

Planning the AIV phase for an Extremely Large Telescope

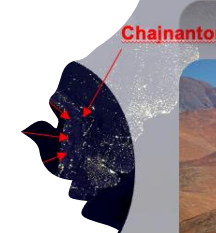
A. Wright

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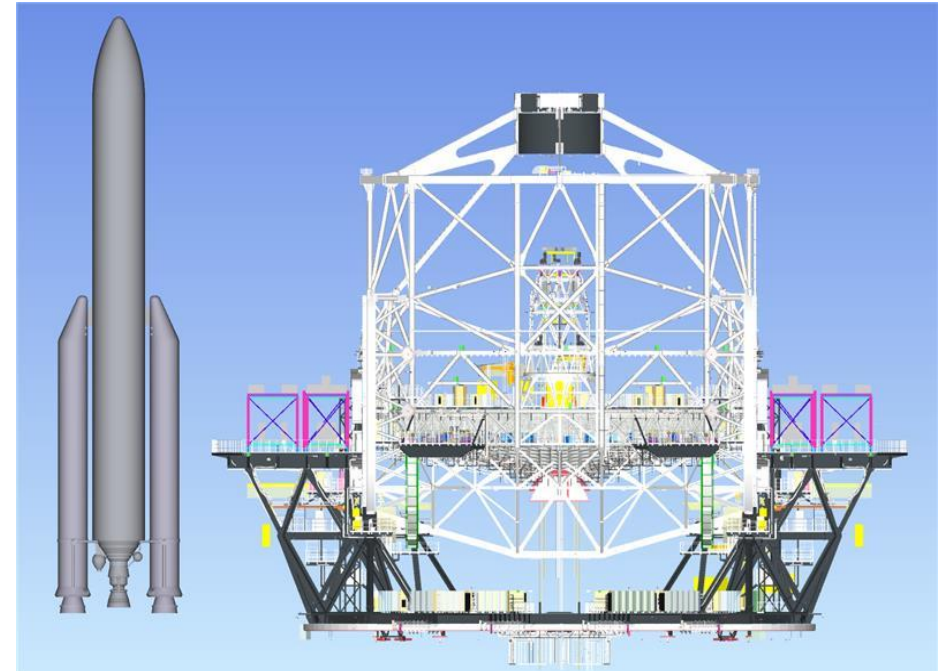
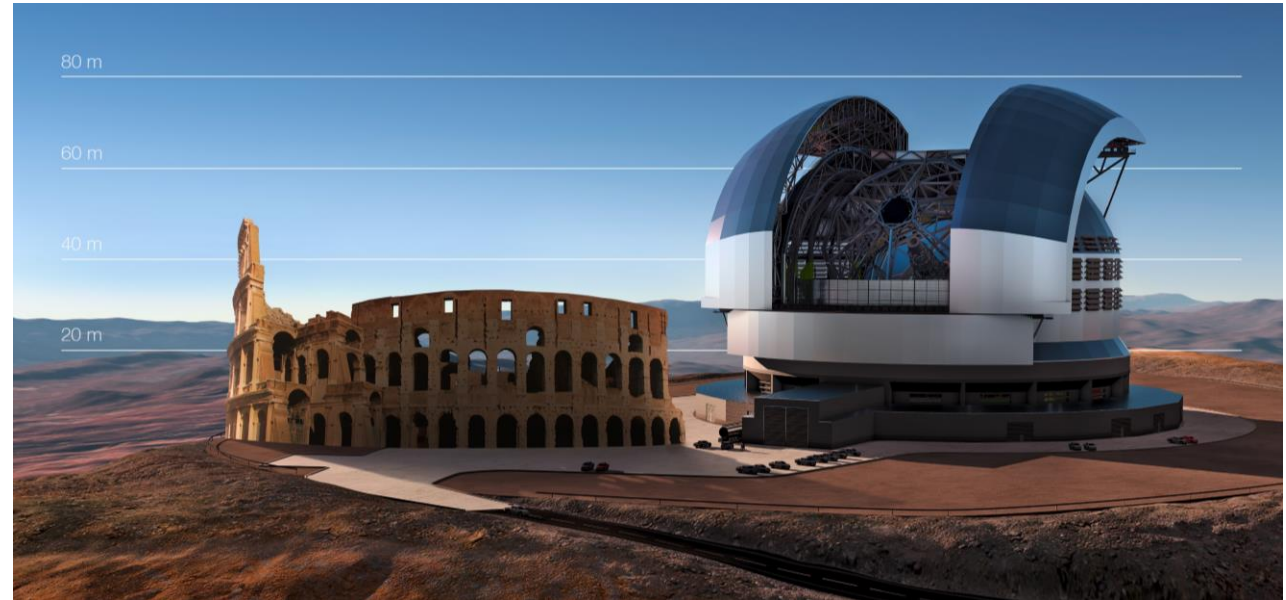
European Southern Observatory

- 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

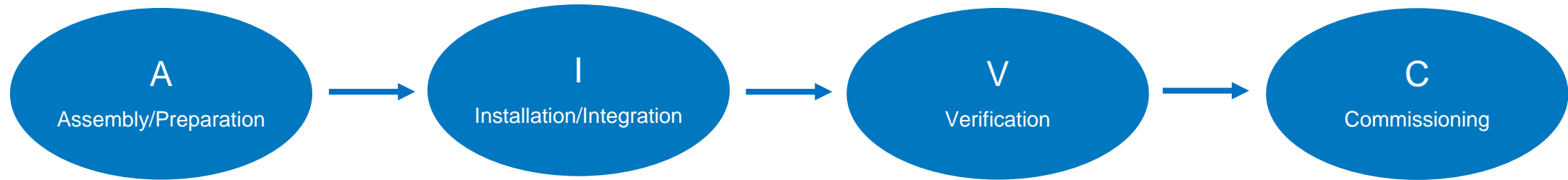


ELT Overview

- Budget 1.4 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 metres 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 Assembly Integration Verification (AIVC)



- AIV covers all activities to prepare the infrastructure and perform the assembly, integration and verification of the telescope at both sub-system and system level – this includes support to the assembly and telescope integration of the science instruments;
- AIV (and Commissioning) includes system tests of the integrated telescope (known as “Technical Commissioning”);
- AIV (and Commissioning) ends with the handover of the completed telescope to the Programme Scientist, for the Science Commissioning phase.

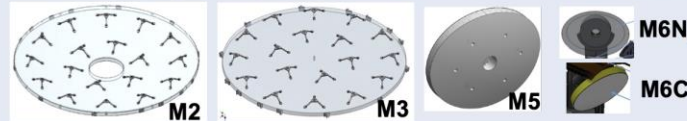
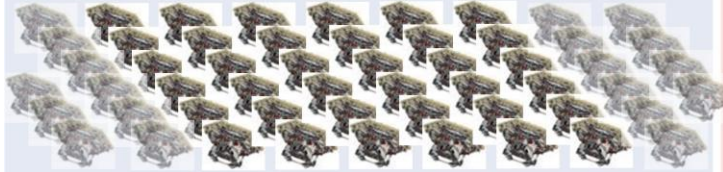
ELT Sub-units AIV



Assembly

ELT Technical Facility

- Mirror Coating (M1, M2, M3, M5, M6s)



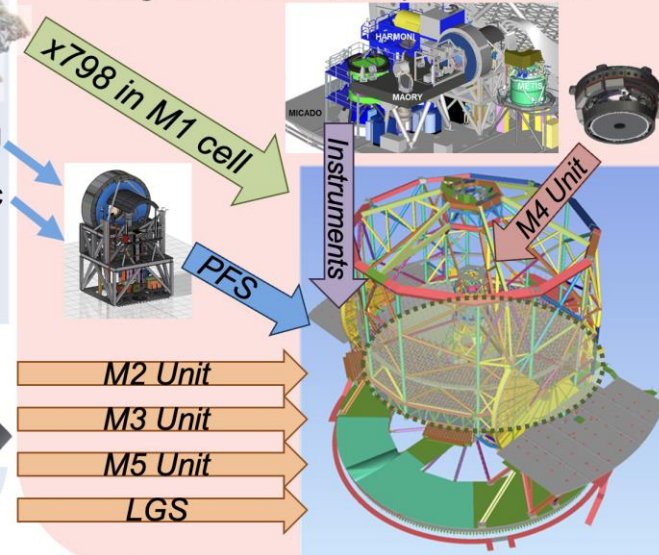
- Assembly and sub-system verification (M2/M3/M5 Units, Laser GS)



