



15479 - Simultaneous detection of Mg, C and O in the variable spectrum of Beta Pictoris to trace dust and ices in exocomets

Cycle: 25, Proposal Category: GO

(UV Initiative)

(Availability Mode: AVAILABLE)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. Flavien Kiefer (PI) (ESA Member) (Contact)	CNRS, Institut d'Astrophysique de Paris	flavien.kiefer@iap.fr
Dr. Alain Lecavelier des Etangs (CoI) (ESA Member)	CNRS, Institut d'Astrophysique de Paris	lecaveli@iap.fr
Dr. Guillaume Hebrard (CoI) (ESA Member)	CNRS, Institut d'Astrophysique de Paris	hebrard@iap.fr
Dr. Alfred Vidal-Madjar (CoI) (ESA Member)	CNRS, Institut d'Astrophysique de Paris	vidalmadjar@iap.fr
Dr. Roger D. Ferlet (CoI) (ESA Member)	CNRS, Institut d'Astrophysique de Paris	ferlet@iap.fr
Dr. Paul A. Wilson (CoI) (ESA Member)	Universiteit Leiden	paw@strw.leidenuniv.nl
Dr. Vincent Bourrier (CoI) (ESA Member)	Observatoire de Geneve	bourrier@iap.fr

VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) -BET-PIC WAVE	COS/FUV STIS/CCD STIS/NUV-MAMA	2	12-Jun-2018 18:01:47.0	yes
02	(1) -BET-PIC WAVE	COS/FUV STIS/CCD STIS/NUV-MAMA	2	12-Jun-2018 18:01:49.0	yes

4 Total Orbits Used

ABSTRACT

Beta Pictoris is a young planetary system embedded in a debris disk that is continually replenished by the collision and evaporation of planetesimals and exocomets. As a result of the edge-on inclination of the debris disk, transiting exocomets can be observed in great detail using absorption spectroscopy.

Previous COS observations yielded the first detection of exocomets in the far-UV, with the discovery of new exocometary species including H, C, N, O and Si. Interestingly, the C/O ratio in the exocomets seems to also distinguish the two dynamically different exocomet populations known to exist in the Beta Pic system.

Our most recent STIS observations led to obtain the first Mg II doublet spectrum almost free of exocomet features. This will allow identifying and measuring any variable absorptions due to exocomets at these wavelengths.

Here we propose to probe the dust-to-ice ratios within the exocomet population surrounding Beta Pic. This objective can be achieved by capturing individual exocomet transit simultaneously in Mg, C, O and CO absorption lines in COS/NUV and STIS/FUV spectra of this young star. Mg is one of the main constituent of silicate (forsterite, enstatite), while C, O and CO are among the main species forming ices in comets.

Numerous and strong variable absorptions were frequently observed separately and at different dates in Mg II, C, O and CO transitions, but were never captured simultaneously at these wavelengths. This will be an unprecedented measurement, allowing us to trace the condensation and evaporation processes and their location in the late stages of planetary formation.

OBSERVING DESCRIPTION

Observation strategy

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We wish to observe Beta Pictoris at 2 different epochs separated by at least 2 weeks. The objective of this program is to put forward transient absorptions in the UV due to transit of exo-cometary clouds in front of Beta Pic. For this purpose it is essential that the system is observed at different well separated epochs. In order to unravel flux dimming due to exocomet transit, we need to compare spectral regions when they present absorption signatures to when they only present the quiet stellar continuum. Our observations of the numerous exo-cometary transits in the Ca II doublet lines of Beta Pic have shown that the rate of exocometary transit fluctuates aperiodically by as much as a factor of 2 during a year. Therefore, the largest possible time separation between our 2 different visits (15 to 100 days) would maximize our chance to get spectra at both low and high exocometary transit rates. It would guaranty the best scientific return for this program, allowing for an unbiased estimation of the abundance of the absorbing

elements evaporated from the transiting comets.

Our main objective is the 'simultaneous' observation of shallow absorption lines at the Mg, C O and CO wavelengths, which was never done for transiting exocomets. Since those absorption could be as shallow as a few percent, it is essential for us to maximize the S/N for all exposures.

