BepiColombo 18th SWT - Tokyo 2019

Sharing and comparing simulation results

A key step for the HEWG community

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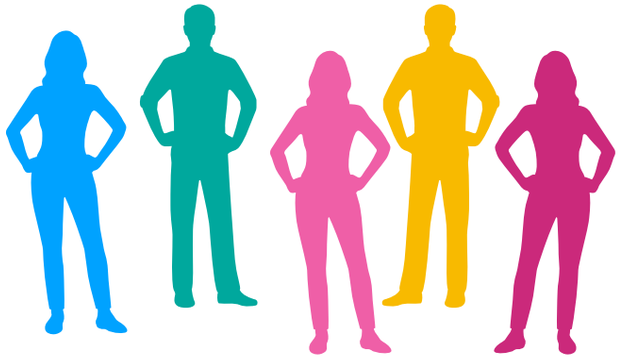
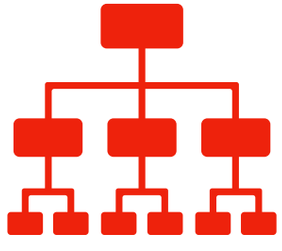
Sharing and comparing… why?

Among the HEWG,
several teams/scientists are computing **numerical simulations**
of the Hermean environment.

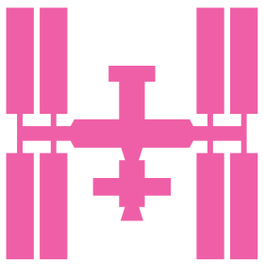


Each simulation code is **different**, with its own **strengths**
and **weaknesses.**
But put together, the ensemble of numerical codes
among the HEWG is a powerful asset for the BepiColombo team.

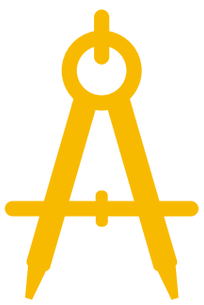


Numerical simulations used for **scientific research** now need
an **official structure** to go beyond the SHOTS project (see the YSG activities).
Official simulation & modeling groups exist (i.e. the MADAWG at Solar Orbiter)

Sharing and comparing… how?



Sharing and comparing require **trusting** each other. Simulation parameters, boundary conditions, equations, solvers, we must know as much as possible.
ex. SHOTS: all parameters and BC are described in a shared document



In order to ease the comparison, an effort must be made to provide simulation results **in the MESO frame**, using **the same units** for the parameters
ex: Lengths in R_M, densities in cm^-3, magnetic field in nT, temperature in K.

The simulations results must be provided in the **same format**, to be analyzed with the same visualization tools
ex: Netcdf, to use Paraview and 3DView (CDPP tool)

ParaView

3DView

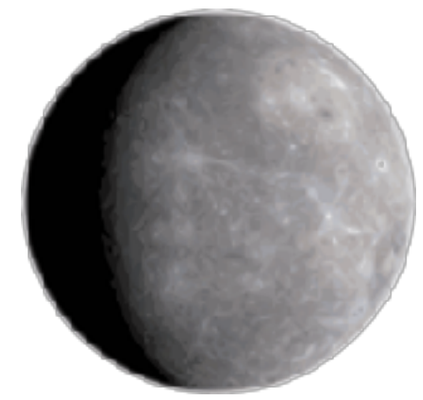
CDPP

Exemple of sharing and comparing: the SHOTS project

7 numerical codes, more than 10 people involved, 1 poster at AGU, many videoconferences, under the supervision of Prof. Usui and Go Murakami

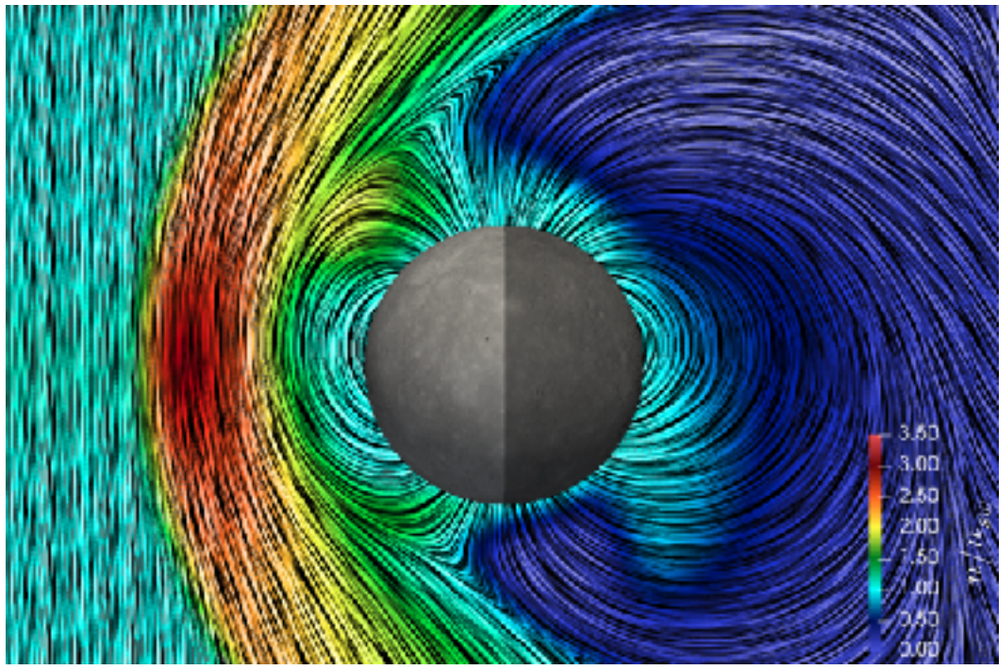
Commun parameters:

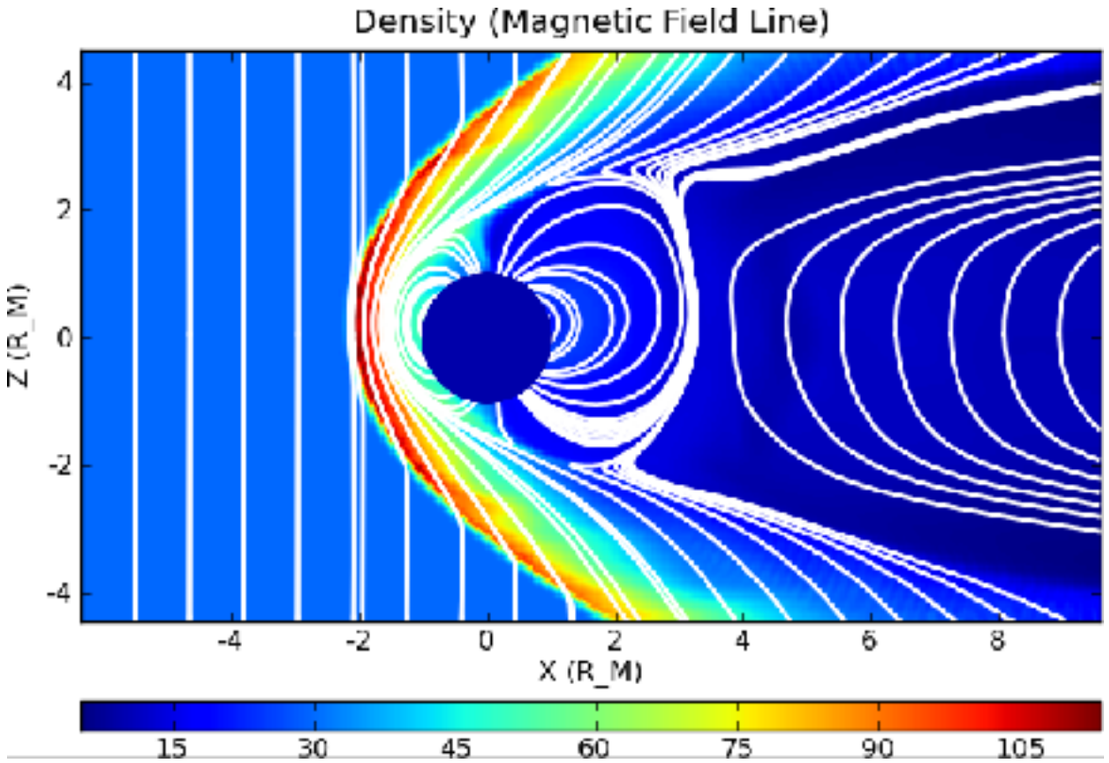
Radius of Mercury RM in km	**2440**	Dipole offset in km	**480**
Resistivity of Mantle in Ohm m	**1.2e+7**	Exosphere	**None**
Core Size in RM	**0.80**	Minimum grid Resolution in	**85**
Dipole Moment in nT RM^3	**190**	Minimum Timestep in s	**1**

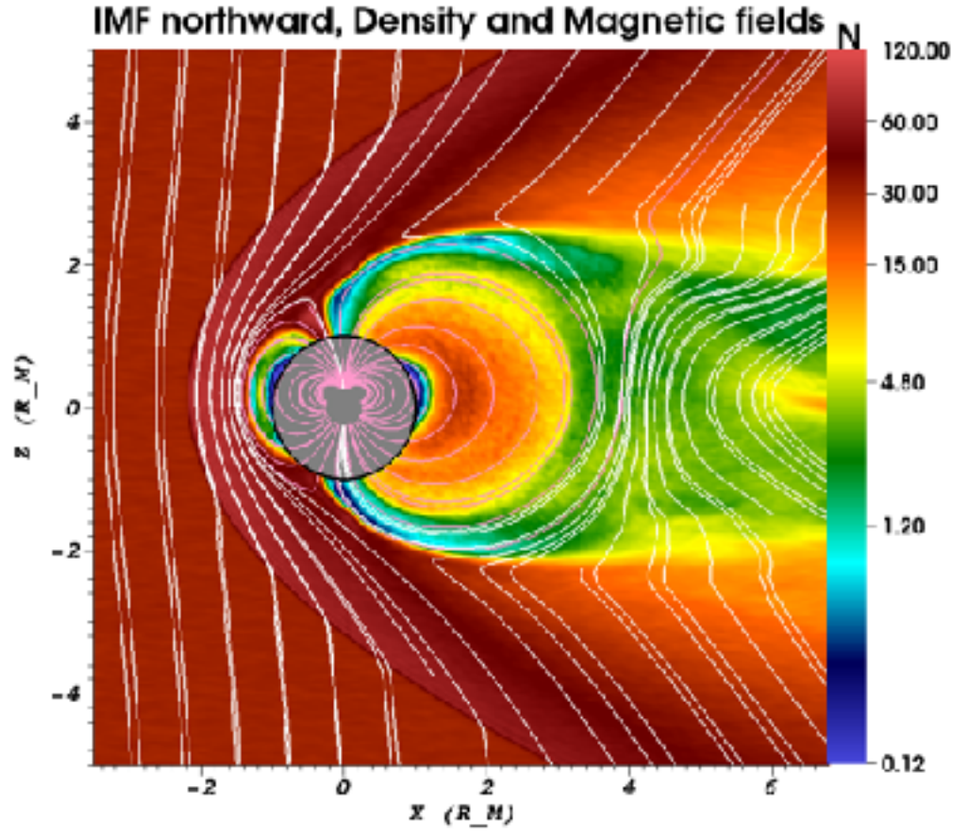


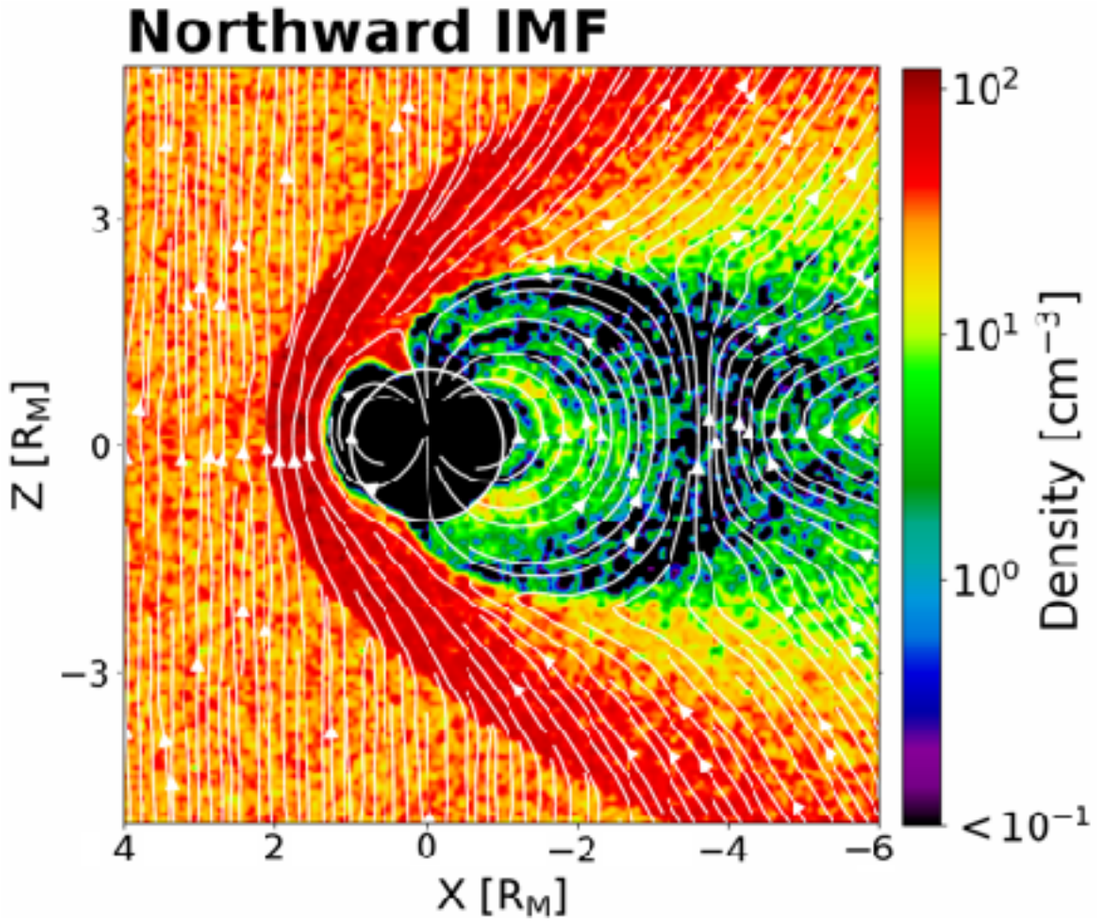
Plasma density in cm^-3	**30**	Plasma velocity in km/s	**400**
Temperature in MK	**0.25**	IMF magnitude in nT	**20**
Plasma beta	**0.6**	IMF direction	**+-Z**
Alfvèn Mach	**5**	Sonic Mach	**4.8**

