

# ***EVM applied to the Extremely Large Telescope Programme***

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**SCE2022 Space Cost Engineering  
16<sup>th</sup> Sept 2022, Public**



## ■ Video

# Agenda

Introduction



Data collection



Earned Value  
Management  
Analysis



Benefits and  
challenges of  
EVM





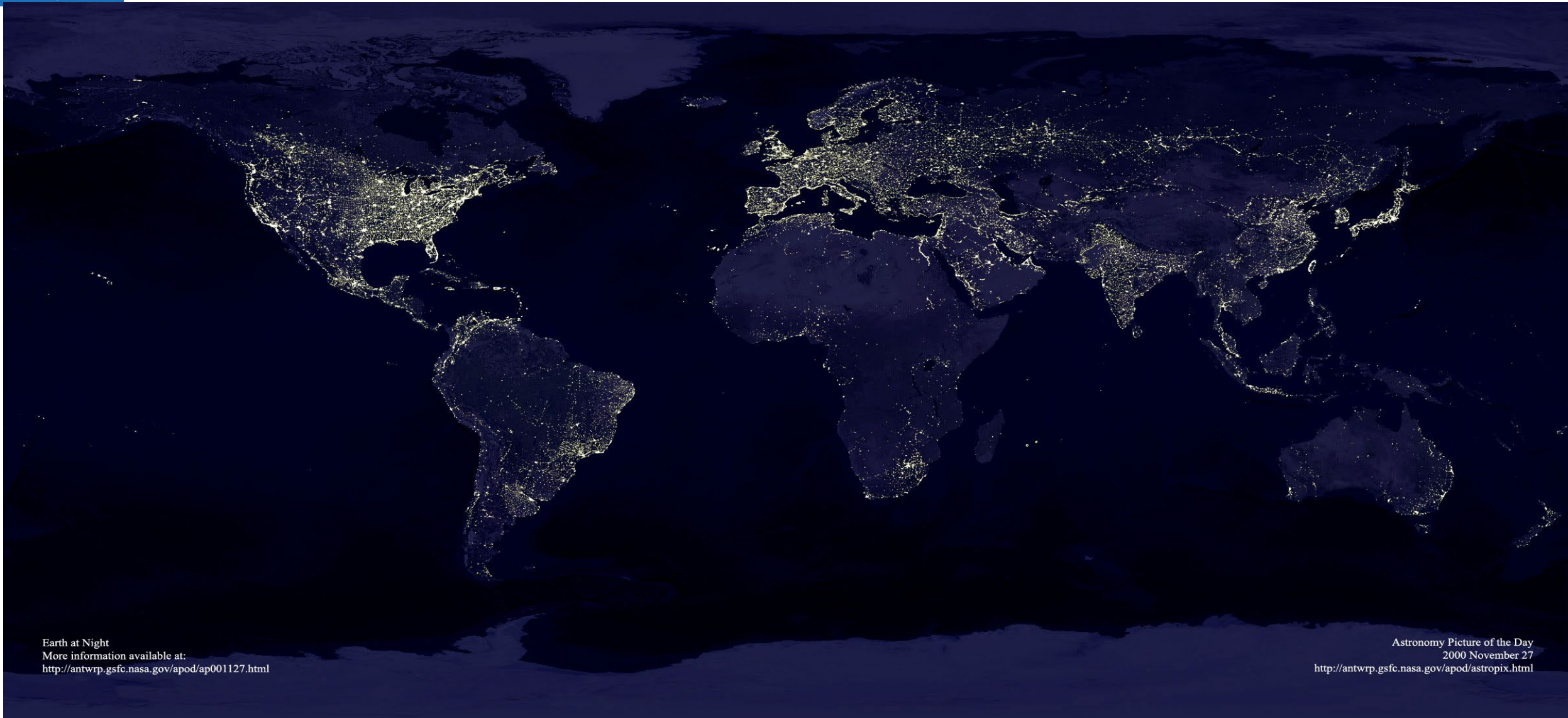
# European Southern Observatory

- ESO enables scientists worldwide to discover the secrets of the Universe for the benefit of all. We design, build and operate world-class observatories on the ground
- Intergovernmental organization established in 1962
- Currently 16 Member States
  - Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom
  - Australia as a strategic partner





# European Southern Observatory



Earth at Night  
More information available at:  
<http://antwrp.gsfc.nasa.gov/apod/ap001127.html>

Astronomy Picture of the Day  
2000 November 27  
<http://antwrp.gsfc.nasa.gov/apod/astropix.html>







# European Southern Observatory



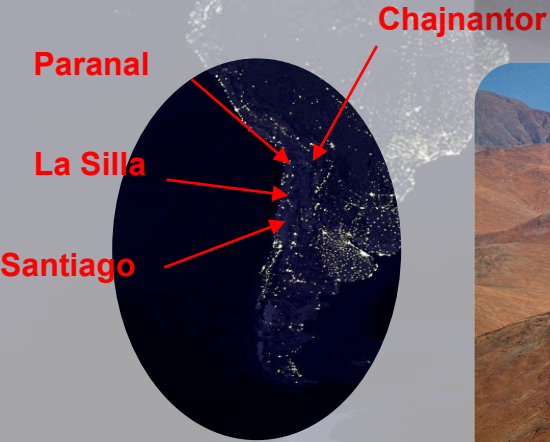
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# European Southern Observatory



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Astronomy Picture of the Day  
 2000 November 27  
<http://antwrp.gsfc.nasa.gov/apod/astropix.html>





