AUTOMATED SCHEDULER SOFTWARE BASED ON METRO UI DESIGN FOR MACE TELESCOPE

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Introduction

Major Atmospheric Cerenkov Experiments (MACE) Telescope

➢ Very high energy gamma-ray telescope set up at Hanle, Ladakh, India

➢ Objective: To study gamma-ray emissions from various cosmic sources in the energy region of 20GeV-10TeV

➢ Distributed Control System
   o Drive Control system
   o Mirror Alignment system
   o CAMERA system
   o Sky Monitoring system
   o Data Archiving System (DAS),
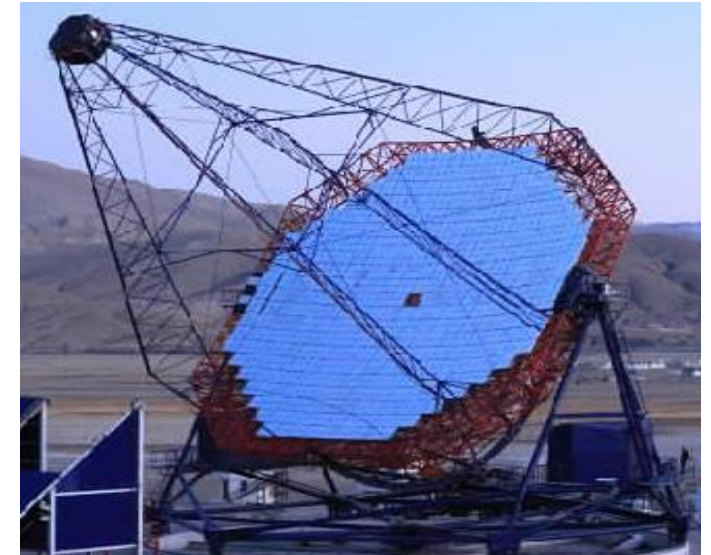   o and Weather Monitoring system (WMS).

Fig. MACE Telescope

MACE Scheduler

➢ Provides an interface to the Astrophysicists to generate observation schedule

➢ The schedule file consists of
  ➢ A set of different sources (astronomical) and their coordinates along with the time of observation
  ➢ Configuration to be used for the observation

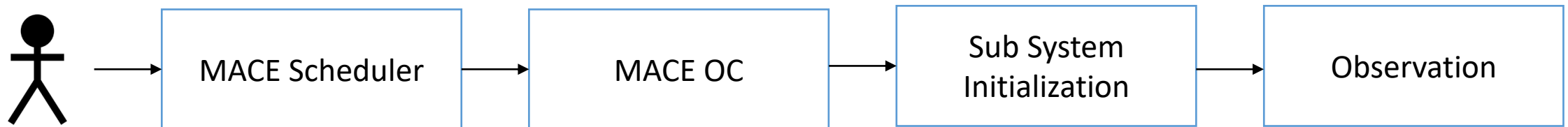➢ Generates date-wise schedules and stores in a configured centralized location


Fig. Observation Sequence

➢ Planning the schedule for day, lunation, up to a year or any specified period

➢ Default source list with default Azimuth and Zenith coordinates

➢ Manual schedule generation for the selected input configuration

➢ Provision for selecting the visible astronomical sources to be observed

➢ Automating the schedule preparation by using a filter set for selecting the sources

➢ Provision various timing plots for Sun, Twilight, Moon Rise set times for deciding the dark period (*the time span during which, there will be no background illumination from sun, moon, twilight*) for observation

➢ It should provide report generation facility.

