

# ***How Amateur Astronomers Can Support the Juno Mission***

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## Summary

Context

Where amateur can support:  
predicting features locations  
contextual observations

What and when ?

How ?

Take away

## Context

- Arrival at Jupiter **July 2016**
- The mission will investigate Jupiter's Origin, Interior, **Atmosphere** and Magnetosphere.

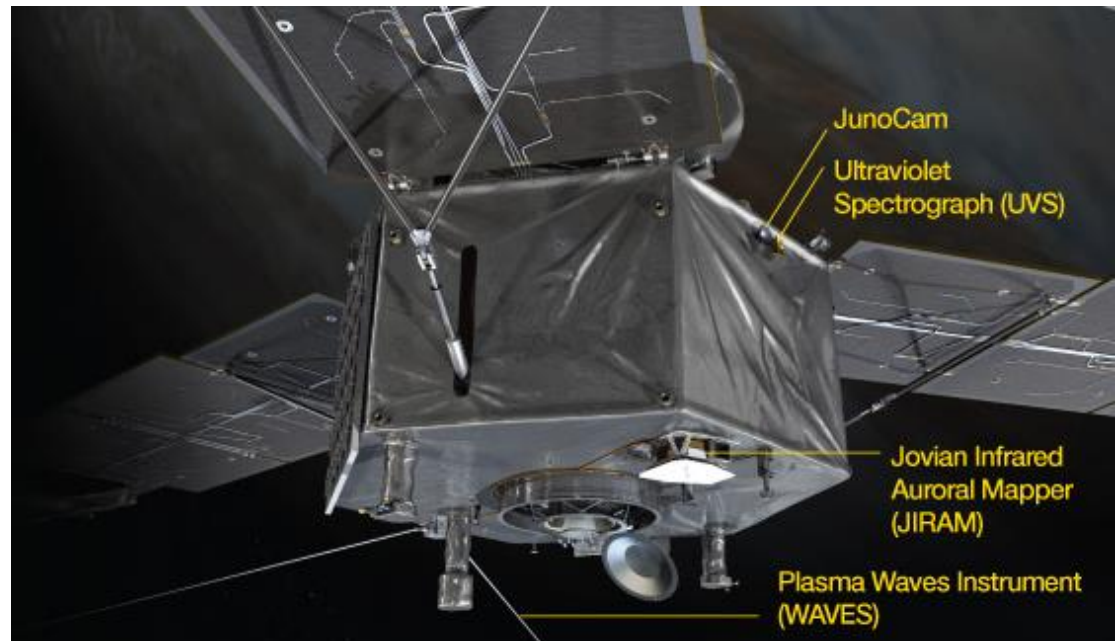
### Remote-sensing instruments:

**Visible cam.** :JunoCam  
no scientific-grade calibration,  
taking images depending on the  
'votes' of the general public.

