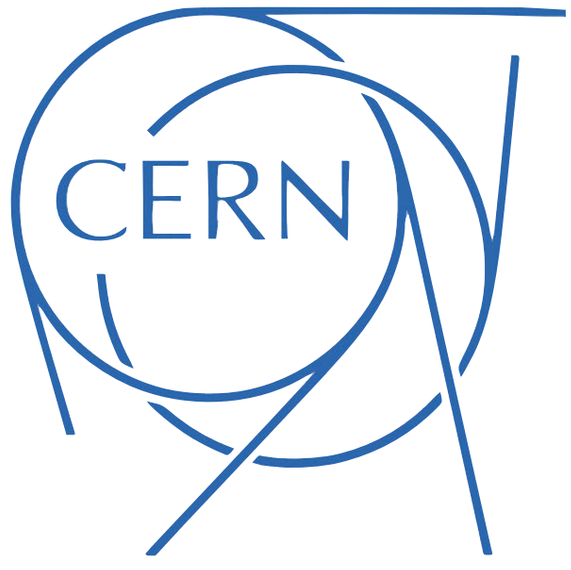
Cloud Chamber Workshop

Konrad Jende, Italian Teachers Programme 2014

Artistic view of a cosmic rays shower.
Credit: ASPERA/Novapix/L.Bret
Source: http://www.aspera-eu.org/index.php?option=com_content&task=view&id=290&Itemid=196



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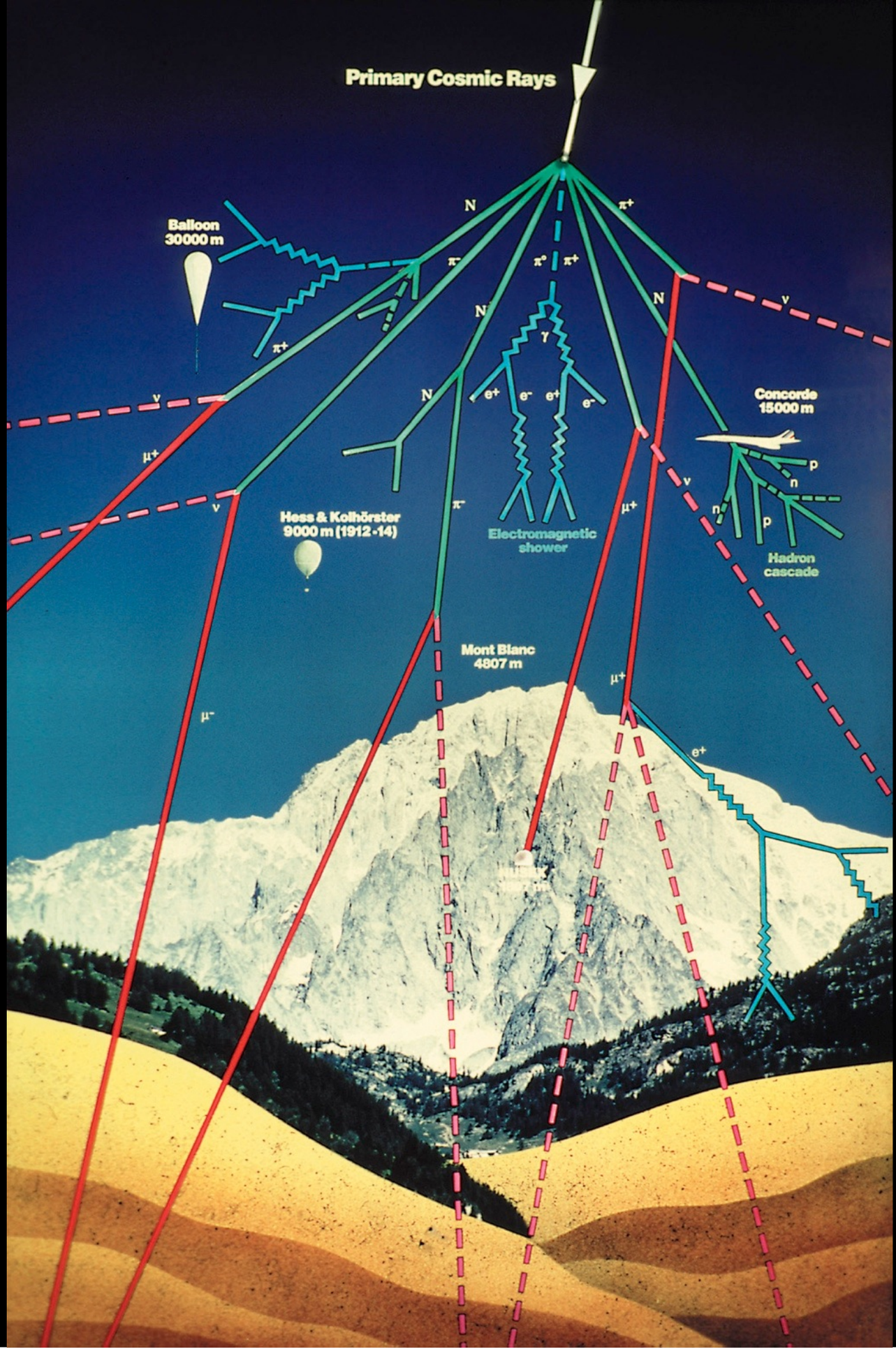
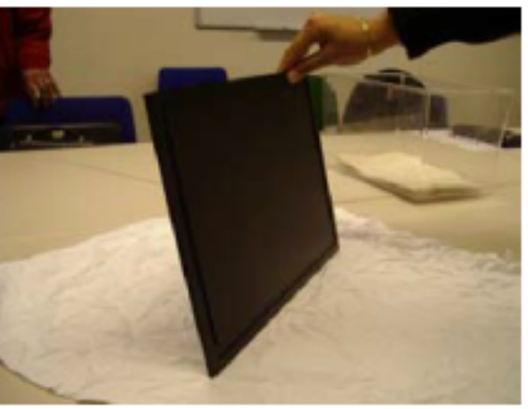


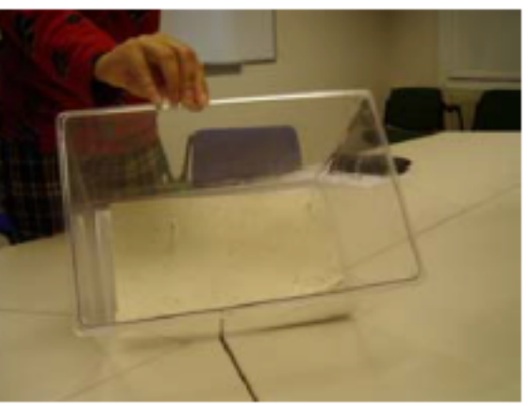
High energy cosmic rays striking atoms at the top of the atmosphere give the rise to showers of particles striking the Earth's surface

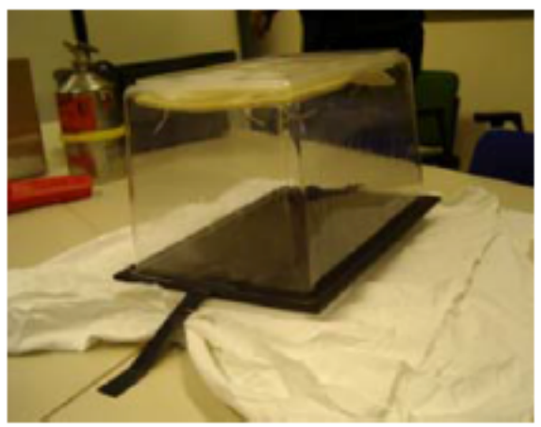
Source: http://cds.cern.ch/record/40407

Outline

1. Instructions
2. Build your cloud chamber
3. Explanations
4. Observation
5. Discussion
6. Another chamber ...





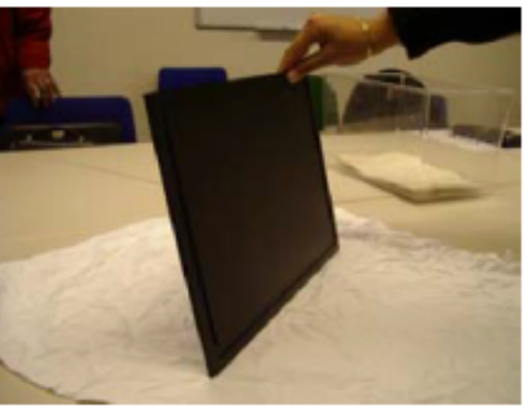


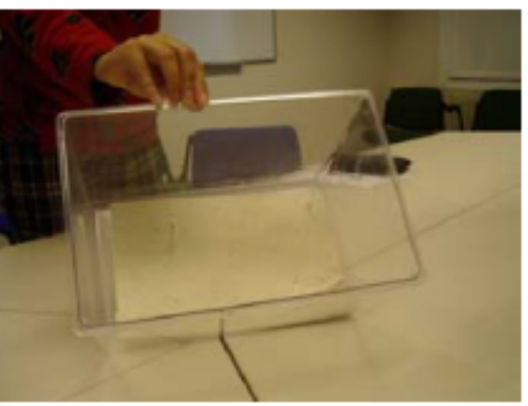
1. Instructions

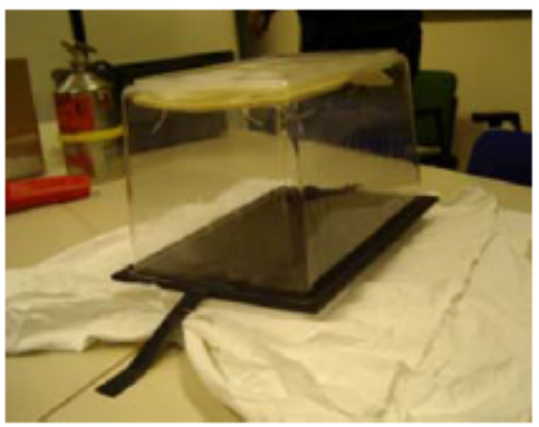
Shopping List

- ☐ A clear, see-through box-like plastic container, with flat sides and an open top, roughly 20 x 30cm (open side) x 15cm (height)
- ☐ A metal plate (at least 5mm thick) to cover the open size of the container completely (plate must be a little bit larger than the box). The plate should be preferably black and should have a little grooves matching the side walls of the plastic box. As this is probably hard to find, you can also use a flat metal plate and use black electrical tape to make the metal plate surface black.
- ☐ A thick felt (few mm), a bit smaller than the bottom of the box.
  4 clips (self-adhesive cable-tie holders + cable ties) to attach the felt to the inside of the bottom of the box
- ☐ A small wooden box that is just a little bit larger in area than the metal plate and approx. 5cm in height. The box later on has to take the ice plates and the metal plate but the sides should not be much higher so that it doesn't cover the plastic box.
- ☐ A very intense, bundled light source, e.g. a slide projector, strong flashlight ...
- ☐ Pure (not 70%) isopropyl alcohol – make sure you get the right one – it will only work well with this one it and keep it out of reach of children).
- ☐ Dry Ice (Careful with your hands – always use thick gloves and never touch the ice directly! The ice is at -78oC; touching it directly will give you a burn.)
- ☐ Security goggles to handle the ice
  Gloves to handle the ice and the alcohol