MACE Scheduler: Software Architecture
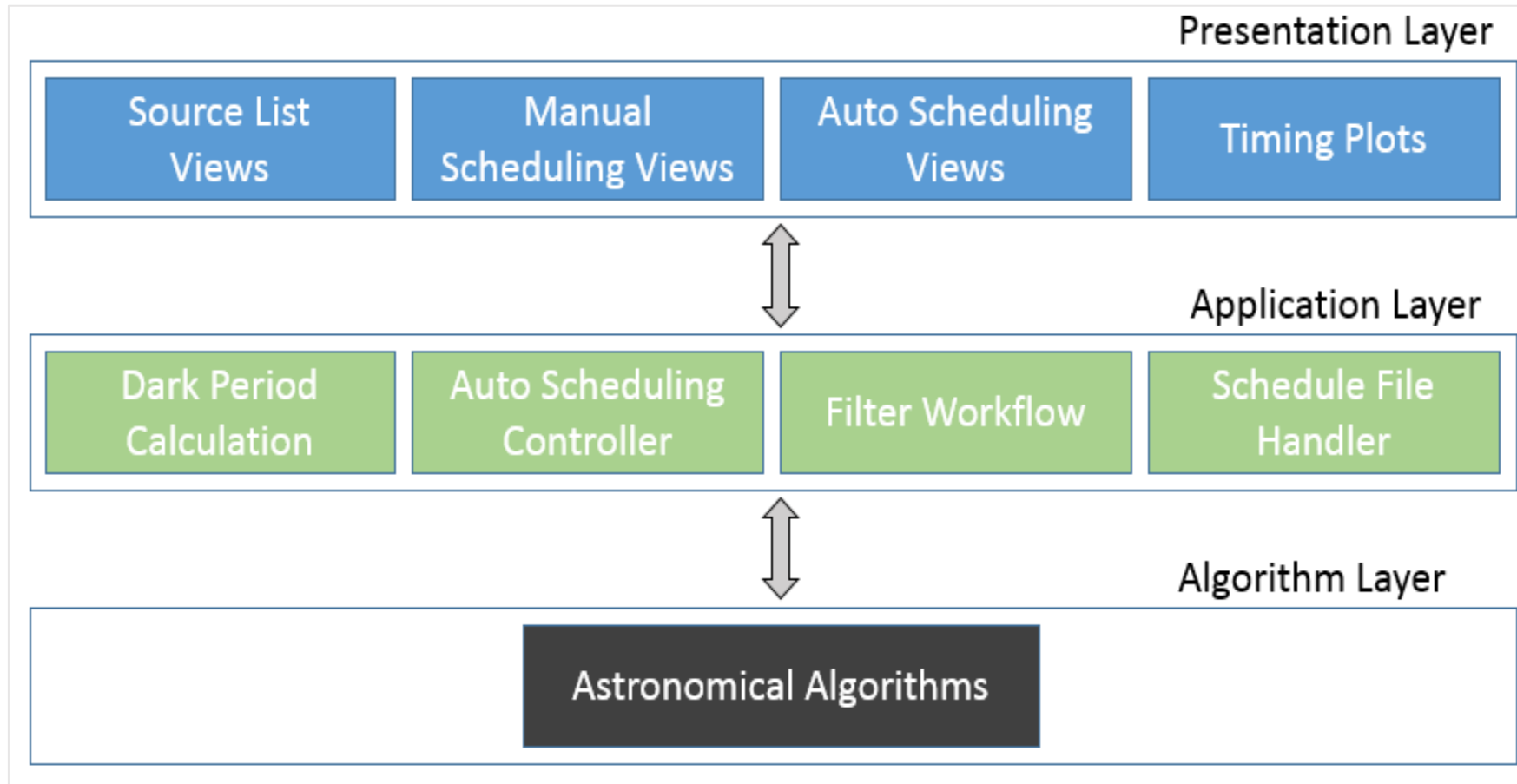
Algorithms:

➢ Calculating Rise/Set time for Sun, Moon and any custom source with defined coordinates

