Minutes of the 2nd International Workshop on Radiopure Scintillators for EURECA

22nd - 23rd September 2009, Institute for Nuclear Research, Kyiv, Ukraine

http://lpd.kinr.kiev.ua/rps09/

Participants:

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17. V. Shlegel (NIIC SB RAS,Russia)
18. V.I. Tretyak (INR, Kyiv, Ukraine)

Reports and discussions:

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1.	Hans Kraus	EURECA – an overview
2.	Ioan Dafinei	Production of radiopure TeO_2 crystals for neutrinoless double beta decay application
3.	Vasily Kornoukhov	First results of $^{40}Ca^{100}MoO_4$ single crystal growing for under-ground physics application
4.	Fedor Danevich	R&D of $CdWO_4$ crystal scintillators from enriched materials for double-β decay experiments
5.	Vladimir Shlegel	Growth of the $^{106}CdWO_4$ Crystal by the Low Thermal Gradient Czochralski technique (LTG Cz)

6.	Ljudmila Nagornaya	Growth conditions of radiopure $ZnWO_4$ scintillation crystals
7.	Evgeniy Galashov	Growth of zinc tungstate by the Low Thermal Gradient Czochralski technique (LTG Cz)
8.	Sergiy Galkin	The concentrations of impurities and point defects in melt grown ZnSe
	All	Discussion

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9.	Vladimir Tretyak	Semi-empirical calculation of quenching factors for ions in scintillators
10.	Valentyna Kudovbenko	Light collection from $ZnWO_4$ cylindrical and hexagonal shape
11.	Vitalii Mikhailik	Performance characteristics of scintillators at cryogenic temperatures
12.	Vladislav Kobychev	On measurability of mBq/kg levels of alpha activity
13.	Denys Poda	Further study of radiopurity of $ZnWO_4$ crystal scintillators
14.	Alexey Shcherban	A new approach to production of radiopure natural and isotopically enriched cadmium and zinc
	All	Discussion and Way Forward
	Hans Kraus	Summary Remarks

Remarks and Conclusions from the reports:

1) The EURECA collaboration intends to build a multi-target detector based on Germanium and Crystal Scintillators
2) There is significant progress in the development of scintillation materials; including crystal scintillators from enriched isotopes ($ZnWO_4$, $^{106}CdWO_4$, $^{40}Ca^{100}MoO_4$)
3) Radiopure TeO_2 crystals developed by CUORICINO / CUORE is an example of successful R&D, requiring construction of special facilities (clean rooms), equipped with clean water production, use of special lab-ware, careful screening of materials, etc.
4) An important method to determine quenching factors for ions in scintillators was presented by Vladimir Tretyak.
5) Test of α active contamination in raw materials for crystal growing should be an important part of a programme to develop radiopure scintillators. However due to low detection efficiency, direct methods (surface barrier spectrometry, gas-filled α chambers, solid-state nuclear α track detectors, scintillation α counters) only allow reaching a sensitivity of 100 – 1,000 mBq/kg, which falls short of the desired sensitivity level of ~ 1 mBq/kg. The only way to reach an overall radiopurity level of < 0.01 mBq/kg requires growth of test crystal samples with their subsequent measurement of their internal α activity in a scheme of scintillator = detector by using pulse-shape discrimination to suppress γ (β) background.

6) Further studies of light collection in $ZnWO_4$ crystal scintillators are necessary: optimisation of photo-detector sizes, shape of reflector, etc
7) The most promising, highest-priority material for EURECA is $ZnWO_4$; the materials in the next priority are $CaWO_4$, $CaMoO_4$, CaF_2. Nevertheless we should not exclude other materials: BGO, MgF_2, Al_2O_3(Ti), $MgWO_4$, $PbWO_4$, $PbMoO_4$, etc.
8) $ZnWO_4$ is at present the most radiopure crystal scintillator with a level of contamination (total α activity) of 0.1–1 mBq/kg. Recrystallization does not improve, but even affects negatively scintillation as well as radiopure properties of the material due to broken stoichiometry.
9) There are possibilities to purify cadmium, zinc and some other elements to the level of 99.9999% by vacuum distillation in the Kharkov Institute of Physics and Technology (KIPT), while the purification of Ca and W are issues that need to be addressed within a dedicated programme.

Proposal for a scientific programme to produce $ZnWO_4$ crystal scintillators with advanced radiopurity and scintillation properties:

1) Deep purification of Zn (99.9999%) in the KIPT by vacuum distillation (requested amount 0.8–1 kg);
2) Deep purification of W by wet chemistry in the NIIC (Novosibirsk, Russia) or / and the NeoChem Company (Moscow, Russia);
3) Production of high purity $ZnWO_4$ powder in the NeoChem Company (Moscow, Russia);
4) Measurements (in INR Kyiv and in the Modane Lab) of radioactive contamination of samples of ceramic used for crystal production;
5) Measurement of Platinum by ULB HPGe γ spectrometry (INR, Kyiv);
6) Growth of two samples of $ZnWO_4$ $\approx\varnothing 40 \times 40$ mm, one in the NIIC (Novosibirsk, Russia) and the second one in the ISMA (Kharkiv, Ukraine);
7) Measurements of radioactive contamination of the samples;
8) As it was shown by CUORICINO / CUORE, special measures are necessary to reach a high level of radiopurity of the crystals: clean rooms, ultra-pure water, careful screening of materials;
9) The EURECA collaboration should find financial possibilities to support the R&D. The very rough cost of the work is at a level of ≈ 20-30 kEuro (without expenses specified in item 8, the cost of which is higher and can be considered in case of positive results for steps 1-7). The work could be done during ≈ 1 year.

Proceedings of the workshop:

Proceedings of the workshop are proposed to be published as an ArXiv e-print (as it was done for RPSCINT 2008). The participants are kindly requested to send their contributions to Vladimir Tretyak before 23 October 2009.

The next workshop (RPSCINT 2010):

The RPSCINT 2009 workshop was quite fruitful. The next workshop (RPSCINT 2010) could be organized again in Kyiv in September 2010. The exact date will be discussed during in a few months.