Exemple of sharing and comparing: the SHOTS project

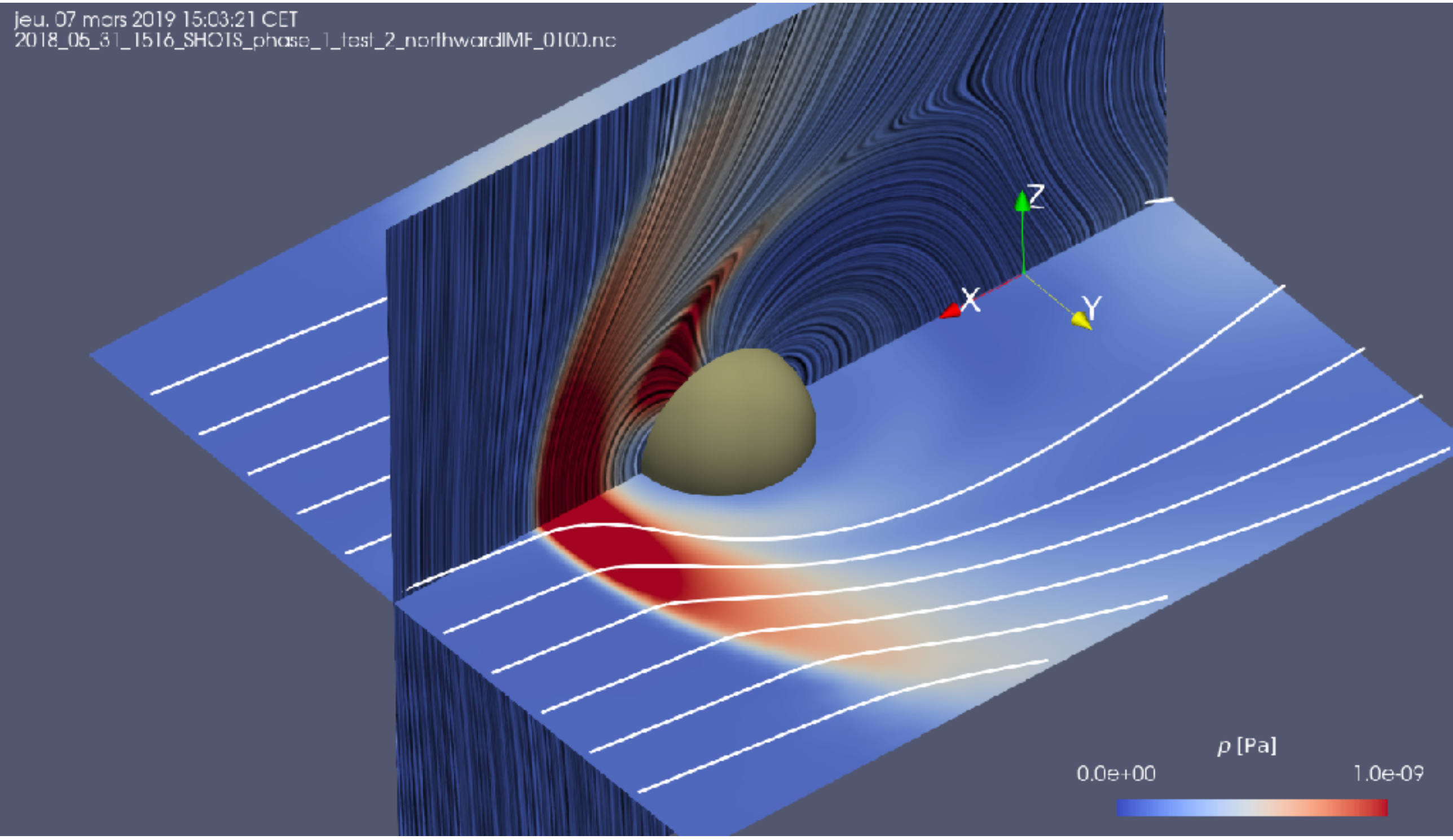