➢ Calculating Moon Phase

➢ Calculating the dark period for any day

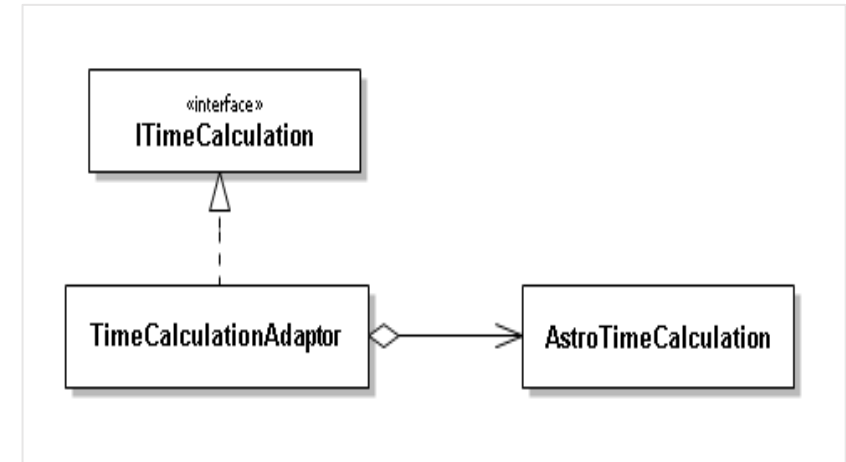➢ Calculating Azimuth and Zenith, given source coordinates and location

Fig. Adaptor Design Pattern for Astronomical Algorithms

MACE Scheduler: Design

Source List:

➢ Source list is organized into catalogues of various types
  ➢ Optical (OP), Galactic (GA), Extra-Galactic (EG) and Positional (PO)

➢ Positional information (Right Ascension (RA) and Declination (DEC)) and priority.
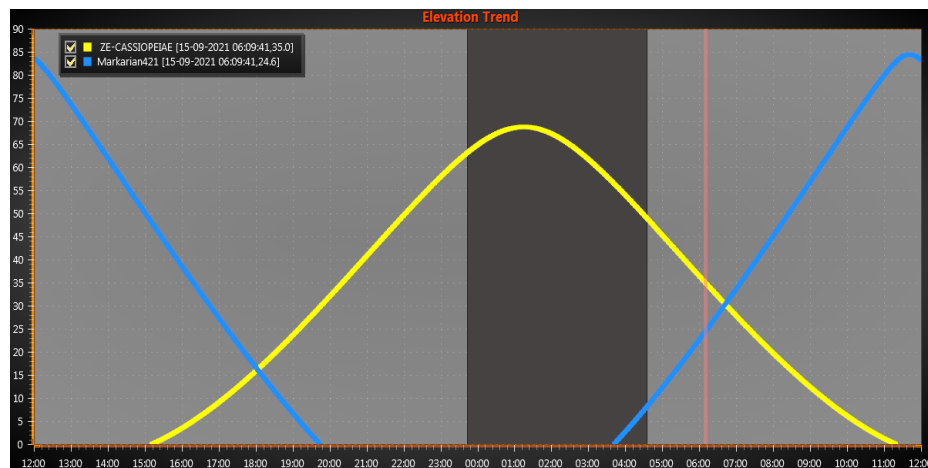
➢ Helps to decide the time period for observation
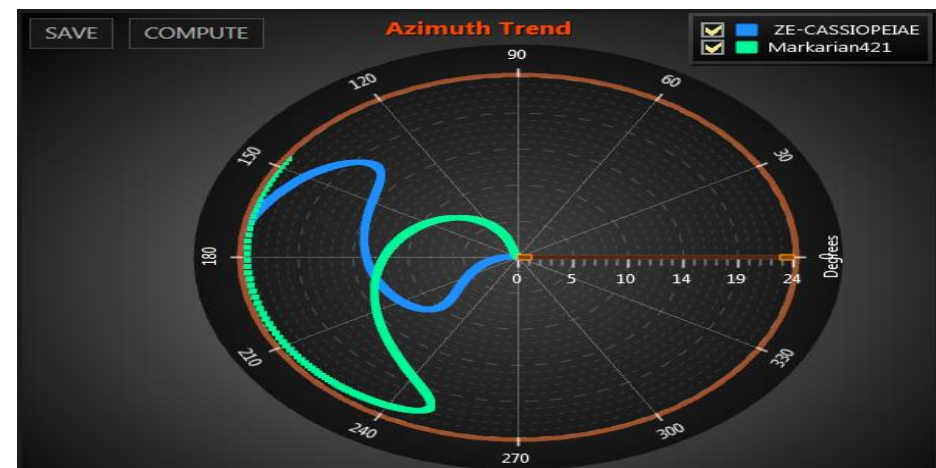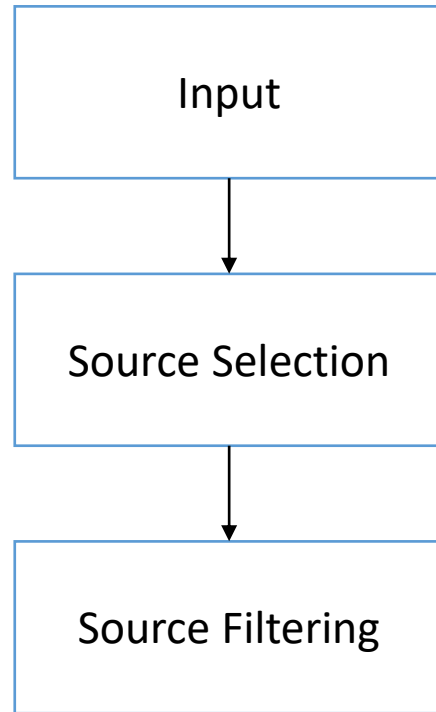