Integration

Dome Auxiliary Building and Telescope

- Assembly and sub-system verification activities (M4, PFS, Instruments)
- Integration and telescope verification

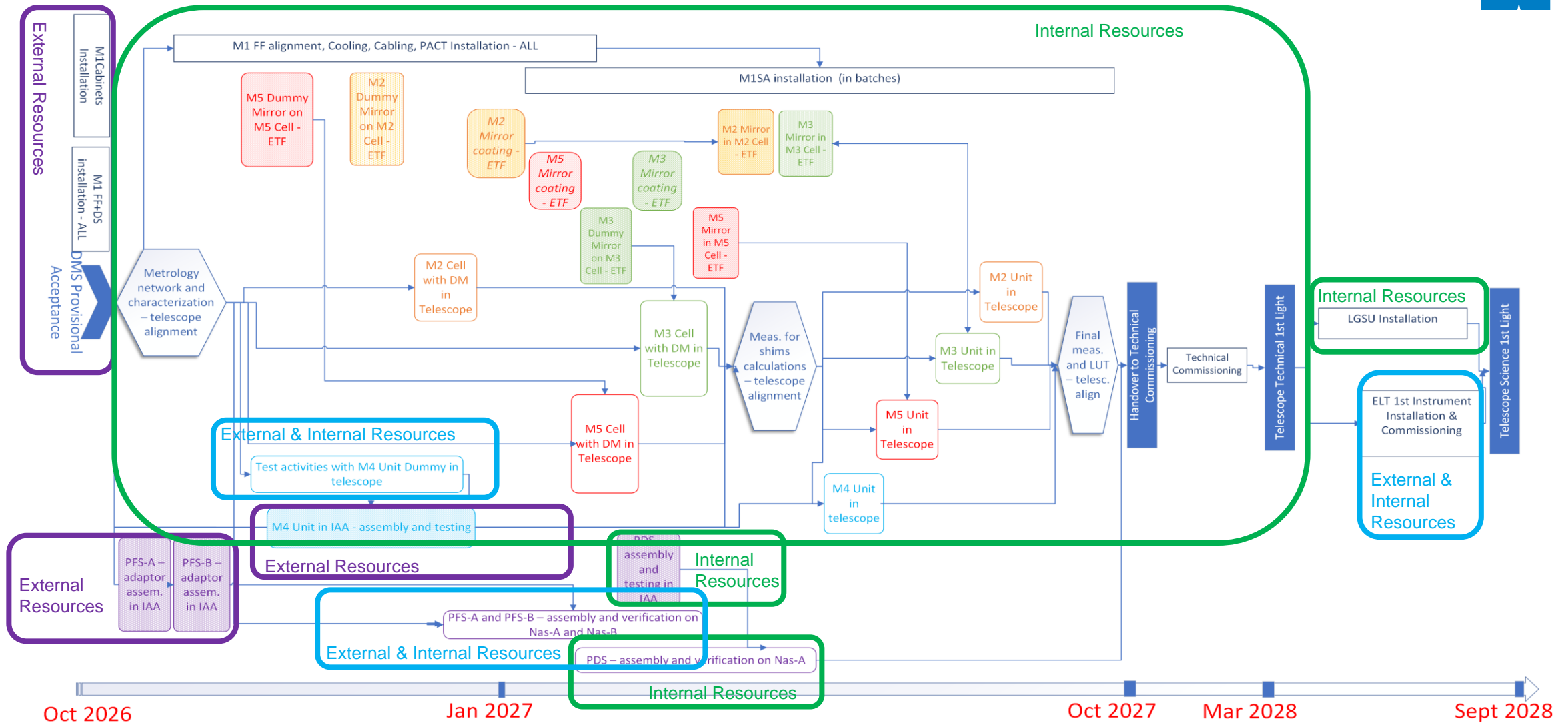


Verification & Commissioning

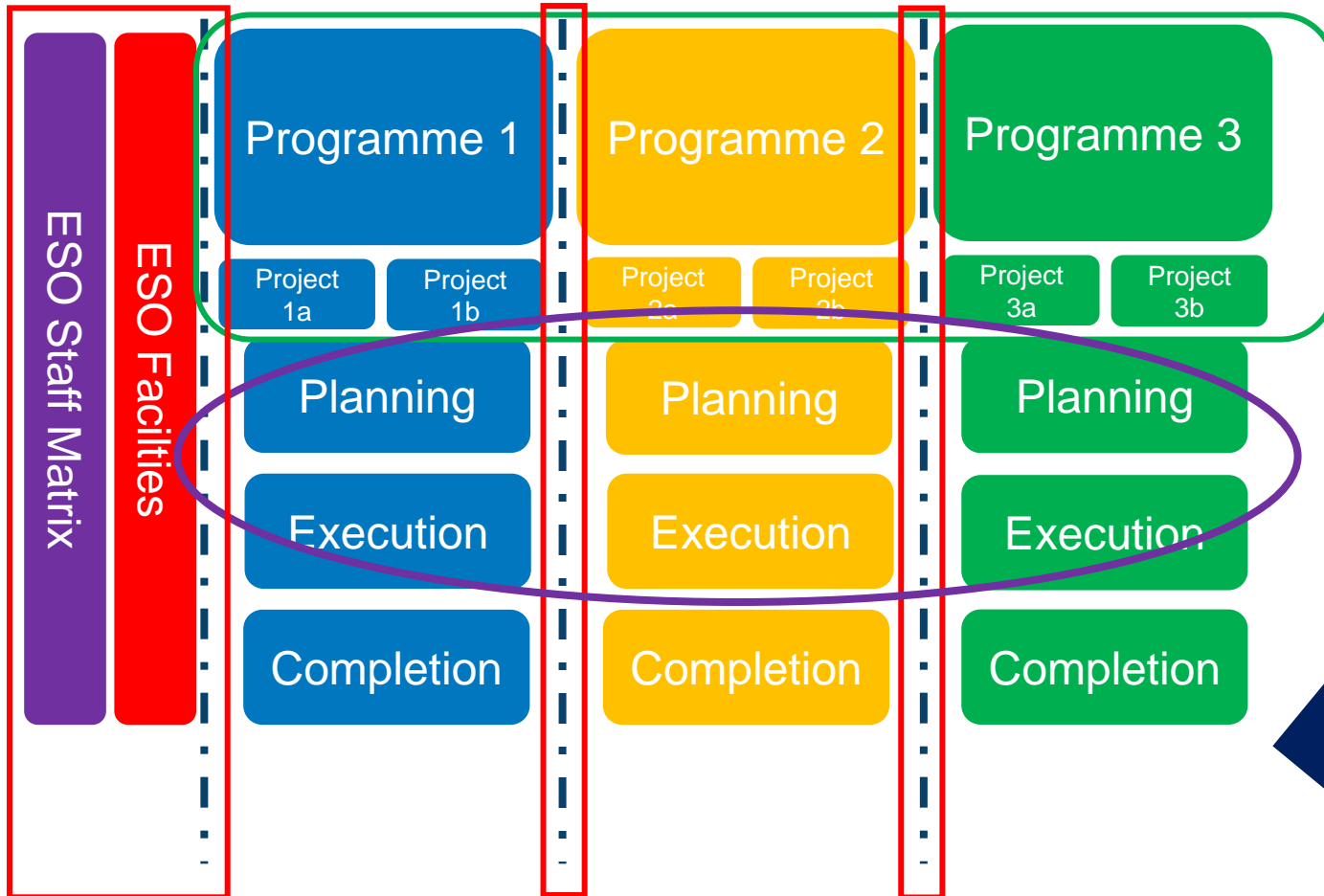


- **ELT sub-units are delivered from different sources:**
 - Built in-house
 - External industrial contracts
 - Combination of both of in-house and External industrial contracts.
- **Integration of the sub-units onto the telescope is performed via different resources:**
 - Internal staff
 - External staff