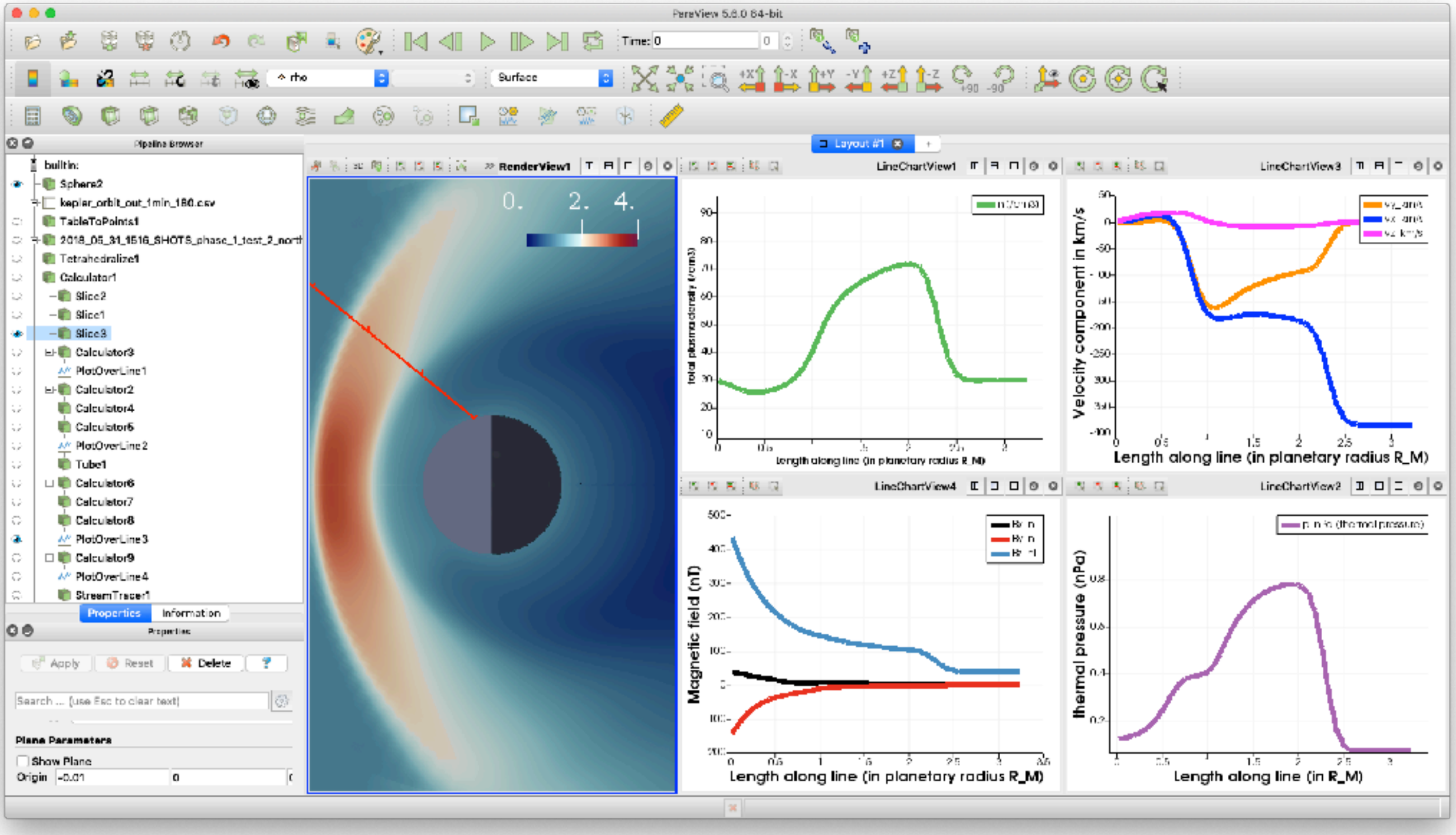




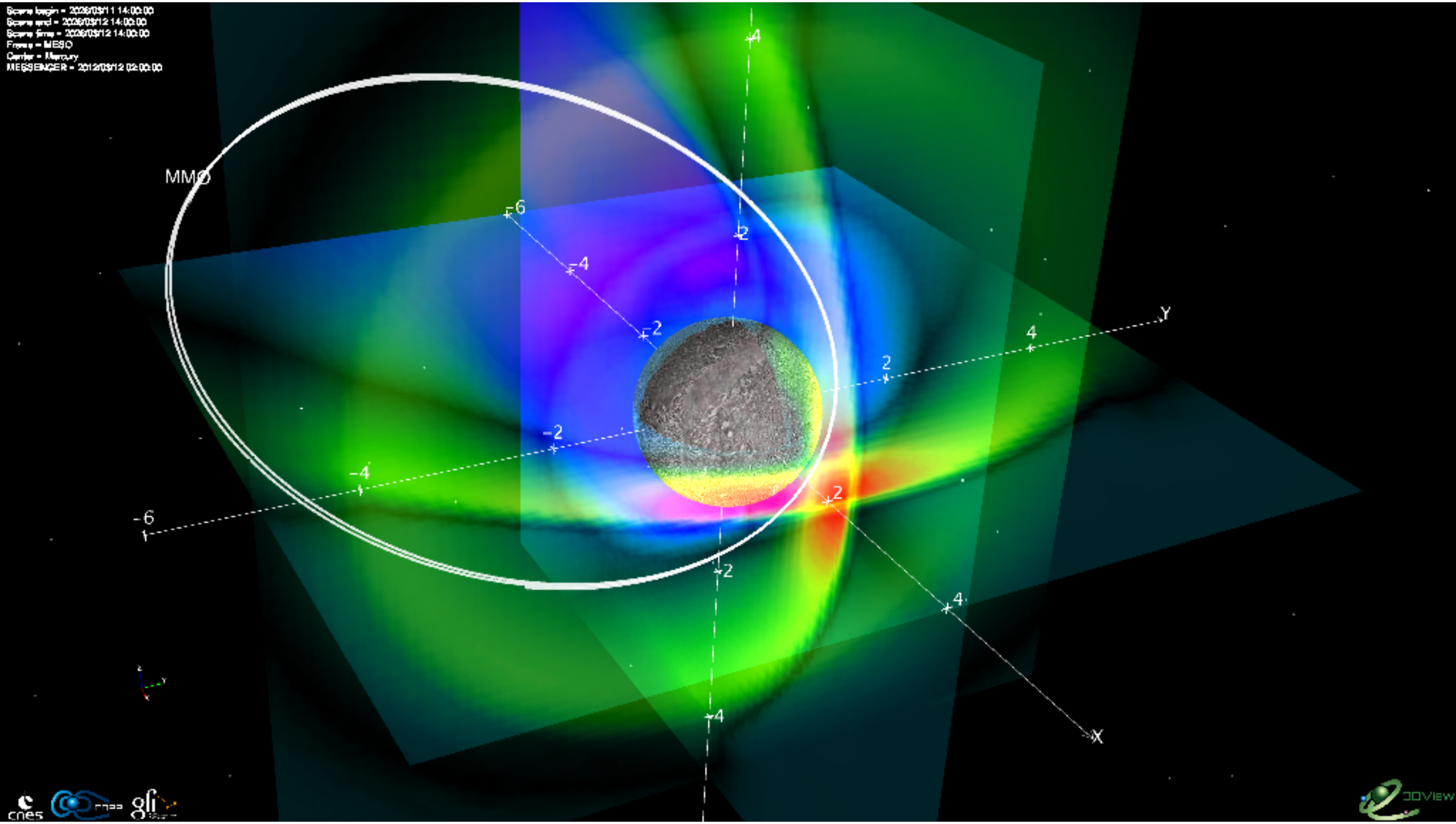
Using Paraview:



Using Paraview:



Using 3DView:



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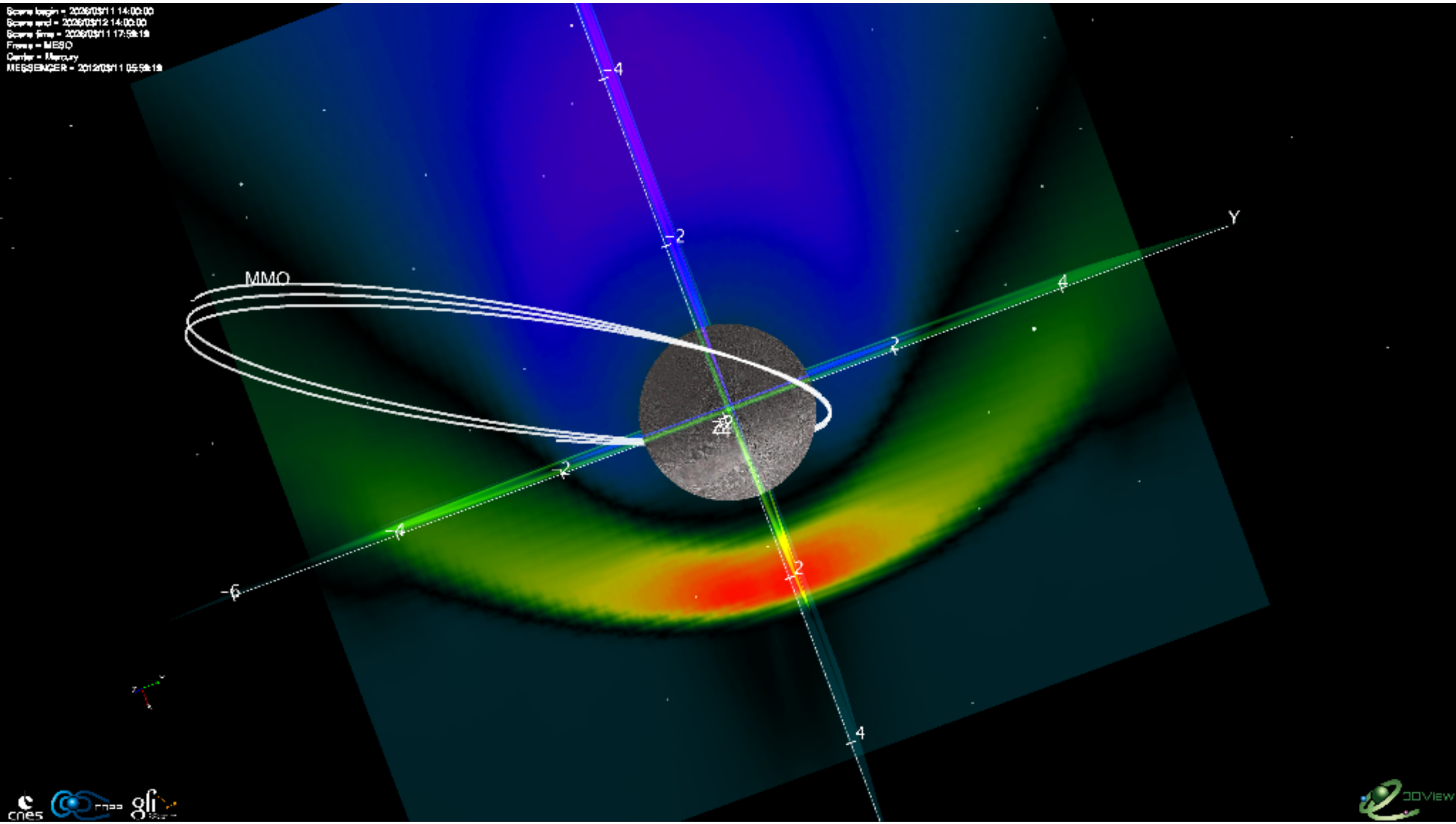

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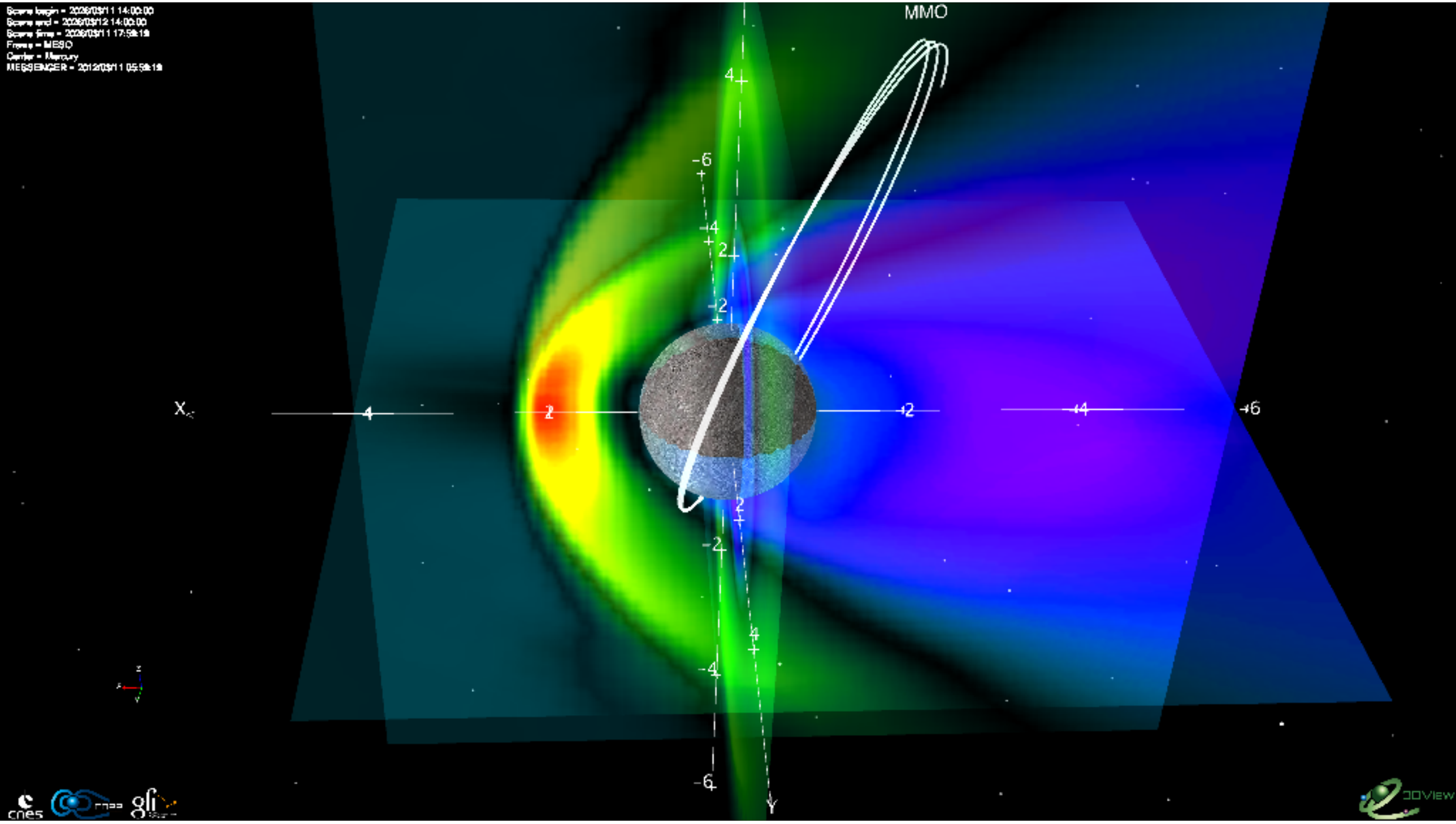

