# 13766 - The nature of stationary components in jets from young stellar objects

Cycle: 22, Proposal Category: GO

(Availability Mode: SUPPORTED)

## INVESTIGATORS


| *Name* | *Institution* | *E-Mail* |
|---|---|---|
| **Dr. Peter Christian Schneider (PI) (ESA Member) (Contact)** | **Universitat Hamburg, Hamburger Sternwarte** | **cschneider@hs.uni-hamburg.de** |
| Prof. Manuel Guedel (CoI) (ESA Member) | University of Vienna | manuel.guedel@univie.ac.at |
| Dr. Jochen Eisloeffel (CoI) (ESA Member) | Thuringer Landessternwarte Tautenburg (TLS) | jochen@tls-tautenburg.de |
| Dr. Hans Moritz Guenther (CoI) (AdminUSPI) | Smithsonian Institution Astrophysical Observatory | hguenther@cfa.harvard.edu |
| Prof. Jurgen H.M.M. Schmitt (CoI) (ESA Member) | Universitat Hamburg, Hamburger Sternwarte | jschmitt@hs.uni-hamburg.de |
| Dr. Jan Robrade (CoI) (ESA Member) | Universitat Hamburg, Hamburger Sternwarte | jrobrade@hs.uni-hamburg.de |
| Dr. Francesca Bacciotti (CoI) (ESA Member) | Osservatorio Astrofisico di Arcetri | fran@arcetri.astro.it |
| Dr. Linda Podio (CoI) (ESA Member) | Osservatorio Astrofisico di Arcetri | lpodio@arcetri.astro.it |
| Dr. Gregory J. Herczeg (CoI) | Peking University | gherczeg1@gmail.com |


## VISITS

| *Visit* | *Targets used in Visit* | *Configurations used in Visit* | *Orbits Used* | *Last Orbit Planner Run* | *OP Current with Visit?* |
|---|---|---|---|---|---|
| 01 | (1) V-DG-TAU<br>CCDFLAT | STIS/CCD | 4 | 29-Jul-2014 21:10:07.0 | yes |

4 Total Orbits Used


## ABSTRACT

There is increasing evidence that jets are essential for the star formation process. Our understanding of the jet launching process is, however, still fragmentary. In particular, new observations revealed (a) that jets from young stellar sources possess hot, stationary components close to the driving source that contrast the well-known moving parts of the jets further out and (b) possible evidence for plasma acceleration within a few 10 AU from

the source.

We propose to follow-up these new results by providing the required diagnostics to uncover the controversial origin of the stationary component and to constrain the location where the outflowing plasma is accelerated. Specifically, we propose to observe the classical T Tauri star DG Tau with STIS and the slit oriented along the jet axis to measure the plasma density of the warm (1e4 K) and hot (1e5 K) parts of the jet to distinguish between proposed models for the stationary component, as well as to follow the plasma traveling through the jet collimation region to test current jet launching models.

**OBSERVING DESCRIPTION**

The goal of the proposed observations is to spatially resolve the intermediate (T = 10e5 K) and low temperature (T = 10e4 K) material within DG Tau's jet as well as to provide a large set of diagnostic lines for a detailed study of the plasma properties within the innermost jet region. We propose to use STIS with the slit oriented along the jet axis. Specifically, we propose a hybrid approach using a combination of the low and medium resolution STIS gratings, which requires only four HST orbits to provide velocity resolution as well as wavelength coverage. In particular, we dedicate one orbit each for the strongest lines tracing the 10e4 and 10e5 K plasma, respectively. Another two orbits provide the large wavelength coverage required for the proposed studies.

One orbit is dedicated to provide velocity resolved data for the traditional jet tracers of the 10e4 K plasma using the G750M grating ([O i] 6363 A, [N ii] 6548 A and the [S ii] doublet around 6720 A). These data will be used to compare the velocity of the 10e4 with the 10e5 K plasma and to follow the knot evolution by comparison with existing HST data. We know from archival STIS G750M data that a single orbit is sufficient to resolve [O i] 6363 A close to the star against the bright stellar background and that other diagnostic lines like [N ii] 6548 A can also be resolved against the nearby bright Halpha line with sufficient S/N > 10.