# ELT Size Overview

80 m

60 m

40 m

20 m

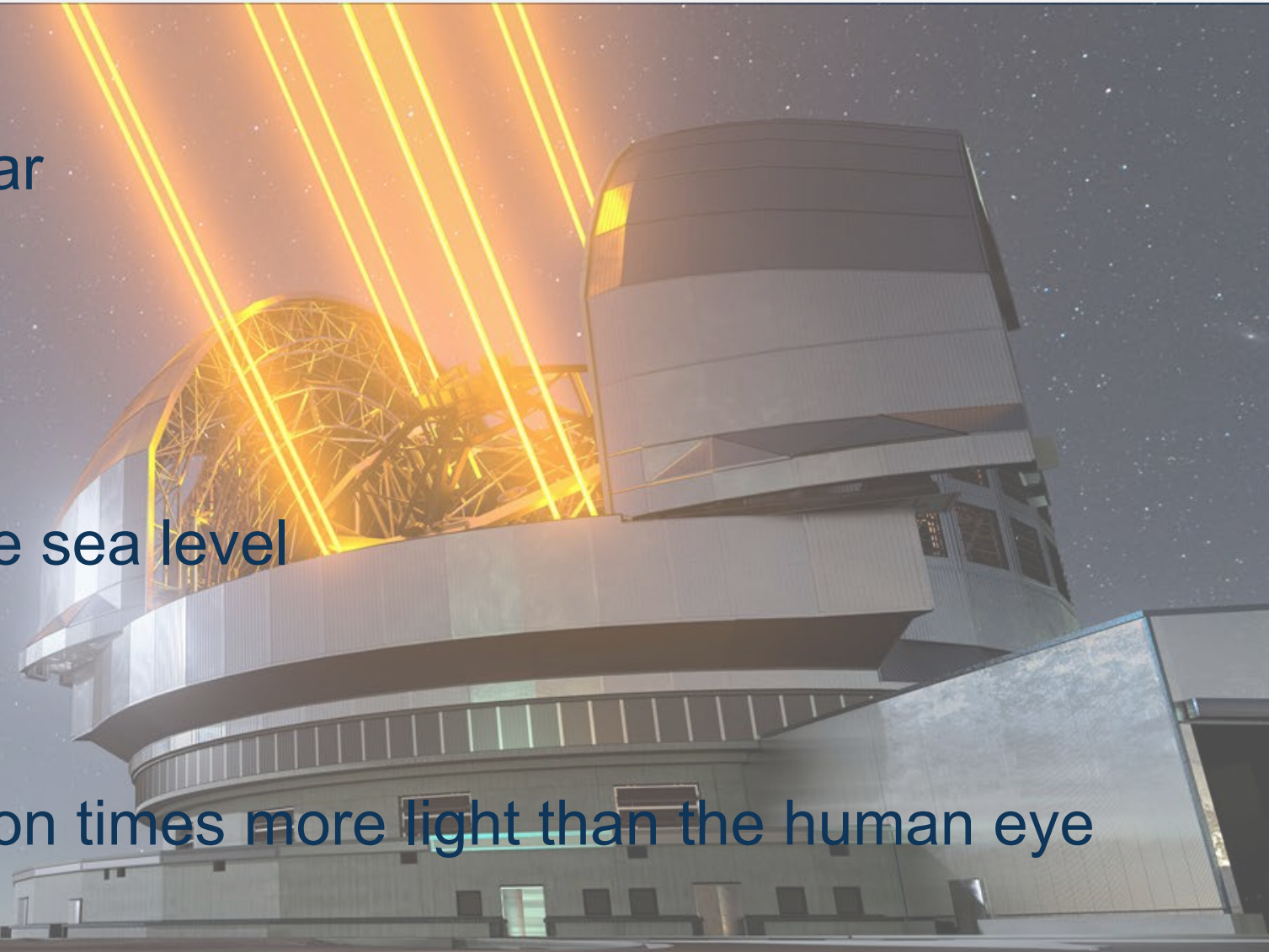


This artist's impression compares the ELT to the Colosseum in Rome, Italy

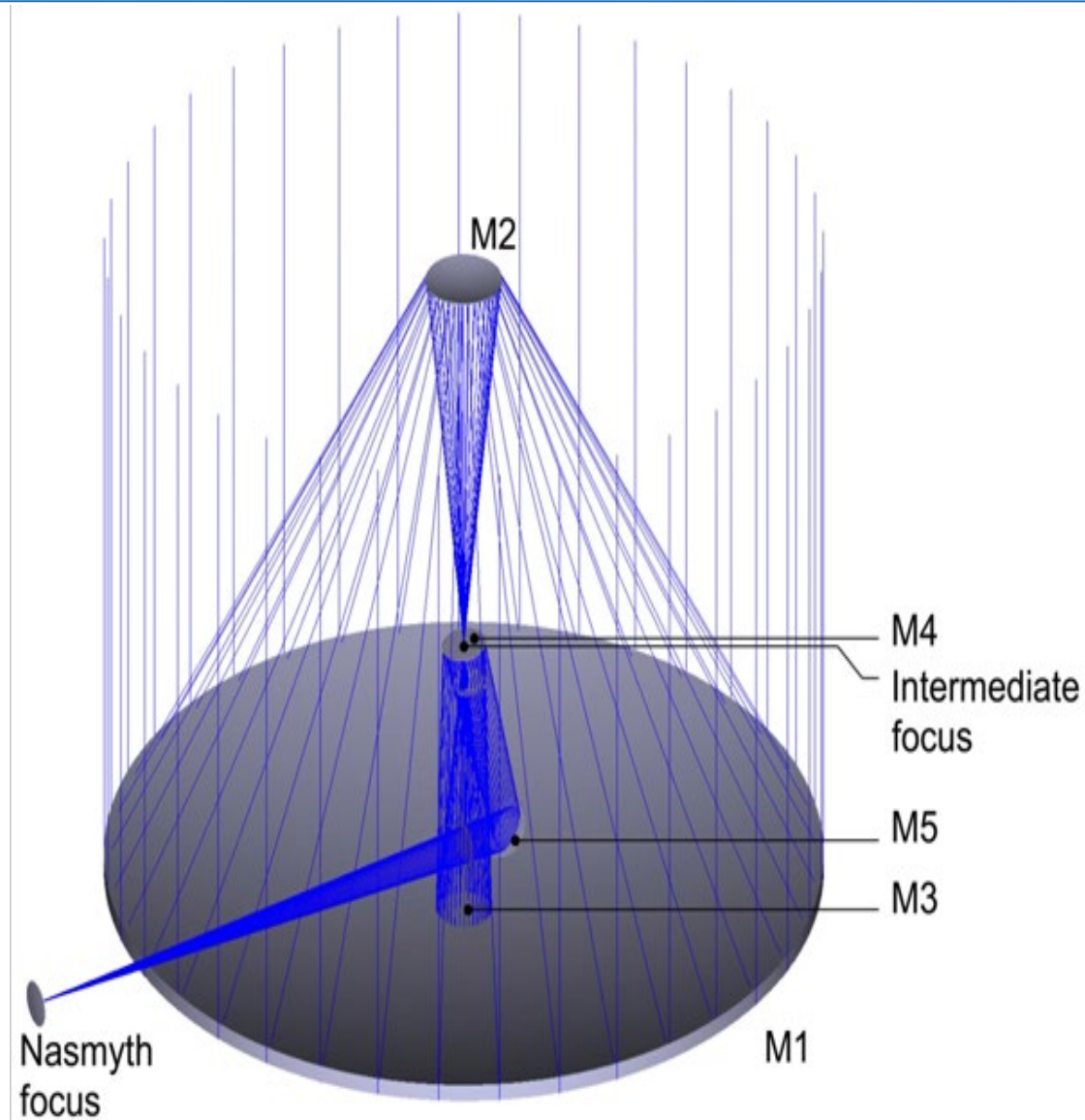


# ELT Facts

- Budget 1.3 Billion EUR
- An average of 100FTEs/year
- Weight
  - Dome 6.100 tonnes
  - Main Structure 3.700 tonnes
  - Glass 140 tonnes (132 tonnes M1)
- Altitude 3.046 meters above sea level
- 30 million Bolts used
- 1.500 km of optical fibres
- Capable to collect 100 million times more light than the human eye



# ELT Optomechanics



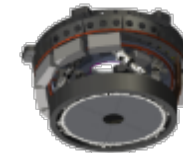
**M1 Unit**  
 39-m  
 Concave – Aspheric f/0.9  
 Segmented (798 Segments)  
 Active + Segment shape Control



**M2 Unit**  
 4-m  
 Convex Aspheric f/1.1  
 Passive + Position Control



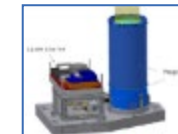
**M3 Unit**  
 4-m – Concave – Aspheric f/2.6  
 Active + Position Control



