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Title **Thermal assessment of the ATHENA X-IFU passive shielding for the particles background reduction.**

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ABBREVIATIONS AND ACRONYMS

Item	Meaning
CryoAC	Cryogenic Anti Coincidence
BKG	Background

APPLICABLE DOCUMENTS

[AD#]	Doc. Reference	Issue	Title
[AD1]			
[AD2]			
[AD3]			
[AD4]			
[AD5]			
[AD6]			

REFERENCE DOCUMENTS

[RD#]	Doc. Reference	Issue	Title
[RD1]	Lotti S. et al., A&A 569, A54, (2014)		In-orbit background of X-ray microcalorimeters and its effects on observations
[RD2]	Lotti S. et al., Proc. of SPIE, 8443, 84435H, (2012)		An efficient method for reducing the background of microcalorimeters applied to ATHENA-XMS
[RD3]			
[RD4]			
[RD5]			

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1 INTRODUCTION

The purpose of this document is to assess from a thermal point of view the implementation of the ATHENA X-IFU passive shielding for the particles background reduction in cryogenic environment. Such a shielding in combination with the CryoAC detector is expected to reduce the X-IFU TES array local bkg [RD1, RD2] down to 5E-2 cts/cm^2/s (single shield), and to 2.1E-2 cts/cm^2/s (sandwich as a combination of 3 shields).

2 THE CASE FOR THE ATHENA L1 FPA

A lot of work is planned to be performed to evaluate the residual particle background around the X-IFU FPA at L2 orbit, moving from the ATHENA L1 geometry to the present FPA. Such a FPA and the related cryostat are in designing phase by the consortium, but at present it is interesting to evaluate what could be the impact of implementing such a passive shielding also in the ATHENA L1 FPA just to have an idea of the numbers we have to deal with.

2.1 Geometry of the shields

Here below we show the geometry of a single shield made of PMMA, and the sandwich solution made of PMMA-W-PMMA (Fig. 1). Here we consider the PMMA instead of the Kapton since at the moment we are not able to find the specific heat data from 0.05K to 2K for the last material. Both the materials are polymers: we do not expect quite different trend between their specific heat. We expect for this change a variation of the BKG of about 10%-15% as shown from their protons stopping power and the electron-to-proton ratio production from a slab of 250 um thickness. GEANT4 simulation are ongoing to assess the numbers.

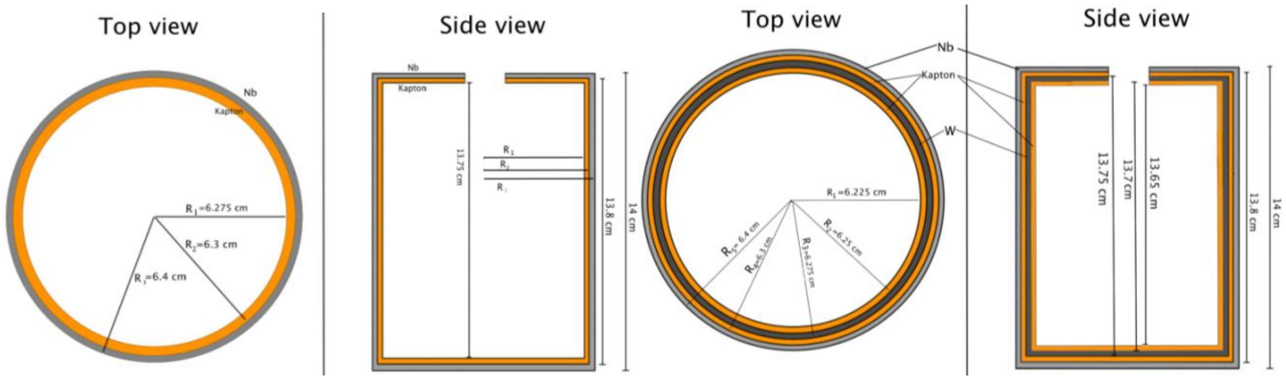

Fig. 1 - (LEFT) The single shield solution. (RIGHT) The sandwich solution.

2.2 ADR Cooling Energy and heats from the shields to be sunk.

We start with the “possible” cooling energy allocation to cool the shields that will be put at 0.05 K. From the slides of I. Charles at the Toulouse (March/2014) Consortium meeting I get what it is necessary to allocate for the X-IFU ADR 1.26uW@50mK per 31 hr: 140 mJ. On the other side L. Duband has shown that from the ESA TRP IXO/ATHENA an ADR featured by 1uW@50mK per 30 hr has been developed, that means 122 mJ.
So, as safe reference condition, we get ~ 120 mJ as real cooling energy for the ADR.
Hence, I suppose to allocate an amount of 10% to the passive shieldings, which translates in 12 mJ: this will be our cap value (TBC). Henceforth it is assumed that ALL the heat will be sunk by the ADR, even though a sorption cooler is envisaged down to 0.3 K. So the evaluations below have to be considered as conservative solutions.

In Fig. 2 it is shown the specific heat of PMMA and what is the expected heat to be sunk by cooling the shield from 2K to 0.05 K.

