



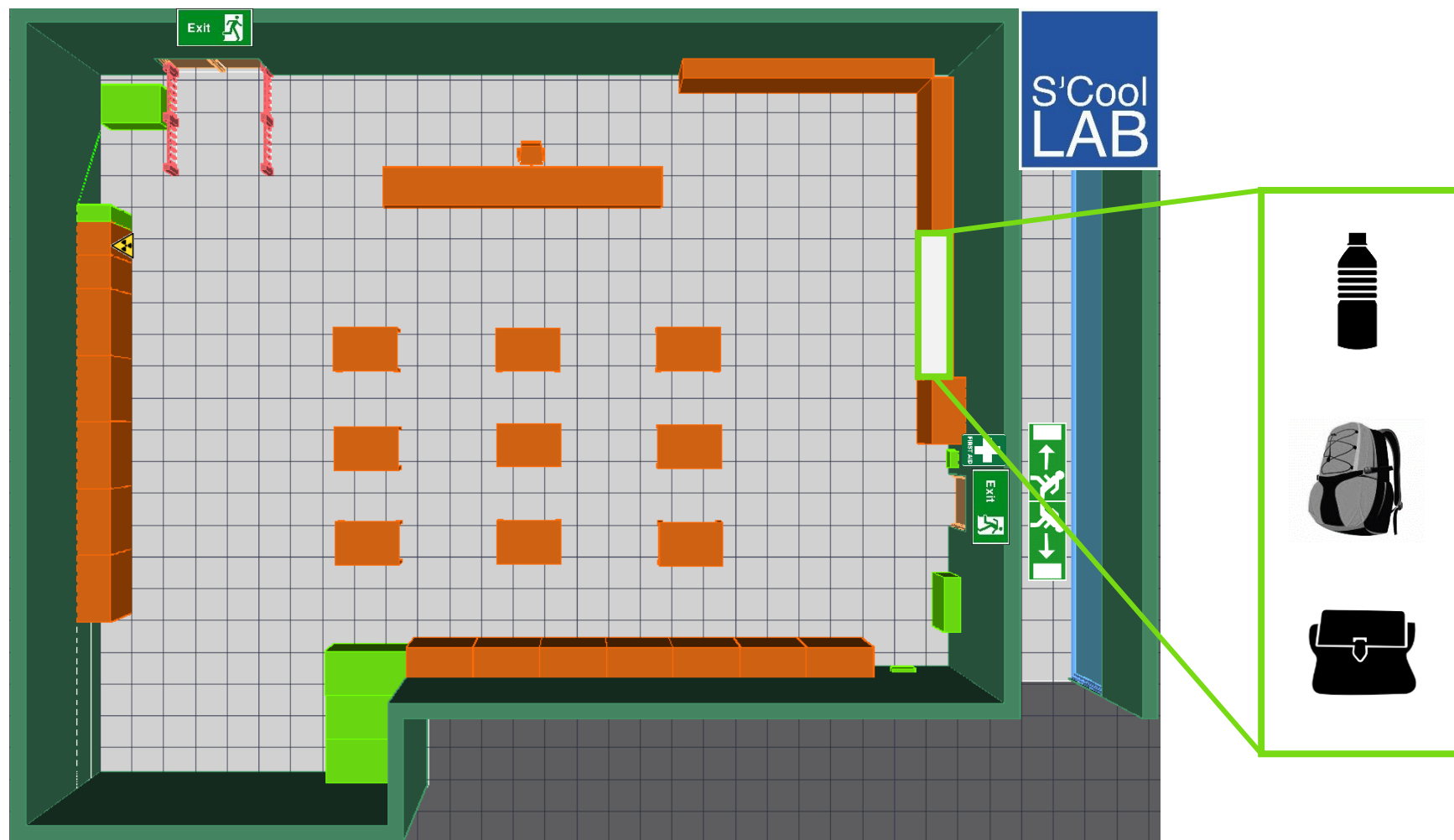
S'Cool
LAB

Welcome to the
International Cosmic Day!

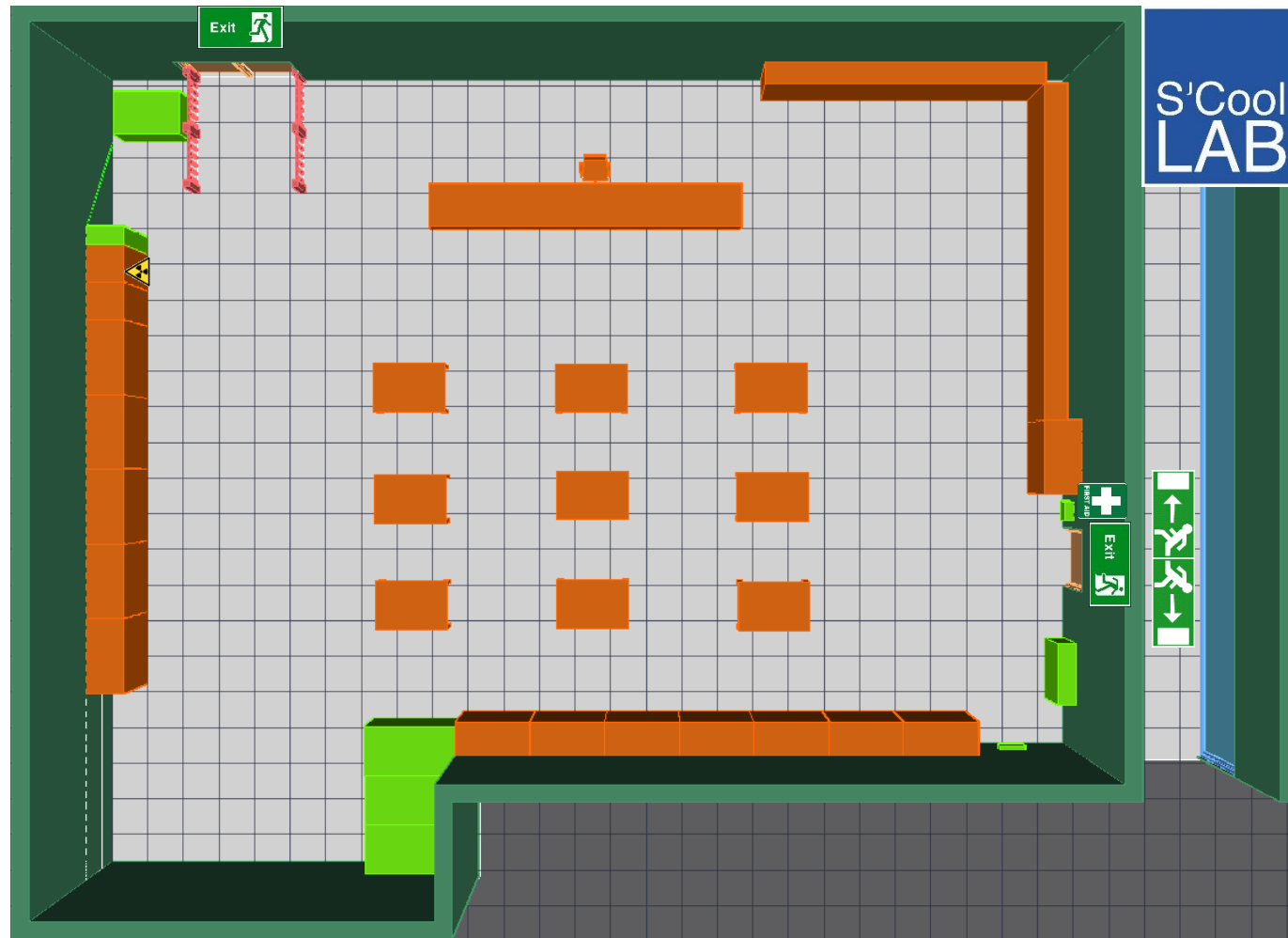
Rules in S'Cool LAB



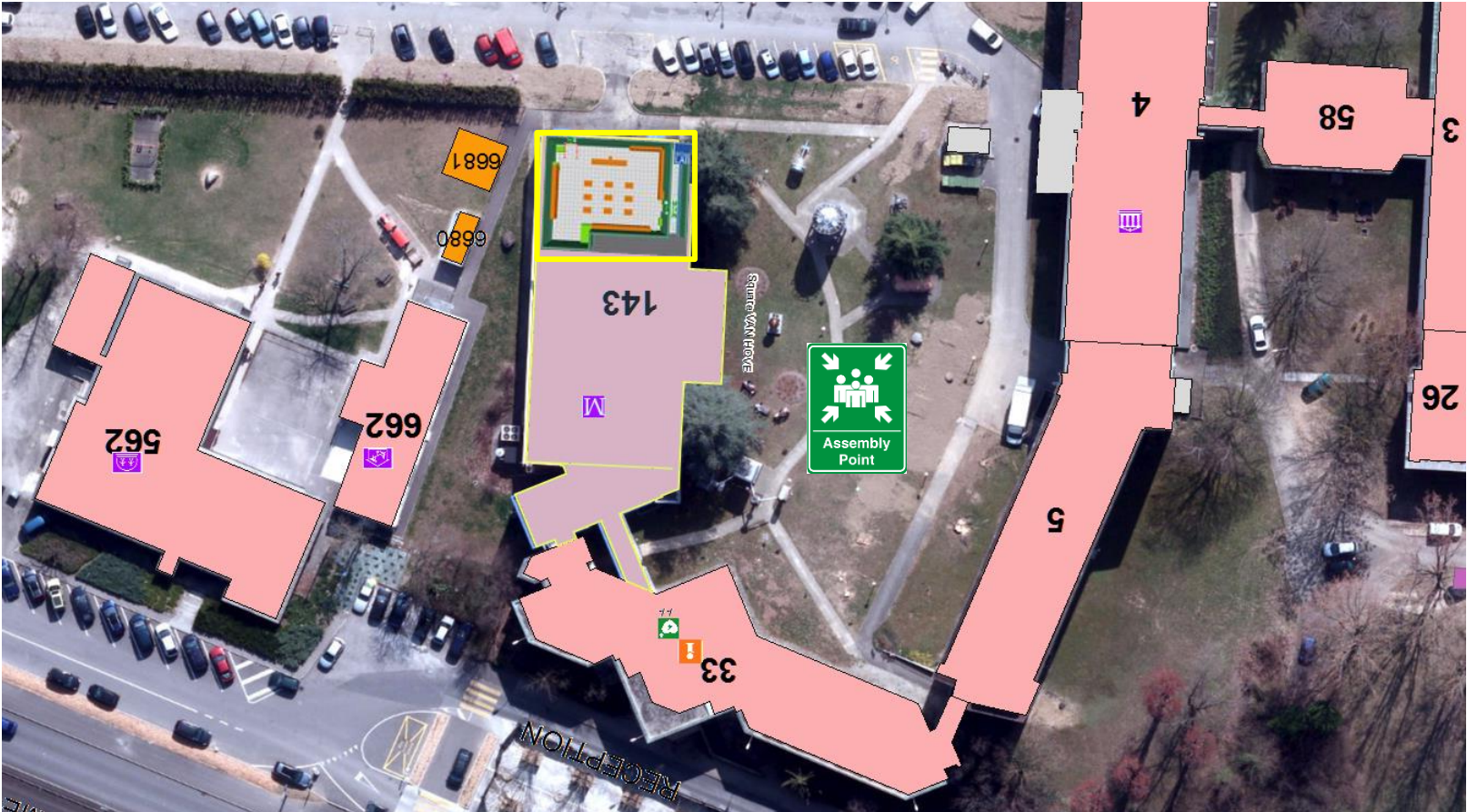
Bags



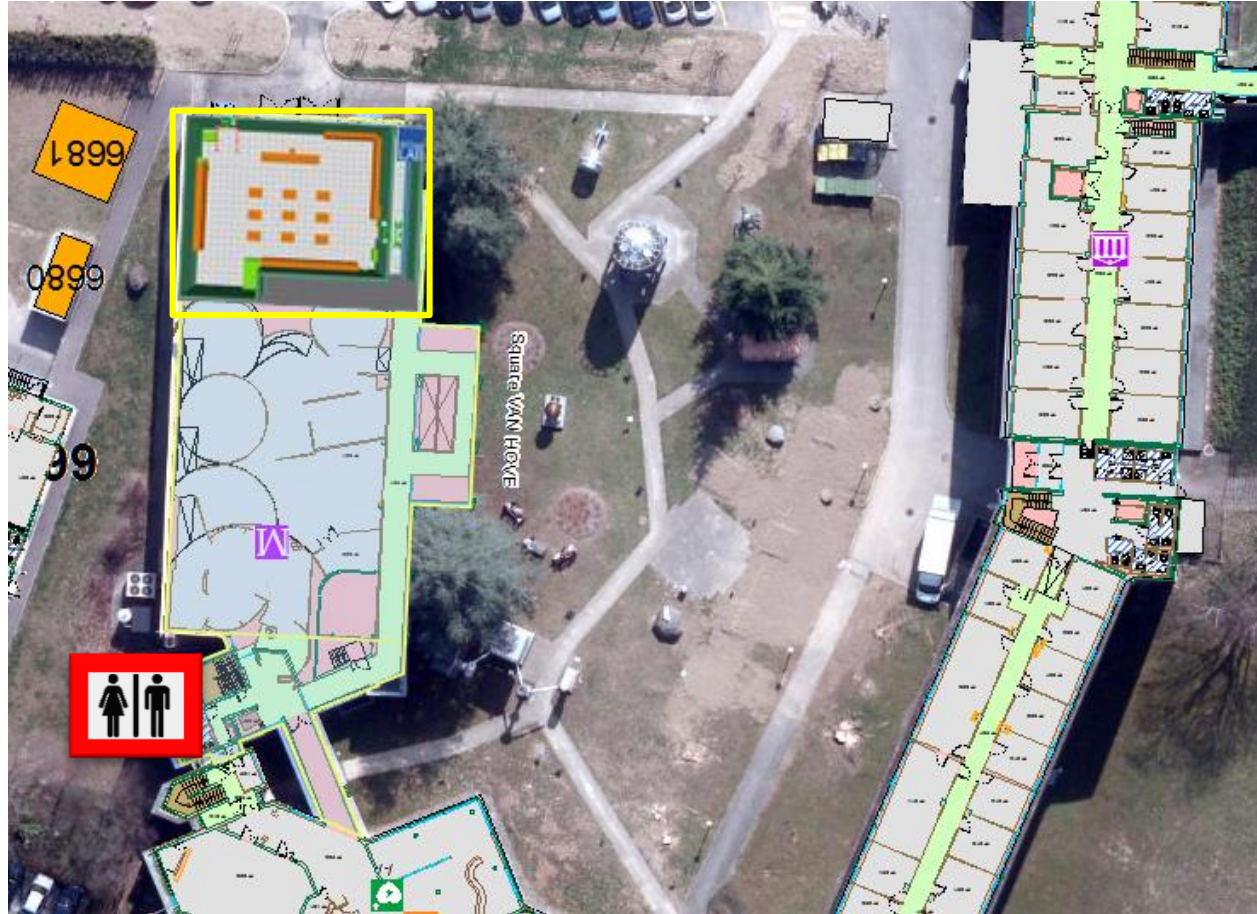
Emergency exits



Assembly point



Rest rooms



Schedule (<https://indico.cern.ch/e/ICD15>)

