The Phase II Language for the Hobby⋆Eberly Telescope

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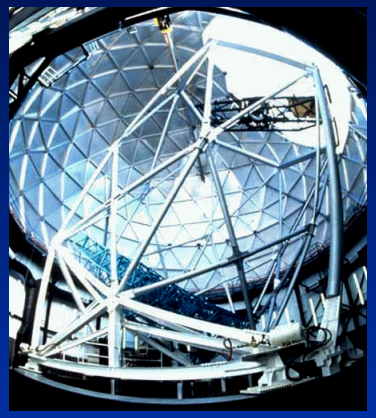
Hobby⋆Eberly Telescope Facts

- The Hobby⋆Eberly Telescope (HET):
  - Is a 9.2 meter fixed altitude telescope using an Arecibo-type tracking mechanism
  - Is a joint project of the University of Texas at Austin, The Pennsylvania State University, Stanford University, Ludwig–Maximilians–Universität München, and Georg–August–Universität Göttingen
  - Is located on Mt. Fowlkes at the McDonald Observatory near Fort Davis, Texas.
  - **Took its first light images in December of 1996**
  - Is currently undergoing scientific commissioning
  - Will run in a queue scheduled service observing mode 85% of the time starting in 1998.



Goals for the Phase II Language

- Constrained motion require detailed planning of observations
- Queued service observing requires a "Phase II" language for PIs to describe what, when, and how to observe.
- The language must:
  - Describe observations such that the HET observer has the flexibility to schedule observations whenever they can be done
  - Allow PI to specify what conditions are not acceptable
  - Allow for time critical, phase critical, and periodic observations
  - Allow for sharing of calibration data between projects
  - Allow for changes in exposure time due to changes in conditions
  - Allow PI to prioritize his/her observations
  - Describe observations in terms familiar to astronomers
  - written in plain text, created in a text editor, without unique software required

Our Template System

- Phase II observing scripts are made up of “templates”. Each template represents a single concept.
  - Summary template: Investigator's contact information & scientific goals
  - Object/Calibrator: Object position, magnitude…
  - Instrument: Wavelength, filter, fiber selection…
  - Constraints: Conditions under which observations are to be made
  - Plan: Sequence of actions to be taken to acquire data
- A template is independent of other templates. Each template
  - Is delineated by ***begin*** and ***end*** keywords
  - Contains a list of keywords and parameters
  - Can have user comments (preceded by the “#” character).

Summary Template

- Contains e-mail and other addresses at which the PI can be contacted
- Contains an abstract provided by the PI outlining the scientific goals and the required data quality to be read by the astronomer acquiring the data
- Allows PI to define the number of objects needed to finish project (if this number is less than number of objects provided)

```
begin_summary:
begin_PI:
        name: Niall Gaffney
        affiliation: UT
        email: niall@rhea.as.utexas.edu
        address: RLM 15.308\Univ. of Texas\Austin, TX 78712
        phone: (512)471-3343
        fax: (512)471-6016
end_PI:
begin_abstract:
        We will observe 100 of the 250 starburst galaxies in this
        list using the longslit mode of the LRS.  The slit will
        follow the major axis of the galaxy or, if present, the bar.
        Each spectra requires a S/N of 50 near 8300 A in order to
        get good stellar kinematics using the Ca absorption line
        triplet.
end_abstract:
num_discretionary: 100
end_summary:
```

Object/Calibrator Template

- Provides the object's position, magnitude, and finding chart
- Can also provide:
  - position angle and fiber/slit setup
  - offsets from acquisition object
  - flux of object being observed
  - orbital elements or positional ephemeris
  - proper motion and radial velocity
  - phase variability information
- Finding charts and fiber/slit setup files are submitted separately.
- Calibrators can be shared with other projects, objects cannot.

```
begin_object: NGC6423
    description: galaxy
    begin_comment: the nucleus is not well defined, so will
    offset from the SAO star near the nucleus
    end_comment:
    ra: 10:22:49.3
    dec: +22:43:26
    equinox: J2000
    pa: 142.3
    fiber_setup: NGC6423_lrs1.fsf
    ra_offset: 52.3
    dec_offset: -42.3
    # magnitude of the acquisition object
    v: 12.4
    # flux of the object being observed
    flux: 8300 continuum 16.4 mag
    rv: 430 km/s
    finding_chart: ngc6423.fit
end_object:
```

