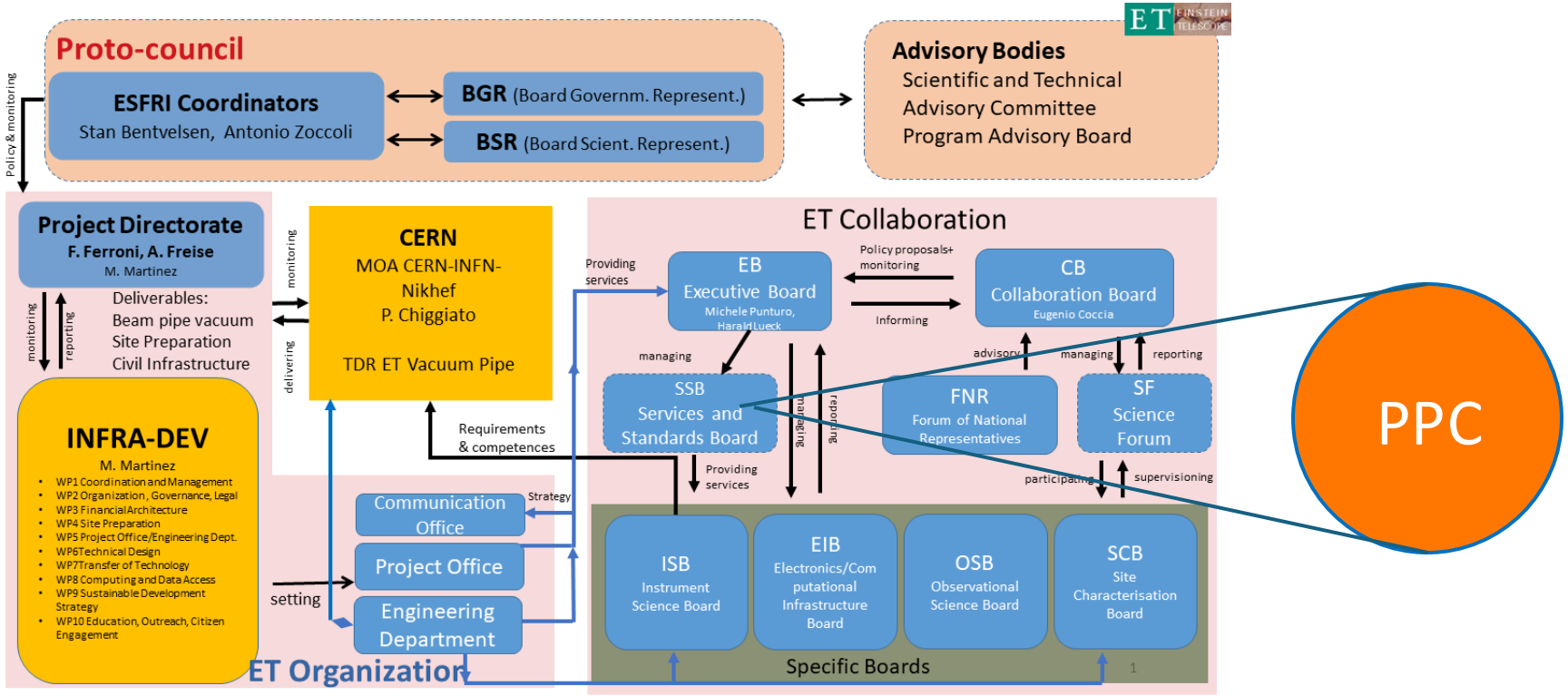
Status of the PProgram

E. Majorana, R. De Rosa



ET-0054A-25 March 2025, last presentation on May 26, 2025 **XV ET Symposium | Bologna**
https://wiki.et-gw.eu/pub/SSB/ProjectProgramCommittee/PPC_ISB.pdf

PProgram motivation

•**Main function 1)** The PPC is in charge for formulating and updating the program of ET (Bylaws Sept 2023). This program must be consistent with the ET CDR and with the TDRs to come and approved by Collaboration Board.

