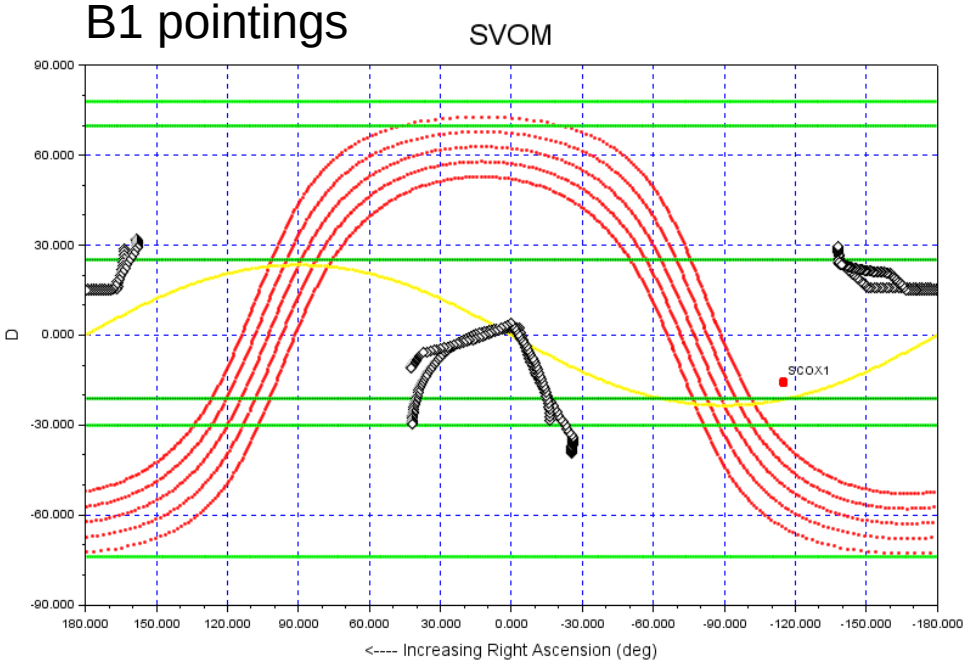
# Attitude law evolution

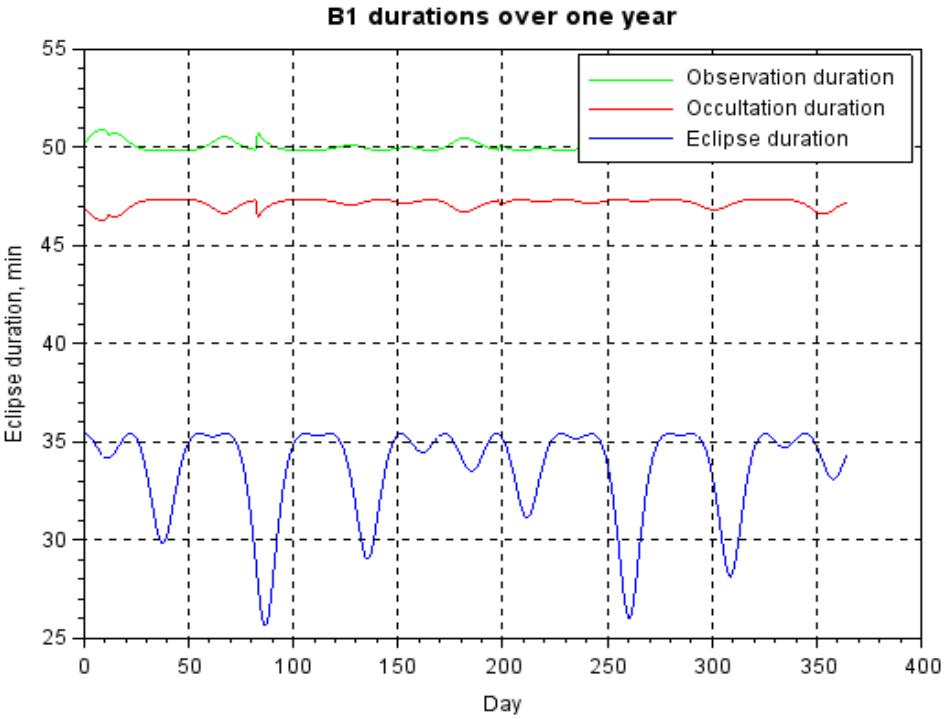
Vincent MORAND
CNES
09/2015

# Goal

- ⇨ Current situation: one pointing each day following B1 attitude law
- ⇨ VT/MXT observation impossible during 48% of the mission due to earth occultation (over one year, 190 days of observation, 175 days of occultation)
- ⇨ Could we do more than one pointing/orbit to increase VT/MXT observation time?