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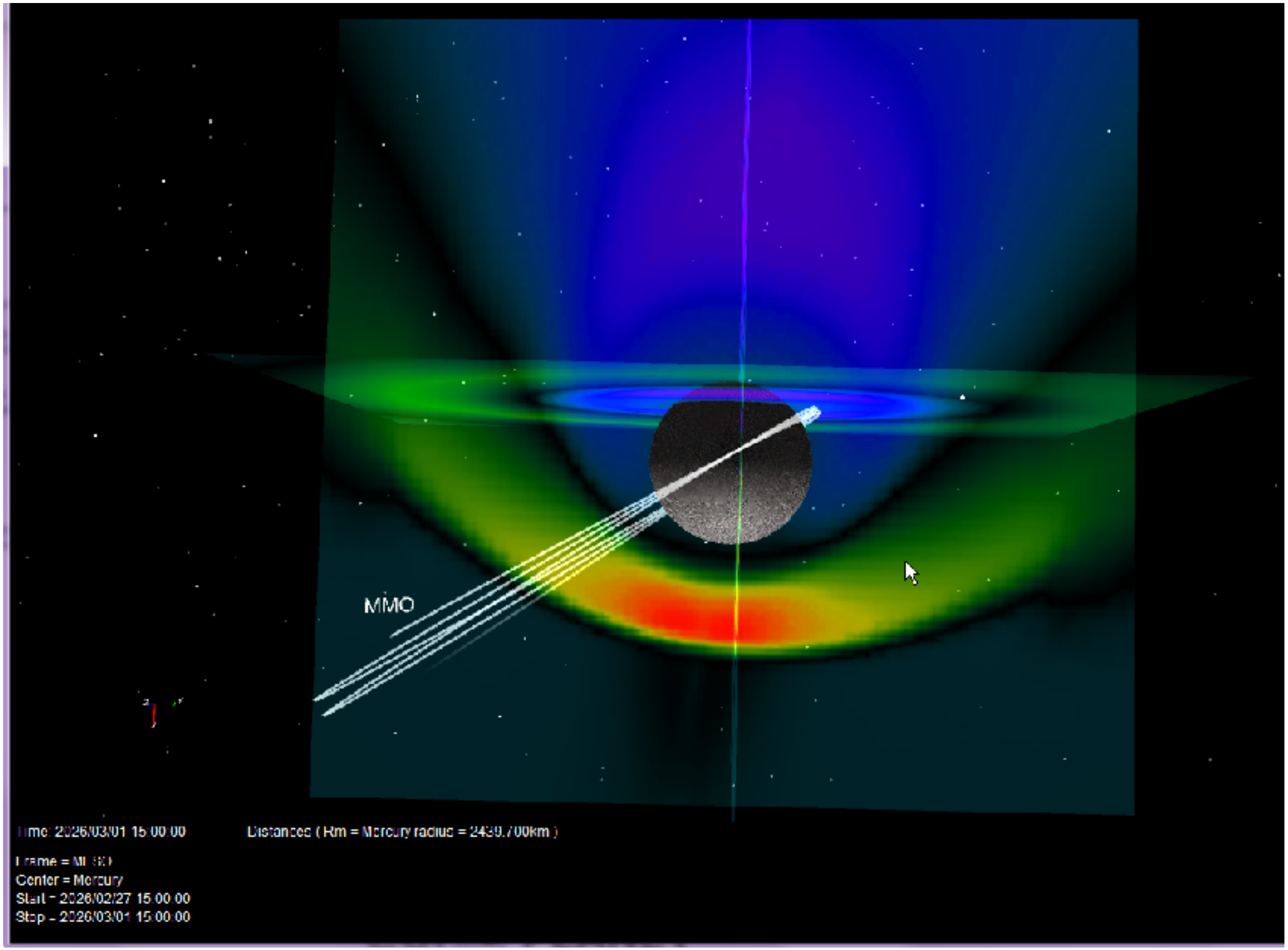
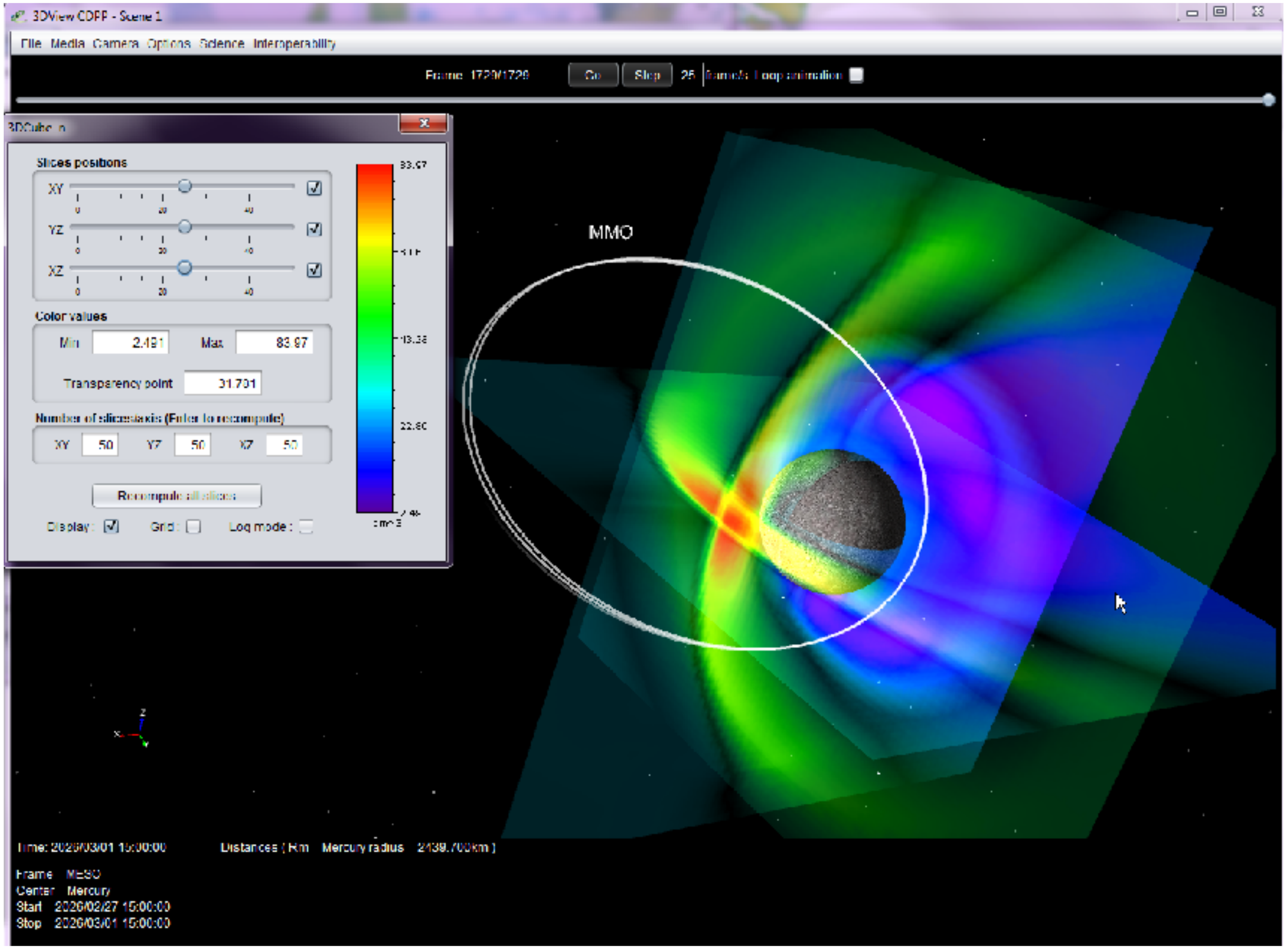