**M4 Unit**  
 2.4-m  
 Flat  
 Segmented (6 petals)  
 Adaptive + Position Control



**M5 Unit**  
 2.7x2.1-m  
 Flat  
 Passive + Fast Tip/Tilt

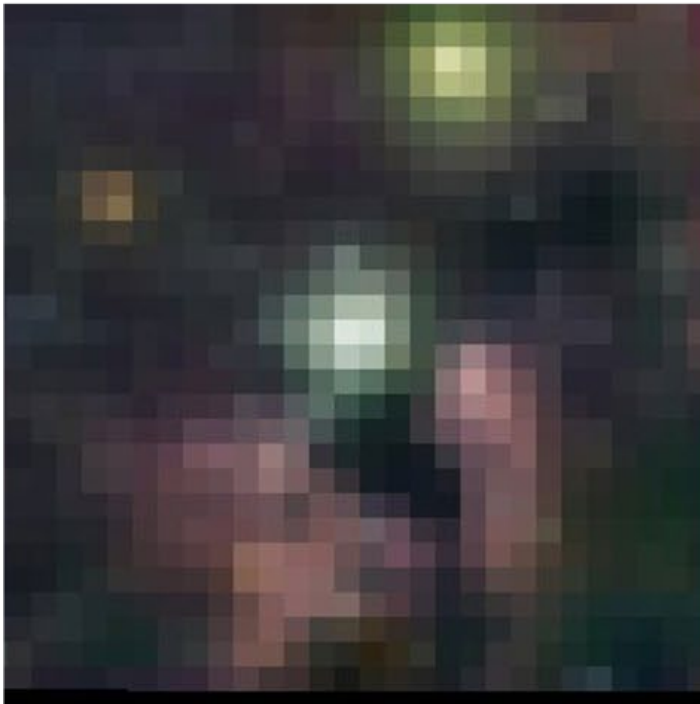


**LGSU**  
 (Laser Guide Star Units)  
 Laser Sources + Laser Beacons  
 shaping and emitting



# Why mirror diameter matters?

Hubble Space Telescope (2,5m)



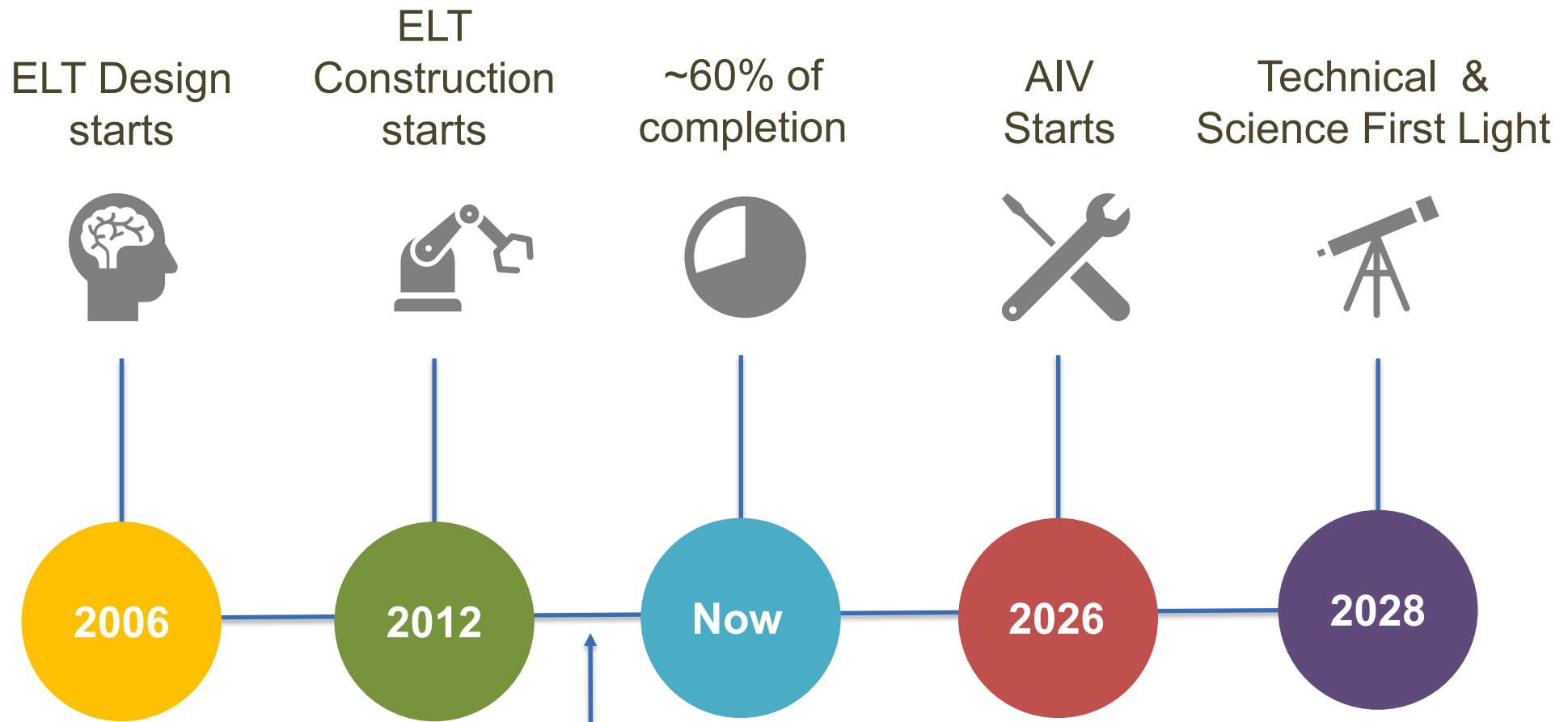
James Webb Space Telescope (6.5m)



ELT (39m)



