TRED 46, TRED 46.2

Stefano Markidis, Alex Vapirev and Giovanni Lapenta

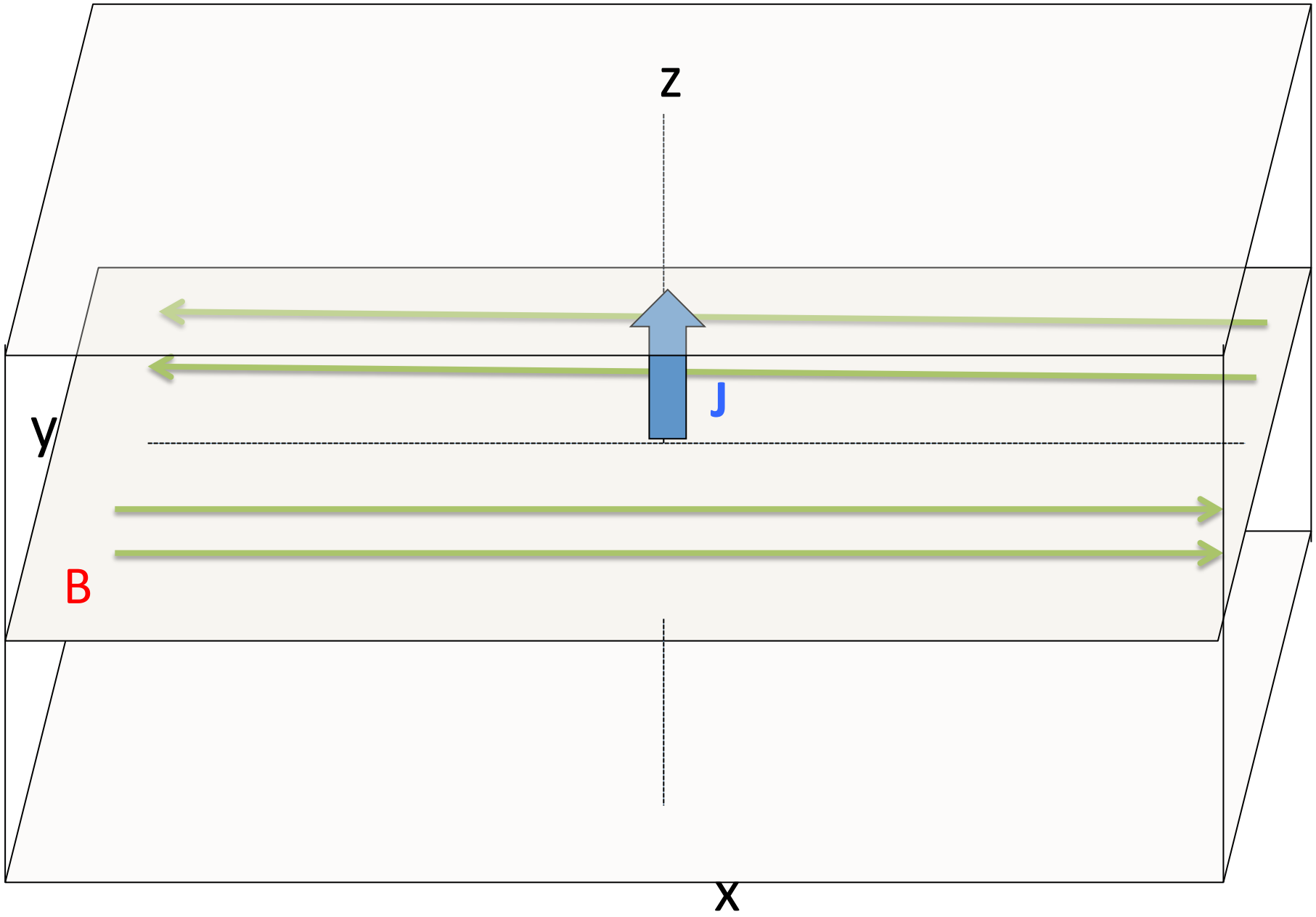
Tred46 – Tred46.2

- Simulation of antiparallel reconnection (no guide field)
- Done in two parts:
  - 0 -> 11000 computational cycles (Probably the main interest for you) – Tred46
  - 10000 -> 16000 computational cycles (restart from 10000) Tred46.2

- Simulations with **3072** cores. Domain decomposition with core grid (virtual topology) **32 x 12 x 8**. Each core used is characterized by a number called **rank**. In threads ranks goes from 0 to 3071. Each rank corresponds to a particular point of the virtual topology and to particular 3D region.

