# AdV+ Phase II next steps

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for the Virgo Collaboration

VIR-1131A-23

# Outline

- Stable recycling cavities
  - Risk analysis
  - Internal review (with timeline)

- Other upgrades for Phase II

- Next steps

- Project Management Organization

# The two options

- Long solution (~80 m)
  - Requires additional buildings and vacuum systems

- Short solution (~10 m)
  - Within the present infrastructure; requires modifications to the vacuum system

- Both solutions allow Gouy phases ~20 degrees
  - Similar to LIGO/KAGRA; tunings are possible

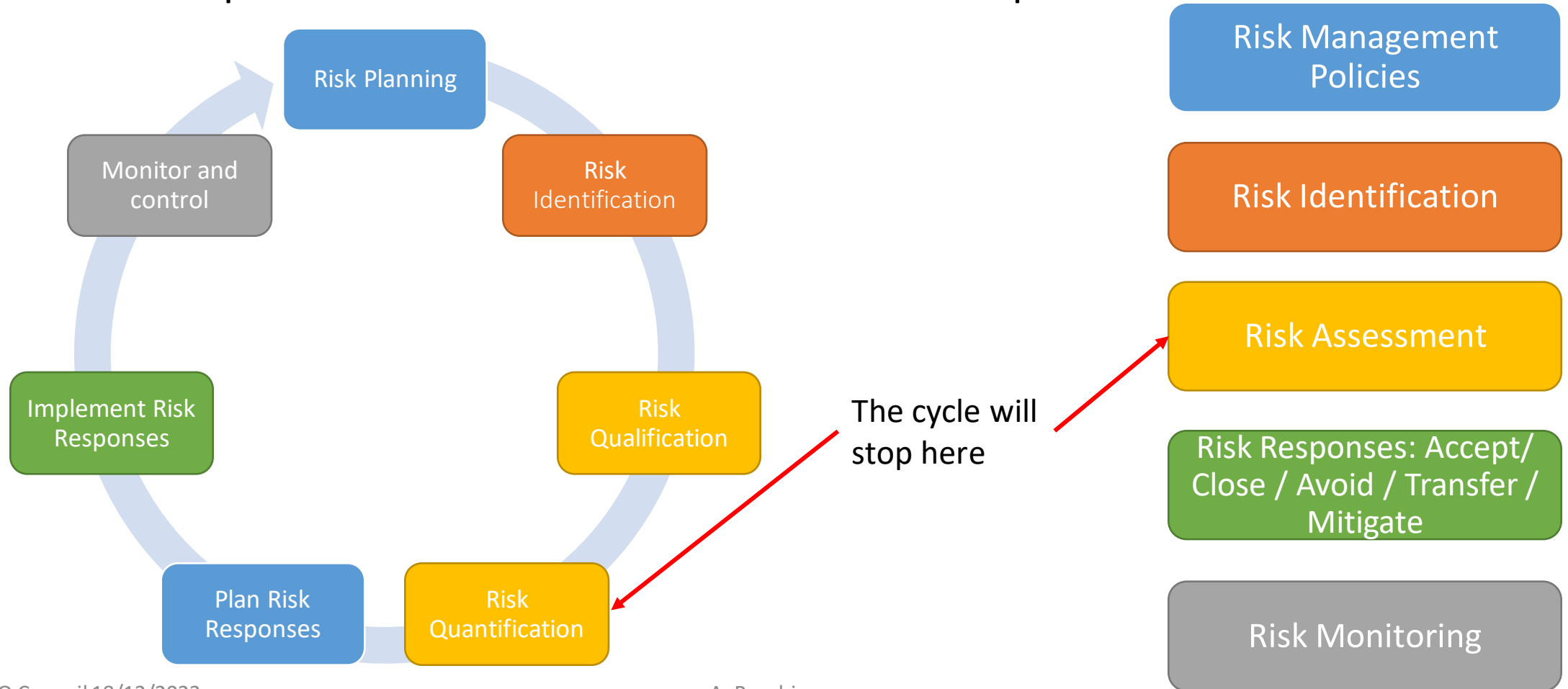- Details in Raffaele's presentation

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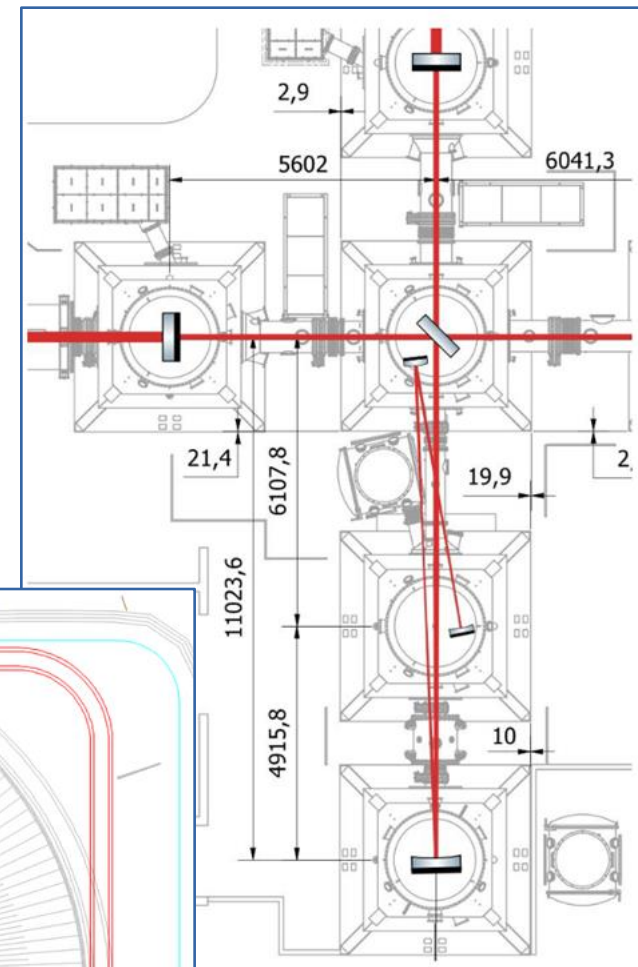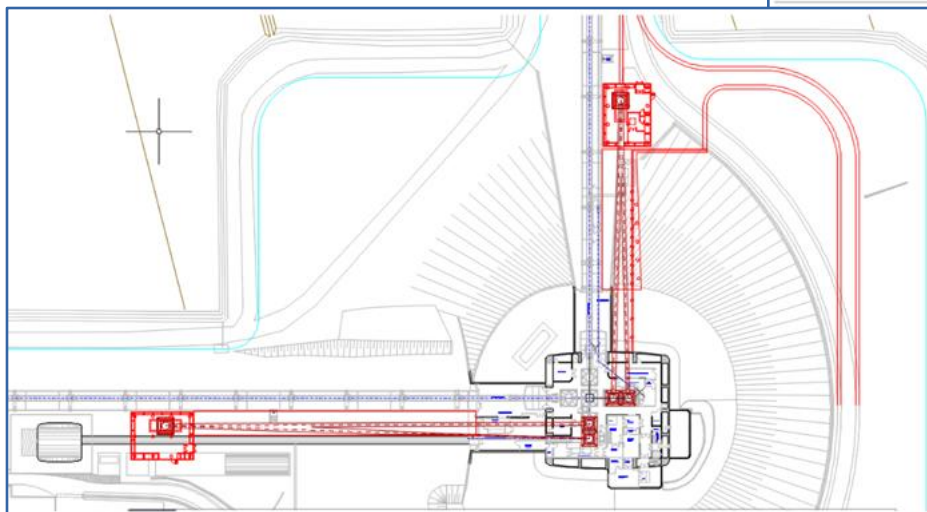
# Two options, one solution

- Two different viable configurations for stable recycling cavities have been studied.

- Preliminary information on cost (and spending profile) and schedule is available.

- The criteria for comparing the two options and the metric to guide the selection have been defined and are based on risk analysis:
  - Technical risks
  - Limitations for Virgo_nEXT
  - Schedule
  - Costs

- Data have been provided by the concerned SSMs (more than 40 risks identified)

| Risk ID | Risk Manager | Risk Description | SS | Option | Risk Evaluation | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Probability | Impact | Impact Type | Severity |
| SC001 | A. Rocchi | Impossibility to keep the present optical configuration for the INJ and DET HWS beams | TCS | Short Cavities | 2 | 2 | Cost | Low |
| SC002 | A. Bertolini | Availability on short term of Maraging steel for blade manufacturing | SAT | Both | 3 | 5 | Schedule | High |

# Risk analysis

- No Risk Lifecycle Management at this stage (but RMP available – VIR-1060A-23);
- It will be implemented with the TDR on the selected option.



