Integral

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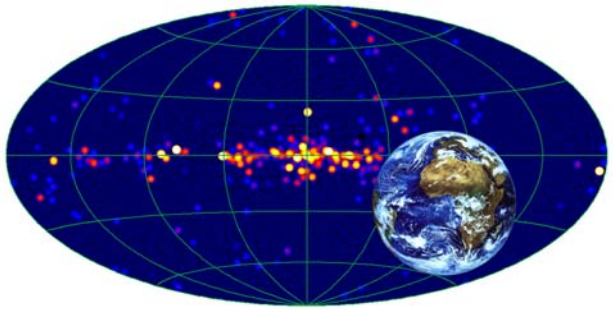
Integral Users Group (Earth Observation)

Integral Earth Observation 2006

- **To Recap:**
  - **4 earth observations in 2006, duration about 30ks each**
  - **Executed post perigee**
  - **Satellite attitude fixed (reference Sun and Gyroscopes) with STR 'blind'**
  - **Orbital motion meant that earth drifted through FoV**
  - **Well defined procedure easy to repeat**



Integral Earth Observation 2

- **What has changed since then?**
  - **MOC team has halved in size**
    - **3 engineers, was 6**
    - **1 analyst, was 2.**
    - **Controllers shared with XMM, were dedicated**
  - **Earth observation proposal 2 is more ambitious**
    - **More observations**
    - **Proposed different observing mode**
    - **Different areas of sky to be observed.**
  - **The orbit of Integral is evolving, in particular the inclination and the longitude of the ascending node are critical for the proposed observations.**
  - **Due to current staffing problems in the FCT an observation in the first 9 months of 2011 is not feasible.**

Integral EO 2 - Proposal

- **EARTH OBSERVATION WITH INTEGRAL: COSMIC X-RAY BACKGROUND, EARTH EMISSION AND GALACTIC RIDGE**
- **Since the MOC team is much reduced a sequence of 16 observations (possibly being executed at night) is a significant load.**
  - **Can the total number of observations be reduced by executing longer observations?**
  - **Requested is 16 * 30ks, What about 8 * 60ks?**
  - **Or a combination of shorter and longer observations?**
  - **MOC have examined the possibility of extended observations**

Integral EO 2 – Slew Type Observation Proposal

- **The proposal requested:**
  - *"An alternative observation strategy would be to perform long slews across the location of the Earth from a position near the apogee of the orbit."*
- **Significant preparation time – FD and FCT**
- **Manpower resources / expertise currently not available at MOC**
- **STR earth constraint is 15degrees, during slew the STR would be blinded for up to 34 degrees**
  - **Attitude reconstruction, less accurate than in 2006**
- **Minimum slew speed used to date is 150deg / hour, use of a slower speed would require a dedicated test campaign with the real satellite – loss of further science time!**

Integral EO 2 – Slew Type Observation Proposal

- At low slew speeds the attitude is likely to become less stable
  - Attitude reconstruction more difficult, larger errors
  - The attitude construction will also be affected by the long STR blinding time
  - Larger corrections at the end of each slew, possible Open Loop slew corrections will be necessary, leading to more dead time.
- Conclusion: this type of observation can only be supported if additional significant manpower is made available to MOC
  - FCT acquisition of experience and expertise
  - FCT development of procedures and testing
  - FD development of slew strategy and testing and attitude reconstruction

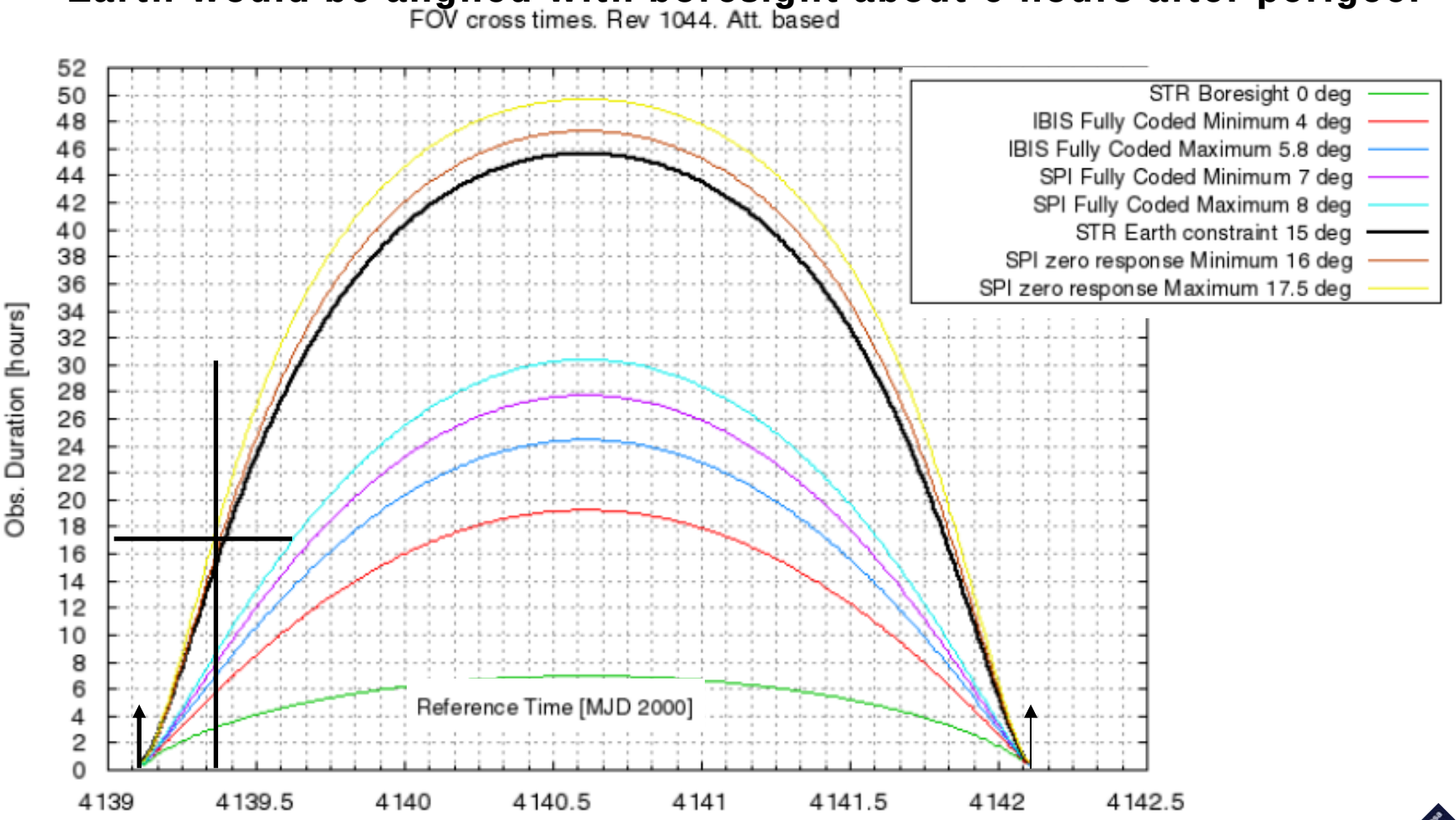
Integral EO 2 – Duration

- **FD study to determine EO duration for EO centred on different times in revolution**
- **Assumptions:**
  - **EO starts at the moment the earth impinges on the SPI zero response region**
  - **EO ends at the moment the earth leaves the SPI zero response region**
  - **SPI zero response region:**
    - Maximum 17.5DEG half cone
    - Minimum 16DEG half cone
  - **Other relevant FoV:**
  - STR Earth constraint 15DEG half Cone
  - SPI Fully Coded Maximum 8DEG Half cone
  - SPI Fully Coded Minimum 7DEG Half cone
  - IBIS Fully Coded Maximum 5.8DEG Half cone
  - IBIS Fully Coded Minimum 4DEG Half cone

Integral EO 2 – Duration

Revolution 1044, Observation Duration of 17 hours.