ELT Construction & AIV Roadmap



ESO Landscape and Overall Challenges



Multiple competing projects and programmes requesting the same resources

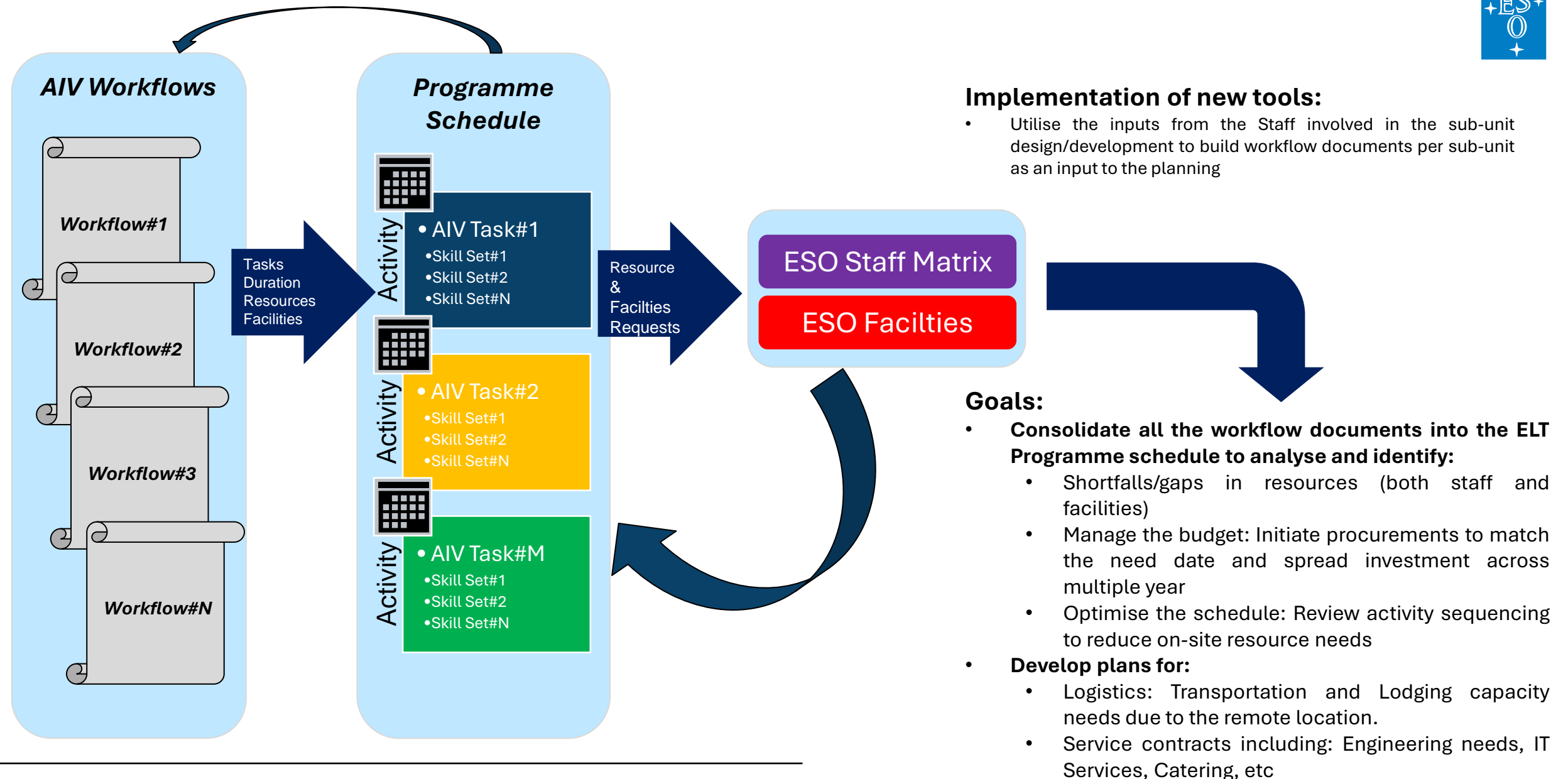
Limited visibility for all needs

- Large Spreadsheets and documents no longer meeting the purpose
- Limited understanding of what/when



Impact to Organisation wide planning

Planning & Controlling Optimisation for ELT AIV



Resource and Facility categorisation



Resources

Facilities

Telescope Status

OPP Activity ID	08.10.15.205.05.35
OPP Activity Desc.	M1 Segment Assemblies – ES Install and Coating
Duration	399d

Predecessors	
OPP Activity ID	OPP Activity Desc.
08.10.15.205.05.30	M1 Segment Assemblies – Unloading & Storage
08.10.15.205.05.15	Edge Sensors – Unloading and Storage
08.10.15.205.05.20	M1SA Hardware – Unloading & Storage
08.10.15.205.05.25	M1SA Handling Equipment – Unloading & Storage
08.10.15.200.10	PAR ETF – M1 Washing Stripping Coating Unit#1 – AIV Commissioning
08.10.10.100.150.60	PAR ETF - M1 Facility Manual Washing Unit Available - AIV Need
06.06.20.20.10.110.20.20	M1 Mirror Coating units (M1CP) - Design & Manufacturing - QC Station - Change of SA Fixations/Installation- On-site

Resources (see AD2)		
Resource ID	Resource Desc.	% Effort.
Y.AIVT.WPM.M1MP	M1 Mirror Polishing WP Manager	First Batch
Y.AIVT.WPM.ES	ES WP Manager	First Batch
Y.AIV.ENG.COA	Coating process Engineer	50%
Y.AIV.ENG.QA	Quality Control Engineers	7%
Y.AIV.TEC-ESO.COA	Coating process Technicians (ESO staff)	100%
Y.AIV.TEC-ESO.COA	Coating process Technicians (ESO staff)	100%
Y.AIV.TEC-ESO.COA	Coating process Technicians (ESO staff)	50%
Y.AIV.TEC-ESO.COA	Coating process Technicians (ESO staff)	50%
Y.AIV.TEC-EXT.COA	Process Technicians (Trainee, Outsourced staff)	100%
Y.AIV.TEC-EXT.COA	Process Technicians (Trainee, Outsourced staff)	100%
Y.AIV.TEC.ME	Mechanical Technicians	20%
Y.AIV.PO.WRHS	Warehouse Staff	20%

Required Facilities (see AD3)		
Facilities ID	Facilities Desc.	Utilisation (Full/Partial)
Z.ETF-M1CA	ETF-M1CA - M1 Coating Area	Full
Z.ETF-M1SA-CART-1	ETF-M1SA-CART-1 – M1SA Cart #1	Full
Z.ETF-M1SA-CART-2	ETF-M1SA-CART-2 – M1SA Cart #2	Full
Z.ETF-M1SA-GRIP-1	ETF-M1SA-GRIP-1 - M1SA Gripper #1	Full
Z.ETF-M1SA-GRIP-2	ETF-M1SA-GRIP-2 – M1SA Gripper #2	Full
Z.ETF-M1SA-HCS	ETF-M1SA-HCS - M1SA Health Check Stand	Full
Z.ETF-M1WA	ETF-M1WA - M1 Working Area	Full
Z.ETF-M1WAT	ETF-M1WAT - M1 Segment Manual Washing Tank	Full
Z.ETF-M1WA.JCR-1T	M1 Working Areas 1 Tonne Jib Crane	Full
Z.ETF-M1WAAL	ETF-M1WAAL - M1 Airlock	Full
Z.ETF-M1WSA	ETF-M1WSA - M1 Wash and Strip Area	Full
Z.ETF-M1WSSA	ETF-M1WSSA - Washing/Stripping Services Area	Full
Z.ETF-SR	ETF-SR - Storage Area	Full
Z.GEN-TRANSP.LFT2T	LFT2t - EELT Lift Truck – 2 tonne electric	Full
Z.GEN-TRANSP.PT	Pallet Truck (General)	Full
Z.GEN-TRANSP.PT	Pallet Truck (Clean area)	Full
Z.ETF-M1CA-BCR2T	ETF-M1-BCR2T - M1 Coating Area Bridge Crane	Full
Z.ETF-M1MW&S-BCR2T	ETF-M1MW&S-BCR2T - M1 Wash & Strip Area Bridge Crane	Full
	Empty SATC	Full
Z.ETF-M1WA-MCCR	ETF-M1WA-MCCR - M1 Working Area - Mobile Counterweight Crane - Room 017	Full