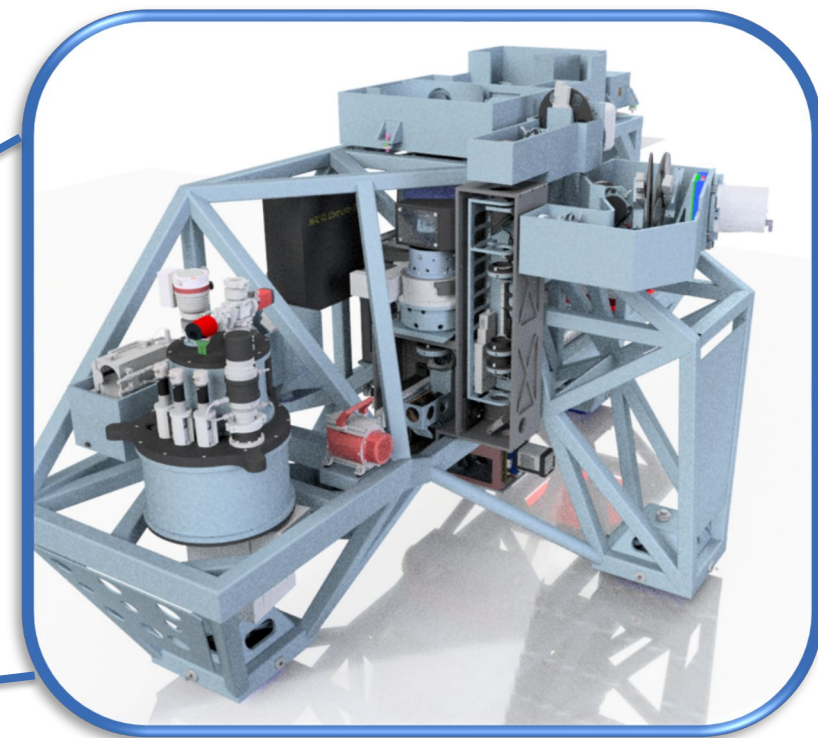
# ELT PgM -Timeline





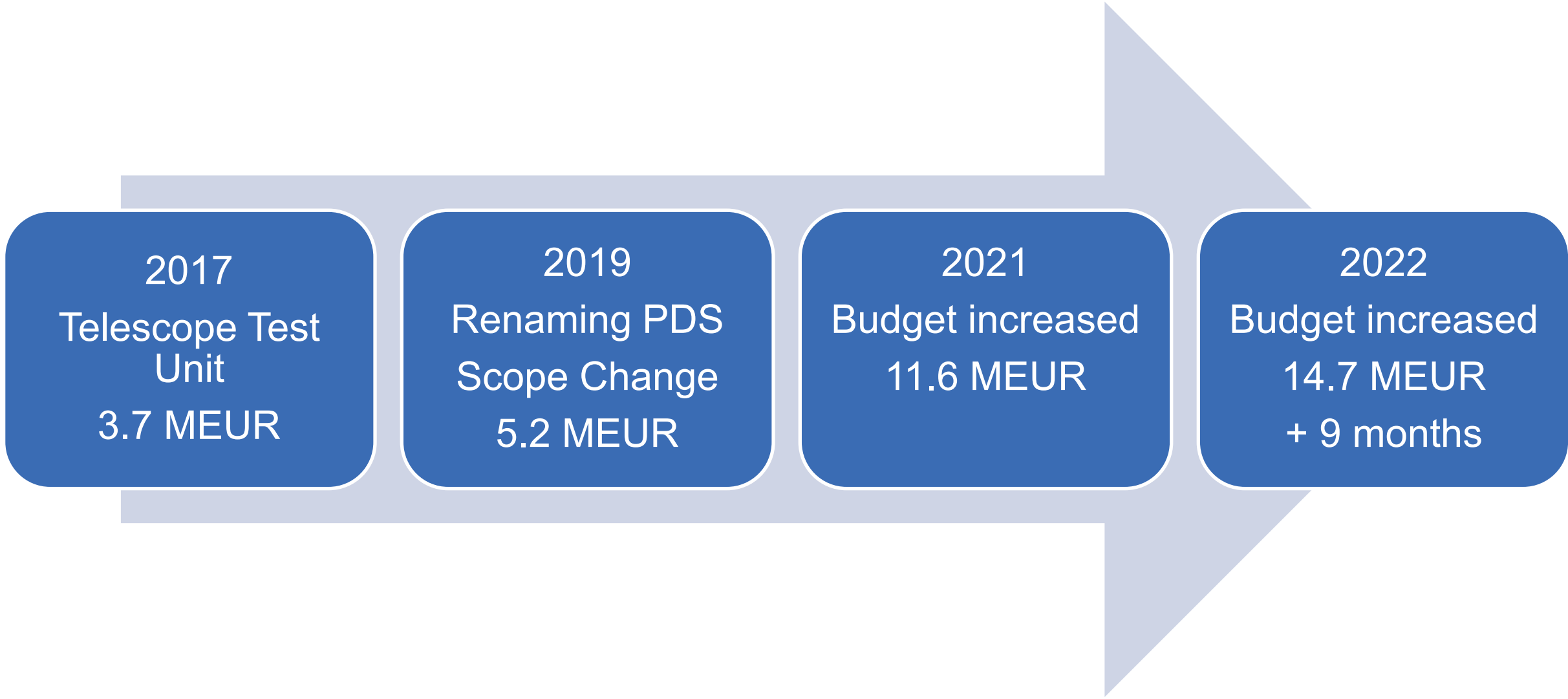
# EVM on Phasing & Diagnostic Station

- The PDS project is an in-house development on the **ELT Programme critical path**
  - Its purpose is to keep the telescope primary mirror phased, diagnosing problems, and helping to maintain the telescope's active and adaptive functions
  - Key element for commissioning the Telescope





# PDS Project history





# Agenda

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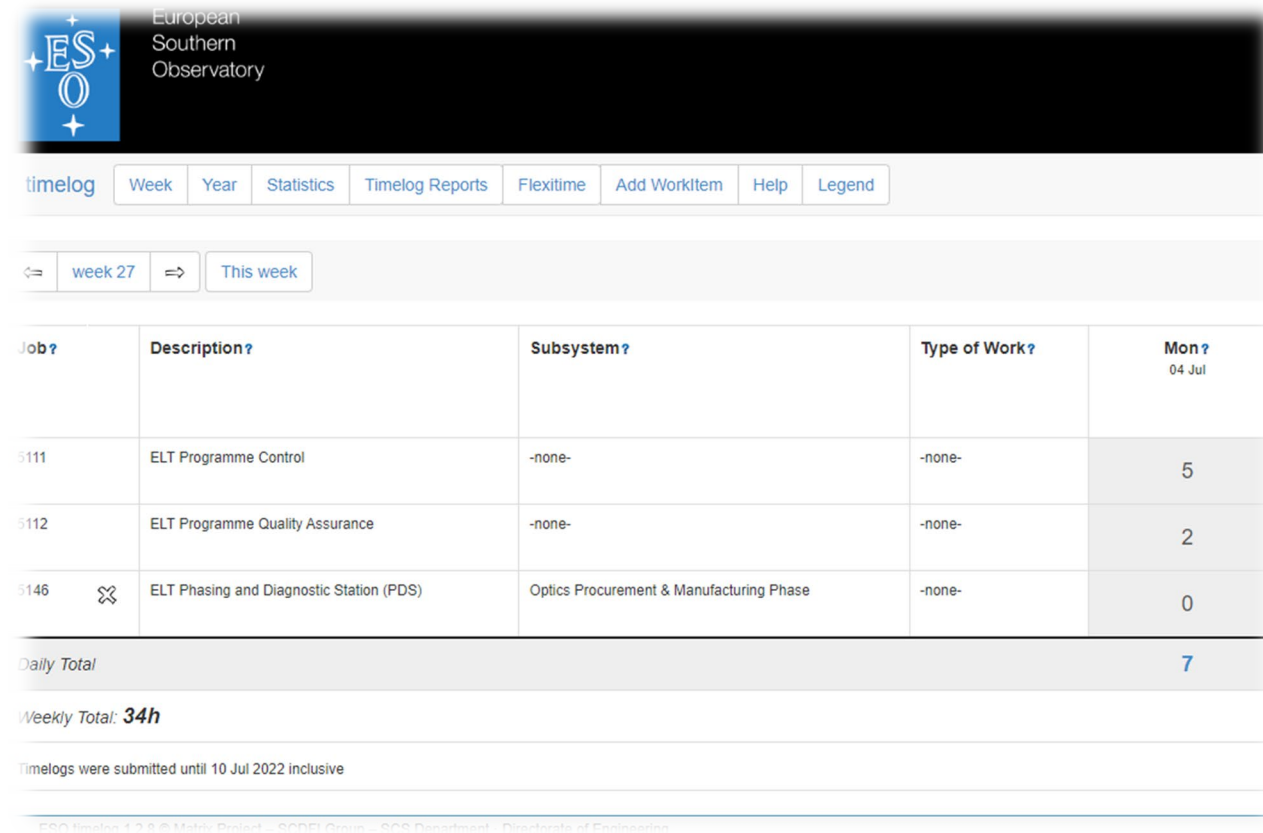


Benefits and  
challenges of  
EVM



## ■ ESO Time tracking tool (Timelog)

- Efficient time tracking
- Actual costs (personnel)
- Down to sub-project level
- Export capabilities
- Monthly reporting to Project Managers



