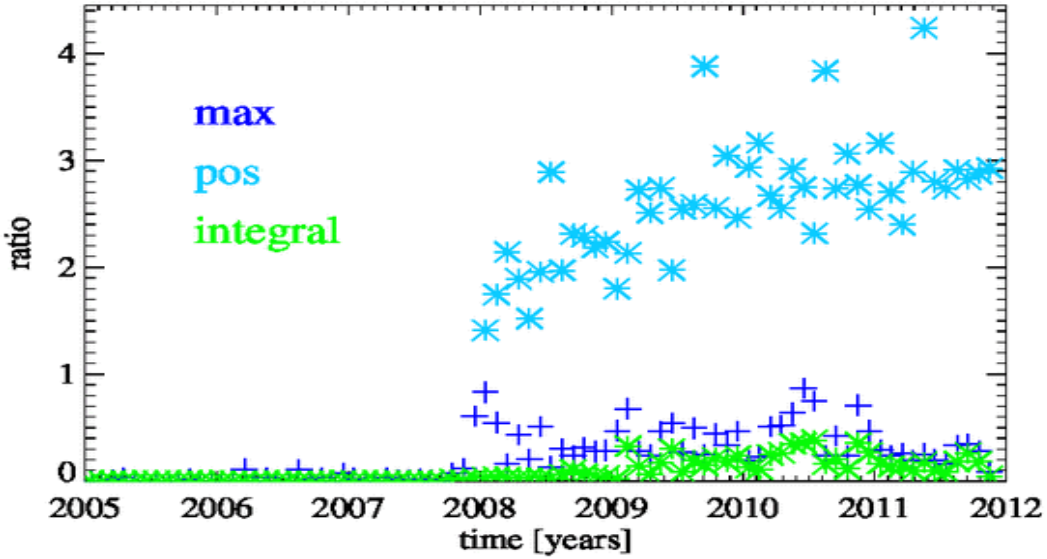


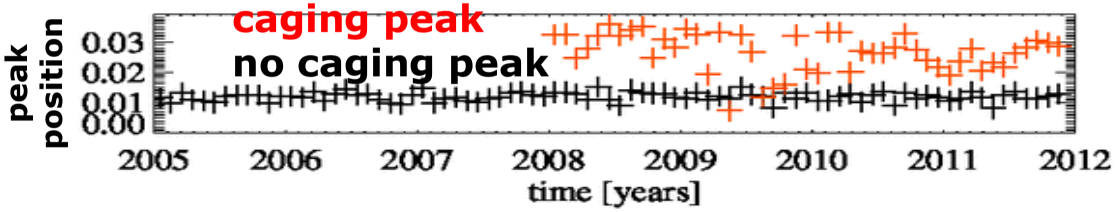
cage instability RW1



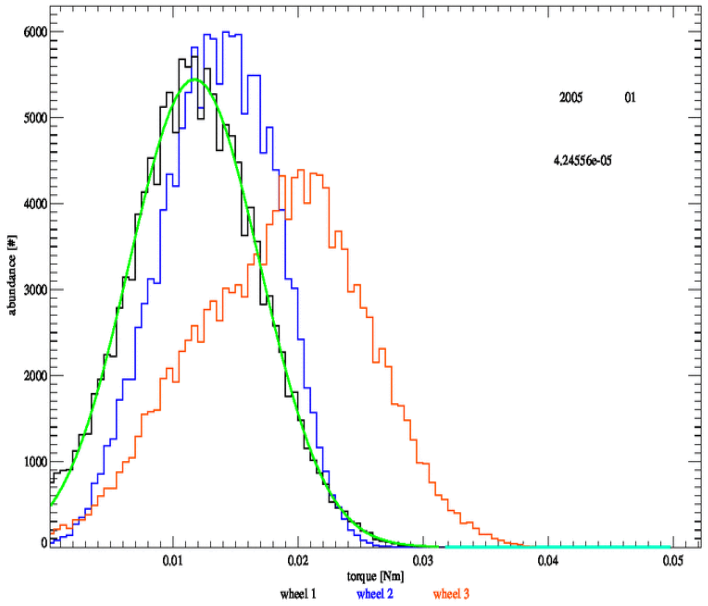
cage instability analysis - evolution