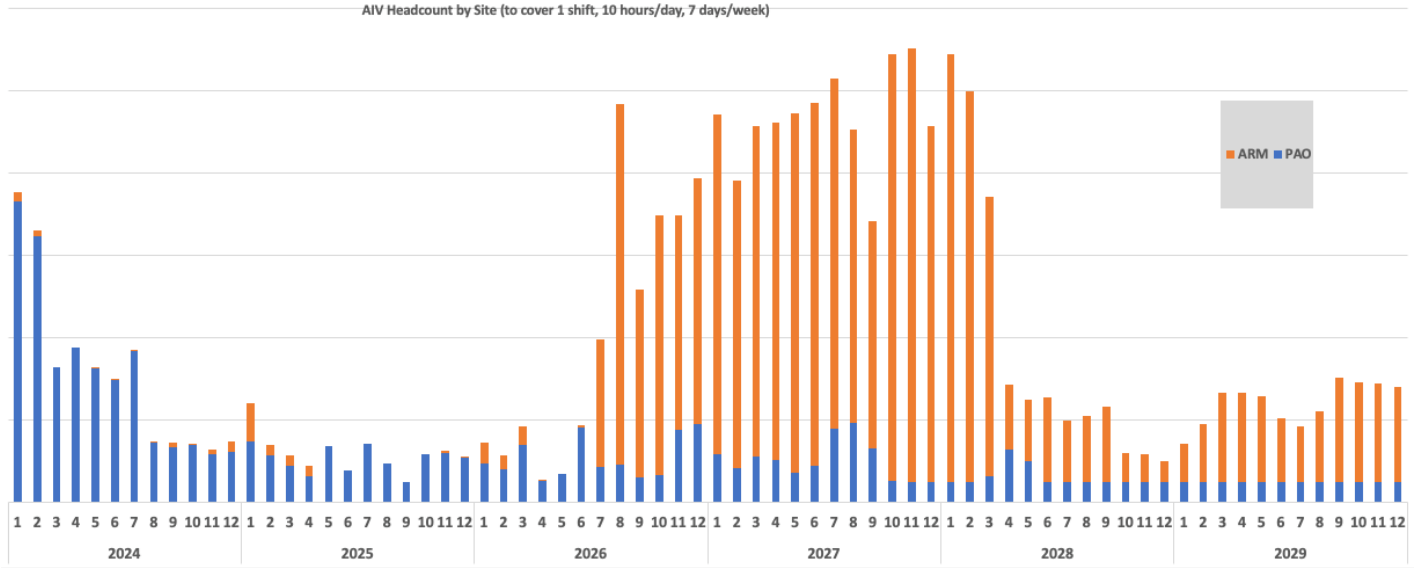
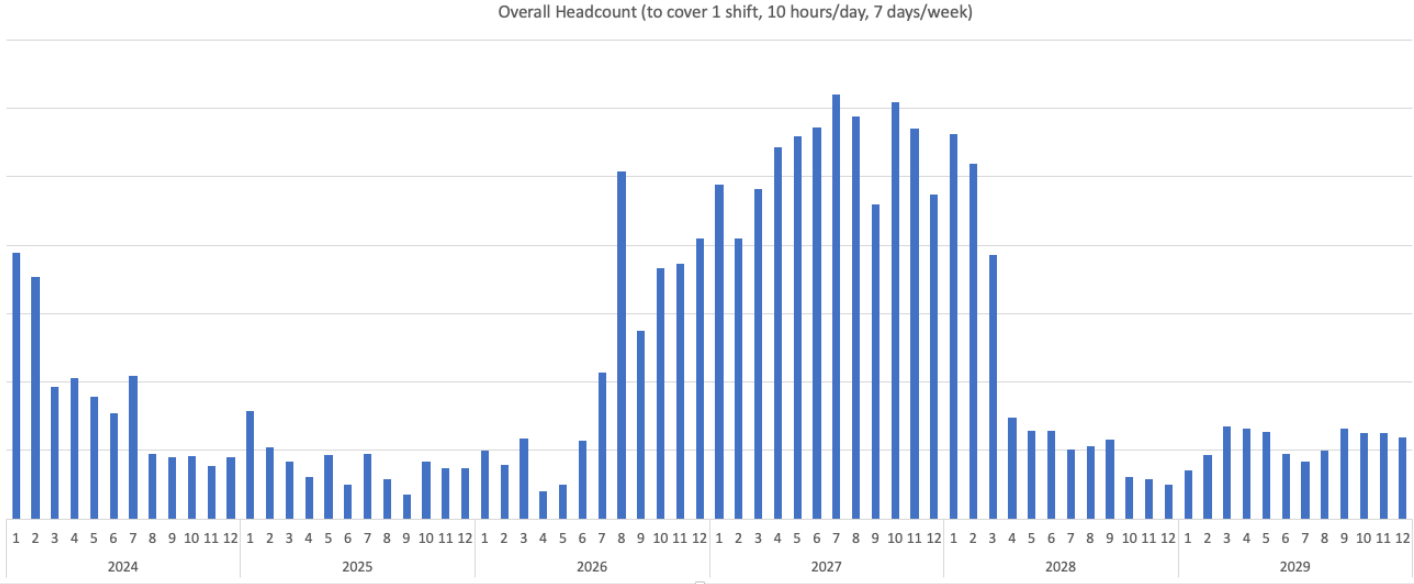
Time-phased detailed plan

Process instances (Production Shifts)			
OPP Subactivity ID	OPP Subactivity Desc.	Items	Duration
08.10.15.205.05.35.05	M1 Segment Coating and ES Install Ramp-up Production Shift #1 (5 Units)	5	7d
08.10.15.205.05.35.10	M1 Segment Coating and ES Install Production Shift #2 (14 Units)	14	7d
08.10.15.205.05.35.15	M1 Segment Coating and ES Install Production Shift #3 (14 Units)	14	7d
08.10.15.205.05.35.20	M1 Segment Coating and ES Install Production Shift #4 (14 Units)	14	7d
08.10.15.205.05.35.25	M1 Segment Coating and ES Install Production Shift #5 (14 Units)	14	7d
08.10.15.205.05.35.30	M1 Segment Coating and ES Install Production Shift #6 (14 Units)	14	7d
08.10.15.205.05.35.35	M1 Segment Coating and ES Install Production Shift #7 (14 Units)	14	7d
08.10.15.205.05.35.40	M1 Segment Coating and ES Install Production Shift #8 (14 Units)	14	7d
08.10.15.205.05.35.45	M1 Segment Coating and ES Install Production Shift #9 (14 Units)	14	7d
08.10.15.205.05.35.50	M1 Segment Coating and ES Install Production Shift #10 (14 Units)	14	7d
08.10.15.205.05.35.55	M1 Segment Coating and ES Install Production Shift #11 (14 Units)	14	7d