2. Build your cloud chamber







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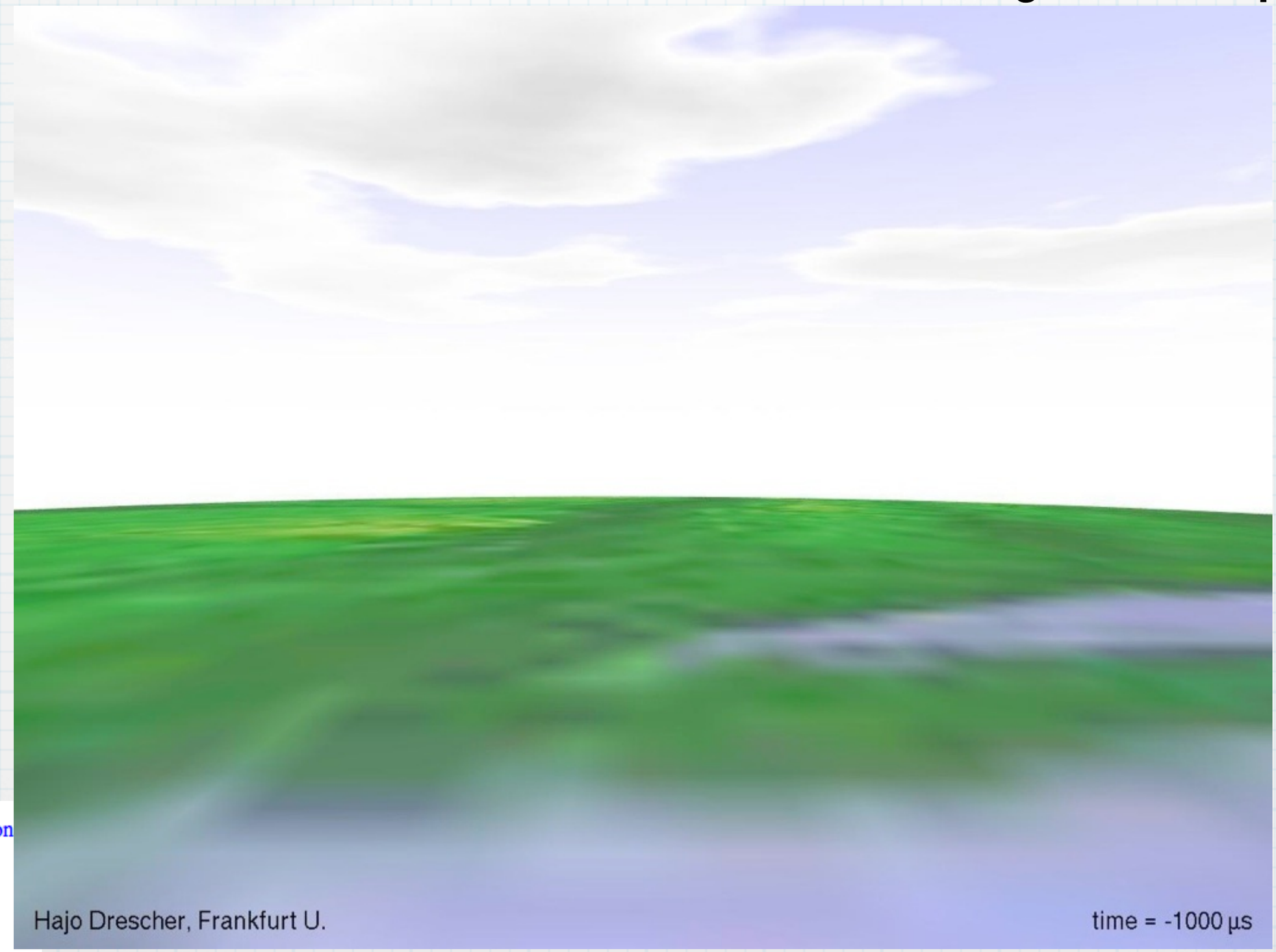
3. Explanations

Air Shower Simulation

blue:electrons/positrons
cyan:photons
red:neutrons
orange: protons
gray: mesons
green:muons

3. Die Teilchen dieser Welt und ihre Eigenschaften

I. Die endliche Lebensdauer von Teilchen - ein alltägliches Beispiel



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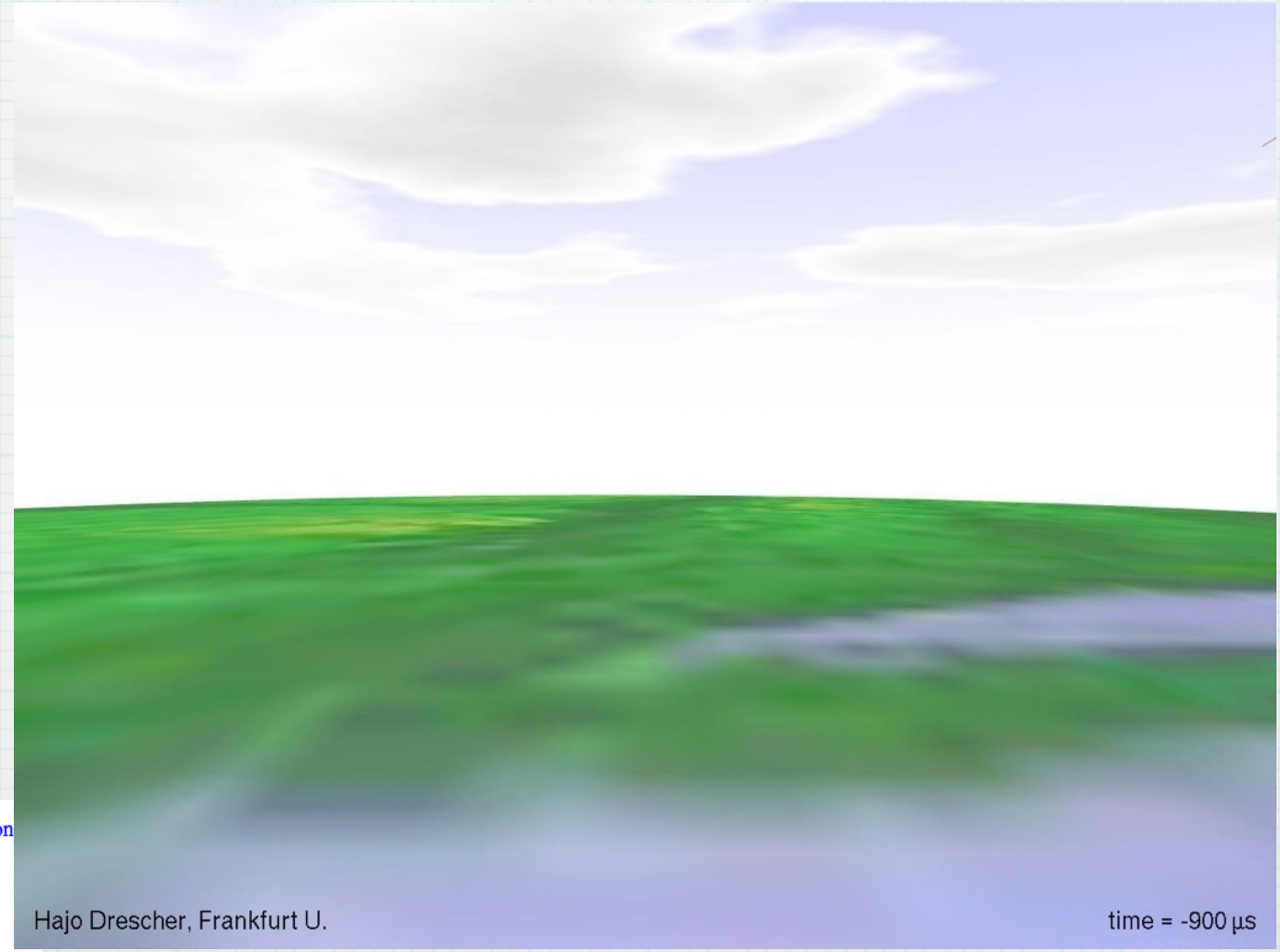

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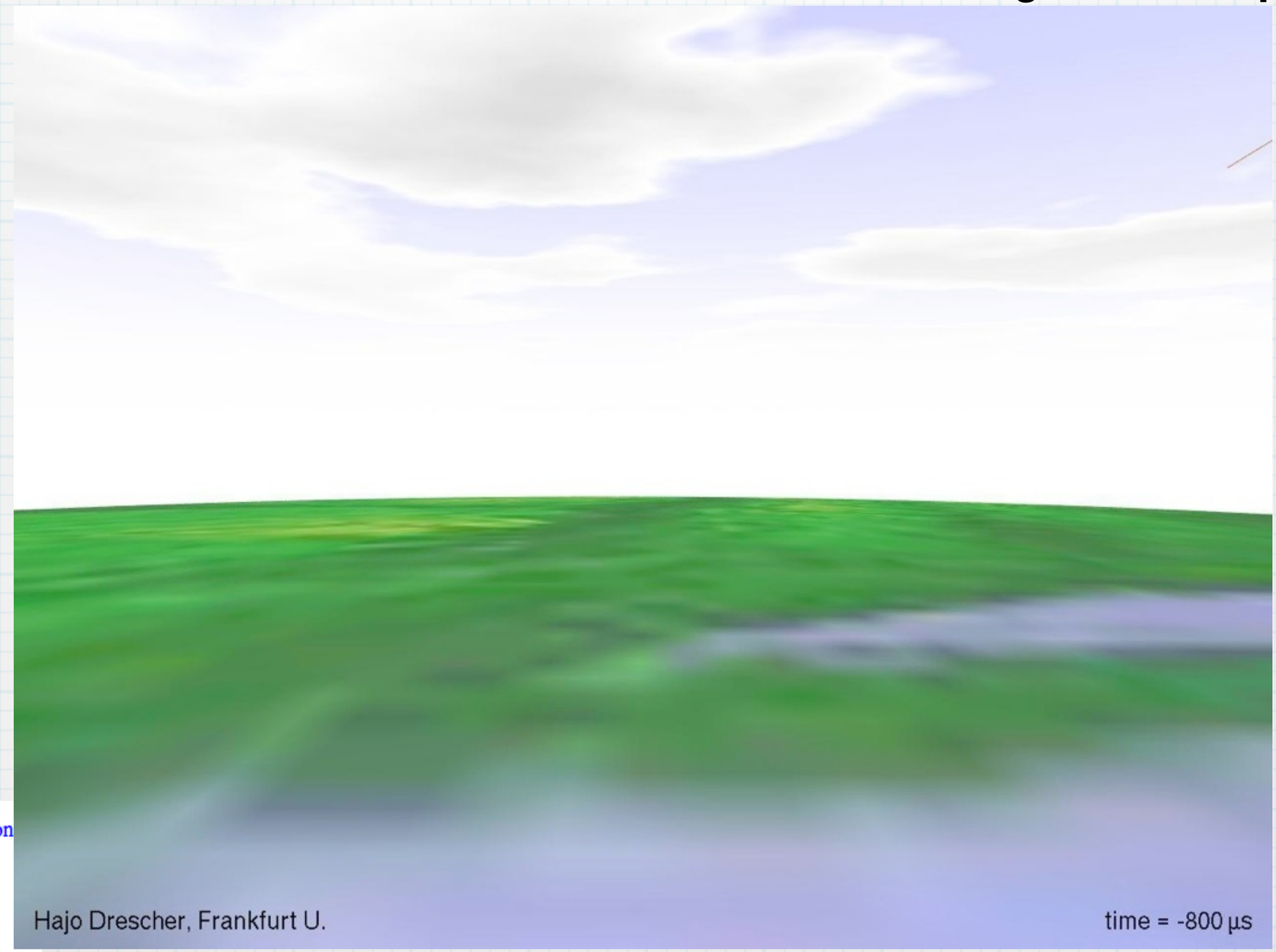