The screenshot shows the ESO Timelog web application interface. At the top left is the ESO logo and the text "European Southern Observatory". Below this is a navigation bar with tabs for "timelog", "Week", "Year", "Statistics", "Timelog Reports", "Flexitime", "Add WorkItem", "Help", and "Legend". A secondary navigation bar shows "week 27" and "This week". The main content area is a table with the following data:

Job?	Description?	Subsystem?	Type of Work?	Mon? 04 Jul
5111	ELT Programme Control	-none-	-none-	5
5112	ELT Programme Quality Assurance	-none-	-none-	2
5146	⊗ ELT Phasing and Diagnostic Station (PDS)	Optics Procurement & Manufacturing Phase	-none-	0
<i>Daily Total</i>				<b>7</b>
<i>Weekly Total: 34h</i>				
Timelogs were submitted until 10 Jul 2022 inclusive				

At the bottom of the screenshot, there is a footer: "ESO timelog 1.2.8 © Matrix Project - SCDF Group - SCS Department - Directorate of Engineering".



## ■ ERP system (Navision)

- Purchase requests
- Actual costs (material)
- Export capabilities

VIEW - PURCHASE REQUESTS

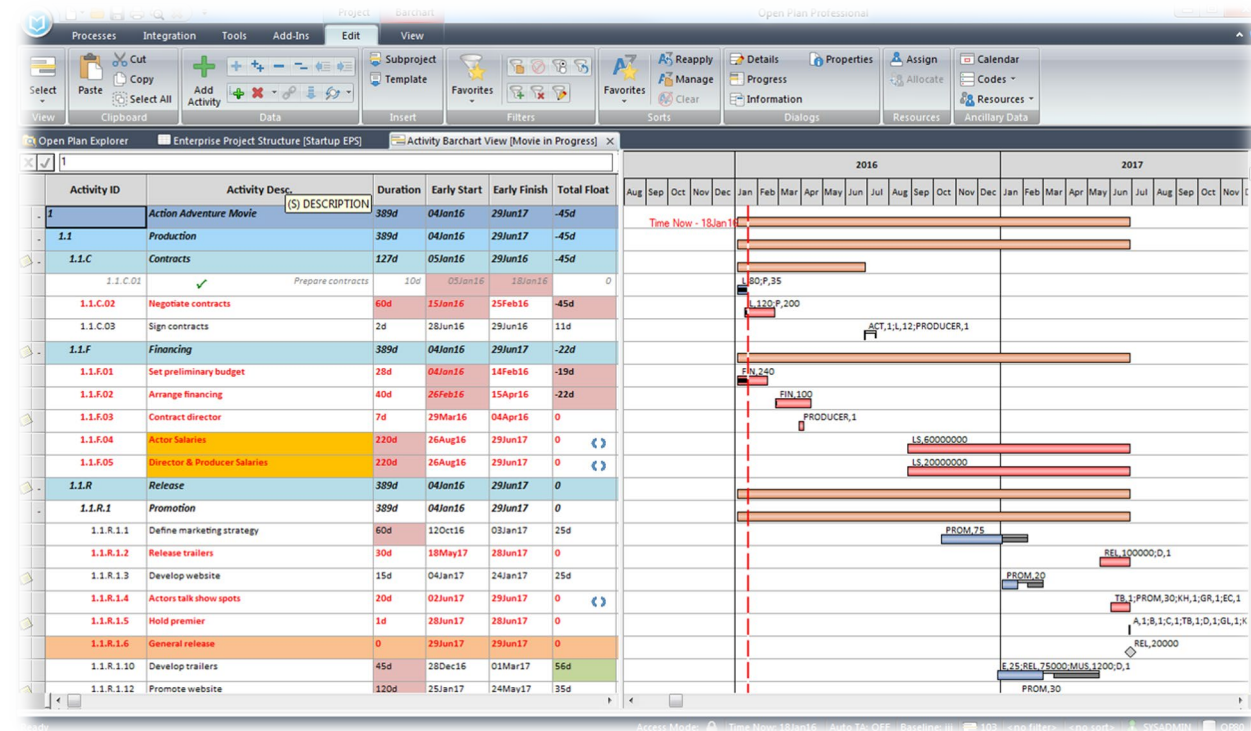
HOME ACTIONS

New Edit View Delete Print... Show as List Show as Chart OneNote Notes Links Refresh Clear Filter Find

Purchase Requests 5146

Status	Submission Date	Document Date	No.	Internal Description	Direct Order	Responsi... Center	User ID	CP User ID	Requester ID	Assistant User ID	Approval Status R...	Job No.	Job Approv...	Approval Status Jo...	Fin... Con...	Buy-from Vendor No.	Buy-from Vendor Name	Location Code
Open		30/06/2017	PR082335		<input type="checkbox"/>	EUROPE					Pending	5146		Pending	<input type="checkbox"/>			GAR.HQB
Released		07/02/2020	PR101027		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Pending	<input type="checkbox"/>			GAR.HQB
Released	03/04/2020	03/04/2020	PR101832		<input type="checkbox"/>	EUROPE					Approved	5146		Approved	<input checked="" type="checkbox"/>			GAR.HQB
Released		09/04/2020	PR101847		<input type="checkbox"/>	EUROPE					Approved	5146		Approved	<input checked="" type="checkbox"/>			GAR.HQB
Released		24/06/2020	PR102605		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Pending	<input type="checkbox"/>			GAR.HQB
Released		24/07/2020	PR102983		<input type="checkbox"/>	EUROPE					Approved	5146		Approved	<input checked="" type="checkbox"/>			GAR.HQB
Released	07/09/2020	07/09/2020	PR103535		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Pending	<input type="checkbox"/>			GAR.HQB
Released	07/09/2020	07/09/2020	PR103536		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Pending	<input type="checkbox"/>			GAR.HQB
Released		16/09/2020	PR103557		<input type="checkbox"/>	EUROPE					Approved	5146		Approved	<input checked="" type="checkbox"/>			GAR.HQB
Released	30/09/2020	13/01/2021	PR103818		<input type="checkbox"/>	EUROPE					Approved	5146		Approved	<input checked="" type="checkbox"/>			GAR.HQB
Released	30/09/2020	30/09/2020	PR103835		<input type="checkbox"/>	EUROPE					Approved	5146		Approved	<input checked="" type="checkbox"/>			GAR.HQB
Released	01/10/2020	02/10/2020	PR103849		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Pending	<input type="checkbox"/>			GAR.HQB
Released		13/10/2020	PR103994		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Approved	<input type="checkbox"/>			GAR.HQB
Released		18/11/2020	PR104585		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Approved	<input type="checkbox"/>			GAR.HQB
Released	23/11/2020	23/11/2020	PR104677		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Approved	<input type="checkbox"/>			GAR.HQB
Released	26/11/2020	26/11/2020	PR104746		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Pending	<input type="checkbox"/>			GAR.HQB
Released	08/12/2020	08/12/2020	PR104975		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Approved	<input type="checkbox"/>			GAR.HQB
Released	09/12/2020	09/12/2020	PR104996		<input checked="" type="checkbox"/>	EUROPE					Pending	5146		Approved	<input type="checkbox"/>			GAR.HQB
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Released	26/01/2021	26/01/2021	PR105511		<input checked="" type="checkbox"/>	EUROPE					Approved	5146		Approved	<input type="checkbox"/>			GAR.HQB
Released	17/02/2021	24/02/2021	PR105812		<input type="checkbox"/>	EUROPE					Approved	5146		Approved	<input checked="" type="checkbox"/>			GAR.HQB
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Released		24/03/2021	PR106269		<input type="checkbox"/>	EUROPE					Approved	5146		Approved	<input checked="" type="checkbox"/>			GAR.HQB
Released	13/04/2021	16/04/2021	PR106504		<input checked="" type="checkbox"/>	EUROPE					Approved	5146		Approved	<input type="checkbox"/>			GAR.HQB
Released	27/04/2021	28/04/2021	PR106524		<input checked="" type="checkbox"/>	EUROPE					Approved	5146		Approved	<input type="checkbox"/>			GAR.HQB
Released	27/04/2021	28/04/2021	PR106658		<input checked="" type="checkbox"/>	EUROPE					Approved	5146		Approved	<input type="checkbox"/>			GAR.HQB
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Released	07/06/2021	08/06/2021	PR107108		<input checked="" type="checkbox"/>	EUROPE					Approved	5146		Approved	<input type="checkbox"/>			GAR.HQB
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Released	11/06/2021	11/06/2021	PR107180		<input type="checkbox"/>	EUROPE					Approved	5146		Approved	<input checked="" type="checkbox"/>			GAR.HQB
Released	11/06/2021	11/06/2021	PR107181		<input checked="" type="checkbox"/>	EUROPE					Approved	5146		Approved	<input type="checkbox"/>			GAR.HQB