Analysis & Performance - Resource and Facility categorisation



Activity
Location

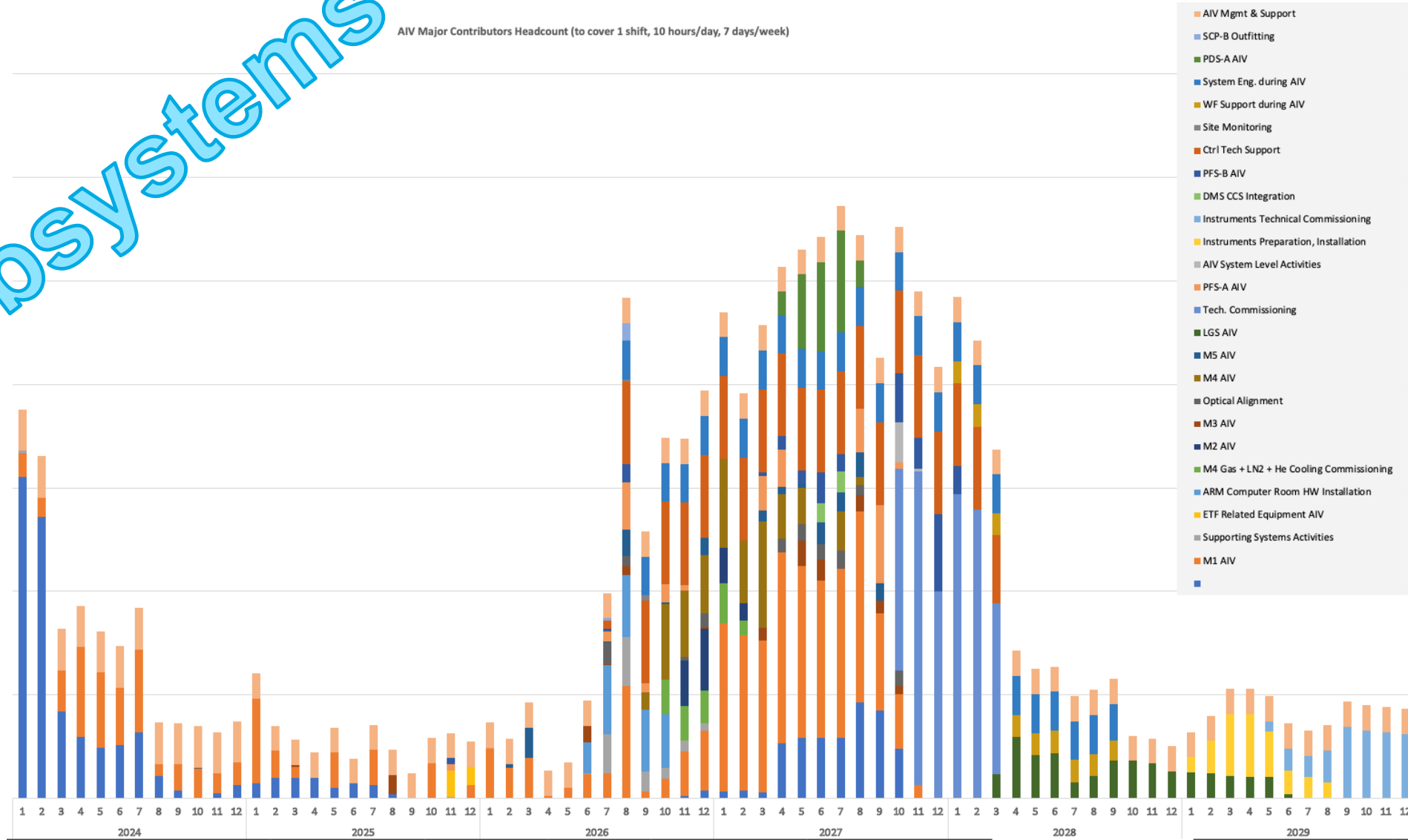


Analysis & Performance - Resource categorisation



Subsystems

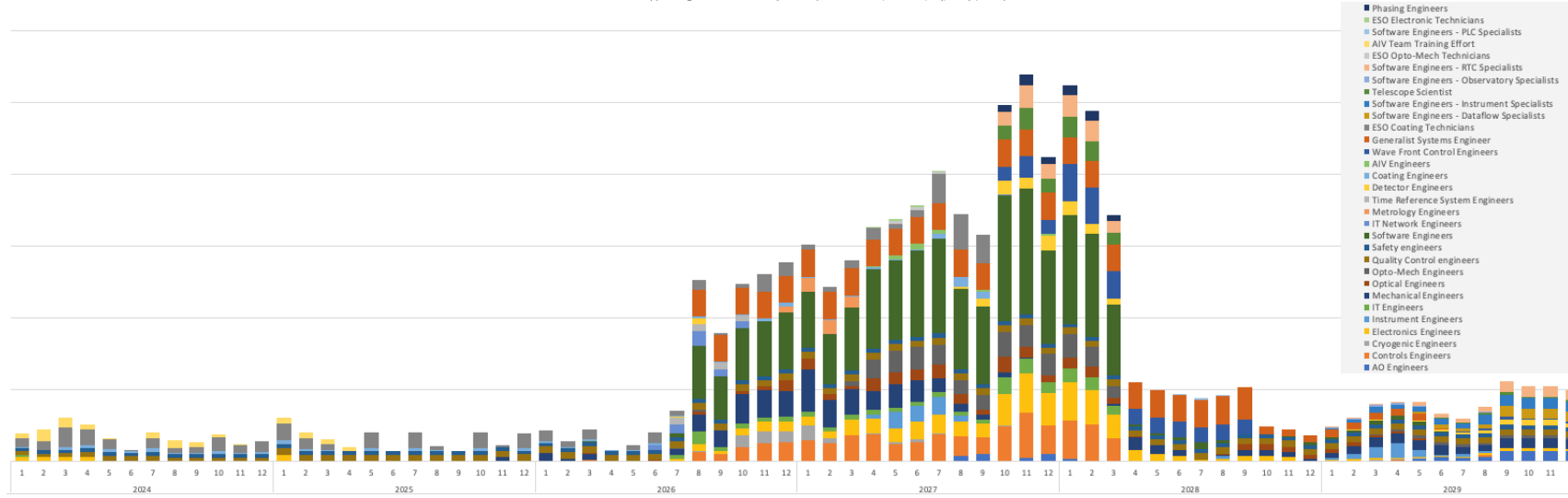
AIV Major Contributors Headcount (to cover 1 shift, 10 hours/day, 7 days/week)



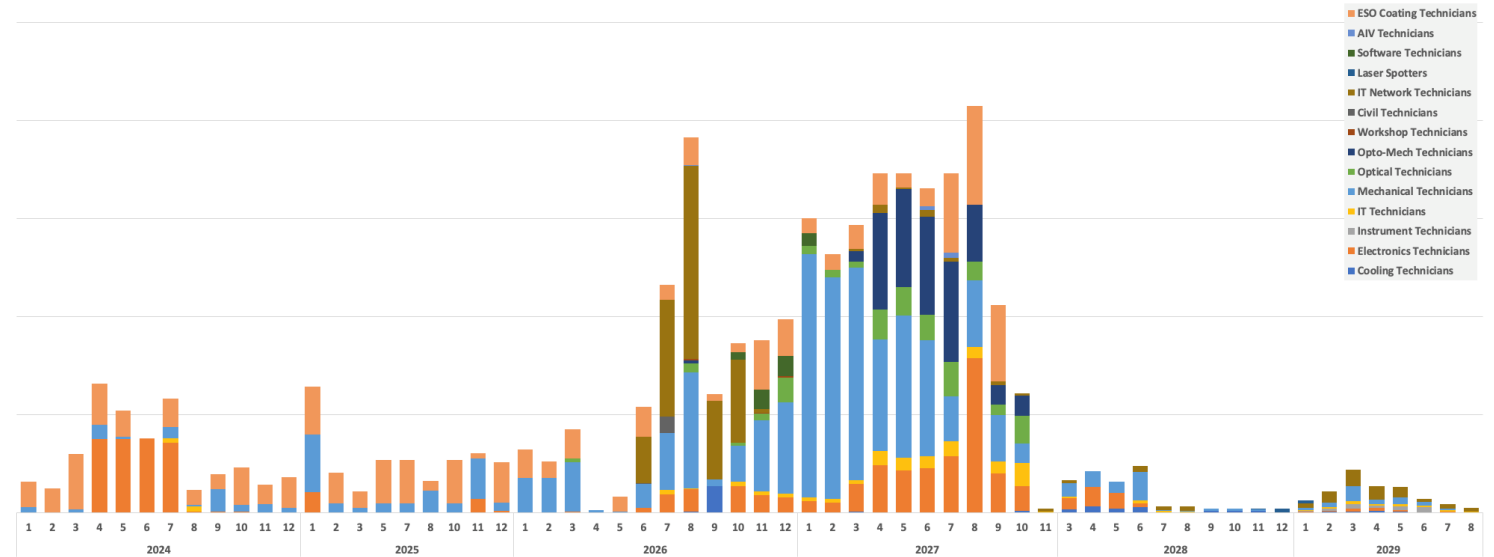
Analysis & Performance - Resource categorisation



AIV Support Engineers Headcount by Skillset (to cover 1 shift, 10 hours/day, 7 days/week)



AIV Support Technician Headcount by Skillset (to cover 1 shift, 10 hours/day, 7 days/week)