Earth would be aligned with boresight about 6 hours after perigee.



Integral EO 2 – Duration

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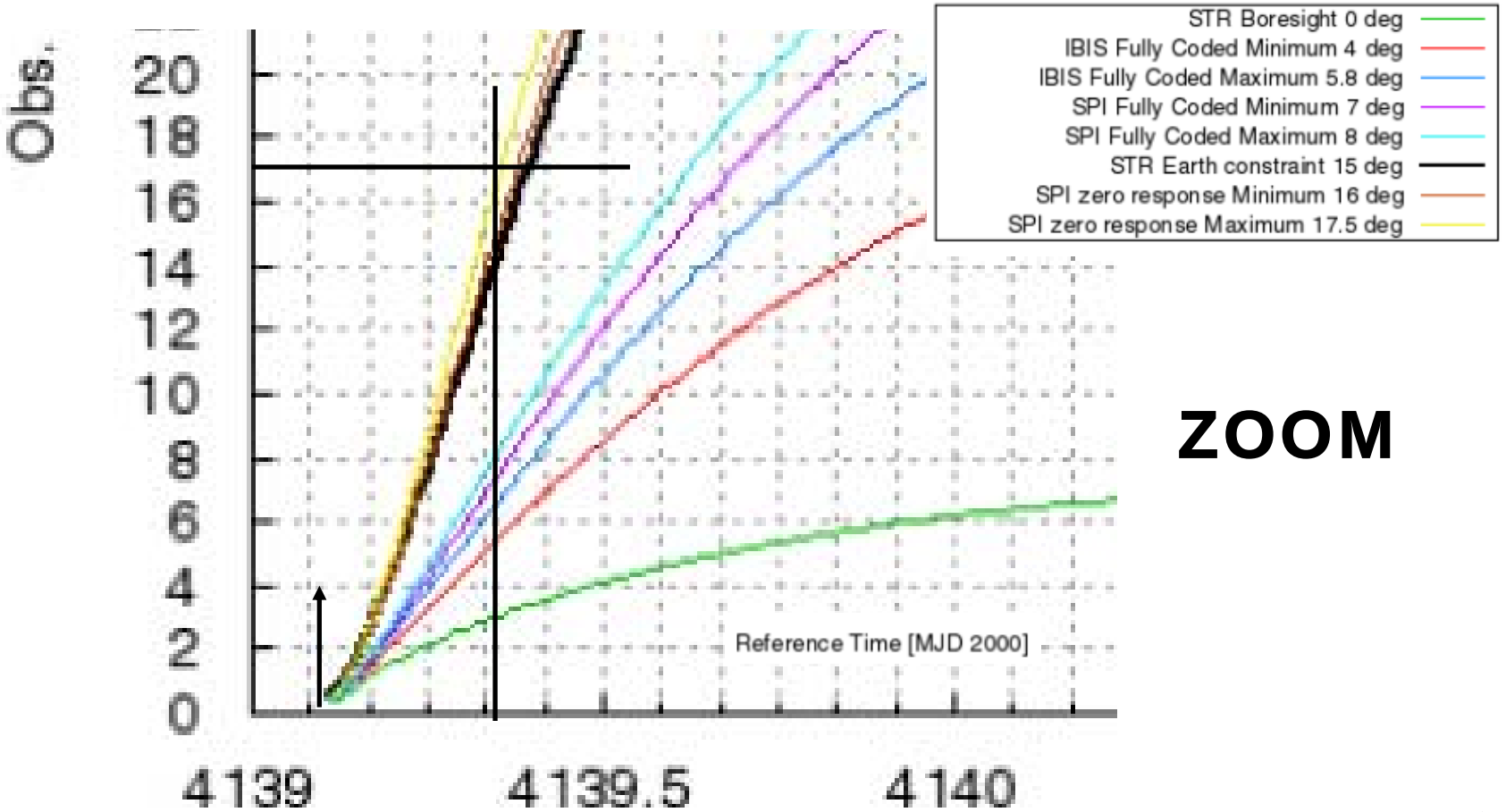
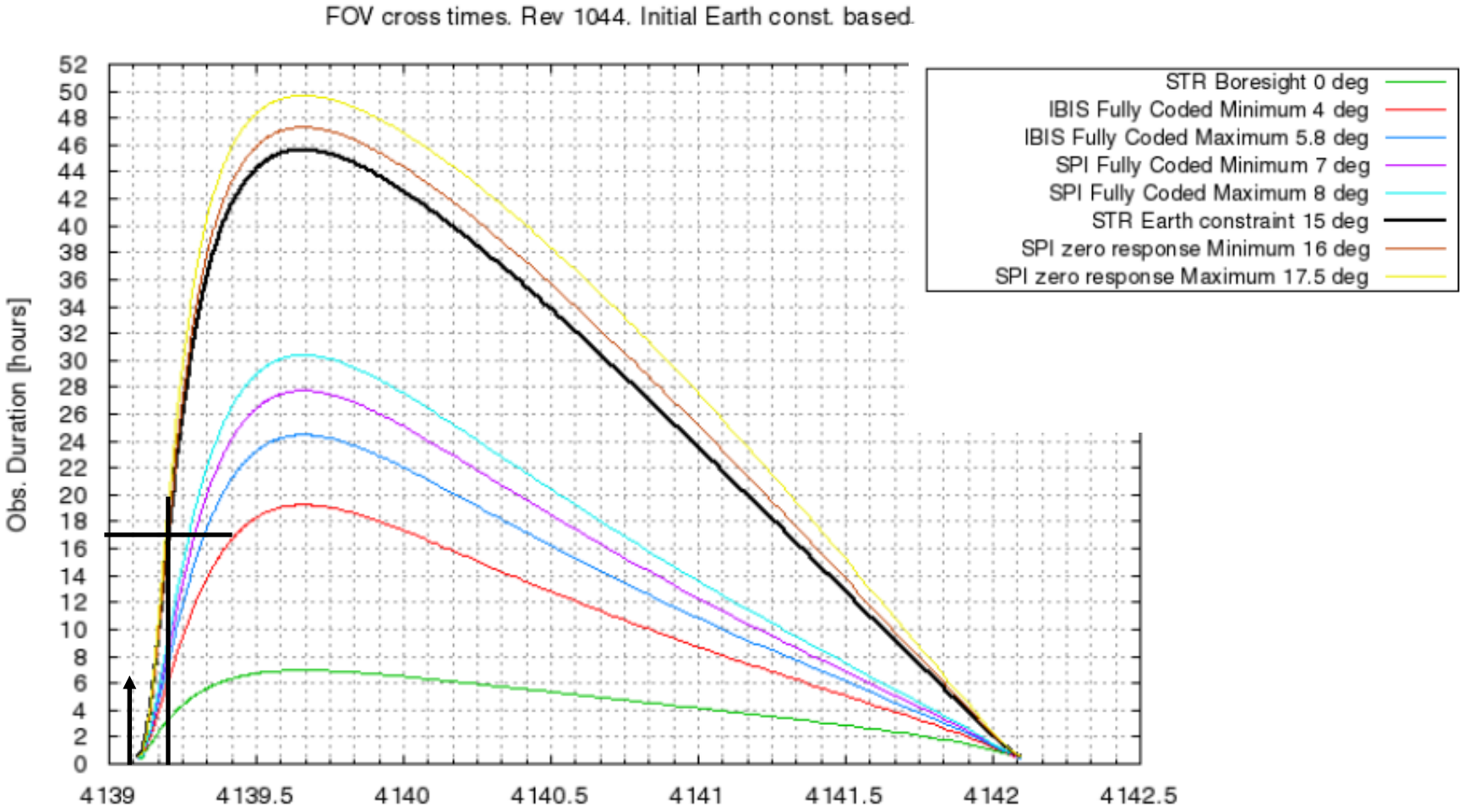