**Infrared cam.:** JIRAM

**Radio:** MWR

**UV** spectrograph



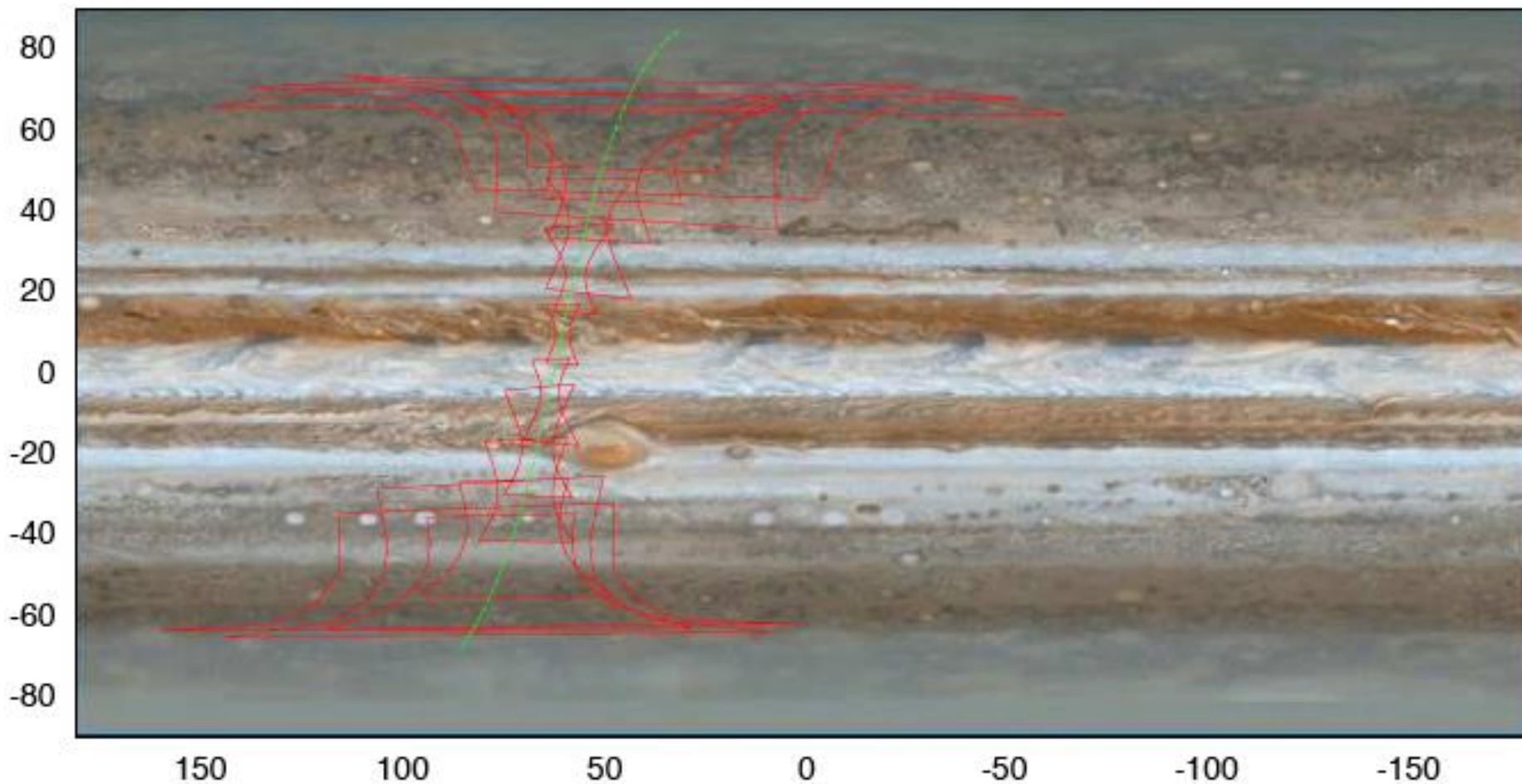
## predicting features locations

- Need to know 3-6 months ahead of the arrival the timing of the initial perijove (PJ)
- Location of features must be based on **predictions** from **data before 2016 Jan-Apr** (the 2015-2016 apparition)
- Use this information to plan initial orbit timing
  - $\pm 20$  min
  - $\pm 12^\circ$  of longitude
- Features of interest:
  - **Great Red Spot** (generally easy to predict)
  - 5- $\mu$ m hot spots (not so easy)
  - ...



## JunoCam longitudinal swath

limited range of longitude (5 to 10°) ...  
orbit 7 -- 2016 Dec 24



**contextual observations over the globe**  
**scientific questions**

- ☐ Is the narrow regions Juno senses **part of wave structure**?
- ☐ Do they represent **global-mean** properties?
- ☐ Are there perturbations in **zonal** (E-W) or **meridional** (N-S) winds?
- ☐ What has been the **evolution** of these features?
- ☐ What is the **relationship** between the properties detected in the **upper** atmosphere and the **deeper** atmosphere?