• The program must be consistent with ETO Directives.

• The ET program is then used by the PPC to define the core tasks of the the ET Collaboration. The list of tasks must be pledged by the RUs/individuals.

•**Main function 2)** The PPC is in charge for negotiating the Collaboration Agreement Documents (CAD) with new member RUs and to annually crosscheck their performance (Bylaws Sept 2023). Standard review activity interval should be embedded in the CAD subscribed by RUs integrated in the timeline.

• PPC must facilitate/optimize as much as possible the collaboration efforts.

• In some cases, the reviews may be performed transversely, by grouping functional or integration aspects dealt by different RUs.

• The definition of the review procedure will be one of the first tasks of PPC.

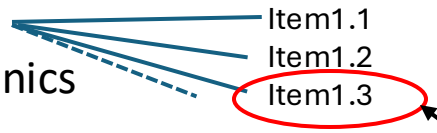
The Project Program is divided in **three Parts.** Each one involves one or more SBs

I. The Science and Data Analysis
II. The Hardware Implementation
III. The Site

Each **Part** is divided in specific **Sections**

1. Science cases
2. Science targets evaluation for the site selection and instrument optimization
3. Modelling and data analysis to extract scientific information from signals
4. Multi-Messenger and multi-band synergies
5. Evaluation of computational needs and requirements

1. Interferometer
2. Controlled mechanics
3. Electronics
4. Vacuum and Cryogenics
5. Underground Apparatus Infrastructure
6. Detector environment sensors



4 descriptors are associated to each item

1. Seismic Characterization
2. Electromagnetic Characterization
3. Air
4. Rock
5. Water

Status of the Main PProgram structure

1. Science cases
2. Science targets evaluation for the site selection and instrument optimization
3. Modelling and data analysis to extract scientific information from signals
4. Multi-Messenger and multi-band synergies
5. Evaluation of computational needs and requirements

1. Interferometer
2. Controlled mechanics
3. Electronics
4. Vacuum and Cryogenics
5. Underground Apparatus Infrastructure
6. Detector environment sensors

1. Seismic Characterization
2. Electromagnetic Characterization
3. Air
4. Rock
5. Water

OK

Section contents (items)
PART I

- Slight tuning going on (Branchesi, Novak)
- Cross-check needed by EIB

1	**science case**	
	1.1	Fundamental Physics and Cosmology
	1.2	Population Studies
	1.3	Subatomic Physics, stellar Collapse and Neutron Stars
2	**Science targets evaluation for the site selection and instrument optimization**	
	2.1	Site-dependent Target Science
	2.2	Science targets
3	**Modelling and data analysis**	
	3.1	Waveforms development
	3.2	Data Analysis Development
	3.3	Common Tools and Definition
4	**Multi-Messenger and multi-band synergies**	
	4.1	Multi-messenger Modelling of GW sources
	4.2	Synergies with electromagnetic Observatories: Instrument Requirements, observational Strategies, joint DA
	4.3	Synergies with Neutrino Observatories: Instrument Requirements, observational Strategies, joint DA
	4.4	Synergies with other ground-based GW Detectors: Instrument requirements, observational strategies, joint DA
	4.5	Multi-band synergies with space-based GW Detectors: Instrument requirements, observational strategies, joint DA
5	**Evaluation of computational needs and requirements**	
	5.1	Mock Data Challenges
	5.2	Detection and Parameter Estimation
	5.3	Low-Latency Infrastructure Requirements.
	5.4	Data and workflow management infrastructure requirements

Section contents (items) PART II

- A specific effort required to ISB to remap the activities
- Cross-check needed by EIB
- ETO roles on specific items