- 14:00 Welcome!
- 14:15-15:00 Cloud Chamber Workshop
- 15:00-16:15 CosMO Experiment
- 16:30 [Skype Call with participants from other institutes](#)

Cloud Chamber Workshop

Outline

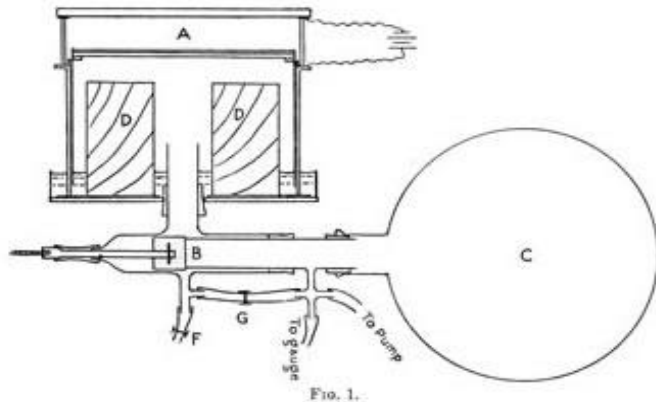
- History
- Step by step tutorial
- Build your own particle detector
- Tidying up
- Discussion and explanations

History

History

Charles T. R. Wilson (1869 - 1959)

This Scottish physicist perfected the first (expansion) cloud chamber in 1911 and received the Nobel Prize in 1927.

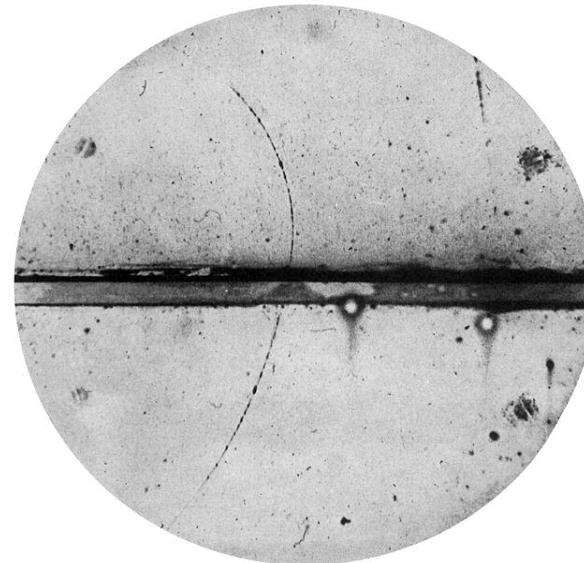


A diagram of Wilson's apparatus. The cylindrical cloud chamber ('A') is 16.5cm across by 3.4cm deep.

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](https://doi.org/10.1098/rspa.1912.0081)

Carl Anderson (1905 - 1991)

This physicist discovered the positron in 1932 and the muon in 1936 using a cloud chamber. He received the Nobel Prize in 1936.

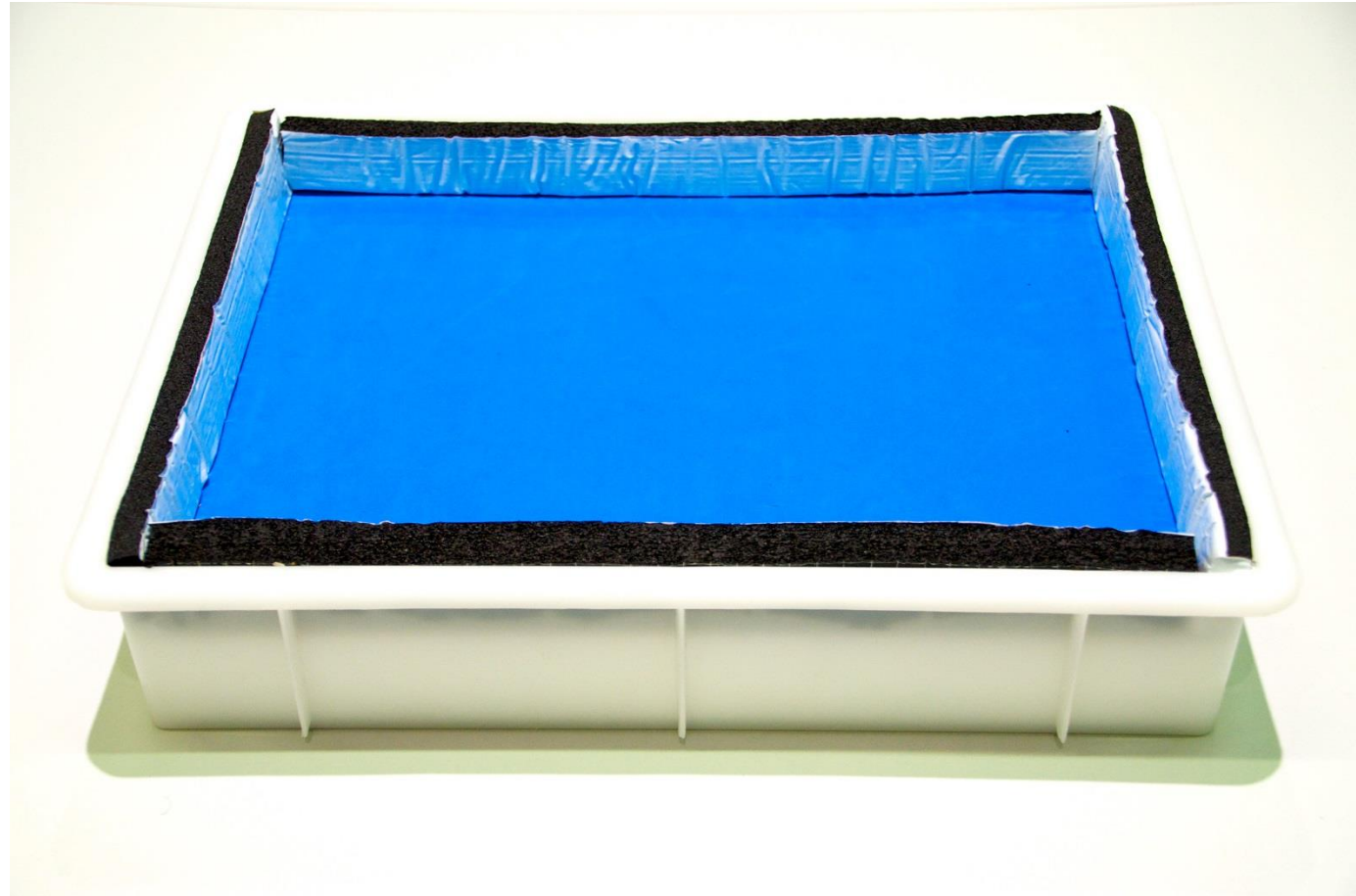


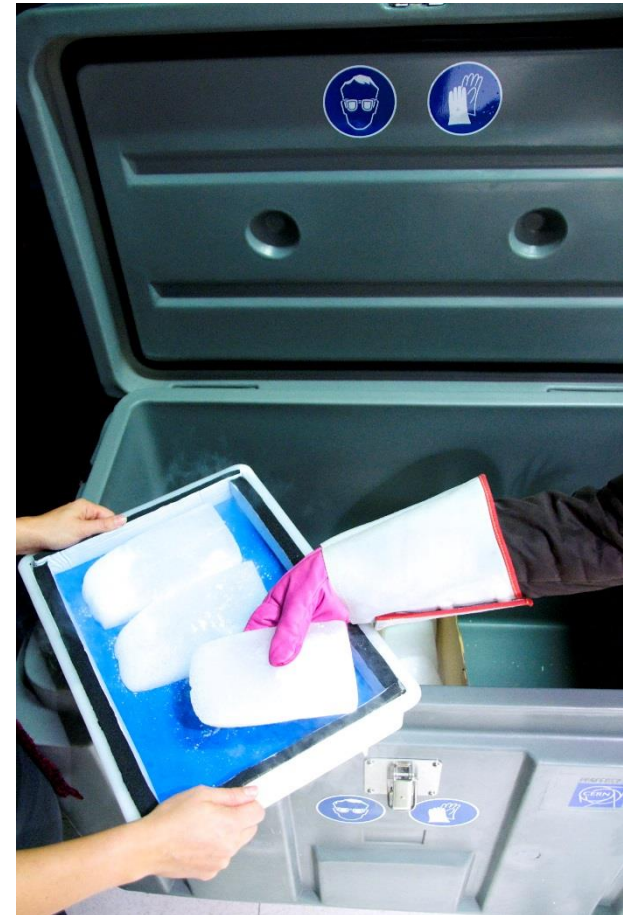
Carl D. Anderson (1905–1991) - Anderson, Carl D. (1933). "The Positive Electron". *Physical Review* 43 (6): 491–494. DOI:[10.1103/PhysRev.43.491](https://doi.org/10.1103/PhysRev.43.491).