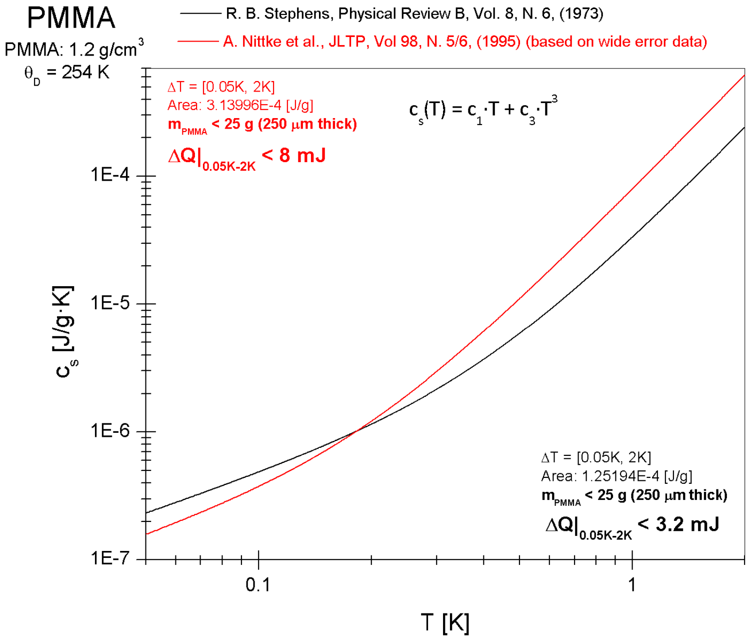

Fig. 2 - Specific heat of PMMA from different bibliographic sources.

We evaluate the following numbers due to the different trends: 3.2 mJ < dQ < 8 mJ. So, a guess value could be 5 mJ.

About the Tungsten, the two trends produce similar data. Hence, the guess value is 5 mJ. For comparison also the PMMA, Copper and Magnesium data are shown.

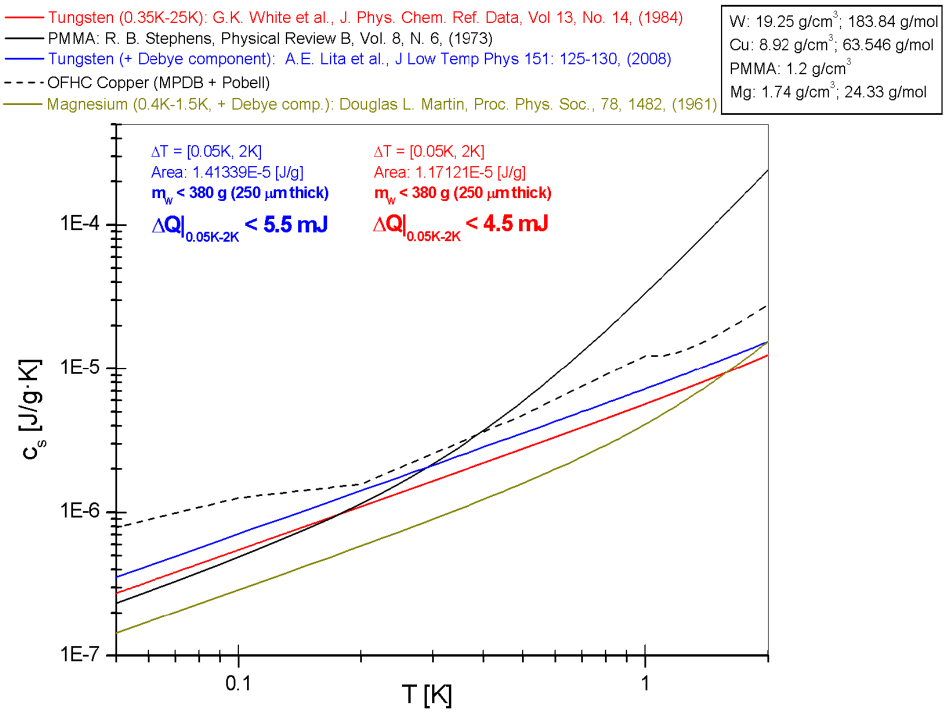

Fig. 3 - Specific heat of Tungsten compared with PMMA, Copper and Magnesium.

The conclusion is that for a single liner of PMMA we need of 5 mJ, and for the sandwich 15 mJ not so far from the assumed cap value.

We remind few things:

1) as conservative solution, along this analysis it has been assumed that all the heat will be sunk by the ADR from 2K to 0.05K, even though a sorption cooler down to 0.3 K is envisaged (from 0.3 K to 0.05 K the heat is << 1 mJ for both the materials)

2) we have to analyse the data provided by the last GEANT4 simulation where we have changed the Kapton in PMMA to understand if the PMMA could be an alternative good solution for reducing the X-IFU local BKG

3) we have to move to the new FPA design, so new sizes than new shields masses, but we have also to optimize the shields thickness since 250 um is only a starting value.

The analysis should also involve thermal conductivity, that could be faced in the next issues of this document.

If the sandwich could be a good solution and feasible to be implemented from the thermal point of view, it is important to understand from the SRON team if such a material, anchored at 50 mK, can be a problem for the TES array since it is a superconductor of Type 1 and its critical temperature is around 15 mK close to 50 mK.