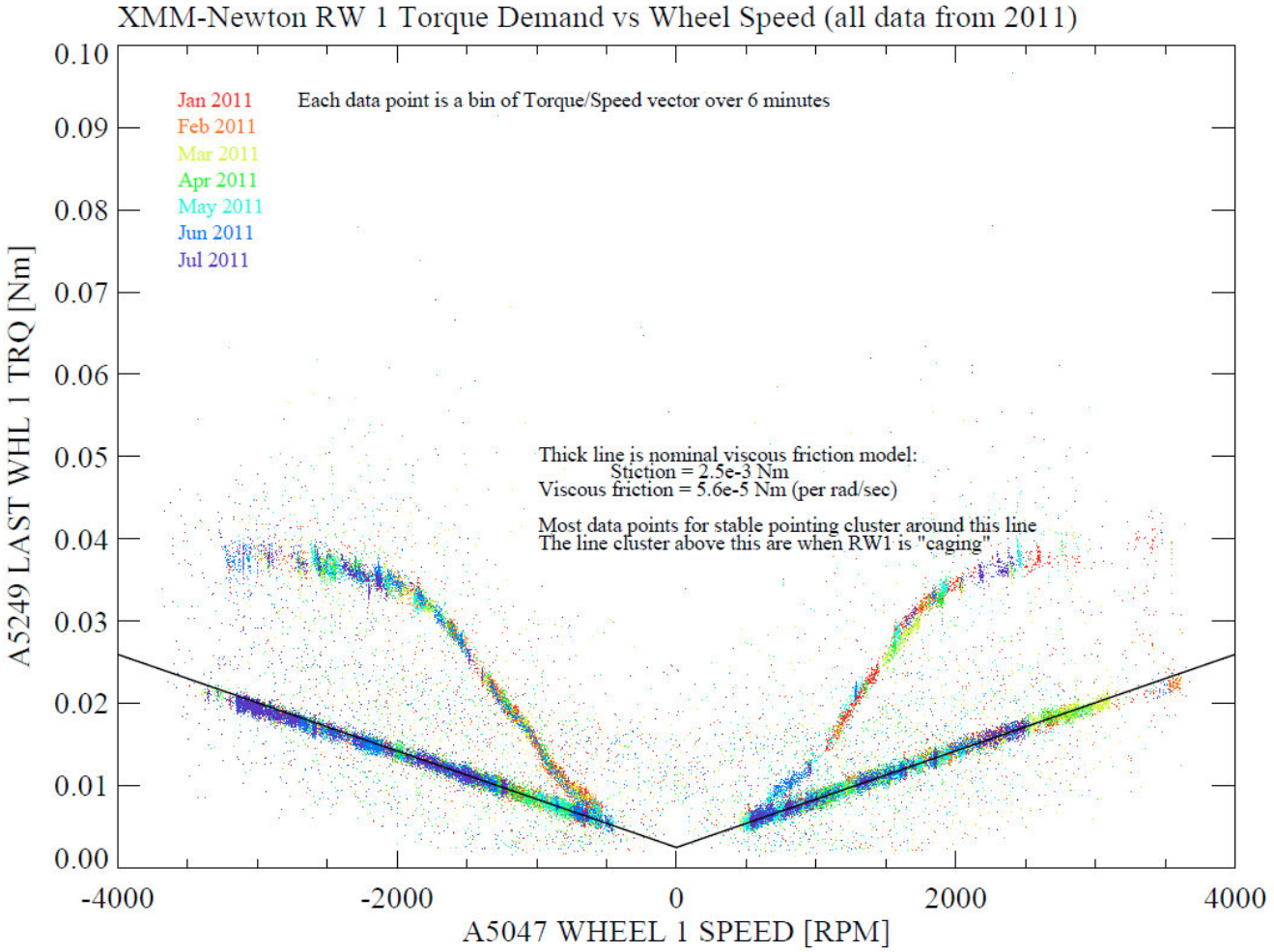
- analysis of histogram plots for each month from 2005 until now
- clear on-set of cage instability in 2008
- evolution over the last 2 years shows no significant further degradation