Coordinate system and initial configuration

- Harris sheet (balance)
- Initial perturbation along a line is applied in the midline of the simulation box (hard-wired in the code)
- Coordinate system NOT GSM!


z
y
J
B
x

Output

- HDF5 binary for each core
- VTK (ASCII), obtained in post processing from HDF5 file. We have a C code to merge all the files and make one file
- Text file for single point output

To view directly hdf5 you need to have installed hdf5 library. **Matlab** supports hdf5 and we have code to read. Pierre Henri (UNIPI) has developed reader for IDL too.

Output

- Settings with simulation parameters. **Setting.txt**
- Total energy,momentum, potential energies, kinetic energies recorded in **ConservedQuantities.txt**.
- Fields saved at low frequency (every 1000 cycles) in hdf format-> **proc_*rank*.hdf**
- Particles saved at very low frequency in hdf format -> **part_*rank*.hdf**
- Restart field with all the fields and particles quantities -> **restart_*rank*.hdf**
- Fields information saved at high frequency in several domain points in text format-> **Virtual Satellites_*rank*.txt**

Settings.txt & settings.hdf

- Two file save the original setting of the simulations
- Cat settings.txt
- h5dump settings.hdf less (need to have installed hdf5 installed on your machine)

Simulation box

- Lx = 40 so x=0 -> x=40
- Ly = 15 so y=0 -> y=15
- Lz = 10 so z=0 -> z=10

Lengths are expressed in di = **ion skin depth**

The BC are periodic in x-direction, and z – direction, while the boundary are perfect boundary condition in y direction.

Grid size

- Nx = 512
- Ny = 192
- Nz = 128

Time step

- Dt = 0.125

The time is expressed in (ion plasma frequency) ^ (-1).

Species (NS) and Mass ratios (qom)

- There are 4 particles species present in the simulation
- Species 0 -> current sheet electrons qom = **256**
- Species 1 -> current sheet ions qom = 1
- Species 2 -> background electrons qom = **256**
- Species 3 -> background ions = 1

The background density is in rho_init = 0.1

B0 (magnetic field configuration)

- B0x = 0.0097 (asymptotic field, chosen to guarantee equilibrium in initial configuration)
- B0y = 0.0
- B0z = 0.0 (no guide field)

Density

- You have charge density as output. To have density n, you need to multiply by 4 pi and sign of the species.
- n = 1.1 (n = 1.0 current sheet + n = 0.1 from background) in the center of the current sheet.

Velocity

- The velocity are normalized to the speed of light in vacuum.