Fig. Elevation Trend

Fig. Azimuth Trend

ICALEPCS 2021

MACE Scheduler: Schedule Generation

Modes for schedule generation; Auto, manual

Auto-Schedule Generation:

➢ Location coordinates (Latitude & Longitude),
➢ time zone,
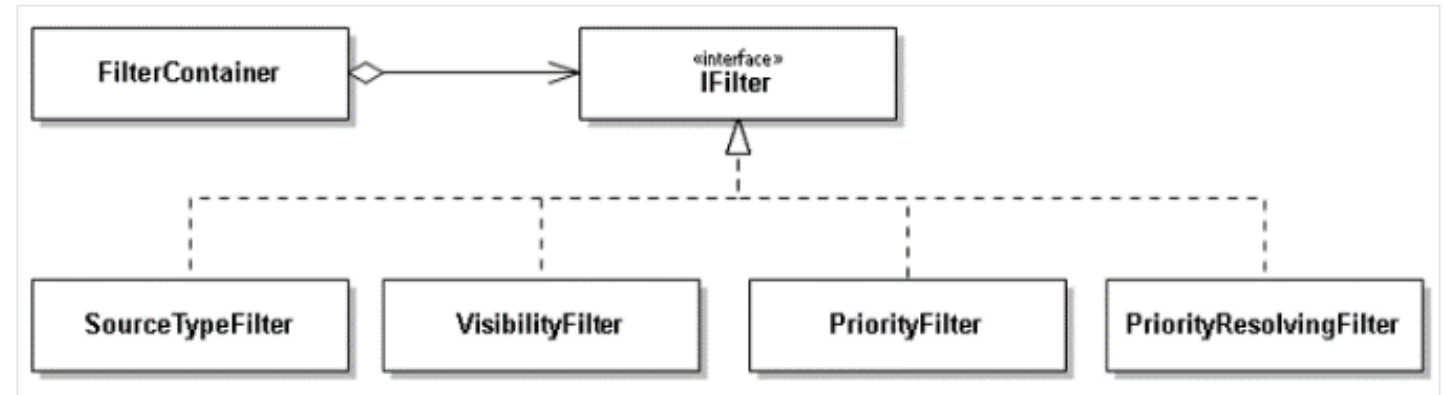➢ date selection,
➢ observation duration and source list

```
┌─────────────┐
│    Input    │
└─────────────┘
       │
       ▼
┌─────────────┐
│Source       │
│Selection    │
└─────────────┘
       │
       ▼
┌─────────────┐
│Source       │
│Filtering    │
└─────────────┘
```