B1 pointings



# Constraints: hypotheses

- A direction in the sky can be seen if :
  1. The angle w.r.t to Sun direction is >90°
  2. The angle w.r.t to Earth limb is >= 20° (NB : Earth apparent angle is ~68°)
  3. P/F constraints w.r.t Sun can be met (SUN in –Xs/+Z quarter of plane)

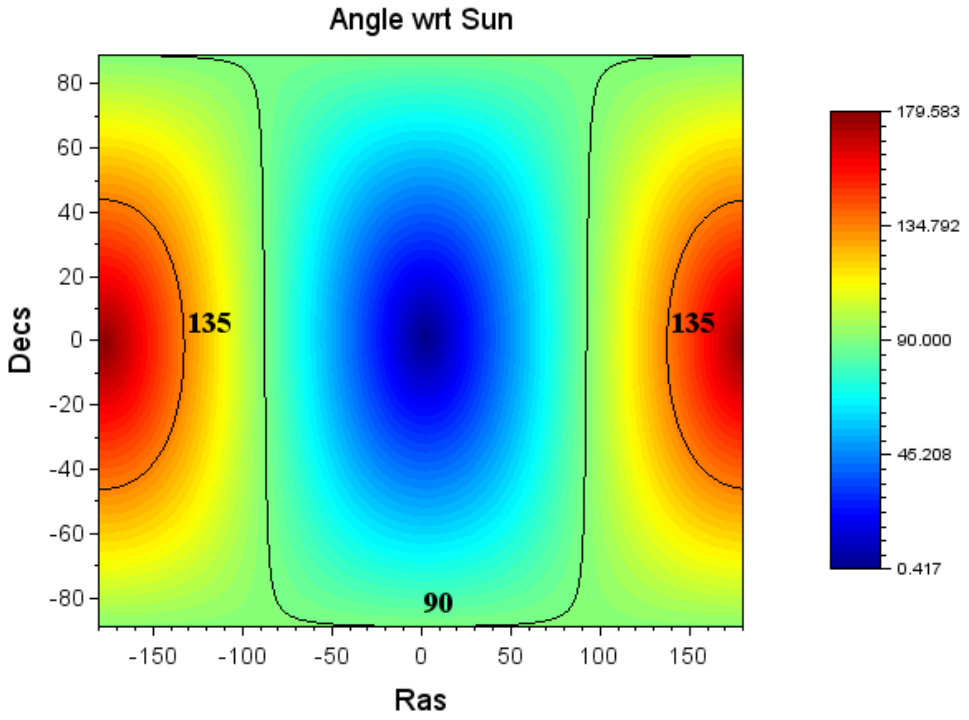
  → We can demonstrate that 3. is OK whenever 1. is

- Results are very sensitive to Earth guard angle:
  - ☑ Angle < 22° → Direction perpendicular to the orbit plane can be seen continuously
  - ☑ Angle > 22° → No such directions with continuous observation

- Results depend on date and initial Right Ascension of Ascending Node, that will be known only after launch

# Sun constraint

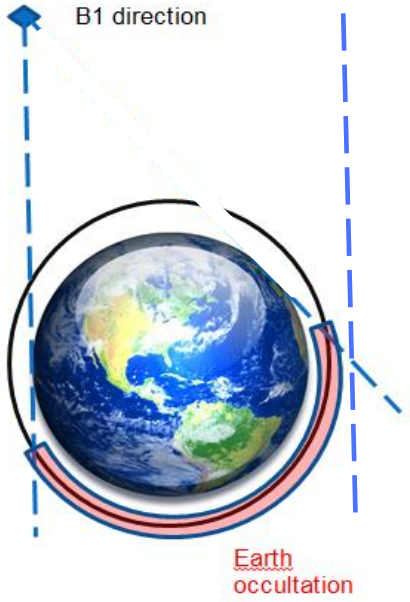
⇨ Angle between SUN and all directions in the sky (1 deg² pixels) at t0

