

Procurement and test of the SiPMs for ProtoDUNE-VD

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Nov 18, 2022

Procurement

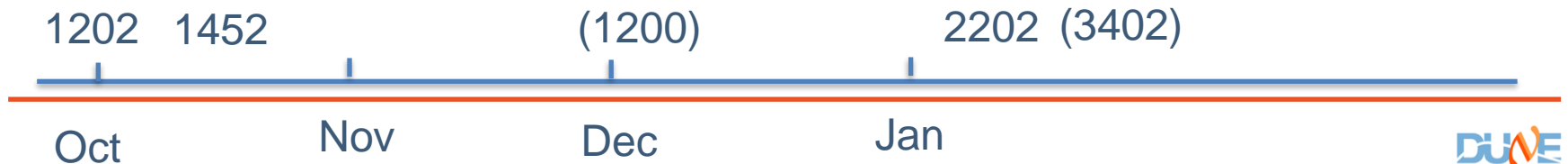
500 HPK SiPMs purchased by INFN and sent to UCSB. **DONE (UCSB)**
[Note: the SiPMs will be installed in the final flexi: no more need to patch the cables]

702 HPK SiPMs purchased by Spain. Available in CIEMAT. Sent to SCEN last week and ready to be installed in flexi (see below)

250 FBK SiPMs purchased by FNAL/CERN. Now at CERN. They will be sent to SCEN next week (see below).

750 FBK SiPMs purchased by INFN. Expected delivery date Jan 20, 2023. On the critical path!

(NEW) purchased **1200 additional HPK SiPMs** to be delivered in early december. Paid by Univ. of Milano Bicocca (500) and FNAL (700)



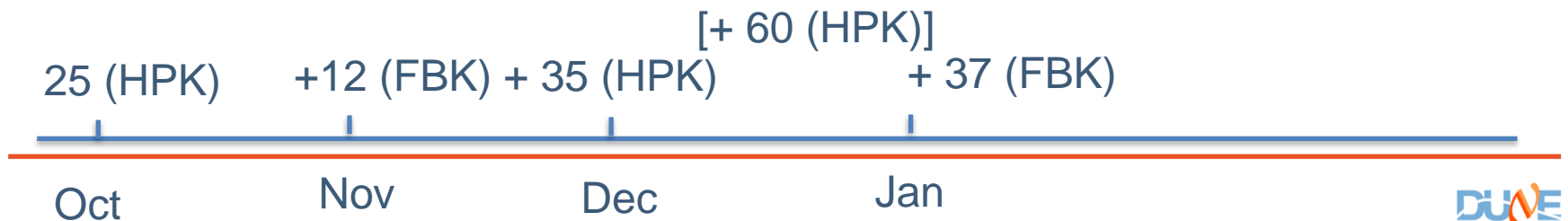
Flexi boards and population

500 HPK SiPMs in 25 flexi boards Boards purchased by UCSB (Cirexx) and populated

140 HPK-like and 60 FBK-like flexi boards produced by Cirexx (US). Sent to SCEN for population.

Population of the flexi in SCEN (Italy) with HPK SiPMs

- Order placed for all SiPMs but the new ones (1200) (paid by Univ. of Milano-Bicocca – grant of A. Minotti)
- Delivery of the 702 HPK SiPM in boards: next week. We asked SCEN to send them directly to CIEMAT and Granada (+6 populated boards to Milano for administration reasons)
- We are negotiating the population of the boards with the new 1200 SiPMs



Population of the flexi in SCEN (Italy) with FBK SiPMs

We got a request from FBK to make a preliminary test of SiPMs in the flexi boards because they are not fully confident about the soldering procedure of SCEN

[note: in FD1-HD FBK SiPMs are not soldered but fixed with a die attach to the G10 boards]

(Painful 😊) agreement:

FBK is testing it right now. Results expected next week.

- If soldering is confirmed, we go on as planned
- If soldering induces a deterioration of the epoxy transparency, FBK will die attach the SiPMs in the flexi boards and do quality tests. In this case, we will cancel the order to SCEN for the population of the FBK flexi boards and use this money to populate the new 1200 HPK SiPMs

SiPM tests

Critical item because the test procedure has never been validated

Proposal from the photosensor WG:

- Test them in group of 20 SiPMs (no time to develop smarter configurations for ProtoDUNE-VD but work ongoing for Module-1)
- 3 thermal cycles, I-V in reverse, DCR in LN, illuminate each SiPM with a LED to check if it is in operation
- Rationale: DCR checks for shorts, LED checks for disconnected SiPMs
- Time: about 1 board/h (7 boards per day in parallel)

Laboratories: CIEMAT, Granada, UCSB + others, if needed (e.g. Milano Bicocca, Valencia)

Delivery to CIEMAT and Granada expected on Nov 28. **1 week of delay with respect to the original plan!** (caused by the delay in the delivery of the flexi boards)

Useful reminder

What is the operating voltage of the ProtoDUNE-VD SiPMs?

In FD1-HD we work at 45% PDE. In ProtoDUNE-VD we suggest to slightly increase the overvoltage to be in the 50% PDE range because the PoF is not tunable once it is installed.

FBK “triple trench” (DUNE custom sensors):

cold: breakdown voltage 27 V, operating voltage $27+4$ V = 31 V [31.5 V is also fine, as suggested by Ryan]

warm: breakdown voltage 33 V, operating voltage $33+4$ V = 37 V [37.5 V is also fine, as suggested by Ryan]

HPK “S16517” (i.e DUNE custom sensors):

cold: breakdown voltage 42 V, operating voltage $42+3$ V = 45 V

warm: breakdown voltage 52 V, operating voltage $52+3$ V = 55 V

Where do these numbers come from?

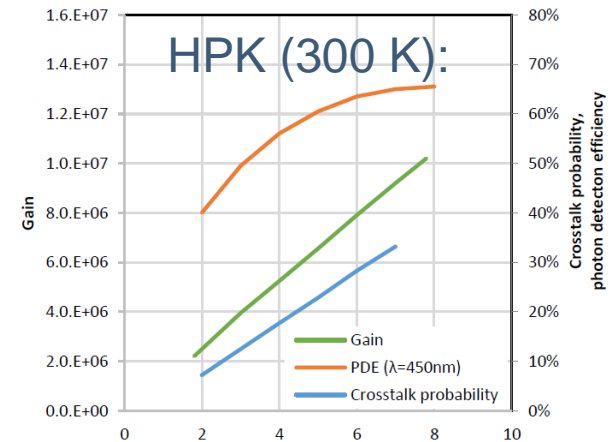
Warm HPK: data from vendor (V_{bk} and OV @ 50% PDE)

Warm FBK: data from vendor (V_{bk} and OV @ 50% PDE)

Cold HPK: V_{bk} data from us. No data on PDE at cold

Cold FBK: both V_{bk} and PDE at cold from us+triumf measurements

- (a) see Elisabetta Montagna's [talk](#)
- (b) see Marco Guarise's [talk](#)
- (c) see Francesco Di Capua's [talk](#)



V_{bd} vs ID array