## Juno's orbits

EVENT	DATE	Elongation
JOI	2016 Jul 5	
Orbit 1C	2016 Aug 27	23°W
Orbit 2 PRM	2016 Oct 19	17°W
Orbit 3 Cleanup	2016 Nov 2	29°W
30-min point	2016 Nov 12	35°W
Orbit 4 PJ	2016 Nov 16	40°W
Orbit 5 PJ	2016 Nov 30	52°W
Orbit 6 PJ	2016 Dec 14	63°W
Orbit 7 PJ	2016 Dec 28	76°W
Orbit 8 PJ**	2017 Jan 11	89°W
Orbit 9 PJ	2017 Jan 25	102°W
Orbit 10 PJ	2017 Feb 8	116°W
Orbit 11 PJ	2017 Feb 22	130°W
Orbit 12 PJ	2017 Mar 8	146°W
Orbit 13 PJ	2017 Mar 22	161°W
Orbit 14 PJ**	2017 Apr 5	176°W
Orbit 15 PJ	2017 Apr 19	172°E
Orbit 16 PJ	2017 May 3	152°E
Orbit 17 PJ	2017 May 17	138°E
Orbit 18 PJ	2017 May 31	124°E
Orbit 19 PJ	2017 Jun 14	110°E
Orbit 20 PJ	2017 Jun 28	97°E

EVENT	DATE	Elongation
Orbit 21 PJ	2017 Jul 12	85°E
Orbit 22 PJ	2017 Jul 26	73°E
Orbit 23 PJ	2017 Aug 9	62°E
Orbit 24 PJ	2017 Aug 23	50°E
Orbit 25 PJ	2017 Sep 5	40°E
Orbit 26 PJ	2017 Sep 19	29°E
Orbit 27 PJ	2017 Oct 3	18°E
Orbit 28 PJ	2017 Oct 17	7°E
Orbit 29 PJ	2017 Oct 31	3°E
Orbit 30 PJ	2017 Nov 14	14°W
Orbit 31 PJ	2017 Nov 28	25°W
Orbit 32 PJ	2017 Dec 12	37°W
Orbit 33 PJ	2017 Dec 26	49°W
Orbit 34 PJ	2018 Jan 9	60°W
Orbit 35 PJ	2018 Jan 23	73°W
Orbit 36 Pjextra	2018 Feb 6	85°W
Orbit 37 Pjextra	2018 Feb 20	99°W
Orbit 35 Deorbit	2018 Mar 6	113°W

\*with MWR-required S/C tilt

Remote-Sensing (MWR) Orbits  
Gravity-Sensing (GS) Orbits

\*Jupiter available for 30 min for airmass<2.0

## what and when ?

Images of the whole disk in **RGB** filters, plus additional filters as possible (e.g. 890 nm “**methane**” and other narrow filters)

- i. **Before**, to **predict** locations of features to help Juno in planning
- ii. At the **same time as the orbit perijoves** for global **context**
- iii. **In between**, to detect **short-term time changes** of atmospheric features, creation of movies
- iv. **After**, to follow up **evolution** of features.