ZOOM

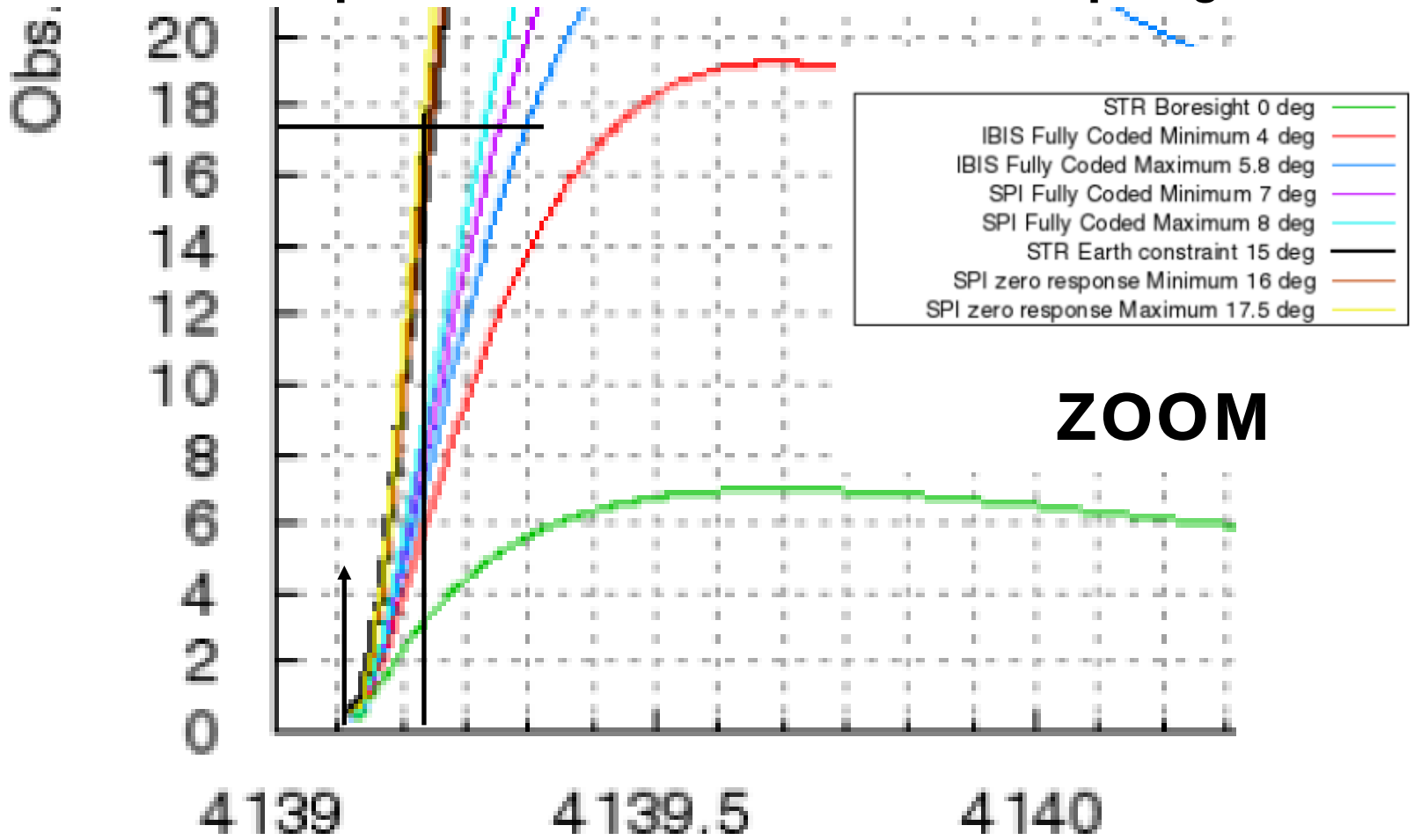
Integral EO 2 – Duration

Need to be on position latest 3 hours after perigee

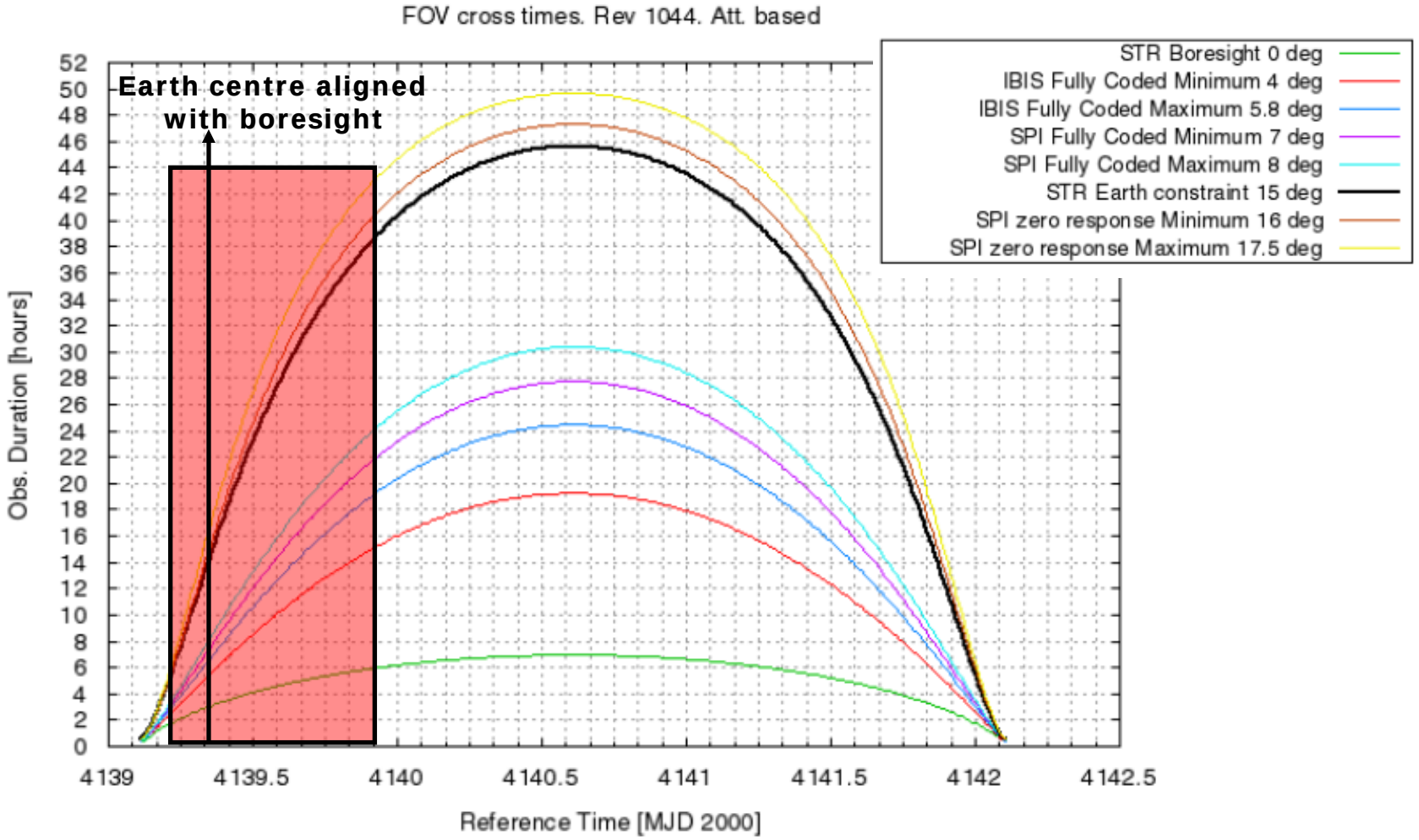


Integral EO 2 – Duration

Need to be on position latest 5 hours after perigee



Integral EO 2 – Duration



Integral EO 2 – Duration

From R. Krivonos:

- *“The observation should begin with Earth outside the (SPI) FOV, let's name it as "off" pointing, and finish with the "off" pointing, when Earth is outside the FOV.*

  The best configuration is when just before and immediately after the observation of the Earth (in the FOV) one observes the same regions of the sky with