Resource categories

Analysis & Performance – Equipment & Facilities conflict analysis

Equipment

Sum of Total Onsite Headcount (Month)				Year Filter	Month Filter						
Activity ID	Activity Description	Resource ID	Resource Description	2028		3	4	5	6		
08.08.10.15.700.10.10	Unpack/unpack of AAU, LPC in EH	Z.GEN-TRANSP.FRKT2	FRK21 - EELT Forklift – 2 tonne electric	1		0	0	0	0		
08.08.10.15.700.10.20	Visual inspection and functional tests of AAU, LPC in IAA	Z.GEN-TRANSP.FRKT2	FRK21 - EELT Forklift – 2 tonne electric	3		0	0	0	0		
08.08.10.15.700.20.10	Integration on telescope of AAU, LPC	Z.GEN-TRANSP.FRKT2	FRK21 - EELT Forklift – 2 tonne electric	0		4	0	0	0		
08.08.10.15.700.30.20	Visual inspection of CU1-4 in IAA	Z.GEN-TRANSP.FRKT2	FRK21 - EELT Forklift – 2 tonne electric	1		0	0	0	0		
08.08.10.15.700.50.10	Unpack/unpack and first inspection LGSU1-6 in NIH	Z.GEN-TRANSP.FRKT2	FRK21 - EELT Forklift – 2 tonne electric	6		0	0	0	0		
08.08.10.15.700.50.20	Reintegration and alignment checks LGSU1-6 in NIH	Z.GEN-TRANSP.FRKT2	FRK21 - EELT Forklift – 2 tonne electric	1		29	0	0	0		
08.08.10.15.700.50.40	Transportation to EH LGSU1-6	Z.GEN-TRANSP.FRKT2	FRK21 - EELT Forklift – 2 tonne electric	0		0	0	2	0		
08.08.10.15.700.10.30	Computer Room outfitted with LGS aux. Electronics (inc. ILS integration)	Z.GEN-TRANSP.FRKT2	FRK21 - EELT Forklift – 2 tonne electric	0		0	0	2	0		
08.08.10.15.700.50.60	Computer Room outfitted with LGSU 1-6 Electronics	Z.GEN-TRANSP.FRKT2	FRK21 - EELT Forklift – 2 tonne electric	4		0	0	0	0		
Grand Total				16		33	4	6			

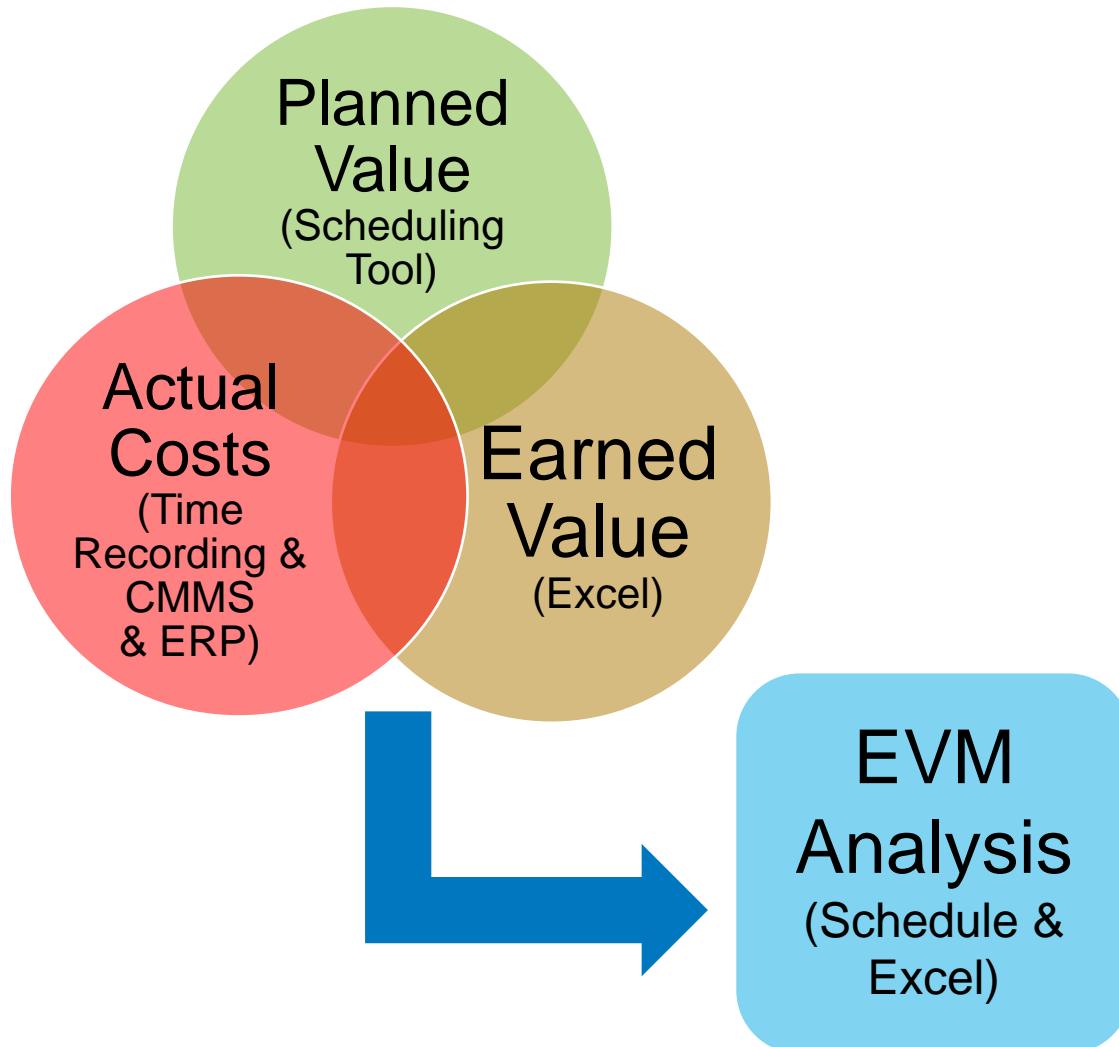
Top down Analysis performed:

- Resolution at Month Level, available by week and day, when required.
- Would a schedule shift resolve and can the change in schedule be accommodated?
- Can a facility be exchanged?
- Should additional facilities be procured?

Areas/Rooms

Sum of Total Onsite Headcount (Month)				Year Filter	Month Filter								
Activity ID	Activity Description	Resource Description	2027	1	2	3	4	5	7	8			
08.08.10.15.209.40	M4 Unit - Checks & Verification in IAA	ME-IAA - Instrumentation Assembly Area	0	0	0	0	21	9	0	0			
08.08.10.15.209.20	M4 Unit - Delivery, Handling, Assembly & Test (Contracted Act.)	ME-IAA - Instrumentation Assembly Area	31	28	31	9	0	0	0	0			
08.08.10.15.213.08.90.30	WFSB Installation on PFA on the MS-NPA	ME-IAA - Instrumentation Assembly Area	14	0	0	0	0	0	0	0			
08.08.10.15.213.12.20.10	M6NB & MSCD Assembly & Verification	ME-IAA - Instrumentation Assembly Area	14	14	0	0	0	0	0	0			
08.08.10.15.213.12.90.10	Transport of the IMB & WFSB to the ME-EH	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	0	0	1			
08.08.10.15.213.12.60.15	Prepare M6N & M6C for Reintegration	ME-IAA - Instrumentation Assembly Area	0	0	0	8	0	0	0	0			
08.08.10.15.213.08.60.05	Prepare M6N & M6C for silver coating	ME-IAA - Instrumentation Assembly Area	14	0	0	0	0	0	0	0			
08.08.10.15.213.12.20.05	NGSB Adapter Assembly & Verification	ME-IAA - Instrumentation Assembly Area	20	0	0	0	0	0	0	0			
08.08.10.15.213.12.90.25	IMA Installation on PFB on MS-NPB	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	0	0	14			
08.08.10.15.213.12.90.15	Readiness Testing IMB, WFSB in the AB-HEMA ME-EH	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	17.5	10.5	0			
08.08.10.15.213.08.60.15	Prepare M6N & M6C for Reintegration	ME-IAA - Instrumentation Assembly Area	8	0	0	0	0	0	0	0			
08.08.10.15.213.08.90.25	IMA Installation on PFA on MS-NPA	ME-IAA - Instrumentation Assembly Area	14	0	0	0	0	0	0	0			
08.08.10.15.213.12.20.40	NGSB Adapter Installation & Alignment	ME-IAA - Instrumentation Assembly Area	0	24	6	0	0	0	0	0			
08.08.10.15.213.12.90.30	WFSB Installation on PFB on the MS-NPB	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	0	0	14			
08.08.10.15.213.12.20.20	Main Structure Unpacking	ME-IAA - Instrumentation Assembly Area	0	2	0	0	0	0	0	0			
08.08.10.15.213.12.15.15	Transport the PFB to the ME-EH	ME-IAA - Instrumentation Assembly Area	10	0	0	0	0	0	0	0			
08.08.10.15.213.12.60.05	Prepare M6N & M6C for silver coating	ME-IAA - Instrumentation Assembly Area	0	0	0	14	0	0	0	0			
08.08.10.15.213.12.20.15	Hosted Metrology Position System (HMPS) Assy & Verification	ME-IAA - Instrumentation Assembly Area	0	4	0	0	0	0	0	0			
08.08.10.15.209.20.110	M4 Unit - Subunit level compliance review (Contracted Act.)	ME-IAA - Instrumentation Assembly Area	0	20	0	0	0	0	0	0			
08.08.10.15.209.20.100	M4 Unit - System verification w/Shell on OTT (Contracted Act.)	ME-IAA - Instrumentation Assembly Area	27	8	0	0	0	0	0	0			
08.08.10.15.209.20.140	M4 Unit - PAC Execution & Achievement (Contracted Act.)	ME-IAA - Instrumentation Assembly Area	0	0	11	9	0	0	0	0			
08.08.10.15.209.20.90	M4 Unit - Shell Installation on OTT (Contracted Act.)	ME-IAA - Instrumentation Assembly Area	6	0	0	0	0	0	0	0			
08.08.10.15.209.20.120	M4 Unit - Training of ESO on Mechanics (Contracted Act.)	ME-IAA - Instrumentation Assembly Area	0	0	20	0	0	0	0	0			
08.08.10.15.209.20.130	M4 Unit - Training of ESO on Electronics & SW (Contracted Act.)	ME-IAA - Instrumentation Assembly Area	0	0	20	0	0	0	0	0			
08.08.10.15.209.60.162	M4 Unit - Testing Phase 1	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	0	5	0			
08.08.10.15.209.60.170	M4 Unit - Shim Adjustment	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	0	1	0			
08.08.10.15.209.60.180	M4 Unit - Testing Phase 2	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	0	5	0			
08.08.10.15.209.60.150	M4 Unit - Transport of M4 Support Structure to IAA & reconfiguration of Internal Transporter	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	0	3	0			
08.08.10.15.209.60.120	M4 Unit - Movement from OTT to Internal Transporter	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	2	0	0			
08.08.10.15.209.60.140	M4 Unit - Installation on ART	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	0	3	0			
08.08.10.15.214.10	Transport the PD5A to the ME-EH	ME-IAA - Instrumentation Assembly Area	0	4	0	0	0	0	0	0			
08.08.10.15.209.60.130	M4 Unit - Transportation to Telescope	ME-IAA - Instrumentation Assembly Area	0	0	0	0	0	1	0	0			
Grand Total			156	104	88	61	12	35.5	38.5				