- Deltek Open Plan
  - Scheduling and resource planning tool enabling EVM implementation at Programme level
  - In 2021, the ELT Programme placed specific focus on the Phasing & Diagnostic Station project



Source: [www.g2.com](http://www.g2.com)



# Tools

- Progress inputs from the Work Package Manager
  - Activity ID & description
  - Actual Start, Actual Finish, % complete, remaining duration

The screenshot shows the Open Plan Professional software interface. The 'Edit' menu is active, and the 'Progress Spreadsheet [OCP-PDS v15]' is open. The table below displays the data from the spreadsheet.

Activity ID	Activity Desc.	Dur.	Baseline Start	Baseline Finish	Actual Start	Actual Finish	Progress Value	Physical % Complete	Activity Type
10	PDS	2739d	07Mar2017	03Sep2027	03/07/17		1351d	25.19	Subproject
10.10	Milestones	1755d	11Dec2020	03Sep2027	12/11/20		1351d	0.00	Subproject
10.2000	Final Design Phase	12967h	07Mar2017	22May2023	03/07/17		1863h	52.22	Subproject
10.2000.10	Final Design Phase - part 2	333d	08Mar2022	14Apr2023	01/06/22		207d	28.93	Subproject
10.2000.10.00	Work Package management	289d	08Mar2022	14Apr2023	03/08/22		0	28.00	ASAP
10.2000.10.10	SE Engineering	289d	08Mar2022	14Apr2023	03/08/22		0	23.00	ASAP
10.2000.10.20	PDS structure	278d	08Mar2022	21Mar2023	03/08/22		195d	10.12	Subproject

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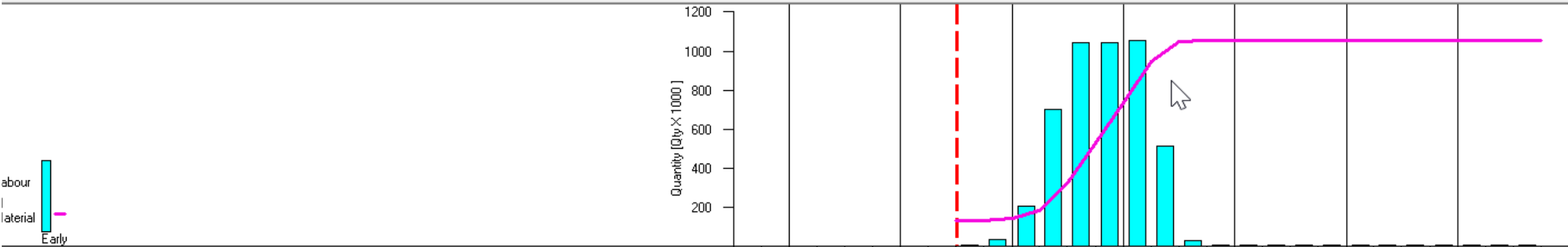
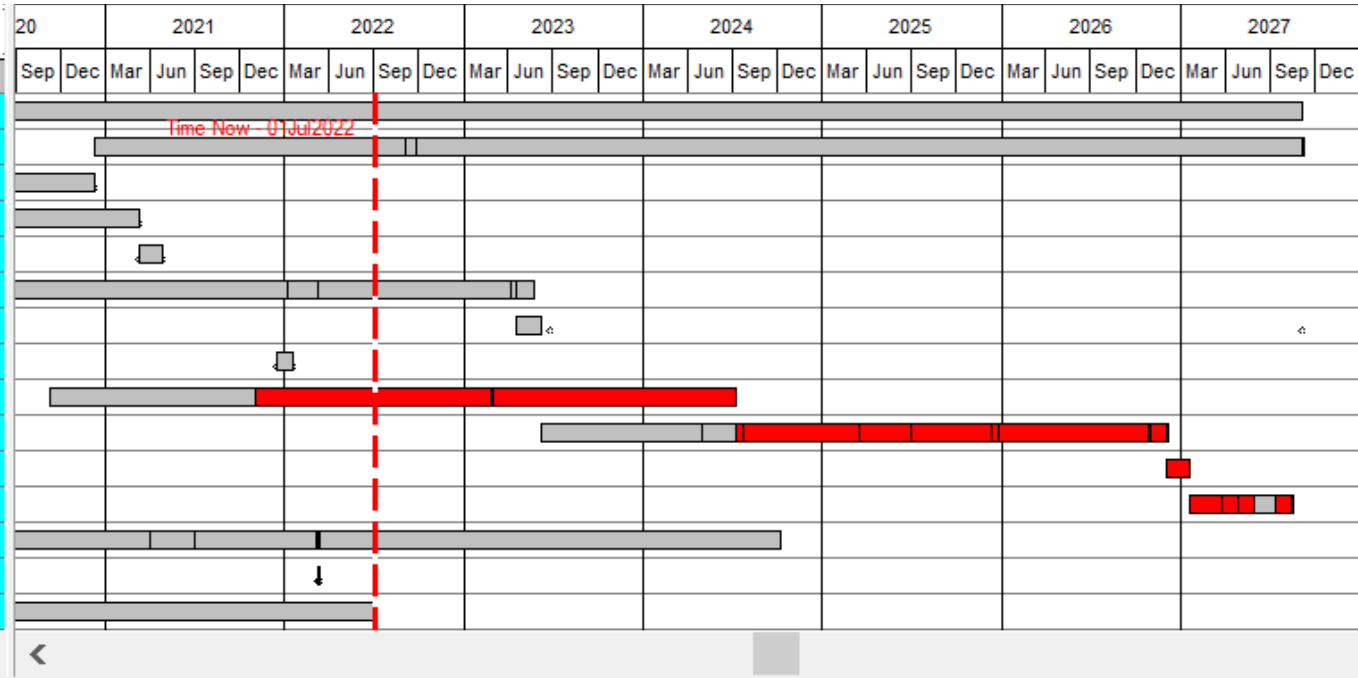






