Wrap up & next steps

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ETO task force on detector layout

Amsterdam meeting - March 18÷20, 2025

Summary of 2L layout

Options under analysis for 2L

Ratio of (cost-volume reduction in CI)/(risk & flexibility cost)
High
Medium
Low

- Optical layout
  - LF Filter cavities in X arm
    - with periscope
      - two alternative routings
    - without periscope
  - HF filter cavity in Y arm
  - 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
  - Bow-tie IMC
- Integrated tower
  - Reduced LF TM susp. height to 13 m
  - Reduced tower height for HF TM
  - Reduced tower height for other HFI optics
  - Reduced tower height for LFI optics
  - Reduce footprint of CAT1 benches
  - Reduced cryostat size
- Detector layout
  - Double cavern
  - Separate HFI and LFI

What more?

Options under analysis for 2L

Open questions

- Consolidate cost-volume reduction on CI and risk/flexibility cost of each option
- Identification of preferred configuration
  - combine all compatible green options
  - merge equivalent options into flexibility envelope
- Finalize list of global (optional) configurations
  - start from chosen configuration
  - consider an individual configuration for each considered change (yellow or red)
  - do not consider combinations unless necessary
  - for each configuration estimate change in
    - civil infrastructure cost
    - technical risk
    - flexibility

Structure of output document(s)

Structure of current document mimics WBS

3.1.1 Science case for baseline triangle layout

3.1.2 Science case for baseline 2L layout

3.1.3 Metrics for performance risk evaluation

3.1.4 Coarse performance risk evaluation for optional 2L optical layouts

3.1.5 Coarse performance risk evaluation for optional technologies and 2L layout

3.1.6 Science case for optional 2L optical layout

3.1.7 Science case for optional technologies and 2L layout

3.1.8 Coarse performance risk evaluation for optional triangle layouts

3.1.9 Science case for optional triangle layouts

Next section will handle the noise budget.

3.2 Noise Budget

The Noise Budget section is subdivided into several sub-tasks.

3.2.1 Noise budget for baseline triangle layout

3.2.2 Noise budget for baseline 2L layout

3.2.3 Noise budget update with optional 2L optical layout

3.2.4 Noise budget update with optional technologies and 2L layout

3.2.5 Noise budget update with optional triangle layout

Next section will handle the optical layout.

3.3 Optical Layout

The Optical Layout section is subdivided into several sub-tasks.

3.3.1 Technical requirements on optical layout from instrument technologies

3.3.2 Optical layout system decomposition and scientific requirements derivation

3.3.3 2L flexibility envelope for arm cavities with baseline technologies

3.3.4 2L flexibility envelope for central interferometer with baseline technologies

3.3.5 2L flexibility envelope for input mode cleaners with baseline technologies

3.3.6 2L flexibility envelope for filter cavities with baseline technologies

3.3.7 2L flexibility envelope for arm cavities with optional technologies

3.3.8 2L flexibility envelope for central interferometer with optional technologies

3.3.9 2L flexibility envelope for input mode cleaners with optional technologies

3.3.10 2L flexibility envelope for filter cavities with optional technologies

3.3.11 Triangle flexibility envelope for arm cavities

3.3.12 Triangle flexibility envelope for central interferometer

3.3.13 Triangle flexibility envelope for input mode cleaners

3.3.14 Triangle flexibility envelope for filter cavities

3.3.15 Update 2L optical layout with baseline technologies

3.3.16 Update 2L optical layout with optional technologies

3.3.17 Update triangle optical layout

The next section will deal with seismic isolation.

3.4 Seismic Isolation

The seismic isolation section is divided into several sub-tasks.

3.4.1 Categorization of suspensions

3.4.2 Identification of baseline and optional suspension design

3.4.3 Preliminary assessment of impact of baseline and optional suspension design on science case

3.4.4 Update on suspension categories

3.4.5 Design of baseline suspension types and identification of geometrical constraints

3.4.6 Design of optional suspension types and identification of geometrical constraints

3.4.7 Requirements web for suspensions

3.4.8 Final assessment of impact of baseline and optional suspension design on science case

The next section will deal with cryogenics.

