PWO discussion during CALOR14

Participants: R. Novotny, V. Dormenev, M. Korzhik, Jindrich Houzvicka + another Crytur associate, C. Woody, TH

- Panda needs ~8500 PWO crystals within the next few years. They have enough PWO to cover the calorimeter end caps, but these additional crystals are needed for the barrel.

- **Situation with SICCAS (SIC)**: According to Rainer the initial PWO delivery from SIC to Panda was acceptable. He had provided them raw materials from BTCP that he had acquired/purchased. The "disaster" (as he called it) started when Marco Battaglieri ordered ~370 PWO crystals for Hall B. Rainer's group tested these for light yield, radiation hardness, etc. and found that 30-40% would have to be rejected. Marco received a replacement for the 30-40% PWO crystals, but according to Rainer the situation for the replacement crystals was as bad as the initial order. Part of the results of these tests are summarized in the report that Carlos sent around earlier. There are many hypotheses why the SIC crystals have such bad radiation hardness including the crystal growth method (different from BTCP), the way SIC used the raw materials (apparently the purity and/or composition was different than they expected), available equipment, and/or unwillingness of the company to invest more effort into PWO production. In January, Rainer provided SIC with raw materials for ~250 PWO crystals. The company agreed to produce these crystals with similar specifications as those that Hamlet ordered in January. As for Hamlet's order SIC said that they can only guarantee a change in attenuation coefficient at 420 nm of less than 1.5 m^{-1}. Panda's specified value is better than $1m^{-1}$ and ideally $<0.75m^{-1}$. Rainer does not seem very optimistic about this order.

- **Alternative PWO option**: About a year ago Hamlet contacted Prague-based Crytur about PWO and following that Rainer got in contact with the company as well. He has since made a contract with Crytur, paid about 100,000 euro to get the production going, and will provide the company with raw materials to produce PWO crystals. He currently has 3 tons of raw materials at hand and about 14 more tons are available from Russia. The total amount of raw materials should be enough for ~10,000 crystals. Crytur will get help from a consultant (Misha Korzhik who is apparently familiar with BTCP working with them for the CMS crystals) on the crystal growth method. The idea is to use Czochralski method which was previously used at BTCP and double or triple doping. Misha made an interesting comment about the CMS crystals saying that those had been doped with La only and not the combination of La and Y that was later found to produce better light yield and radiation hardness. If all goes well with the PWO production, Rainer will order the additional crystals needed. Crytur's estimate for the pricing is a relatively large cost per crystals in the starting phase, which may decrease to ~$1000/crystal for large quantities in the long run. Rainer seemed optimistic about the Crytur option.

- **Opportunity for NPS**: in an ideal situation NPS would require ~1000 new PWO crystals within the next ~5 years. In the future, an electromagnetic calorimeter for the EIC could require 5000-6000 PWO crystals. Craig Woody who is co-spokesperson of the EIC calorimeter R&D consortium suggested to submit a proposal to the EIC R&D opportunity in June with the main focus being R&D with Crytur produced PWO crystals and their readout using different methods, e.g., conventional PMTs, SiPMs or APDs. The latter are also being tested for the scintillating fiber EIC calorimeter R&D. One could imagine doing similar characterizations as those we are planning to do with the SIC crystals. The readout would be an interesting addition as it apparently

had never been done with PWO. Craig said that he will talk with Huan Huang (UCLA) who is the other co-spokesperson on the consortium to see how such a PWO proposal would fit in the overall EIC R&D plans. He recommended to also speak with Glenn Young from JLab who is currently Chair of the EIC R&D committee to explain the current PWO supply problems.