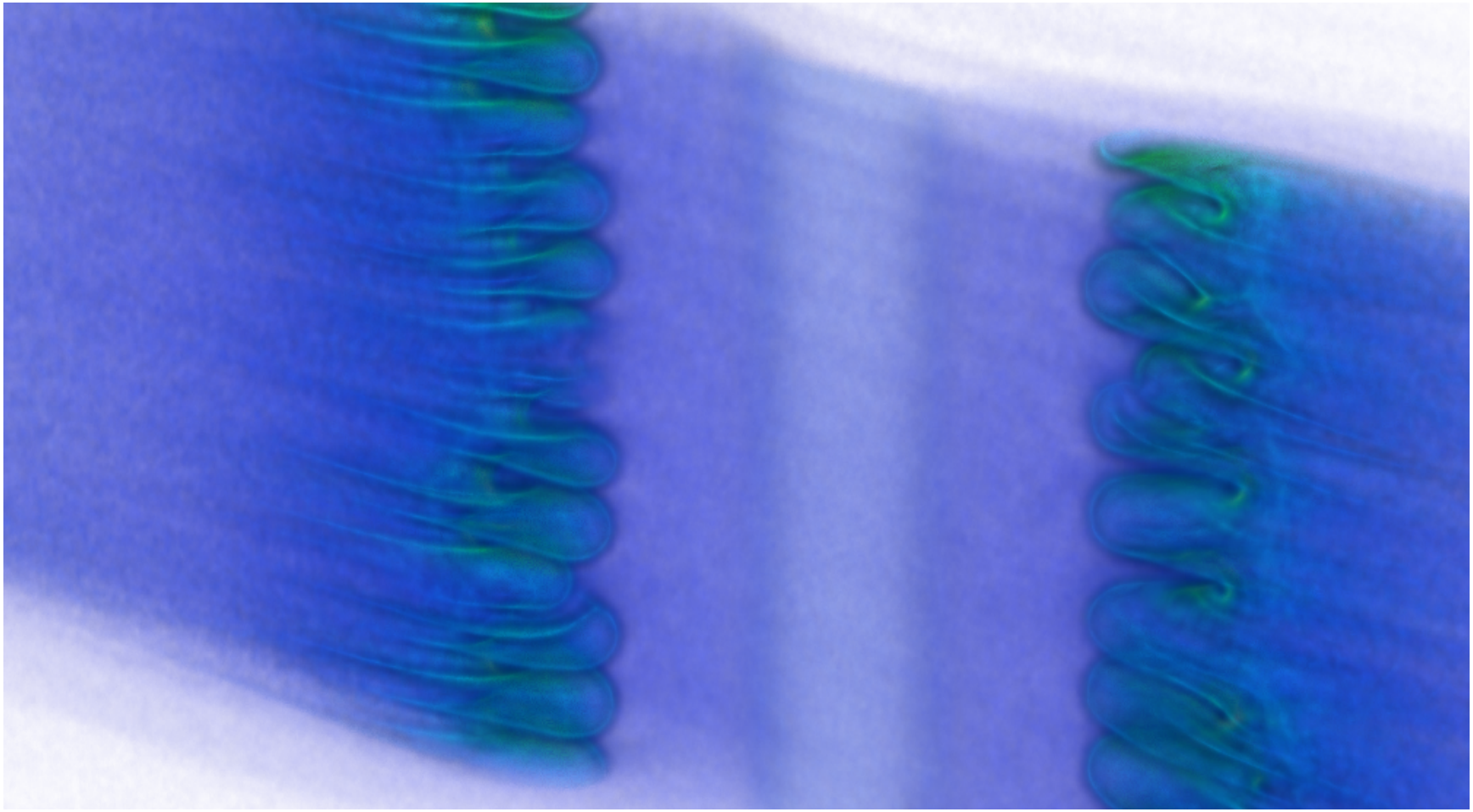
Conserved quantities file

- Useful to check the conservation laws are violated. If variations are > 5% simulation are disregarded and redone changing time step and grid spacing.

