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Urgent expenses for O5 upgrades

{{tds_code}}

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1. Scope of the document

The purpose of this document is to give a brief overview of the O5 upgrade urgent expenses to be carried out in 2024, before the release of the TDR.

2. Introduction

The plan of upgrades in preparation for O5 has the main target to overcome the limitations in the present optical layout. In fact, the difficulties in operating the detector with marginally stable recycling cavities became evident after the addition of the signal recycling cavity. For this reason, to allow the detector to benefit from all the techniques aimed at the reduction of quantum noise (high-power operation and frequency dependent squeezing), it has been decided to start the activities needed for the installation of stable recycling cavities.

The current timeline is driven by the procurement and realization times of some key items: the recycling mirrors and their suspension system prototypes, the vacuum chambers for PRM2/SRM2 and the prototype for the new SAT control electronic boards. To potentially participate in O5 before it concludes, we propose to advance these expenditures using the already available AdV+ Phase II Project budget, prior to the delivery and review of the TDR.

List of urgent expenses and their justification

1. Recycling mirrors:

There are three mirrors for each cavity (PRC and SRC). The requested expense concerns the procurement of the blanks and the order for the polishing. The dimensions of the mirrors have been defined in the Short Stable Cavities Preliminary Design Document ([VIR-0461B-24](#)) and will not change during the assembly phase of the TDR. On the other hand, some polishing specifications (namely the RoCs) could change in the next months, however the budget requested is needed to start the call for tender procedure, and the final specifications can be communicated to the polisher at a later date. Before proceeding with the procurement of the blanks, a light Internal Design Review will be carried out.

The overall budget request is **1.5 M€**.

2. Suspension prototypes:

In order to minimize the technical risk associated with the implementation of new seismic attenuation systems for the recycling cavity optics, it has been decided to produce and characterize prototypes for all new suspensions: PRM/SRM benchtop payloads; PRM2/SRM2; PRM3/SRM3 and SIB1/SDB1 benches. Since the characterization phase must give useful information for the finalization of the executive design, and well in advance of the final production, it is mandatory to start this activity before the end of 2024. It must be noted that the executive design of these prototypes will be the core of

the TDR chapters of the corresponding deliverables. Thus, as such, a full Internal Design Review will be done before allowing the commitment of the budget.

The budget requested for this activity is about **0.4 M€**.

3. Vacuum chambers for PRM2/SRM2:

These two vacuum chambers have a design very similar to the existing minitowers, and only minor changes are expected during the TDR assembly phase. For this reason the design of the corresponding vacuum chambers is already well advanced and the planning is to start the call for tender (it should be noted that a convention has to be put in place between EGO and CNRS for this purpose). In order to reduce the amount of work to be done in 2025, it is asked to start the fabrication of these two vacuum chambers this year. This will allow not only to have them available in time in 2025, but also to reduce the charge of work to be made in 2025 when the same persons will have to take care of the preparation of the other vacuum chambers and to other various tasks for the preparation of the central building. As for the suspensions, the design of these chambers will represent the corresponding TDR chapter, which will undergo the full Internal Design Review before committing the funds.


Their cost has been evaluated to be about **0.4 M€**.

4. SAT control electronics prototype:

Due to the aging of the components of the Superattenuator control electronics, the Pisa, Bologna and Perugia groups have recently presented a proposal for the development of new boards in view of O5 ([VIR-0406A-24](#)). The project internal review is already in progress and expected to end in a few weeks. Thus, a minimum budget is needed to start the prototyping activity, which is critical for the schedule of the implementation on the detector. In fact, it must be considered that, in order to maintain the detector' operability, the replacement of the old electronics must proceed serially one suspension at a time.

The requested budget is **0.1 M€**.

Item	Requested budget [M€]
Recycling mirrors	1.5
Suspension prototypes	0.4
Vacuum chambers for PRM2/SRM2	0.4
SAT control electronics prototype	0.1
Total	2.4

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3. Conclusions

To avoid a significant impact on the current schedule, some urgent expenditures must be committed in 2024. The risk of allocating budget to incorrect items is minimal, as these components are necessary for both Plan A and Plan B. The only difference is that, in the latter case, installation on the detector will occur at a later stage.