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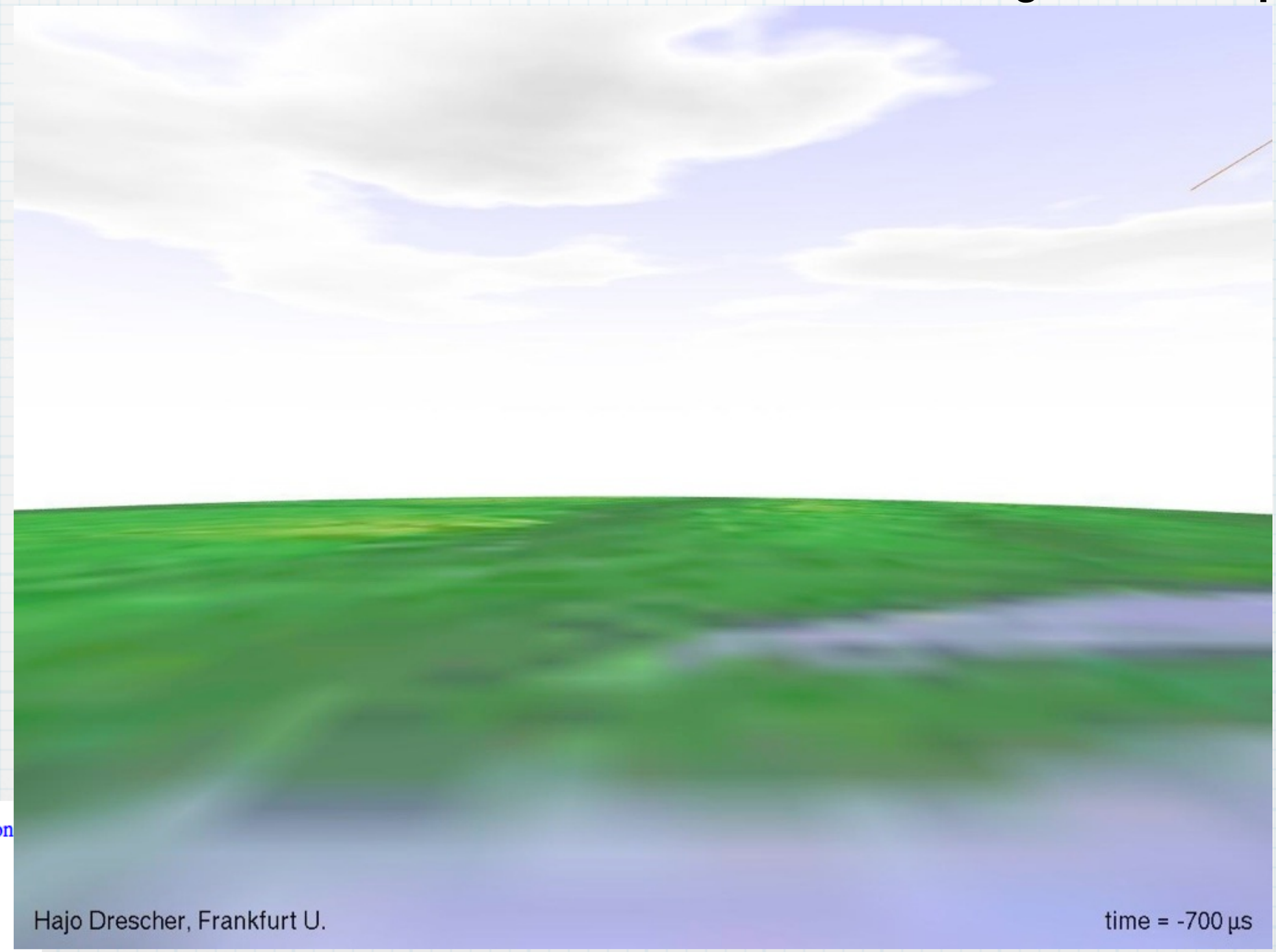

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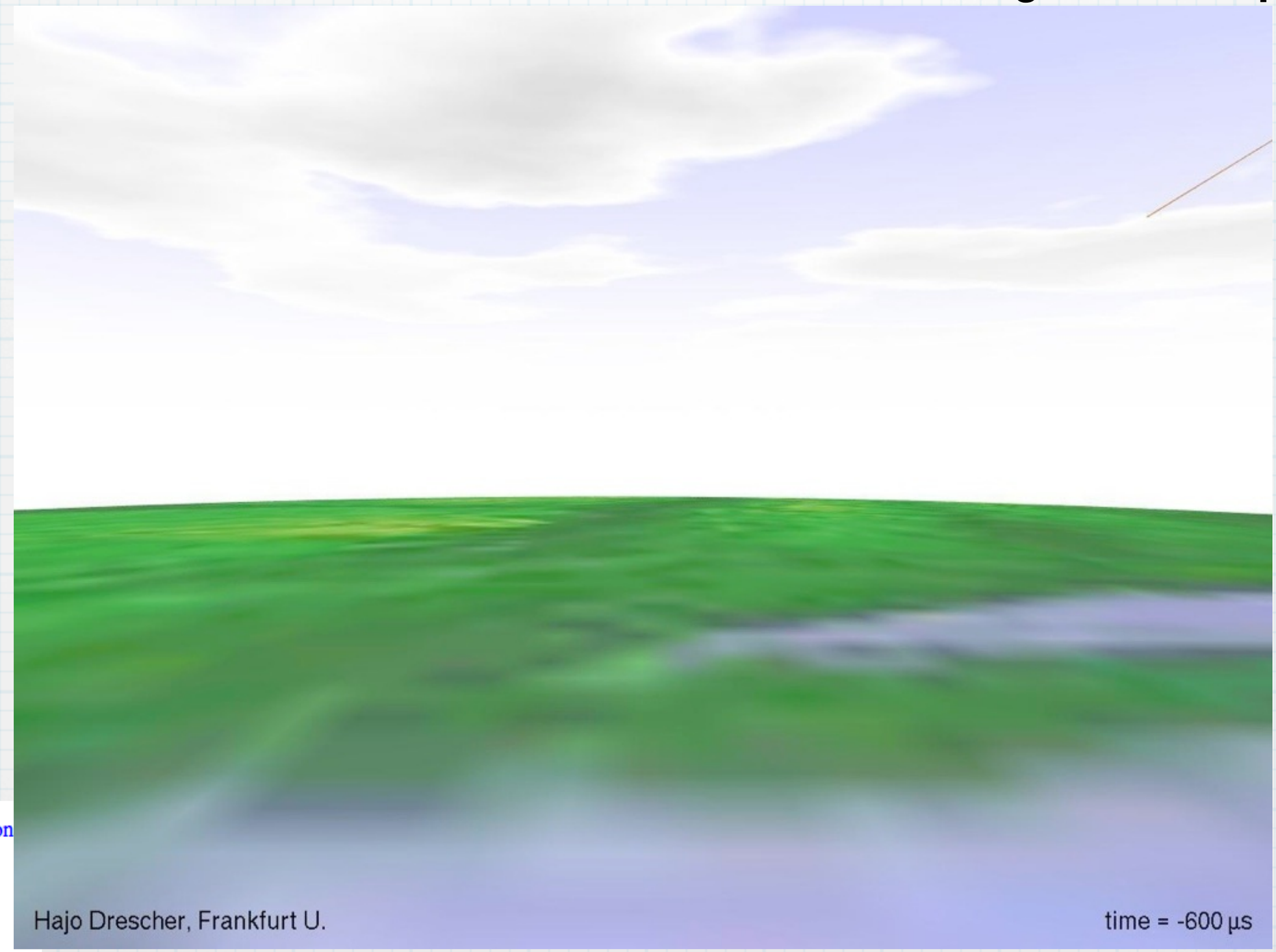