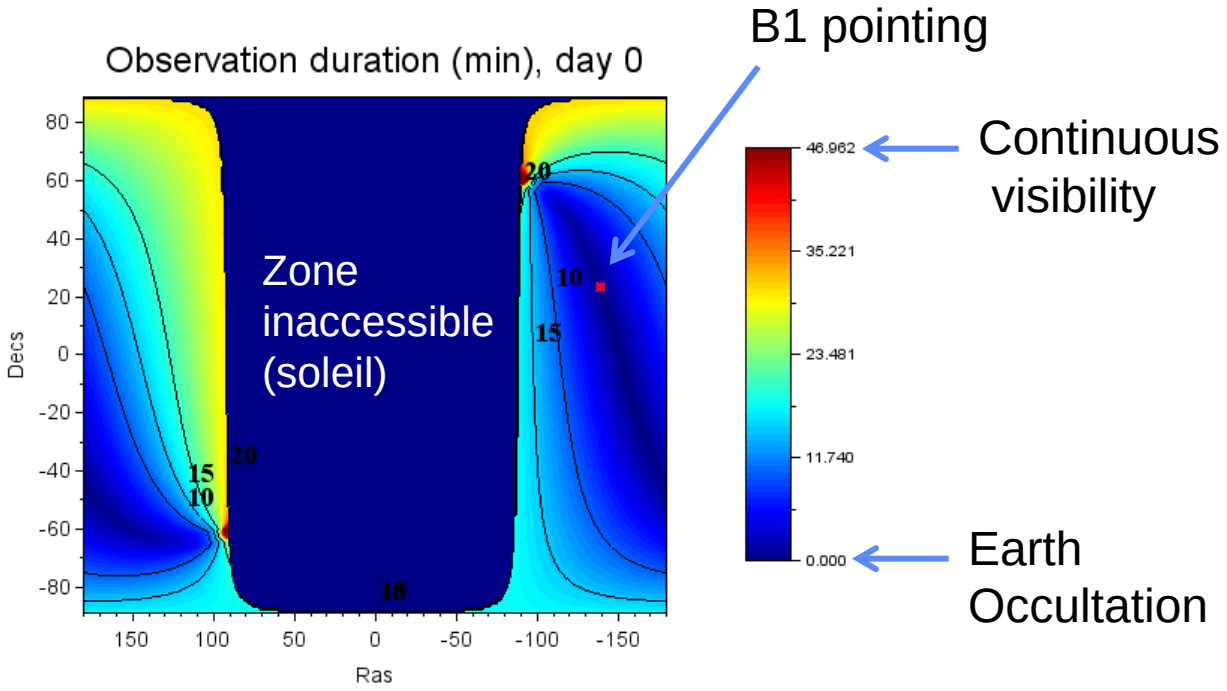



⇨ Half of the sky can be observed when considering only Sun constraint(angle > 90°)

# Observation duration – first day

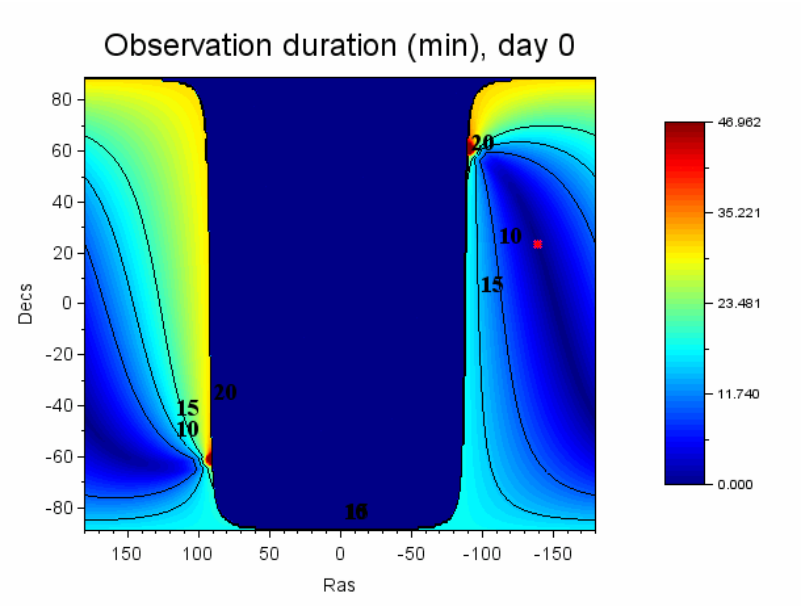
- We are interested in the « useless » part of the orbit where we have Earth occultation when using B1 attitude (duration ~47 min)
- We plot the observation durations we can have on this orbital arc for each pixel of the sky

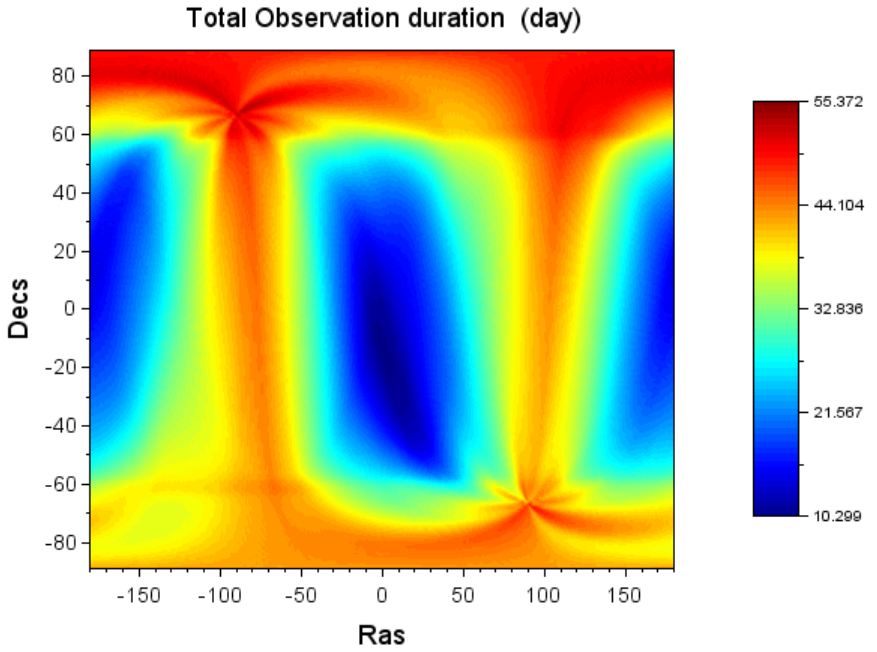


# Observation duration over 1 year

- ⇨ We compute the results each day over 1 year
  - ☑ All the sky is observable
  - ☑ Maximal observation duration vary from 10 to 55 days

