



LAURA ASQUINI

ON BEHALF OF THE SOXS CONSORTIUM

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NEAPLES, 25/06/24

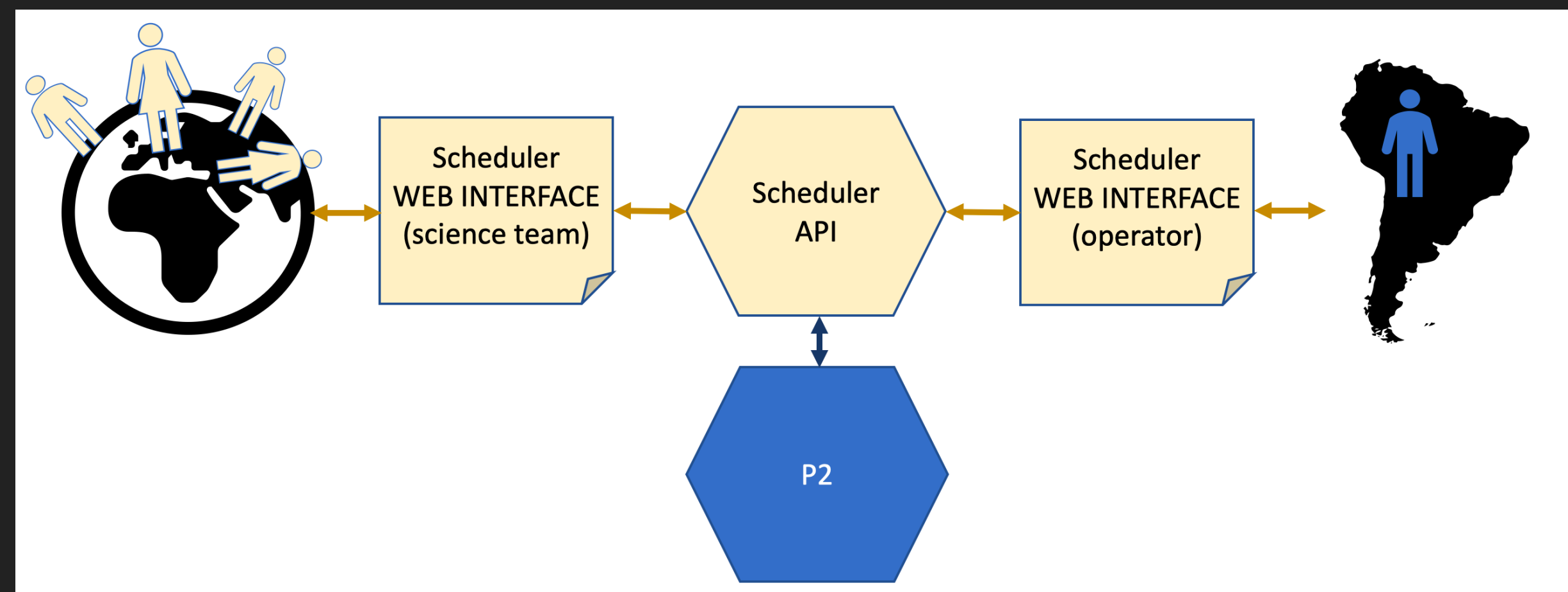
OPERATION SOFTWARE AND PHILOSOPHY

OUTLINE

- ▶ The envisioned observing night
- ▶ How to get your follow up:
 - ★ What targets / Pre-approval
 - ★ Marshall
 - ★ Urgent OBs
- ▶ The scheduler:
 - ★ Science Team interface
 - ★ Scheduling algorithm
 - ★ Automated night management

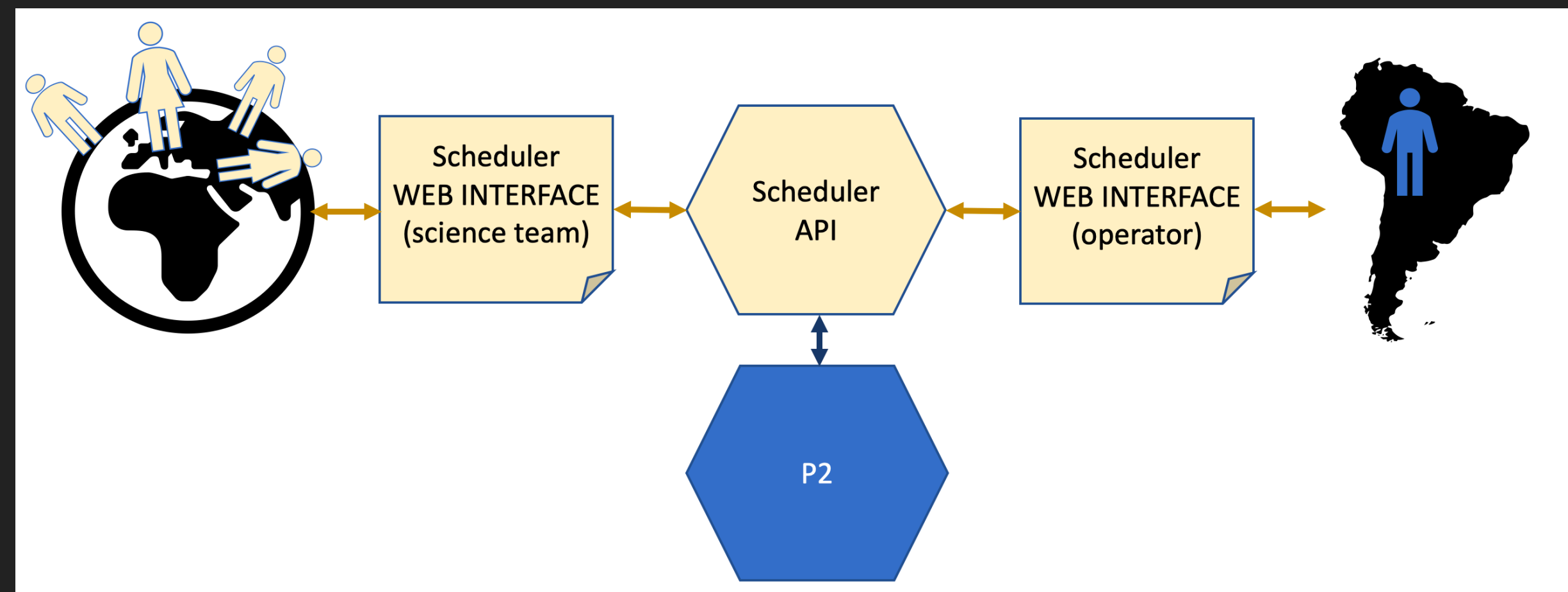
OPERATION REQUIREMENTS – CHILEAN AFTERNOON

- ▶ We work on ToOs, schedule decided daily
- ▶ No astronomer on the mountain, the scheduler will do all the work
- ▶ The Science Team (PIs, aka you) will gather online to approve the proposed schedule



OPERATION REQUIREMENTS - CHILEAN NIGHT

- ▶ Somebody will be on call for trouble shooting
- ▶ Operations start
- ▶ Tio intervenes only if something goes wrong (VES is self updating, BOB autofetch enabled)



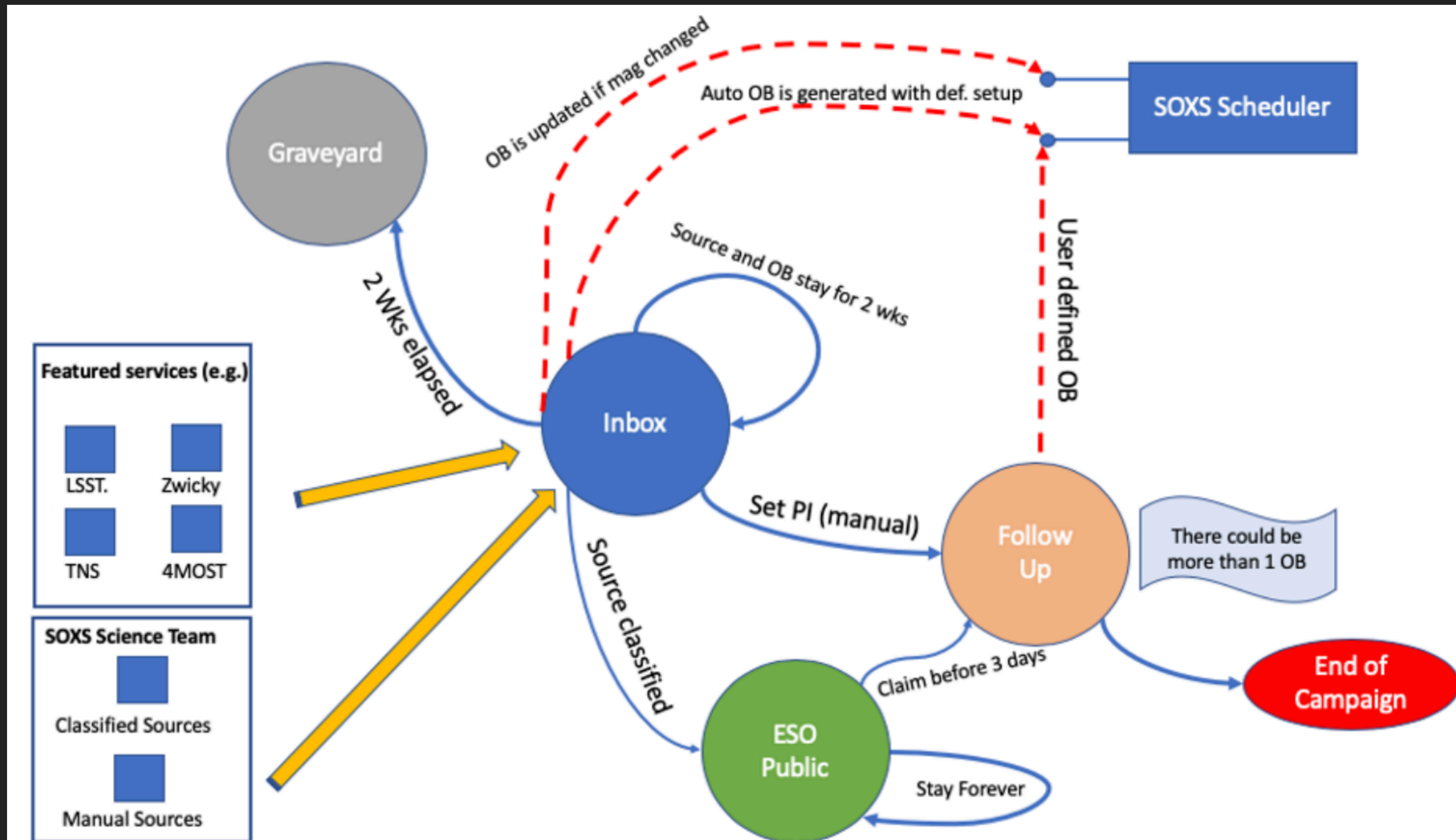
WHAT TARGETS

- ▶ I will refer to three categories of targets: **Classification, follow-up, urgent**
- ▶ All of these will fall within our (well defined) science cases

PRE-APPROVAL

- ▶ To request a follow-up observation, PIs will need to submit a mini-proposal to our Scientific Committee
- ▶ Swift procedure, following our guidelines (see Sergio's talk)

MARSHALL - SOURCE FLOW



MARSHALL

- ▶ The Marshall aggregates all of the info from new/old transients
- ▶ Sends Classification OBs/ Updates automatically to the scheduler

The screenshot shows the Marshall web interface for object AT2024lwg. The interface is divided into several sections:

- identity:** AT2024lwg (highlighted in yellow), no stamp, aka: GOTO24cvf, list: inbox, pessto id: 41486262.
- object info:** ra & dec: 20:59:47.34 -30:10:35.96 [314.94728 -30.17666], galactic coords: 14.93255 -39.63654, pre-disc non-detection: 15 days ago (2024-06-04), discovery date: (+5hr) (2024-06-20), date added to marshall: (+3hr) (2024-06-20).
- host info:** A small image showing the object's location in the sky.
- lightcurve:** A plot of Magnitude vs. MJD. The plot shows a single data point at magnitude 18.46. The y-axis ranges from 18.2 to 19.0, and the x-axis ranges from 60465 to 60485.
- actions:** A vertical menu with icons for a list, a refresh button, an OB button, and a clock icon.