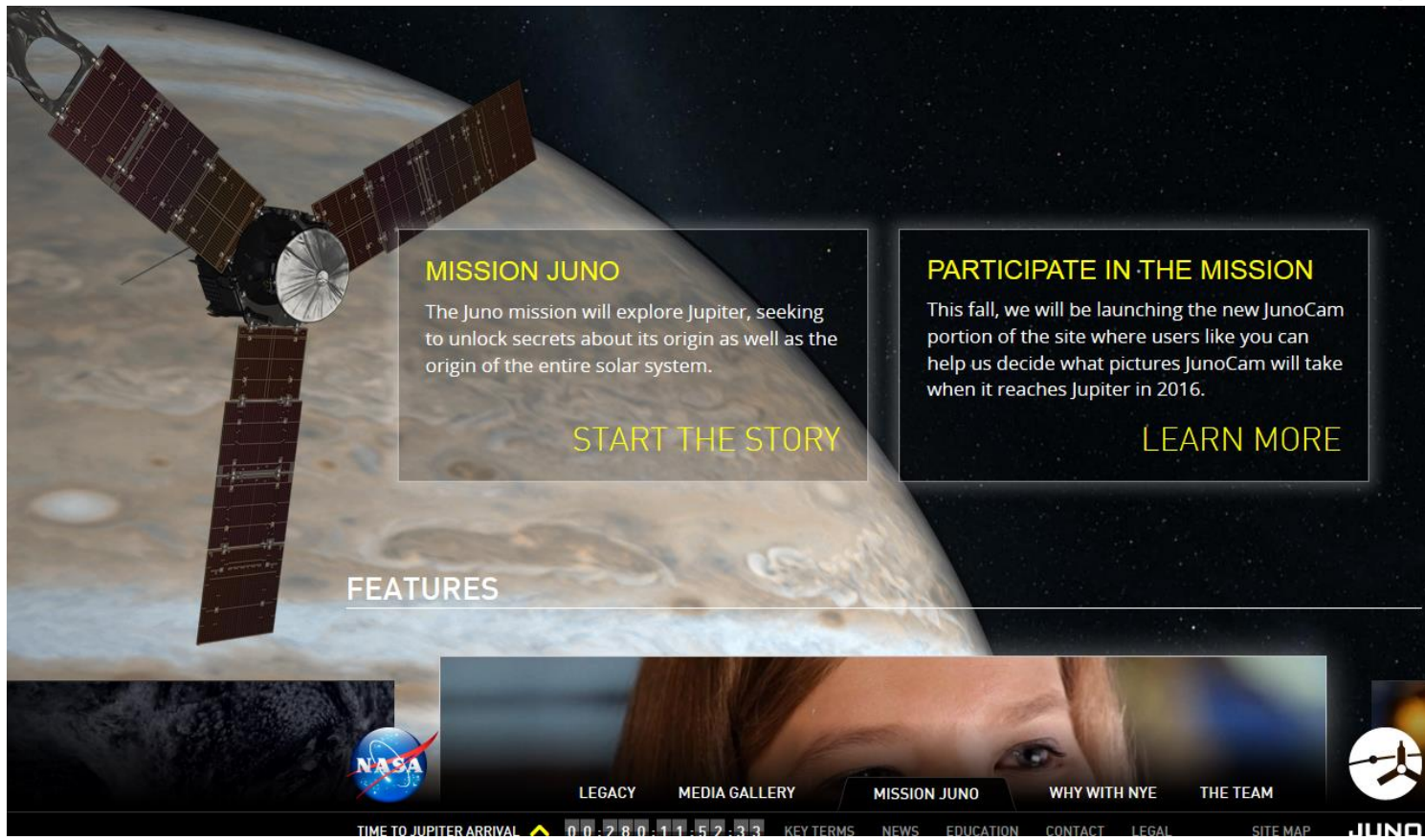
This will also help **building cylindrical maps** of Jupiter for the **voting** of the public on which features to target with JunoCam.



## how ?

“Participe in the mission” on **Juno website** <http://missionjuno.swri.edu/>

**Upload images** in any standard format but for scientific value rather non destructive formats (**PNG, TIF, FITS**), as well as **WinJupos packages**.



(beta screenshots)

## LOGIN

Welcome to Mission Juno Beta!

EMAIL

you@example.com

PASSWORD

LOGIN

[forgot password?](#)

MENU

PROFILE: ALANANDERSON-82

MISSION JUNO : BETA

[send feedback](#)

PROFILE HOME

UPLOADS

SETTINGS

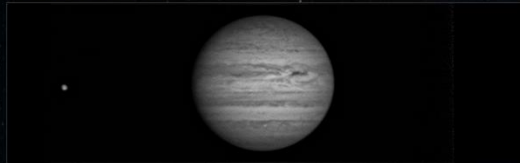
+ UPLOAD DATA

## UPLOADS

Welcome to the uploads section. Here you can view the content you've submitted as well as their approval status.