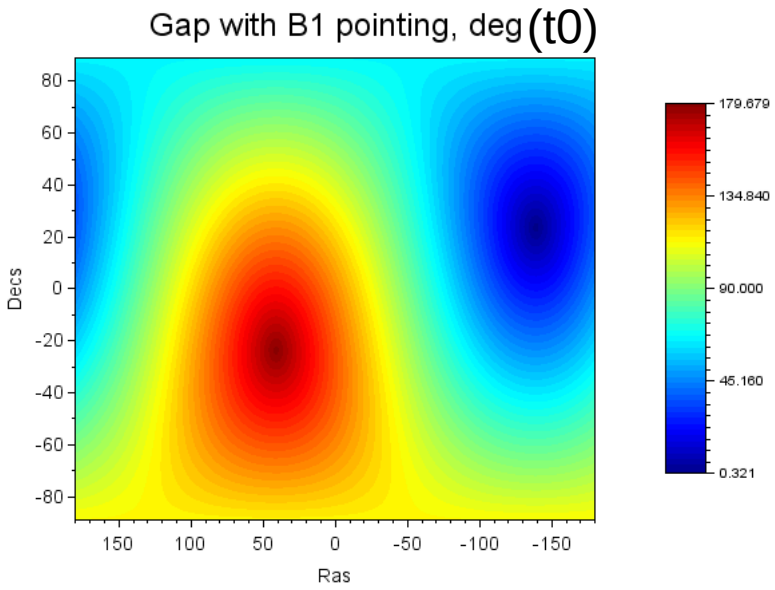


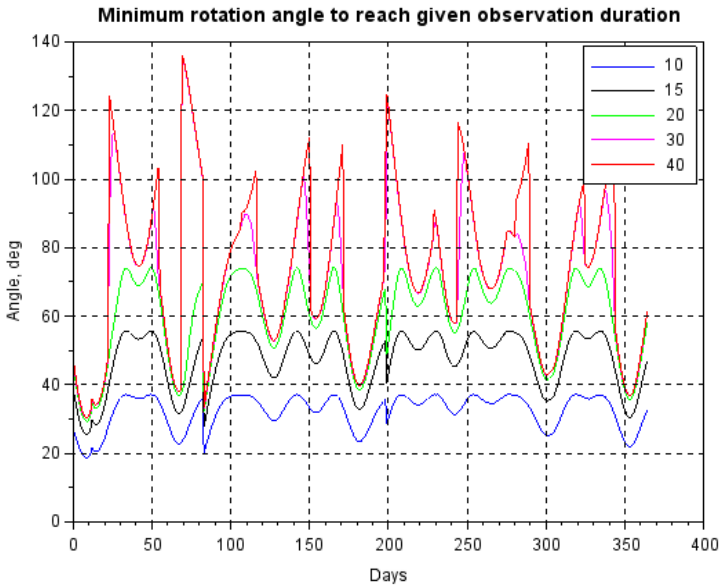




- ⇨ These durations does not take slew durations into account (yet, see next slides)

# Gap with B1 law

- ⇨ At any time it's easy to compute the angular gap with B1 pointing
- ⇨ For information we plot the minimum rotation angle necessary to get a given observation duration, for each day of the year




(min)

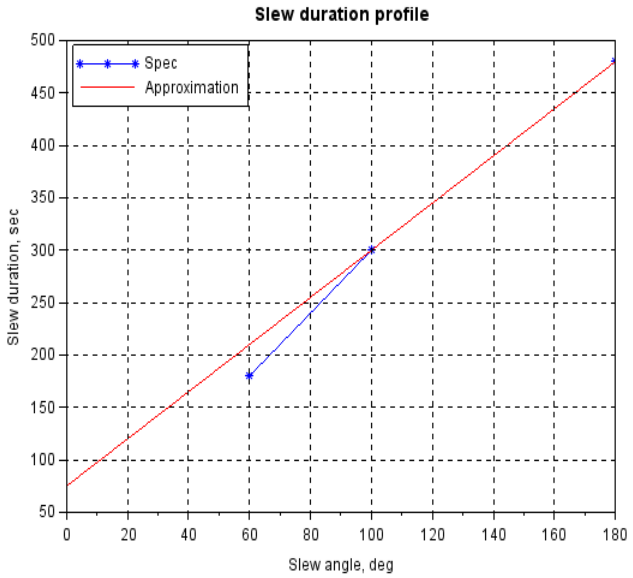
- ⇨ A profile slew_duration = f(slew_angle) is now needed

# Slew duration profile

SAT__SV-SC-DF-036-SECM:

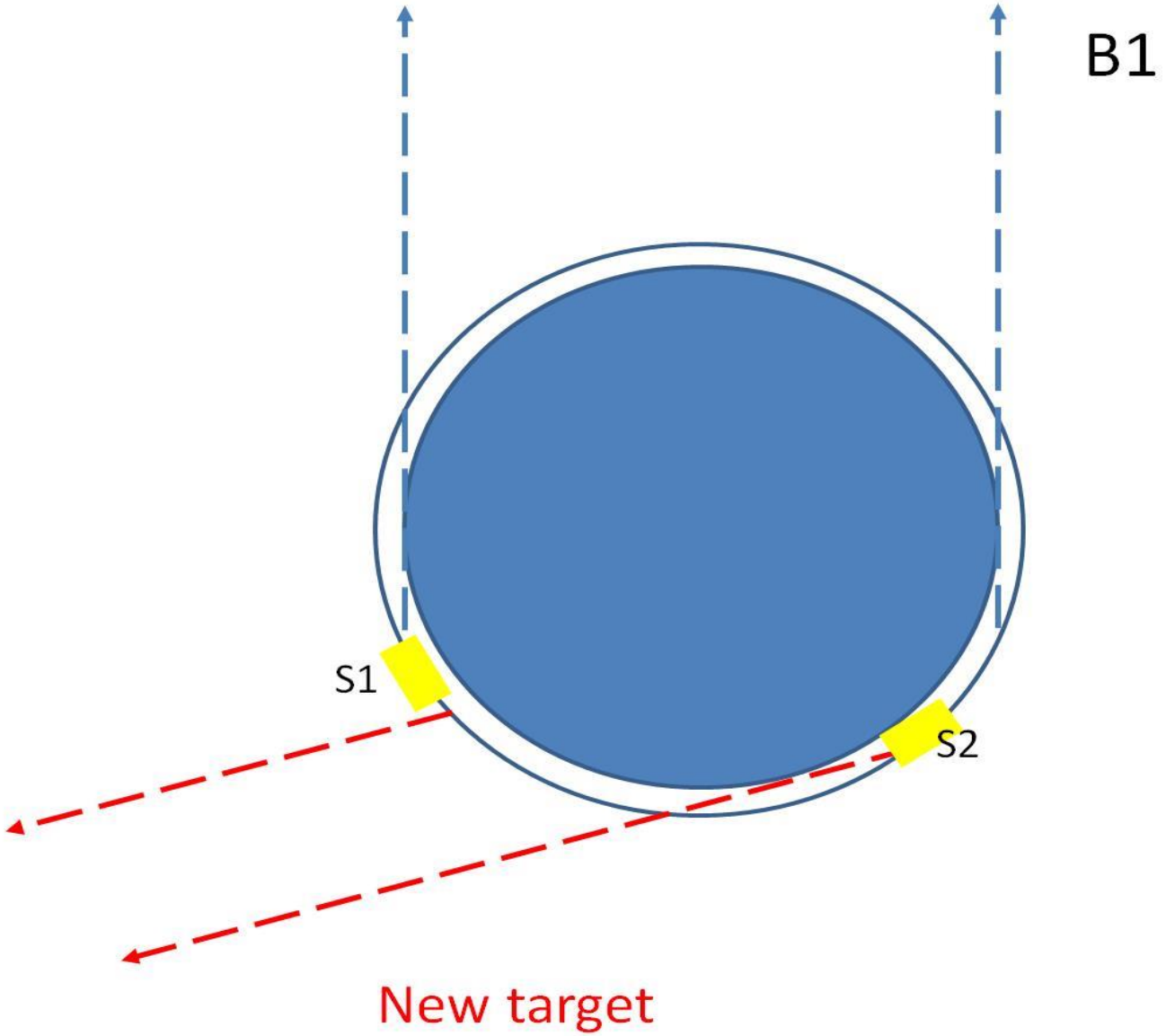
| Attitude Slew Requirement | | | |
|---|---|---|---|
| **Xs slew** | azimuth:±45°, elevation: ±45° | Xs | When GRB happening |
| **In 5 min** | 100° | Space axis | Completing Slew & settle down in command time |
| **In 3 min** | 60° | | |
| **In 8 min** | 180° | Xs | |

!!! First basic approach to be confirmed!!!