The cycle will stop here

Risk Planning
Risk Identification
Risk Qualification
Risk Quantification
Plan Risk Responses
Implement Risk Responses
Monitor and control

Risk Management Policies
Risk Identification
Risk Assessment
Risk Responses: Accept/ Close / Avoid / Transfer / Mitigate
Risk Monitoring

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# How to combine the data

- Goal is to produce a single comparison table for the two options.

Total Cost

| Index | Option 1 | Option 2 |
|---|---|---|
| Cost (Severity) [M€] | 5 (1,7) | 3 (1,2) |
| Time (Severity) [Months] | 24 (10) | 36 (20) |
| Flexibility | 3 | 5 |
| Technical risks | 44 | 66 |

Possible cost increase

Flexibility for future upgrades (V_nEXT)

Technology risk

Possible delay

Schedule length

# Risk analysis

- Preliminary Risks identification (cost, schedule, technology) is done.

- Main goal of this effort is to:
  - Provide data for the comparison of the two options (and lead to a choice).
  - Provide placeholders for issues to be tackled during TDR production (when the full Risk Management Plan will be enforced).

- Procedure (and metric) for producing the comparison table between the two options has been proposed
  - First task of the internal review committee is to assess the validity of this metric

# Internal review

- Since this choice is a major step for the Collaboration, it has been decided to appoint an internal review committee.

- The goal of the ongoing process is to arrive at a choice, based on as objective and quantitative criteria as possible, for the baseline configuration of stable cavities to be presented to the EGO Council.

- Proposed timeline:
  - January 15: release by the project management of a document with the detailed risk assessment and a proposal of a baseline configuration for stable cavities.
  - January 31: release of the report from the review committee.
  - February 5-8: Virgo week. Collaboration-wide discussion on the proposal of a baseline configuration and presentation of the report of the review committee.
  - February 8: VSC meeting. Final discussion on the proposal for the baseline solution. The document with the proposal is sent to the EGO Council.

# AdV+ Phase II

- Main changes
  - Larger beams on end test masses
    - 6 cm radius $\Rightarrow$ 10 cm radius
  - Larger end mirrors
    - 35 cm diameter $\Rightarrow$ 55 cm diameter
    - 40 kg $\Rightarrow$ 100 kg
  - Better mirror coatings
    - Lower mechanical losses, less point defects, better uniformity
  - New suspensions/seismic isolators for large mirrors
  - Further increase of laser power
    - 40W $\Rightarrow$ 60W $\Rightarrow$ 80 W