3.5 Cryogenics

The cryogenics section is divided into several sub-tasks.

3.5.1 Requirements tree for cryogenics

3.5.2 LF TM cryostat and payload baseline system decomposition

3.5.3 Cryopumps baseline system decomposition

3.5.4 Cryogenic infrastructure baseline system decomposition

3.5.5 LF TM cryostat and payload options technology concept

3.5.6 Cryopumps options technology concept

3.5.7 Cryogenic infrastructure options technology concept

The next section will handle the vacuum technologies.

3.6 Vacuum

The vacuum section is divided into several sub-tasks.

Structure of current document mimics WBS

3.6.1 Vacuum pipes and support baseline configuration for 2L

3.6.2 Tower vacuum baseline configuration for 2L

3.6.3 Vacuum pipes and support optional configuration for 2L

3.6.4 Tower vacuum optional configuration for 2L

3.6.5 Vacuum pipes and support configuration for triangle

3.6.6 Tower vacuum configuration for triangle

The next section will deal with tower integration.

3.7 Tower Integration

The tower integration section is divided into several sub-tasks.

3.7.1 LF TM tower baseline design

3.7.2 HF TM tower baseline design

3.7.3 Other core optics baseline design

3.7.4 Suspended benches baseline design

3.7.5 LF TM optional design

3.7.6 HF TM optional design

3.7.7 Other core options optional design

3.7.8 Suspended benches optional design

The next section will handle the technical infrastructure.

3.8 Technical Infrastructure

The technical infrastructure section is divided into several sub-tasks.

3.8.1 Technical infrastructure baseline system decomposition for 2L

3.8.2 Technical infrastructure options technology concept for 2L

3.8.3 Technical infrastructure for triangle

The next section will handle the detector layout.

3.9 Detector Layout

The detector layout section is divided into several sub-tasks.

3.9.1 Preliminary brainstorming

3.9.2 Review of criteria

3.9.3 2L detector layout update for baseline technologies

3.9.4 2L detector layout update for optional technologies

3.9.5 Triangle detector layout update

The next section will deal with civil infrastructure.

3.10 Civil Infrastructure

The civil infrastructure section is divided into several sub-tasks.

3.10.1 Criteria and tools for civil infrastructure layout

3.10.2 Criteria and tools for civil infrastructure costing

3.10.3 2L baseline civil infrastructure

3.10.4 Identification of most critical elements for costing in baseline 2L layout

3.10.5 Civil infrastructure for updated 2L detector layout with baseline technologies

3.10.6 Cost breakdown for updated 2L detector layout with baseline technologies

3.10.7 Criteria update

3.10.8 Identification of most critical elements for costing in optional 2L detector layout

3.10.9 Civil infrastructure for updated triangle detector layout with optional technologies

3.10.10 Cost breakdown for updated triangle detector layout with optional technologies

The next section will deal with risk analysis.

3.11 Risk Analysis

The risk analysis section is divided into several sub-tasks.

3.11.1 Risk management plan and tools

3.11.2 Risk assessment and evaluation for baseline seismic isolation

3.11.3 Risk assessment and evaluation for optional seismic isolation

3.11.4 Risk assessment and evaluation for baseline cryogenics

3.11.5 Risk assessment and evaluation for optional cryogenics

3.11.6 Risk assessment and evaluation for baseline vacuum system

3.11.7 Risk assessment and evaluation for optional vacuum system

3.11.8 Risk assessment and evaluation for 2L optical layouts

3.11.9 Risk assessment and evaluation for triangle optical layouts

Proposal for document structure update

- Main document
  - Basic system decomposition
  - Updated optical & detector layout (2L and triangle), comparison with 2024 reference
  - Integrated tower categories
  - flexibility envelope for detector layout
  - Summary of risk and flexibility analysis
  - Noise budget and comparison with reference science case