Instrument & Constraint Templates

- Instrument Template:
  - Used to specify instrument selection and setup parameters
  - Can specify all variable parameters (aperture, wavelength, CCD binning)
  - Has predefined standard setups to promote shared calibrations.
- Constraint Template:
  - Lists the constraints that must be met to make an observation
  - Contain telescope, sky, moon, and seeing limits for the observation.

```
begin_instrument: lrs_setup1
    begin_comment: the longslit must be positioned with the
    galaxy nucleus at the north end
    end_comment:
    instrument: lrs
    grating: grism1
    aperture: longslit
end_instrument:

begin_constraint: very_good
    begin_comment: The seeing constraint is critical, as
    there is a star 2 arcseconds from the nucleus that cannot
    contaminate the spectrum.
    end_comment:
    moon: new
    max_seeing: 1.3
    # at most 15% of the beam misses the primary
    min_througput: 85
    min_mirrors: 91
end_constraint:
```

Observing Plans

- A plan is an observation or sequence of related observations. It can contain
  - Whether the plan is a required or optional part of the project
  - Priority of this observation relative to those listed in the rest of the script
  - Date, time, and phase start times for the observation if needed
  - Which object(s) to observe for how long
  - Lamps, Darks, Calibrators, and Bias frames may be shared with other projects
  - A request to wait a specified amount of time to allow periodic observations at a later time.

```
begin_plan: SAO102332
        # this plan demonstrates the wait command
        instrument: lrs_setup1
        constraint: very_good
        class: required
        priority: 2
        # start on the 18th of Nov. +/- 3 days 12
        # hours
        utdate_start: 18/11/1997 delta 3 12:00:00
        do-object: SAO102332 800 scaled 2
        do-flat: 50 5
        do-lamp: Ar 10 5
        schedule-dark: 500 5
        schedule-calibrator: bluestar 50 fixed 1
         # wait three +/- 1 days before continuing
        schedule-wait: 3 delta 1
        constraint: not_so_good
        do-object: SAO102332 800 scaled 2
end_plan:
```

Unique HET Phase II features

- The HET's limited sky access at any given time and variable aperture with track position lead to two unique features in the queue scheduling of observations.
  - Two ways to request an observation:
    - do - tells the observer to do this now. No other project will be active in the time between observations (e.g. "do" a flat right after my object; do-object, do-flat, do-lamp).
    - schedule - tells the observer that this needs to be done at some convenient time tonight or, if possible, in the morning. (e.g. "schedule" some flats and a blue star for sometime tonight; schedule-flat, schedule-wait).
  - Fixed vs. scaled integration times:
    - PI may specify a normal "fixed" value for the integration time
    - PI may give an estimated exposure time for defined nominal conditions and mark it as a "scaled" observation. This will be scaled at the start of the exposure according to the current conditions to conserve the S/N ratio

Macros

- Used to simplify repeated parts of templates and/or plans
  - Reduces typing
  - Makes scripts with many objects easier to write
- Variables can be passed to macro when it is called
- Calls to macros from within a macro possible (can pass macro to be called to another macro)
- Can be used to create single line WIYN style target tables that expand into full scripts

```
begin_macro: M1 $object $ra $dec $secondmacro $itime
# this demonstrates how a single macro can expand
# into different templates making single line macros
# work like a the WIYN target tables
begin_object: $object
        ra: $ra
        dec: $dec
        equinox: J2000
end_object:
begin_plan: $object
        instrument: I1
        constraint: C1
        # note that macros can call other macros
        do-macro: $secondmacro $object $itime
end_plan
end_macro:

# the following line expands into both an object and plan
do-macro:  M1  IRAS44.443  10:44:23  -3:12:45  M2  1000
```