Step by step tutorial

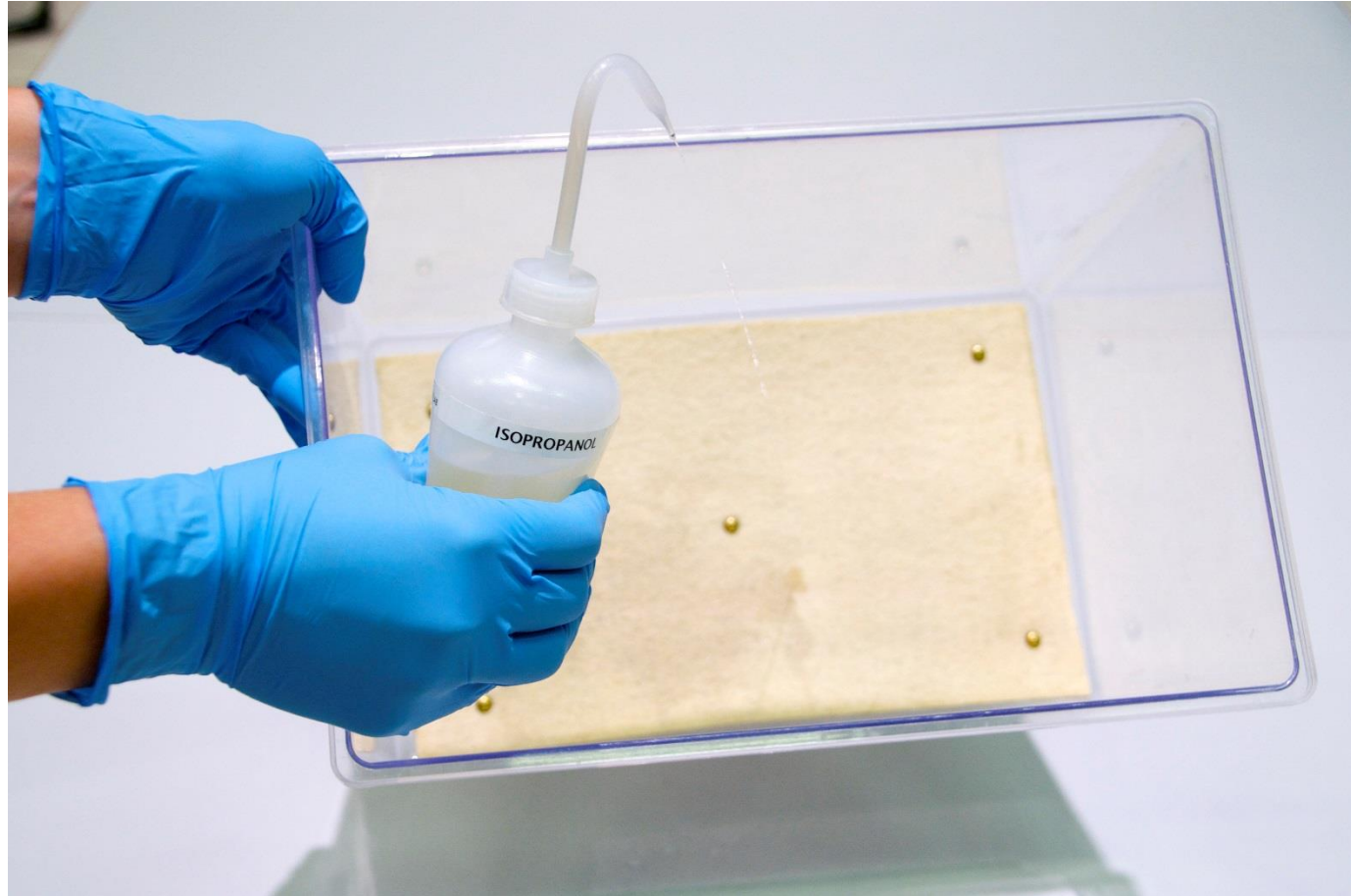
Build your cloud chamber - step by step



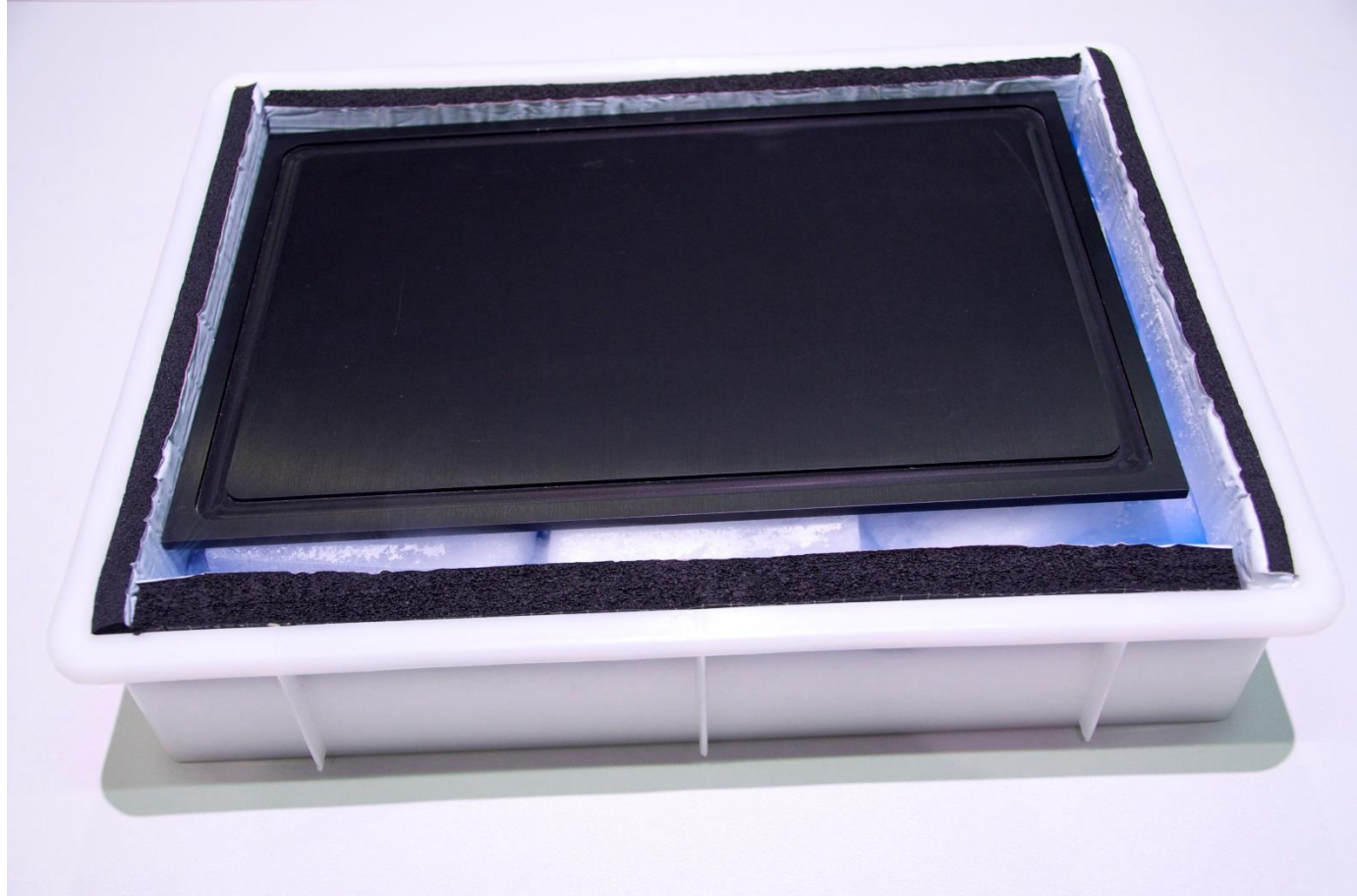


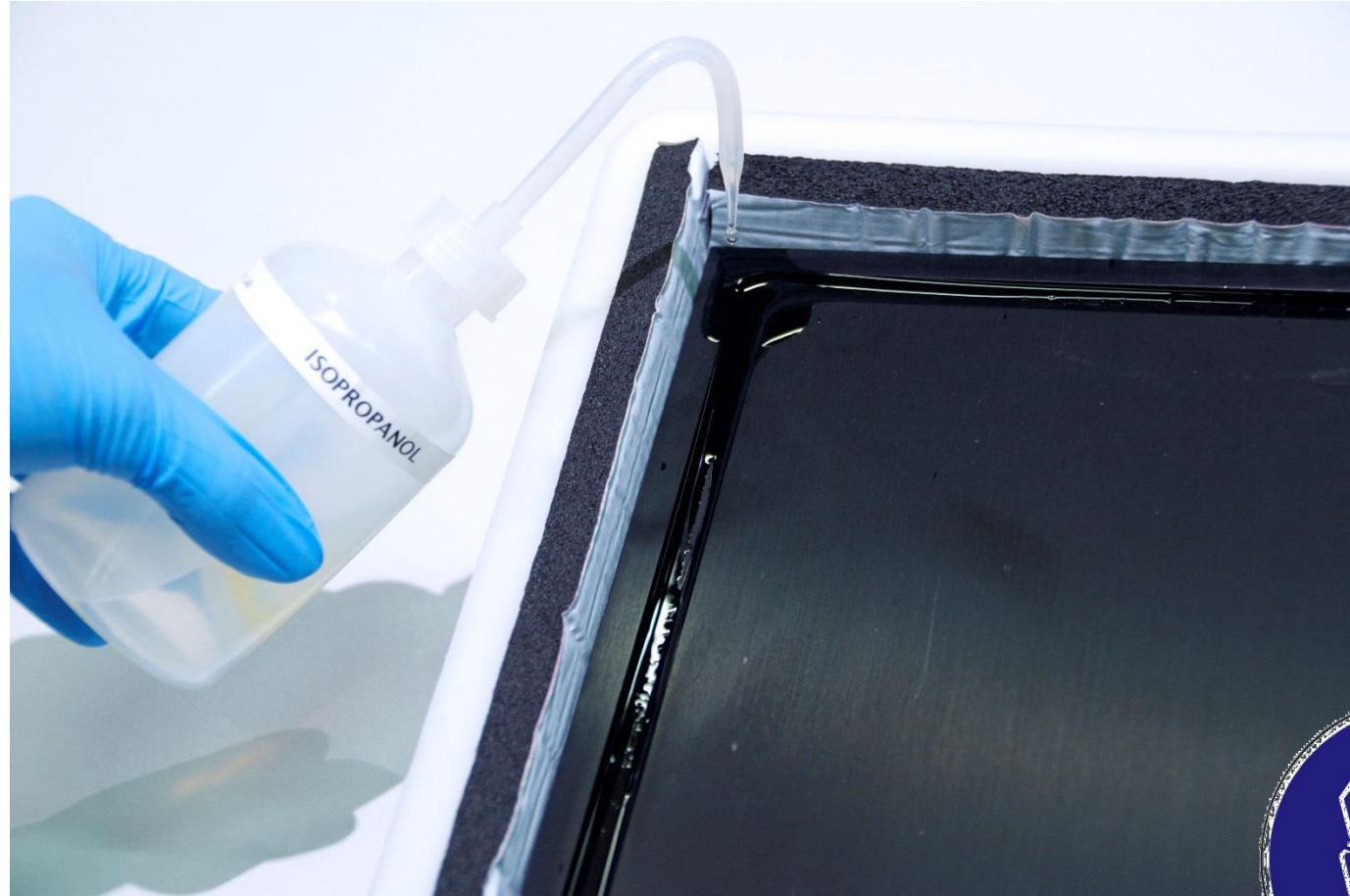




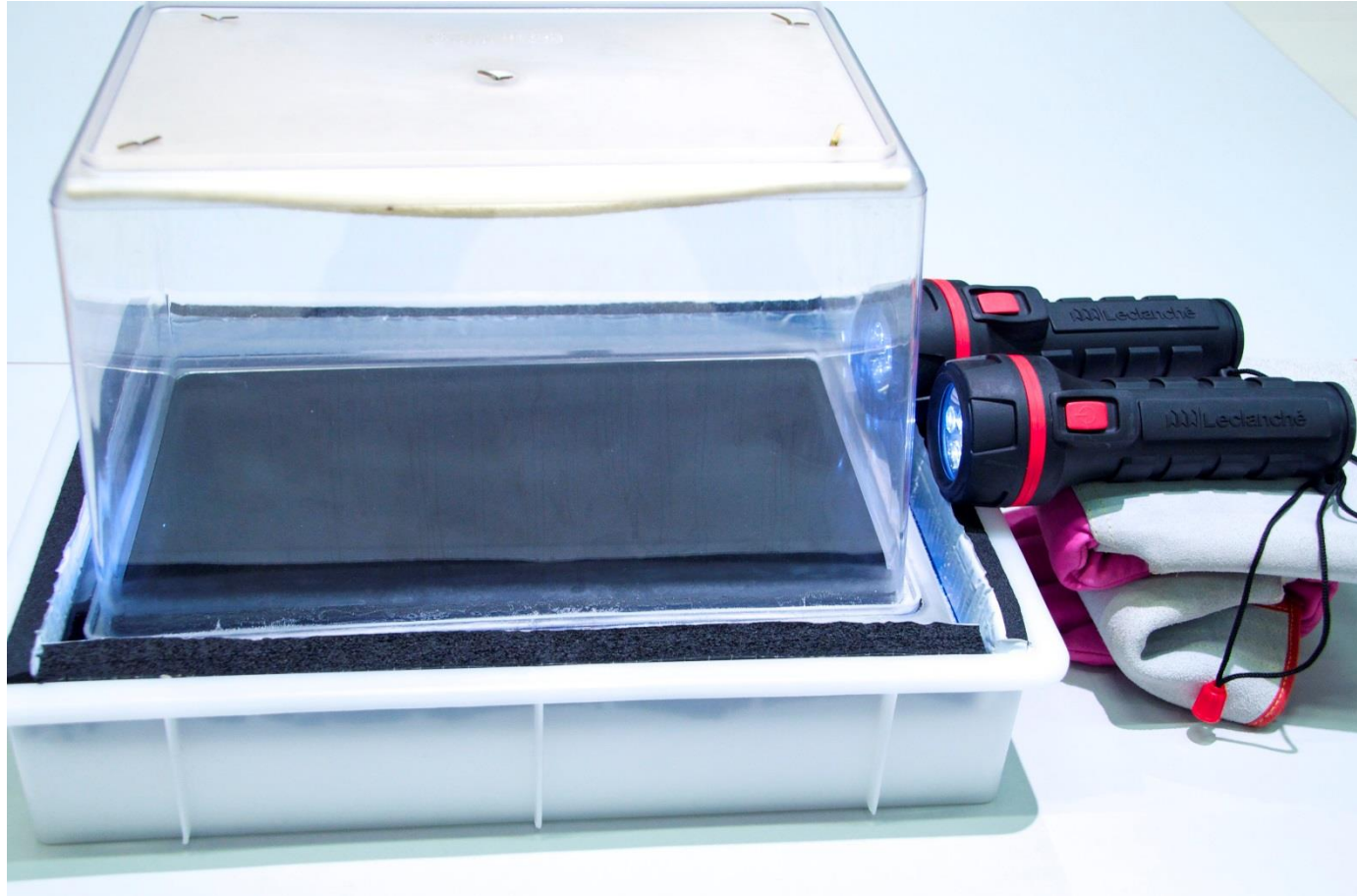




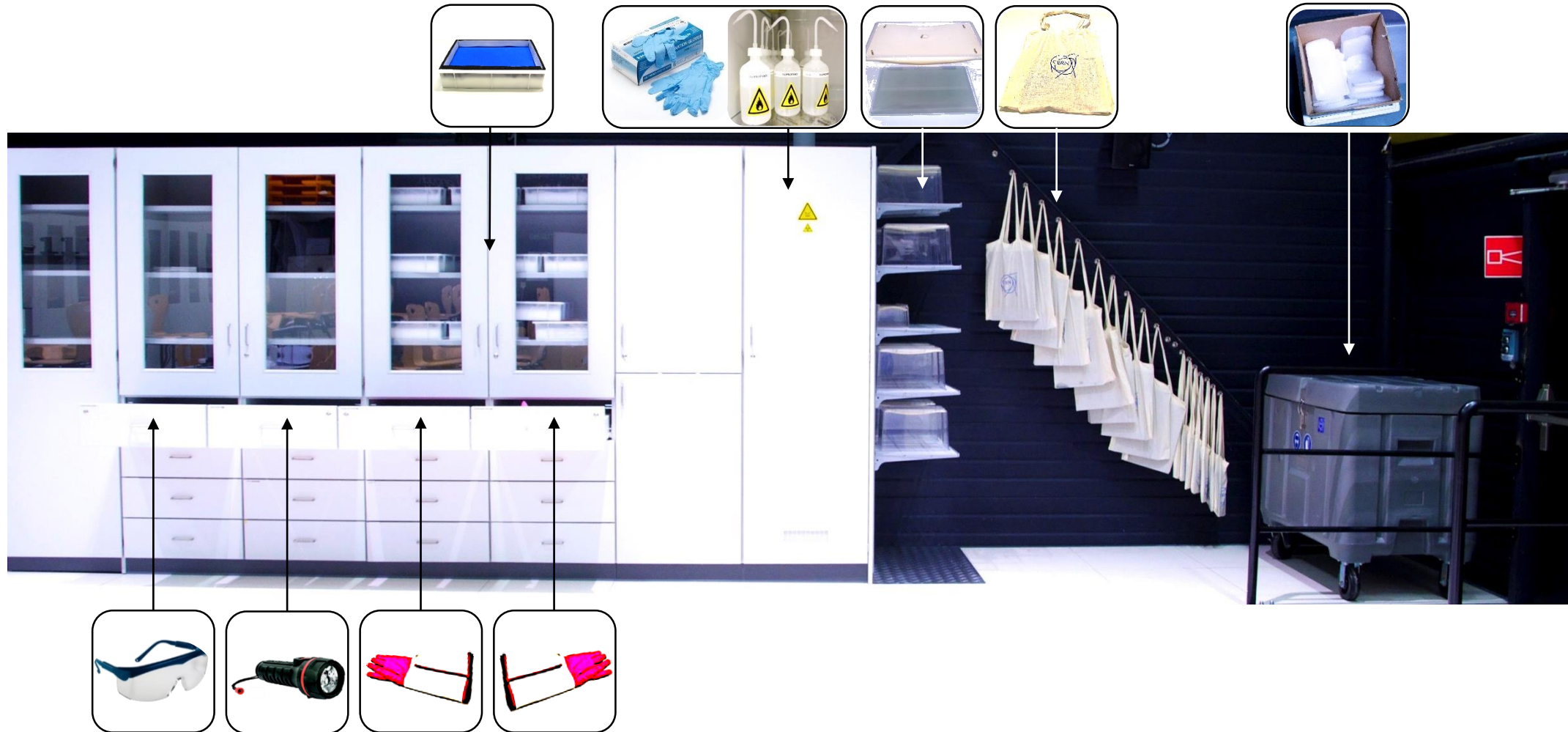








👉 Build your own particle detector!