$$t_{slew}(s) = 75 + 2.25 * \alpha(deg)$$

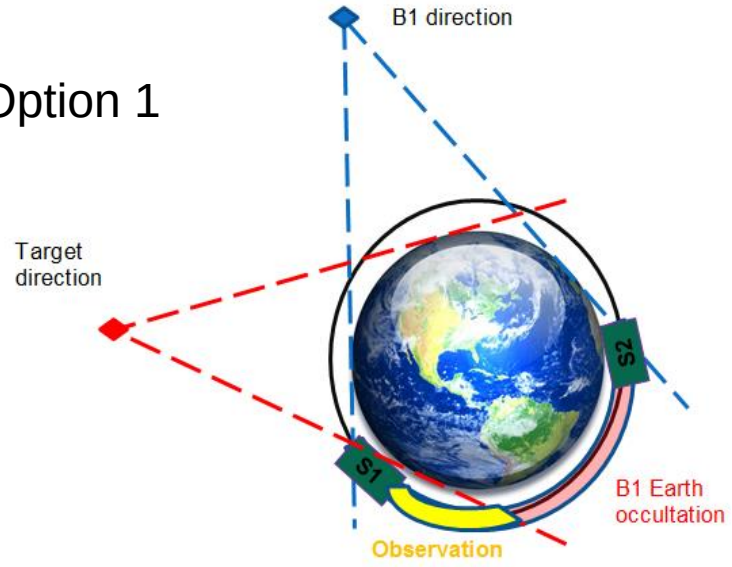
Evolution de la  loi d'attitude

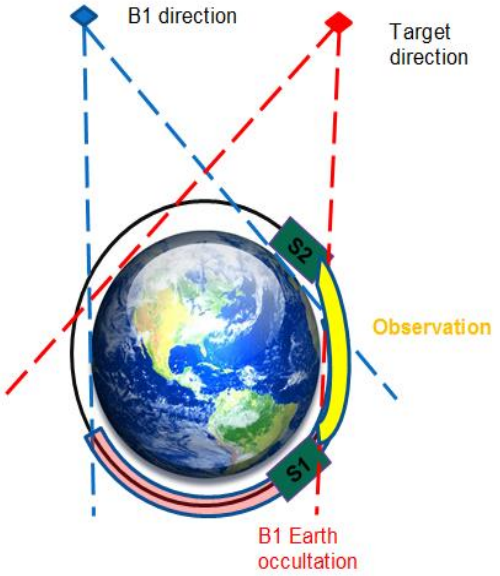


# Slew position on the orbit

- ⇨ Option 1 : « maximizing » B1 observation time
  - ☑ Slew during Earth occultation time only
  - ☑ Observation duration of the new target is reduced by a duration ϵ [0, 2*s] (s = slew duration)
- ⇨ Option 2 : given observation time for the target
  - ☑ Slew before and after target observation, even out of Earth occultation
  - ☑ B1 observation duration is reduced
  - → **Option 2 is not preferred**