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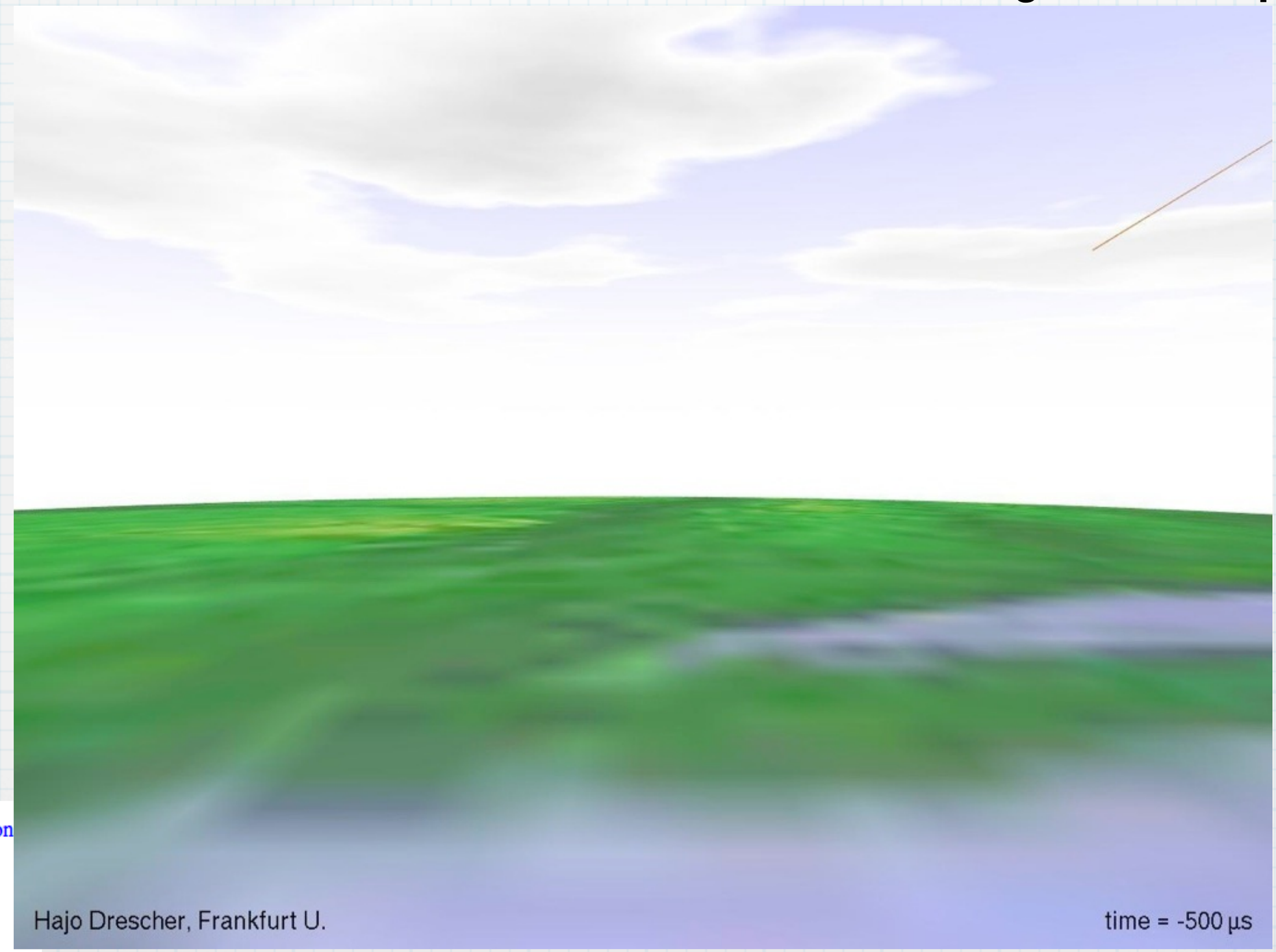

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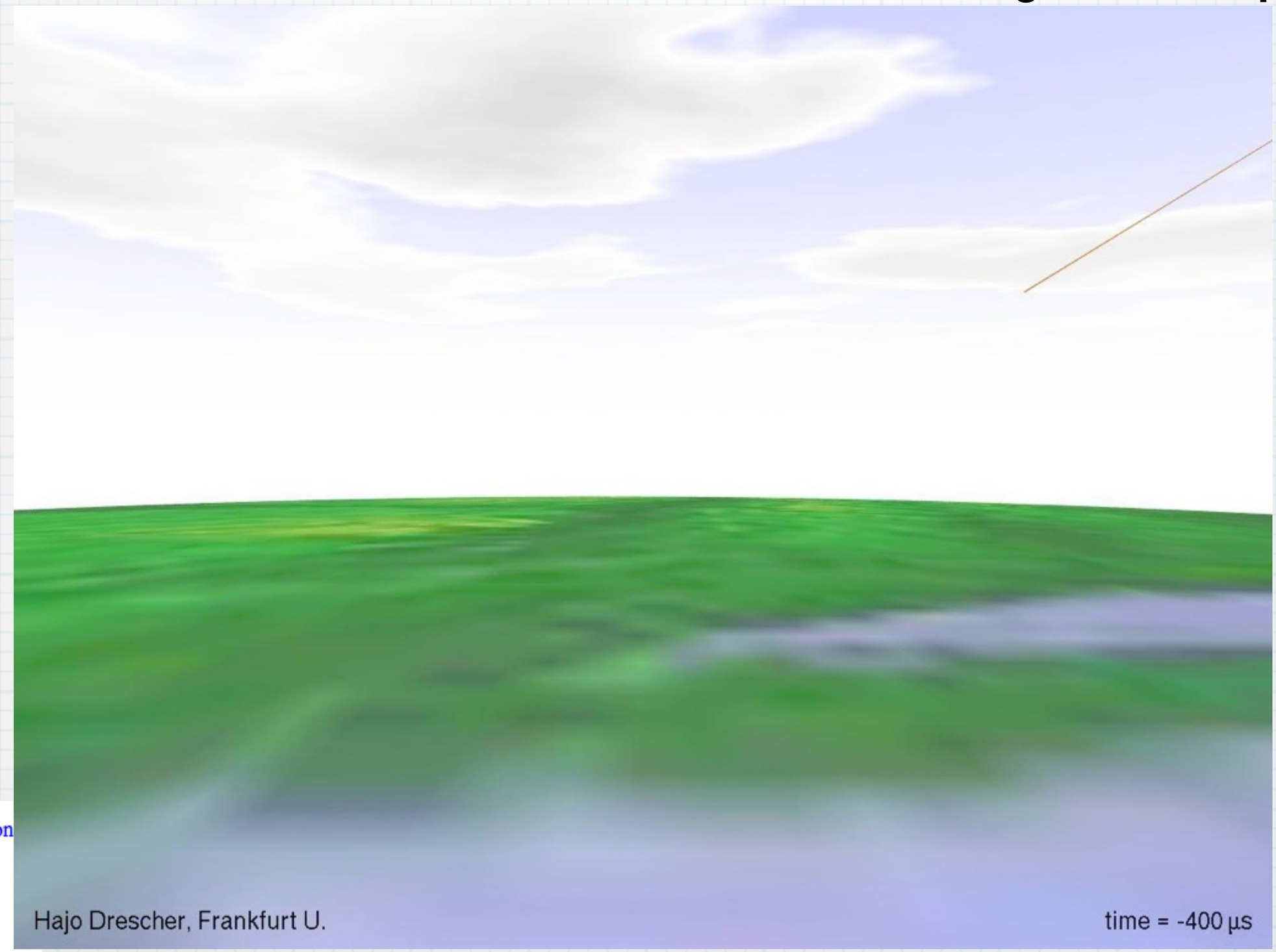

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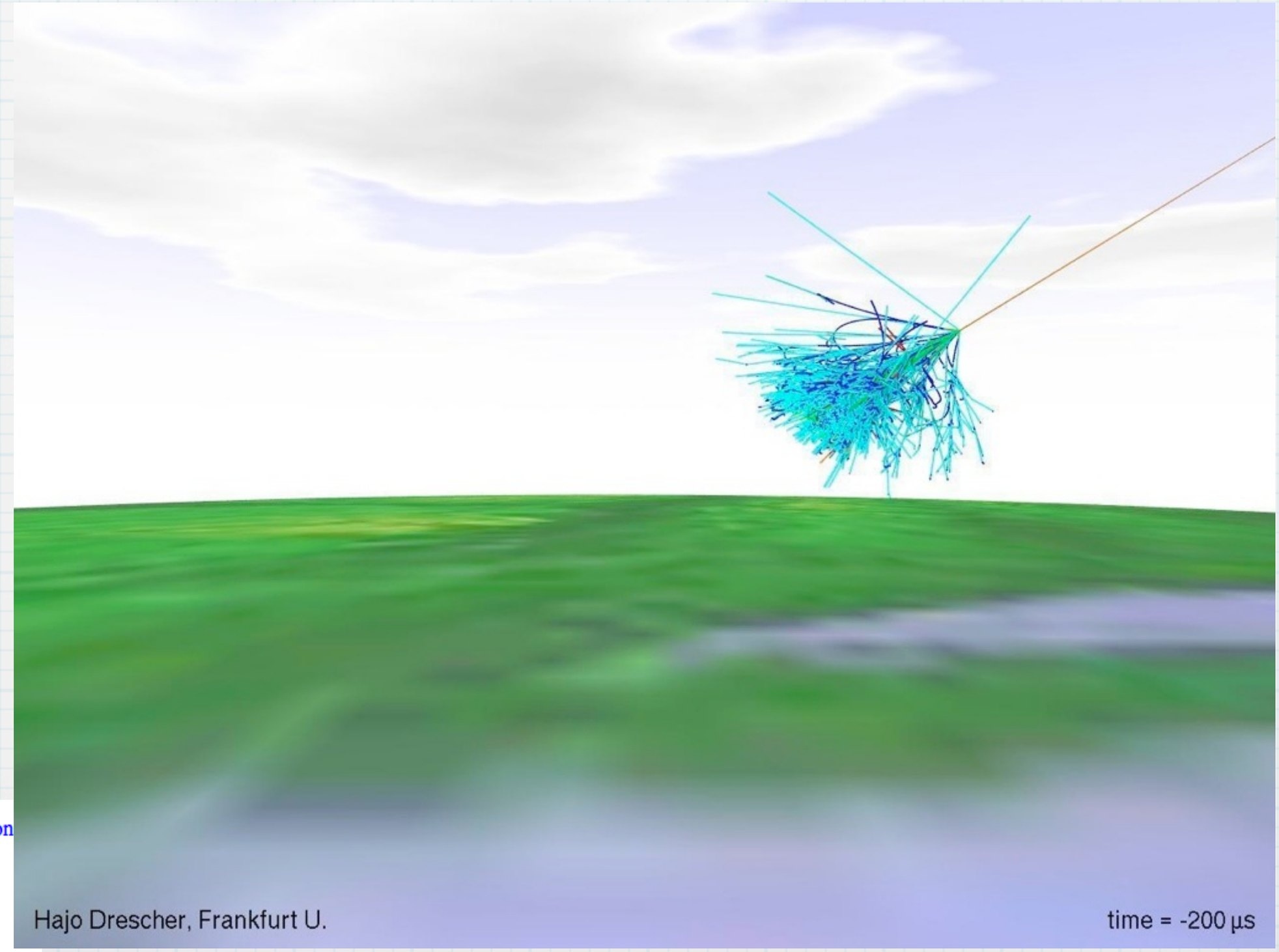