Using 3DView:



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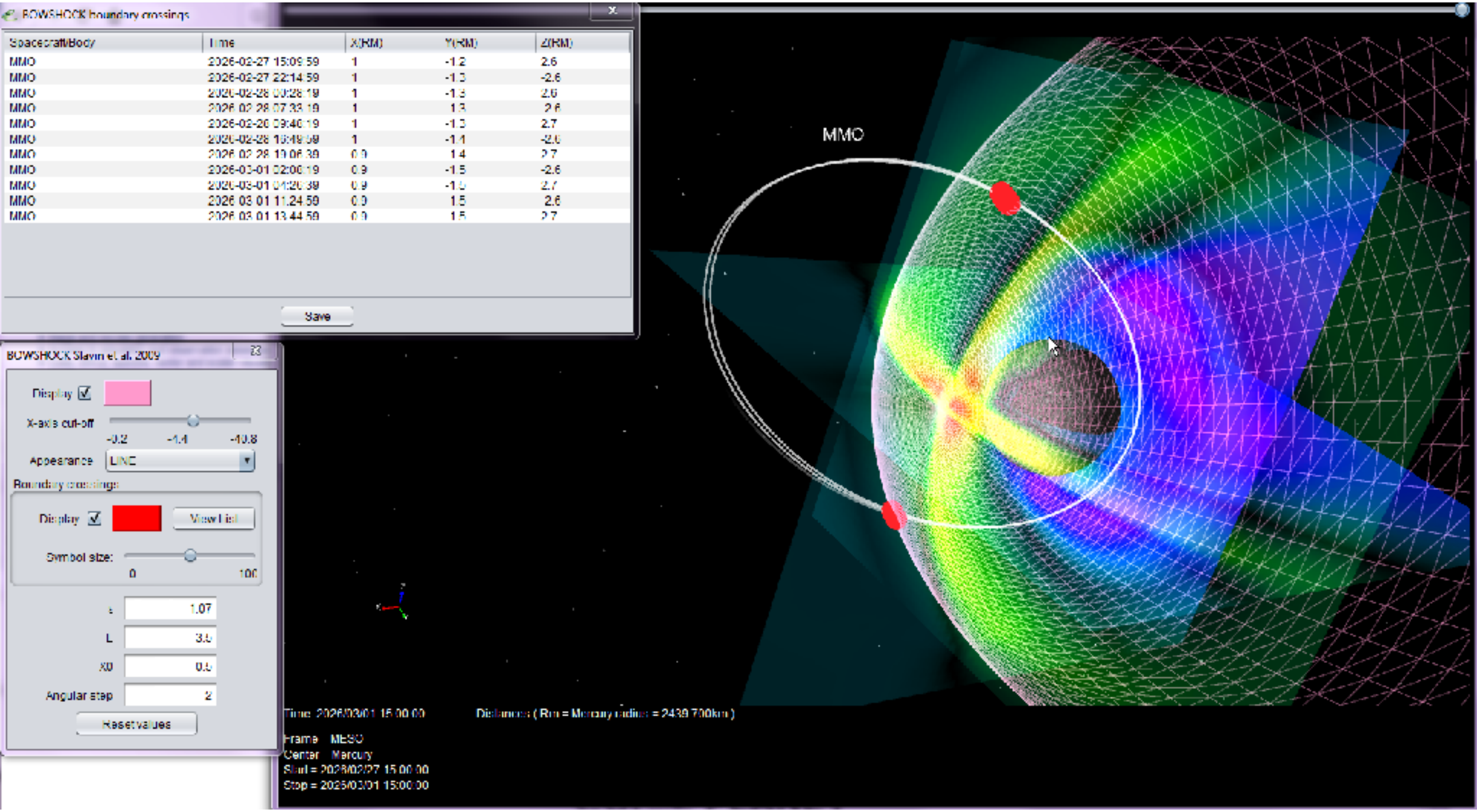
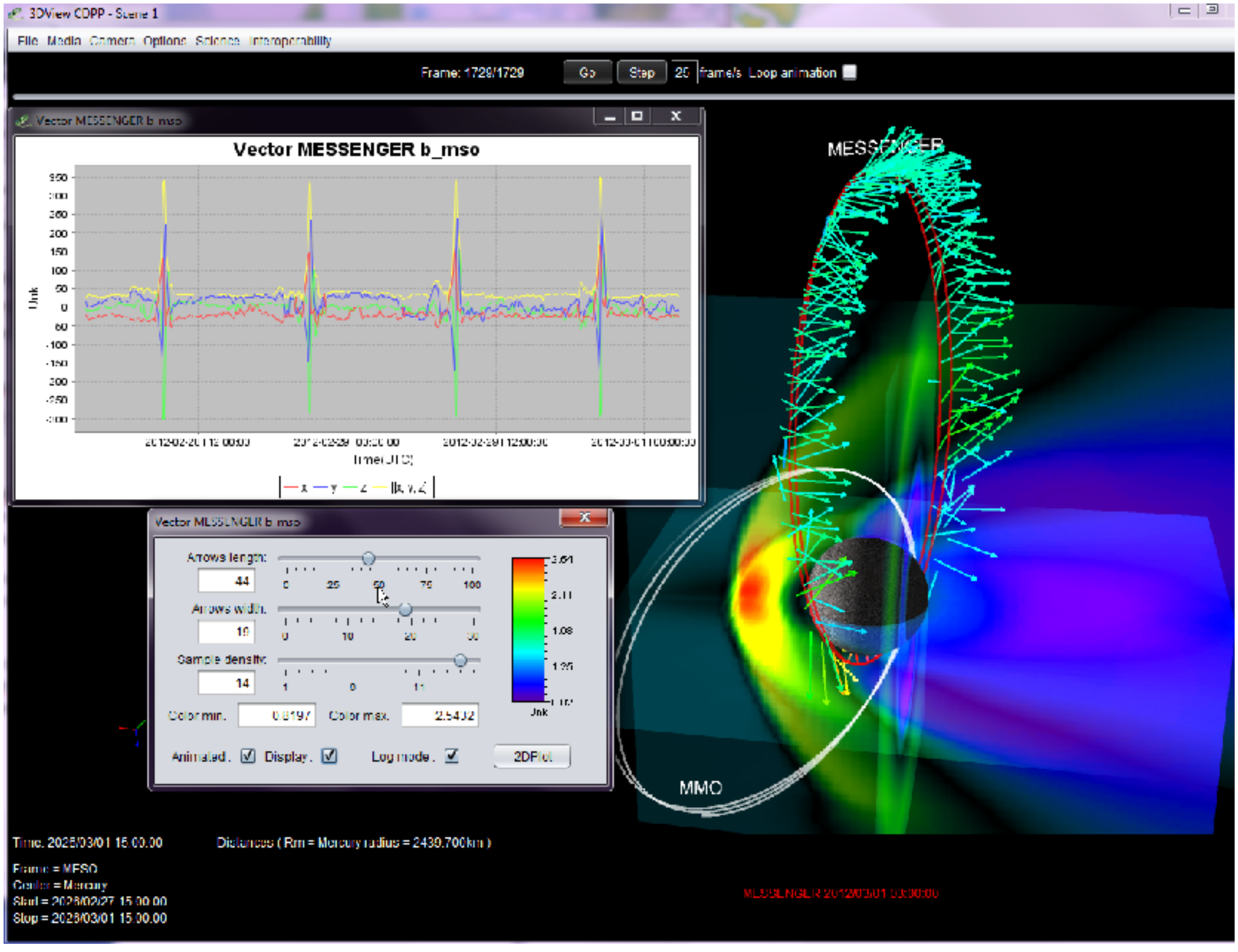


