

ETO Task-Force: DELTA

Optical Layout team

24/03/2025

Reminder: Where to find the “baseline” informations

- Most of the informations are centralised on git
 - [Triangle 10 km](#)
 - [L 15 km](#)
- including also the feedback tracking system

☐ Common triangle/L issue handling 0 of 1 checklist item completed
#13 · created 5 days ago by anna.green
needs input Repo Development

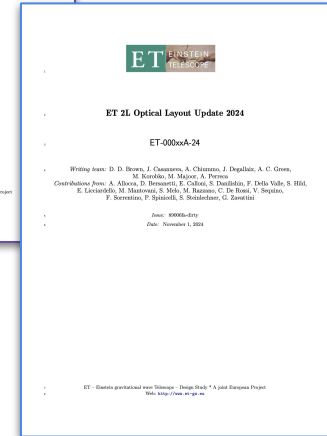
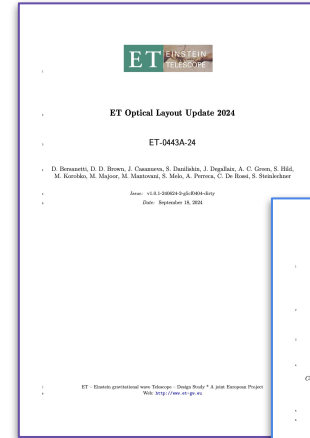
☐ Confirmation: suspension system requirements practically unchanged between Δ and L configurations. updated 4 days ago
#12 · created 1 week ago by holland

☐ Clarity in text on drivers of SEC length.
#11 · created 1 week ago by holland

☐ table 2 LF minor adjustments updated 1 week ago
#10 · created 1 week ago by anna.green
Arm cavity Quick Section 3: analysis

☐ table 1 RoCs updated 1 week ago  1
#9 · created 1 week ago by anna.green
Arm cavity Section 3: analysis Urgent

☐ HF SEC optical coatings okay during lockloss?
#8 · created 1 week ago by holland

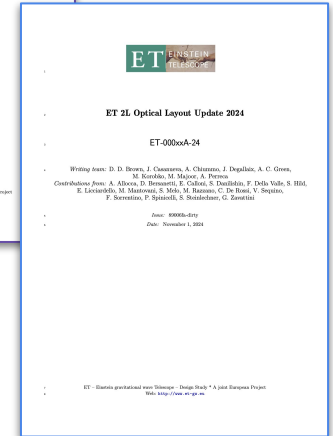
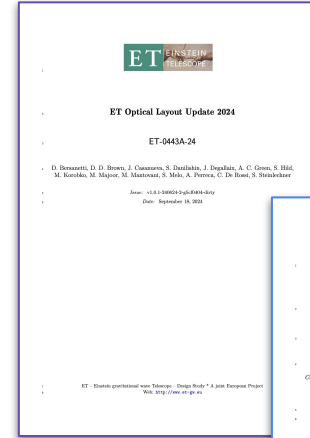


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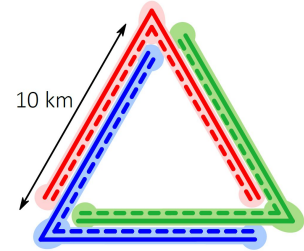
ETO Task Force (2L)

- More informations in shared folders in teams
- Some additional documents:
 - ET Optical layout: [Flexibility demand](#)
 - ETO Task Force: [Ongoing tasks and results](#)
 - + other documents: Detector layout, Risk A., etc.



Transition to Delta

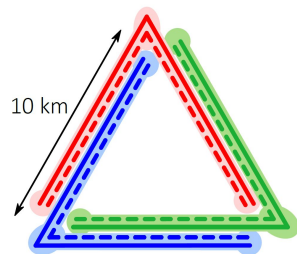
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- Most of the informations will be merged in common documents
- A brainstorming on Delta is necessary
 - Current Status
 - Evaluate all the informations we learnt from ETO Task-Force 2L design

Delta design: Current Status

- Optical and Detector layout “baseline” ready (2024)
- Review completed
- Comments from reviewers available on Git
- Noise Budget update:
 - New document matching the Delta optical layout release: [ET-0007C-23](#)
 - Data for sensitivity curves are publicly available on [git](#)



 **ET Sensitivity Curves** [Ⓢ]

main et-sensitivity-curves / +

Find file Edit Code

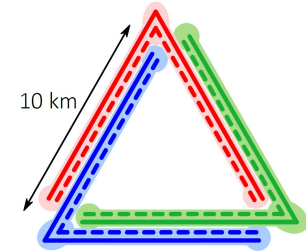
 Update README.md to include a disclaimer
mikhail.korobko authored 1 month ago

03bfe9b4 History

Name	Last commit	Last update
data	Add HF LF data vectors	2 months ago
images	Add new directory	2 months ago
.DS_Store	Add HF LF data vectors	2 months ago
README.md	Update README.md to include a disclai...	1 month ago