- Target: BNS range 145-260 Mpc (LIGO aims at 240-320 Mpc)
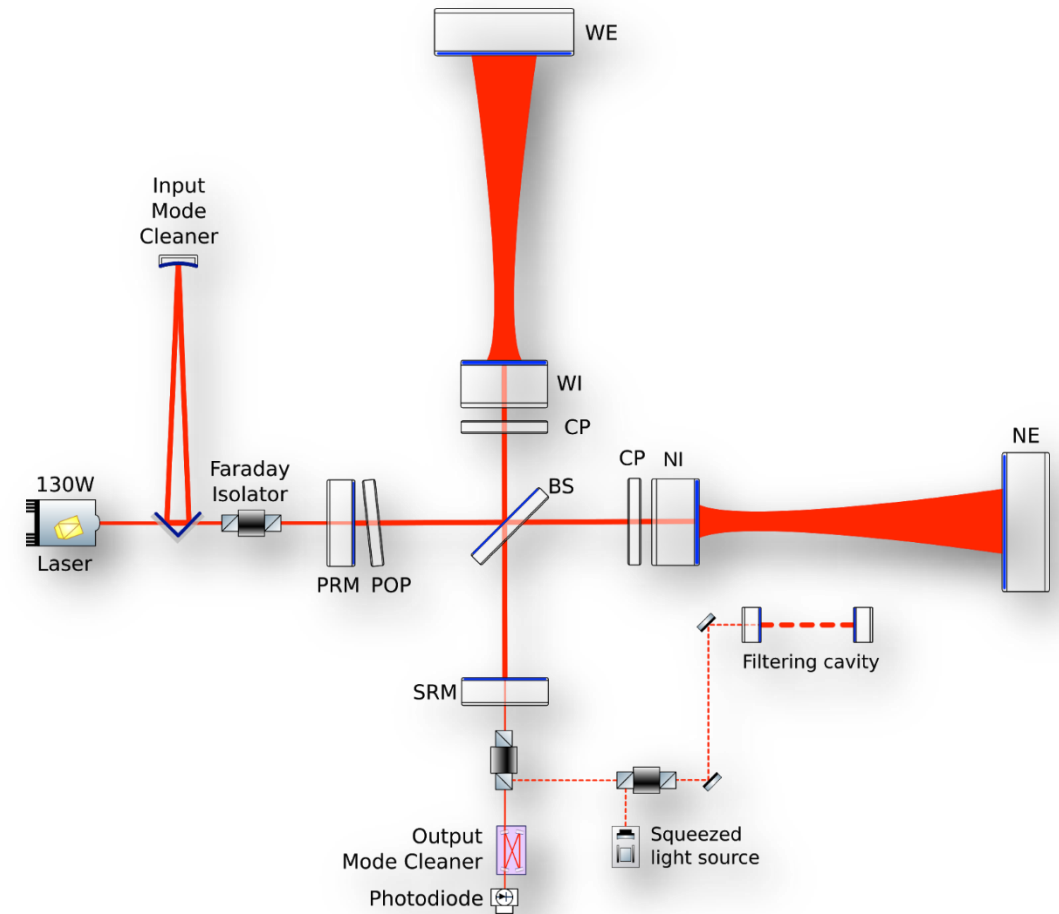
# Coating research

## Slide 9: 3. Status in November

### Summary: best results on HR stacks

| | TiGeO2 CSU | | TiGeO2 LMA | | TiSiO2 Five Nine | TiSiO2 LMA | |
|---|---|---|---|---|---|---|---|
| Sample | 230627a | 230015 | 11474 | | | 11422 | 11420 |
| Annealing Temp (°C) | 600 | 600 | 600 | 600 | 850 | 850 | 600 |
| Absorption (ppm) | 2.6 ** | 2.3 * | 1.8 ** | 2.6 * | 0.82 **** | ** | 0.78 * |
| Scattering (ppm) | *** | 120 * | | 9.5 * | 4.6 | | 7.7 * |
| CTN (ALIGO ratio) | 0.67 ° | *** | 0.8 | *** | 0.76 | 0.71 | *** |
| Defects | | 5 large bubbles many defects | Few bubbles | Few bubbles | | Cracks | Cracks |

\* LMA measurement   \*\* MIT measurement
\*\*\* Not measured   \*\*\*\* PCI Glagow
° Optimized stack

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## Slide 12: Conclusion

➢ **TiGeO2 :**
  ➢ **Bubbles after annealing**
  ➢ **Absorption too high**
  ➢ **CTN best value:**
    ➢ **0.8 of aLIGO on HR coated in the GC**
    ➢ **0.67 on CSU optimized stack**

➢ **TiSiO2 :**
  ➢ **Cracks (and sometimes bubbles) after annealing**
  ➢ **Optical losses (Absorption & Scattering) within specifications if no bubbles**
  ➢ **Best CTN value: 0.71 of aLIGO on HR coated in the GC**

