ANAIS status report

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ANAIS status report

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Abstract. We report the status of the ANAIS (Annual modulation with NAI Scintillators) experiment focusing on the developments towards the improvement of the background level of our detectors and the reduction of the energy threshold.

1. Introduction

ANAIS is the large scale conclusion of previous studies carried out with different prototypes by the University of Zaragoza group at the Canfranc Underground Laboratory (LSC). The complete experiment will use about 100 kg of NaI(Tl) crystals to study the expected annual modulation [1] in the galactic dark matter signal. A possible enlargement of target mass has been recently considered and funding asked for. DAMA/LIBRA [2], an experiment performed at the Gran Sasso National Laboratory, accumulating several annual cycles of data (also with NaI scintillators), obtained (and recently confirmed with larger statistics) a positive signal for the above mentioned annual modulation [3]. This result is difficult to reconcile with those obtained with other targets in different experimental approaches [4]-[9] but comparison is strongly model dependent. For that reason, ANAIS (that uses the same target and technique that DAMA/LIBRA) appears in the last roadmap of ApPEC/ASPERA as the experiment that would allow testing such result with an independent experimental set-up and in a model-independent way. For this goal, some of the experimental features of ANAIS should be improved and we are focusing efforts in the corresponding directions. Energy threshold below 2 keV should be achieved in order to improve sensitivity for the annually modulated WIMP signal. This goal is addressed by using new high quantum efficiency photomultiplier tubes and by developing new energy estimators at very low energies, as well as a better noise rejection. Background at low energy should be kept as low as possible. After characterization of the available NaI(Tl) crystals, the measured ^{40}K bulk crystal contamination appears as the most dangerous at the very low energies of interest for ANAIS and has forced ANAIS to look for more radiopure crystals, implying the development of new purification techniques.

2. ANAIS Status

We summarize the present status of the ANAIS experiment in the following topics:

- NaI(Tl) crystals radiopurity: In the case of NaI, radiopurity of the crystal is identified as one of the main issues to allow an important improvement in sensitivity. After characterization of existing ANAIS crystals (14 hexagonal 10 kg each NaI(Tl) detectors stored at LSC) background at low energy seems to be dominated by contaminations in the crystal itself, in particular ^{40}K. Activities in the range from 15 to 20 mBq/kg have been measured for these available detectors. Anticoincidence between modules has been found to be helpful to reject background although not enough to achieve the required sensitivity. New NaI(Tl) crystals with very low content in potassium should be used in ANAIS requiring the development of new purification techniques. In this direction ANAIS is starting to search for new possibilities and contacts with different enterprises and research groups at international level have been established. On the other hand, ^{210}Pb is also an important background source if the contamination is placed on the surface of the crystals or in the encapsulation materials and should be avoided by conveniently polishing the surface of the crystal and carefully selecting the encapsulation material. Efforts in this direction are also ongoing. Nonetheless, these set-ups with old crystals have allowed verification of the linearity of the response down to 3 keV (see figure 1) thanks to a special mylar window in the encapsulations developed at Zaragoza (see figure 2).

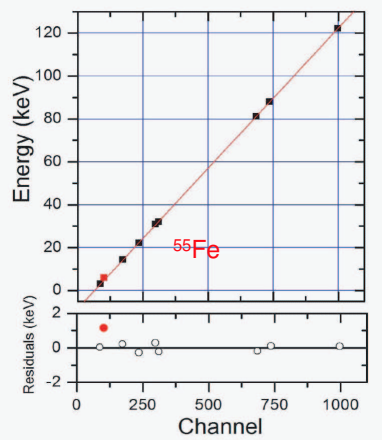

Figure 1. Linearity plot obtained with low energy sources. 5.9 keV from ^{55}Fe is seen at a lower energy indicating possible surface effects.

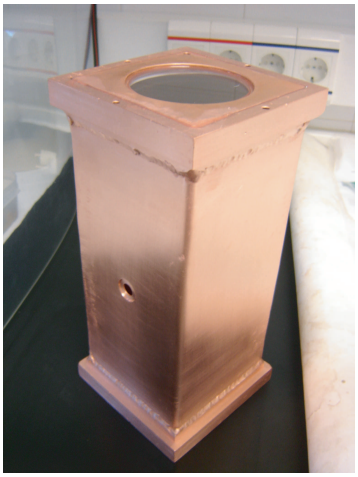

Figure 2. One of the ANAIS prototypes.

