

INTRODUCTION

As requirements increase, a management process supported by software tools becomes mandatory. For many years, requirements management tools were not affordable for institutions with moderate resources. This opened a gap between the engineering capabilities of these institutions and those of large resources. At **cosmoBots.eu**, an NGO aimed at helping robotic or astronomical instrumentation projects with a positive social impact, we did not agree with this scenario and decided to bridge the gap by providing a **free and open source solution for everyone**. The project offices of two future telescopes (**EST** and **NRT**) use our tool to manage their requirements. This is possible thanks to the co-operation and synergies between **IAC**, **GTC** and **cosmoBots.eu**.

OPEN/FREE SOFTWARE

cosmoSys-Req is not built as a single software tool, but as an **ecosystem of free/open software tools**. **Redmine** is the collaborative web application that we transform through plugins to manage requirements. **GraphViz** creates clickable diagrams that help engineers navigate through requirement dependencies. The **Git + Gitlab** combination provides import/export, version control, baselines, collaborative document editing, among others. **LibreOffice** is used to create import, export and report documents. **Carbone.io** allows users to create their specific report formats visually, without writing code. **yEd** is a fantastic diagramming tool that enhances diagram-based analysis. **Docker** provides the technology to deploy cosmoSys-req from a simple script. **Ruby**, **Python**, and **Jupyter** are used for process implementation.

DIAGRAMS, DIAGRAMS, DIAGRAMS ...

cosmoSys-req handles **hierarchy** and **dependency** diagrams. Hierarchy diagrams are used to **turn the database into documentation**. The dependency diagrams show **how the scientific requirements have been derived through the system requirements to arrive at the implementable requirements** (hardware, optics, software, mechanics...). Clicking on a requirement will show the user all predecessors and successors of the requirements.

REQUIREMENTS OWNERSHIP

Commercial tools often tend to hijack your models. Their interoperability is limited to protect your provider's business. Their export formats do not contain the complete models, to prevent users from porting their models to a new tool. **Who owns your requirements?** The cosmoSys-req export format contains the full database and REST interoperability is complete. Since you can leave the tool at any time, you are the real owner of your requirements. This is very convenient for projects that are just starting out. In fact, you can even modify the tool to your liking – welcome to the community!

REFERENCES

cosmobots.eu
redmine.org
carbone.io
yworks.com/products/yed

Docker.com
git-scm.com
gitlab.com
libreoffice.org

Contact: cosmobots.eu@gmail.com

Check it online at:
<http://csys.cosmobots.eu:3000/projects/demo>

ID	subject	description	Req?	status	parent	blocking_items	rqLevel	rqType
0000-0017	Performance requirements			rqApproved			None	Info
0000-0018	Field of view	The telescope field of view shall be 90° x 90°.		rqApproved	0000-0017	SCI-0002	System	Opt
0000-0019	Total transmission	The total throughput of the system including telescope and instruments shall be > 10% for the complete range of wavelength. It shall be optimized for 854.2 nm.		rqApproved	0000-0017	SCI-0019,SCI-0028	System	Opt
0000-0020	Wavelength coverage	Wavelength coverage shall be from 380 nm to 2300 nm.		rqStable	0000-0017		System	Opt

M2 assembly

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rq #2519 | 00M2-0017 OPEN

Change status
 rqStable
 rqApproved
 rqRejected

Custom queries
 Blocking_Isolated
 EmptyContainers
 Issues assigned to me
 Reported issues
 Roots
 Updated issues
 Watched issues

00M2-0015: Performance requirements
 rq #00M2-0016: Light beam reflecting, Performance

M2 Mirror optical aperture
 Added by cosmoSys Admin about 1 month ago. Updated about 1 month ago.

Status: rqDraft Start date: Due date: % Done: 0%
 Priority: Normal Estimated time: 0%
 Assignee: -

csOldCode: 00M2-0017 Start date: Due date: % Done: 0%
 csID: 00M2-0017 Start date: Due date: % Done: 0%
 csChapter: 001.001.001. Start date: Due date: % Done: 0%
 rqType: Opt Start date: Due date: % Done: 0%

Description
 The M2 Mirror optical aperture shall be an annular area with external diameter of 800 mm and internal diameter of 210 mm.