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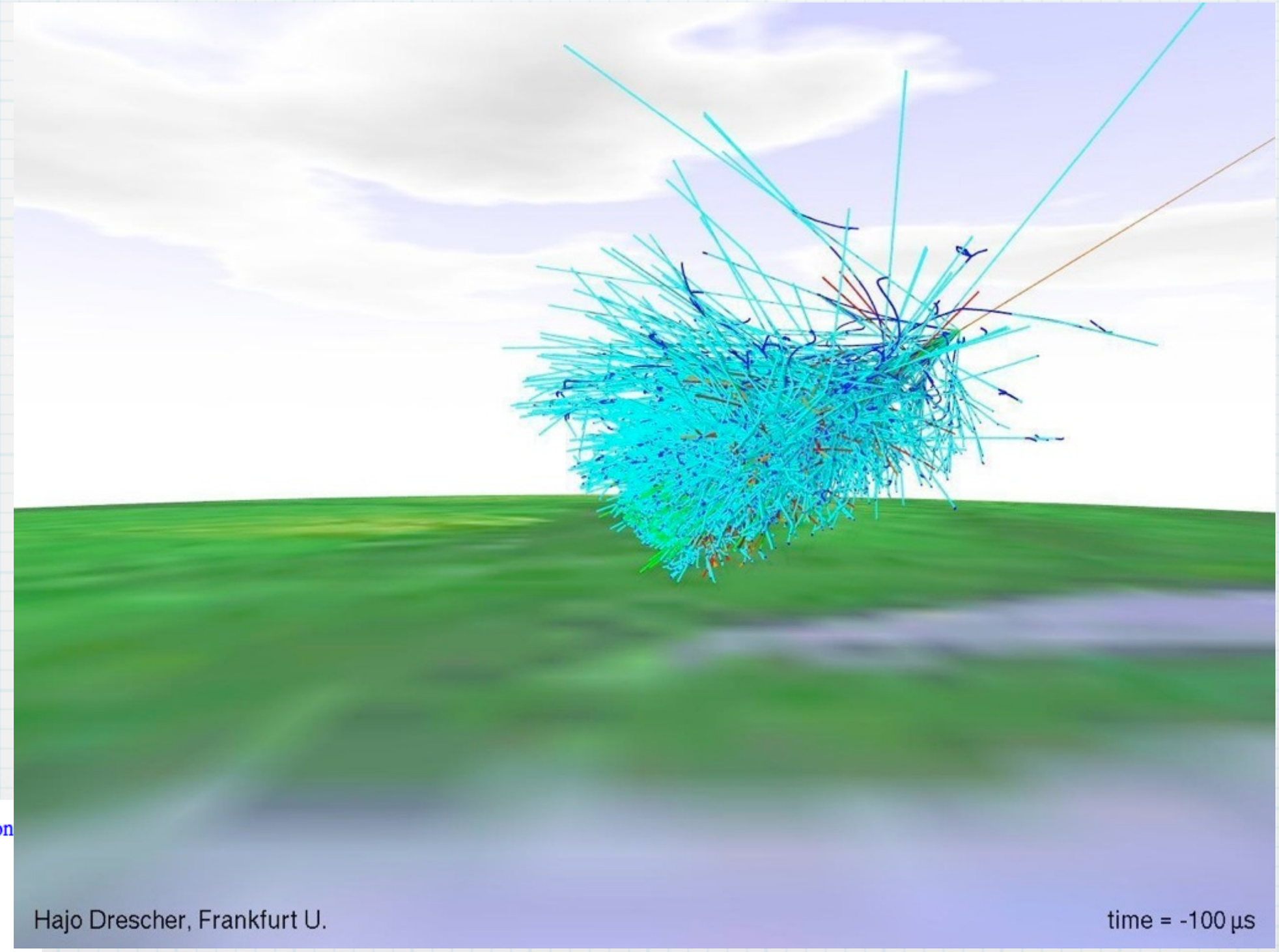

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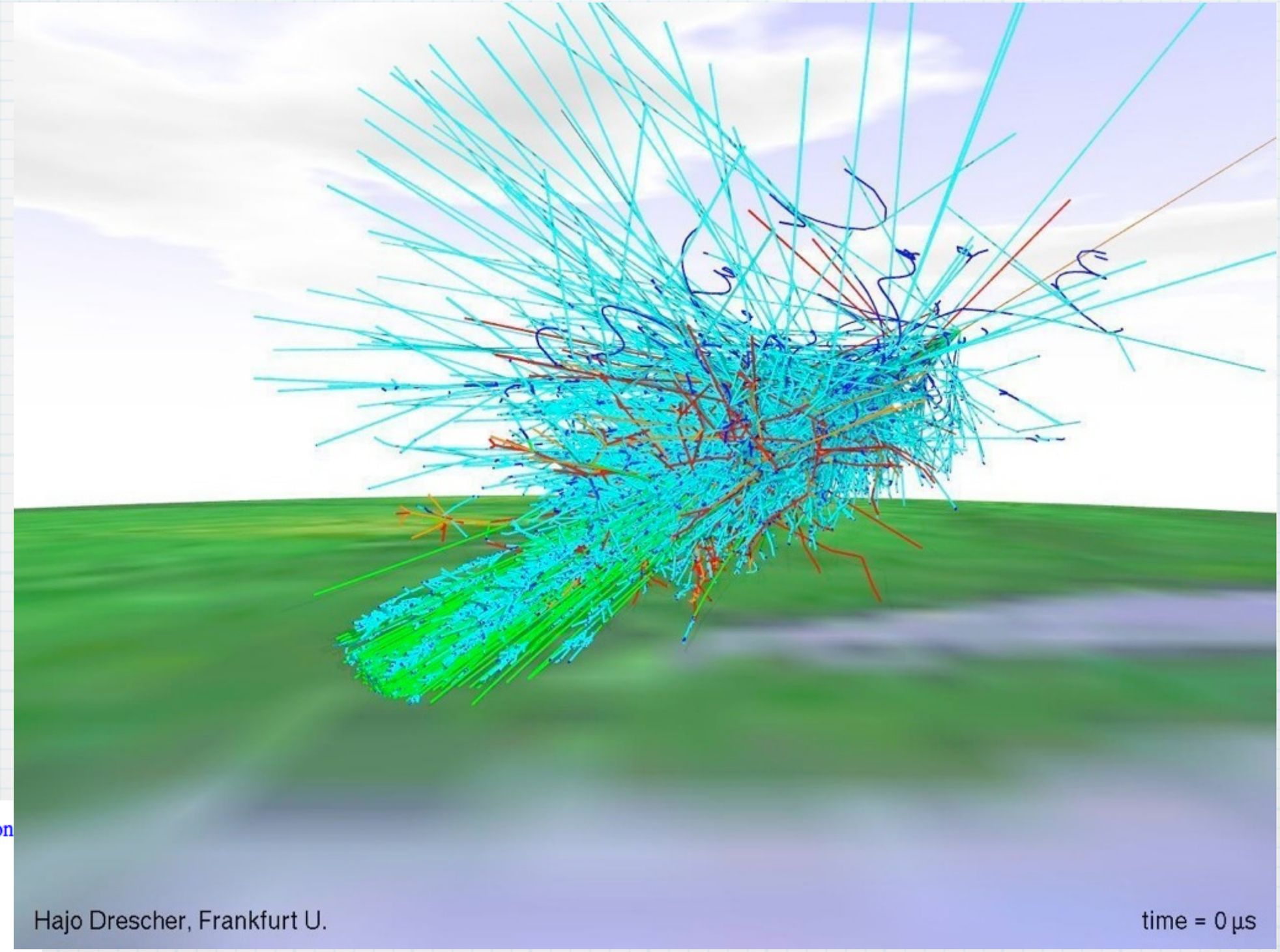

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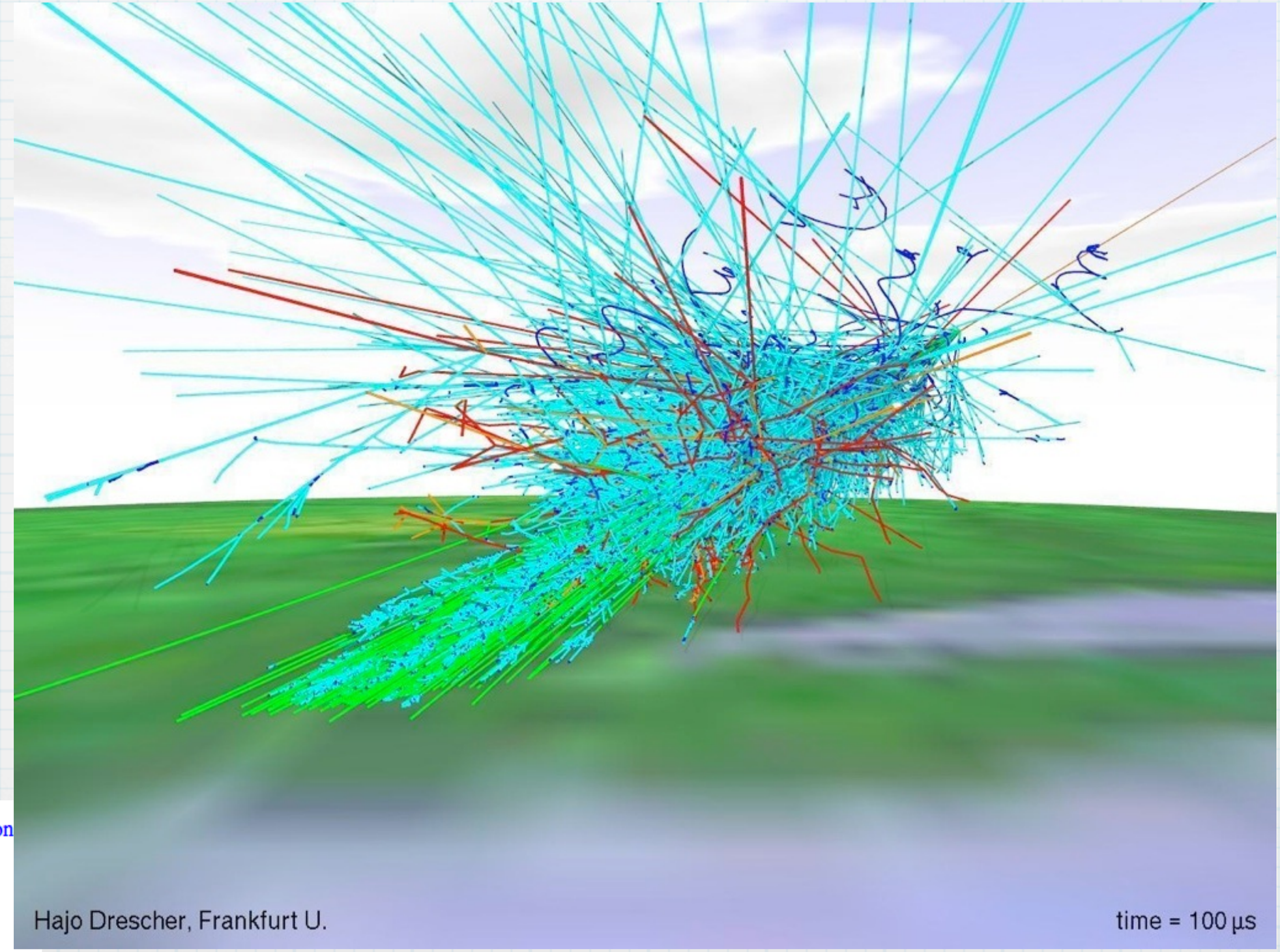