21 Apr 2015 20:49 UT

PLANNING



INFO

ADMIN ACTIONS

1/1



TIME TO JUPITER ARRIVAL 01:019:22:25:27

LEGAL CONTACT SITE MAP




MISSION JUNO : BETA

PROFILE HOME

UPLOADS

SETTINGS

21 Apr 2015 20:49 UT



INFO

ADMIN ACTIONS

PLANNING

0.114

WAVELENGTH

Infrared

The following are highly encouraged, but not required

DATA ZIP of additional data

Choisissez un fichier

Aucun fichier choisi

DESCRIPTION

ENCOURAGED, BUT OPTIONAL DATA :

CM1°

233.4

CM2°

243.0

CM3°

180.6

OBSERVATION LATITUDE°

use "-" for south

43.57

OBSERVATION LONGITUDE°

use "-" for west

1.32

EXPOSURE LENGTH in seconds

318

MISC. OTHER



Derotation used on several images

SUBMIT DATA

send feedback

+ UPLOAD DATA

PROFILE: ALANANDERSON-82

TIME TO JUPITER ARRIVAL 01:019:22:18:06

LEGAL

CONTACT

SITE MAP

CC BY

12



[illegible]

Upload your images of Jupiter, comment on the images, and vote on what pictures JunoCam will take when it reaches Jupiter.

Upload your telescopic images and data of Jupiter to help the team plan the mission

**GO TO PLANNING**

Create and comment on points of interest in Jupiter's atmosphere

COMING IN FALL

**Vote on points of interest for JunoCam to capture during its orbit of Jupiter**

COMING IN 2016

Browse other users' processed images from JunoCam or download, process, and submit your own images.

COMING IN 2016

We're calling all amateur astronomers to upload their telescopic images and data of Jupiter. These uploads are critical for the upcoming Discussion section (coming this fall) and will help NASA successfully plan the future of the mission.

If you're a veteran astrophotographer or if you're just getting started with your first telescope, we highly recommend you read our Submission Guidelines ([link to pdf](#)) before submitting data. In the PDF you'll find information about the best capture and process workflows as well as links to free software and tutorials.

In the Discussion section, you can select a point of interest in Jupiter's atmosphere and share it with the community or browse through other users' suggestions and comment on them. These points will form the foundation for the voting phase.

This is where the magic happens! During the voting phase you will determine the best locations in Jupiter's atmosphere that JunoCam will capture. You will get a limited number of votes per orbit to devote to your favorite points of interest. You can also track the results as other users cast their ballots too.

Make sure to favorite any points of interest you're following in the Discussion session to know when you can vote on it. We'll even notify (if logged in: [link to notification settings in profile](#), else: [link to sign up page](#)) you when it's time to vote!

Once JunoCam has taken the images you have voted on, we'll post them for you in Processing. From here you can download the raw images, process them with your choice of software and reupload them to the site for other users to view.



## how ?

Usual workflow for amateur imaging:

### Action

### Output

- |  |                            |
|--|----------------------------|
| a. <b>Acquisitions</b> with one filter                                     | acquisition movies         |
| b. <b>Alignment+Stacking</b> of the best frames (ex: <i>Autostakkert</i> ) | stacks w/ Jupiter centered |
| c. <b>Enhancement</b> of stacks (ex: <i>Registax</i> wavelets)             | enhanced images            |
| d. <b>Calibration</b> of image (Measurement in <i>WinJupos</i> )           | calibrated images          |
| e. <b>Derotation</b> of images ( <i>WinJupos</i> )                         | one single derotated image |

or:

- |   |                               |
|---|-------------------------------|
| a1. One single long <b>acquisition</b> with one filter            | one acquisition movie         |
| a2. <b>Calibration</b> of video (Measurement in <i>WinJupos</i> ) |                               |
| a3. <b>Derotation</b> of video ( <i>WinJupos</i> )                | one single derotated image    |
|   | raw stack image calibration   |
| b1. <b>Stacking</b> of the best frames (ex: <i>Autostakkert</i> ) | one stack w/ Jupiter centered |
| c1. <b>Enhancement</b> of stack (ex: <i>Registax</i> wavelets)    | one enhanced image            |

## how ?

Optionnaly for **uploading of raw images** for the Juno team:

### Action

- a. **Acquisitions** with one filter
- b. **Alignment+Stacking** of the best frames (ex: *Autostakkert*)
- c. **Enhancement** of stacks (ex: *Registax* wavelets)
- d. **Calibration** of image (Measurement in *WinJupos*)
- d2. Load of b. raw stack in d. calibrated images**
- e. **Derotation** of images (*WinJupos*)

### Output

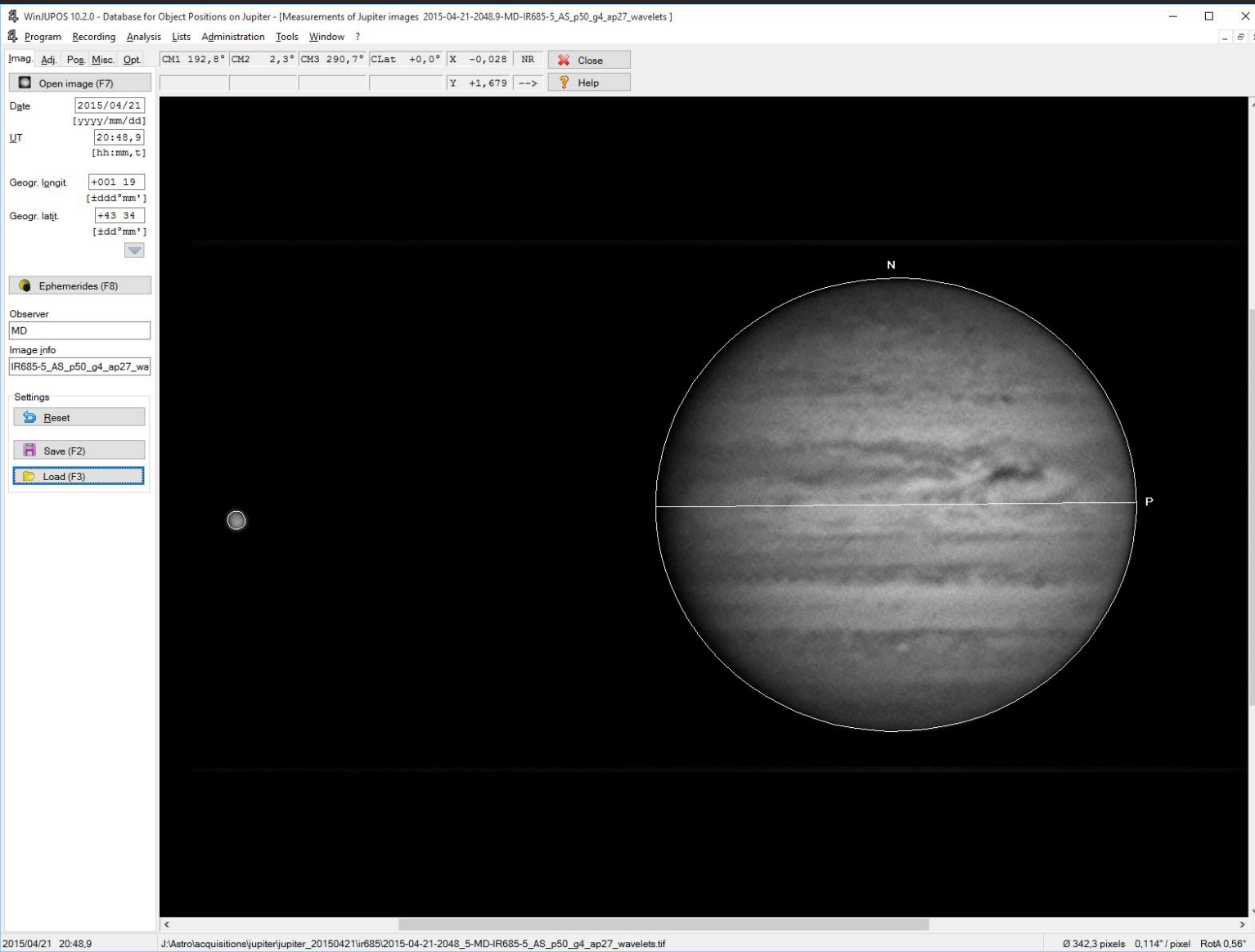
- acquisition movies
- stacks w/ Jupiter centered
- enhanced images
- calibrated images
- raw calibrated images**
- one single derotated image