Option 1

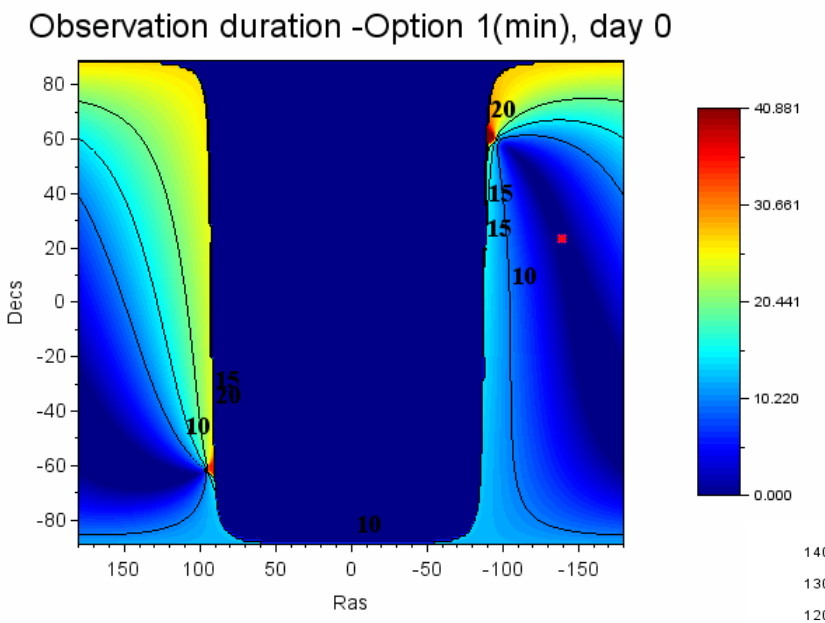


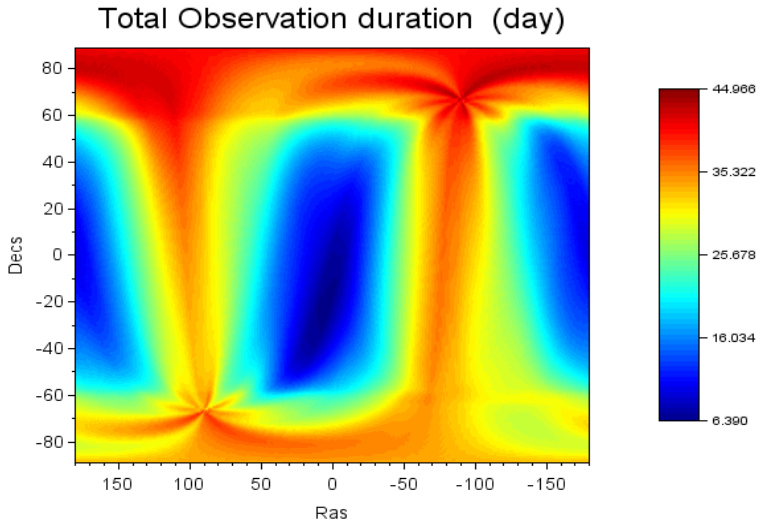



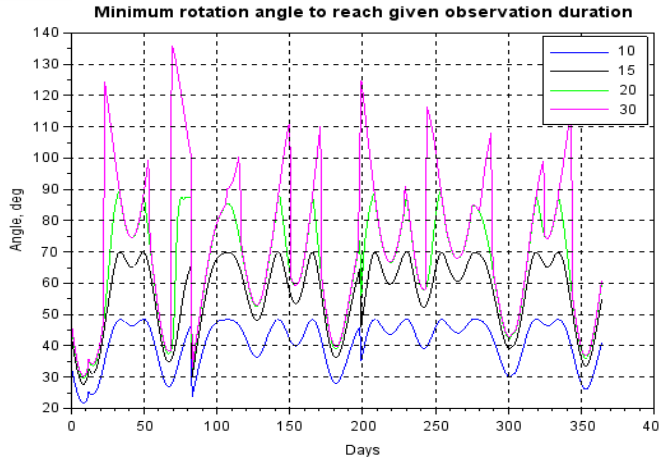

Option 2

# Results for Option 1

Observation durations taking slew manoeuver into account. Slews occur only during Earth occultation for B1 pointing

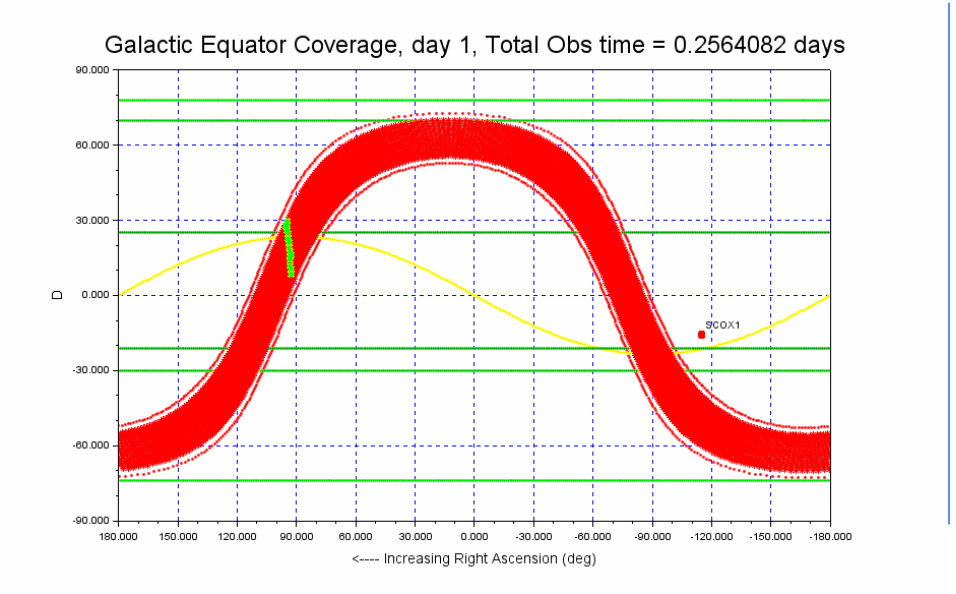


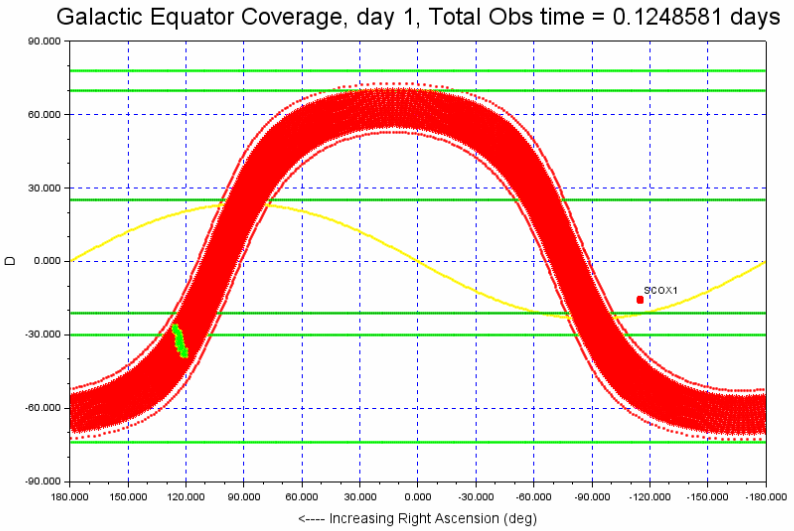



# Example of observation strategy (1/2)

- Goal is to observe the galactic plane +/- 7° over one year, with 1 pointing (assumed with 1 deg² of FOV) during Earth occultation for each orbit
  - ☑ 365 * 15 = 5475 targets
  - ☑ Selecting which target should be observed at which orbit is a **complex programmatic problem**. Here are two simple solutions **that are not optimum** (Images are animated gif, final results on next slide)



