



S'Cool  
LAB

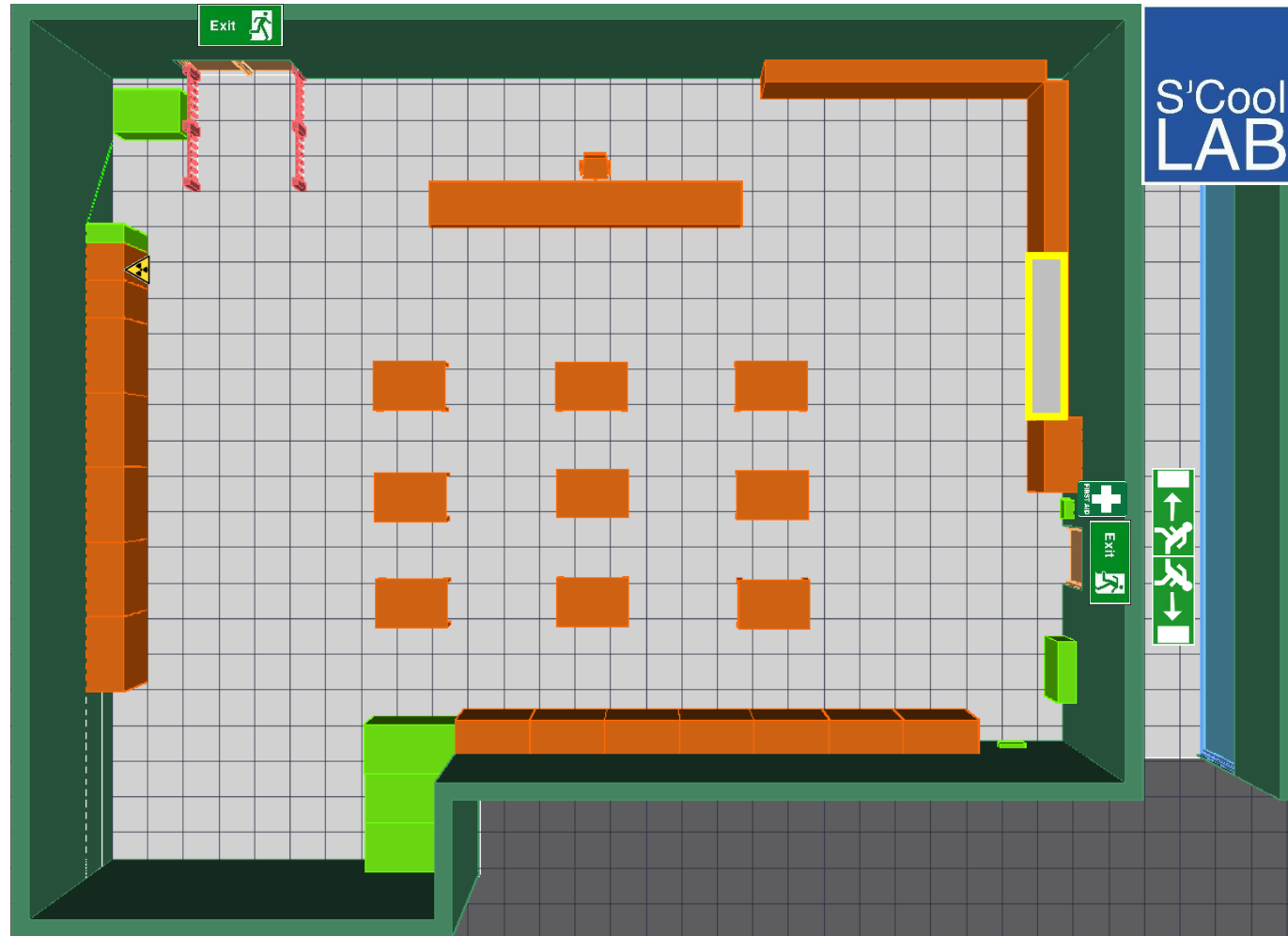