Alternatively:

- a1. One single long **acquisition** with one filter
- a2. **Calibration** of video (Measurement in *WinJupos*)
- a3. **Derotation** of video (*WinJupos*)
- b1. **Stacking** of the best frames (ex: *Autostakkert*)
- c1. **Enhancement** of stack (ex: *Registax* wavelets)

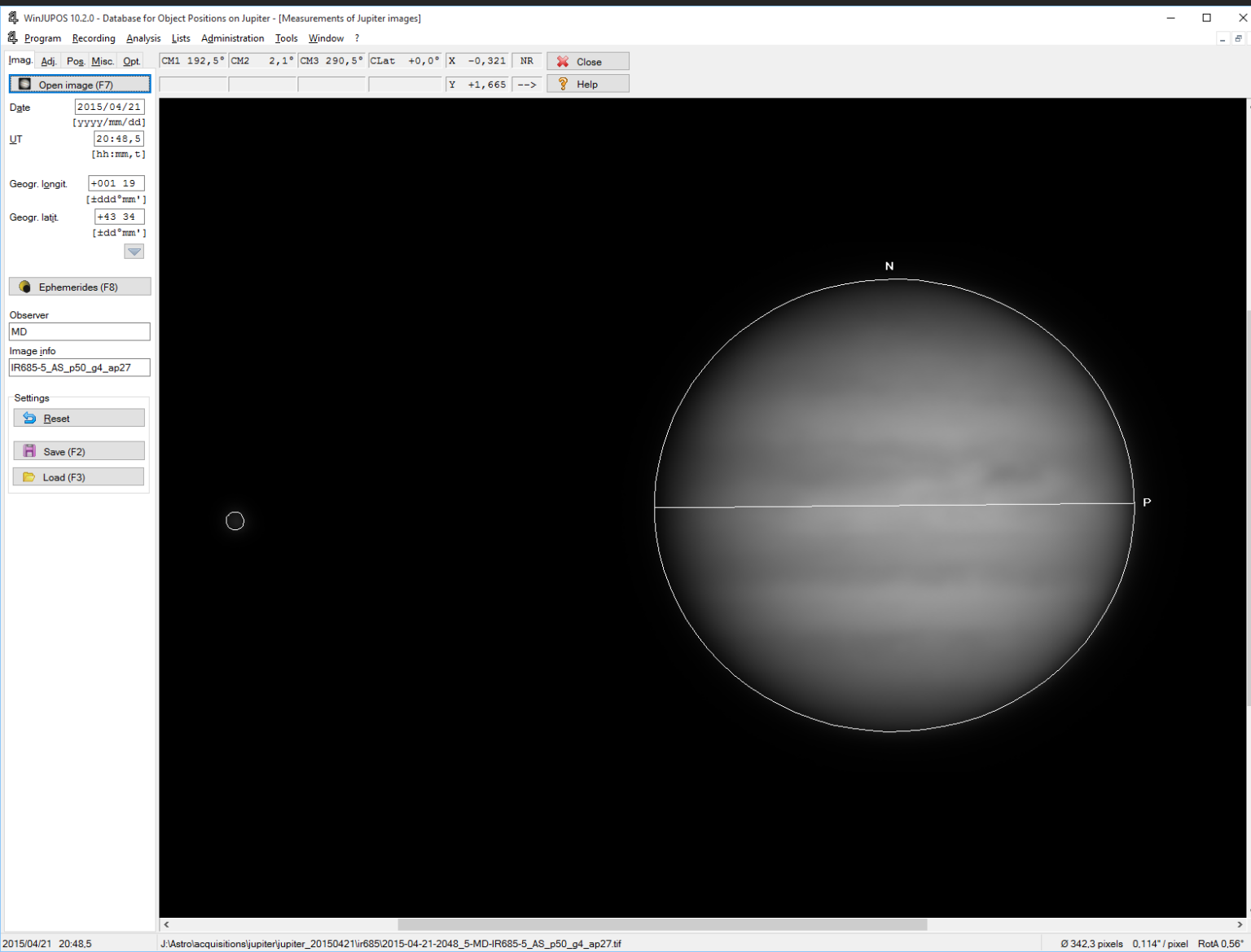
- one acquisition movie
- one single derotated image
- raw calibrated image**
- one stack w/ Jupiter centered
- one enhanced image