1	**Interferometer**	
	1.1	The interferometer layout (provides the agreed document concerning the core optics)
	1.2	Core optics (Optical Cavities and BS, Coatings)
	1.3	Injection system (lasers, IMC, REFC, benches)
	1.4	Detection system (OMC, photodiodes special arrangements expected)
	1.5	Auxiliary QNR systems
	1.6	TCS/RoC sensing/RoC actuation systems
	1.7	Calibration system
	1.8	Scattered light mitigation
2	**Controlled Mechanics**	
	2.1	Seismic isolation system layout for the core optics (provides the agreed document
	2.2	Core Optics Seismic Isolation System (includes local and inertial control devices)
	2.3	Bench Seismic Isolation systems (includes local and inertial control devices)
	2.4	Room Temperature Payloads (includes Local control devices)
	2.5	Cryogenic Payloads (includes specific local control devices)
	2.6	Digital control devices meant for suspended mechanics
3	**Electronics and related SW**	
	3.1	Multipurpose (support to Interferometer sensing and control and mechanics)
	3.2	Digital RT connection
	3.3	DAQ
	3.4	Front-end Computing facility (EIB expert)
4	**Vacuum and cryogenics**	
	4.1	Room Temperature vacuum
	4.2	Cryotraps for RT vacuum
	4.3	TM cryostats and cryotraps
	4.4	Underground vacuum service
	4.5	Frontend data storage service and distribution CRYOVAC
5	**Apparatus**	
	5.1	Cryogenics
	5.2	HVAC ETO ?? EGO INFRAS ??
	5.3	Clean Rooms ETO ?? EGO INFRAS ??
	5.4	Cranes … ETO ?? EGO INFRAS ??
	5.5	Fiber Network ETO ?? EGO INFRAS ?? EIB ??
6	**Detector environment sensors**	
	6.1	Seismometers/Tilt/Newtonian Noise reconstruction
	6.2	EM (includes Schumann…, active injection,…)
	6.3	Air (pressure/T/Humidity)
	6.4	Acoustic/LIDAR (atmospheric NN)

Section contents (items) PART II

- Effort by ISB chairs to remap WPs activities on the contents

- Cross-check needed by EIB
- ETO roles on specific items
- Names of editors: TBD by ISB, just seed options provided so far

1	**Interferometer**	
	1.1	The interferometer layout **WP 3.1, WP 3.2, WP 3.3**
	1.2	Core optics **WP 2.1, WP 2.2**
	1.3	Injection system **WP 2.4**
	1.4	Detection system **WP 2.4**
	1.5	Auxiliary QNR systems **WP 2.5**
	1.6	TCS/RoC sensing/RoC actuation systems **WP 2.6**
	1.7	Calibration system **WP 3.5**
	1.8	Scattered light mitigation **WP 2.7**
2	**Controlled Mechanics**	
	2.1	Seismic isolation system layout for the core optics **WP 3.1, WP 3.2, WP 3.3**
	2.2	Core Optics Seismic Isolation System **WP 1.1**
	2.3	Bench Seismic Isolation systems **WP 1.5, WP 1.6**
	2.4	Room Temperature Payloads **WP 1.3**
	2.5	Cryogenic Payloads **WP 1.2**
	2.6	Digital control devices meant for suspended mechanics
3	**Electronics and related SW**	
	3.1	Multipurpose (support to Interferometer sensing and control and mechanics)
	3.2	Digital RT connection **WP 3.4**
	3.3	DAQ **WP 3.4**
	3.4	Front-end Computing facility (EIB expert)
4	**Vacuum and cryogenics**	
	4.1	Room Temperature vacuum **WP 4.1**
	4.2	Cryotraps for RT vacuum **WP 4.3**
	4.3	TM cryostats and cryotraps **WP 4.3**
	4.4	Underground vacuum service
	4.5	Frontend data storage service and distribution CRYOVAC
5	**Apparatus**	
	5.1	Cryogenics **WP 4.4**
	5.2	HVAC ETO ?? EGO INFRAS OK!
	5.3	Clean Rooms ETO ?? EGO INFRAS OK!
	5.4	Cranes … ETO ?? EGO INFRAS OK!
	5.5	Fiber Network ETO ?? EGO INFRAS ?? EIB ??
6	**Detector environment sensors**	
	6.1	Seismometers/Tilt/Newtonian Noise reconstruction **WP 5.5, WP 5.1**
	6.2	EM **WP5.2**
	6.3	Air **WP5.2**
	6.4	Acoustic/LIDAR **WP 5.1**