Discovery magnitude: 18.46 TNS L-GOTO-band 2024-06-20 +5hr
Latest magnitude: 18.46 GOTO L-GOTO-band 2024-06-20 +5hr
Current mag estimate: 18.46

MARSHALL

- ▶ The follow up requests will be created from the SOXS Marshall
- ▶ Will either create them ex-novo, or claiming a classification target/a known source
- ▶ These will be sent to the Scheduler DB (our own)

The screenshot shows the Marshall web interface for object AT2024lwg. The interface is divided into several sections: identity, object info, host info, lightcurve, and actions. The identity section shows the object name AT2024lwg and a placeholder for a stamp with the text "no stamp". The object info section provides coordinates (ra & dec: 20:59:47.34 -30:10:35.96, galactic coords: 14.93255 -39.63654) and discovery information (pre-disc non-detection: 15 days ago, discovery date: 2024-06-20, date added to marshall: 2024-06-20). The host info section shows a small image of the object. The lightcurve section displays a graph of magnitude vs. MJD, with a red arrow pointing from the graph to the actions section. The actions section contains a menu with options: a list icon, a refresh icon, "OB", and a clock icon. The current magnitude estimate is 18.46.

identity

[AT2024lwg](#)

no stamp

aka: [GOTO24cvf](#)

list: [inbox](#)

pessto id: [41486262](#)

object info

ra & dec:
20:59:47.34 -30:10:35.96
[314.94728 -30.17666]

galactic coords:
14.93255 -39.63654

pre-disc non-detection:
15 days ago
(2024-06-04)

discovery date:
(+5hr)
(2024-06-20)

date added to marshall:
(+3hr)
(2024-06-20)

host info

lightcurve

actions

discovery magnitude:
18.46 TNS L-GOTO-band
2024-06-20
+5hr

latest magnitude:
18.46 GOTO L-GOTO-band
2024-06-20
+5hr

current mag estimate:
18.46

MARSHALL

- ▶ The follow up OB is fully customizable (templates, **fixed time of observation, to do today**)
- ▶ Could look something like this

The screenshot displays the MARSHALL software interface, which is used for configuring astronomical observations. It features a blue header bar with navigation icons (telescope, settings, video, list, image, clipboard). The main content area is divided into several sections:

- PI Name:** The Manager
- Operator:** (empty field)
- Target Name:** (empty field)
- Right Ascension:** (empty field)
- Declination:** (empty field)
- Magnitude:** (empty field)
- Airmass:** 2
- Moon angular distance:** 90
- Sky transparency:** 2
- Lunar illumination:** (empty field)
- PWV:** (empty field)
- Seeing:** (empty field)

Below these parameters, there is a section for instrument settings, titled "XSHOOTER_slit_obs_AutoNodOnSlit". This section contains a list of parameters with their corresponding values:

Parameter	Value
UVB_slit	1.0x11
VIS_slit	0.9x11
NIR_slit	0.9x11
uvb_exposure [0, 36000]	0
uvb_readout_mode	100k/1pt/hg
vis_exposure [0, 36000]	0
vis_readout_mode	100k/1pt/hg
nir_exposure_DIT [0, 36000]	0
number_of_nir_subintegrations_NDIT [0, 36000]	1

At the bottom right of the interface, there are two buttons: "Close" and "Save".

URGENT OBS

- ▶ Directly sent through the Scheduler interface
- ▶ Full customization (could actually look like this)
- ▶ Top priority target

PI Name: The Manager

Operator:

Target Name:

Right Ascension:

Declination:

Magnitude:

Airmass: 2

Moon angular distance: 90

Sky transparency:

Lunar illumination:

PWV:

Seeing:

XSHOOTER_slit_obs_AutoNodOnSlit

UVB_slit	1.0x11
VIS_slit	0.9x11
NIR_slit	0.9x11
uvb_exposure [0, 36000]	0
uvb_readout_mode	100k/1pt/hg
vis_exposure [0, 36000]	0
vis_readout_mode	100k/1pt/hg
nir_exposure_DIT [0, 36000]	0
number_of_nir_subintegrations_NDIT [0, 36000]	1

Close Save

SCIENCE TEAM INTERFACE

SOXS
SCHEDULER

Opened Night: 23-06-2024

24-06-2024 09:43:30 UTC

The Manager

Air Temp.(2m)[°C] **NotAvailable**
Wind Speed(10m)[m/s] **NotAvailable**
Wind Dir.(10m)[deg] **NotAvailable**
Rel. Hum.(2m)[%] **NotAvailable**
Bar. Press.(2m)[hPa] **NotAvailable**

Seeing["] **NotAvailable**
Dew Temp.(2m)[°C] **NotAvailable**

SCHEDULE
OBSERVABLE OB
FOLLOWUP ESO & URGENT OB

Schedule
CloseNight


ID	Scheduled	Target	Type	Obs. Start	Obs. End	Actions
7716		AT2022odq	CLASSIFICATION	2024-06-23 23:18:21.586	2024-06-23 23:28:21.586	
58565		Follow_up_5	FOLLOW UP	2024-06-23 23:23:21.308	2024-06-23 23:33:21.308	
8973		ATLAS23jqc	ESO OB	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	
8973		ATLAS23jqc	ESO OB	2024-06-23 23:38:21.308	2024-06-23 23:43:21.308	
7354		SN2022ewg	CLASSIFICATION	2024-06-23 23:43:21.307	2024-06-23 23:58:21.307	
63771		ESO_OB24	ESO OB	2024-06-23 23:58:21.308	2024-06-24 00:33:21.308	
46753		ESO_OB24	ESO OB	2024-06-24 00:28:21.308	2024-06-24 01:03:21.308	
		ESO_OB24	ESO OB	2024-06-24	2024-06-24	

- Night Management
- Night Report
- GTO Progress
- Weather Forecast
- Average Conditions
- Search OB
- Full OB list
- New OB
- New Urgent OB
- Show Logs

[Changelog v0.195](#)

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SCIENCE TEAM INTERFACE



**SOXS
SCHEDULER**

Opened Night: 23-06-2024

24-06-2024 09:47:05 UTC



The Manager

Air Temp. (2m)[°C] NotAvailable
Seeing[""] NotAvailable

SCHEDULE

Schedule CloseN

ID	Scheduled	Target	Obs. Starts	Obs. Ends	Coordinates	Fixed_time	Slots
7716							
58565							
8973							
8973							
7354							
63771							
46753							

OBs Suggested to substitute selected OB (58565)

ID	Scheduled	Target	Obs. Starts	Obs. Ends	Coordinates	Fixed_time	Slots
8973		ATLAS23jqc	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	[196.638,-36.2741]	false	[2]
8973		ATLAS23jqc	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	[196.638,-36.2741]	false	[2]
8973		ATLAS23jqc	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	[196.638,-36.2741]	false	[2]
8973		ATLAS23jqc	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	[196.638,-36.2741]	false	[2]
8973		ATLAS23jqc	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	[196.638,-36.2741]	false	[2]
8973		ATLAS23jqc	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	[196.638,-36.2741]	false	[2]
8973		ATLAS23jqc	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	[196.638,-36.2741]	false	[2]
8973		ATLAS23jqc	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	[196.638,-36.2741]	false	[2]
8973		ATLAS23jqc	2024-06-23 23:28:21.570	2024-06-23 23:33:21.570	[196.638,-36.2741]	false	[2]

URGENT OB

Changelog v0.195

Close

SCIENCE TEAM INTERFACE

SOXS SCHEDULER

Opened Night: 23-06-2024

24-06-2024 09:40:12 UTC

The Manager

Air Temp.(2m)[°C] **NotAvailable** Wind Speed(10m)[m/s] **NotAvailable** Wind Dir.(10m)[deg] **NotAvailable** Rel. Hum.(2m)[%] **NotAvailable** Bar. Press.(2m)[hPa] **NotAvailable**
 Seeing["] **NotAvailable** Dew Temp.(2m)[°C] **NotAvailable**

SCHEDULE
OBSERVABLE OB
FOLLOWUP ESO & URGENT OB

List of Observable OBs (644) Free Slots

Items by page 50

1
2
3
4
5
6
7

▲ID	OB Type	Target Name	Ra.	Dec.	Magnitude	Exp. Time [s]	Obs. from to	N. Slots	Actions
.	<div style="display: flex; justify-content: space-between; font-size: x-small;"> 0 360 </div>	<div style="display: flex; justify-content: space-between; font-size: x-small;"> -87 40 </div>	<div style="display: flex; justify-content: space-between; font-size: x-small;"> 9 22 </div>	<div style="display: flex; justify-content: space-between; font-size: x-small;"> 0 40959 </div>			
7173	Classification	AT2022nle	12h14m37.2s	+30d13m51.24s	19.413	5266	1-24	12	<div style="display: flex; flex-wrap: wrap; gap: 5px;"> 📄 🔍 🗑️ ⬆️ 📄 🔍 🗑️ ⬆️ </div>
7179	Classification	AT2022nlj	15h06m09.84s	-04d49m24.996s	20.45	13687	1-83	30	<div style="display: flex; flex-wrap: wrap; gap: 5px;"> 📄 🔍 🗑️ ⬆️ 📄 🔍 🗑️ ⬆️ </div>
7180	Classification	AT2022nlk	15h48m54.24s	-03d43m51.348s	19.89	8171	1-91	18	<div style="display: flex; flex-wrap: wrap; gap: 5px;"> 📄 🔍 🗑️ ⬆️ 📄 🔍 🗑️ ⬆️ </div>
7181	Classification	AT2019iug	15h13m54.24s	+00d17m22.9272s	19.8083	7579	1-82	17	<div style="display: flex; flex-wrap: wrap; gap: 5px;"> 📄 🔍 🗑️ ⬆️ 📄 🔍 🗑️ ⬆️ </div>

