

General introduction to ETO Design Task Force

F. Sorrentino

on behalf of the ETO task force on detector layout

ET Symposium - Bologna, May 26, 2025

Scope of task force

Background

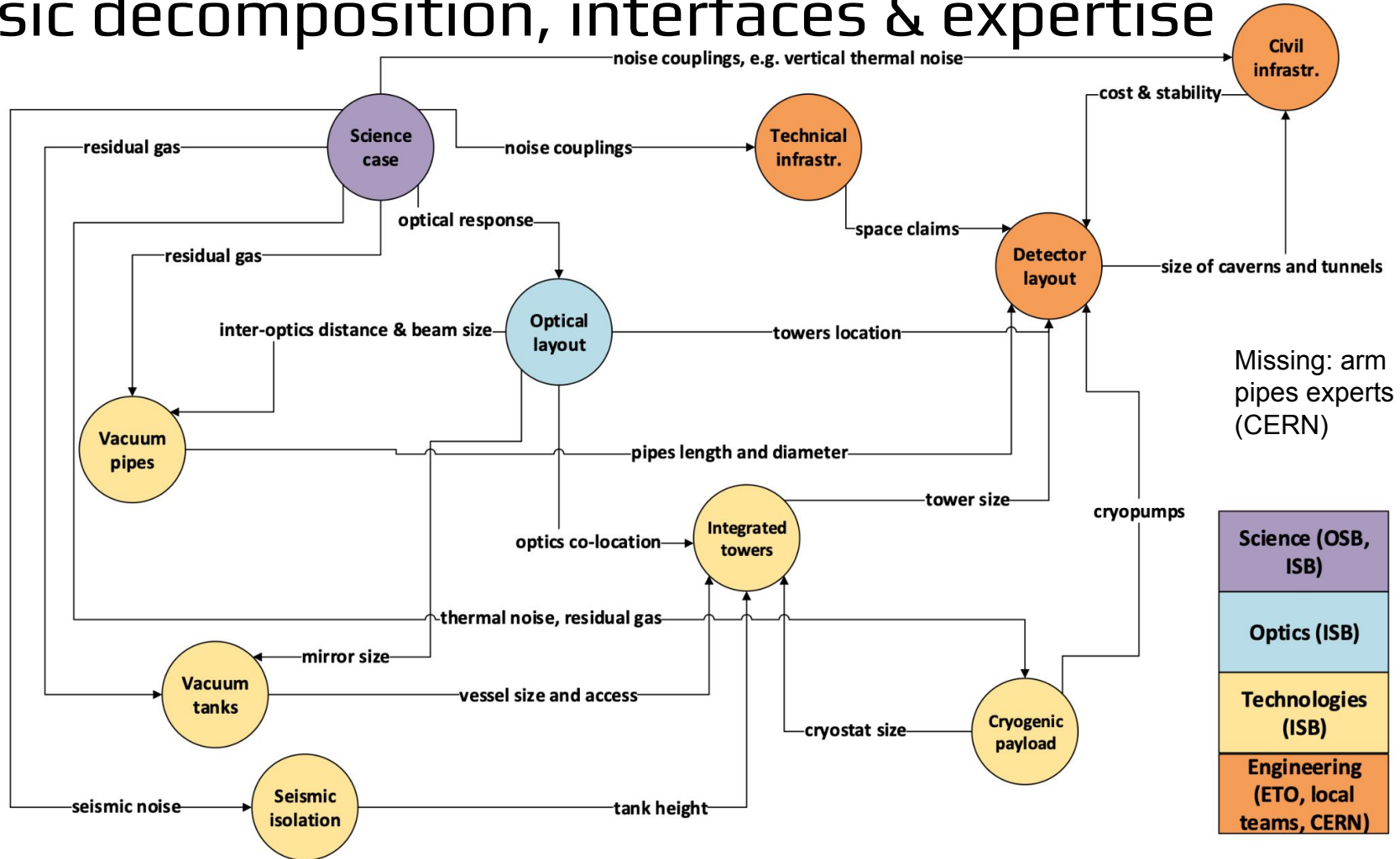
- 2020 ESFRI proposal
- 2024 optical layout update (ETC-ISB)
 - Triangle first, then 2L
- 2024 detector layout (ETO-ED)
 - Triangle first, then 2L
- **Informal** feedback by civil engineering experts from local teams:
 - infrastructure to host updated detector layout would be significantly more expensive than for the ESFRI proposal