One orbit using the G430M will provide velocity resolution for the strongest line tracing the 10e5 K plasma ([O iii] 5007 A). For the estimate of the required exposure time, we again relied on archival HST data (a short 180 s G430L exposure) and estimate a representitive flux of 10e14 erg/s/cm2 (this value is about half the total flux given in Schneider et al. 2013, because the emission is spatially distributed). However, the dominant noise source is the subtraction of the stellar continuum. Using the STIS ETC, we estimate from the archival data a continuum rate of 2.4 counts/pixel/s at the peak of the stellar continuum and < 1 counts/pix/s 0. 1 away from the stellar position so that we achieve S/N > 9 farther than 0. 1 arcsec from DG Tau and a single orbit will be sufficient for our science goals.

Lastly, two orbits using the L-mode gratings are required to reach sufficient S/N in lower luminosity diagnostic lines. The exposure time for the G430L (one orbit) is driven by the [Ne iii] 3968 line seen in the short (180 s) G430L exposure at low S/N of about 3. Thus, one orbit providing 2800 s on target time will allow us to measure the line with S/N of 11. The exposure time for the G750L grating (one orbit) is more difficult to estimate, because no HST data of the [Fe ii] lines exist and we extrapolate from the Fe lines and [O i] 6300 A measured by Hartigan et al. (2004) for HN Tau. The [O i] flux is larger in DG Tau (about about a factor of seven). On the other hand, the continuum emission is also stronger by a factor of about 3 so that we expect to detect the lines with similar or better S/N as Hartigan et al. using a single orbit of integration time which was sufficient to derive the density with 0.15 dex accuracy close to the source.

The position angle of the jet (PA=226 degree) is known from previous observations (HST and ground based AO). A tolerance of +-1 deg in position angle is acceptable for this jet. We will use the same successful acquisition strategy as in previous programs (e.g. Prop-ID 12199). In summary, we request a single visit consisting of four orbits (each providing 50 min visibility time when using increased scheduling flexibility).

## Visit

**Proposal 13766, Visit 1 (01), implementation** Wed Jul 30 01:10:09 GMT 2014

**Diagnostic Status: No Diagnostics**

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 90D TO 92 D; ORIENT 270D TO 272 D

*Comments: All observations within one visit to provide near-simultaneous coverage of all diagnostics.*

## Patterns

| # | Primary Pattern | | Secondary Pattern | Exposures |
|---|---|---|---|---|
| (1) | Pattern Type=STIS-ALONG-SLIT<br>Purpose=DITHER<br>Number Of Points=3<br>Point Spacing=0.5078<br>Line Spacing= | Coordinate Frame=POS-TARG<br>Pattern Orientation=90.0<br>Angle Between Sides=<br>Center Pattern=false | | (2), (3), (5) |
| (2) | Pattern Type=STIS-ALONG-SLIT<br>Purpose=DITHER<br>Number Of Points=4<br>Point Spacing=0.35546<br>Line Spacing= | Coordinate Frame=POS-TARG<br>Pattern Orientation=90.0<br>Angle Between Sides=<br>Center Pattern=false | | (4) |

## Fixed Targets

| # | Name | Target Coordinates | Targ. Coord. Corrections | Fluxes | Miscellaneous |
|---|---|---|---|---|---|
| (1) | V-DG-TAU | RA: 04 27 4.7000 (66.7695833d)<br>Dec: +26 06 16.05 (26.10446d)<br>Equinox: J2000 | | V=12.5+/-1.1 | Reference Frame: ICRS |

*Comments: The coordinates are from 2MASS and corrected for proper-motion as measured by Zacharias et al. (2003) for 2015. The proper-motion is small with 2.9 and -18.2 mas/yr for RA and Dec, respectively. Therefore, we do not enter proper-motion values into the form, but rather use a value appropriate for the approx. observing time. From previous observations, we know that these coordinates almost perfectly center the star in the ACQ aperture.*