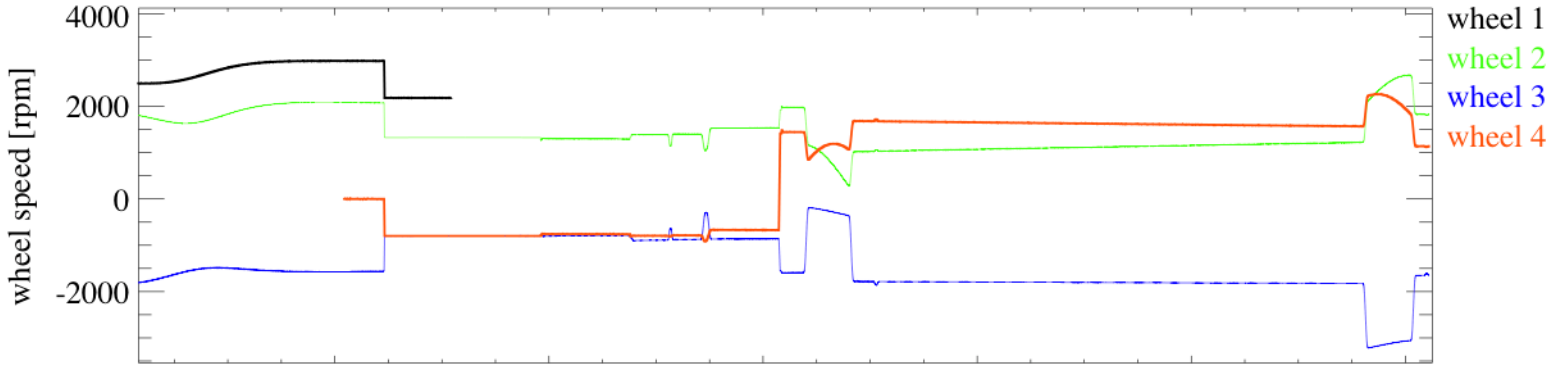
wheel1 wheel2 wheel3

cage instability analysis – butterfly plots

- Plotting wheel speed versus torque indicates if the cage instability is present for all wheel speeds
- For higher speeds the factor in torque increase during the caging state does flatten off