a comparable exposure. This allows the best interpolation of the background. From this point of view a 3-steps pattern off+on+off makes an ideal "observation" with comparable exposure for "on" and two "off" (together) (e.g. 1 hour + 2 hours + 1hour).”

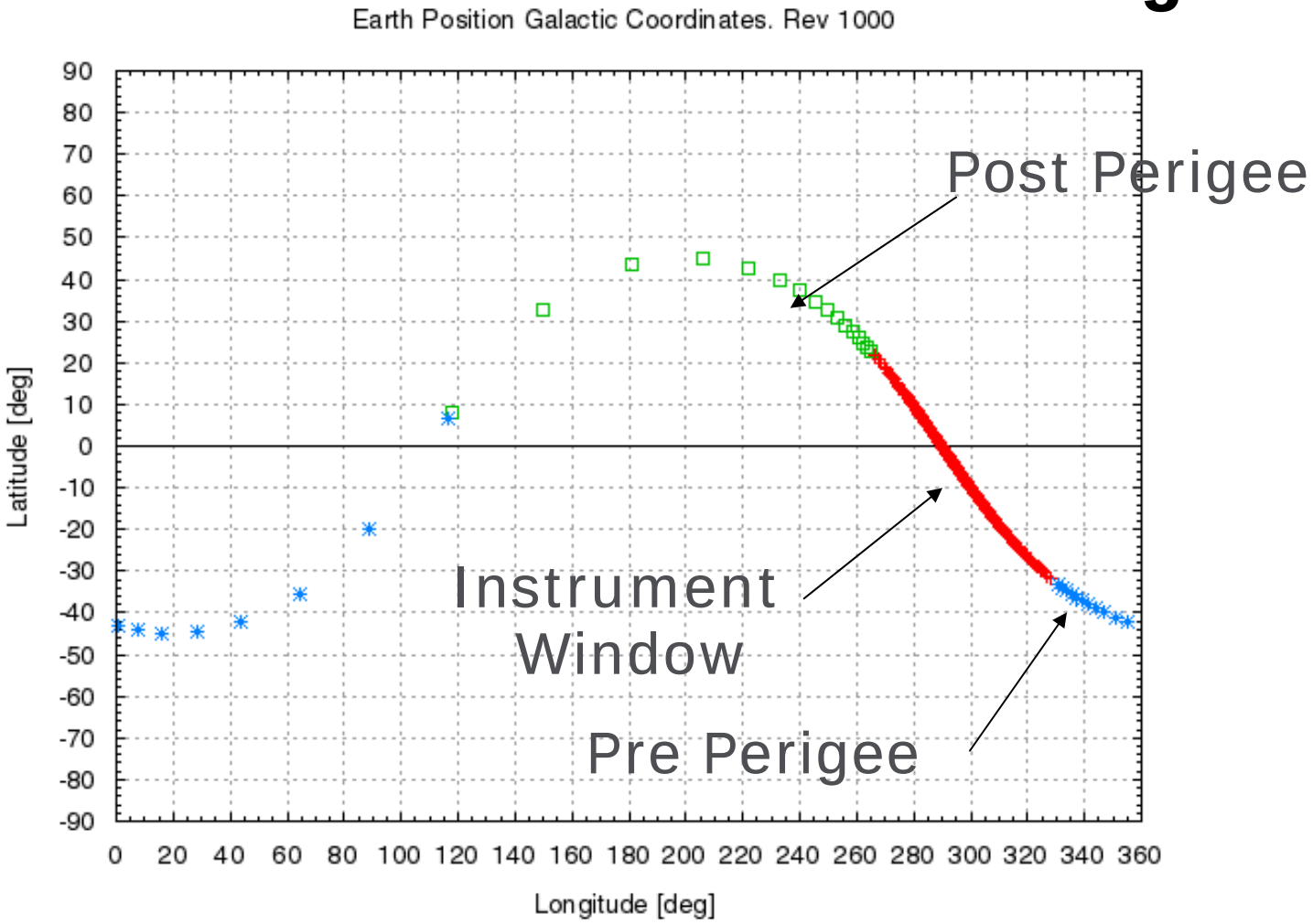
  - Such a requirement is difficult to fulfil, in the case of the 60ks (17hour observation) we must be on target 3 hours after perigee.
  - The INSTRUMENT window starts 4 hours after perigee. Hence we have only no observation time before the start of the SPI occultation. Requirement would be 7.5hours.
  - Potentially observe same sky area pre perigee