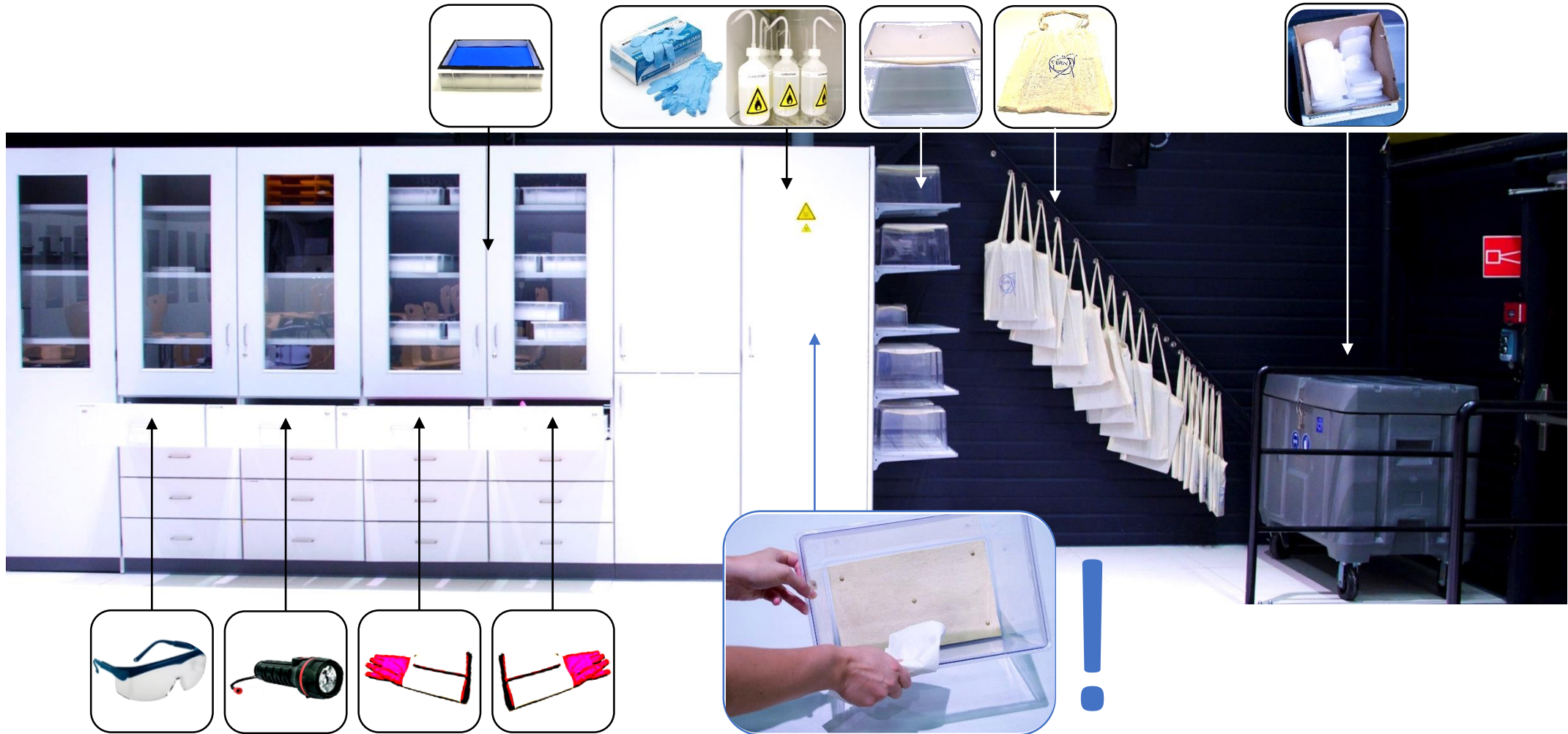


Build your own particle detector!

Tasks

- Observe your Cloud Chamber
- Find the optimal torch position and the optimal observation position
- Describe visible tracks (shape, length, width, ...)
- Discuss the reason for these tracks
- Count the number of tracks you can see for 1 minute, repeat this measurement 2 times

👉 Tidying up



Discussion and explanations

CosMO Experiment

Additional Material

Air Shower Simulation

Cosmic Ray Air Shower Pictures

by H.-J. Drescher drescher@th.physik.uni-frankfurt.de.

Air showers are cascades of secondary particles induced in the atmosphere by high energy cosmic rays. What you see here is a **visualisation of realistic simulations of these showers**. Of course, not all of the particles in a shower are displayed, there are far too many! The **fraction displayed here is about $1e-6$** , sampled with a **thinning algorithm**.

blue:electrons/positrons

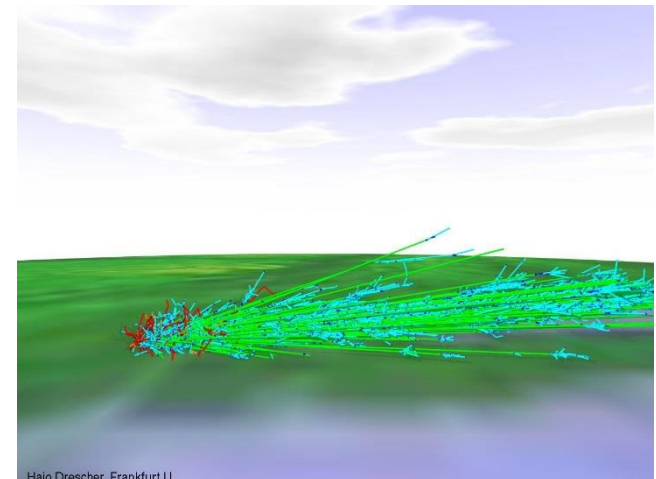
cyan:photons

red:neutrons

orange: protons

gray: mesons

green:muons



<http://th.physik.uni-frankfurt.de/~drescher/CASSIM/>

blue:electrons/positrons

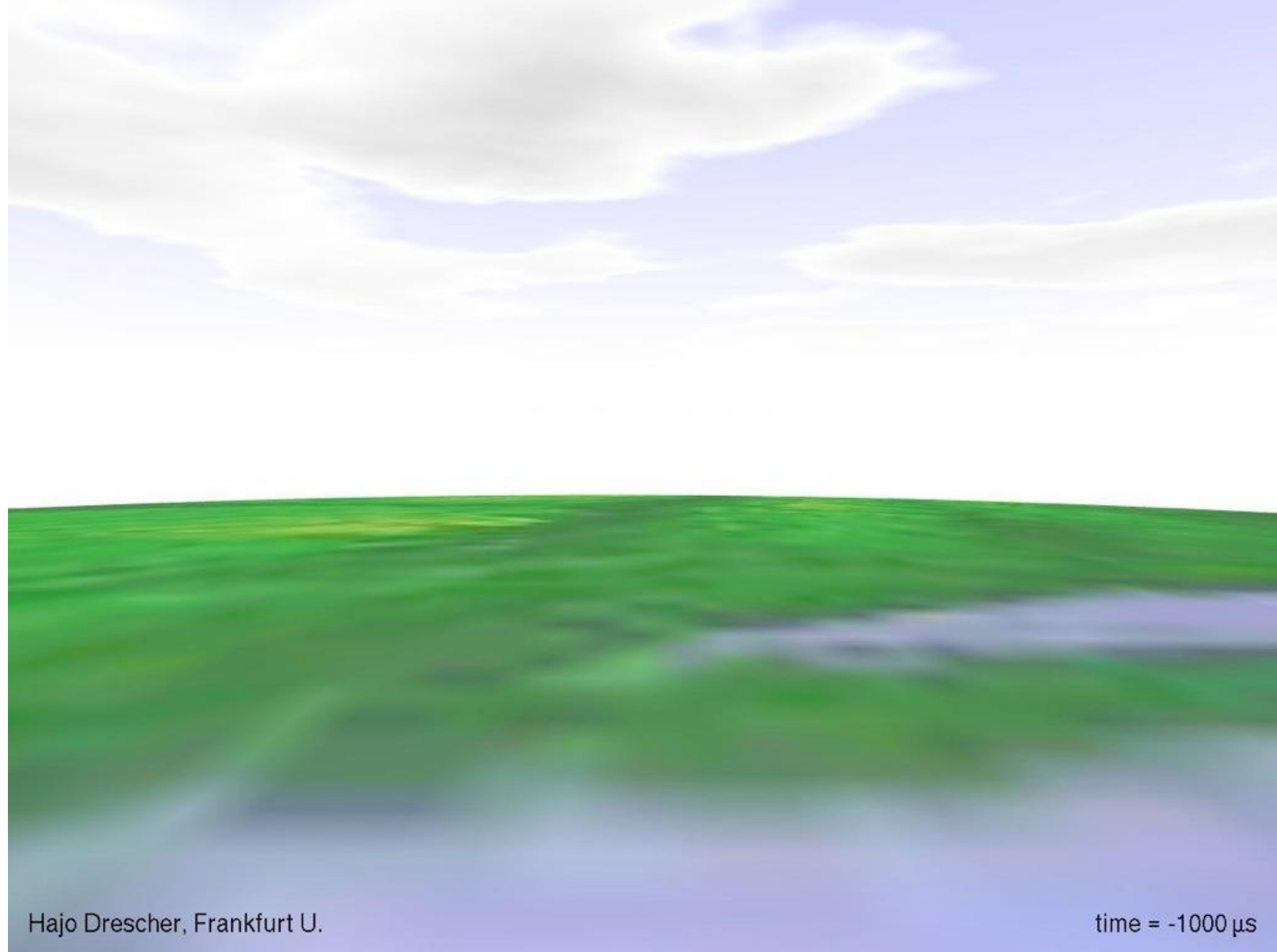
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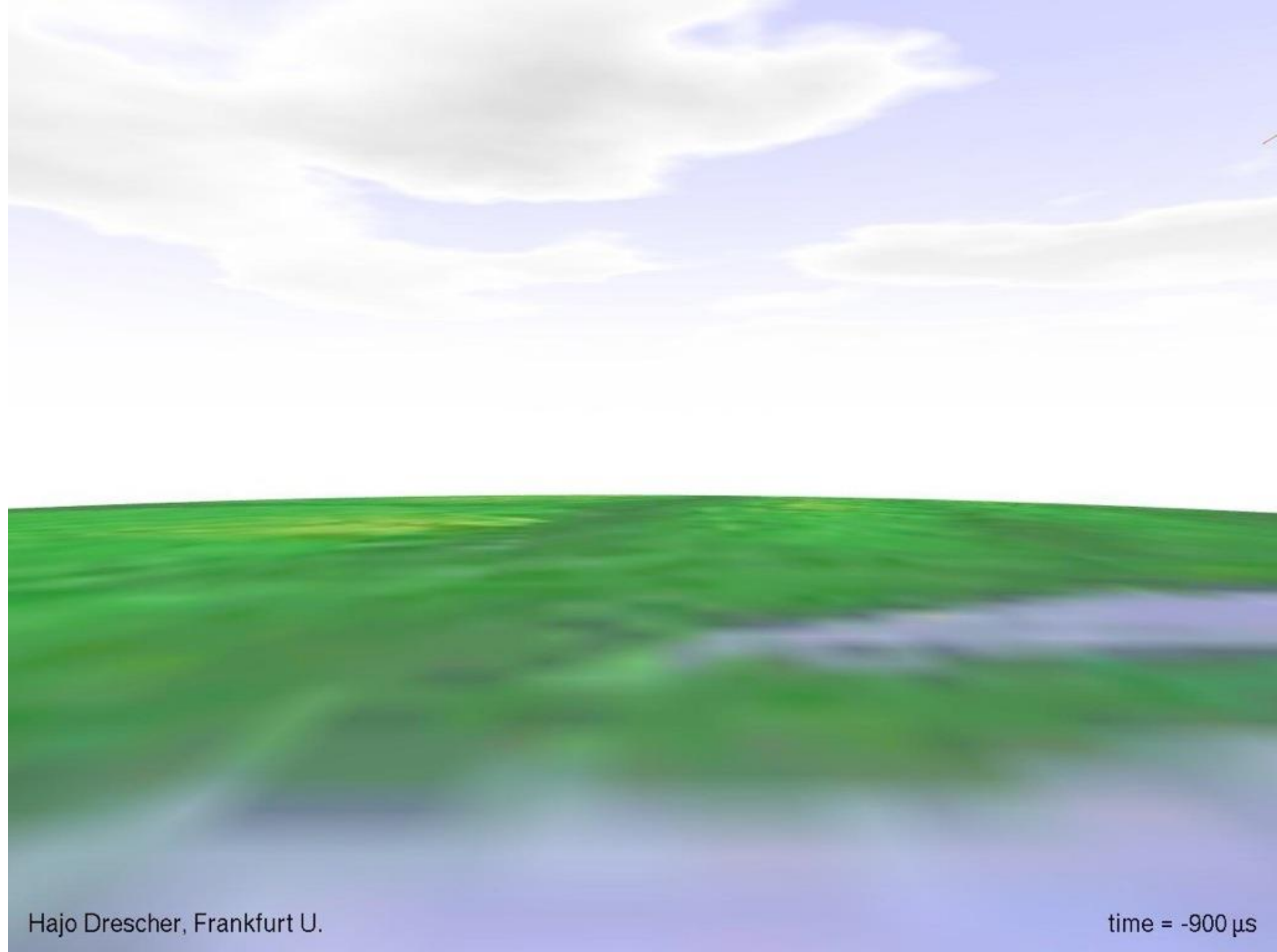
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blue:electrons/positrons