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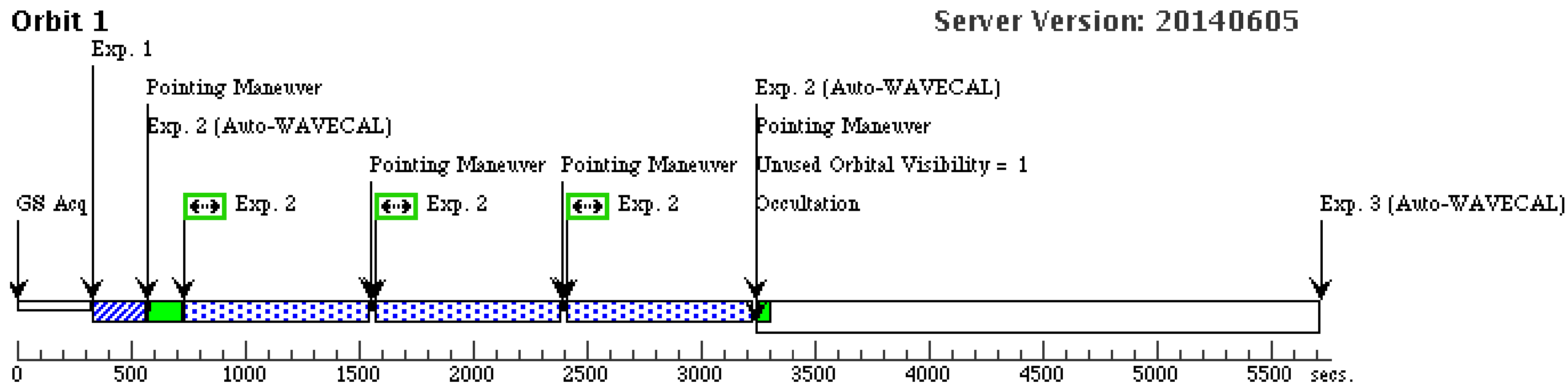