Integral EO 2 – Target Visibility

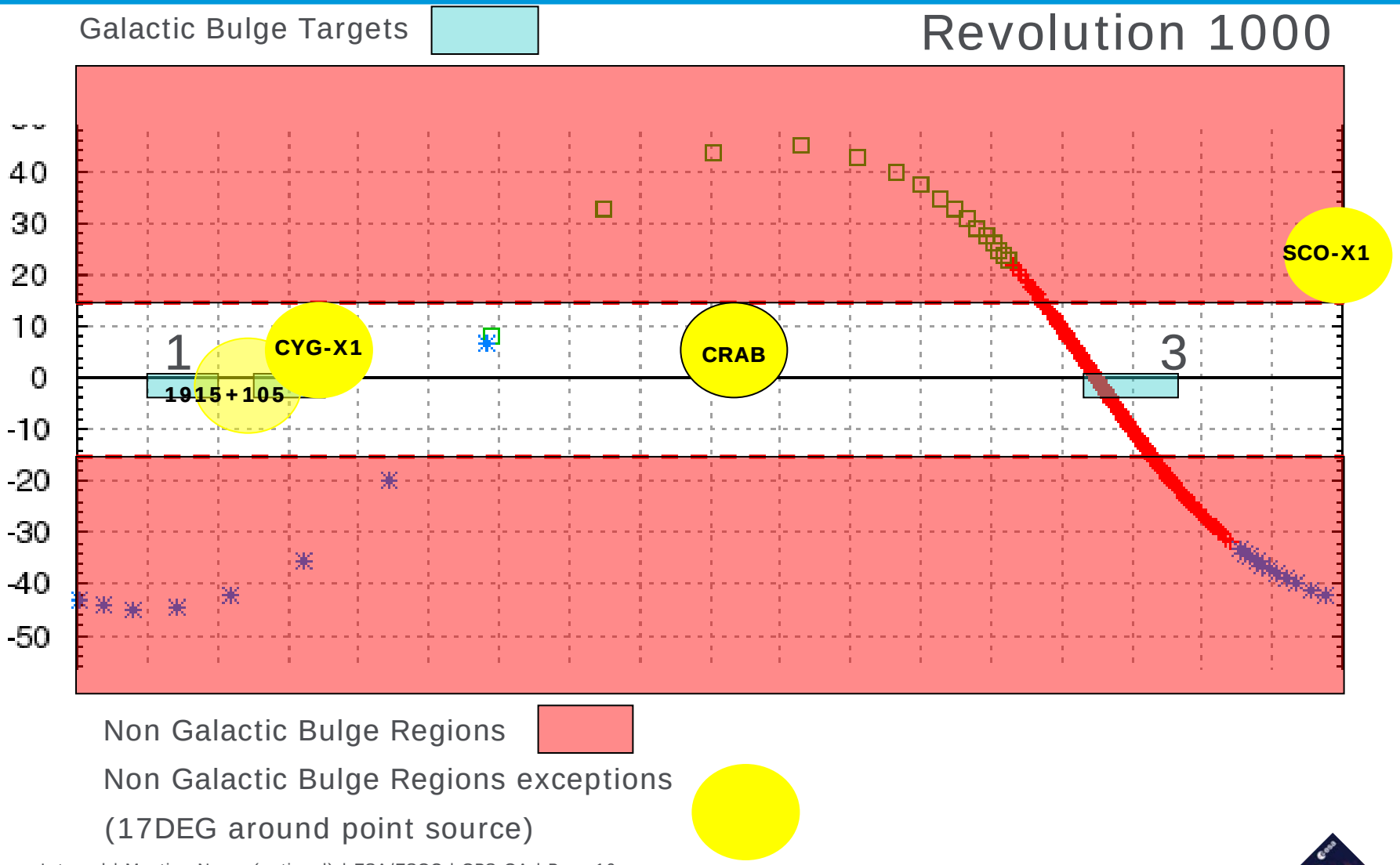
- Non galactic bulge Region defined as:
  - *R. Krivonos: "any sky region excluding Galactic plane at |b|<15 degrees. Additionally we ask also to exclude from the FOV the following bright sources: Crab, Sco X-1, Cyg X-1 and GRS 1915+105.*
- Galactic bulge Regions defined as:
  - *1) Longitude region l~ 50-70 deg centered at l=60 deg..*
  - *2) Longitude region 20-40 deg, the observation centered at l=30 deg.*
  - *3) l=300 deg. For this area a margin on latitude* (should this be longitude?) *of +/-15 Degrees is allowed.*
  - *Additionally, the position in Galactic latitude may be varied from 0 to -5 deg.*
  - The limit of b~ -5 to 0 degrees applies to all three of the above regions, although for (3) it is preferable to stay closer to 0 (no bright sources)