Fig. Steps For Auto Schedule Generation

FilterContainer ◇──────→ «interface» IFilter

SourceTypeFilter   VisibilityFilter   PriorityFilter   PriorityResolvingFilter

Fig. Filter Container
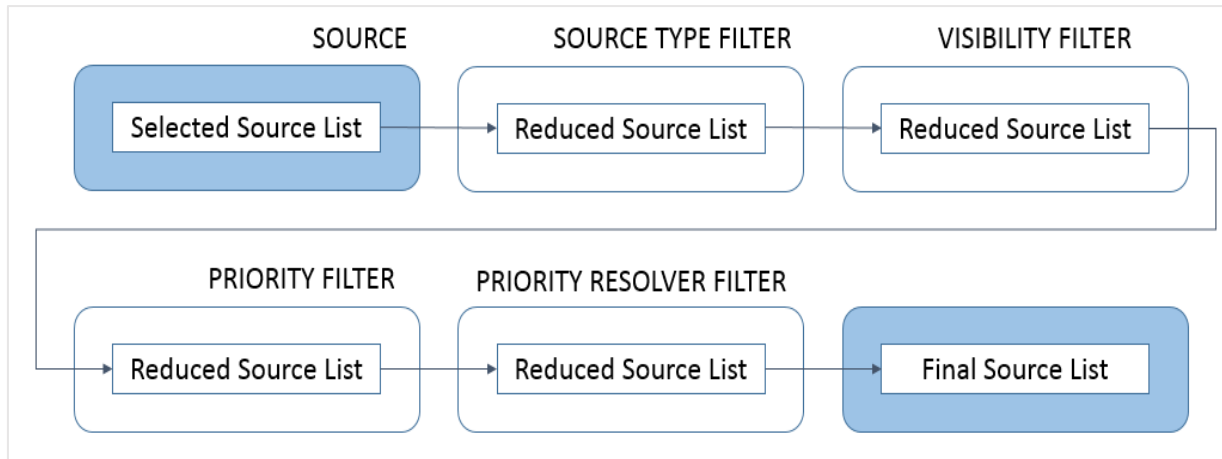
Auto-Schedule Generation:

➢ Custom User Filter: Source Azimuth > 50 and having 45 < Zenith < 90

Fig. Filter Workflow
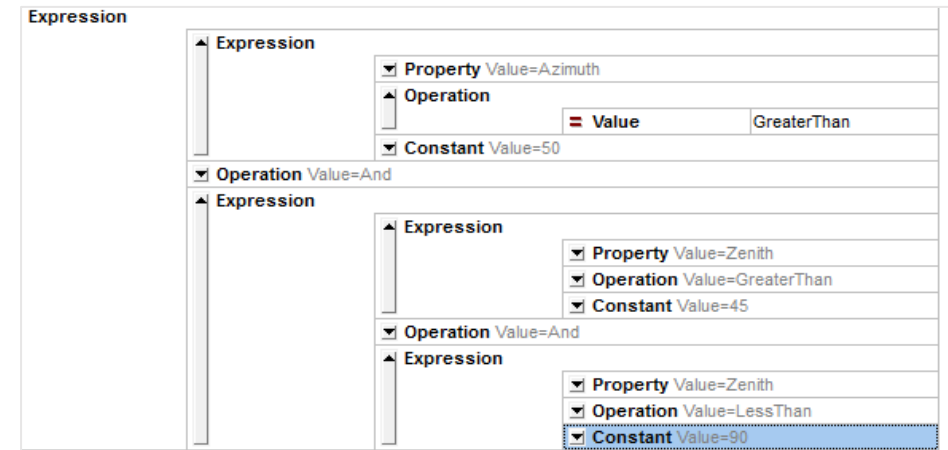

Fig. Custom User Filter

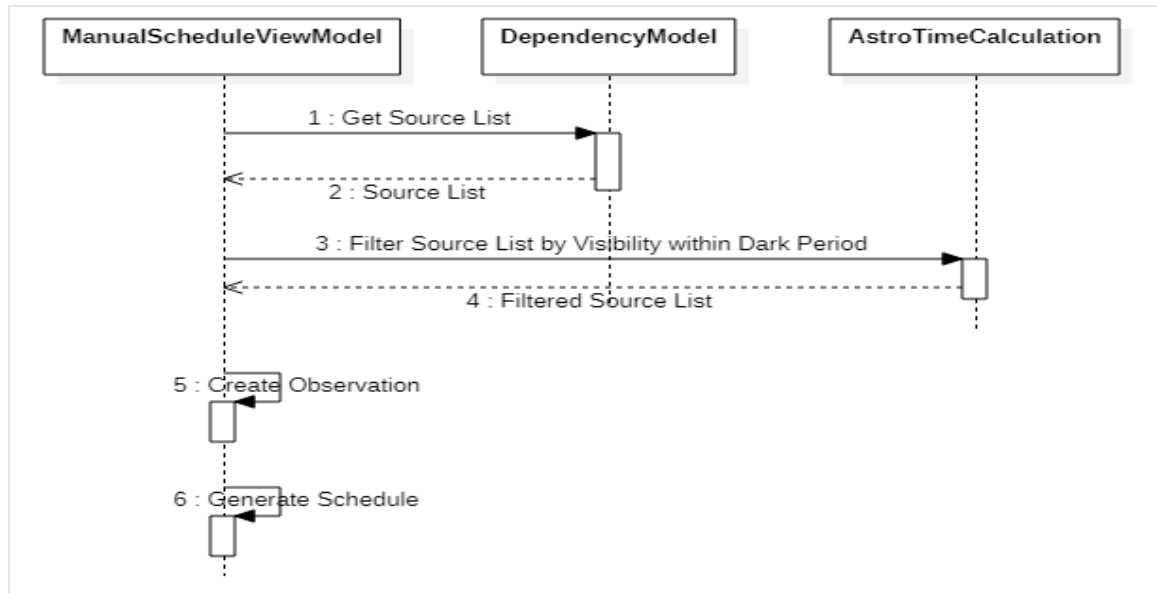## Manual Schedule Generation:

Fig. Manual Schedule Generation

1. Visible sources having overlap with Dark Period
2. Configuration
3. Schedule the sources as per the available dark time span

Fig. Rise set time plot

MACE Scheduler: Reports

➢ Visibility Reports

NAME	01-09-2021	02-09-2021	03-09-2021
BLACK PERIOD	20:03-00:48	20:01-01:41	20:00-02:40
AL-ANDROMEDAE	23:21-04:04	23:17-04:00	23:13-03:56
BE-CASSIOPEIAE	00:20-03:10	00:16-03:06	00:12-03:02

Fig. Visibility Information

Schedule Info:
➢ Sources being observed
➢ observation time span
➢ dark time available
➢ tracking mode information
➢ configuration to be used

➢ Schedule Reports

10-09-2021	OP- ZE-CYGNI	08:41 09:11	GA-0FGLJ1958.1+2848	09:11 09:41	EG-BLLacertae	09:41 10:11
11-09-2021	OP- ZE-CYGNI	09:18 09:48	GA-0FGLJ1958.1+2848	09:48 10:18	EG-BLLacertae	10:18 10:48
12-09-2021	OP- ZE-CYGNI	10:00 10:30	OP- ZE-PEGASI	10:30 11:00	EG-BLLacertae	11:00 11:30
13-09-2021	OP- ZE-CYGNI	10:48 11:18	OP- ZE-PEGASI	11:18 11:48	OP- BE-ANDROMEDAE	11:48 12:18
14-09-2021	OP- ZE-CYGNI	11:42 12:12				