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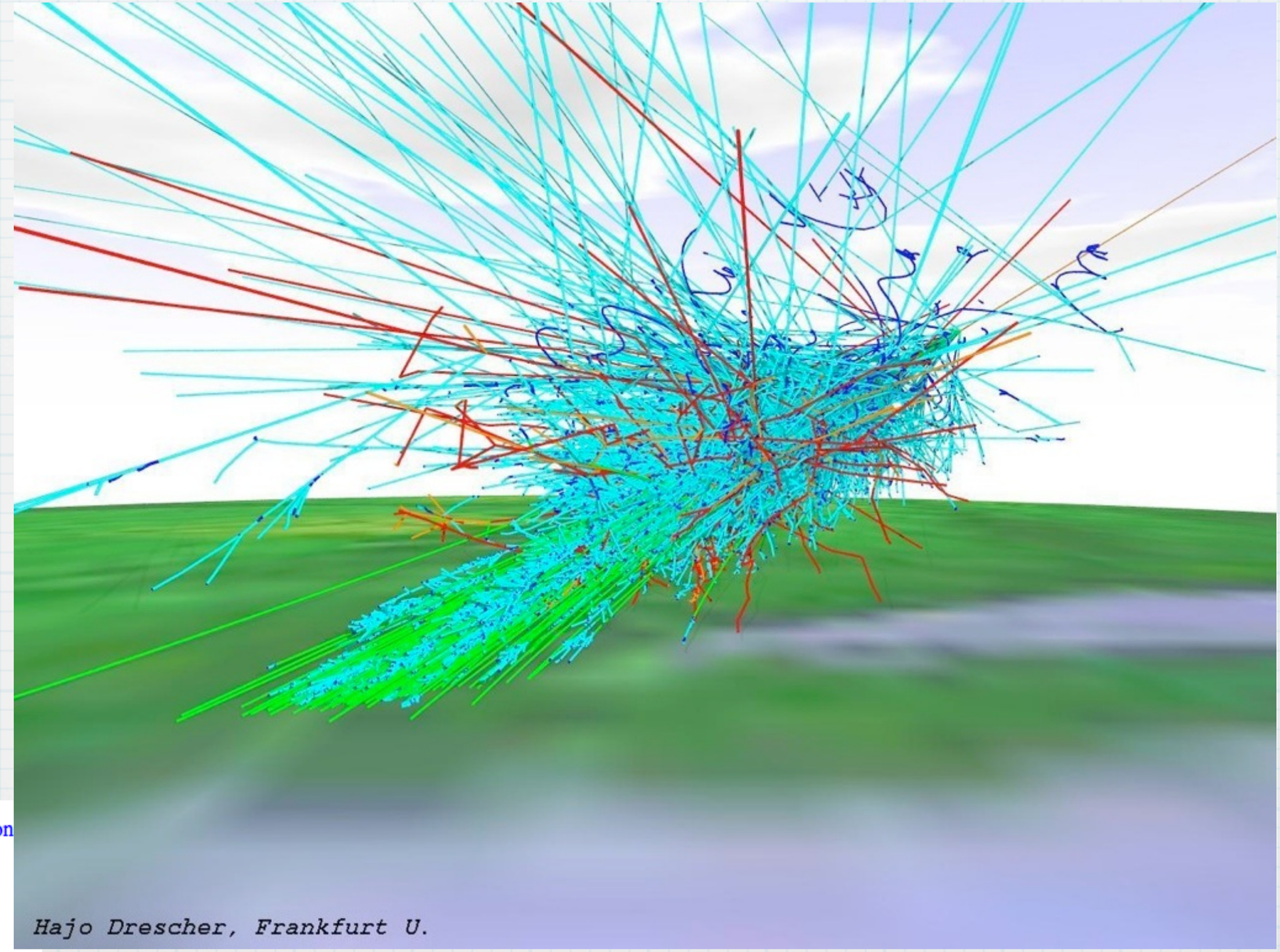

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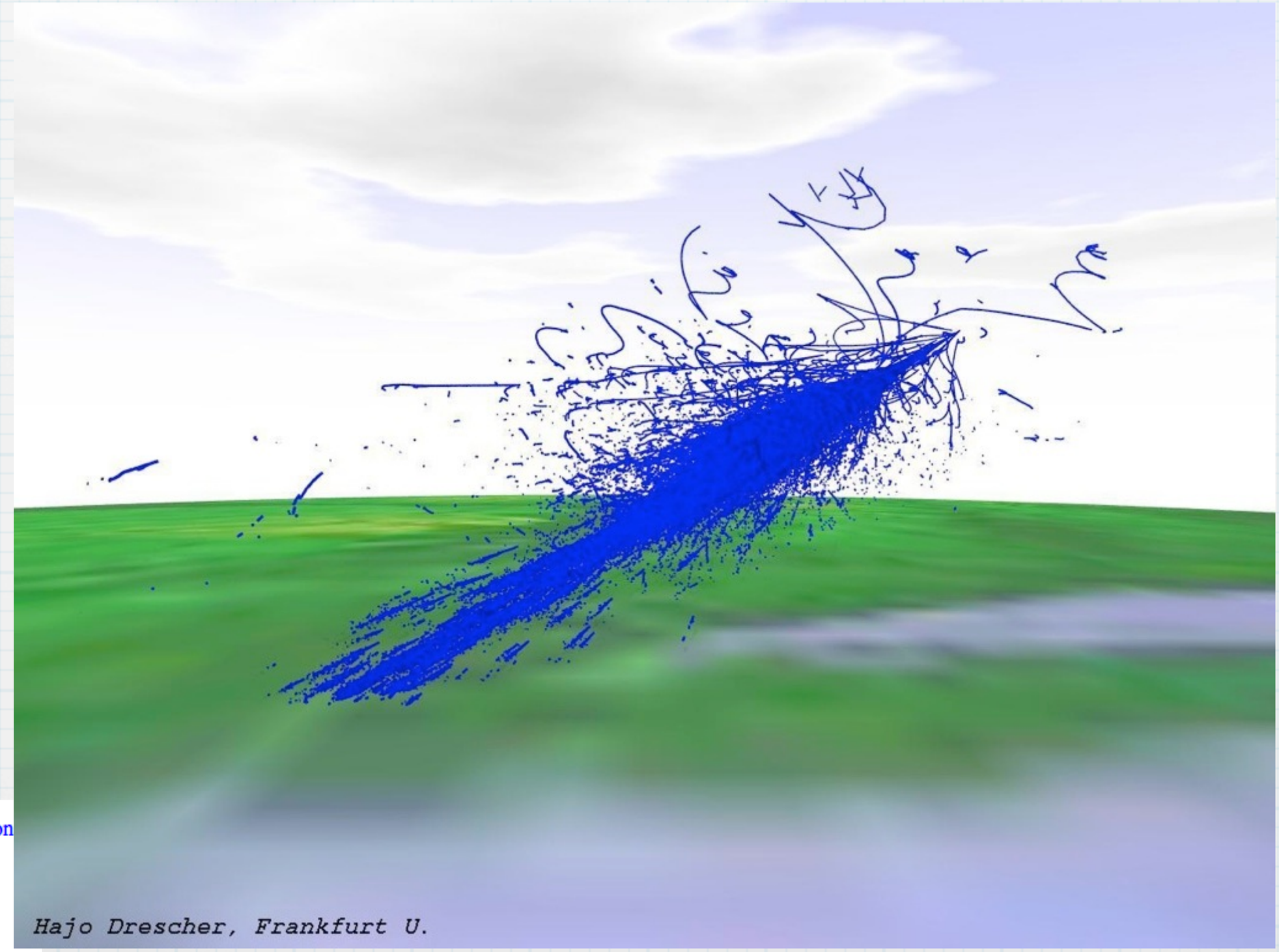

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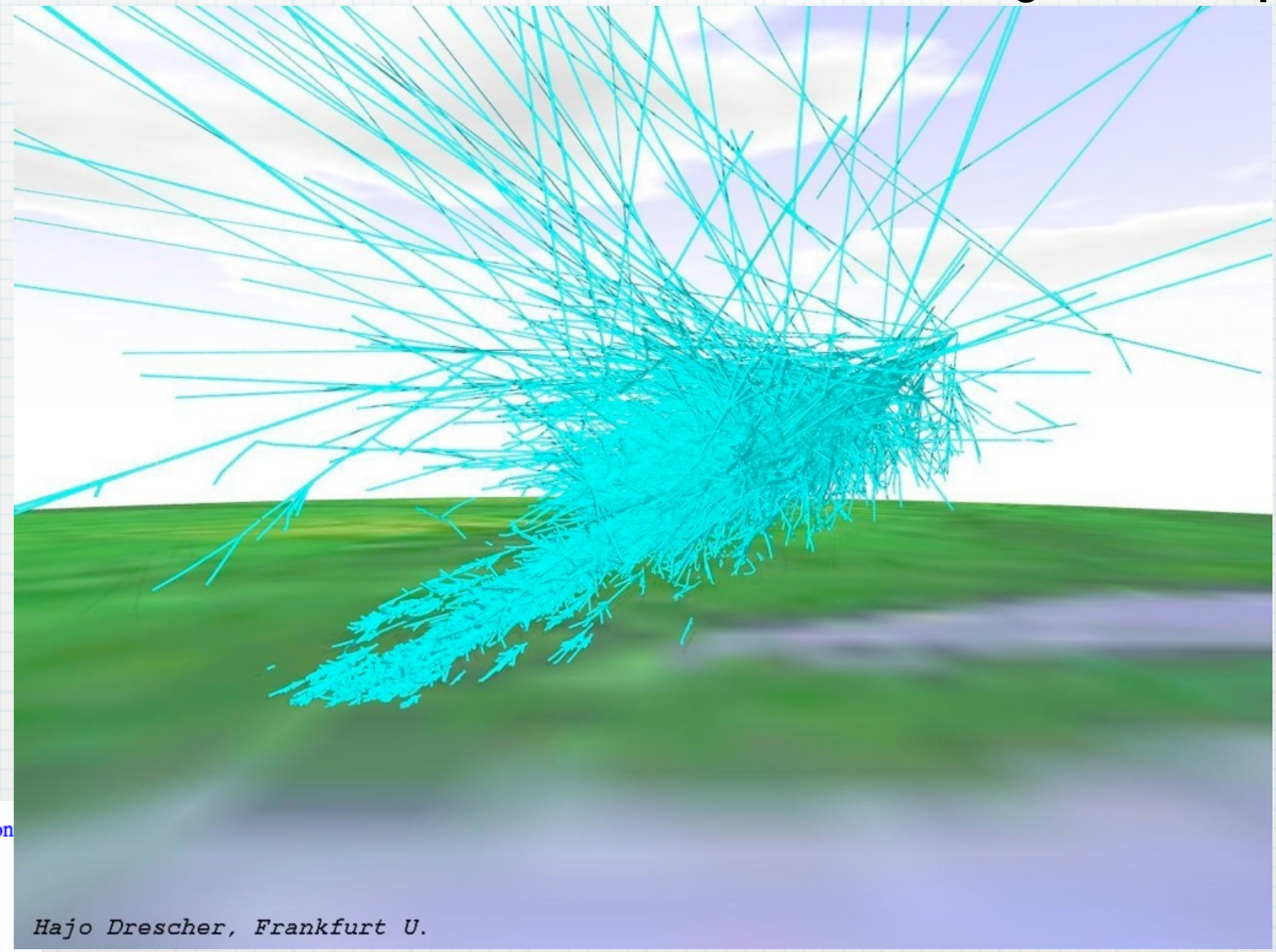