Section contents (items)
PART III

OK

1	**Seismic Characterization**	
	1.1	Surface and underground seismic noise
	1.2	Localization of anthropogenic seismic noise sources
	1.3	Site characterization for Newtonian Noise (sensor distribution optimization)
2	**Electromagnetic Characterization**	
	2.1	Surface and underground magnetic noise
	2.2	Impact of local EM noise sources (trains, windmills, ...)
3	**Air**	
	3.1	Surface acoustic noise including wind (for atmospheric Newtonian noise studies)
	3.2	Infrasound/air pressure underground propagation
	3.3	LIDAR + Cloud camera for atmospheric Newtonian Noise
4	**Rock**	
	4.1	Faults and fractures
	4.2	Rock mechanical data and mass characterization
5	**Water**	
	5.1	Hydrogeological model
	5.2	Hydraulic conductivity and porosity of the underground environment

Names of editors ready

The motivation of this Workshop

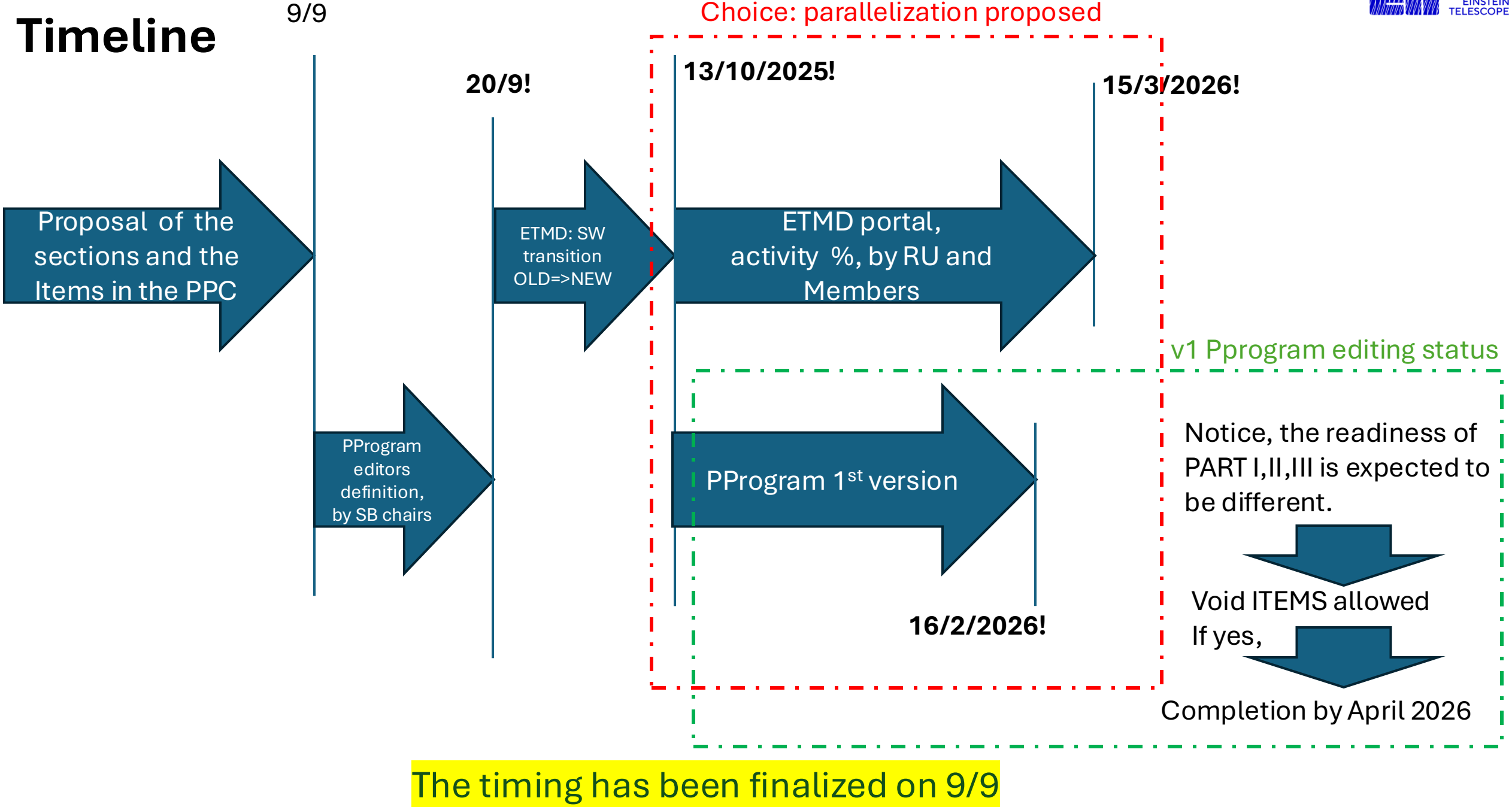
- Initially, an interface level was proposed by PPC, meant not to touch the definition of the activities in the ETMD and the internal breakdown of each SpecificBoard (SB).