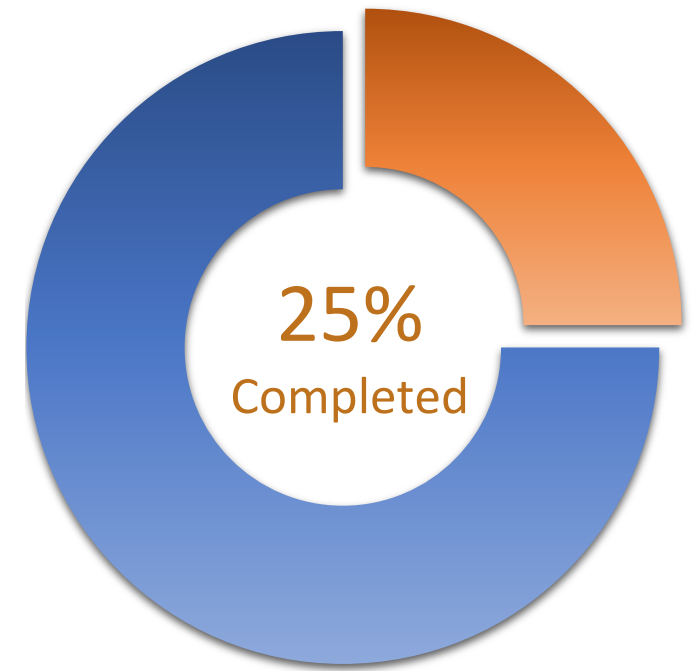
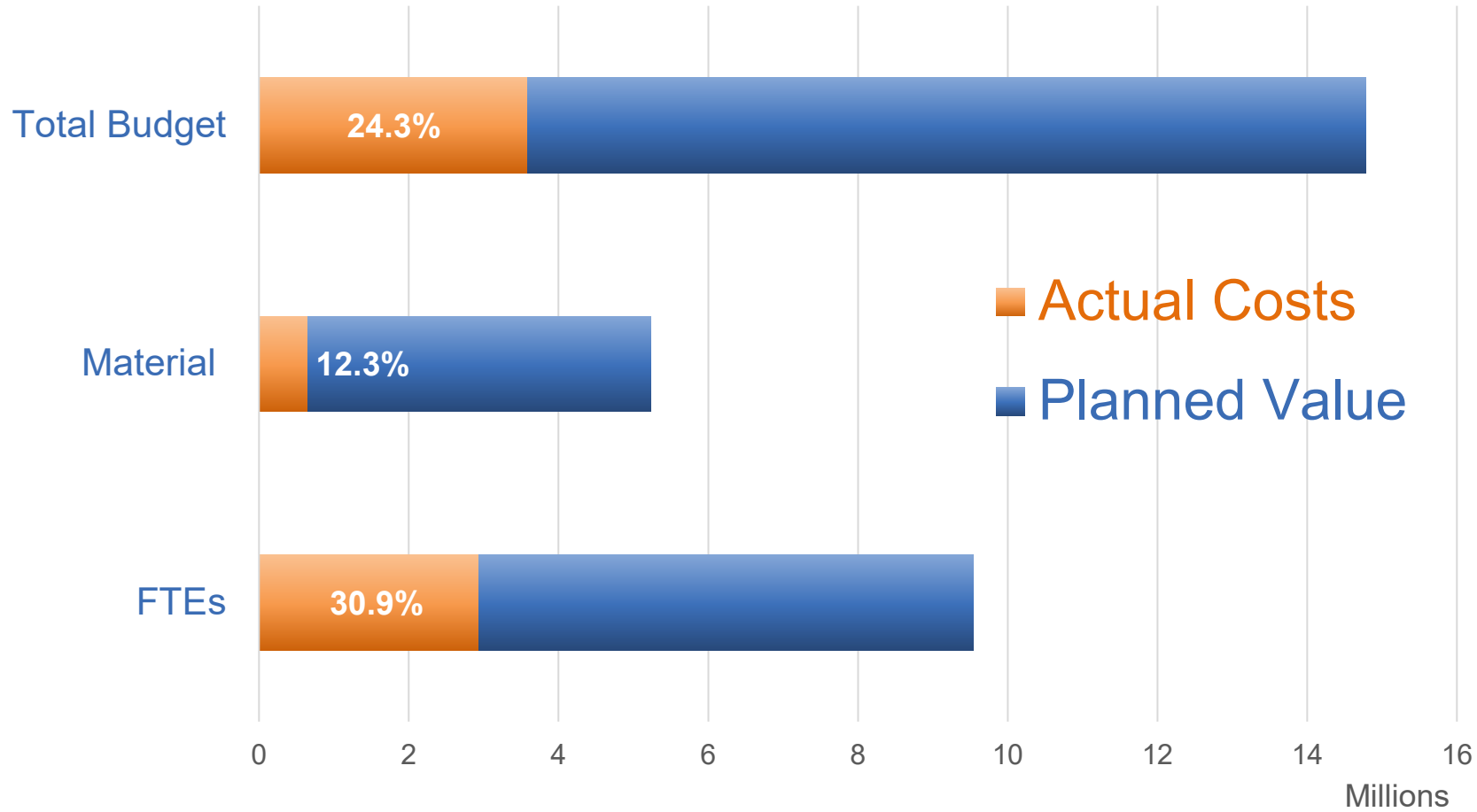
# Project Top-Level View

Activity ID	Activity Desc.	Early Start	Early Finish	Duration
10	PDS	07Mar2017	03Sep2027	2739d
10.10	Milestones	11Dec2020	03Sep2027	1755d
10.20	Phase 1	12Nov2018	11Dec2020	545d
10.1000	Preliminary Design Phase	09Sep2019	12Mar2021	395d
10.1100	PDR Review	12Mar2021	27Apr2021	32d
10.2000	Final Design Phase	07Mar2017	23May2023	1620.9d
10.2100	FDR Review	18Apr2023	06Jun2023	36d
10.2300	Optics FDR Review	15Dec2021	17Jan2022	24d
10.2500	Optics Procurement & Manufacturing Phase	08Sep2020	08Jul2024	1000d
10.3000	MAIT Phase	07Jun2023	03Dec2026	912d
10.3500	Packing/Shipping	04Dec2026	19Jan2027	33d
10.4000	Chile	20Jan2027	13Aug2027	148d
10.5000	Camera Systems (Deliverables to PDS)	07Mar2017	08Oct2024	1980d
10.6000	Additional components (Control, Mechanics, Optics)	08Mar2022	09Mar2022	2d
10.7000	Actual/ Invoiced procurements	07Mar2017	30Jun2022	1388d





# Monitoring Spending & Progress





# EVM analysis

## Down to sub-projects level

- CPI & SPI indexes highlight areas of the project that are
  - Ahead or lagging behind
- The results require interpretation
- The indexes help the PM to flag potential issues in a glimpse