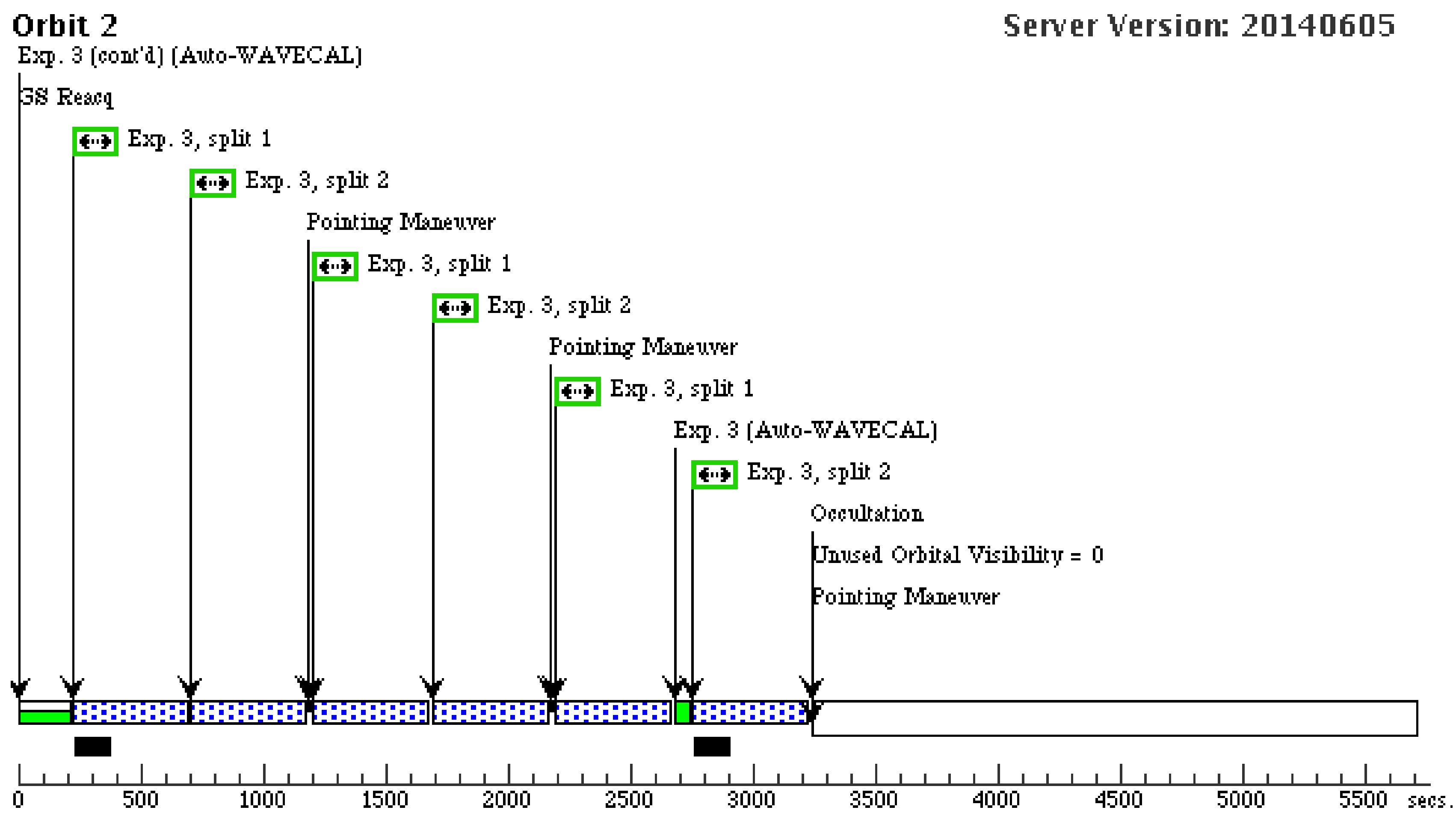
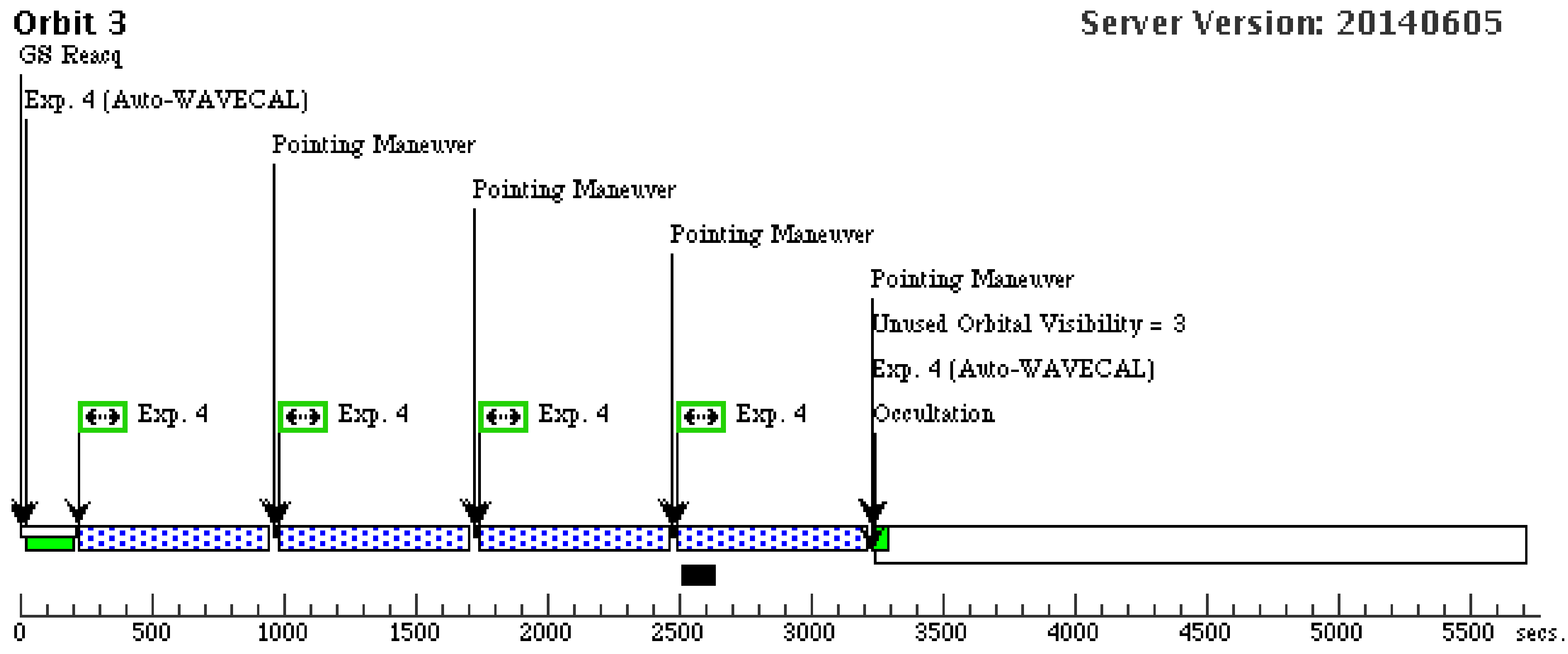
**Exposures**