📄 Changelog v0.195

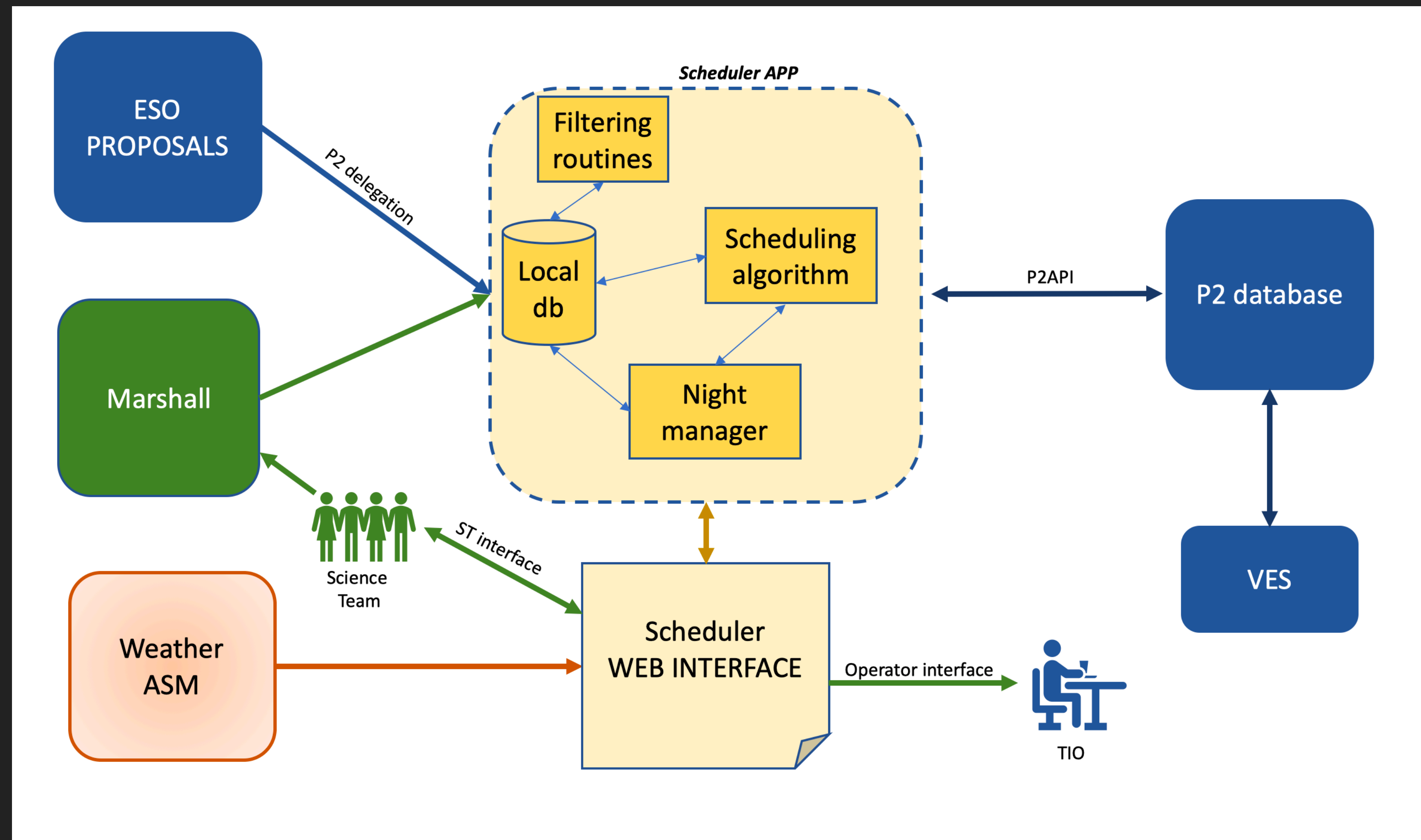
MANY USER-FRIENDLY TOOLS

The scheduler interface has many tool to aid the science team during their operations, mainly to:

- ▶ Modify the proposed schedule
- ▶ View the OB specifics
- ▶ View the Guaranteed Time of Observation status
- ▶ View weather forecasts

COMPONENTS

- ▶ Fed by Marshall and ESO p2DB
- ▶ Several routines distribute the workload
- ▶ Synched to P2 with automatically



FILTERING

- ▶ Using Astroplan
- ▶ In order to identify the time period during the night when the target respects all given constraints (airmass, moon sep)
- ▶ Every OB is associated with an “observability grade” based on target coordinates, observatory location
- ▶ Scripts run every 300 s, the OBs are always updated

SCHEDULING

- ▶ “Static” schedule
- ▶ 2 algorithms
- ▶ Follow up OBs with Priority Scheduler from Astroplan
- ▶ Classification targets with GGF
- ▶ Still TBD, we may open up other possibilities

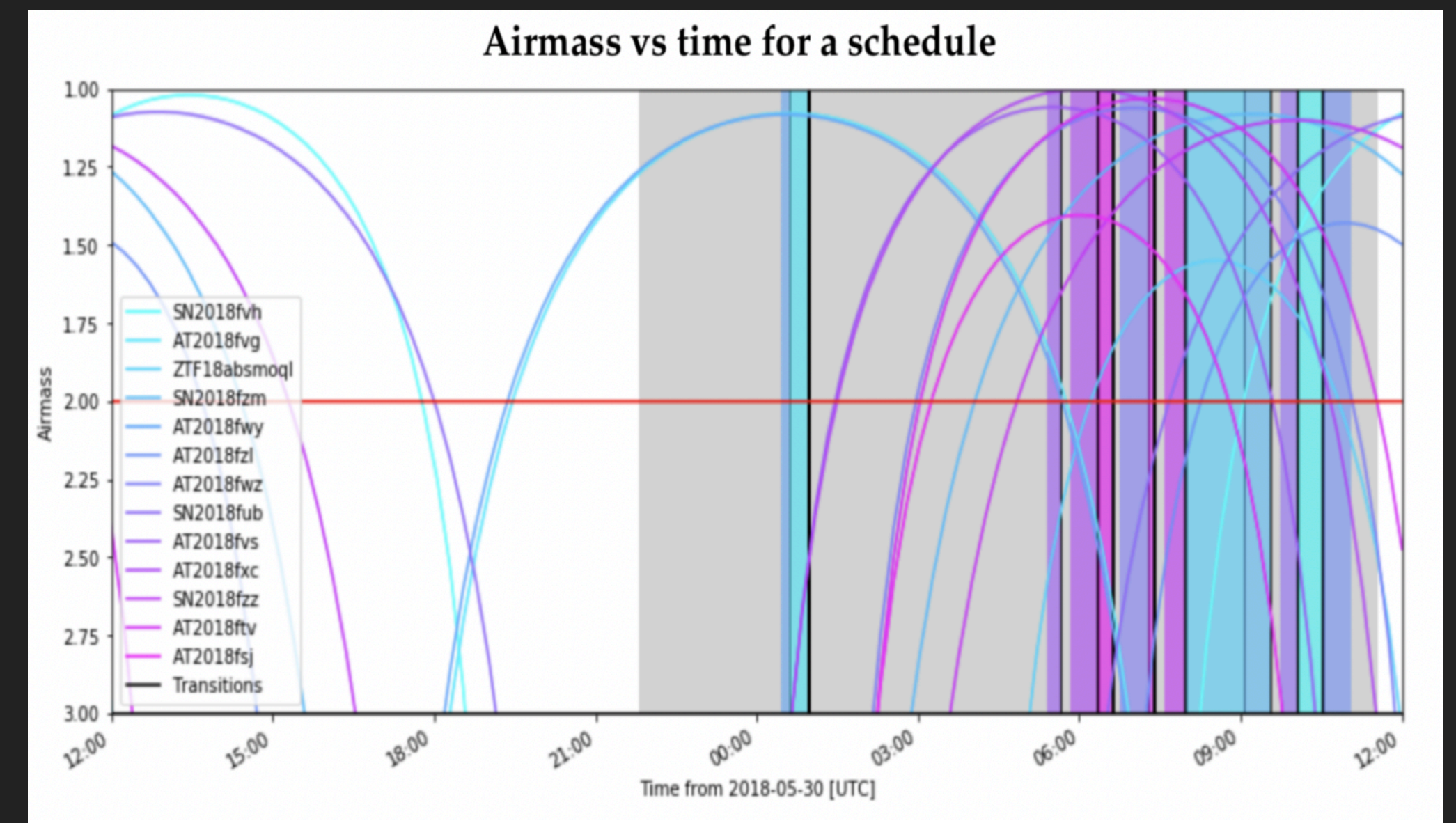
The screenshot displays the SOXS SCHEDULER interface. At the top, it shows the current night status: "Opened Night: 23-06-2024" and "24-06-2024 09:43:30 UTC". The user is identified as "The Manager". A sidebar on the left contains navigation options: Night Management, Night Report, GTO Progress, Weather Forecast, Average Conditions, Search OB, Full OB list, New OB, New Urgent OB, and Show Logs. The main content area is titled "Schedule" and includes a "CloseNight" button. Below this is a table with the following data:

ID	Scheduled	Target	Type	Obs. Start	Obs. End	Actions
7716		AT2022odq	CLASSIFICATION	2024-06-23 23:18:21.586	2024-06-23 23:28:21.586	
58565		Follow_up_5	FOLLOW UP	2024-06-23 23:23:21.308	2024-06-23 23:33:21.308	
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46753		ESO_OB24	ESO OB	2024-06-24 00:28:21.308	2024-06-24 01:03:21.308	