- Annexes
  - Technical drawings & plots
  - Tables
  - **Extended supporting document**
    - Workflow
    - Basic design of critical elements
    - Options and tradeoffs
      - Optical layout
      - Critical technologies
    - Details and methods
      - system decomposition
      - risk/flexibility analysis
      - noise budget and science case

Structure of main document

- Introduction, scope and structure of the document
- Basic system decomposition
- Optical layout
  - common features, definition of flexibility demand
  - baseline 2L layout (i.e. our choice), main features and comparison with 2024 reference 2L layout
  - baseline triangle layout (i.e. our choice), main features and comparison with 2024 reference triangle layout
- Integrated towers
  - Summary of tower categorization
- Detector layout
  - common features, definition of flexibility envelope
  - baseline 2L layout (i.e. our choice), main features and comparison with 2024 reference
  - baseline triangle layout (i.e. our choice), main features and comparison with 2024 reference
- Risk and flexibility
  - rationale for risk and flexibility analysis
  - analysis on 2L: list of options, comparison of baseline configuration with options and with 2024 reference
  - analysis on triangle: idem
- Performance
  - Noise budget for baseline configuration, comparison with 2024 reference
  - Summary of science case for baseline configuration, comparison with reference
- Appendix - list of annexes

Extended supporting document

- Study logic and workflow
- Detailed system decomposition
- Optical layout
  - Detailed explanation of fexibility envelope and flexibility demands
  - description of available options for 2L
  - description of available options for triangle
- Integrated towers
  - Main design options for seismic isolation
  - Main design options for cryogenics
  - Main options for tower access
  - Rationale for tower categorization
- Detector layout
  - explanation of major space claims (clean room, scaffoldings, technical rooms, cryovenics infrastructure, etc.)
  - optional 2L layouts
  - optional triangle layouts
- Civil engineering
  - Tools and criteria to determine cost of civil infrastructure vs detector layout changes
- Risk and flexibility
  - Extended explanation of risk and flexibility analysis
  - Identification of options
- Performance
  - Tools for noise budget
  - Figures of merit for science case and performance risk quantification
  - Derivation of scientific requirements on main design parameters

Technical annexes

- Technical drawings
  - 2D model for optical layouts (baseline & options for 2L and triangle)
  - 3D models for detector layout (baseline & options for 2L and triangle)
  - Technical drawings of individual elements? Suspensions, integrated tower, cryostat, etc.
- Plots
  - Sensitivity curves for reference and optional layouts
  - Science case plots for reference and optional layouts
  - Interactive plots for science requirements on design parameters
  - etc
- Additional supporting documents (incorporate in single extended supporting document?)
  - Flexibility envelope/demands for optical layout
  - System decomposition?
  - Tower categorisation?
  - etc
- Tables
  - System decomposition
  - Tower categorization
  - TRL
  - Risk register
  - Rigidity matrix
  - Flexibility envelope & demand

Next steps

Next steps

- Finalisation of 2L detector layout and common tasks
- Start working on triangle layout

Schedule

- deadline for document delivery
  - 21/5 to external review committee
  - 9/5 preliminary draft to ETO directorate
- overleaf document(s)
  - new format implemented in Overleaf within end of this week
  - reassign writing tasks on next Monday
  - draft for main and accompanying document ready for discussion on CERN meeting on 5/5
- analysis on 2L layout options to be concluded within mid April
  - impact on CI cost; risk & flexibility analysis
- start studying triangle layout right after Amsterdam meeting
  - review optical layout and detector layout in view of changes done on 2L
  - restore brainstorming on possible configurations
- **Next weekly meeting**
  - summary from science case
  - optional design for cryostat
  - recap of triangle optical layout
  - brainstorming on configuration options for triangle
  - writing tasks assignments for main and accompanying documents
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