Task force mandate (on ET Coordinators' proposal)

- adapt detector layouts of ET towards an **acceptable** preliminary **costing** for the civil **infrastructure**
 - for both triangle and 2L geometries **independently**
 - while **maintaining** ET's **scientific performance**

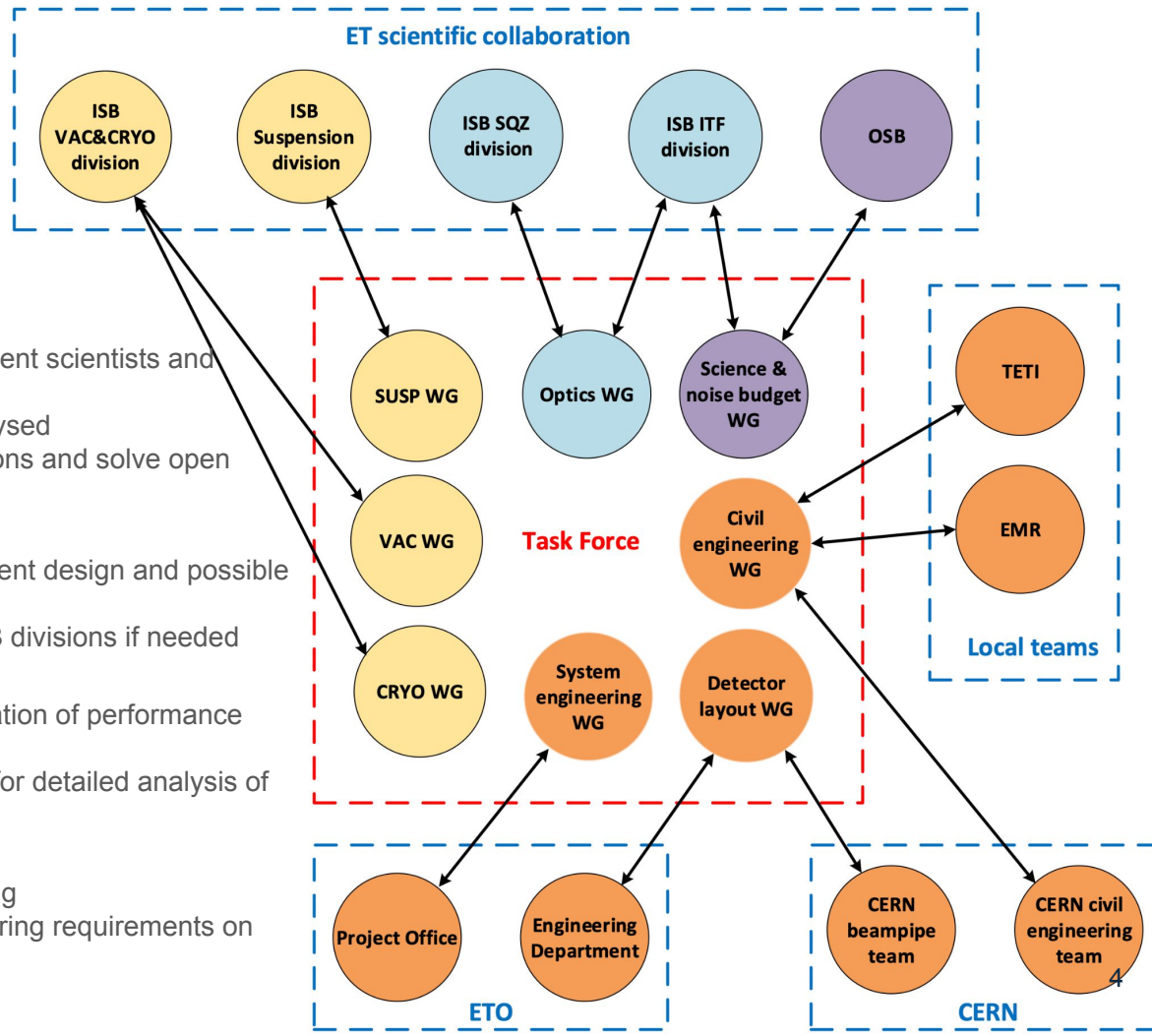


Basic decomposition, interfaces & expertise



Working groups and external interactions

- Plenary task force meetings bring together instrument scientists and engineers;
 - outcome include design options to be analysed
 - asynchronous work to analyse design options and solve open questions for next iteration
- Task force members from ISB
 - provide information about baseline instrument design and possible alternative options
 - share part of the open questions within ISB divisions if needed
- OSB liaisons
 - Provide prompt feedback for coarse evaluation of performance risk during configuration search
 - Carry out extensive analysis work to OSB for detailed analysis of science case on selected options
- Local teams liaisons
 - Share and refine criteria for civil engineering
 - Identify and discuss most relevant engineering requirements on infrastructure