## how to calibrate raw image (1/2)



Phase d.

## how to calibrate raw image (2/2)



Phase d2.

## how to create transmission package to be uploaded as zip file on Juno website

WinJUPOS 10.2.0 - Database for Object Positions on Jupiter - [Measurements of Jupiter images]

Program Recording Analysis Lists Administration Tools Window ?

Imag. Adj. Pos. Misc. Out. CM1 192,5° CM2 2,1° CM3 290,5° CLat +0,0° NR Close

Distance --> Help

Measure distance

Map computation  
Template settings (global)

Compile map (F12)

Create transmission package

Choose folder for transmission package

Rechercher dans : Neptune

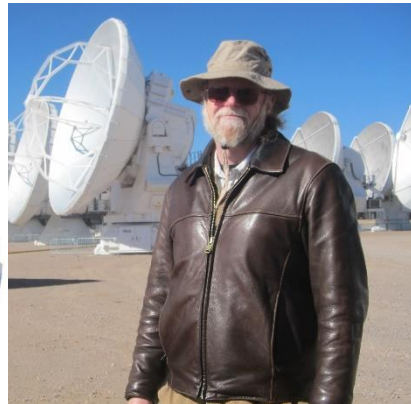
Nom	Modifié le	Type	Taille
Articles	26/04/2015 20:32	Dossier de fichiers	
charts	22/09/2015 00:04	Dossier de fichiers	
drifts	09/08/2015 13:03	Dossier de fichiers	
Img2013	06/11/2014 11:20	Dossier de fichiers	
Img2014	11/08/2015 22:07	Dossier de fichiers	
Img2015	22/09/2015 17:03	Dossier de fichiers	
macros	12/11/2014 14:53	Dossier de fichiers	
measures	21/09/2015 23:52	Dossier de fichiers	
Pro	30/07/2015 16:14	Dossier de fichiers	
selections	21/09/2015 23:43	Dossier de fichiers	
Travaux	14/09/2015 16:12	Dossier de fichiers	
Windprofile	04/08/2015 07:27	Dossier de fichiers	

Dossier: Sélectionner un dossier Annuler

Ø 342.3 pixels 0.114" / pixel RotA 0.56"

## Take away

- Amateur coverage needed before arrival, during and around perijoves by Juno team (2016-2018)
- Upload required of these images on dedicated webpage
- Useful for predicting interesting features locations and understanding global context of Juno's observations



**JUNO WANTS YOU !**