We will divide the 2 orbits of each 2 visits into 1 orbit dedicated to STIS/NUV and 1 orbit dedicated to COS/FUV:

-- The first orbit on STIS, will consists in a ~2101s exposure on the STIS-MAMA/NUV/E230H echelle grating to observe the Mg II line at 2800 Ang., aiming at S/N>80. In order to maximize that number, we request to move the WAVECAL exposure to after the time of occultation of Beta Pictoris.

-- The second orbit on COS will make use of an FUV G130M grating centered around 1300 Ang (preferably both segments of the 1327 at LP3). It will consists in a ~2012s exposure, split into 4x503s exposures on ALL different FP-POS of the detector. It will be dedicated to observe the C, O and CO lines at 1329, 1335, 1392 and 1302 Ang. aiming at S/N>30.

Since Beta Pic is very bright ($V \sim 3.86$), we carefully chose the configurations and exposure times with both STIS and COS instruments:

-- We will use the 31x0.05NDA slit that guaranties a limited illumination of the STIS-MAMA. It was selected over the 0.1x0.03 aperture, based on simpler target acquisition overheads, while with similar optical properties. We checked that the count rate for this bright A5 star was below the bright object limit using the 31x0.05NDA filter.

-- Moreover, the use of the COS FUV gratings exposes the detector to possibly large flux at the Lyman-alpha line. We were particularly careful to test the exposures to high airglow and using conservative upper limit to stellar emission at these wavelengths (1216 Ang.) using the ETC with the G130M/1327 grating. We specially verified the goodness of buffer time and bright object limit (using FWHM~2 Ang., flux=4e-12).

Use of the COS/FUV-G130M/1327 grating

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In order to fullfill the main scientific objective of the current program, we request using the G130M/1327 at LP3 on both segments for the science exposure. Indeed, previous measurements on C, O and CO of Beta Pic spectrum using COS were done with this configuration (programs #15396 and #15412, PI: P. A. Wilson), as also advised on COS science-cases (<http://www.stsci.edu/hst/cos/cos2025/ScienceCase3.pdf>). Using the exact same configuration would allow us to obtain the best comparison of the new spectra with existing ones, which is a critical aspect of our program searching for time-variable spectral features. Moreover, this configuration lowers the probability of gain sag in segment B, that unfortunately mimic real

spectral variations.

Need for an early first visit

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In 2017, the Hill sphere of the directly imaged planet Beta Pictoris b transited its host star, Beta Pic, providing the first opportunity to observe the circumplanetary environment around a young (~23 Myr) directly imaged planet. The ongoing analysis of the data already obtained (programs #14089, #15396 and #15412, PI: P. A. Wilson) show promising signs of a possible detection. To confirm the observed absorption it is important to have enough post-transit observations in order to confirm that the absorption does not repeat itself again when the Hill sphere of the planet is no longer transiting.

The exocomet observations, which this program was awarded time for, can be executed at any time, however, in order to maximise the scientific return of the aforementioned Hill sphere transit observations, we request that the first visit of this program occurs not too long after the transit event. In the interest of maximising the scientific return of the previous program, and without affecting this program in any way, we ask that the first observation be done before November 2018.

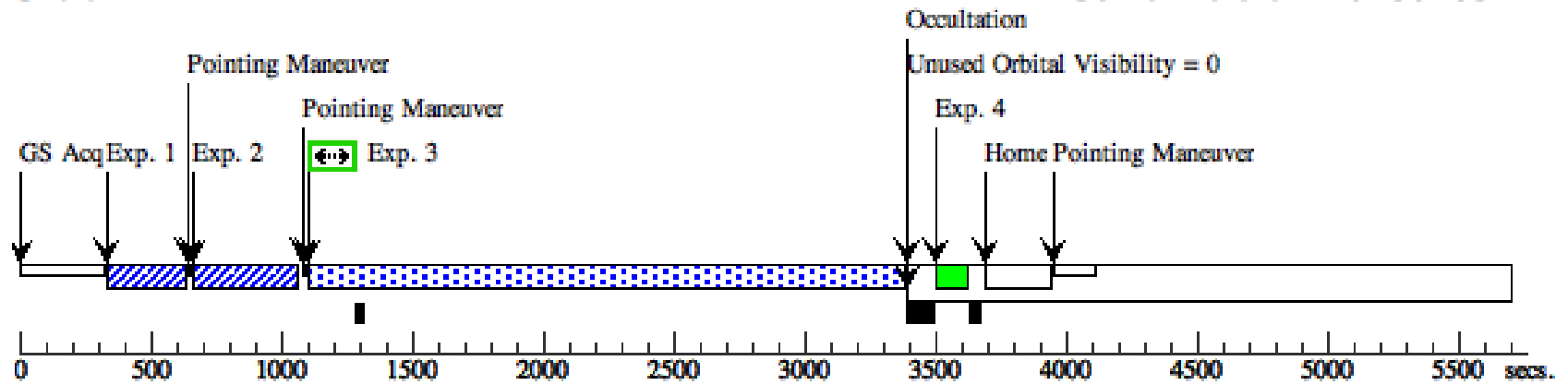
Proposal 15479 - Visit 01 - Simultaneous detection of Mg, C and O in the variable spectrum of Beta Pictoris to trace dust and ices in e...