Example of LaTeX formulas

- simple: $m = \frac{y_2 - y_1}{x_2 - x_1}$
- multiple: $P_{POWER} = \frac{U_{POWER}}{I_{POWER}}, r_{\alpha} \cdot s_{\beta} = (r \cdot s)_{\alpha+\beta}, x_{1/2} = -\frac{p}{2} \pm \sqrt{\left(\frac{p}{2}\right)^2 - q}$

rqRationale
 The external diameter was indicated by the optical designer as 800mm and 700mm. In order to add mechanical

00M2: M2 assembly

1.: Performance requirements

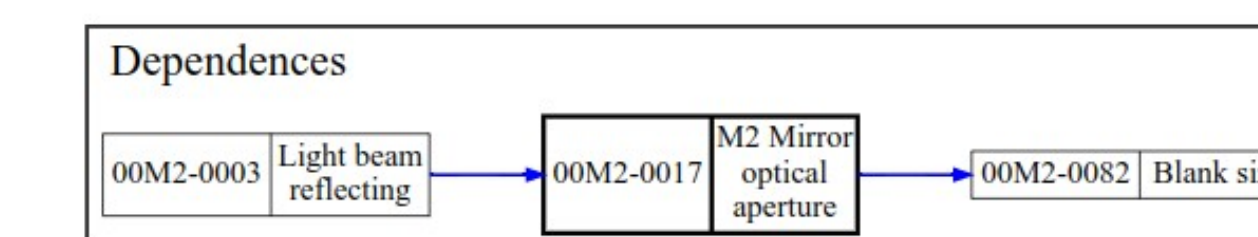
1.1.: Light beam reflecting, Performance

1.1.1. 00M2-0017: M2 Mirror optical aperture

The M2 Mirror optical aperture shall be an annular area with external diameter of 800 mm and internal diameter of 210 mm.

Example of LaTeX formulas

- simple: $m = \frac{y_2 - y_1}{x_2 - x_1}$
- multiple: $P_{POWER} = \frac{U_{POWER}}{I_{POWER}}, r_{\alpha} \cdot s_{\beta} = (r \cdot s)_{\alpha+\beta}, x_{1/2} = -\frac{p}{2} \pm \sqrt{\left(\frac{p}{2}\right)^2 - q}$