Using 3DView:



Implementing the data/simulation model: the theory

Make the right conversions

- simulation units to commun shared units
- simulation frame to MESO

Create the NetCDF file

- our original simulation grid = spherical, refined grid
- uniform cartesian grid (x,y,z)

Create the XML file (« tree »)

- The « parameter key » must have the same name as in the netcdf
- Store the netcdf file somewhere accessible by an URL, same for the XML file

Vizualise and do some science

- Learn how to use Paraview and the CDPP tools

Implementing the data/simulation model

- Exemple of an XML file for the description of a run
- Here for a 3D cube of magnetic field (LATMOS hybrid model for Mars)
  - Code/model description
  - Parameter description
  - Access URL
- The collection of these XML descriptors makes a ***tree***
- Trees can be made visible in tools & databases

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    spase://IMPEX/NumericalOutput/LATMOS/Hybrid/Mars_11_01_13/Mag/3D
  </ResourceID>
 −<ResourceHeader>
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    <ReleaseDate>2013-06-11T00:00:00.000</ReleaseDate>
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  +<Contact></Contact>
  </ResourceHeader>
  <AccessInformation>
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  +<AccessURL></AccessURL>
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  </AccessInformation>
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  −<CoordinateSystem>
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    <UnitsConversion> 1000 > m </UnitsConversion>
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    <RegionEnd> 9555.1 16100.0 16100.0 </RegionEnd>
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−<Parameter>
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    <ParameterKey>Bx,By,Bz</ParameterKey>
    <Units>nT</Units>
    <UnitsConversion> 1 E-9 > T </UnitsConversion>
  +<Field></Field>
  </Parameter>
  <SimulationProduct>3DCubes</SimulationProduct>
</NumericalOutput>
```

Implementing the data/simulation model: in practice

1. **Create the NetCDF file**

   Spherical refined grid was a big difficulty

2. **Create the XML file (« tree ») with only 1 parameter, the plasma density**

   Need to understand with information is necessary or not

3. **Fix the XML file**

4. **Make the right conversions**

5. **Adapt the XML file**

6. **Fix the NetCDF file**

7. **Complete the XML file with the other parameters**

8. **Do some science**

Implementing the data/simulation model: you want to do it, too?

Try to create the NetCDF file by yourself, otherwise, please ask for help!

Do we have experts of file conversions within the BepiColombo team?
Could ESA/JAXA/national agencies help? We could need specialists…
It's important that, in the end, each team is able to produce the netcdf files

Store the netcdf file somewhere with an URL

If many teams participate, where do we store the simulations files?

Create the XML file (« tree »)

In Toulouse, many people would be happy to help you for the first one!

Do exciting science :D

Conclusion:

Among the HEWG,
Many simulation codes
= great richness !

BUT we need to work **together**!

We need a better **organisation**,
and **commun tools**
(a webpage, Paraview, 3DView, …)

We need to decide of **commun units**
for the physical quantities

The SHOTS team will show
the way :)

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Thank you!