Tue Jun 12 22:01:51 GMT 2018

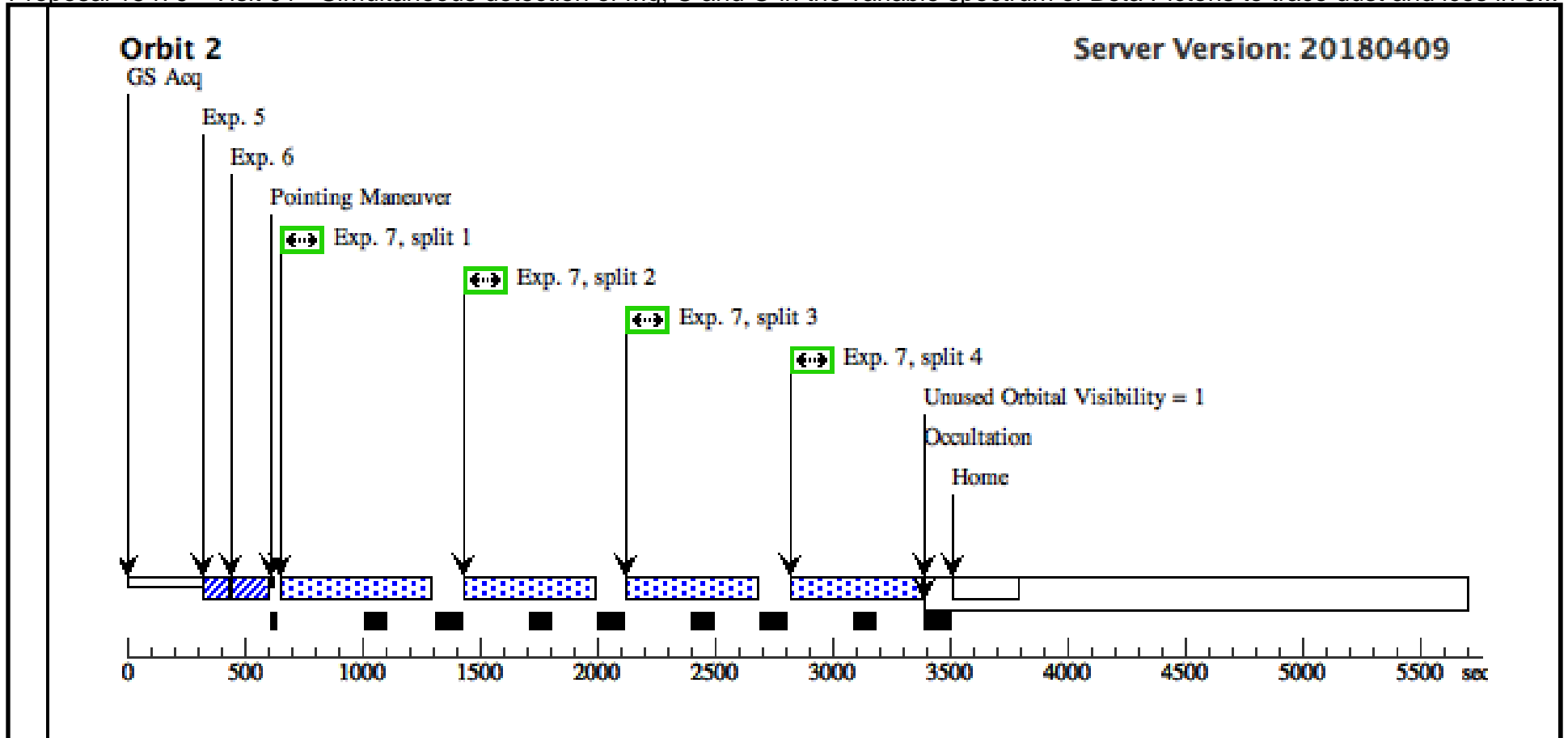
Visit	Proposal 15479, Visit 01, implementation Diagnostic Status: No Diagnostics Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, COS/FUV Special Requirements: BEFORE 01-NOV-2018:00:00:00 Comments: First orbit: Beta Pic is observed with STIS-MAMA/NUV/E230H grating Second orbit: Beta Pic is observed with COS/FUV/1327 grating Timing requirement: the scientific return of this program would be maximised if the first visit is executed before the 01-NOV-2018.																																																																																																			
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Orbit 1