1.1.2. 00M2-0018: M2 Mirror optical prescription

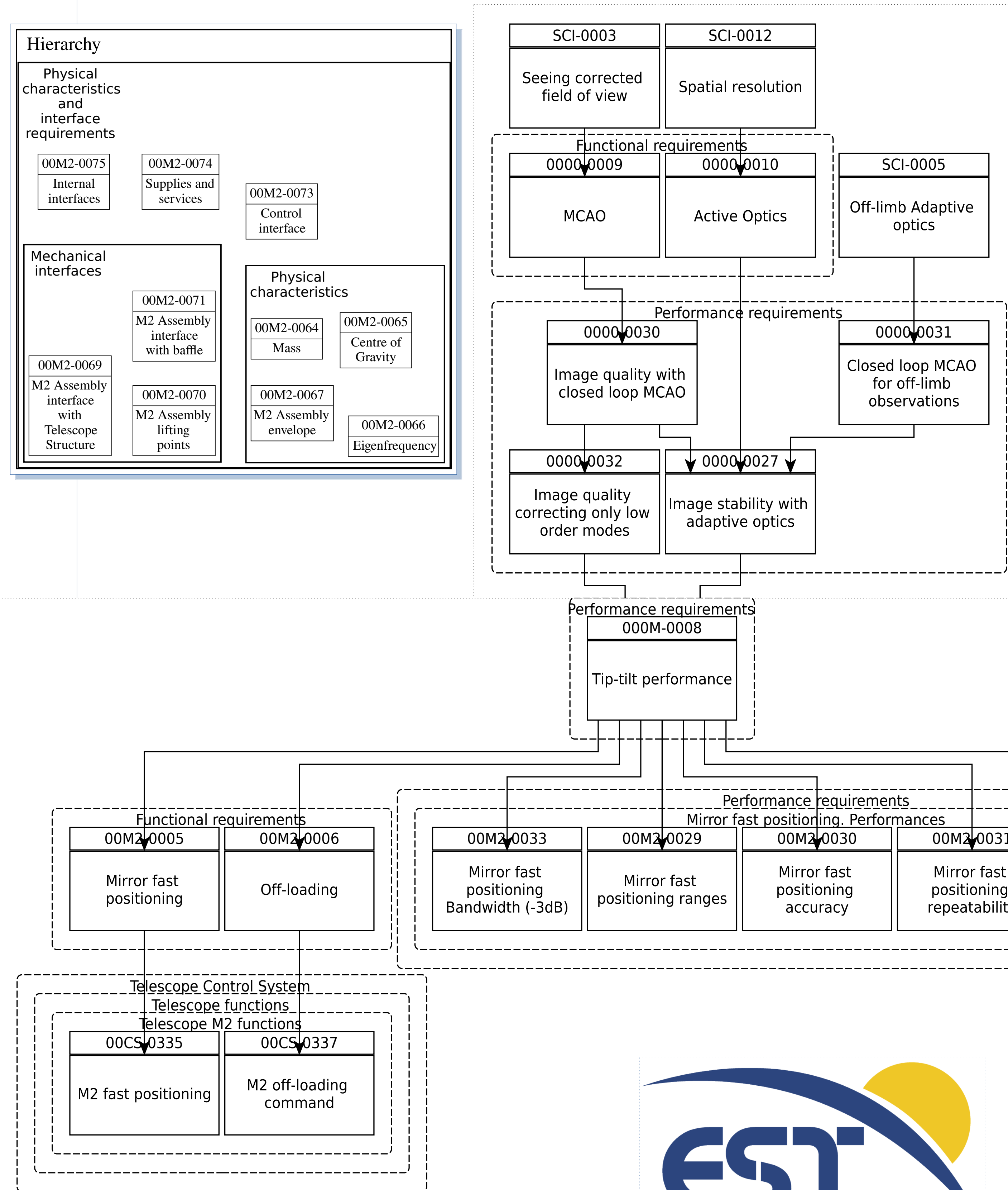
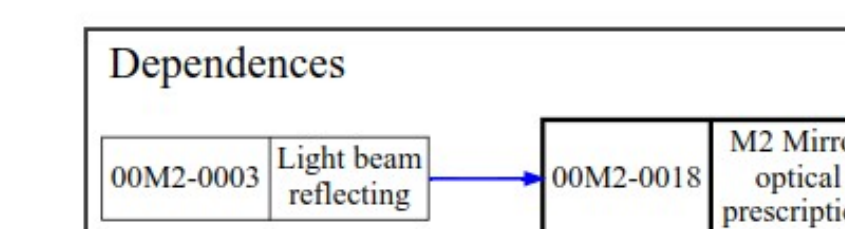
The nominal reflective surface of the M2 shall be concave ellipsoid. The Radius of Curvature of the M2 nominal reflective surface shall be 2156.42mm ± 1.0 mm. The Conic Constant of the M2 nominal reflective surface shall be -0.634448 ± 0.0003.

The sagitta of the nominal reflective surface shall be given by:

$$Z = c^2 / (2(1 + \sqrt{1 - (1 + K) * c^2 * r^2}))$$

Where,

- c: 1/Radius of curvature
- r: is the radial coordinate
- K: Conic Constant
- Z: is the sagitta of reflective surface



Screenshots courtesy of the EST Project Office.