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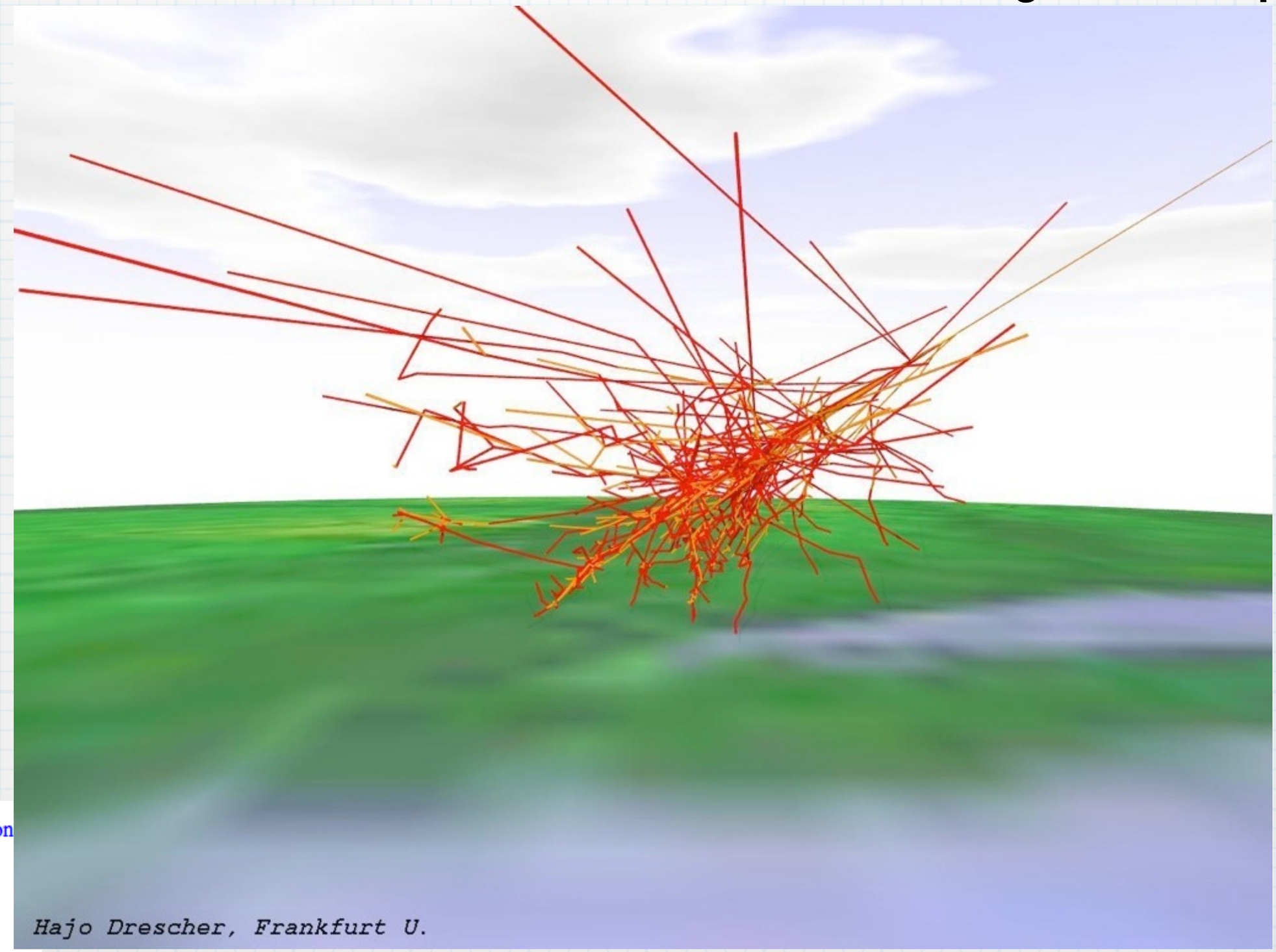

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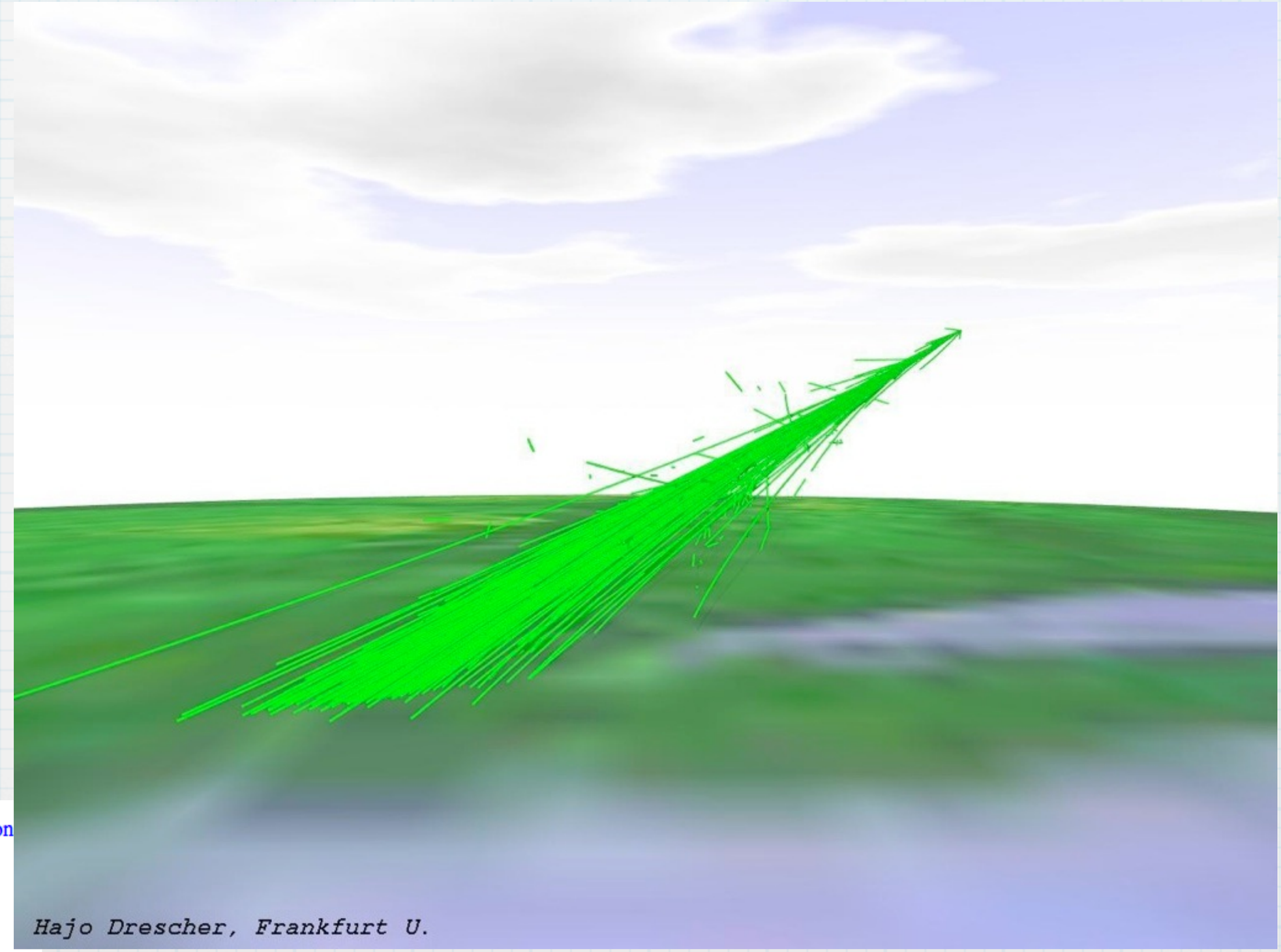
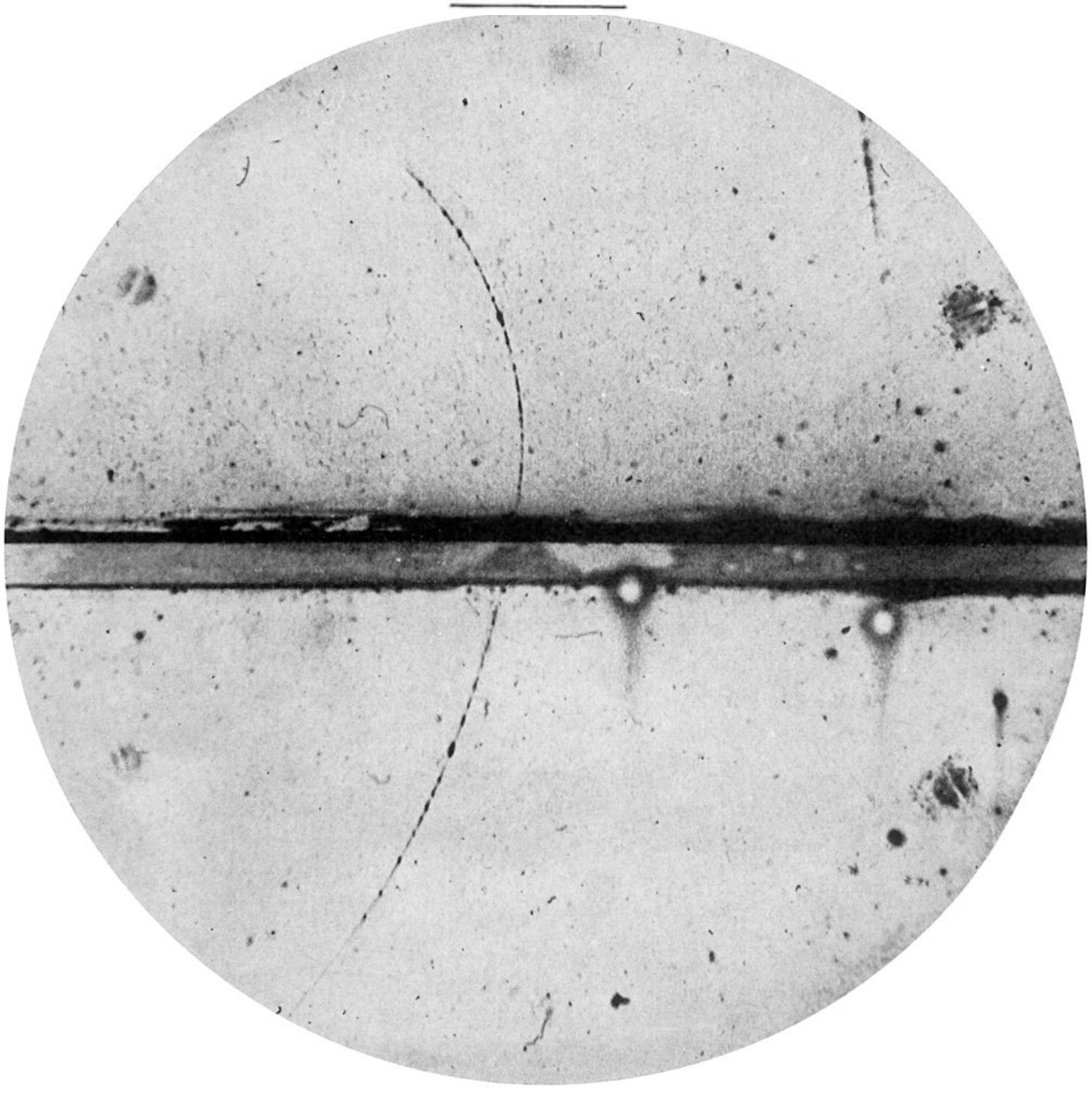