Fig. Schedule Information

MACE Scheduler: Reports

Schedule Info:
- Multi-dimensional schedule information
- Sources being observed
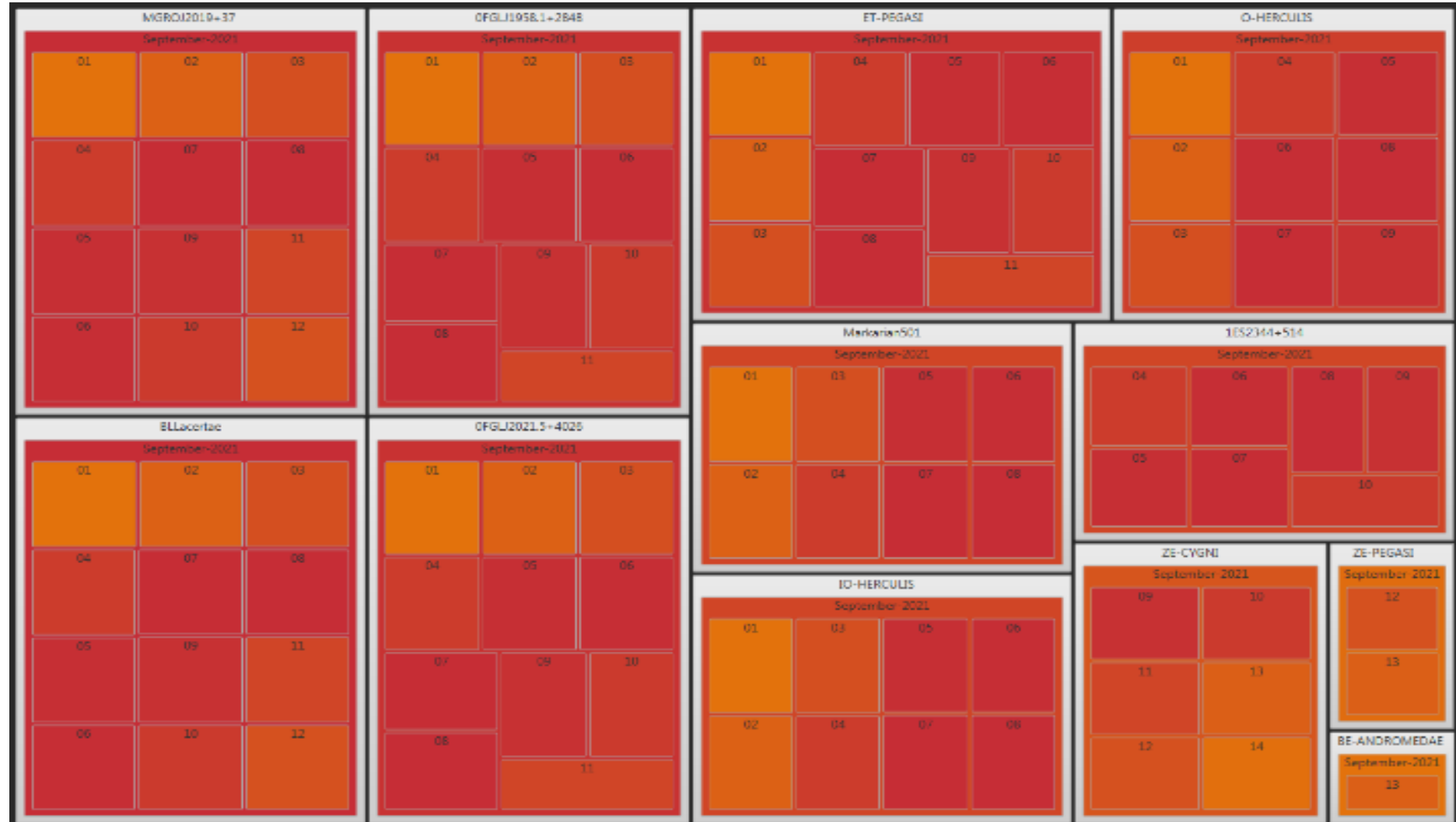- observation time span
- dark time available

Fig. Treemap Visualization of schedule info

MACE Scheduler: UI Design

- ➢ Inspired by Microsoft Design Language (MDL)

- ➢ Focus on *"content than chrome"*

- ➢ Technologies
  - ➢ UI Design- WPF Framework following MVVM style
  - ➢ Programming- C#, CLI C++

Fig. Custom calendar control

MACE Scheduler: Conclusion

- ➤ Automates the schedule generation through filter workflow

- ➤ Intuitive user interface for scheduling manual observations

- ➤ Timing plots showing the available Dark Period and Sun, Moon, Selected Source's rise/set times

- ➤ Design for extending to any custom developed astronomy algorithms

- ➤ Reports view

- ➤ MACE telescope has been Operational since 2020

Thank you