Analysis & Performance - EVM System - Tools

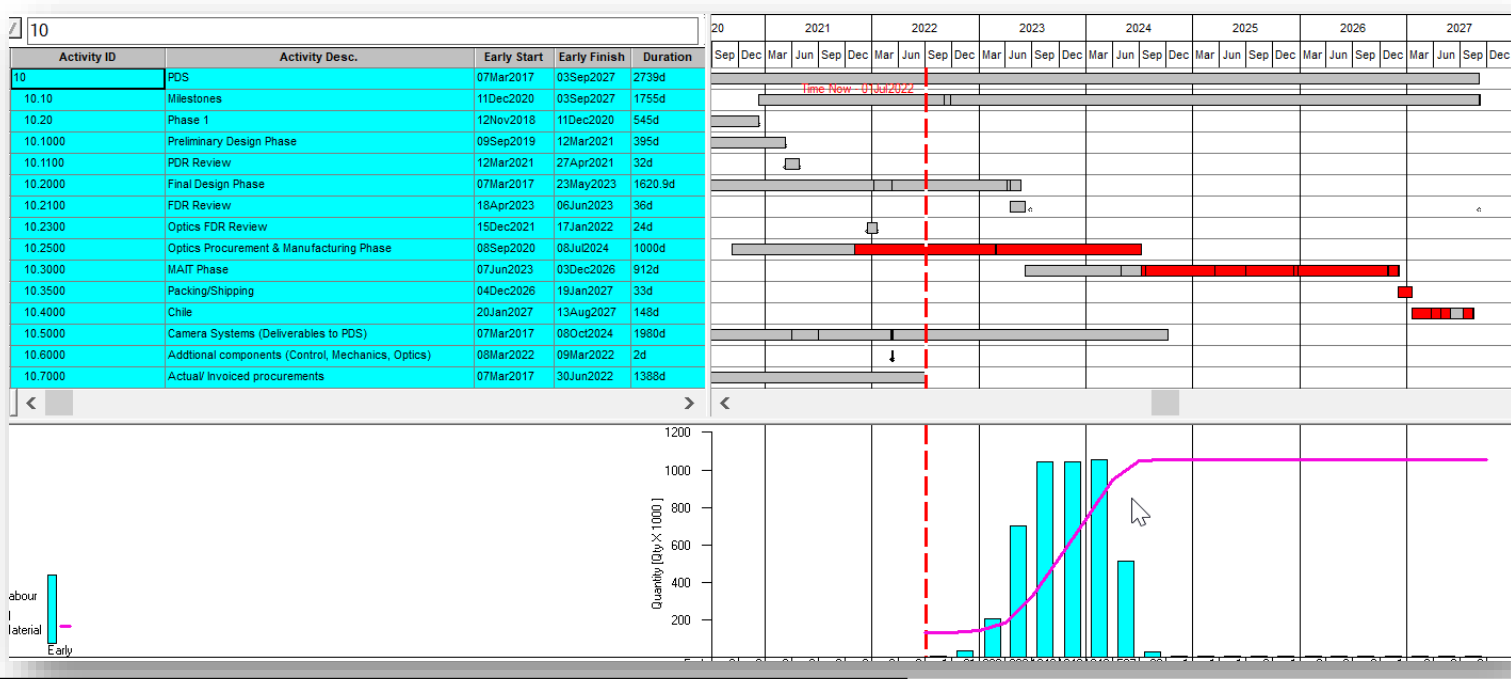


- **PV** – Scheduling Tool (Open Plan)
- **AC** – Time Recording (TimeLog) and CMMS for external people . ERP is used to collect the level of consumption of Material Budget. Then posted into Open Plan
- **EV** – Macro-Based Excel to collect the data into the Scheduling tool (Open Plan)
- **EVM Analysis** is performed in Open Plan and graphically represented in MS Excel

Analysis & Performance - How do we establish 'Planned Value'?



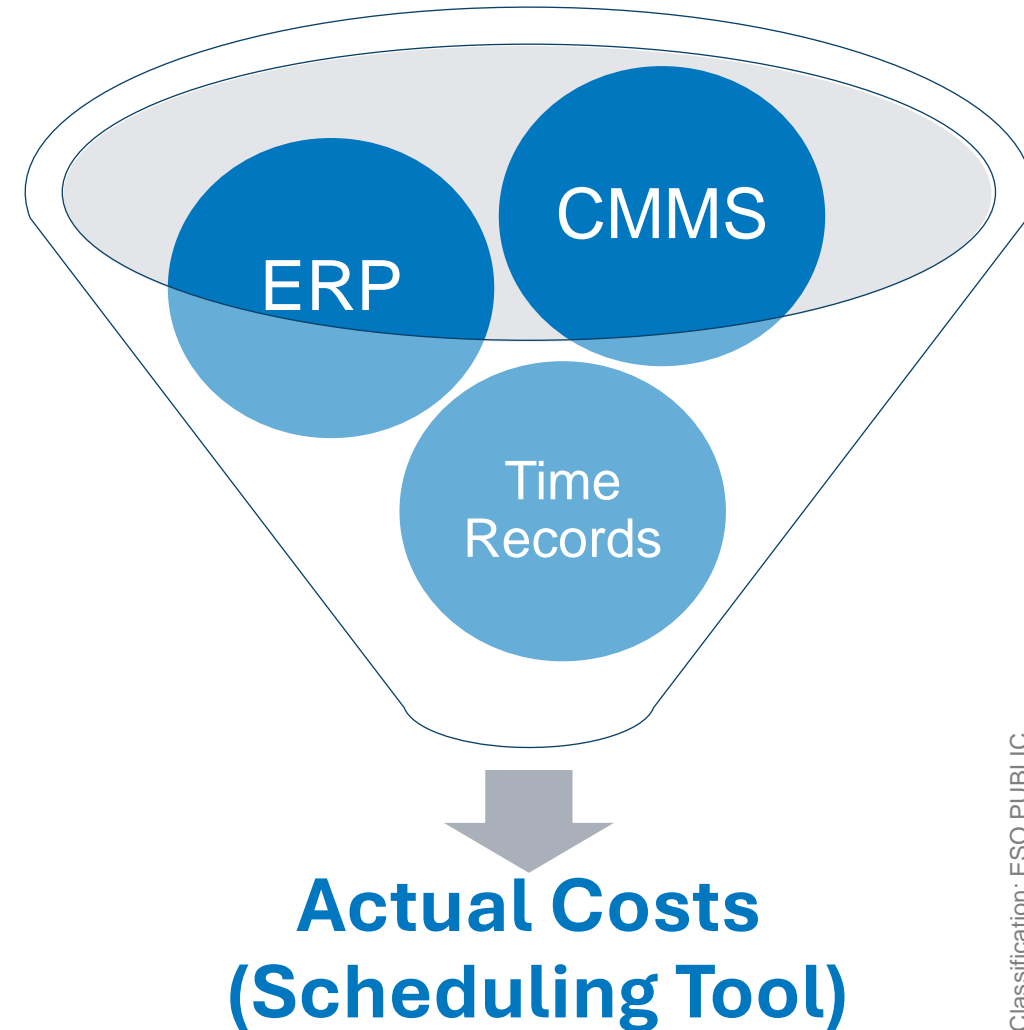
- ESO Scheduling tool – OpenPlan
- Scheduling and resource planning tool enabling EVM implementation at Programme level
- In 2021, the ELT Programme placed an EVM Analysis on the Phasing & Diagnostic Station project
- In 2024, the ELT Programme is expanding its EVM Analysis on the AIV Phase of the ELT Construction Programme