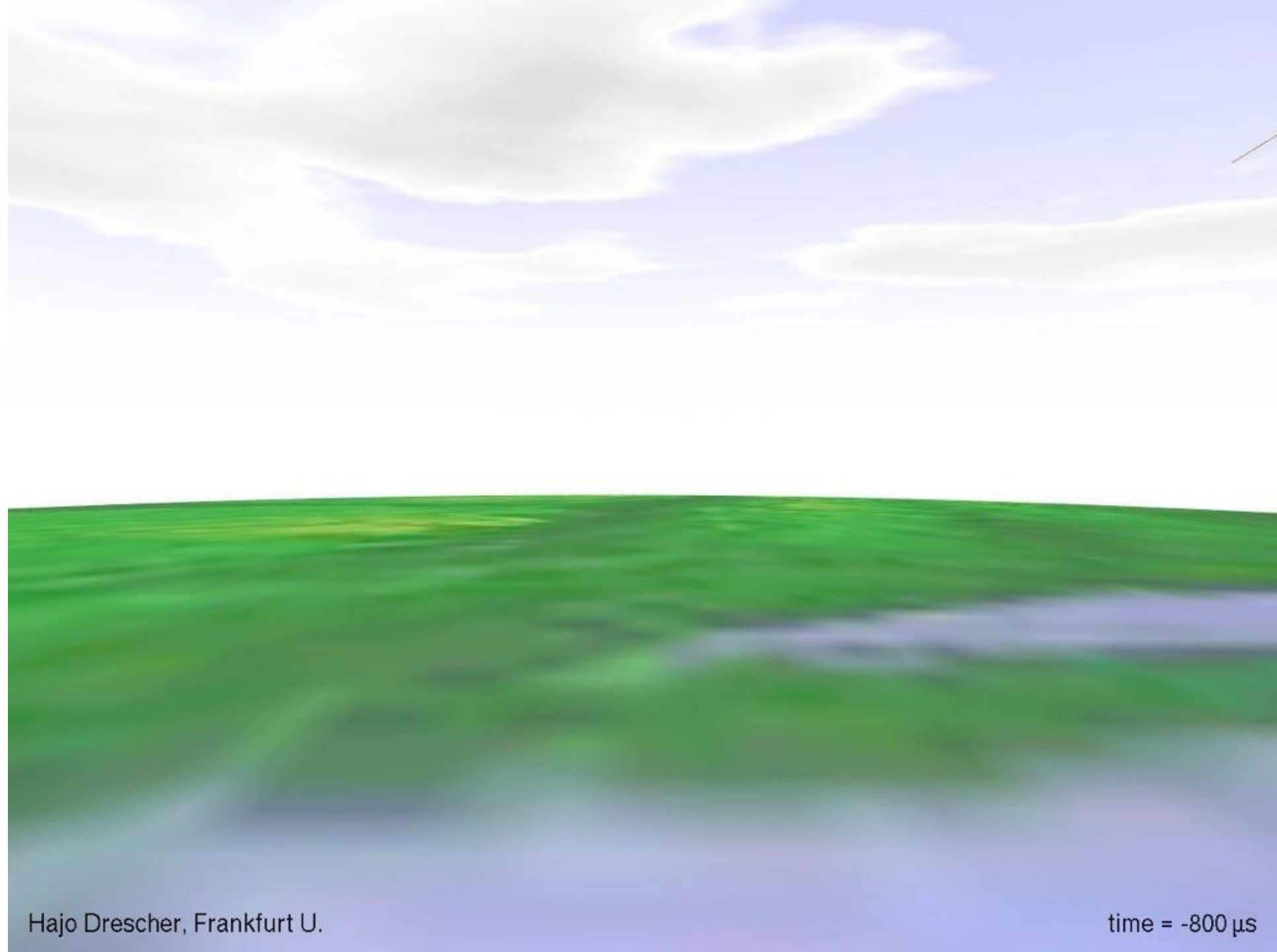
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red:neutrons