Integral EO 2 – Target Visibility

Earth Position as seen from Integral



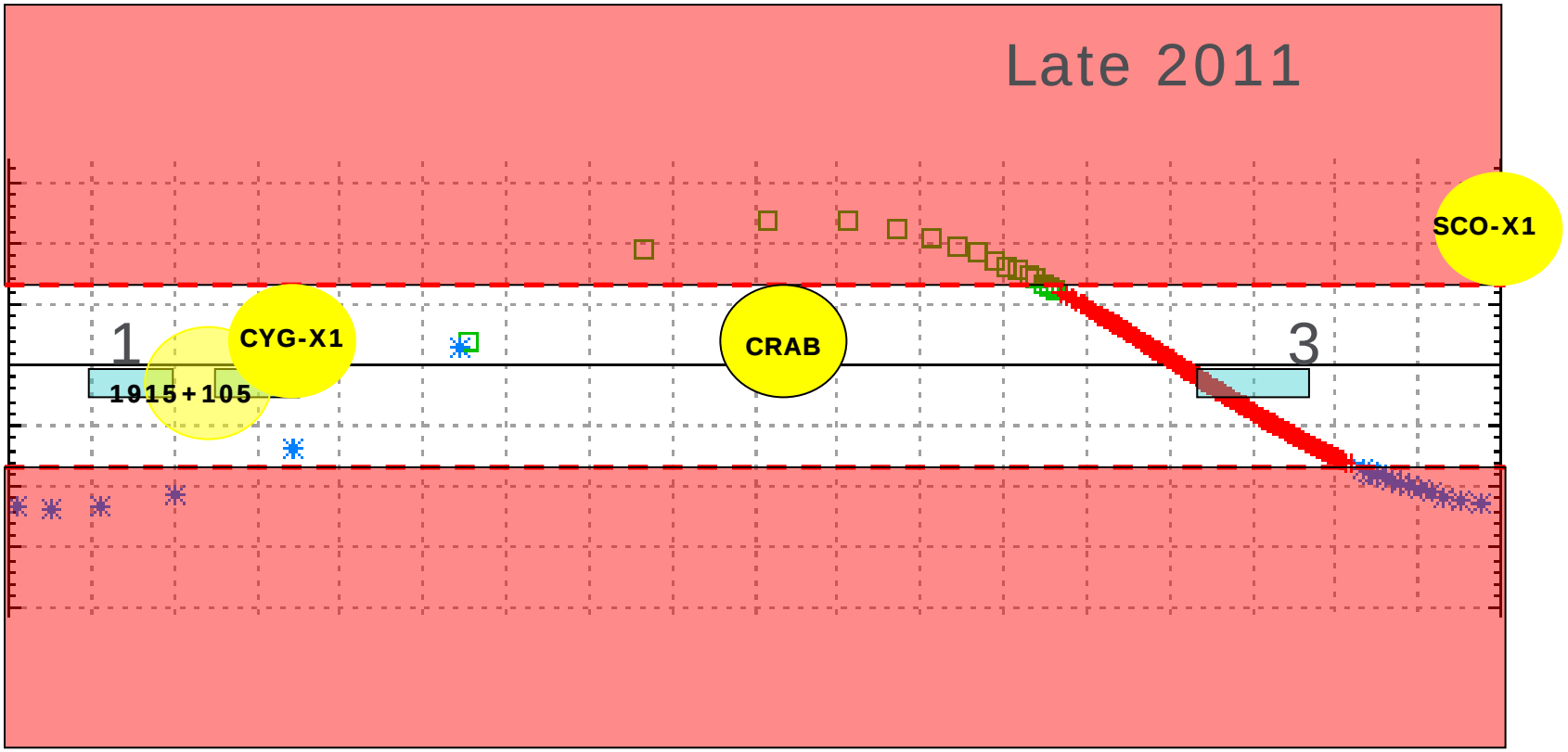
Integral EO 2 – Target Visibility



Integral EO 2 – Target Visibility

Galactic Bulge Targets

Revolution 1100

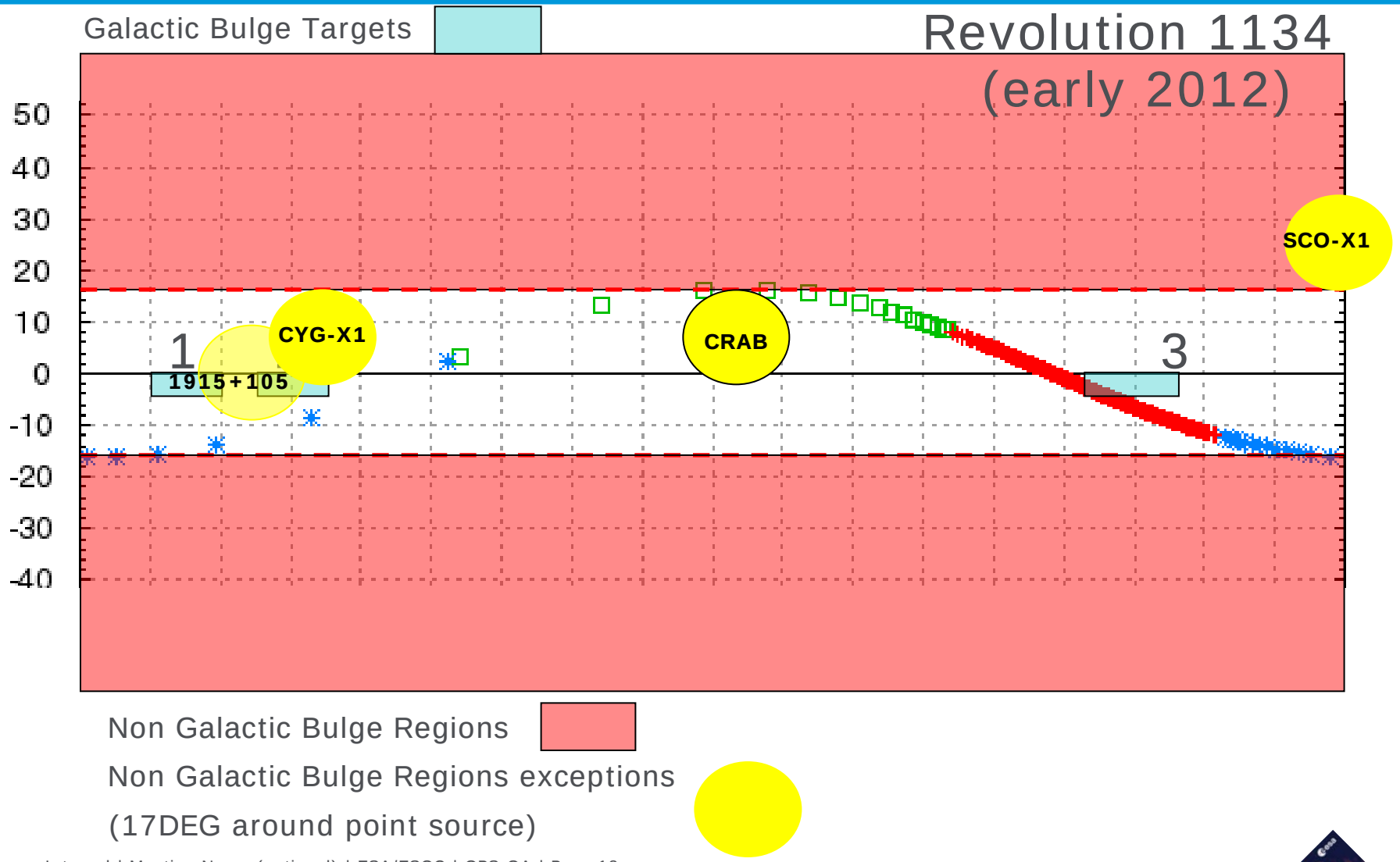


Non Galactic Bulge Regions

Non Galactic Bulge Regions exceptions

(17DEG around point source)