- High quantum efficiency photomultipliers: New photomultipliers with very high quantum efficiency (larger than 42%) are being tested in Zaragoza, and will be mounted in a prototype detector at Canfranc in the near future. The improvement in sensitivity with respect to the previously used in ANAIS could allow reducing the threshold of the experiment below 2 keV. On the other hand, radioactivity of these PMTs is being assessed at the low background test bench in Canfranc and seems to be too high in order to be used in the ANAIS final set-up (see table 1). More radiopure high efficient options are being searched for in collaboration with HAMAMATSU Photonics.

- Characterization of a new ultrapure NaI(Tl) crystal: A new ultrapure NaI(Tl) crystal (9.6 kg) has been very recently mounted (we will refer to it as Prototype IV) in order to better characterize ANAIS set-up background at low energy. An ETP (Electrolytic

Table 1. PMTs internal contamination measured at Canfranc for Electron Tubes ET 9302 and Hamamatsu high quantum effieciency and low background models.

Isotope	ET 9302B (mBq/PMT)	Ham High QE (Bq/PMT)[1]	Ham Low BKG (Bq/PMT)[2]
^{40}K	420±50	184.5±0.9	0.4
^{232}Th	24±4	0.42±0.04	0.3
^{238}U	220±12	0.51±0.03	0.2

[1] Values corrected with respect to online presentation.[2] Values reported by manufacturer

Tough Pitch) Copper encapsulation has been built for this prototype and screened at the low background radiopurity test bench at LSC. The crystal has been coupled to two low background PMTs (ET 9302B) and first tests are being carried out.

- A preliminary run: ANAIS-0. With ANAIS Prototype IV, after being completely characterized, we will start a long measurement in the best background conditions. Stability of the operation conditions should be conveniently monitored. New electronics and acquisition system may also be tested. Although 10 kg is not enough to confirm DAMA/LIBRA results, ANAIS-0 will be the final test bench for ANAIS.

3. Conclusions

ANAIS collaboration is working to improve the performances of the detectors, focusing on the reduction of the background level (towards 1 count/keV/kg/day) and of the energy threshold (below 2 keV). Dedicated set-ups at the old Canfranc facilities have allowed to measure the ^{40}K contamination of various NaI(Tl) crystals finding too high levels. We were able nonetheless to certify the linearity of the response down to 3 keV with an energy threshold at 2 keV. Cleaner crystals as well as new high QE and low background PMTs are being investigated at present. We are developing also new acquisition and monitorization systems which will be soon tested in an ANAIS-0 run with a single prototype detector. The collaboration aims to have the set-up for the whole experiment ready when the new Canfranc Underground Laboratory will be operative.

Acknowledgments
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References

[1] Cebrián S *et al.* 2001 *Astroparticle Physics* **14** 339-350
[2] Bernabei R *et al.* 2008 *NIM A* **592, 3** 297-315
[3] Bernabei R *et al.* 2008 *EPJ C* **56, 3** 333-355
[4] Akerib D *et al.* [CDMS Collaboration] 2004 *Phys. Rev. Lett.* **93** 211301; Ahmed Z *et al.* 2009 *Phys. Rev. Lett.* **102** 011301
[5] Sanglard V *et al.* [EDELWEISS Collaboration] 2005, *Phys. Rev. D* **71** 122002
[6] G. Angloher *et al.* [CRESST Collaboration] 2005 *Astropart. Phys.* **23** 325-339
[7] Lebedenko V N *et al.* [ZEPLIN-III Collaboration] 2009 *Phys. Rev. Lett.* **103** 151302
[8] Benetti P *et al.* [WARP Collaboration] 2008 *Astropart. Phys.* **28** 495-507
[9] Angle J *et al.* [XENON10 Collaboration] 2008 *Phys. Rev. Lett.* **101** 091301