orange: protons

gray: mesons

green:muons



blue:electrons/positrons

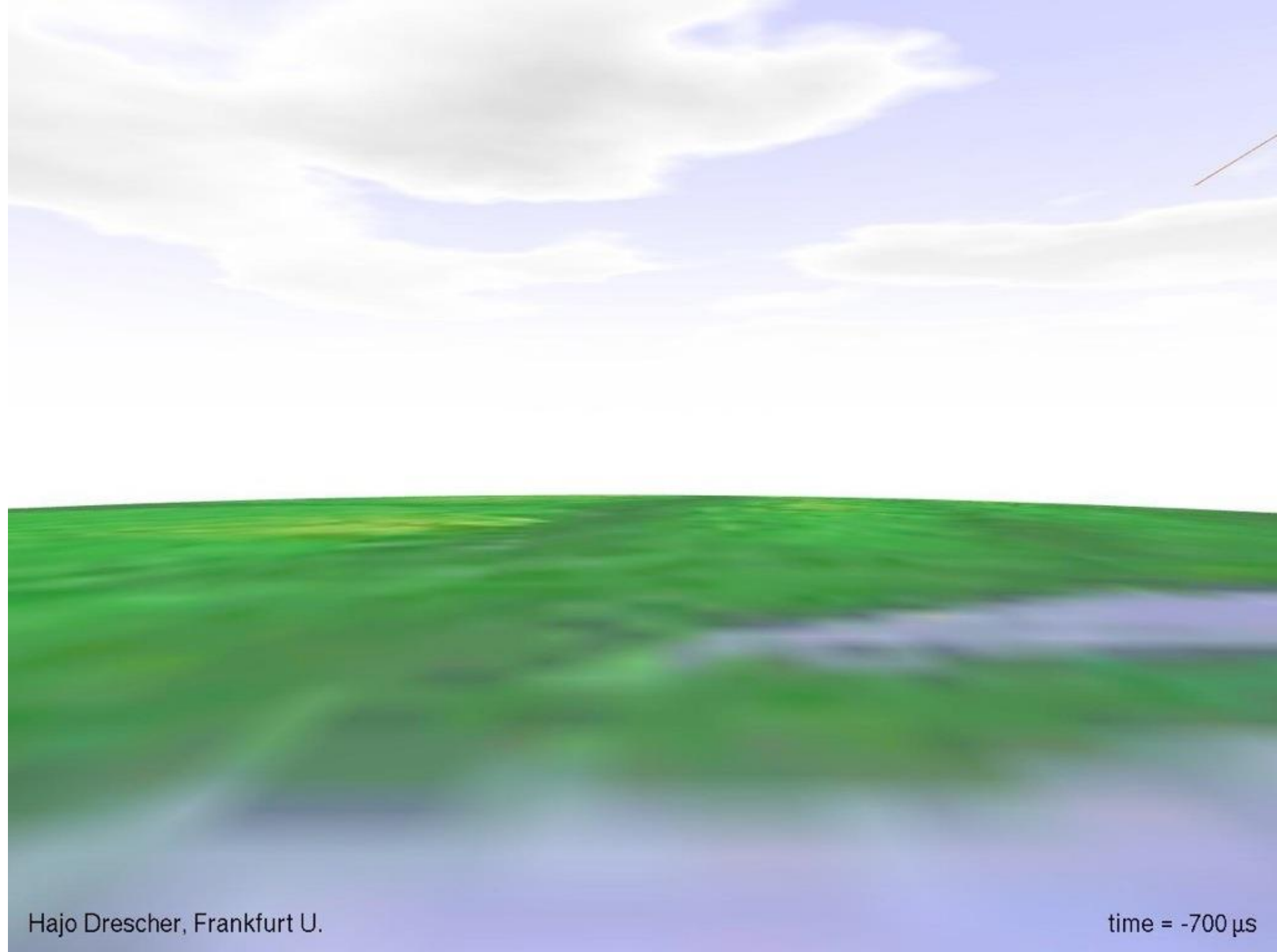
cyan:photons

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orange: protons

gray: mesons

green:muons



blue:electrons/positrons

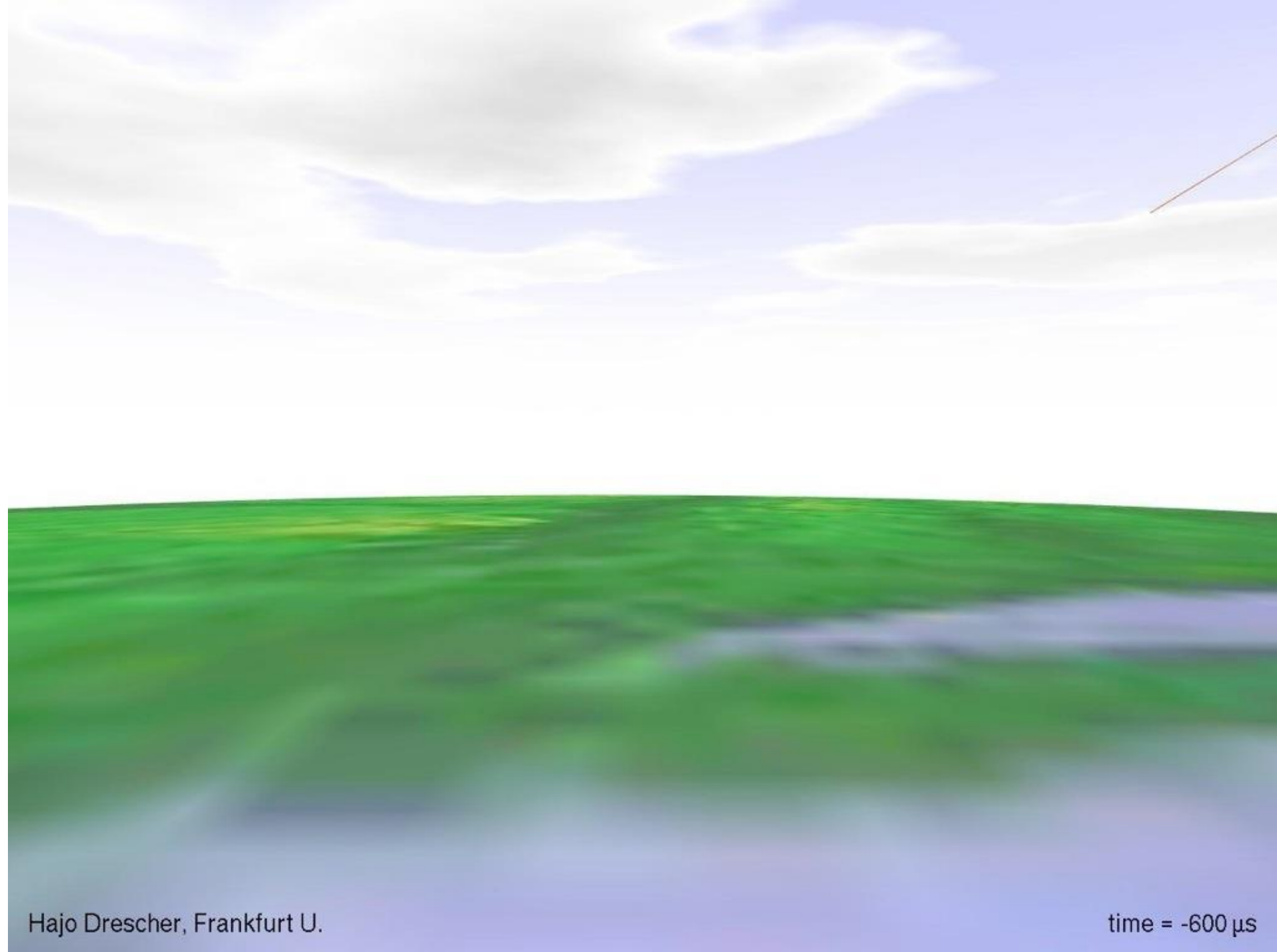
cyan:photons

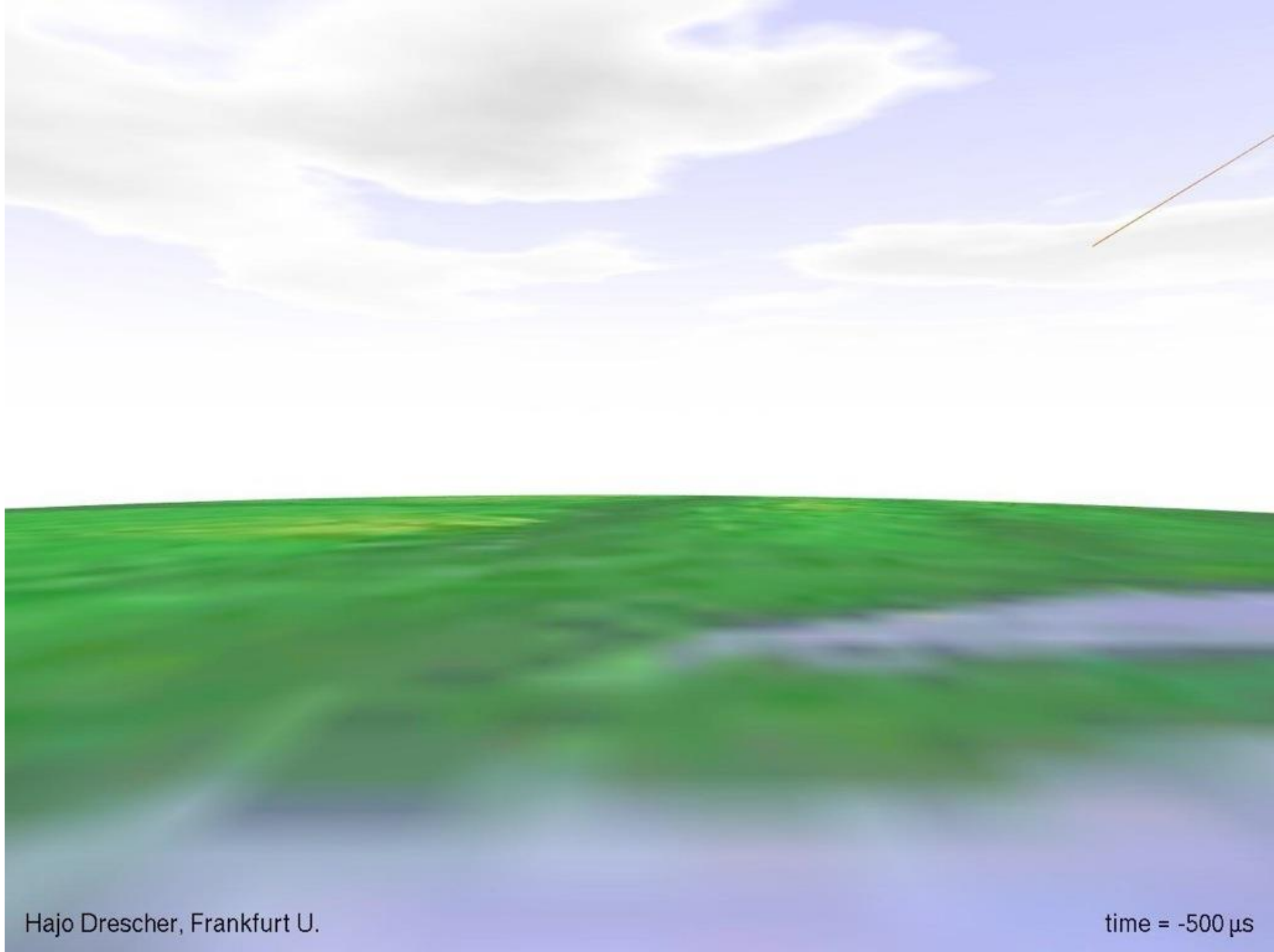
red:neutrons

orange: protons

gray: mesons

green:muons





blue:electrons/positrons

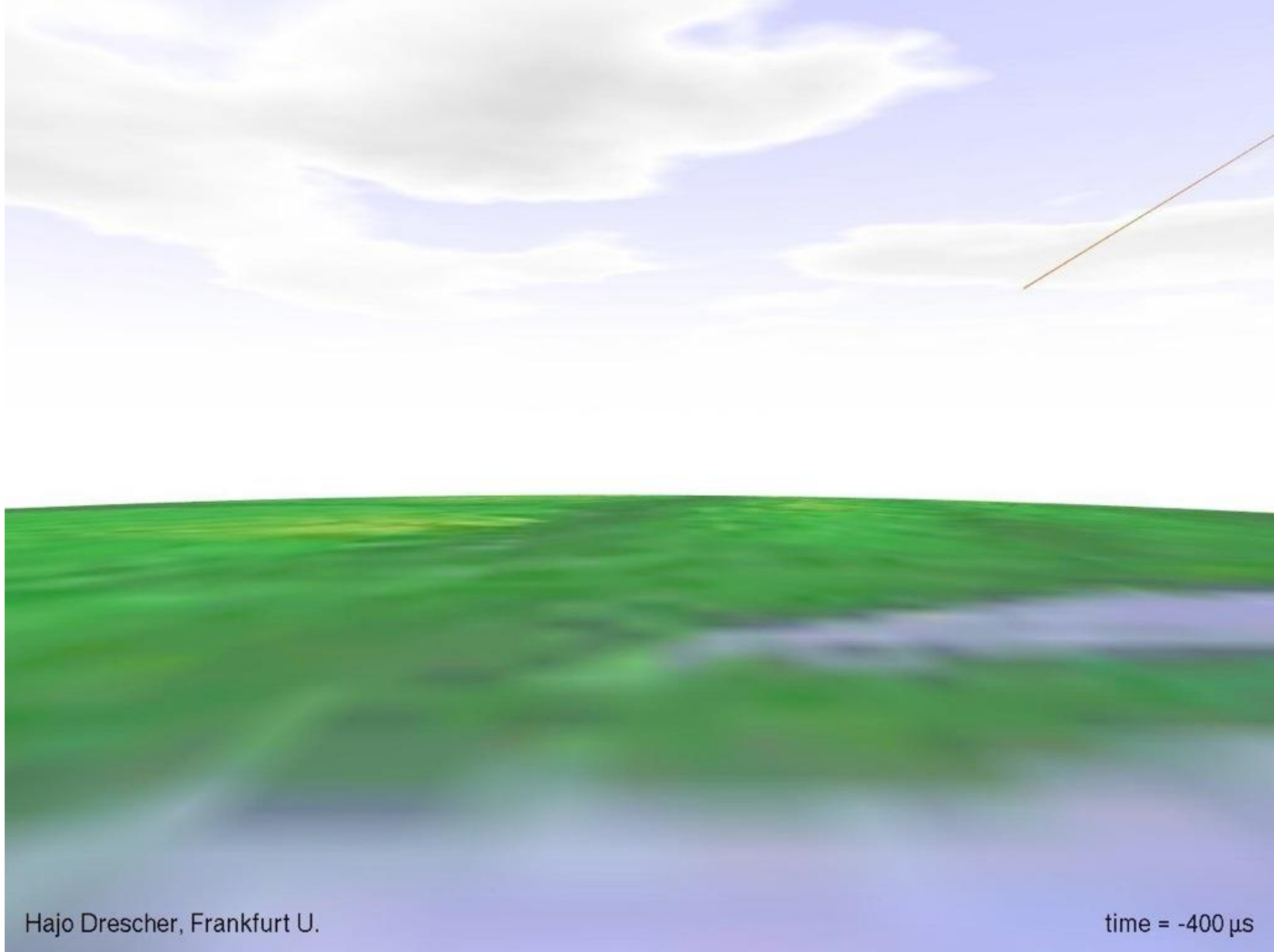
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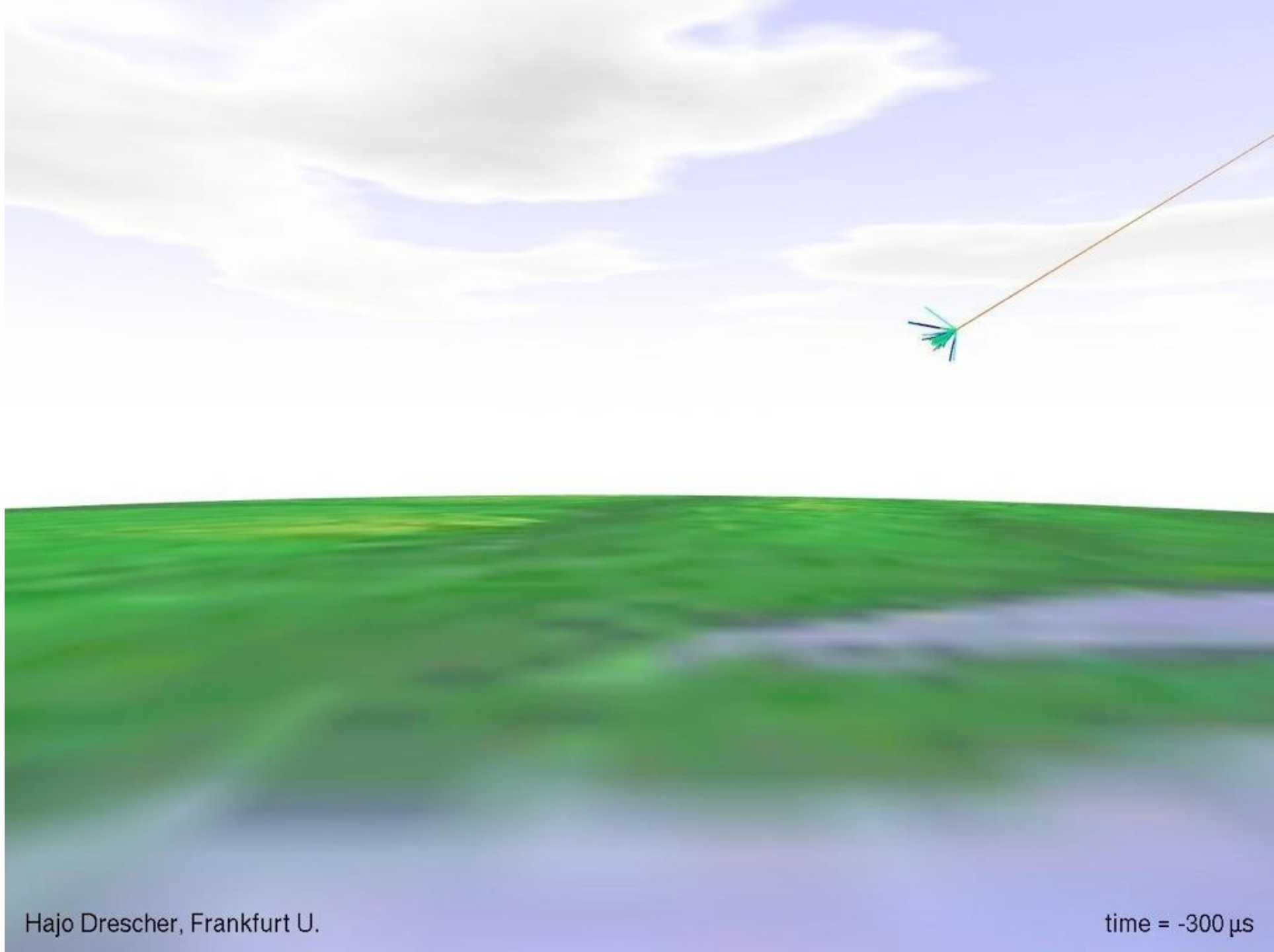
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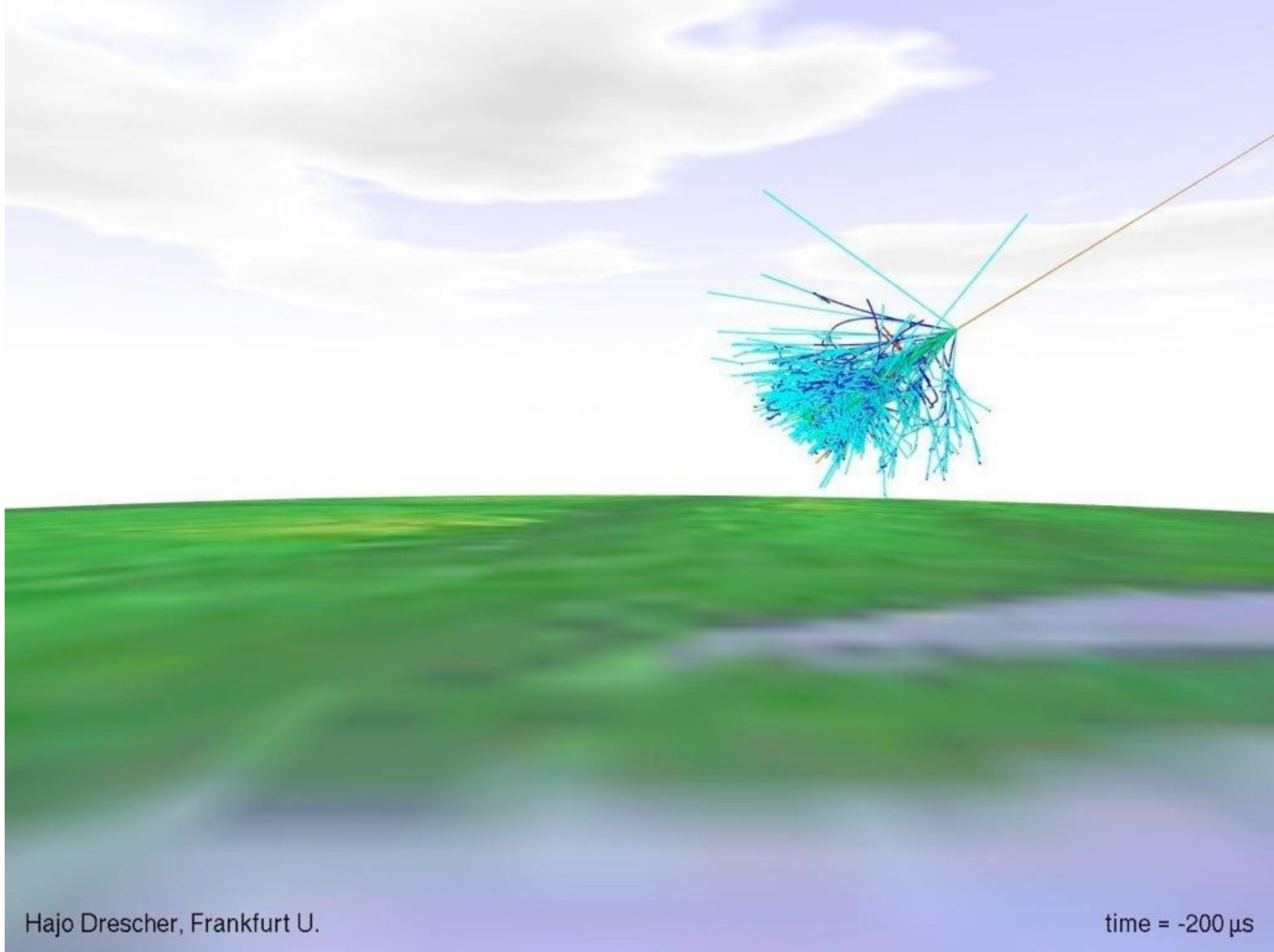
cyan:photons