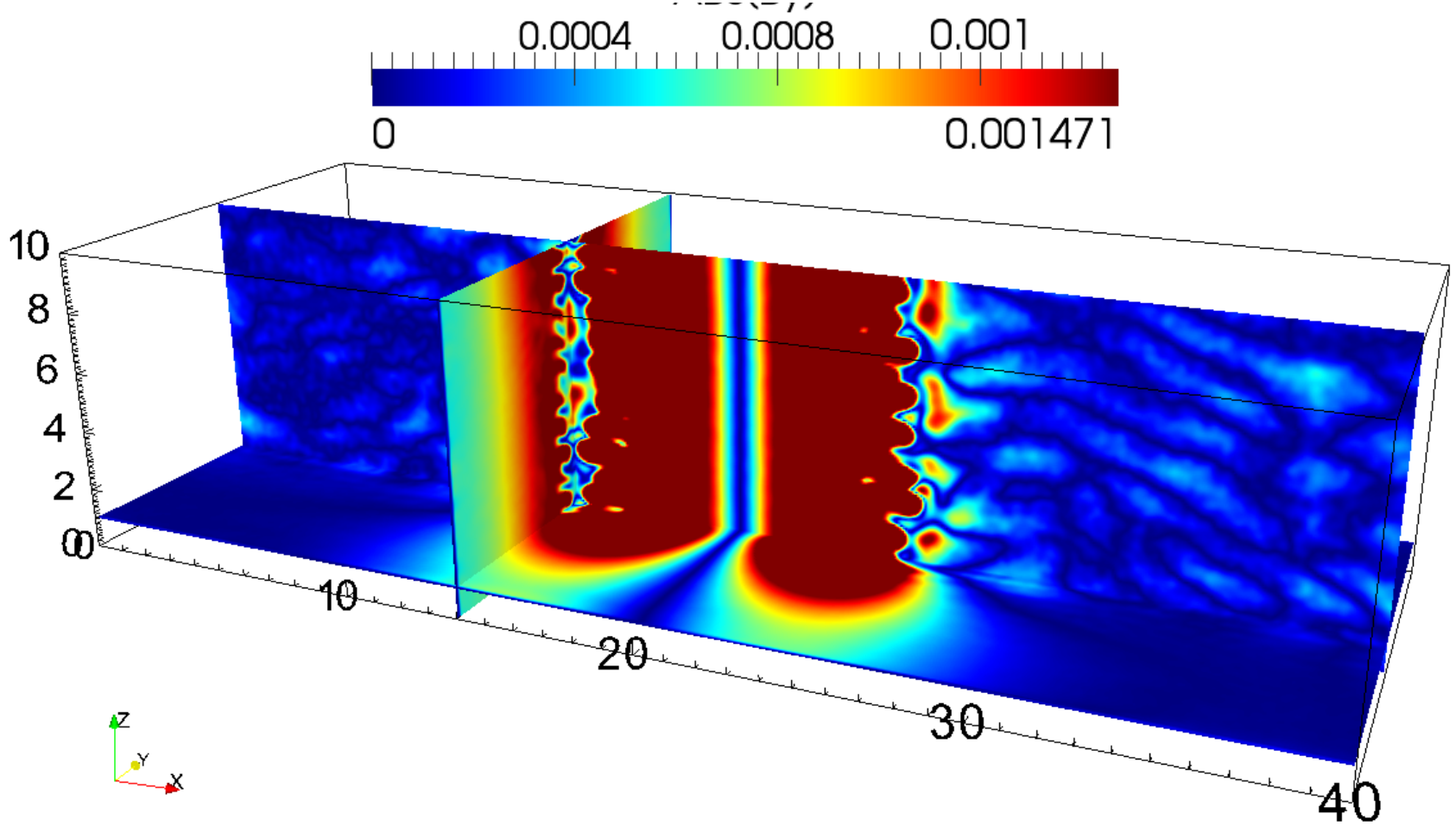
File procs

- Each proc file saves B, E, rho (for each species), J (for each species), p (for each species).
- Saved every 1000 cycles in tred46
- All the proc combined in a vtk file, to give the fields all over the domain
- Derived quantities, such as Epar and Eperp and fluid velocity are calculated also in postprocessing.
- The vtk files are visualized with Paraview and Visit.
- They give very good overview, and suggest which point in the simulation are interesting to follow

Proc -> Je intensity (from Visit)



Proc abs(By) from Paraview



Part files

- They record particle position, velocity, and statistical weight (variable for current sheet particle, constant for background particles)
- Not present in tred46

Restart files

- Provide all the information for restarting a simulation from certain cycle.
- In tred46, we have a restart file at 10,000
- Useful for getting all the particle information we don’t have from part.