Delta design update: Starting point

- Evaluate results from ETO Task-Force 2L and their implementation where possible
 - Otherwise find alternative solutions



Einstein Telescope

ETO Task Force on detector layout- 18/20.02.2025

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

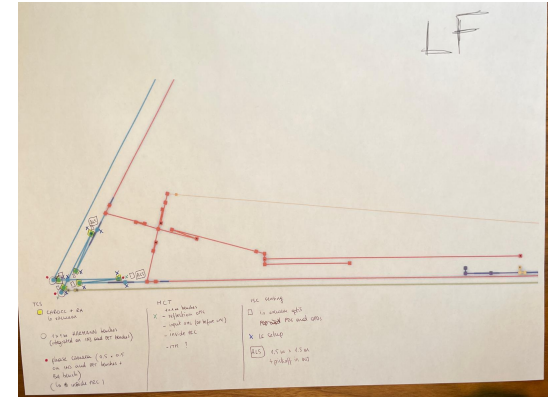
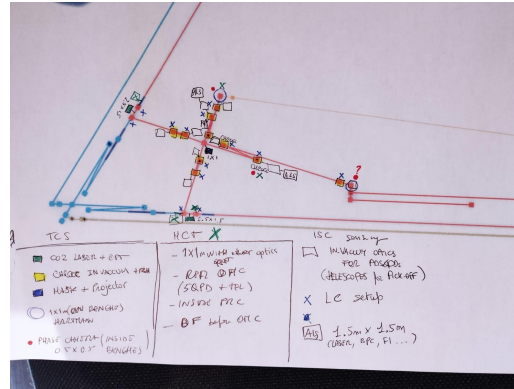
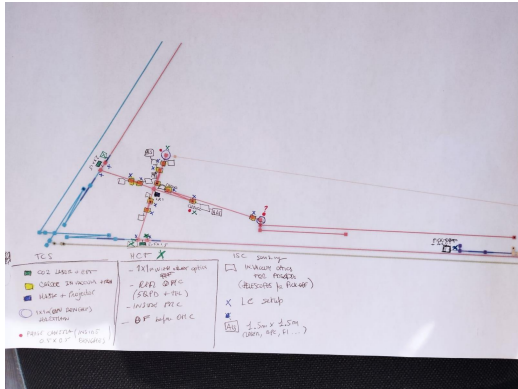
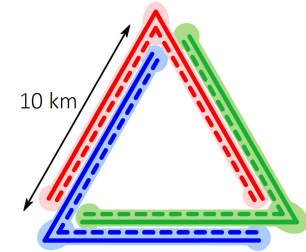
What more?

 EINSTEIN TELESCOPE

Fiodor's [slides](#)

Delta design update: some additional items

- HF BS area and Recycling Cavities to be checked
- Auxiliary benches to be verified for both 2L and Delta
 - Need help from ALS, TCS, CAL...



Bonus Slides

Δ Optical Layout: Top-level requirements and assumptions

Changes vs 2L; Changes for the Taskforce

Requirements we started with:

- overall geometry: Δ-shape, ~10km arm length
- each interferometer sits mostly in a 2D plane, HF stacks exactly above LF
- Several (4) interferometers per 'side' of the detector
- minimise the number of optics as far as reasonably possible
Optical losses, controls, noise

Assumptions we used:

- HF is more tolerant to suspension/controls noises
 - simplified suspension
 - Less strict number of optics
 - HF plane can sit above LF plane
- the arm cavities are frozen (for the moment)
 - fixes the laser beam parameters

A global optimisation at the end will re-check & validate the whole design

Δ Recycling Cavities: optical requirements

Changes vs 2L

Assumptions for LF:

- $\lambda = 1550$ nm, 211 kg silicon test masses
- low power + cryogenics = no thermal effects (and limited thermal actuation)
- Can have small beam sizes
- no length constraint for the recycling cavities
- **General requirements** for the recycling cavities (same for SEC and PRC):
 - reduce the beam size from the arm cavities
 - stable cavity, one way Gouy phase $\sim 20^\circ$
 - ~Collimated beam at beamsplitter (contrast defect/astigmatism)
 - minimise astigmatism and number of optics
 - BS AoI 60°

Assumptions for HF:

- $\lambda = 1064$ nm, 200 kg fused silica test masses
- We can tolerate (some) more optics for HF due to reduced suspension/controls noise requirements
- No length constraint for the PRC, strong length constraint for SEC (**less severe than 2L**)
- Significant thermal deformation
 - prefer reflective optics
 - BS AoI 45°
 - we cannot tolerate small spot sizes in the PRC
- General recycling cavity requirements (as LF)
- Additional requirements for the path to the BS
 - beam radius > 26 mm at the BS (thermal effects)
 - require a telescope between the arm cavities and BS *and* between BS and recycling mirrors ←!
- **Very constrained** physical distance between ITM and BS (*fixed by LITM cryo, stacking HF/LF, BS AoI*)

Conceptual optical layout *before adjustments by detector layout* (May 2024)