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Date: 01/01/00
File: REQ_00M2-0017

Code: REQ_{D.PROJECT.CODE} { }

{d.project.children[i].status:ifREQ(rqErased):hideBegin}

1. {D.PROJECT.CHILDREN[I].INFOTYPE:IFEQ(1):HIDEBEGIN}
 {D.PROJECT.CHILDREN[I].IDENTIFIER};
 {D.PROJECT.CHILDREN[I].INFOTYPE:HIDEEND};{D.PROJECT.CHILDREN[I].SUBJECT}

{d.project.children[i].infoType:ifEQ(1):showBegin}
 {d.project.children[i].description:convCRLF()}
 {d.project.children[i].infoType:showEnd}
 {d.project.children[i].infoType:ifEQ(1):hideBegin}
 {d.project.children[i].description:convCRLF()}

Rationale
 {d.project.children[i].rqRationale:convCRLF()}

Attribute	Value
BD ID	{d.project.children[i].id}
Type	{d.project.children[i].rqType}
Level	{d.project.children[i].rqLevel}
Sources	{d.project.children[i].rqSources}
Target	{d.project.children[i].target}
Chapter	{d.project.children[i].csChapter}
RqVar	{d.project.children[i].rqVar}
RqValue	{d.project.children[i].rqValue}

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Date: 01/01/00
File: REQ_0008

Code: REQ_0008 { }

2. FUNCTIONAL REQUIREMENTS

2.1 0000-0008: Telescope function

The function of the telescope is to observe the sun.

Rationale

Attribute	Value
BD ID	304
Type	Complex
Level	System
Source	EST-000-EPO-SPE-0041V1
Target	
Chapter	002.001.
RqVar	
RqValue	rqApproved
State	rqApproved

M2 assembly

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00M2. m2-assembly: M2 assembly requirements

1. 00M2-0015: Performance requirements

1.1. 00M2-0016: Light beam reflecting, Performance

1.1.1. 00M2-0017: M2 Mirror optical aperture The M2 Mirror optical aperture shall be an annular area with external diameter of 800 mm and internal diameter of 210 mm.

1.1.2. 00M2-0018: M2 Mirror optical prescription The nominal reflective surface of the M2 shall be concave ellipsoid. The Radius of Curvature of the M2 nominal reflective surface shall be 2156.42mm ± 1.0 mm. The Conic Constant of the M2 nominal reflective surface shall be -0.634448 ± 0.0003.

1.1.3. 00M2-0019: M2 Mirror coating The M2 Mirror Optical Surface shall be a reflective surface with a reflectivity of 99.99% ± 0.01% in the wavelength range of 380 nm to 2300 nm.

1.2. 00M2-0020: Mirror slow positioning, Performance.

1.2.1. 00M2-0021: Mirror slow positioning ranges This requirement defines the range of motion for t...

$$s_m = \frac{r_{\alpha} \cdot s_{\beta}}{r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta}}$$

1.2.2. 00M2-0022: Mirror slow positioning time This requirement defines the settling time for the step movement of...

$$t_s = \frac{1}{\omega_n} \sqrt{\frac{2}{\zeta}}$$

1.2.3. 00M2-0023: Mirror slow positioning accuracy This requirement defines the accuracy required for...

$$a = \frac{r_{\alpha} \cdot s_{\beta}}{r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta}}$$

1.2.4. 00M2-0024: Mirror slow positioning repeatability This requirement defines the repeatability require...

$$r = \frac{r_{\alpha} \cdot s_{\beta}}{r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta}}$$

1.2.5. 00M2-0025: Mirror slow positioning resolution This requirement defines the resolution require...

$$r = \frac{r_{\alpha} \cdot s_{\beta}}{r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta}}$$

1.2.6. 00M2-0026: Mirror slow positioning settling time for step response This is the settling time for the step movement of...

$$t_s = \frac{1}{\omega_n} \sqrt{\frac{2}{\zeta}}$$

1.3. 00M2-0027: Mirror fast positioning, Performances

1.3.1. 00M2-0028: Mirror fast positioning ranges This requirement defines the range of motion for t...

$$s_m = \frac{r_{\alpha} \cdot s_{\beta}}{r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta}}$$

1.3.2. 00M2-0029: Mirror fast positioning accuracy This requirement defines the accuracy required for...

$$a = \frac{r_{\alpha} \cdot s_{\beta}}{r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta}}$$

1.3.3. 00M2-0030: Mirror fast positioning repeatability This requirement defines the repeatability require...

$$r = \frac{r_{\alpha} \cdot s_{\beta}}{r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta} + r_{\alpha} \cdot s_{\beta}}$$