- On the contrary, ETCB asked to make an effort to align the ETMD to the program. Also in this case, the internal organization of the SBs relies on the vision of the chairs and is not required to be changed.

How to implement the rearrangement:
ETMD management & RU coordinators (G Hemming)

Works performed **in parallel**, by SB chairs and PPC:
involvement of collaborators as editors of the **Item Operative Status** pages of the PProgram

Timeline



The timing has been finalized on 9/9

Editing the PProgram details

RATIONALE FOR WRITING THE PP: ITEM OPERATIVE STATUS (IOS)

I. The Science and Data Analysis ← Part

1. Science cases ← Section

1.1 Fundamental Physics and Cosmology (x.X) ← Item

…

II. The Hardware Implementation

1 Interferometer

1.1 The interferometer layout

III. The Site

1 Seismic Characterization

1.1 Surface and underground seismic noise

Each chapter has the same structure

The program is defined by describing the ITEM OPERATIVE STATUS (IOS)

Rather intuitive to write for Parts II and III, but also suitable for Part I

Example for the ITEM 1.1, The interferometer layout

II.1.1.A The basic layout

II.1.1.B Short-term R&D (solution expected by 5y): with the present layout, what is the tolerance to accommodate the possible evolutions matured through specific R&Ds ?)

II.1.1.C Backup solutions (in case of B failure): deserving development since NOW !

II.1.1.D Medium and Long-term R&D (solution expected by > 5y): void or content

IOS IS OK ALSO FOR CHAPTER I

I. The Science and Data Analysis ← Part

1. Science cases ← Section

1.1 Fundamental Physics and Cosmology (x.X) ← Item

…

Each chapter has the same structure

II. The Hardware Implementation

1 Interferometer

1.1 The interferometer layout

III. The Site

1 Seismic Characterization

1.1 Surface and underground seismic noise

The program is defined by describing the ITEM OPERATIVE STATUS (IOS)

Example for 1.1, Fundamental Physics and Cosmology

II.1.1.A "The basic Layout" ➔ **Actual Referenced Science Cases Conclusions** for the ITEM Physics and Cosmology

II.1.1.B "Short-term scenario" ➔**Perspective or expected evolution foreseen upon observations** (5y) e.g. given present models and observations, do we envisage novel scenarios to be studied ? May they impact on the requirements of the detector ? Recommendations (if any) ?