The Positive Electron

CARL D. ANDERSON, *California Institute of Technology, Pasadena, California*
(Received February 28, 1933)

Out of a group of 1300 photographs of cosmic-ray tracks in a vertical Wilson chamber 15 tracks were of positive particles which could not have a mass as great as that of the proton. From an examination of the energy-loss and ionization produced it is concluded that the charge is less than twice, and is probably exactly equal to, that of the proton. If these particles carry unit positive charge the curvatures and ionizations produced require the mass to be less than twenty times the electron mass. These particles will be called positrons. Because they occur in groups associated with other tracks it is concluded that they must be secondary particles ejected from atomic nuclei.

Editor



Carl D. Anderson (1905–1991) - Anderson, Carl D. (1933). "The Positive Electron". Physical Review 43 (6): 491–494. DOI:10.1103/PhysRev.43.491.

Cloud chamber photograph of the first positron ever observed Original caption: A 63 million volt positron passing through a 6 mm lead plate and emerging as a 23 million volt positron. The length of this latter path is at least ten times greater than the possible length of a proton path of this curvature.

Further experiments at CERN

ATLAS collision point

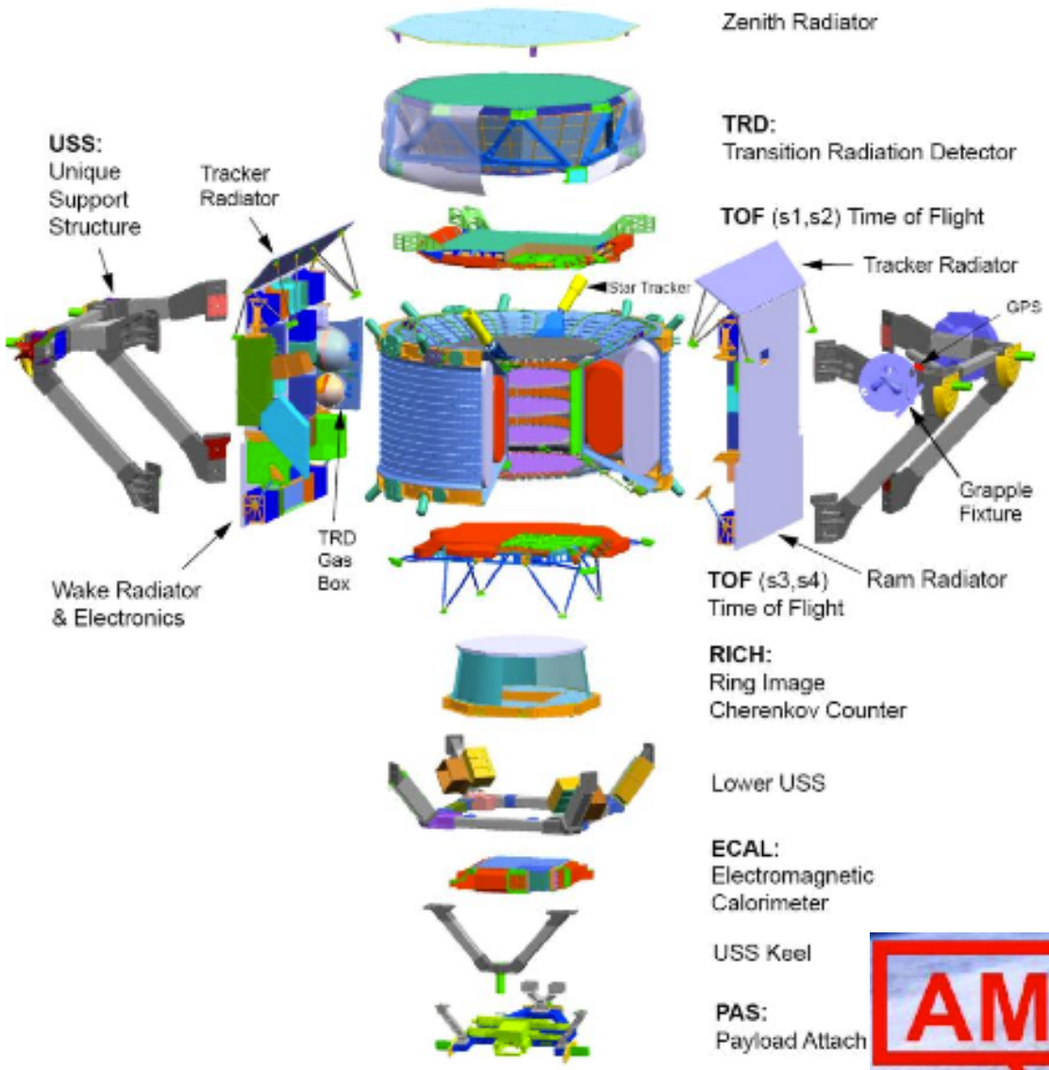
LHCf detector 2

LHCf detector 1

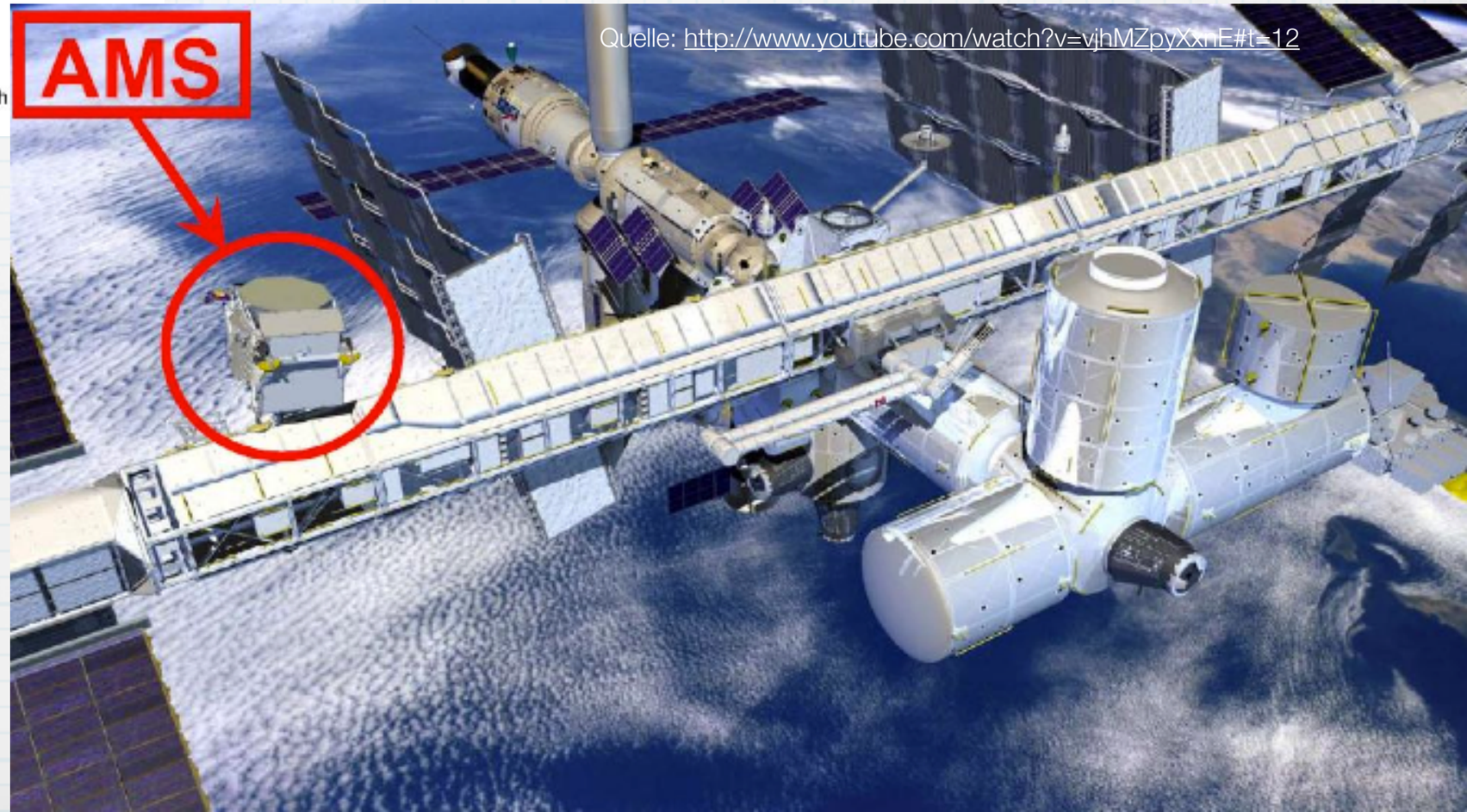
Neutral secondary particles

LHCf experiment at LHC - small (length: 30cm, mass: 70kg) but effective

Source: http://cds.cern.ch/record/1518935/files/CERN-Brochure-2012-008-Eng.pdf



Video auf Folie 10: “**STS 134 Space Shuttle Endeavour AMS 02 Install timelapse**”



Quelle: http://www.youtube.com/watch?v=vjhMZpyXxnE#t=12

4. Observations

Tasks:

Observe with your cloud chamber.

Describe (shape, length, width, ...) which tracks you see.

Guess which particles create which tracks.

5. Discussion

At the whiteboard we discuss your results - Follow me!

Further Readings

C. T. R. WILSON: On an Expansion Apparatus for Making Visible the Tracks of Ionising Particles in Gases and Some Results Obtained by Its Use. Proc. R. Soc. Lond. A. 1912 87 277-292 doi:10.1098/rspa.1912.0081 (published 19 September 1912)

Credits

CERN Cloud chamber workshop developed by:

D. BERTOLA , M. CIRILLI , J. FLAMMER , G. SCHLAGER , S. SCHUH , P. SCHUNE , M. STORR

Konrad Jende - konrad.jende@cern.ch

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6. Another chamber ...

If you are able to spend 23.000 CHF ... but have a look.

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