| # | Label | Target | Config,Mode,Aperture | Spectral Els. | Opt. Params. | Special Reqs. | Groups | Exp. Time (Total)/[Actual Dur.] | Orbit |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Acquisition | (1) V-DG-TAU | STIS/CCD, ACQ, F28X50LP | MIRROR | ACQTYPE=POINT | GS ACQ SCENARIO BASE1B3 | | 0.2 Secs (0.2 Secs)<br>*[==>]* | *[1]* |
| 2 | G430M | (1) V-DG-TAU | STIS/CCD, ACCUM, 52X0.2 | G430M<br>4961 A | CR-SPLIT=NO;<br>GAIN=1 | | Pattern 1, Exps 2-2 in Visit 1 (01) (1) | 900 Secs (2313 Secs)<br>*[==>771.0 Secs (Pattern 1)]*<br>*[==>771.0 Secs (Pattern 2)]*<br>*[==>771.0 Secs (Pattern 3)]* | *[1]* |
| 3 | G750M | (1) V-DG-TAU | STIS/CCD, ACCUM, 52X0.2 | G750M<br>6581 A | GAIN=1;<br>CR-SPLIT=2 | | Pattern 1, Exps 3-3 in Visit 1 (01) (1) | 872 Secs (2616 Secs)<br>*[==>(Pattern 1, Split 1)]*<br>*[==>(Pattern 1, Split 2)]*<br>*[==>(Pattern 2, Split 1)]*<br>*[==>(Pattern 2, Split 2)]*<br>*[==>(Pattern 3, Split 1)]*<br>*[==>(Pattern 3, Split 2)]* | *[2]* |
| 4 | G430 L, 4 individual exposures | (1) V-DG-TAU | STIS/CCD, ACCUM, 52X0.2 | G430L<br>4300 A | CR-SPLIT=NO;<br>GAIN=4 | | Pattern 2, Exps 4-4 in Visit 1 (01) (2) | 689 Secs (2756 Secs)<br>*[==>(Pattern 1)]*<br>*[==>(Pattern 2)]*<br>*[==>(Pattern 3)]*<br>*[==>(Pattern 4)]* | *[3]* |
| 5 | G750L | (1) V-DG-TAU | STIS/CCD, ACCUM, 52X0.2 | G750L<br>7751 A | CR-SPLIT=3;<br>GAIN=4 | | Pattern 1, Exps 5-5 in Visit 1 (01) (1) | 800 Secs (2480.4 Secs)<br>*[==>275.6 Secs (Pattern 1, Split 1)]*<br>*[==>275.6 Secs (Pattern 1, Split 2)]*<br>*[==>275.6 Secs (Pattern 1, Split 3)]*<br>*[==>275.6 Secs (Pattern 2, Split 1)]*<br>*[==>275.6 Secs (Pattern 2, Split 2)]*<br>*[==>275.6 Secs (Pattern 2, Split 3)]*<br>*[==>275.6 Secs (Pattern 3, Split 1)]*<br>*[==>275.6 Secs (Pattern 3, Split 2)]*<br>*[==>275.6 Secs (Pattern 3, Split 3)]* | *[4]* |
| 6 | Fringe flat | CCDFLAT | STIS/CCD, ACCUM, 52X0.2 | G750L<br>7751 A | | | | *[==>(Copy 1)]*<br>*[==>(Copy 2)]* | *[4]* |
| 7 | Fringe Flat point source | CCDFLAT | STIS/CCD, ACCUM, 0.3X0.09 | G750L<br>7751 A | | | | *[==>(Copy 1)]*<br>*[==>(Copy 2)]* | *[4]* |

Orbit Structure




Orbit 2
Server Version: 20140605
Exp. 3 (cont'd) (Auto-WAVECAL)
GS Reacq
Exp. 3, split 1
Exp. 3, split 2
Pointing Maneuver
Exp. 3, split 1
Exp. 3, split 2
Pointing Maneuver
Exp. 3, split 1
Exp. 3 (Auto-WAVECAL)
Exp. 3, split 2
Occultation
Unused Orbital Visibility = 0
Pointing Maneuver
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 3
Server Version: 20140605
GS Reacq
Exp. 4 (Auto-WAVECAL)
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Unused Orbital Visibility = 3
Exp. 4 (Auto-WAVECAL)
Occultation
Exp. 4
Exp. 4
Exp. 4
Exp. 4
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.

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