red:neutrons

orange: protons

gray: mesons

green:muons



blue:electrons/positrons

cyan:photons

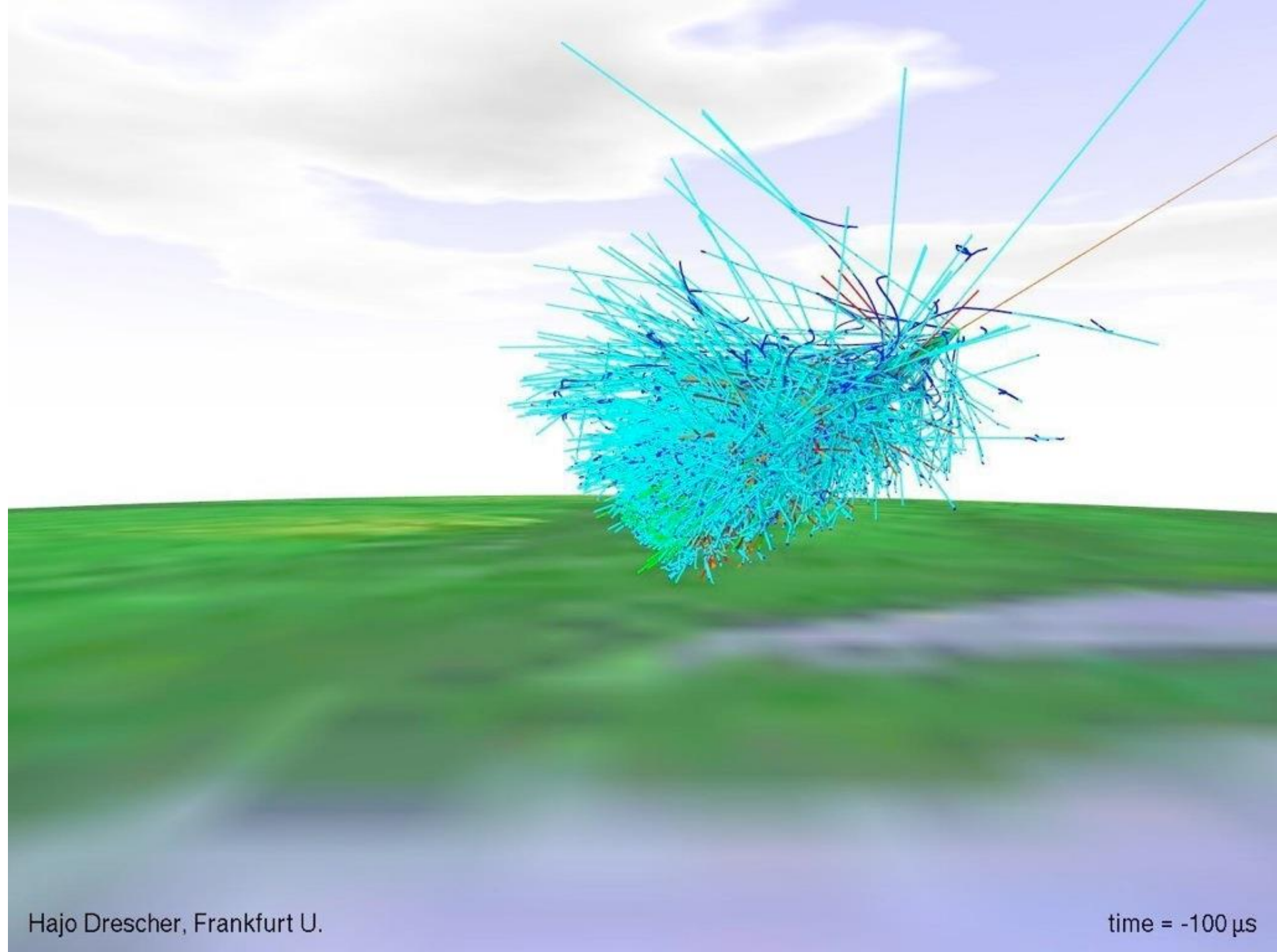
red:neutrons

orange: protons

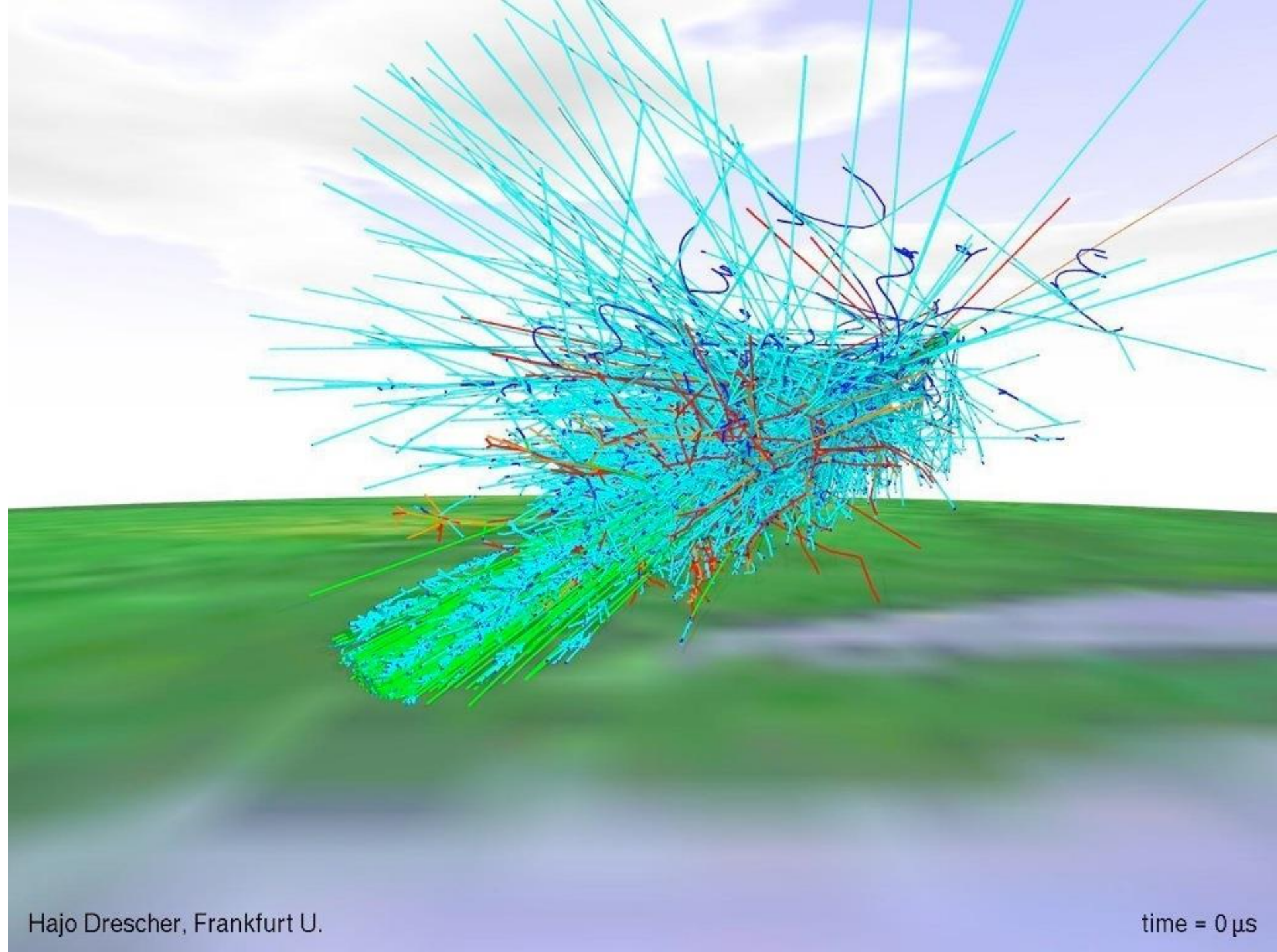
gray: mesons

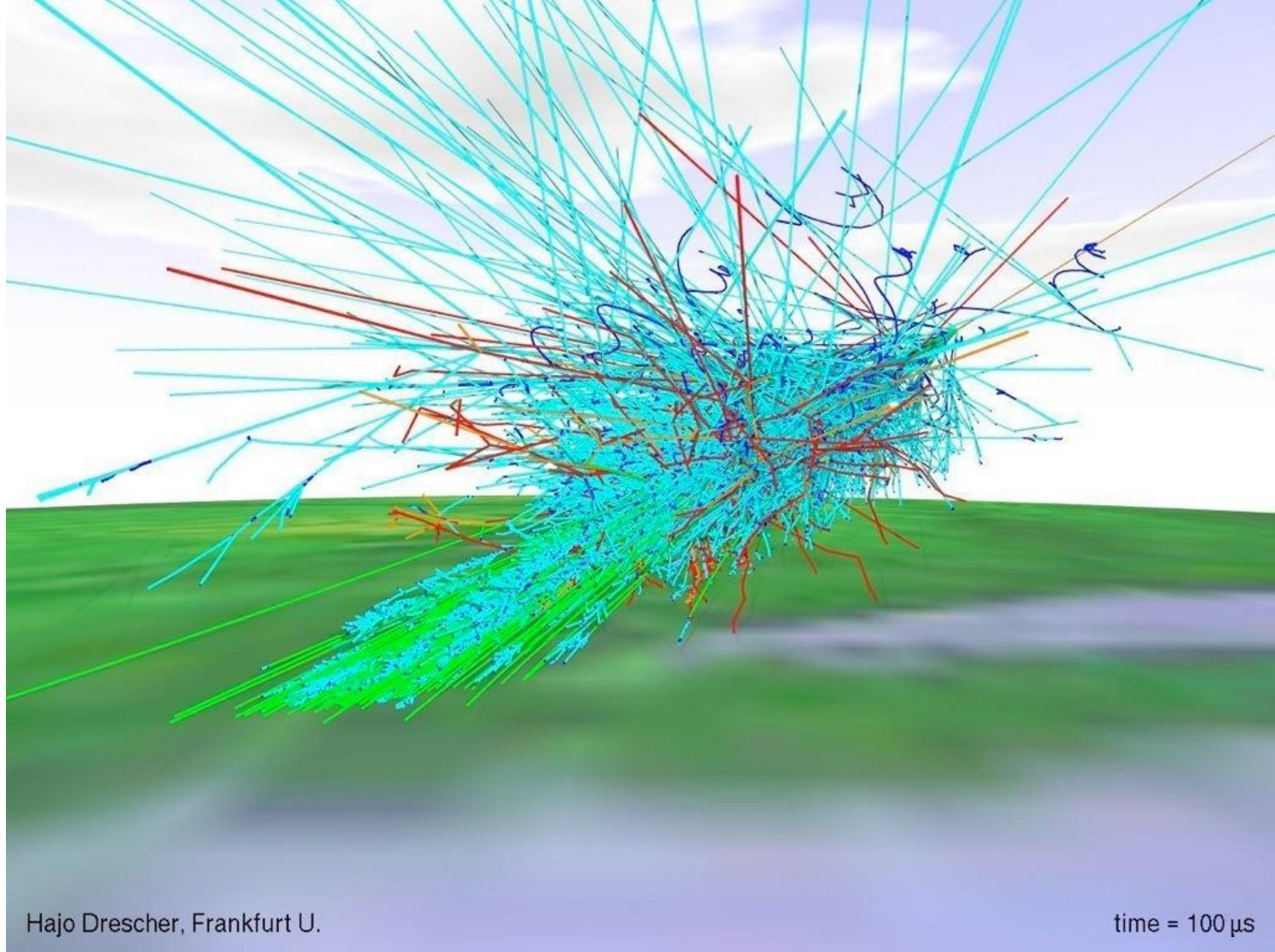
green:muons

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



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





blue:electrons/positrons

cyan:photons

red:neutrons

orange: protons

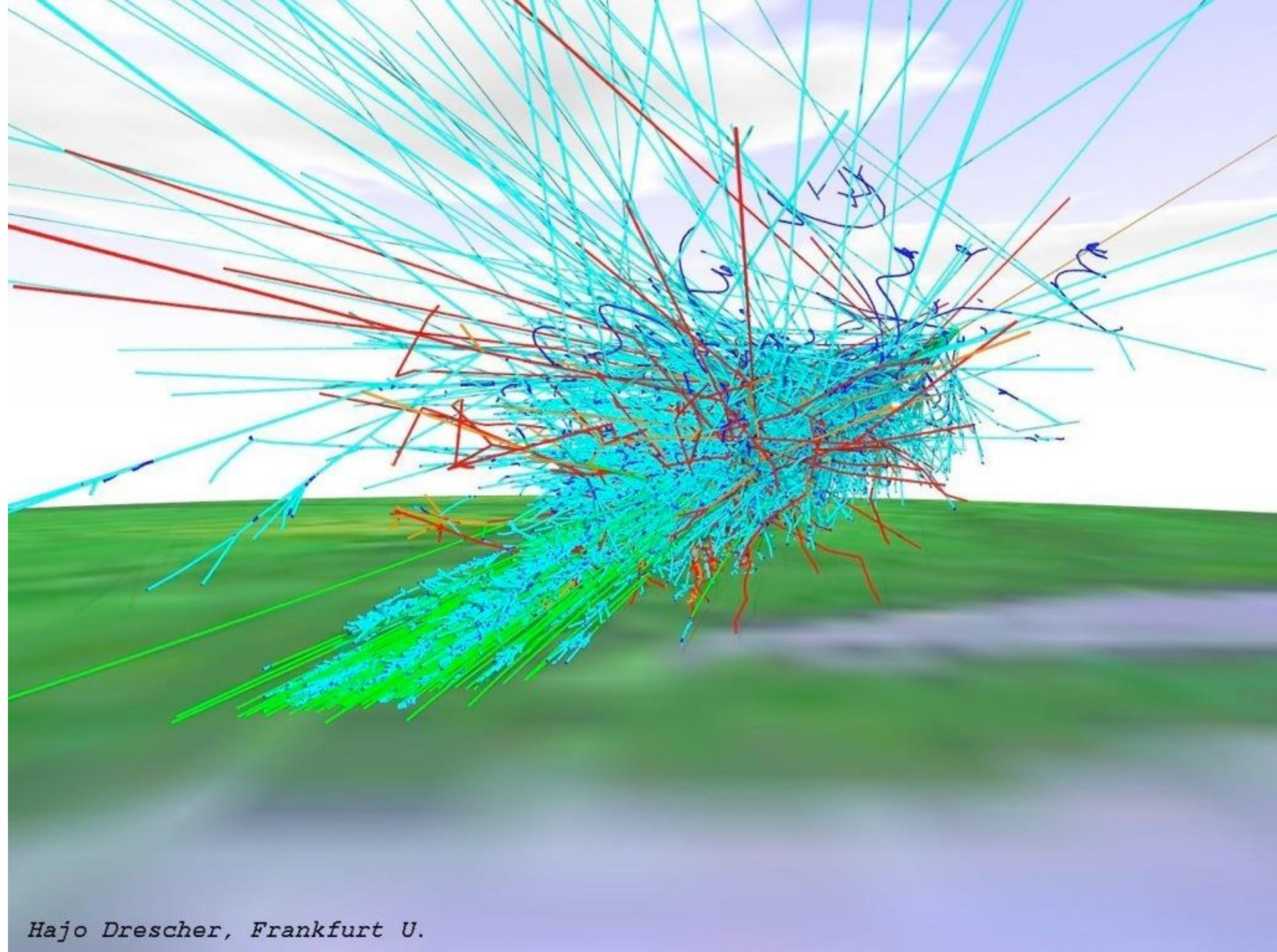
gray: mesons

green:muons

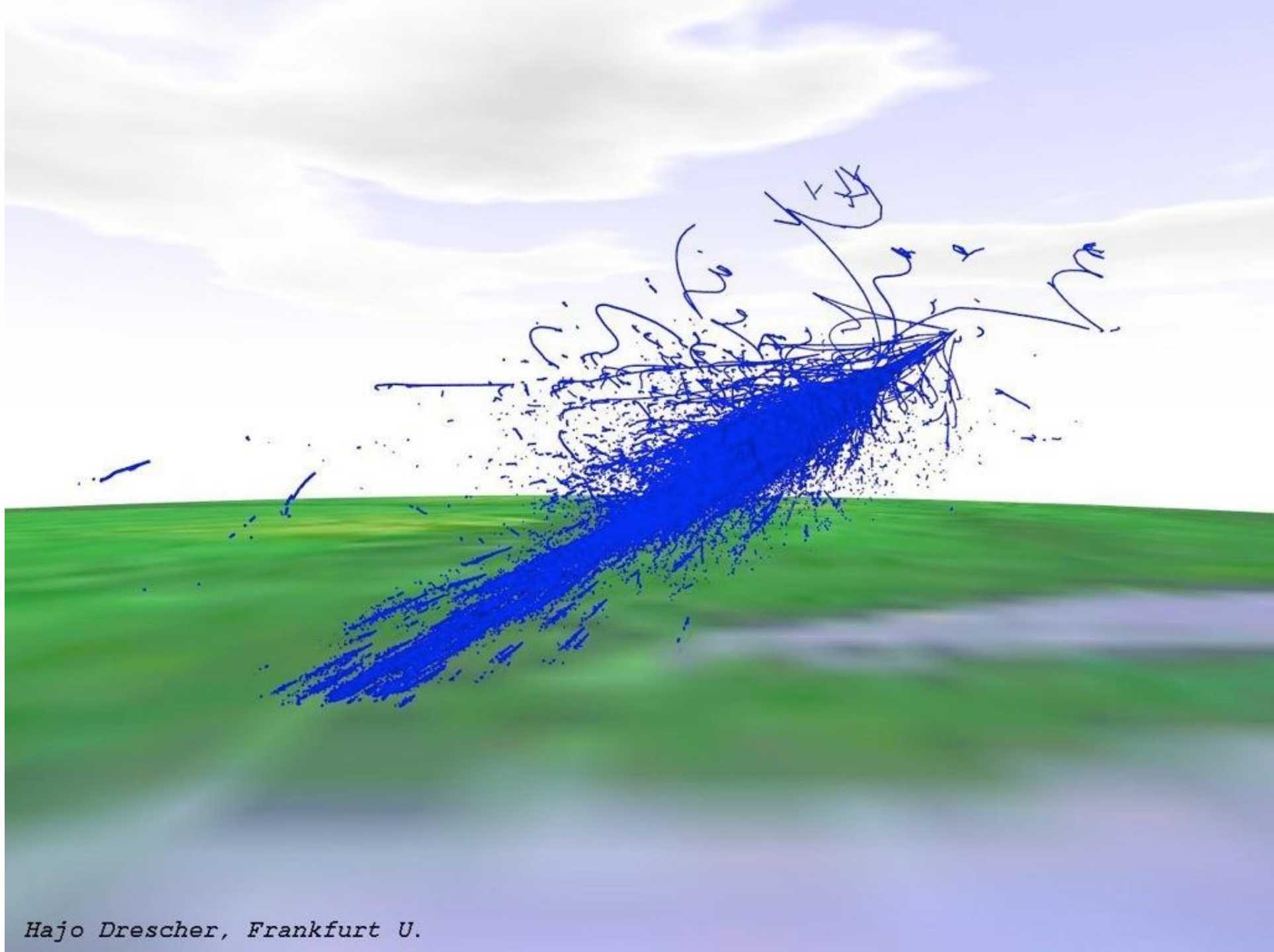
Hajo Drescher, Frankfurt U.