Integral EO 2 – Target Visibility



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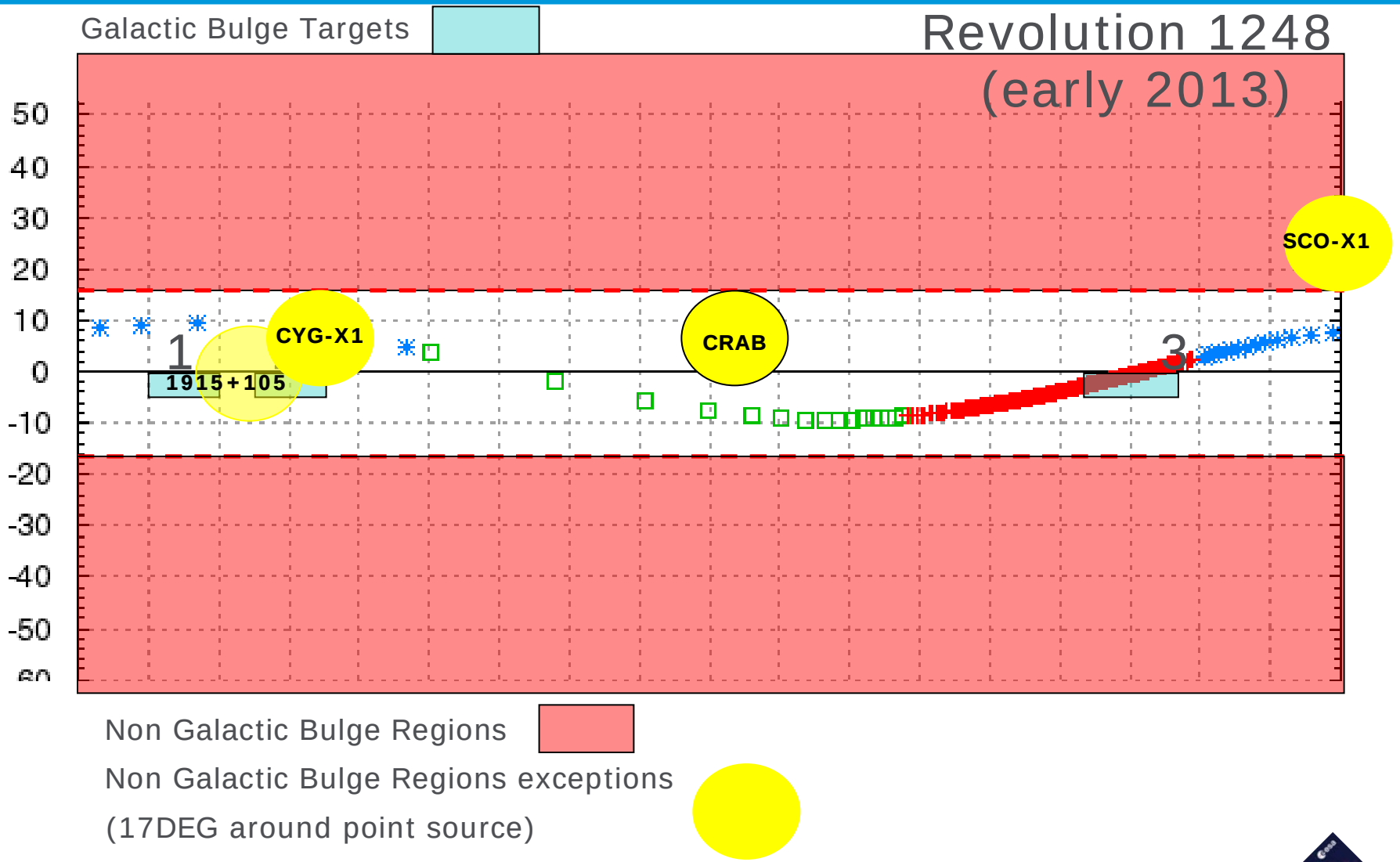

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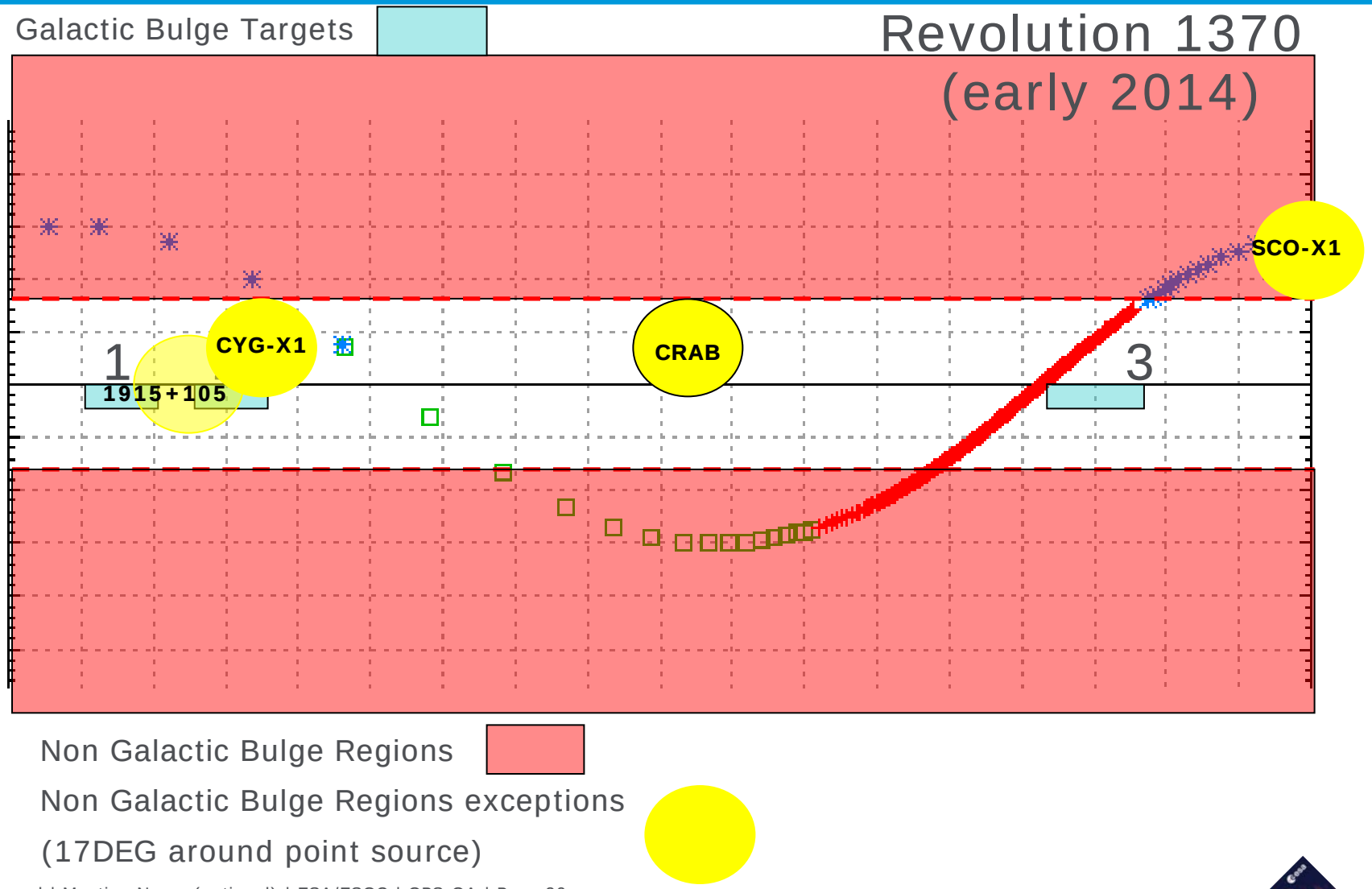