Server Version: 20180409



Orbit Structure



Proposal 15479 - Visit 02 - Simultaneous detection of Mg, C and O in the variable spectrum of Beta Pictoris to trace dust and ices in e...

Tue Jun 12 22:01:51 GMT 2018

Visit	Proposal 15479, Visit 02, implementation Diagnostic Status: No Diagnostics Scientific Instruments: STIS/NUV-MAMA, STIS/CCD, COS/FUV Special Requirements: AFTER 01 BY 15 D TO 100 D Comments: First orbit: Beta Pic is observed with STIS-MAMA/NUV/E230H grating. Second orbit: Beta Pic is observed with COS/FUV/1327 grating. Timing requirement: the second visit should be executed at least 15 days after the first visit.																																																																																																			
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Exposures	<table border="1"> <thead> <tr> <th>#</th> <th>Label (ETC Run)</th> <th>Target</th> <th>Config,Mode,Aperture</th> <th>Spectral Els.</th> <th>Opt. Params.</th> <th>Special Reqs.</th> <th>Groups</th> <th>Exp. Time (Total)/[Actual Dur.]</th> <th>Orbit</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>ACQ</td> <td>(1) -BET-PIC</td> <td>STIS/CCD, ACQ, F25ND5</td> <td>MIRROR</td> <td></td> <td></td> <td>Sequence 1-4 Non-Int in Visit 02</td> <td>1 Secs (1 Secs) [==>]</td> <td>[1]</td> </tr> <tr> <td>2</td> <td>PEAK</td> <td>(1) -BET-PIC</td> <td>STIS/CCD, ACQ/PEAK, 31X0.05NDA</td> <td>G430M 4451 A</td> <td></td> <td></td> <td>Sequence 1-4 Non-Int in Visit 02</td> <td>1 Secs (1 Secs) [==>]</td> <td>[1]</td> </tr> <tr> <td>3</td> <td>STIS EXPO SURE (STIS.sp.11 66374)</td> <td>(1) -BET-PIC</td> <td>STIS/NUV-MAMA, ACCUM, 31X0.05NDA</td> <td>E230H 2812 A</td> <td>WAVECAL=NO</td> <td></td> <td>Sequence 1-4 Non-Int in Visit 02</td> <td>2101 Secs (2101 Secs) [==>]</td> <td>[1]</td> </tr> <tr> <td>4</td> <td>WAVECAL WAVE</td> <td></td> <td>STIS/NUV-MAMA, ACCUM, 0.2X0.09</td> <td>E230H 2812 A</td> <td></td> <td></td> <td>Sequence 1-4 Non-Int in Visit 02</td> <td>[==>]</td> <td>[1]</td> </tr> <tr> <td>5</td> <td>PEAKXD (COS.sp.116 6426)</td> <td>(1) -BET-PIC</td> <td>COS/FUV, ACQ/PEAKXD, PSA</td> <td>G130M 1291 A</td> <td>LIFETIME-POS=LP4; SEGMENT=BOTH</td> <td></td> <td>Sequence 5-7 Non-Int in Visit 02</td> <td>1.4 Secs (1.4 Secs) [==>]</td> <td>[2]</td> </tr> <tr> <td>6</td> <td>PEAKD (COS.sp.116 6426)</td> <td>(1) -BET-PIC</td> <td>COS/FUV, ACQ/PEAKD, PSA</td> <td>G130M 1291 