time = 100 μ s

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



Hajo Drescher, Frankfurt U.



blue:electrons/positrons

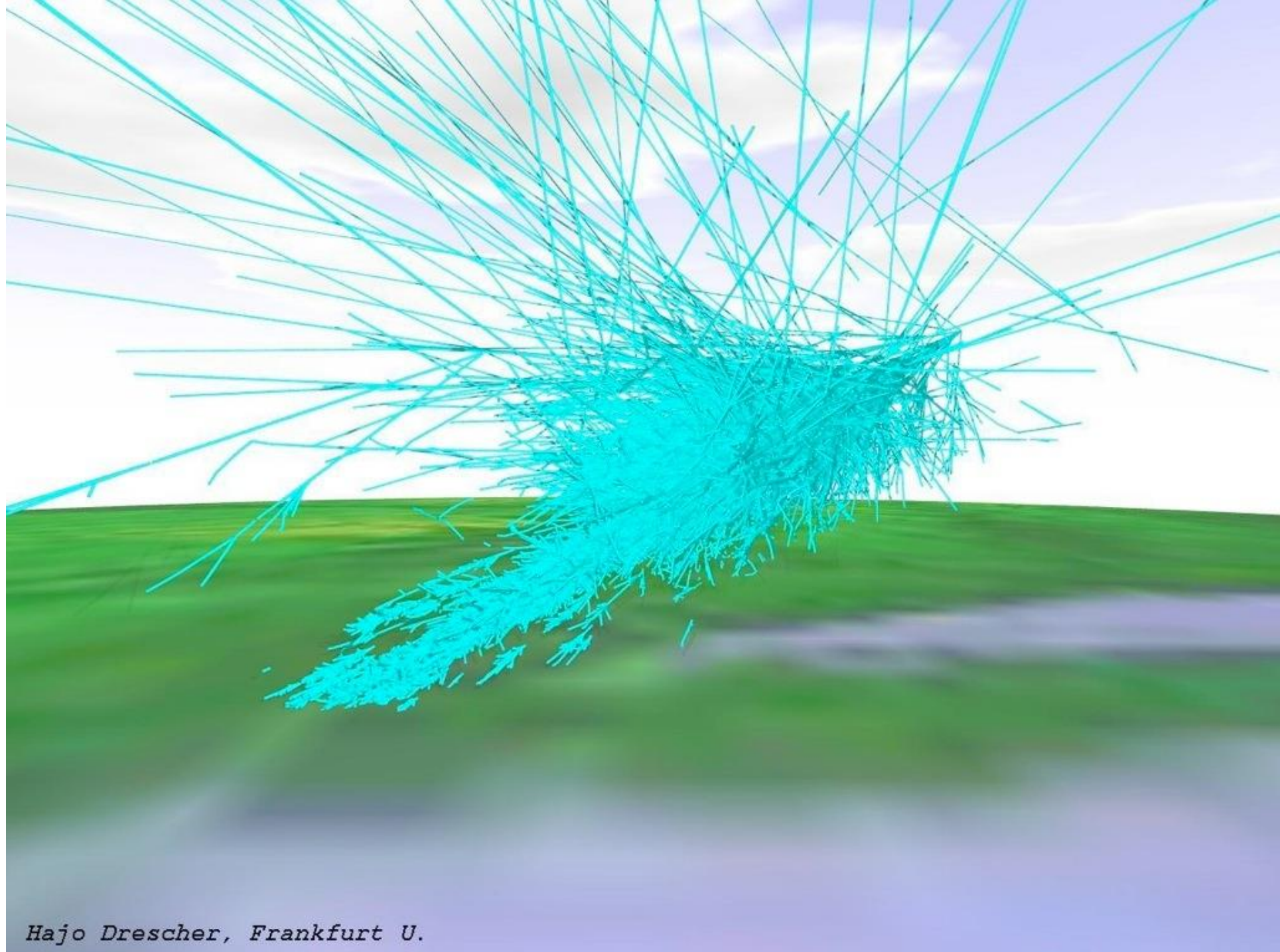
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blue:electrons/positrons

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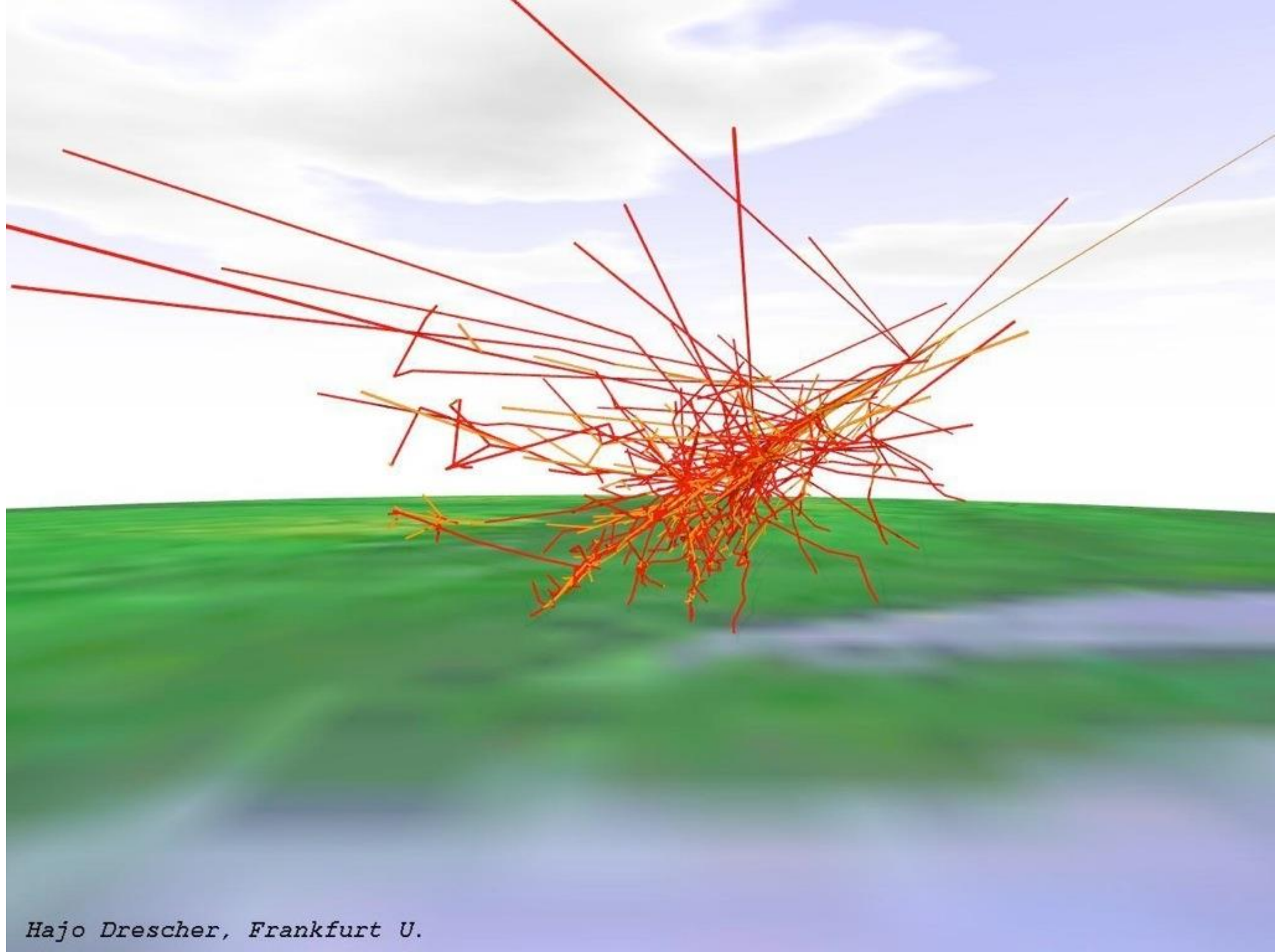
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Hajo Drescher, Frankfurt U.



blue:electrons/positrons

cyan:photons

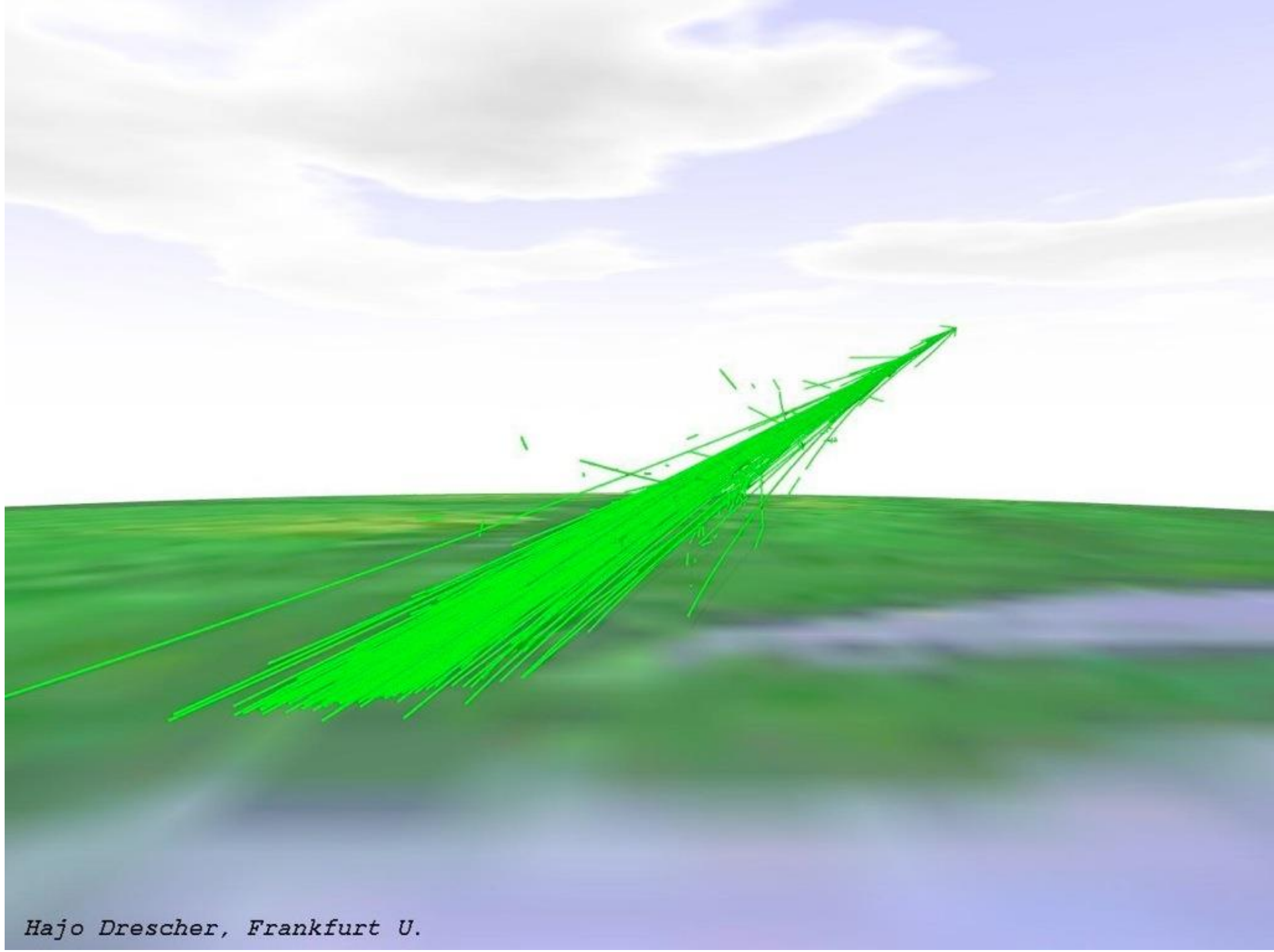
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Hajo Drescher, Frankfurt U.



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Cosmic rays at CERN



CLOUD (Cosmics Leaving Outdoor Droplets)

- Explore the influence of cosmic rays on cloud formations
- Uses protons from the proton synchrotron to simulate the cosmic rays
- Uses an advanced cloud chamber so that the effect on different types of clouds can be analysed

AMS (Alpha Magnetic Spectrometer) Experiment on the International Space Station

- Records cosmic ray events
- Looks for dark matter, antimatter and missing matter
- The detector measures 64 cubic metres and weighs 8.5 tonnes



Tests for the LHC

Before LHC was running, cosmic rays were used for the detectors, like CMS and ALICE, to test that everything is working

Pictures:

<http://www.stfc.ac.uk/news/cern-experiment-shows-pine-fresh-trees-help-cloud-formation/>

<http://home.cern/about/experiments/ams>