Activity ID	Duration	Activity Desc.	Baseline Start	Baseline Finish	Actual Start	Actual Finish	Physical % Complete	CV	SV	CPI	SPI	BCWS (PV)	BCWP (EV)	ACWP (AC)	BAC	ETC	EAC	VAC
0	2725d	PDS	07Mar2017	03Sep2027	07Mar2017		25.10				0.98							
10.10	1741d	Milestones	11Dec2020	03Sep2027	11Dec2020		0.00				0.00							
10.20	545d	Phase 1	12Nov2018	11Dec2020	12Nov2018	11Dec2020	100.00				0.00							
10.1000	395d	Preliminary Design Phase	09Sep2019	12Mar2021	09Sep2019	12Mar2021	100.00				1.00							
10.1100	32d	PDR Review	12Mar2021	27Apr2021	12Mar2021	27Apr2021	100.00				1.00							
10.2000	13255h	Final Design Phase	07Mar2017	22May2023	07Mar2017		52.16				0.95							
10.2000.00	1305d	Final Design Phase - part 1	07Mar2017	07Mar2022	07Mar2017	07Mar2022	100.00				1.00							
10.2000.10	369d	Final Design Phase - part 2	08Mar2022	14Apr2023	06Jan2022		28.84				0.88							
10.2000.10.00	289d	Work Package management	08Mar2022	14Apr2023	08Mar2022		28.00				0.97							
10.2000.10.10	289d	SE Engineering	08Mar2022	14Apr2023	08Mar2022		23.00				0.80							
10.2000.10.20	278d	PDS structure	08Mar2022	21Mar2023	08Mar2022		10.12				0.92							
10.2000.10.30	289d	IR Arm	08Mar2022	14Apr2023	08Mar2022		34.84				1.07							
10.2000.10.40	245d	Visible side	08Mar2022	02Mar2023	08Mar2022		42.55				1.24							
10.2000.10.50	284d	AQGC	08Mar2022	14Apr2023	08Mar2022		57.74				1.02							
10.2000.10.60	296d	PDS electronics	08Mar2022	09Feb2023	19Apr2022		18.90				0.53							
10.2000.10.70	317d	Software	14Mar2022	27Jan2023	06Jan2022		34.76				0.66							
10.2000.10.80	279d	MAICA1	08Mar2022	08Feb2023	08Mar2022		16.70				0.51							

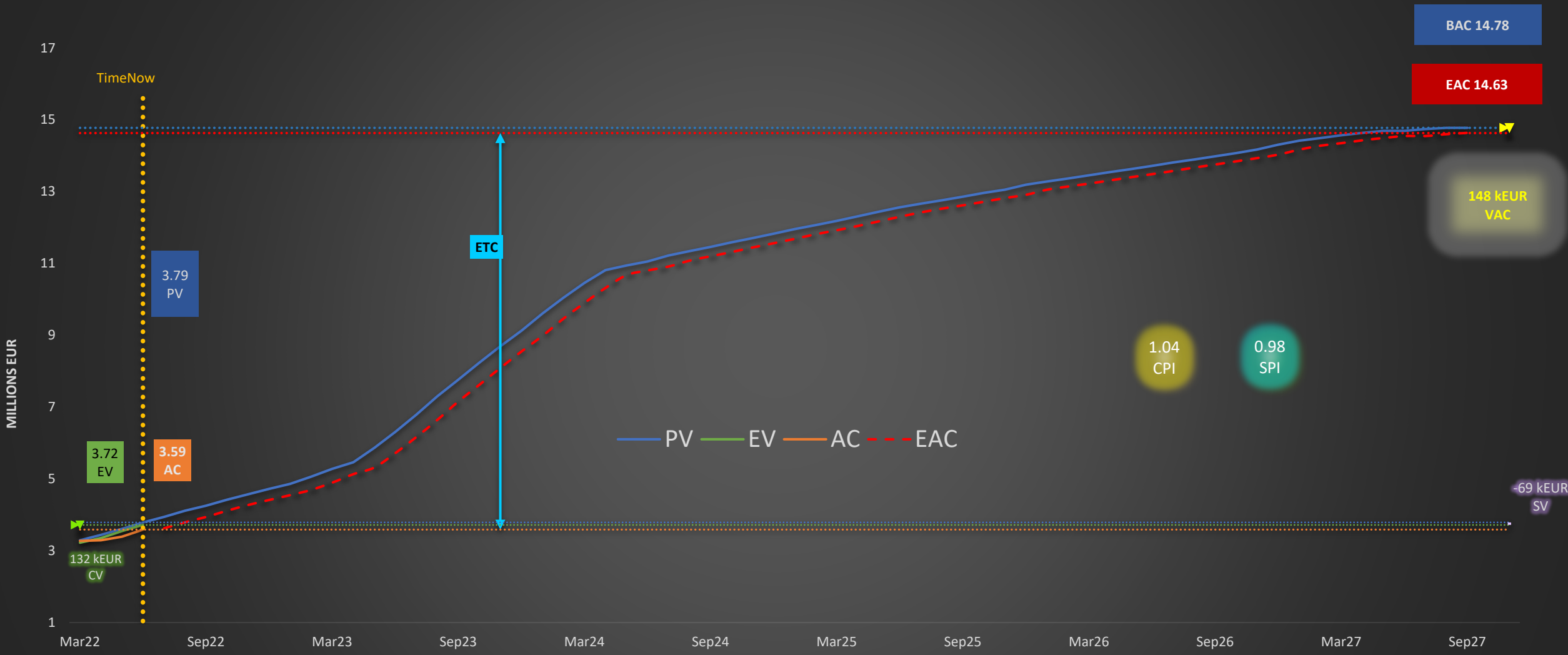
Project Performance metrics per phase







# EVM reporting



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# Benefits

- Monthly report on the project cost and schedule performances
  - Insight
  - More accurate project timeline
- FTEs (Full Time Equivalent) planning forecast
  - Refine resource estimates
- Raising awareness within the team
- Change management (deviations)
  - Implementation of preventive or corrective actions
- Additional project management tool
  - Control over the scope of work

## SCOPE TRIANGLE

The Project Management Golden Triangle



Scope and the Triple Constraints; i.e., The Four Fundamental "What's of Every Project"

Source: sketchbubble.com



# Challenges

- EVM Implementation using Deltek Open Plan
  - EVM Concept (fairly new at ESO)
  - Steep learning curve to adapt to the built-in EVM features
  - Procedure development
    - Changes require retrofitting the way we integrate data
  - Rolling waves change & re-baselining
    - Complex set of steps to implement
    - Time-bound (monthly report)



Source: <https://casn.berkeley.edu/>

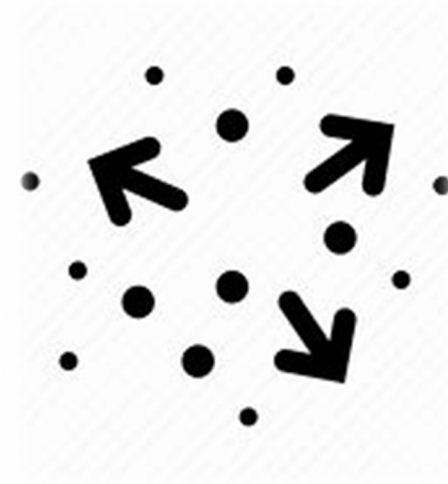
# Challenges

## ■ ESO Time tracking tool limitations

- Separated tool from our ERP
- Based on an average FTE value
- No time-bound nor standard ways of recording (% per month vs hour per day)
- Missing special leave, long-term leave etc.

## ■ Data distribution across multiple tools

- Time recording system
- ERP
- Planning tool (Macro to extract data into Excel)



Source: [www.iconfinder.com](http://www.iconfinder.com)







# Any questions?

■ Video