Overview of task force work

- Started on January 2025
- Weekly plenary meetings
 - usually on Monday afternoon, except first one on Jan 8
- Topics addressed in weekly meetings included:
 - Brainstorming on alternative configurations
 - Identification of available options in optical layout & critical technologies
 - Identification of main interfaces
 - Tools for science case, detector layout, civil engineering
 - Structure of output documents
- In-person workshops
 - 1st workshop - methods consolidation & 2L layout update - Pisa, February 18÷20
 - 2nd workshop - 2L layout consolidation - Amsterdam, March 18÷20
 - 3rd workshop - triangle layout update - CERN May 5÷7
- Several aperiodic meetings with subgroups of experts on specific topics (~2/week)



Configurations for triangle and 2L

- New baseline: main changes from 2024 reference
 - LF Filter cavities in X arm with periscope
 - HF filter cavity in Y arm with periscope
 - 2-mirror FC -> reduced pipe diameter
 - Reduced length of LF IMC
 - Merging HF IMCs in same tunnel
 - Route BHD through BS
 - Other reshuffling in central area
 - Tower access constrained on LF_TM (bottom), SQZ (lateral), and few other
 - in flexibility envelope otherwise
 - Reduced LF TM susp. height to 13 m
 - Reduced tower height for other HFI optics
 - Reduce footprint of CAT1 benches
- Alternative configurations

 1. Double cavern
 2. No periscope for LF_FC
 3. Alternative routing for SQZ beam
 4. Bow-tie IMC
 5. Reduced tower height for HF TM
 6. Reduced tower height for LFI optics
 7. Reduced cryostat size

Main outcomes from task force

- Basic system decomposition - interfaces and requirements flow
- Updated optical layout (both triangle & 2L)
 - FC in main tunnel, reduced IMC length, reshuffling of central interferometer
 - Update of flexibility envelope, assessment of flexibility demands
- Integrated towers
 - Improved classification, reduction of benches footprint and tower height
- Detector layout update
 - **Volume claims reduced by ~25%** from 2024 reference layout (both triangle & 2L)
 - Better definition of technical infrastructure (cryogenics, clean rooms, noisy rooms)
 - Assessment of flexibility envelope
- Interface with civil engineering
 - Identify main cost drivers, estimate relative cost changes vs detector layout
 - Review of engineering requirements
- Risk and flexibility analysis on design choices
- Noise budget and comparison with reference science case
 - Derivation of key scientific requirements

Output documents

Main document: baseline detector layout

Extended supporting document: details and study logic

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The ET Baseline Detector Layout

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Supporting Document for The ET Baseline Detector Layout

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Output documents

Technical annexes: tables, 2D&3D drawings, technical specifications (33 additional files)