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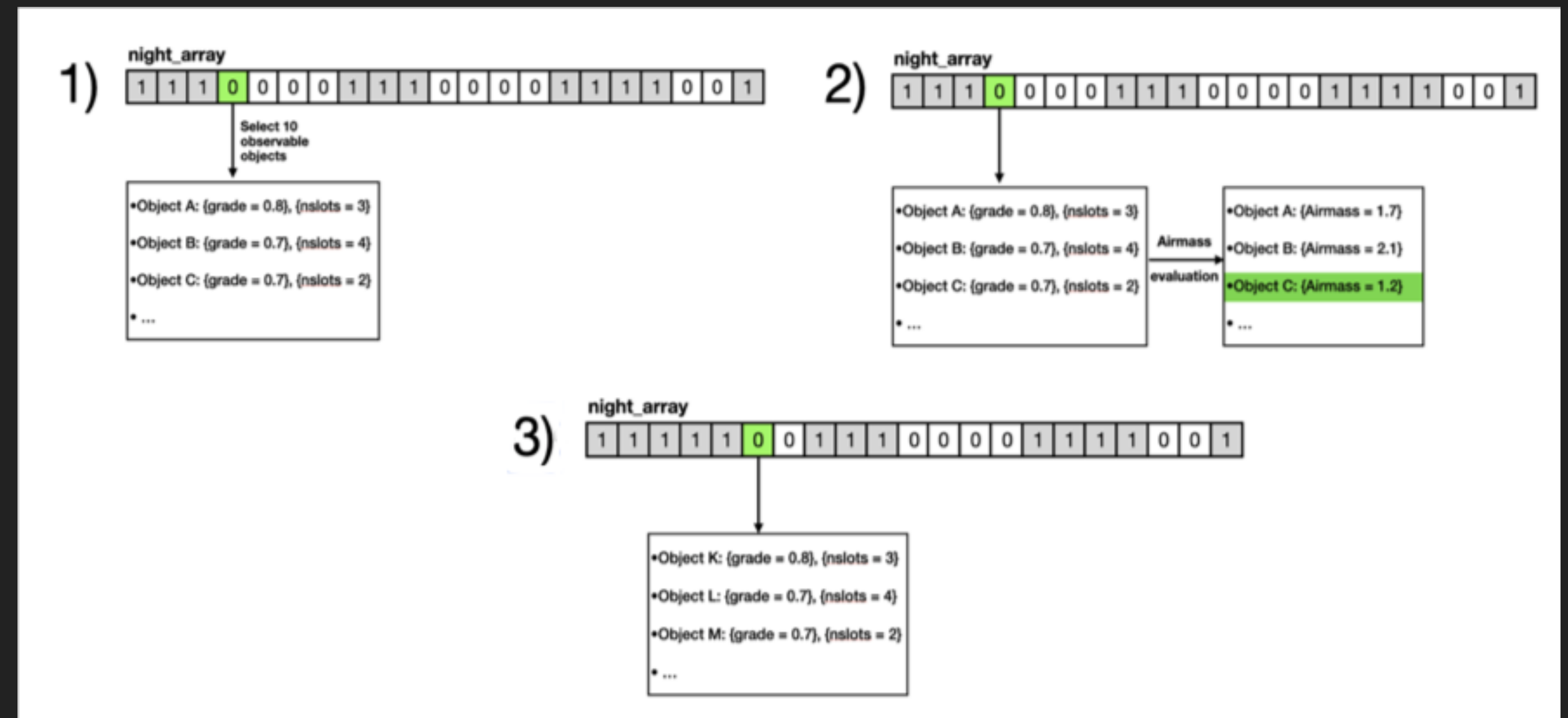
PRIORITY SCHEDULER

- ▶ Sorts and schedules by priority (duh...)
- ▶ Optimizes constraints with 1 minute time-grid



GRADED GAP FILLER

- ▶ During filtering, every OB is associated with a "grade"
- ▶ The algorithm is greedy, finds a hole in the schedule and wants to fill it
- ▶ Chooses 10 targets with highest grade, checks their constraints for that hole
- ▶ Winner gets scheduled



NIGHT MANAGING

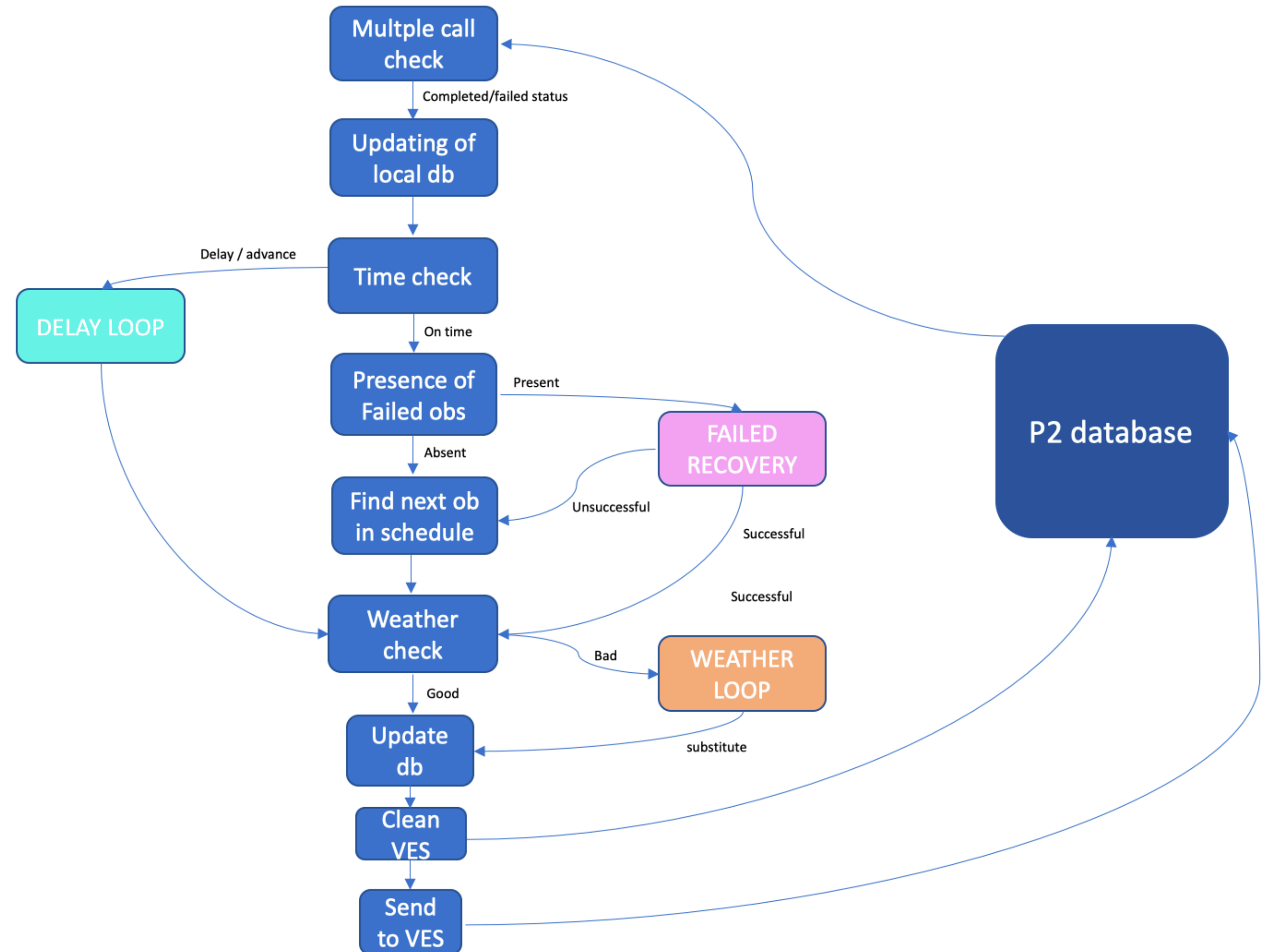
- ▶ “Static” part of the night is optimized
- ▶ A dynamic algorithm reacts in real time
- ▶ Actual automation, TIO will not need to intervene unless something goes wrong
- ▶ The algorithm is summarized in the “Next OB” function

NEXT OB FUNCTION

We identified three main sources of problems:

- ▶ Delays/advances in schedule
- ▶ Presence of failed OBs
- ▶ Weather conditions change

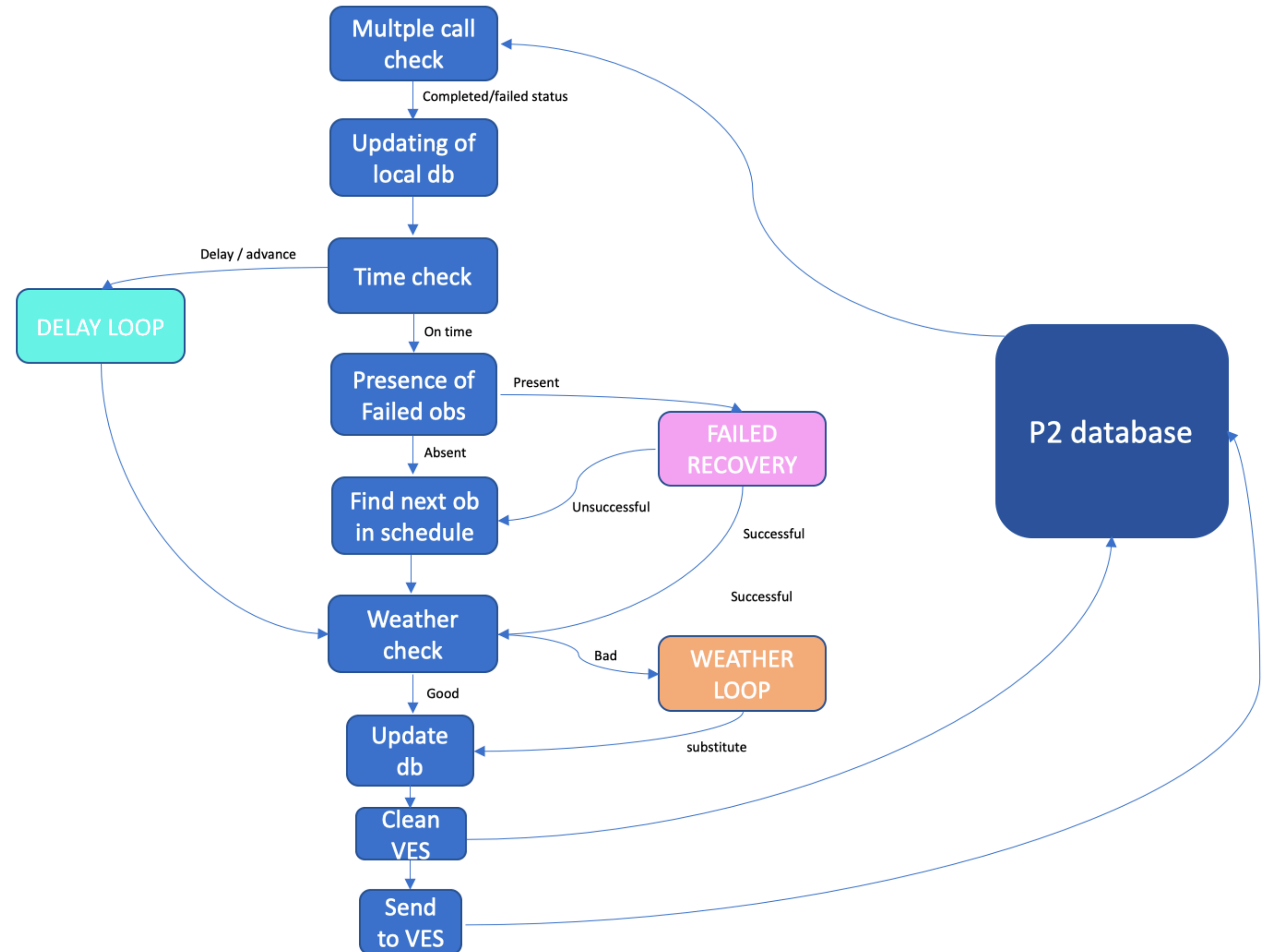
Each of them was coded in a "recovery loop"



