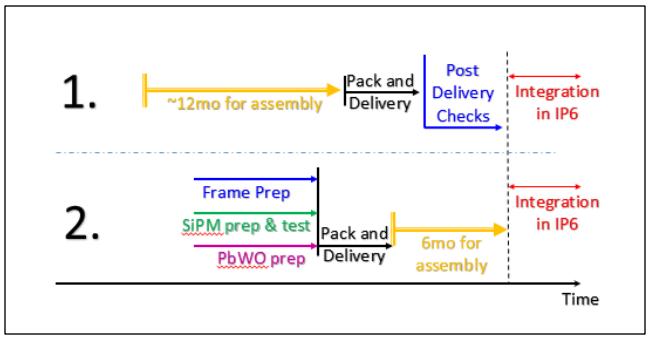
EEEMCAL Space/Room requirements for construction/assembly

July 2024

The following is the overall current plan based on a discussion with an EEEMCAL subgroup, where option (1) is for on-site assembly to occur at JLab and option (2) is for wrapping and prep at Jlab but final assembly at BNL. A very rough schematic visualizing the two options is shown below.



Option (1): this option is preferable in general, for the following reasons: better access to experts, ease of assembly and access to JLab, etc. It may also be advantageous to have the assembly at JLab since it would allow for a longer assembly time, possibly staged, or carried out in multiple waves rather than continuously. Overall, this option gives more flexibility and time to work out issues during the assembly and pre-installation phases.

Option (2) It is feasible but means that the assembly process would have a hard stop date when integration needs to begin. Depending on how the group that designs/constructs the mechanical frame wants to handle that process this option could complicate their strategy. This option could have an advantage if there are any long lead items that would make a later assembly stage a better option. Starting later means there would be more time to accumulate either the $PbWO_4$ or the SiPM assemblies.

A few additional comments:
* It could be beneficial that, in either choice of plan, that the actual assembly of the detector be made more flexible. Having the (university/lab group) mechanical assembly team, e.g., IJCLab-Orsay, teach the process to a staff member so that if issues arise it could avoid work stoppage.

* Option (1) will require some special work done to create a support frame with vibration mitigation that can support the weight of the detector stably and safely. It would need to disperse the load and possibly a special transport would need to be involved. But these are engineering challenges and we believe solutions can be worked.

* Both options would presumably require that long term storage space is needed here at JLab for the crystals and electronics, but having the frame stored and assembly done at JLab would be the better option for reasons above. And both methods will require that some standalone testing DAQ post assembly.

The following is based on another discussion with an EEEMCAL subgroup about the period from crystals/SiPMs arriving to shipping components or the entire detector to BNL, highlighting the space requirements as requested. This may of course need further iterations.

1) In the scenario, where we proceed with the procurement through the project the crystals would arrive, be checked, and then be accepted. Based on the Crystal SOW, it seems that the place where the checking of the crystals could be JLab. This might have certain advantages as we already have some space and equipment set up for this checking.

The storage space for the crystals includes a few different aspects that I outline below. For example, in addition to the crystals we would also need storage space for the wrapping material (ESR and Tedlar wrapper) and space for the actual wrapping.

2) At this time, we will assume that the wrapping material will be sourced from a vendor. If there is a need **to prepare the wrapping material in-house, we would need a table in a clean space, approximately 300 ft^2 with cabinets for storage.** Preparing the wrapping material would require about ~200 hours.

3) Having the wrapping material available at the correct sizes the next step would be the pre-shaping of the ESR material. For this a specialized jig is required - at JLab we have 16 jigs available from the NPS project - and an industrial oven. **For the pre-shaping with the oven another workspace of ~300ft^2 would be required and it would need to be a dust-free environment. In the current updated safety environment**, this work would likely have to be performed by skilled workers. For storage of the wrapping material and final shaped articles three standard storage cabinets would be sufficient. It would also be necessary to have ESD (static free) bags at hand.

4) The **wrapping of the crystals with the pre-shaped wrapping material we estimate to require another 300 ft^2 clean space (different from the oven space above) with an additional storage space of 350 ft^2 holding four rolling rack type shelving units** as used for the NPS assembly final stage. Based on our NPS experience, the wrapping would take about six months with one senior postdoc, one postdoc, one senior grad, and three additional skilled workers (scientists/faculty/university researcher).

5) After these steps are done, we could indeed consider performing the assembly of crystals into the frame at JLab (as you say in point #2 below) and then transporting the detector long distance up to BNL. I have no experience with such transportation but after considering in detail the steps, it seems worth further exploring. Do we have any idea about costs of transportation of a full (shock-sensitive) detector?

13) (out of order item as additional steps necessary - see below) For the f**inal assembly a work space of three times the size of the EEL-118 room at JLab (still must get the dimensions), a 5-ton crane, and a high-bay area for movement/loading and unloading of the final detector would be needed**. We **estimate a minimum of six months to assemble the detector** assuming four skilled workers and many students.

Of course, before final assembly of the detector, we should also consider the steps for the SiPMs, e.g.,

6) SiPMs will arrive, be checked (initial Vopp testing, inventorying, and storage), and accepted. This could be done at universities.

7) SiPMs are mounted on their boards - either in-house or sent to a vendor

8) Need storage of the SiPM boards

9) We assume that the SiPM boards will be assembled with PWO blocks and tested together. This would allow for a module matching with crystals during the testing and calibration phase

10) After steps 6 - 9 are complete, one could consider assembly of the crystal modules into the frame at JLab (same as point #5 above)

Also, before the final assembly we will need to consider cables and front-end electronics testing.

11) Cables for LV and signals on SiPMs will need to be QA checked for noise and voltage rating specifications to be decided later, but no less than expected experimental loads and voltages

12) Testing of FEE including the signals and LV distribution systems with real hardware elements for QA checks

13) listed above

14) Shipping the final article to BNL

15) Integration/final testing of the detector in-situ