II.1.1.C Backup solutions (in case of B failure)

II.1.1.D Medium and Long-term studies (at the moment we do not have the tools to approach this issue, but we are developing them,.... as they might be quite interesting… > 5y) e.g. NONE

PPV0r1

Subtitle

The Project Program Committee

TEXT

September 4, 2025

.....

How to edit

The document is based upon the Item Operative Status (IOS) descriptors. They are four:

- **A** The basic layout
- **B** Short-term R&D (solution expected by 5y) e.g. once fixed today the layout, what is the tolerance to accommodate the possible evolutions matured through specific R&Ds ?)

- **C** Backup solutions (in case of B failure, meant to be studied since the beginning)
- **D** Medium and Long-term R&D (solution expected by > 5y) e.g. NONE

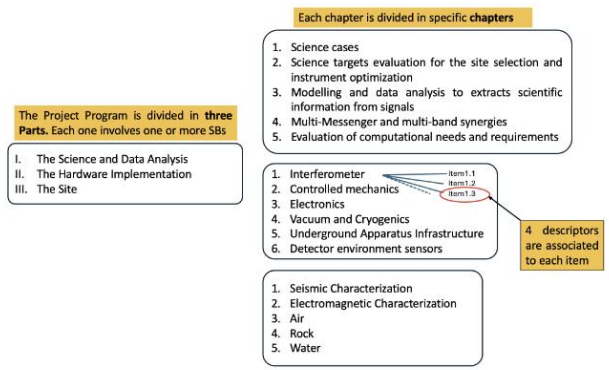
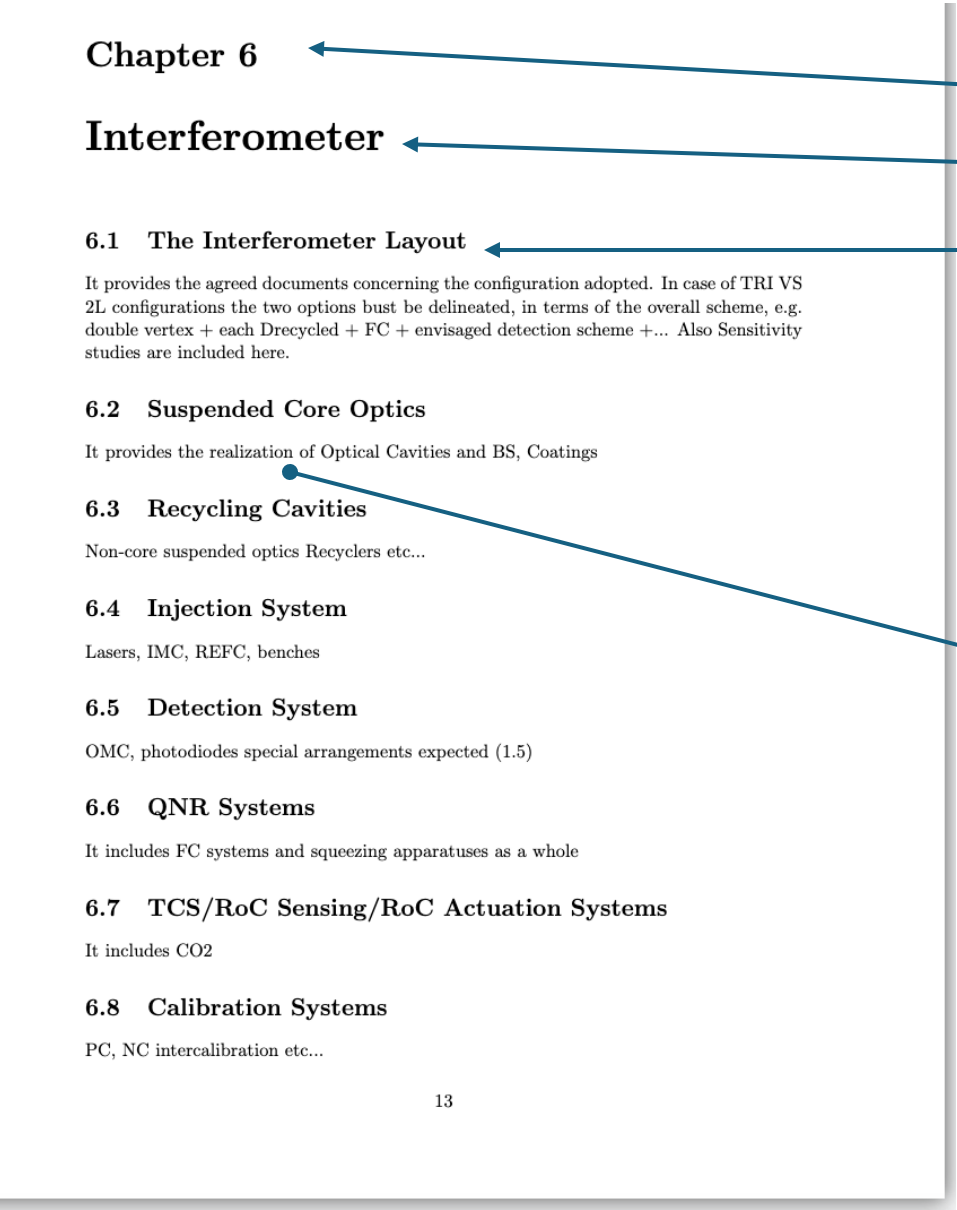