➢ **We are not yet ready to coat a pathfinder**
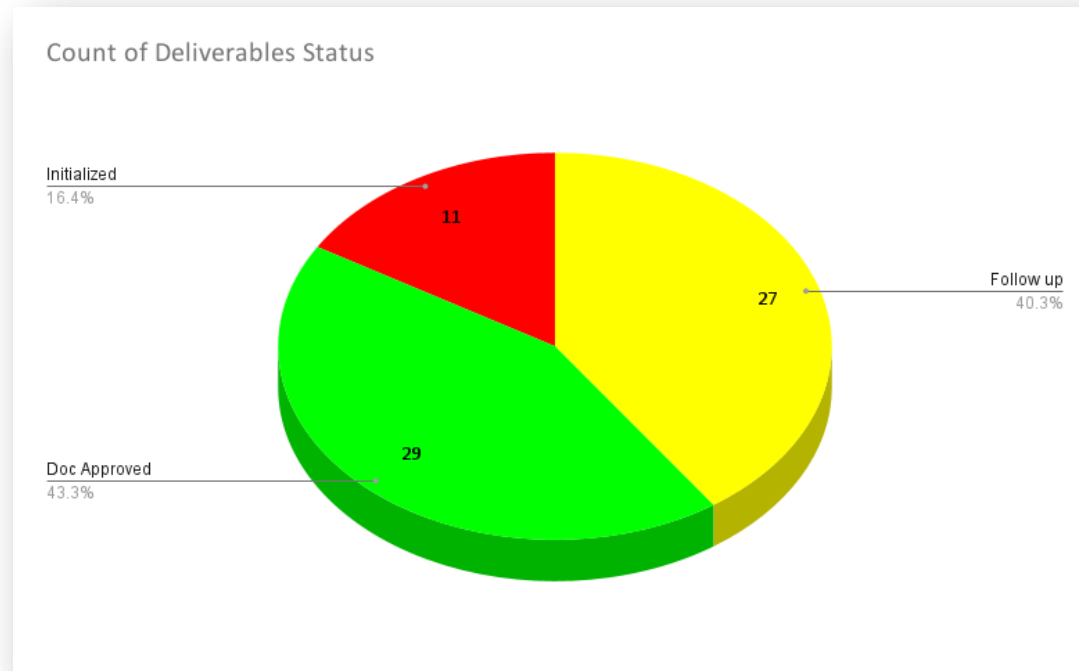
C. Michel, VIR-1002A-23

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- Bottom line: there are progresses but no better coating available yet
  - N.B. This can affect also the LIGO schedule

# Status of the budget

- About 52% of the budget committed (where Production Readiness Reviews are complete)

- Review of the deliverables' TDR chapters not yet finished (43% done)

### Count of Deliverables Status



| WBS | Cost | Committed | Remaining |
|---|---|---|---|
| OSD | | | |
| PSL | 308 | | 308 |
| INJ | 196 | 3 | 193 |
| DET | 416 | 15 | 401 |
| SLC | 307 | 159 | 148 |
| MIR | 7203 | 6992 | 211 |
| PAY | 663 | 358 | 305 |
| TCS | 1253 | 17 | 1237 |
| SAT | 385 | 24 | 361 |
| ALS | 16 | | 16 |
| ISC | | | |
| DAQ | 250 | 186 | 64 |
| CAL | 360 | 10 | 350 |
| NNC | | | |
| VAC | 1089 | 187 | 902 |
| **Total** | **12446** | **7951** | **4496** |
| Contingency | 1416 | | |
| **Total w/cont.** | **13862** | | |

# Next steps

- After submission of the baseline design document to the Council:

1. Produce the PBS for Stable Cavities

2. Assemble the WBS and TDR for Stable Cavities
   a. Start (if needed) review process of the Organization Breakdown Structure

3. Define final configuration for Phase II (Large ETMs or not, other improvements)

4. Define interfaces between Stable Cavities and Phase II
   a. Deliver and implement a Requirements Management Plan
   b. Implement the existing Risk Management Plan

5. Start Change request processes for Phase II deliverables interfering with Stable Cavities

6. Assemble global planning for installation (and commissioning – with the next commissioning coordinator) of Stable Cavities and O5 upgrades.

# Project Management Structure

- Current OBS (VIR-0597C-19) includes:
  - The Upgrade Coordinator (aka the Project Leader)
  - The Technical Manager (also serving as Configuration Manager)
  - The System Engineer (also serving as Quality Manager and Risk Manager)
  - Five System Managers, each sub-managing a fraction of the SubSystems:
    - ITF – for OSD, PSL, INJ, SLC, DET, SBE
    - SUM – for MIR, TCS, PAY, SAT, CRD
    - ESC – for ISC, ALS, DAQ, CAL
    - ENV – for NNC, INF, VAC, EMS
    - QNR – for SGD, SVS, SIN, FLT

# Project Management Structure

- ## My personal opinion on this structure is:
  - ### The division in "Systems" follows some criteria of functionality, but does not help managing interfaces between SS belonging to different Systems
    - Needed to define new over-structures to make some SS talk to each other (i.e. the optical tuning working group – with a loosely defined mandate)
  - ### Mandates of the SMs and SSMs are strongly overlapping (this has created frictions)

> - The SM is the person directly responsible to the Project Leader for ensuring that the design, construction and commissioning of the subsystems inside the system perimeter are carried out on schedule, within the budget and in a way that guarantees the required performance.