Name	▼	Date Modified	Size	Kind
▼ Technical Drawings for distribution		Today, 15:10	--	Folder
▼ Triangle		Today, 15:09	--	Folder
Cross-sections arm cavity tunnel (triangle configuration).pdf		Today, 13:08	105 KB	PDF Document
2025-05-21 ET Triangle Optical Layout vector version.dwg		Today, 13:08	211 KB	AutoCAD DWG
2025-05-21 ET Triangle Optical Layout (vector version).pdf		Today, 13:08	437 KB	PDF Document
2025-05-21 ET Triangle Optical Layout (scale version).pdf		Today, 13:08	409 KB	PDF Document
2025-05-21 ET Triangle Detector Layout.pdf		Today, 13:08	636 KB	PDF Document
2025-05-21 ET Triangle Detector Layout.dwg		Today, 13:08	453 KB	AutoCAD DWG
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Cross-sections arm cavity tunnel (L configuration).pdf		Today, 13:08	108 KB	PDF Document
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2025-05-21 ET L Optical Layout (scale version).pdf		Today, 13:08	248 KB	PDF Document
2025-05-21 ET L Detector Layout.pdf		Today, 13:08	317 KB	PDF Document
2025-05-21 ET L Detector Layout.dwg		Today, 13:08	212 KB	AutoCAD DWG
▼ TD4 - Tower CAT mapping drawings		Today, 15:09	--	Folder
2025-05-23 ET Triangle Tower CAT mapping.pdf		Today, 13:08	555 KB	PDF Document
2025-05-23 ET 2L CAT mapping.pdf		Today, 13:08	421 KB	PDF Document
▼ Risk - TRL - DSM - PoC Technical Annexes		Today, 15:09	--	Folder
Volume and Cost Calculations - Penalty of Change.xlsx		Today, 13:08	2,1 MB	Microso...k (.xlsx)
Technology Readiness Level TRL Study.xlsx		Today, 13:08	118 KB	Microso...k (.xlsx)
Full Risk Study.xlsx		Today, 13:08	510 KB	Microso...k (.xlsx)
DSM - Rigidity Matrix.xlsx		Today, 13:08	1,5 MB	Microso...k (.xlsx)
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▼ Triangle (TAB1-6)		Today, 15:09	--	Folder
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TAB5_ET-Triangle Civil Functional Volumes output table - FINAL.pdf		Today, 13:08	153 KB	PDF Document
TAB4_ET-Triangle Detector Layout output table - FINAL.pdf		Today, 13:08	166 KB	PDF Document
TAB3_ET-Triangle Optical Layout output table - FINAL.pdf		Today, 13:08	361 KB	PDF Document
TAB2_ET-Triangle Integrated Towers output table - FINAL.pdf		Today, 13:08	236 KB	PDF Document
TAB1_ET-Triangle System Decomposition output table - FINAL.pdf		Today, 13:08	194 KB	PDF Document
▼ 2L (TAB7-12)		Today, 15:09	--	Folder
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TAB11_ET-2L Civil Functional Volumes output table - FINAL.pdf		Today, 13:08	149 KB	PDF Document
TAB10_ET-2L Detector Layout output table - FINAL.pdf		Today, 13:08	167 KB	PDF Document
TAB9_ET-2L Optical Layout output table - FINAL.pdf		Today, 13:08	358 KB	PDF Document
TAB8_ET-2L Integrated Towers output table - FINAL.pdf		Today, 13:08	227 KB	PDF Document
TAB7_ET-2L System Decomposition output table - FINAL.pdf		Today, 13:08	110 KB	PDF Document
▼ 3D Detector Layout Model Links		Today, 15:09	--	Folder
250523_Trimble_Connect_quick_guide.pdf		Today, 13:08	406 KB	PDF Document
2025 ET Baseline Triangle Detector Layout.url		Today, 13:08	135 bytes	Website location
2025 ET Baseline L Detector Layout.url		Today, 13:08	135 bytes	Website location



Next steps

- Following the mandate by ET Coordinators, ETO directorate set up an international review committee
 - composition: 8 members from LIGO Lab, LSC, KAGRA, PSI, CERN
 - terms of reference: review will focus on
 - Mandate Compliance & Infrastructure Feasibility
 - Clarity, Consistency & Supporting Information
 - Scientific & Design Justification
 - Risk, Flexibility & Decision Support
- Output documents by task force were delivered to review committee on 23/05
- Draft documents shared with ETC since 12/05 - periodically updated until delivery
- Review outcome expected in ~2 weeks
- Task force to provide final version after review by **end of June**
- ETC EB is organising an independent review

ETO task force @ ET Symposium

- **ISB/ETO parallel session Monday @16:15**
 - R. Meijer - System decomposition
 - R. Meijer - Integrated towers
 - A. Green & A. Perreca - Optical layout updates, flexibility envelope and flexibility demands
 - M. Majoor - Detector layout updates
 - J. Bratanata - Requirements to civil infrastructure
- **ISB/ETO parallel session Tuesday @11:30**
 - G. Mahmoud - Risk management critical role. Risk assessment status and risk management evolution
- **Plenary session Thursday @9:00**
 - M. Korobko & U. Dupletsa - OSB work for the Task Force
- **Plenary session Thursday @14:45**
 - F. Sorrentino - ETO Design Task Force update
- ... and several related talks in ISB parallel sessions