NEXT OB FUNCTION

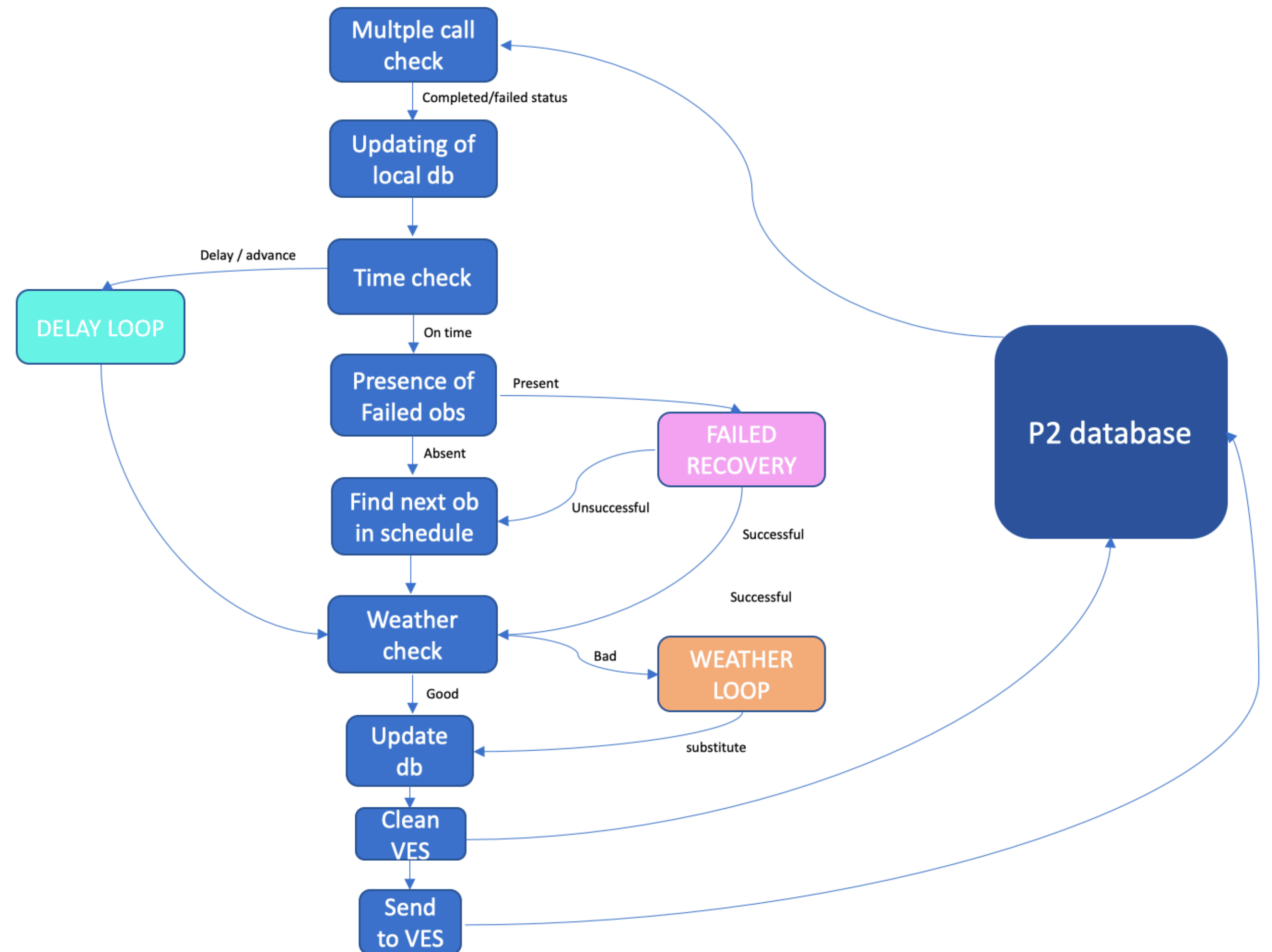
They all share common ideas:

- ▶ Performing the related check
- ▶ Preserving and re-optimizing prioritized targets
- ▶ Re-arranging remaining time



NEXT OB FUNCTION

- ▶ Relieves the Operator from any decision-making process
- ▶ Every change is promptly synchronized with P2 and local db
- ▶ The algorithm is automatically triggered



WARNINGS

- ▶ Talking to a machine: your word is its law
- ▶ Overbooking is bad
- ▶ Scientific priority will have the last word
- ▶ We will all have to deal with our internal gto: shoot your shots carefully!

THE IMMEDIATE FUTURE

- ▶ Real life testing in September (la Silla)
- ▶ A few housekeeping/troubleshooting features to be added
- ▶ We do listen to user feedback!

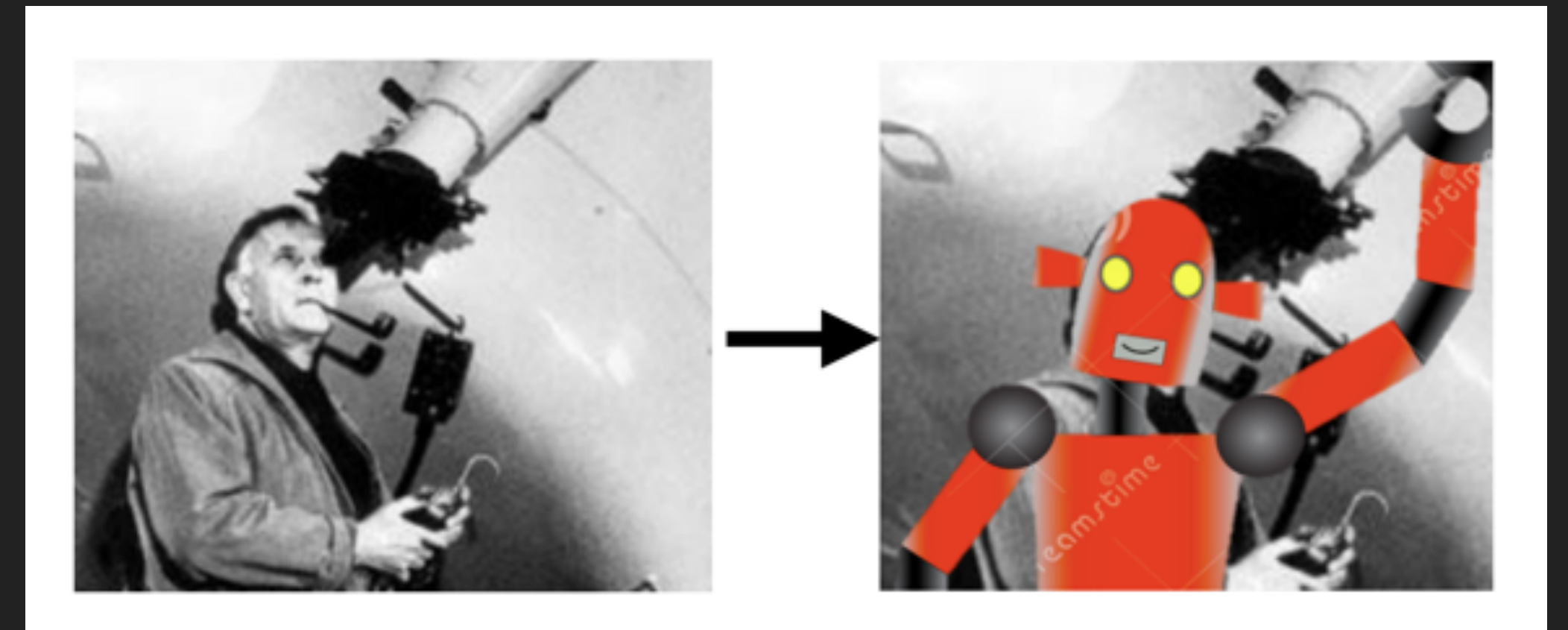
THE IMMEDIATE FUTURE

- ▶ Real life testing in September (la Silla)
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THANK YOU!