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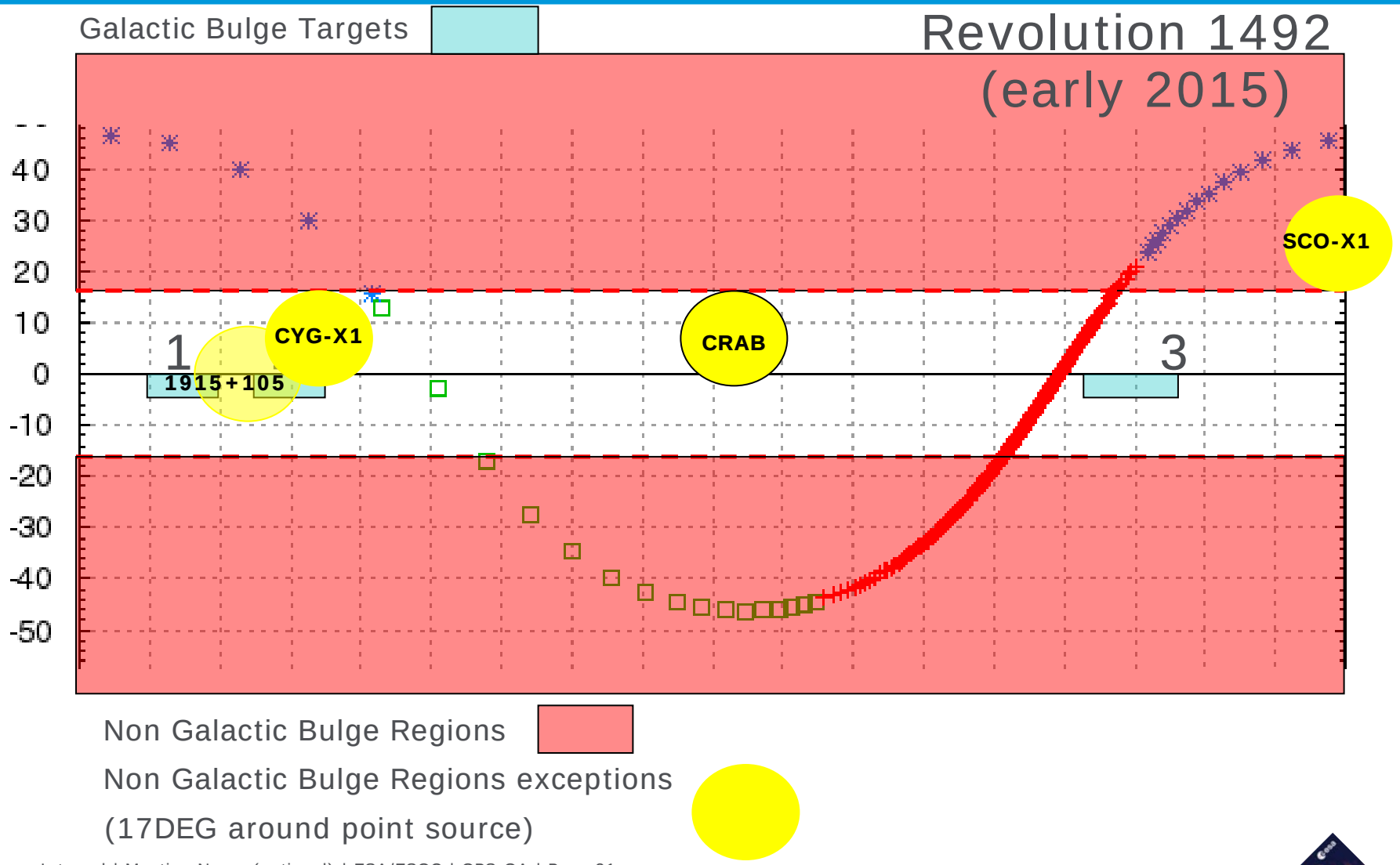

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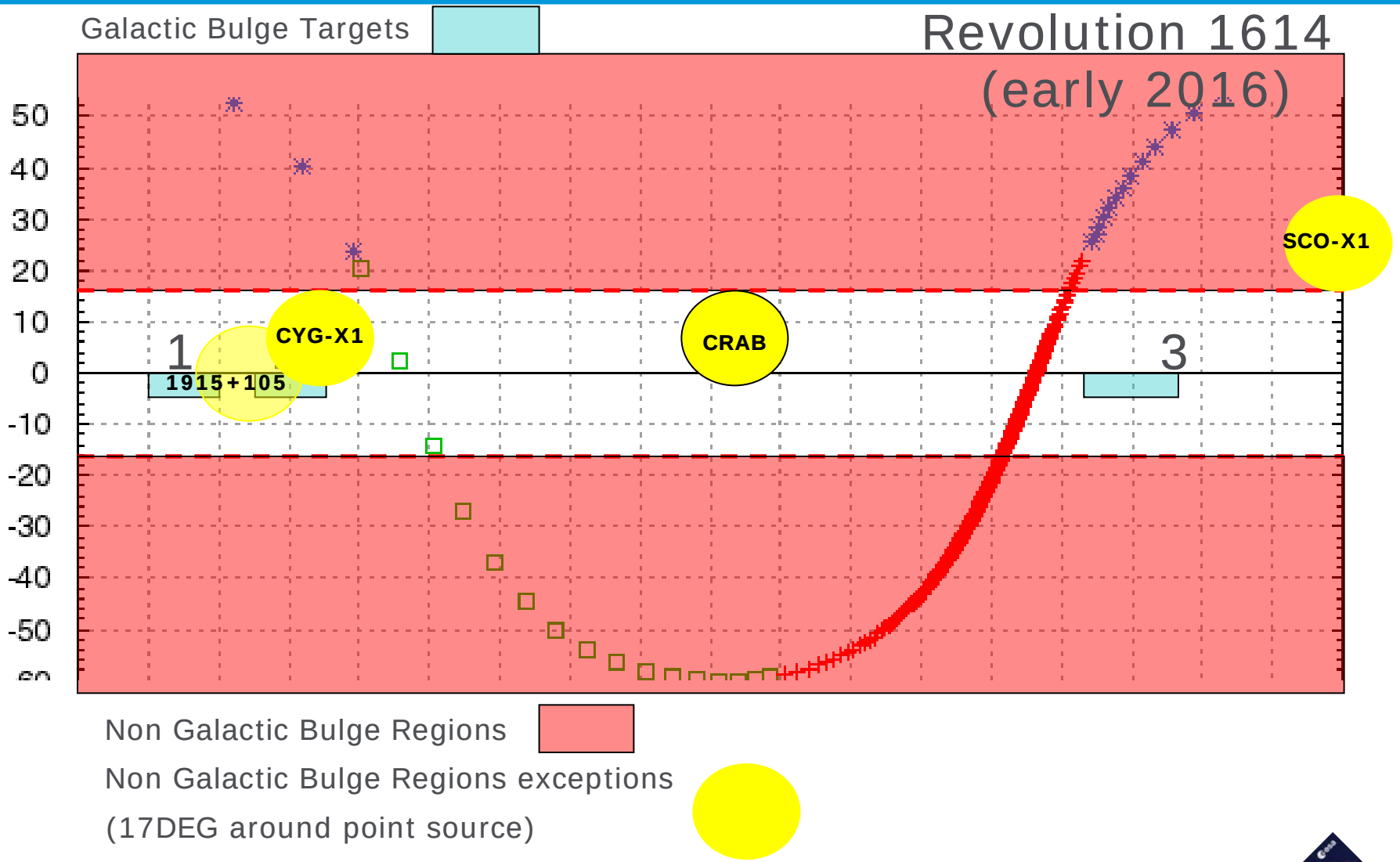

Integral EO 2 – Target Visibility

- Due to the evolving orbit the visibility of non galactic bulge targets is becoming more constrained and will not be feasible from late 2011 until mid (?) 2014.
  - Further mission extension mandatory!
- Only galactic bulge region 3 is visible; until late 2013.