Figure 2: the item is the main element of the PP. The program is defined by describing its main features

Now, given Fig. 2, suppose that in the Part II the item 1.2 of Chapter 1 is *Core optics*. IOS identifiers for *Core optics* will be:

- II.1.2.A Existing technologies
- II.1.2.B Short-term R&D (solution expected by 5y)
- II.1.2.C Back-up solutions (in case of B failure, meant to be studied since the beginning)
- II.1.2.D Medium and Long-term R&D (solution expected by > 5y)

The criterion to be adopted is simple. Each descriptor of the operative IOS must be mentioned, and the four descriptors should not exceed 10 pages.



Chapter 6

Interferometer

6.1 The Interferometer Layout

It provides the agreed documents concerning the configuration adopted. In case of TRI VS 2L configurations the two options bust be delineated, in terms of the overall scheme, e.g. double vertex + each Drecycled + FC + envisaged detection scheme +... Also Sensitivity studies are included here.

6.2 Suspended Core Optics

It provides the realization of Optical Cavities and BS, Coatings

6.3 Recycling Cavities

Non-core suspended optics Recyclers etc...

6.4 Injection System

Lasers, IMC, REFC, benches

6.5 Detection System

OMC, photodiodes special arrangements expected (1.5)

6.6 QNR Systems

It includes FC systems and squeezing apparatuses as a whole

6.7 TCS/RoC Sensing/RoC Actuation Systems

It includes CO2

6.8 Calibration Systems

PC, NC intercalibration etc...

13

6.9 Scattered Light Mitigation

In all the aspects, both suspended, fixed and instrumented baffles

PART (ordered as “Chapter” by LaTeX..)

Section

ITEM

The content detail of the Pprogram is expressed by the 4 descriptors IOS (Item Operative Status)

LENGTH PROPOSED FOR THE ITEM Descriptors A,B,C,D

- **Min 1000 charactes** each (initially we proposed 2000, 1 page)
- **GRAND TOTAL MAX** (A+B+C+D) **8 pages** (initially proposed to be 10 pages, consider the figures)
- **Notice: the solution is flexible** and allows a the gradual completion

122-488 pages

the case “None”, possible for B,C,D, is accounted with an empty half page