A</td> <td>STEP-SIZE=0.9; NUM-POS=5; CENTER=DEF; LIFETIME-POS=LP4; SEGMENT=BOTH</td> <td></td> <td>Sequence 5-7 Non-Int in Visit 02</td> <td>1.4 Secs (1.4 Secs) [==>]</td> <td>[2]</td> </tr> <tr> <td>7</td> <td>COS EXPO SURE (COS.sp.116 6456)</td> <td>(1) -BET-PIC</td> <td>COS/FUV, TIME-TAG, PSA</td> <td>G130M 1327 A</td> <td>BUFFER-TIME=240; FLASH=YES; FP-POS=ALL; LIFETIME-POS=LP3; SEGMENT=BOTH</td> <td></td> <td>Sequence 5-7 Non-Int in Visit 02</td> <td>2012 Secs (2012 Secs) [==>503.0 Secs (Split 1)] [==>503.0 Secs (Split 2)] [==>503.0 Secs (Split 3)] [==>503.0 Secs (Split 4)]</td> <td>[2]</td> </tr> <tr> <td colspan="10"> Comments: In the ETC run, the strength of the Stellar Lyman-alpha line has been set to an extremely conservative upper limit to calculate the Buffer-time and check the Bright Objects Limit (FWHM=2 Angstrom, Flux=4e-12). </td> </tr> </tbody> </table>										#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	1	ACQ	(1) -BET-PIC	STIS/CCD, ACQ, F25ND5	MIRROR			Sequence 1-4 Non-Int in Visit 02	1 Secs (1 Secs) [==>]	[1]	2	PEAK	(1) -BET-PIC	STIS/CCD, ACQ/PEAK, 31X0.05NDA	G430M 4451 A			Sequence 1-4 Non-Int in Visit 02	1 Secs (1 Secs) [==>]	[1]	3	STIS EXPO SURE (STIS.sp.11 66374)	(1) -BET-PIC	STIS/NUV-MAMA, ACCUM, 31X0.05NDA	E230H 2812 A	WAVECAL=NO		Sequence 1-4 Non-Int in Visit 02	2101 Secs (2101 Secs) [==>]	[1]	4	WAVECAL WAVE		STIS/NUV-MAMA, ACCUM, 0.2X0.09	E230H 2812 A			Sequence 1-4 Non-Int in Visit 02	[==>]	[1]	5	PEAKXD (COS.sp.116 6426)	(1) -BET-PIC	COS/FUV, ACQ/PEAKXD, PSA	G130M 1291 A	LIFETIME-POS=LP4; SEGMENT=BOTH		Sequence 5-7 Non-Int in Visit 02	1.4 Secs (1.4 Secs) [==>]	[2]	6	PEAKD (COS.sp.116 6426)	(1) -BET-PIC	COS/FUV, ACQ/PEAKD, PSA	G130M 1291 A	STEP-SIZE=0.9; NUM-POS=5; CENTER=DEF; LIFETIME-POS=LP4; SEGMENT=BOTH		Sequence 5-7 Non-Int in Visit 02	1.4 Secs (1.4 Secs) [==>]	[2]	7	COS EXPO SURE (COS.sp.116 6456)	(1) -BET-PIC	COS/FUV, TIME-TAG, PSA	G130M 1327 A	BUFFER-TIME=240; FLASH=YES; FP-POS=ALL; LIFETIME-POS=LP3; SEGMENT=BOTH		Sequence 5-7 Non-Int in Visit 02	2012 Secs (2012 Secs) [==>503.0 Secs (Split 1)] [==>503.0 Secs (Split 2)] [==>503.0 Secs (Split 3)] [==>503.0 Secs (Split 4)]	[2]	Comments: In the ETC run, the strength of the Stellar Lyman-alpha line has been set to an extremely conservative upper limit to calculate the Buffer-time and check the Bright Objects Limit (FWHM=2 Angstrom, Flux=4e-12).									
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