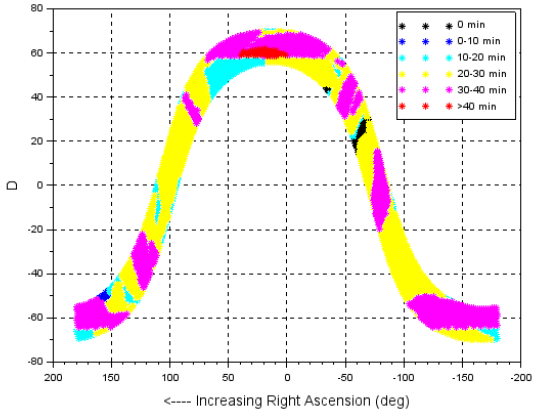



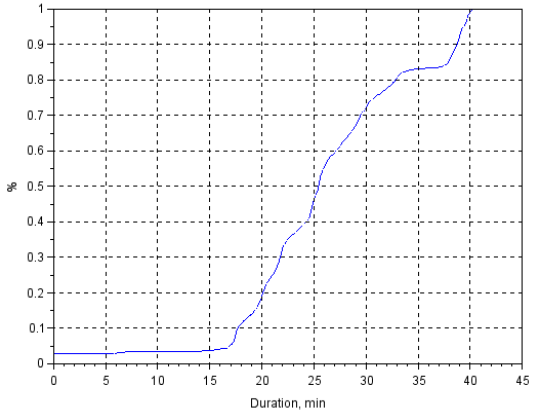

Red : area of interest
Green : FOV (pointings…)

# Example of observation strategy (2/2)

## ⇨ Final results with repartition of observing durations

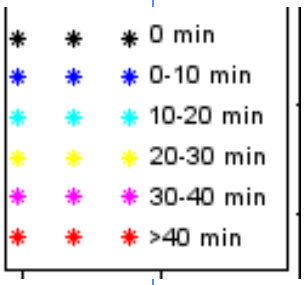
Galactic Equator coverage, Obs time= 99.058005Days



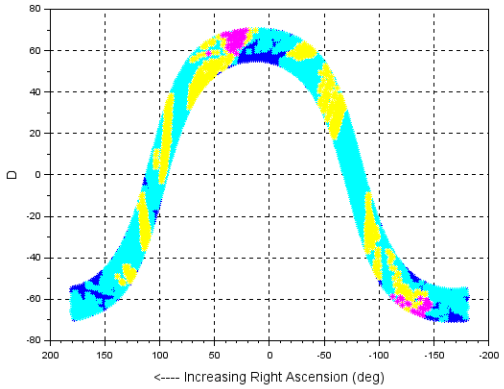



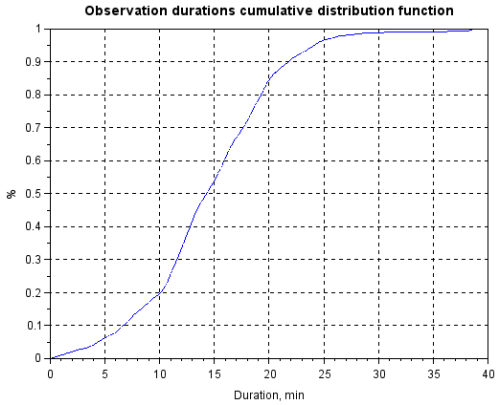

- Almost complete coverage (97%)
- Total of 99 days of observation duration
- Total observation time goes 190 days to 289 days

→ **Gain = 52 %**




Galactic Equator coverage, Obs time= 55.045416Days




- **« Complete » coverage**
- Total of 55 days of observation duration
- Total observation time goes 190 days to 245days

→ **Gain = 29 %**

**NB: the observation sequencing has not been optimized**

# Conclusion

- This is only a geometrical analysis
  - ☑ TBC: slew duration
  - ☑ Thermic aspects, power budget, memory… to be assessed
  - ☑ Moon constraint should be added?
- The slew shall be done during Earth occultation to minimize impact on B1 observation durations
- Target choices is TBD by science
- Examples of gain over 1 year
  - ☑ Cover 97% of galactic plane +/- 7° : Total observation time goes from 190 days to 289 days (+99 days) → Gain = 52 %
  - ☑ Cover 100% of galactic plane +/- 7°: Total observation time goes from 190 days to 245 days (+55 days) → Gain = 29 %
  - ☑ Optimum to be found if necessary

# SVOM science Wokshop in les Houches

- In order to promote the mission and to inform the scientific community we plan to write a SVOM white paper.
- In order to prepare the first draft of this paper we plan to organize a workshop at Chamonix Mont-Blanc (Ecole des Houches) next year from April 10 to April 15.
- The title of the workshop is: The Deep and Transient Universe in the SVOM Era: New Challenges and Opportunities.
- This workshop will also be a great opportunity to gather the SVOM science community for the first time.
- If you are interested please send an email to: svom2016@gmail.com before September 30
- SVOM science meeting in Paris to prepare this workshop (end of November)