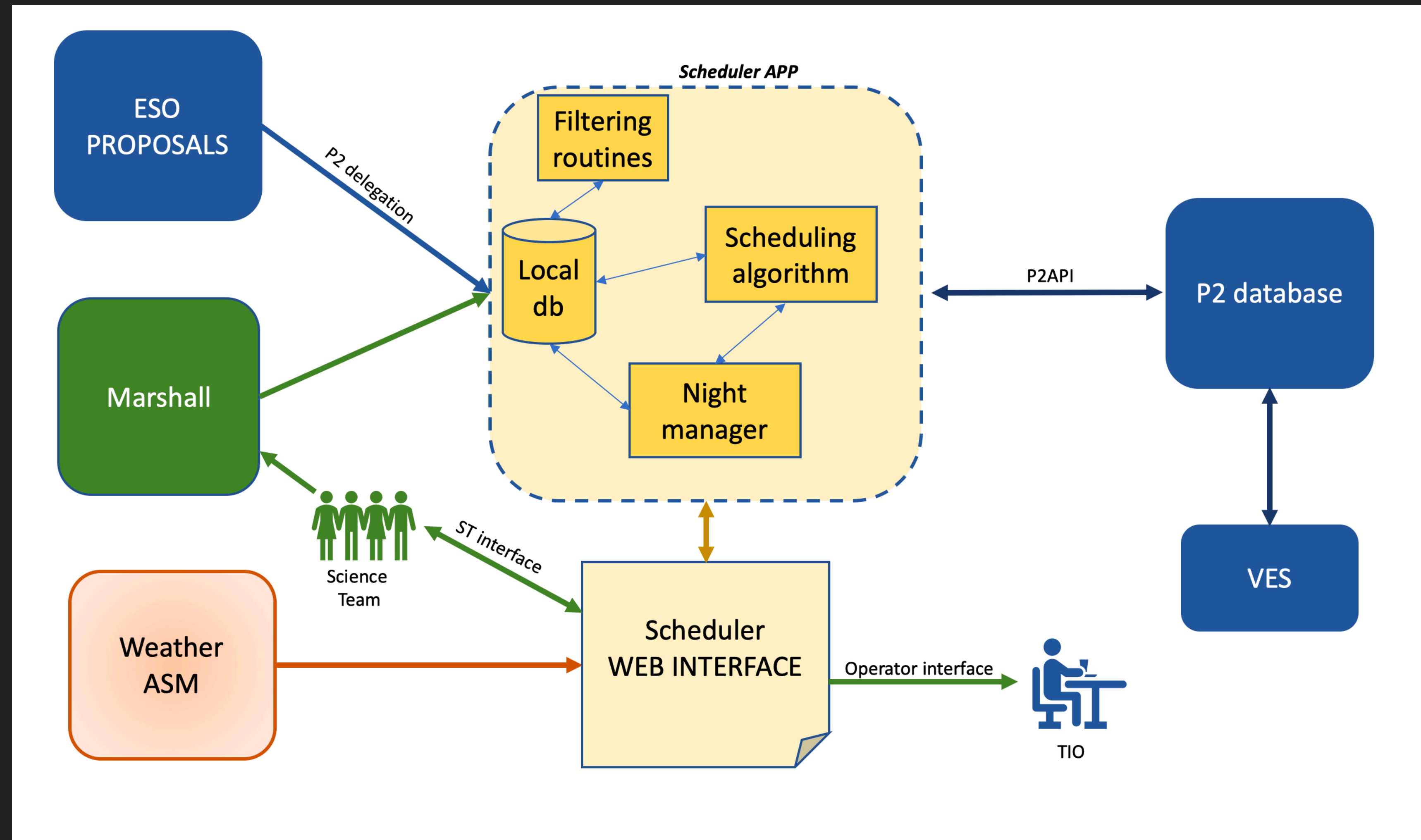
GOALS AND REQUIREMENTS

- ▶ Full automation of the scheduling process
- ▶ Providing a schedule of observable targets
- ▶ Optimization of the observation quality and time at the telescope
- ▶ Reliable automated decisions for management of unforeseen events
- ▶ Operation tracking
- ▶ Flexibility



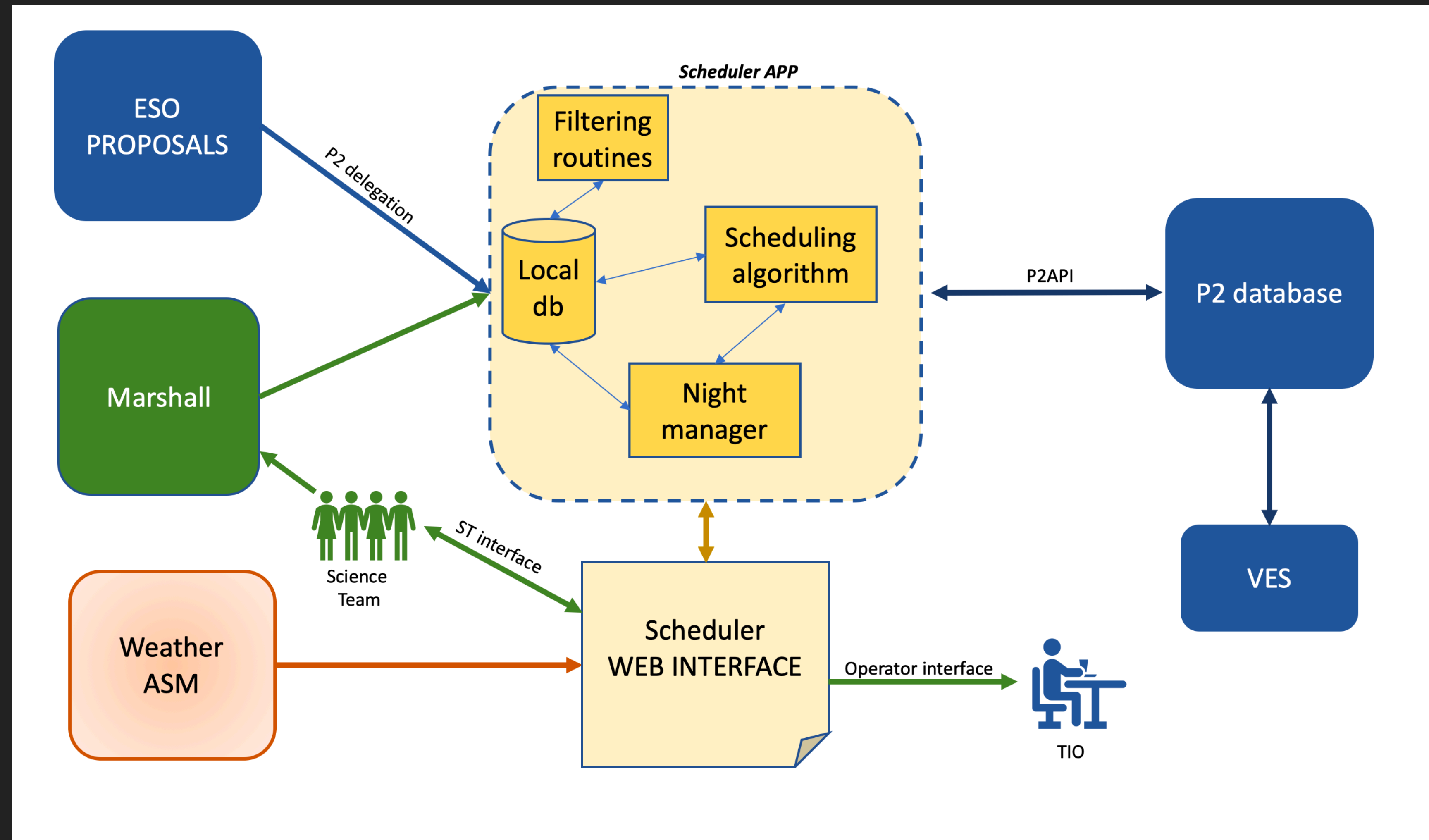
THE SCHEDULER

- ▶ RESTful API
- ▶ Python, Flask micro-framework
- ▶ MySQL database
- ▶ Containerized using Docker
- ▶ Applicable to any ground-based facility



THE SCHEDULER

- ▶ Fed by various databases
- ▶ Various operating routines deal with different tasks
- ▶ Accessible by different users with their customized interface



KEY CONCEPT:

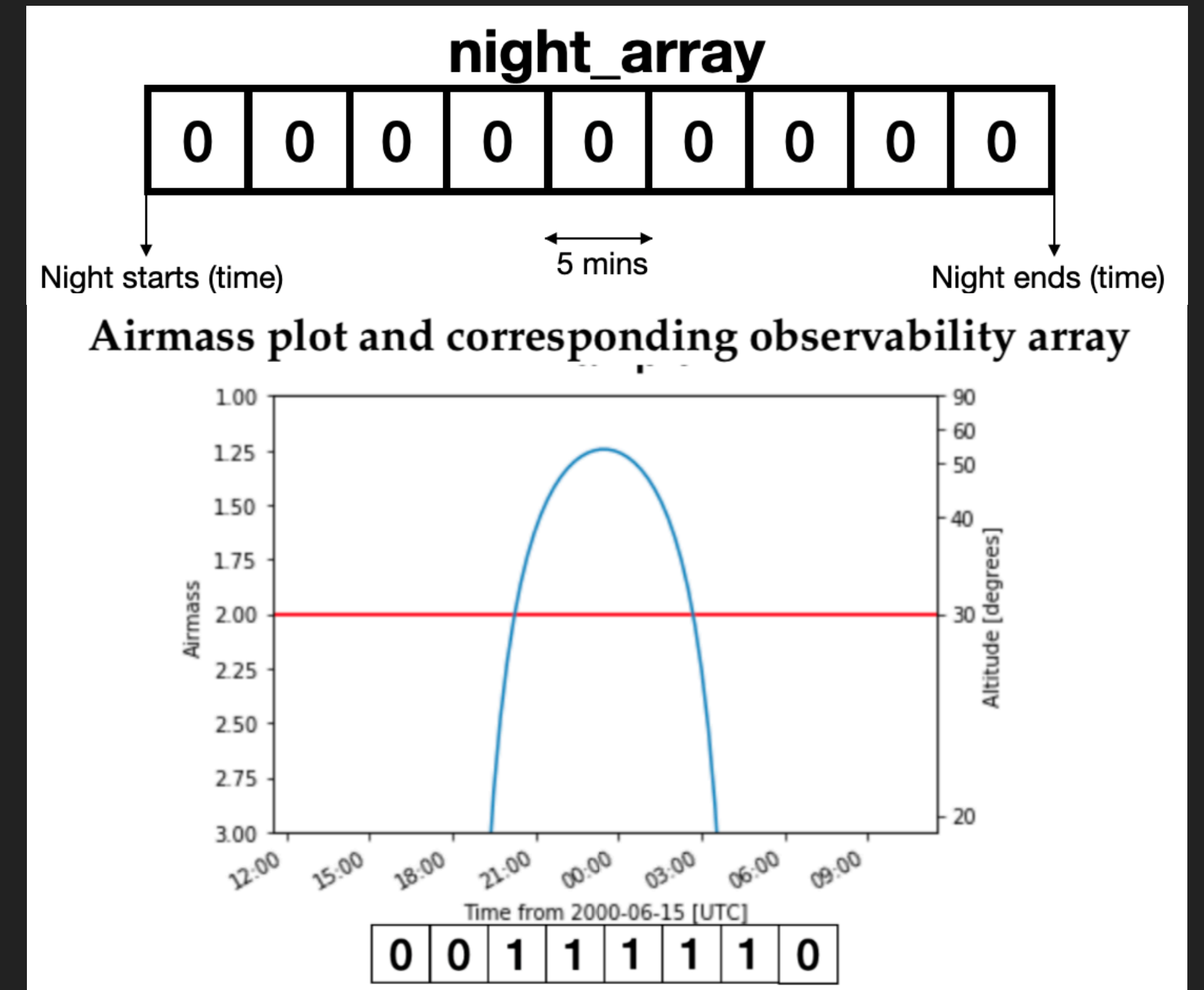
Observing Blocks (OBs) are the smallest unit for astronomical observations, containing all the information needed to carry it out (coordinates, exposure time, instrument setup...)