Analysis & Performance - How do we collect 'Actual Costs'?



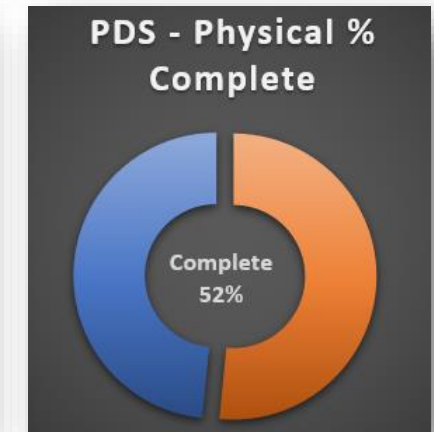
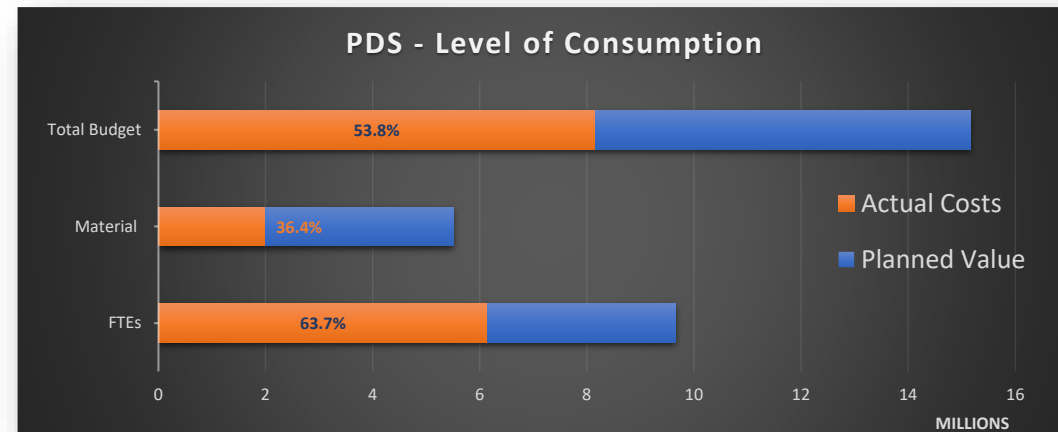
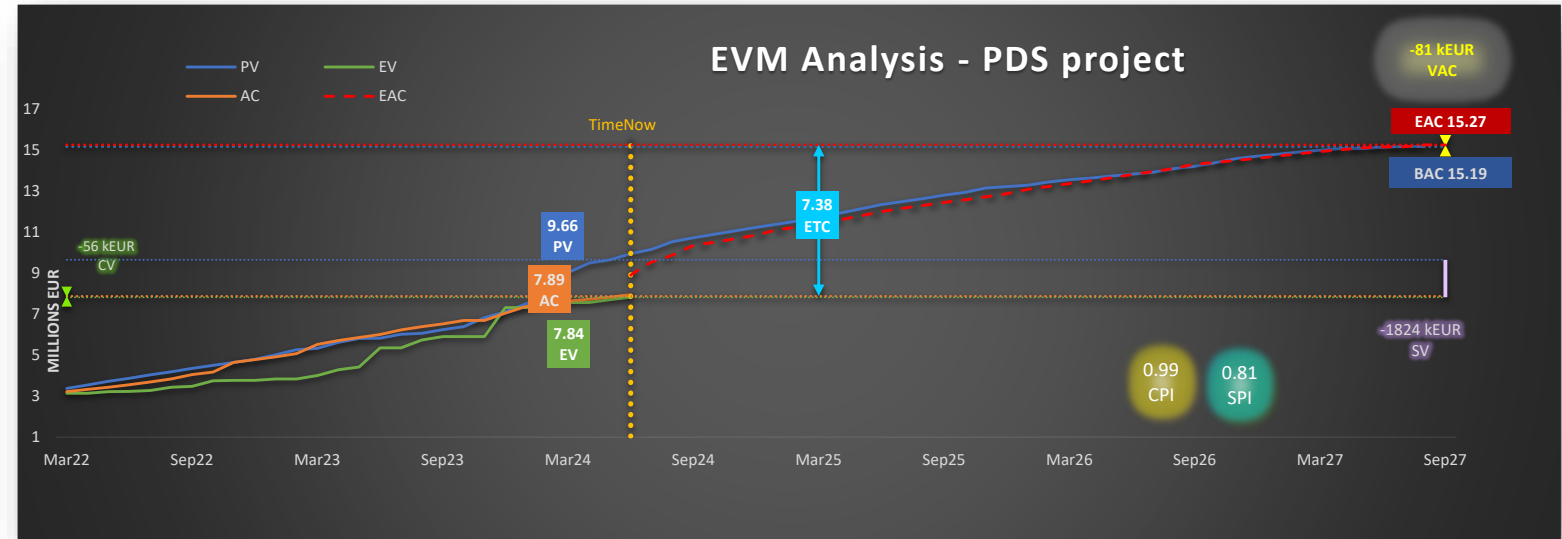
- ESO Computerized Maintenance Management System (CMMS)
 - Hours recoded in a Cost Centre by Contractors
- ERP
 - Commitments paid
- ESO Time Recording Tool – TimeLog
 - Hours recorded in the Cost Centres by ESO Employees



Analysis & Performance - EVM Results & Reporting



- **Progress** inputs from the Work Package Manager are collected in a template before posting in the Scheduling Tool
- **KPIs** are calculated by the Scheduling Tool → CPI, SPI, VAC, CV, ETC, EAC



Expected Benefits & Challenges of EVM applied to AIV Planning



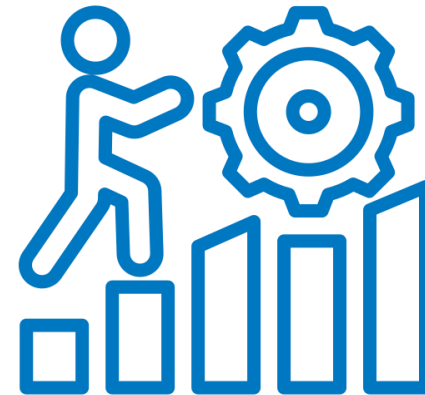
- **Benefits**

- Integrated Material and Workforce costs management
- Improve visibility and control over the scope of work
 - Identify & update Dependencies as the project evolves
 - Refine resource estimates (FTEs).
 - Change management (deviations). Implementation of preventive or corrective actions
 - Raising awareness within the team



- **Challenges**

- Implementation of Change Management
- Gathering of Data using multiple tools
- Current process scalability



Conclusions

Advantages of centralised information

- Enables Information based decision making
- Improved Planning
- Resource usage optimisation
- Ease of reporting and follow up across programmes/projects

Challenges

- New planning process enforcement
- Common process for information exchange
- Limited Information integration
- Limited Buy-in from stakeholders

Way forward

- Expansion of the solution
- Inclusion of planning from other areas to increase overall planning visibility and accuracy
- Improved data integration and information exchange

Thank you!

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Connect with ESO