> - The SSM is the person ensuring that the design, construction and commissioning of the subsystem is carried out on schedule, within the budget and in a way that guarantees the required performance.

  - ### Not enough person-power for some crucial processes for the Project Management:
    - Enforce Risk Management Plan
    - Enforce Requirements Management Plan

# Project Management Structure

- To solve these issues, my proposal is to:
  - Remove the division into Systems
  - Move towards a more Project-oriented organization by forming a Project Office by adding to the current person-power:
    1. A dedicated Quality/Risk Manager
       - Positive feedback from Christelle Buy, she is available to take on the task, requiring hiring a junior engineer with a fixed-term contract.
    2. An On-site Integration Manager

  - Two more positions would be very useful: a Configuration Manager and a Requirements Manager

- The missing positions in the PO organigram may require hiring (or different schemes, as done for the ET Project Office)

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The bottom line

# Conclusions

- Two viable solutions for implementing stable recycling cavities in Virgo have been studied.
  - Methodology and criteria for the choice are under internal review.

- Very busy months ahead for the Collaboration:
  - SSMs for the preparation of the O5 upgrade (at large including Stable Cavities)
  - Collaboration members to serve as internal reviewers
  - Project Office to coordinate all these efforts

- Re-organization of the Project Management structure to help running some relevant project processes.

- Need to keep up with LIGO upgrades: we must not think that stable cavities are the only Virgo upgrade in view of O5.

# Spare slides

# How to combine the data

- Goal is to produce a single comparison table for the two options.

- Proposal (under review):
  - For **Costs** and **Schedule**: compute the sum of the risk severities of the concerned option.

| Cost (k€) | Option 1 | Option 2 |
|---|---|---|
| Risk 1 | 7,5 | 210 |
| Risk 2 | 26,25 | 1,5 |
| Risk 3 | 150 | 10,5 |
| … | | |
| Risk Severity | 183,75 | 222,00 |

| Schedule (months) | Option 1 | Option 2 |
|---|---|---|
| Risk 1 | 0,5 | 2,7 |
| Risk 2 | 1,5 | 0,6 |
| Risk 3 | 4,2 | 1,8 |
| … | | |
| Risk Severity | 6,2 | 5,1 |

These values are a measure of how much the cost/schedule can increase for each of the options

# How to combine the data

- Goal is to produce a single comparison table for the two options.

- Proposal (under review):
  - For **Technology**: take the sum of the severity scores of the different configurations.
  - Less straightforward for the "Limitations for Virgo_nEXT", a possible way to go:
    - Limitations will be assigned a Flexibility_index equal to +1, while, in case of clear advantages, the value of the Flexibility_index will become -1. The overall Flexibility_index of each configuration will be evaluated by summing the indexes of advantages and disadvantages.
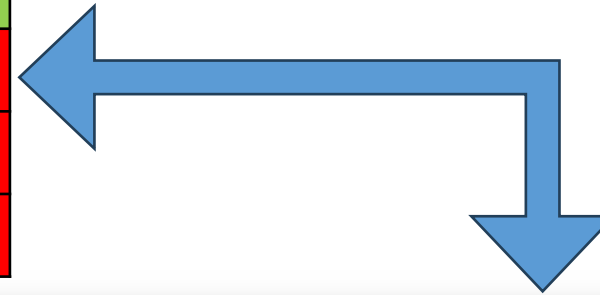
| Technical | Option 1 | Option 2 |
|-----------|----------|----------|
| Risk 1 | 2 | 16 |
| Risk 2 | 10 | 3 |
| Risk 3 | 20 | 7 |
| … | | |
| Risk Severity | 32 | 26 |

Some are coming in the form of risks

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How to make a decision?

- Need to collect:
  - ◆ Technical risks
  - ◆ Schedule (and schedule risks)
  - ◆ Cost (and cost risks)

- Then the basic questions will be (in order of importance):
  - ◆ Are there dangerous technical risks?
  - ◆ Are there limitations for Virgo-nEXT?
  - ◆ Will we be able to join O5? If yes, when?
  - ◆ How much does it cost?