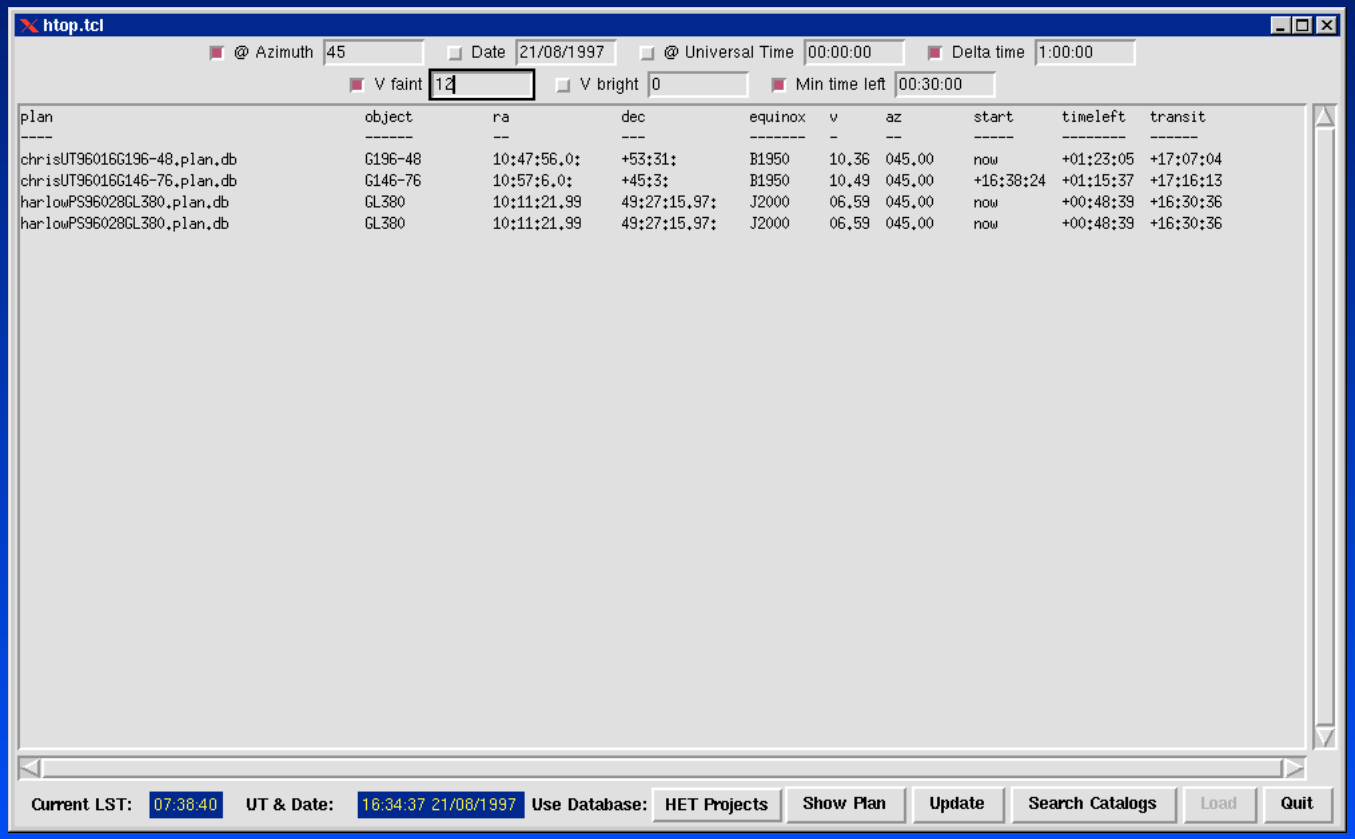
Script verification and execution

- Templates for a each observing project are written by the PIs and concatenated into a single script.
- Scripts are e-mailed to HET operations and are automatically checked for syntax upon receipt.
- Scripts are compiled into a relational database.
  - Currently 37 scripts in the HET commissioning databases (20 stellar, 15 ex-gal, and 2 planetary, of which 12 are periodic monitoring projects) totaling over 3000 objects.
- Software tools are used to schedule and execute plans.
  - Automatically generate scripts to drive instrument control systems.
  - Currently, plans are scheduled manually as the night progresses
  - Eventually, new tools will help observer build a nightly schedule and then modify it in real time as condition and forecasts change.

Htop - manually selecting plans

Simple tool for determining what can be done when.

- Tool reads in HET projects and other object databases.
- User can specify time/date, magnitude limits, telescope azimuth, and time remaining on object.
- Tool determines which objects fit those criteria.
- Result can be loaded directly into plan execution tool.



Runplan - the plan execution tool

Provides observer with:

- Source & instrument info
- Observing conditions (used to scale exp. time)
- Abstract
- Instrument & telescope communication
- Comments from templates
- Queued calibrations
- Logged actions

Observer chooses plan, acquires objects, executes instrument script, and examines data.