This is a memo of the discussions and decisions about NuSTAR taken place on Wed 27, March 2013, in Session VIII: Working Groups IV - 14:00-17:30: Clusters of Galaxies III in IACHEC 2013 meeting in Theddingworth.

1) NuSTAR

In IACHEC 2012 meeting we discussed with NuSTAR representatives Karl, Kerstin and Fiona about adding a few clusters of galaxies to the NuSTAR calibration program. We selected A1795, A2029 and Coma, since they have been observed with all major X-ray satellites (e.g. ROSAT, Chandra, XMM-Newton, Suzaku and Swift). They are bright and hot nearby clusters and thus provide plenty of photons in the overlapping NuSTAR band.

In 2013 meeting Niels-Jörgen presented NuSTAR simulations for Coma which indicated a significant stray light problem. Since the extent of Coma is much wider than the NuSTAR field-of-view, a fraction of photons from the bright regions outside the FOV (a box with size 13 arcmin) will end up in the FOV due to double scattering in the mirrors. (*Niels-Jörgen: a few words about the difference of stray light and ghost X-rays. Kerstin's presentation says ghost rays come from 3-40 arcmin off-axis and stray light from 3-6 degrees. This implies that my phrase "stray light" means "ghost rays" in NuSTAR language. We have to examine both components. Also, we have to study the 3-6 region around the clusters for bright sources.*) If this component is significant compared to the emission originating from within the FOV via single scattering, we have to evaluate, how accurately it can be removed from the data. We have to estimate the level of uncertainties the subtraction will introduce, and what is its effect to our analysis. If this turns out too large, we have to change our cluster list to contain a bit more distant clusters, e.g. from the REXCESS sample, whose angular extent is smaller and thus would produce less stray light. We have to cross-correlate the observation data bases of the other X-ray satellites to find clusters that have been observed by all or most of the major X-ray satellites.

Jukka and Niels-Jörgen will examine the stray light problem via NuSTAR simulations. By changing the orientation of the instrument the stray light can be minimised (*Karl, perhaps a few words here. The optimal orientation may introduce complications to the observation timeline. Right?*) We will thus examine two cases: a) the worst and b) the optimal orientation. This needs to be finished well before the planning of the NuSTAR observation program for the second year. (*When exactly?*)

Jukka will provide Niels-Jörgen with a spectral model of A1795 within the central r=6 arcmin region and an XMM-Newton *(vignetting corrected, background subtracted?)* image of the full FOV **(Task 1)**. Niels-Jörgen will perform the simulations and compare the stray light spectrum within the central r=6 arcmin region with the spectrum of the emission originating from the r=6 arcmin central region of A1795 to see if the stray light component is significant **(Task 2)**. If it is significant, Niels-Jörgen will estimate the uncertainties involved in the subtraction of the stray light component and Jukka will use the info to estimate the effect to stack residual analysis **(Task 3, conditional)**. We repeat the analysis to A2029 **(Task 4)**. Aslo, Niels-Jörgen will check from his already existing Coma simulations, how the stray light spectrum within the central r=6 arcmin circle compares with the spectrum of the emission originating from the r=6 arcmin central region of Coma. **(Task 5)**

If the stray light effect is negligible, we can keep our cluster list. If not, then we proceed to REXCESS clusters and repeat the above analysis **(Task 6, conditional).**

Once we have finished the above feasibility study and selected the best 3 clusters, we pass the information to Karl who will proceed to implementing these clusters into the NuSTAR calibration program **(Task 7)**

2) Task list

Task_nr	Responsible	Description	Deadline	Status
1	Jukka	A1795 input to NJW	April 2013	open
2	NJW	A1795 simulations	May 2013	open
3	JN,NJW	Stray light systematics, conditional	May 2013	open
4	JN,NJW	Repeat Tasks 1-3 to A2029	June 2013	open
5	JN, NJW	Repeat Tasks 2-3 to Coma	May 2013	open
6	JN, NJW	REXCESS clusters, conditional	Aug 2013	open
7	Karl	Clusters to NuSTAR program	Sep 2013?	open