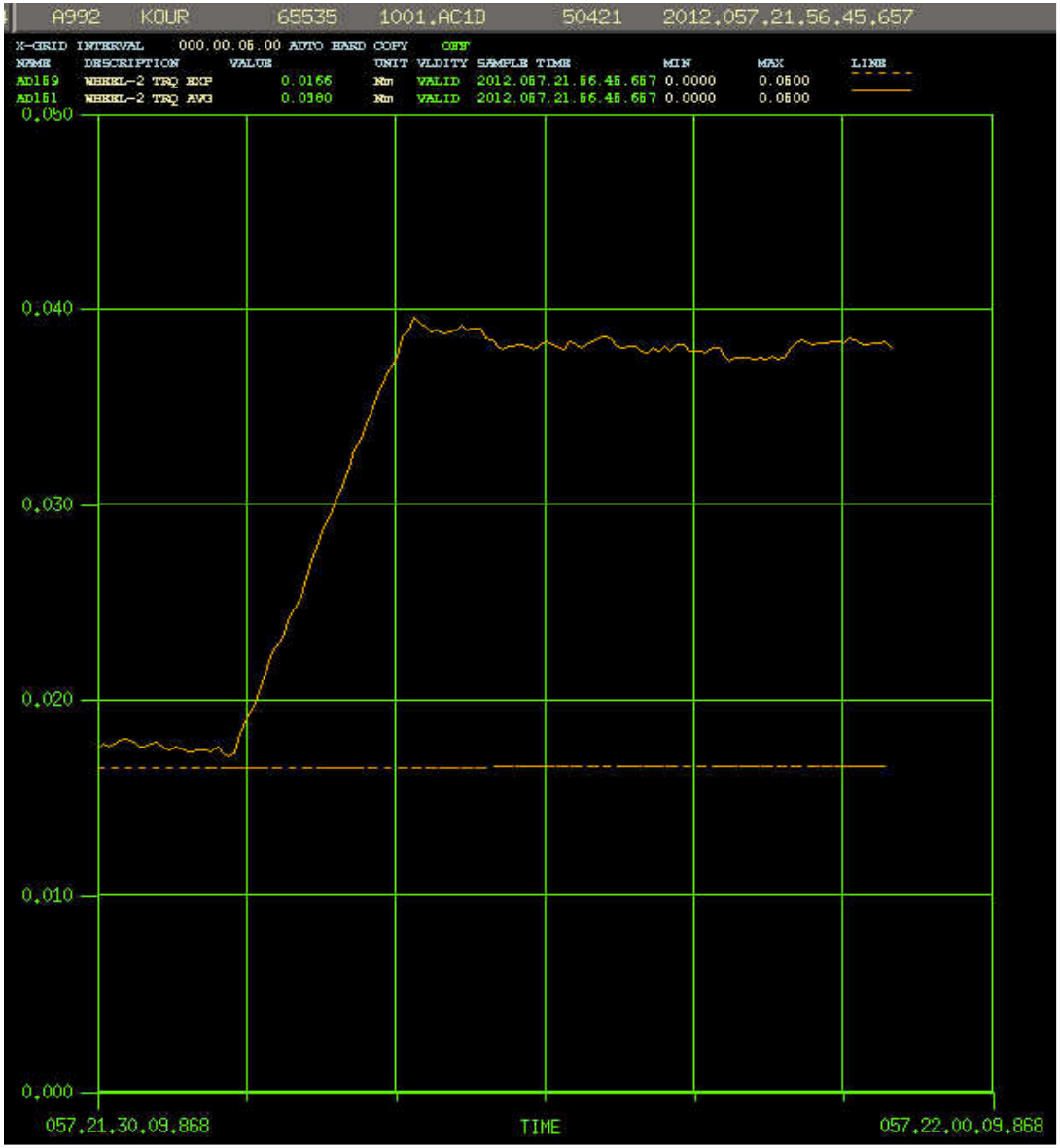
cage instability: actions taken



- ASU recommended to go ASAP from wheel 1-2-3 to 2-3-4 control
- After testing on the simulator wheel 1 has been switched of and wheel 4 has been put into control
  - F/D configuration control issue in combination with F/D design issue and TOO request caused an ESAM entry some days later
- Wheel 1 is now waiting for "re-lubrication": each reaction wheel has an oil reservoir, that allows injecting oil in the bearing. This should cure the cage instability
- Currently Astrium/Bradford in combination with ESOC are working on a procedure to perform this re-lubrication

cage instability monitoring

- Comparing the predicted torque as a function of wheel speed with the actual speed over time indicates when a wheel is in caging stage
- This method can be used near real time
- Weighting cage states with 1 and one cage stages with 0 gives as well the cage fraction in a certain time interval
- This method is been implemented to monitor
- Derived parameter implemented on MCSs