The scheduler will work with four main types of OBs:

- ▶ Follow Up OBs (High priority - SOXS)
- ▶ Classification OBs (Low priority - SOXS)
- ▶ ESO OBs (High priority)
- ▶ Urgent OBs (Highest priority - SOXS)

FILTERING

- ▶ Using Astroplan library
- ▶ Parametrization of the night with array
- ▶ Observability arrays are created for each OB
- ▶ Processing and Updating scripts run every 15 minutes



GRADING SYSTEM

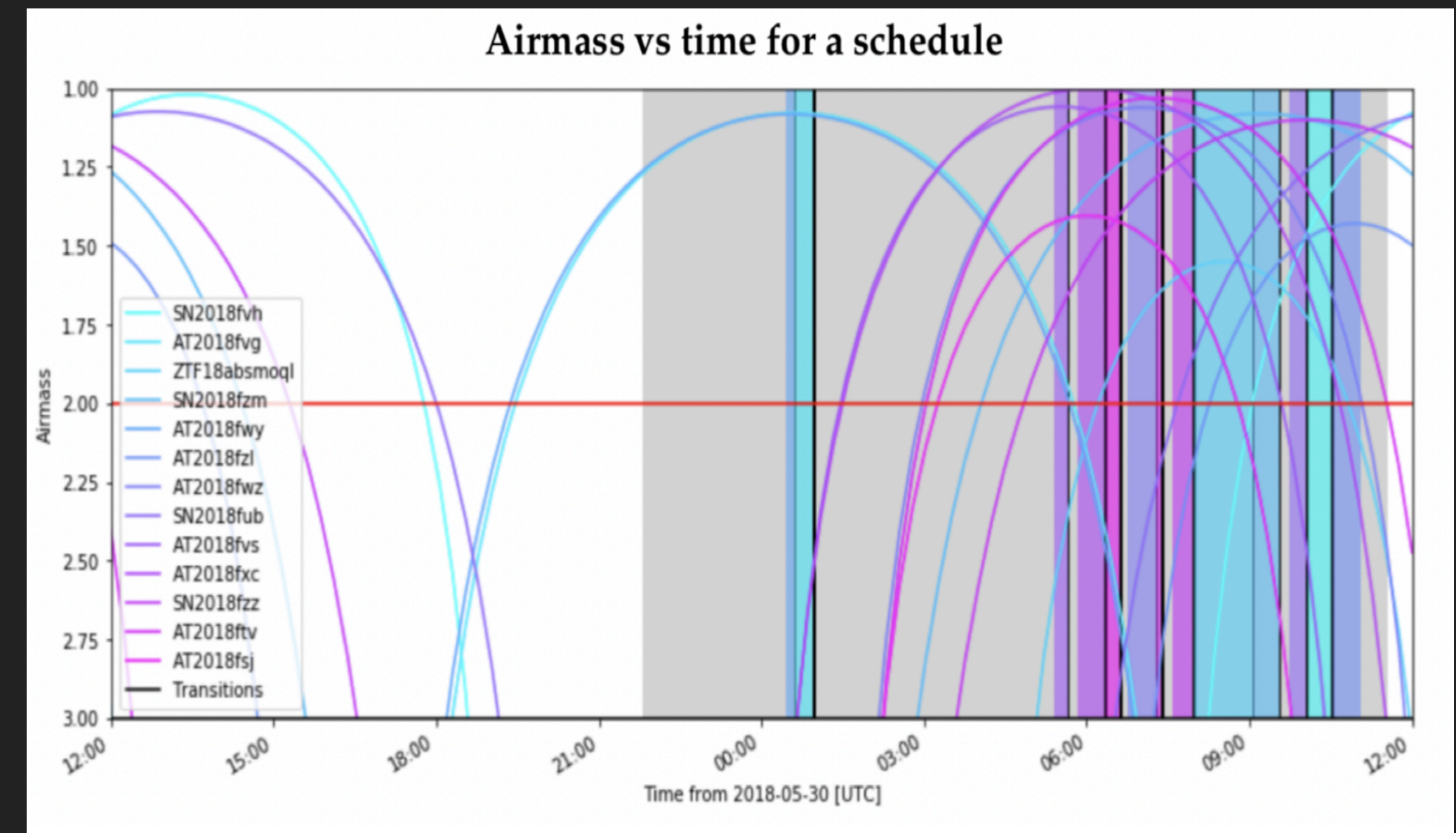
- ▶ Adaptation and extension of what is currently used for observation planning
- ▶ every target is associated with a grade P_i , i.e. the convolution of all the probabilities P_i the target has to satisfy the i -eth constraint
- ▶ e.g. for airmass:

$$P_z = \frac{h_z}{h_z(z_{\text{requested}} = 1.7, \delta = \text{lat}_{\text{observatory}})}$$

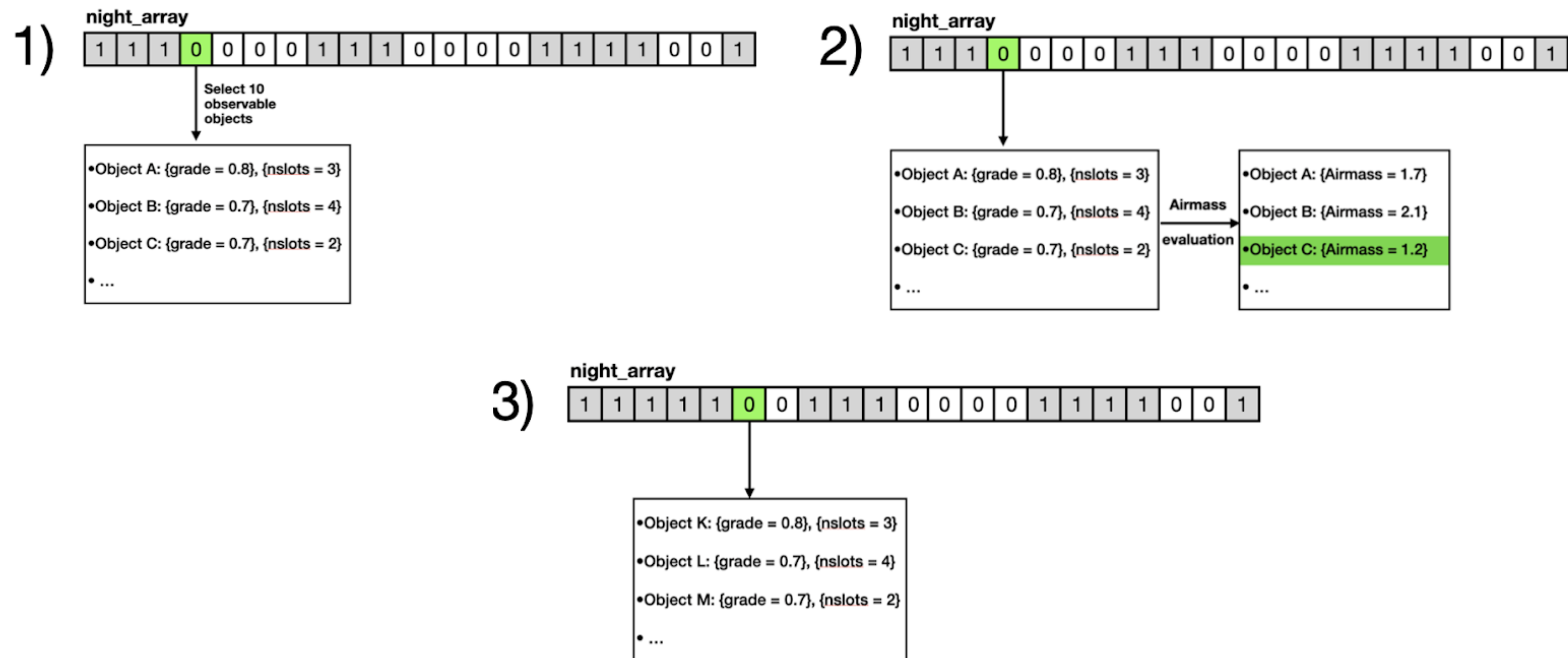
$$h_z = 24/360 * a \cos \left(\frac{\sin(\text{alt}) - \sin(\text{lat}_{\text{observatory}}) \sin(\delta)}{\cos(\text{lat}_{\text{observatory}}) \cos(\delta)} \right)$$

SCHEDULING ALGORITHM – PRIORITY SCHEDULER

- ▶ Priority scheduler, built-in scheduler in Astroplan
- ▶ Sorts targets by priority, finds for each one the best time of observation
- ▶ Lacks the objective of making complete use of the night
- ▶ Computationally demanding
- ▶ Used for Follow Up targets and ESO proposals



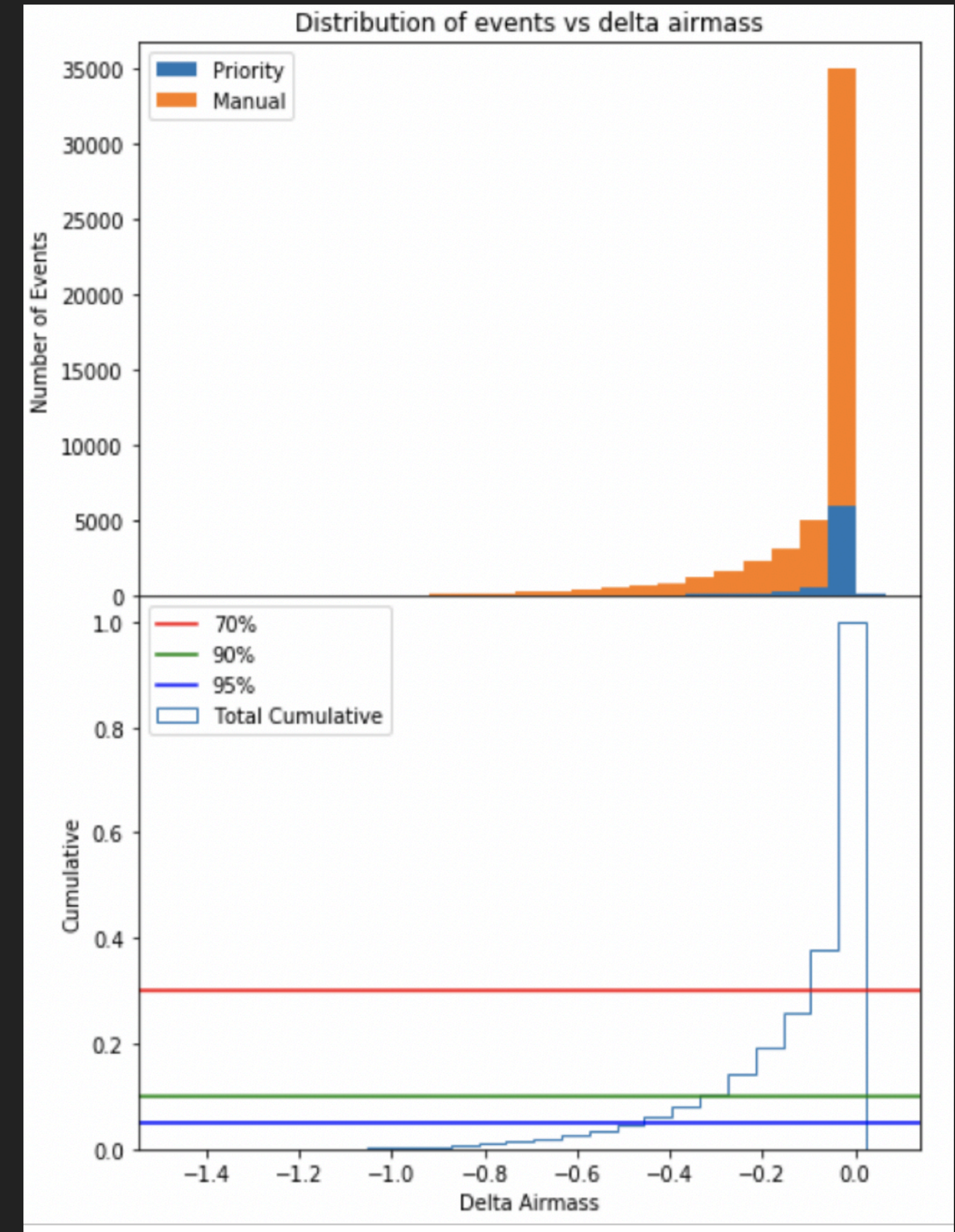
SCHEDULING ALGORITHM - GRADED GAP FILLER (GGF)



PRIORITY AND GGF COMPARED

Can we trust this algorithm?