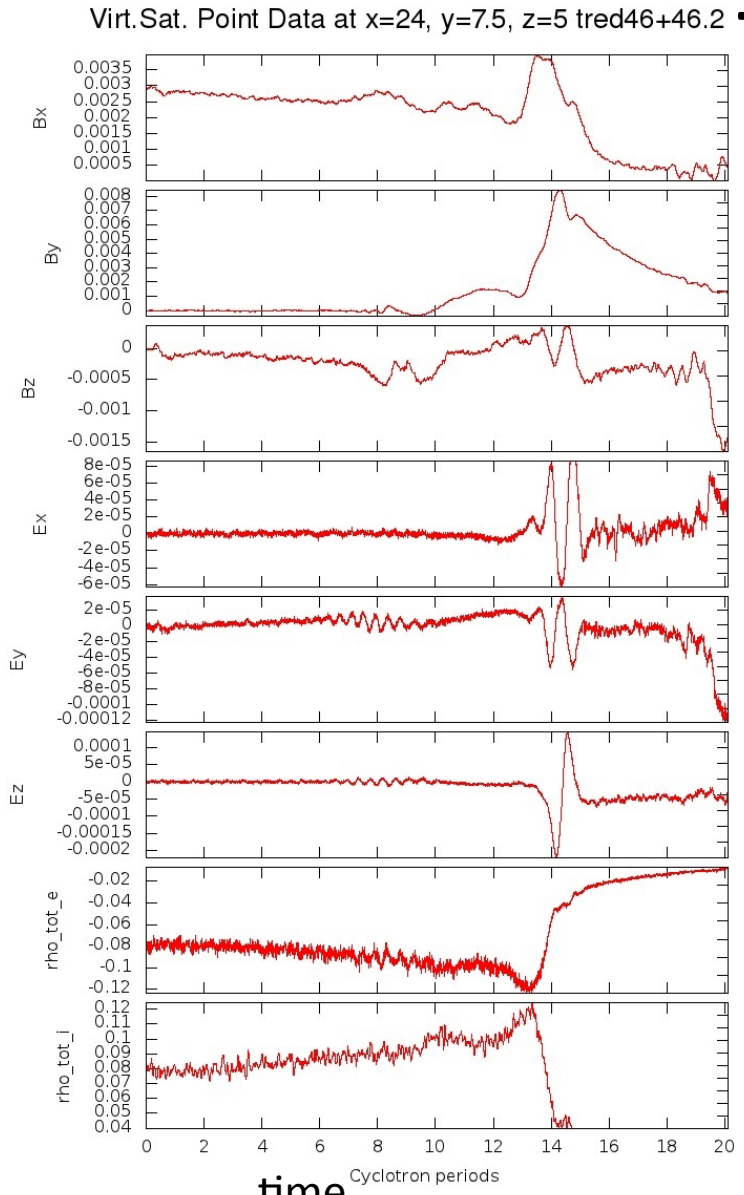
Virtual satellites

- 27 probes for each processor on 3x3x3 grid
- Header with the position of each probe
- At each cycle, a line in Virtual satellite with **Bx, By, Bz, Ex, Ey, Ez, Jxe, Jye, Jze, Jxi, Jyi, Jzi, rhoe, rhoi** is recorded;

Virtual Satellites File Structure

- 27 X
  - x_sat, y_sat, z_sat
- For each computational cycle
  - 27 x
    - **Bx, By, Bz, Ex, Ey, Ez, Jxe, Jye, Jze, Jxi,Jyi, Jzi, rhoe, rhoi**

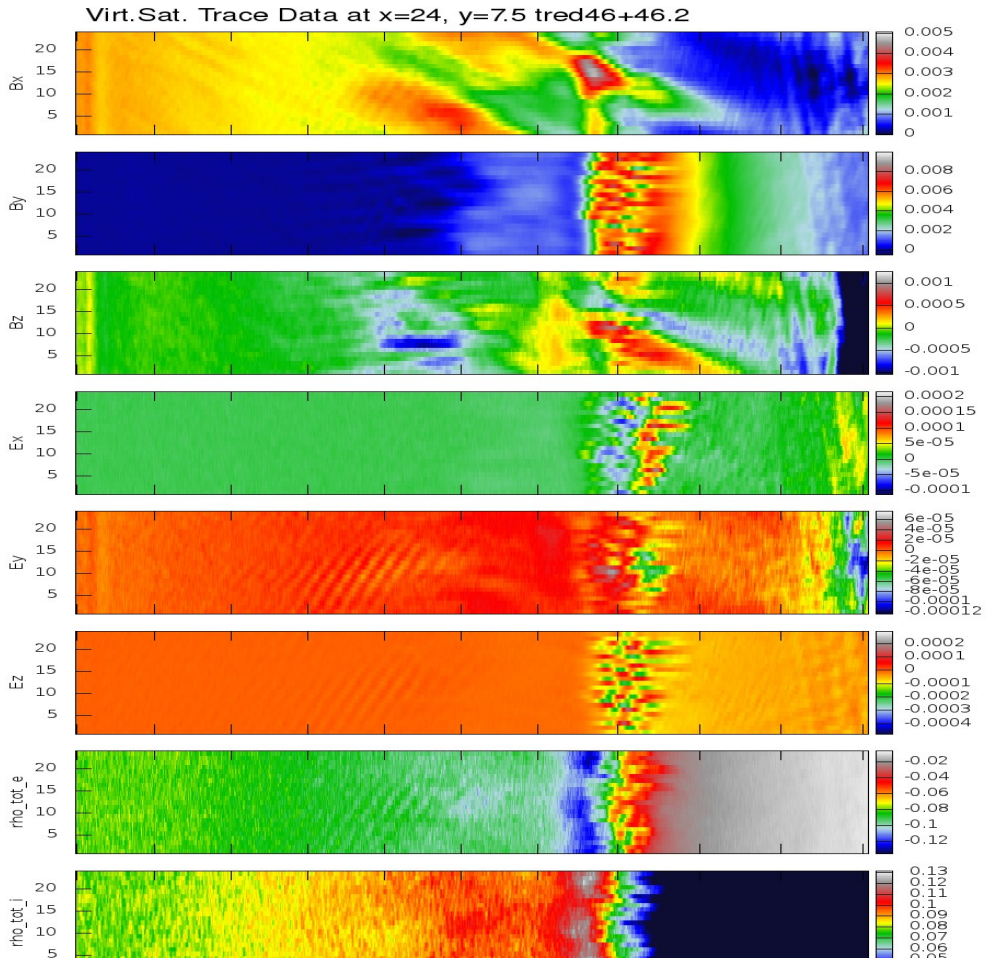
Virtual satel



7.5 z = 5

From Alex

X = 24, y = 7.5



From Alex

Difficulties

- Need to identify the point you want to study, and identity the rank that point is located
- Format of the Virtual satellites

We can provide scripts to solve these two problems.