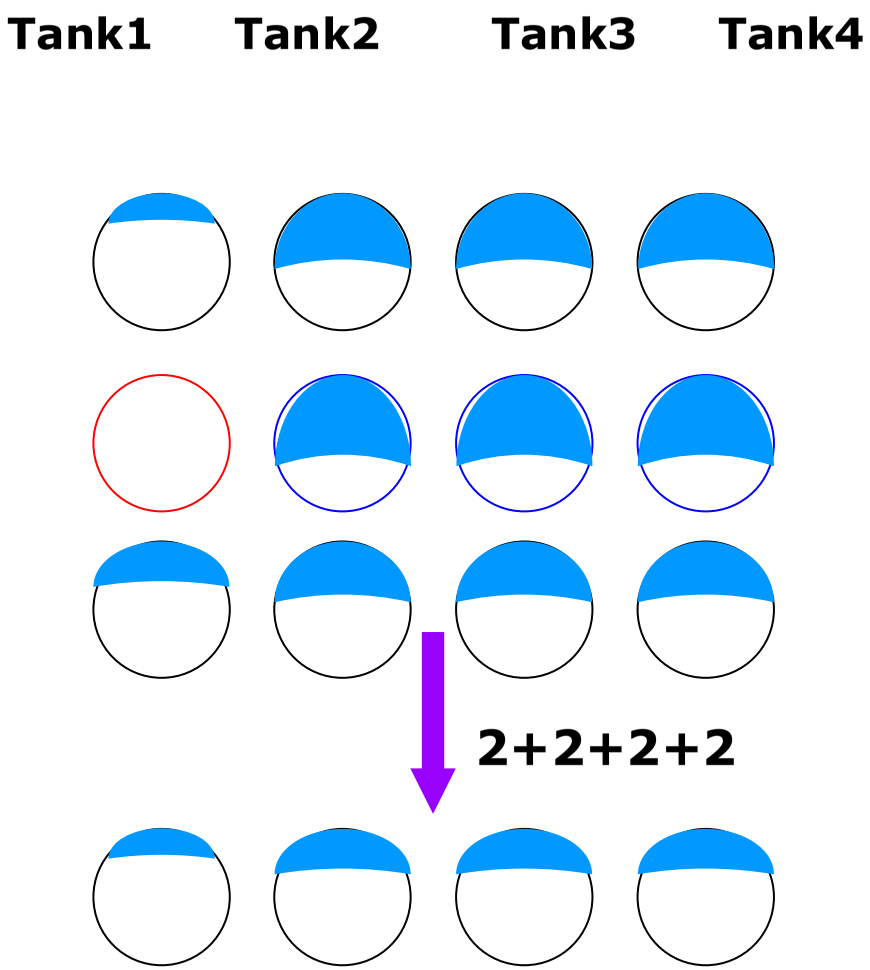
fuel saving options

- **4WD**: potential for 50 % of fuel saving according to F/D estimates
  - Feasibility phase 1 has been kicked off September 2011 with Astrium
  - Algorithms:
    - 2 new modes (TCM4W, IPS4W)
    - Slight modification on AMD
    - TBD: check ESAM and FDIR
  - S/W
    - The average processor load is estimated to increase by < 1%
    - From a RAM memory point of view, about ~ 2300 words will be required by the new (8000 words still available)
  - Cost and schedule for Phase 2 (implementation) will be available by mid April
  - Decision at MEOR 28/06
- **Reduction of wheel speed limits** around 0 from 200 rpm to 65 rpm
- **Flexible Perigee attitude**: delayed until end of collision monitoring, since fixed attitude is required

MCS migration

- Mission Control System H/W has reached its end of life support
- Migration process has been started
  - Migration to Solaris 10 using H/P T4 server
  - Virtualization of Clients and Servers
  - Migration in parallel with INTEGRAL
  - End of process in 2013
  - Will migrate as well the Back Up system at Redu while moving it to ESAC/Cebreros (TBD)

fuel migration



- Design of Tank system of XMM requires fuel migration from auxiliary tanks to main tank at near depletion status (38 kg left)
- Fuel migration will be performed by temperature delta between main tank and aux tanks (Delta T = 8-11 K)
- First migration process planned for 2015 (3WD)
- Migration process needs to be repeated after usage of 8 kg (1 per year 4WD, ½ year with 3WD)

outlook

- Astrium final presentation for XMM 4WD 17/04
- UG meeting 19/04
- Mission Extension Operations Review 28/06

- MCS migration with finalization early 2013
- Wheel-1 re-lubrication in Summer
- Fuel Migration “dry-run” ☺ in autumn