- ▶ Our first Monte Carlo simulations, with the 2018 ePESSTO data
- ▶ 40 different nights simulated, with 100 schedules per night
- ▶ 90% of events are scheduled at airmass less than 0.3 from their best \rightarrow deg

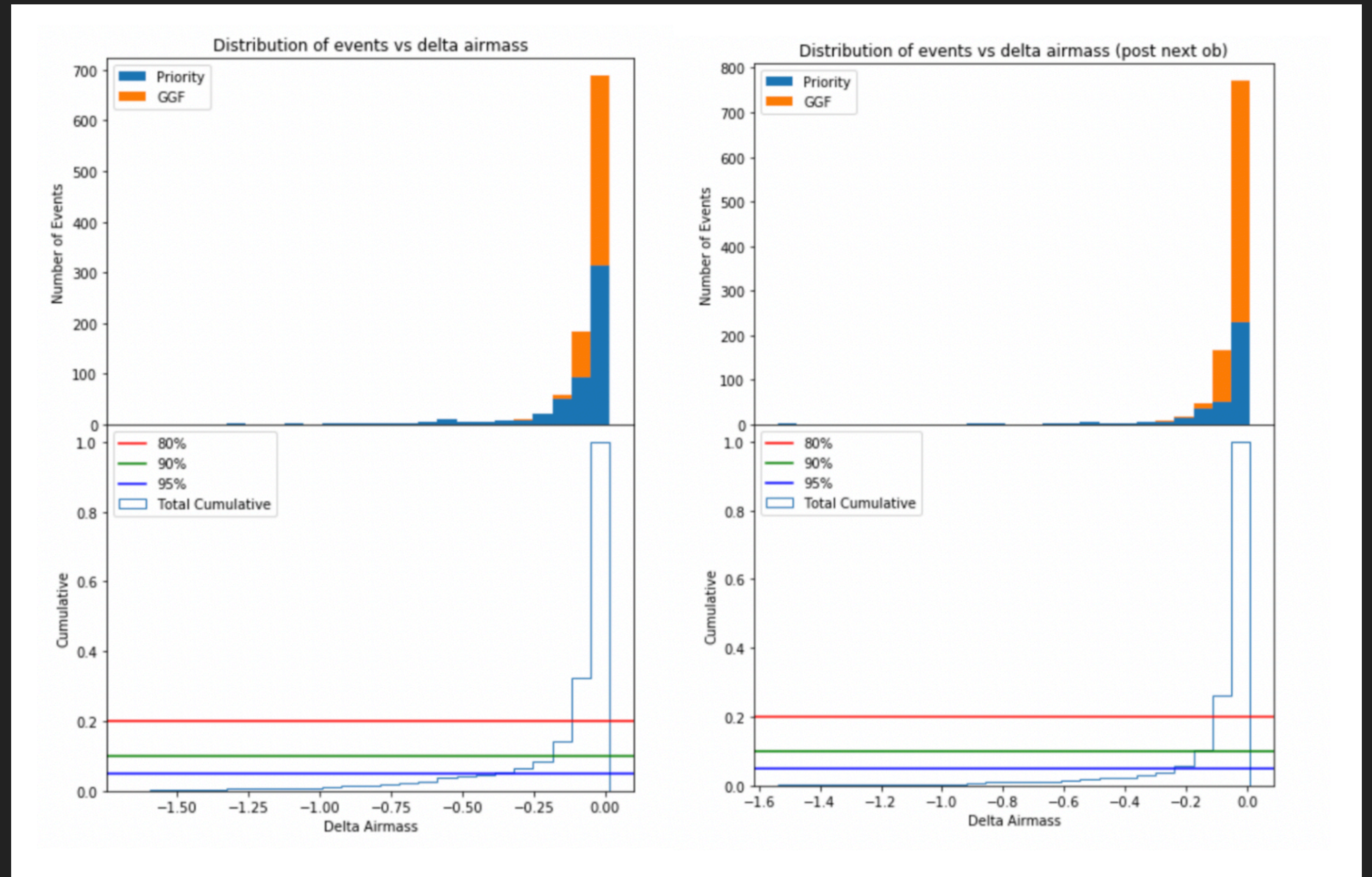


STRESS TESTING THE ALGORITHM

- ▶ Summer nights
- ▶ Gross overbooking (an average of 11/day High Priority targets with exposure of about 40 minute)
- ▶ Randomized weather conditions (based on published ESO data)
- ▶ Further “delays” every 2-3 days

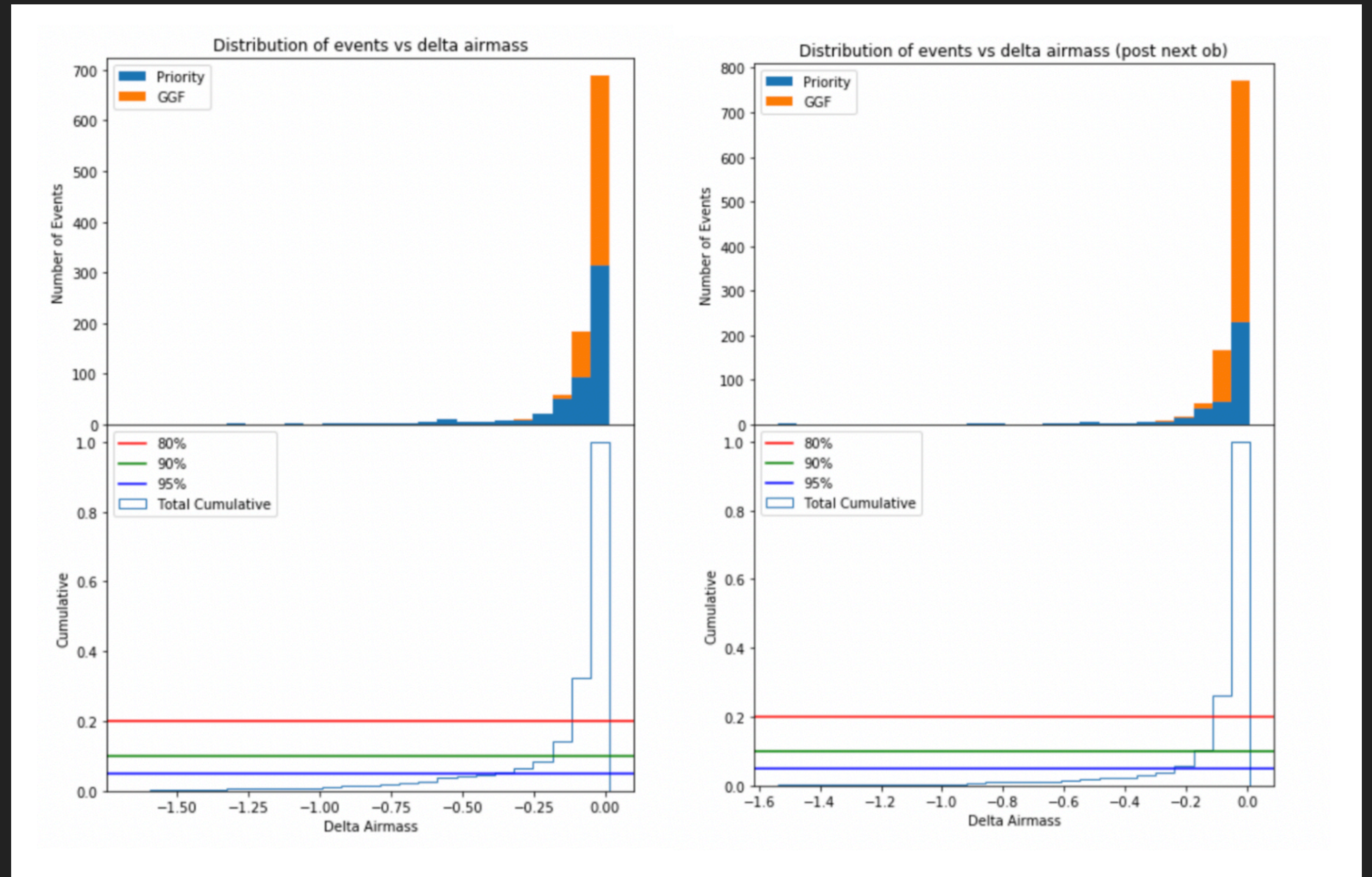
STRESS TESTING THE ALGORITHM

- ▶ 54.4% of high priority targets observed within a day from creation
- ▶ Further 18.2% recovered within 30 days.
- ▶ Highlights the important of the work from the Science Team.





STRESS TESTING THE ALGORITHM

- ▶ 95% of the resulting obs were observed within 0.2 airmass from their best
- ▶ For a 45° altitude, it corresponds to 3° vertical shift



THE OPERATOR INTERFACE

**SOXS SCHEDULER**Opened Night: 13-09-202302-10-2023 14:24:17 UTCThe Operator 1

Air Temp.(2m)[°C] **10.8** Wind Speed(10m)[m/s] **19.2** Wind Dir.(10m)[deg] **39** Rel. Hum.(2m)[%] **31** Bar. Press.(2m)[hPa] **766.5**
Seeing["] **NotAvailable** Dew Temp.(2m)[°C] **-3**

Visitor Execution Sequence

NEXT OB

Currently in VES

ID	Type	Target	Ra	Dec	Obs. Start	Obs. End	Status	Max. Seeing	Actions
7574	CLASSIFICATION	AT2022nyr	16h16m28.32s	-65d38m33s			P	0.8	RETRY

Changelog v0.194

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THE DAEMON

- ▶ Even more automated
- ▶ Exploits the characteristics of the Broker of Observing Blocks
- ▶ Actions by the TIO only in case of problems