# Rules in S'Cool LAB

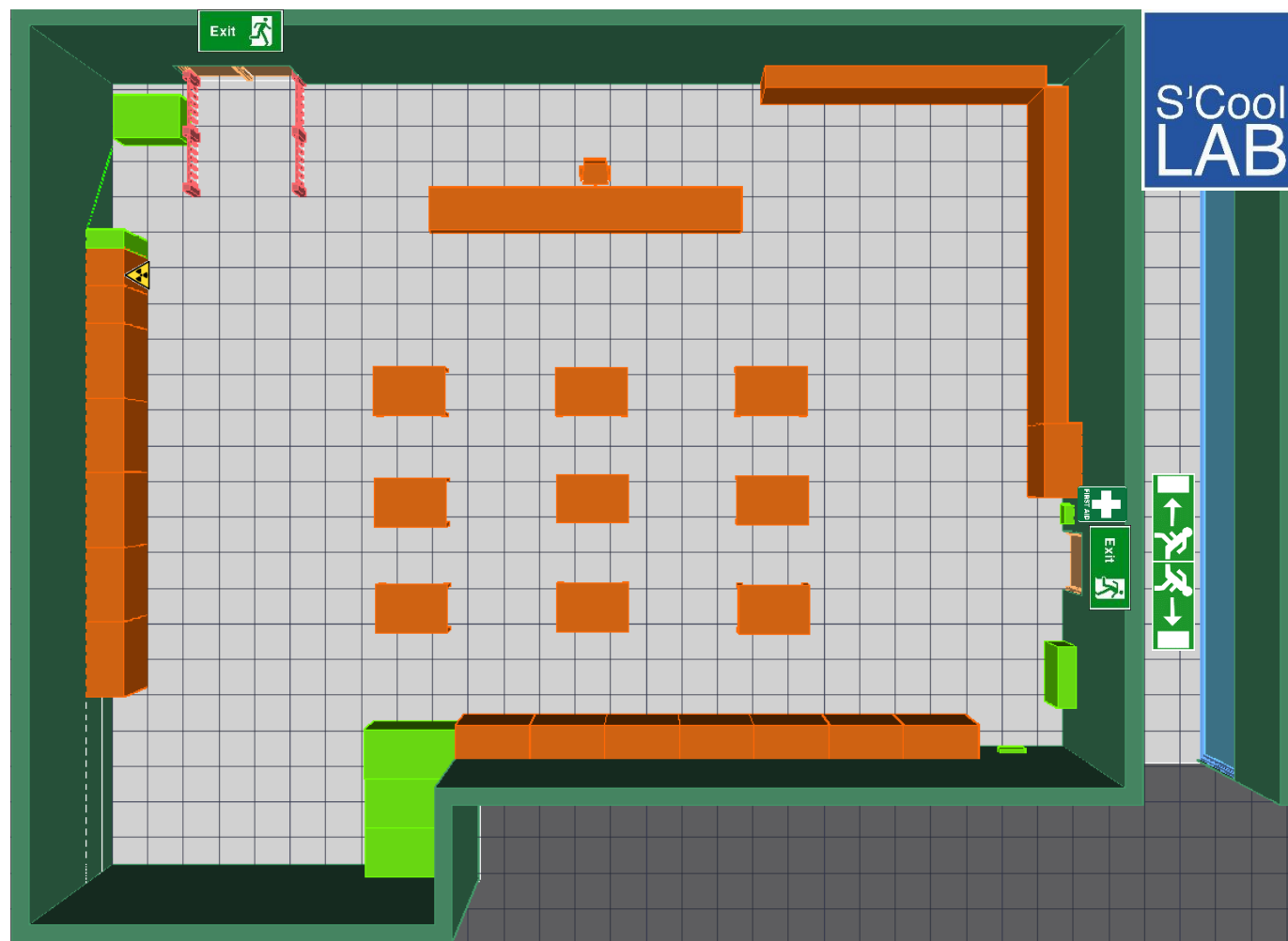


# Bags

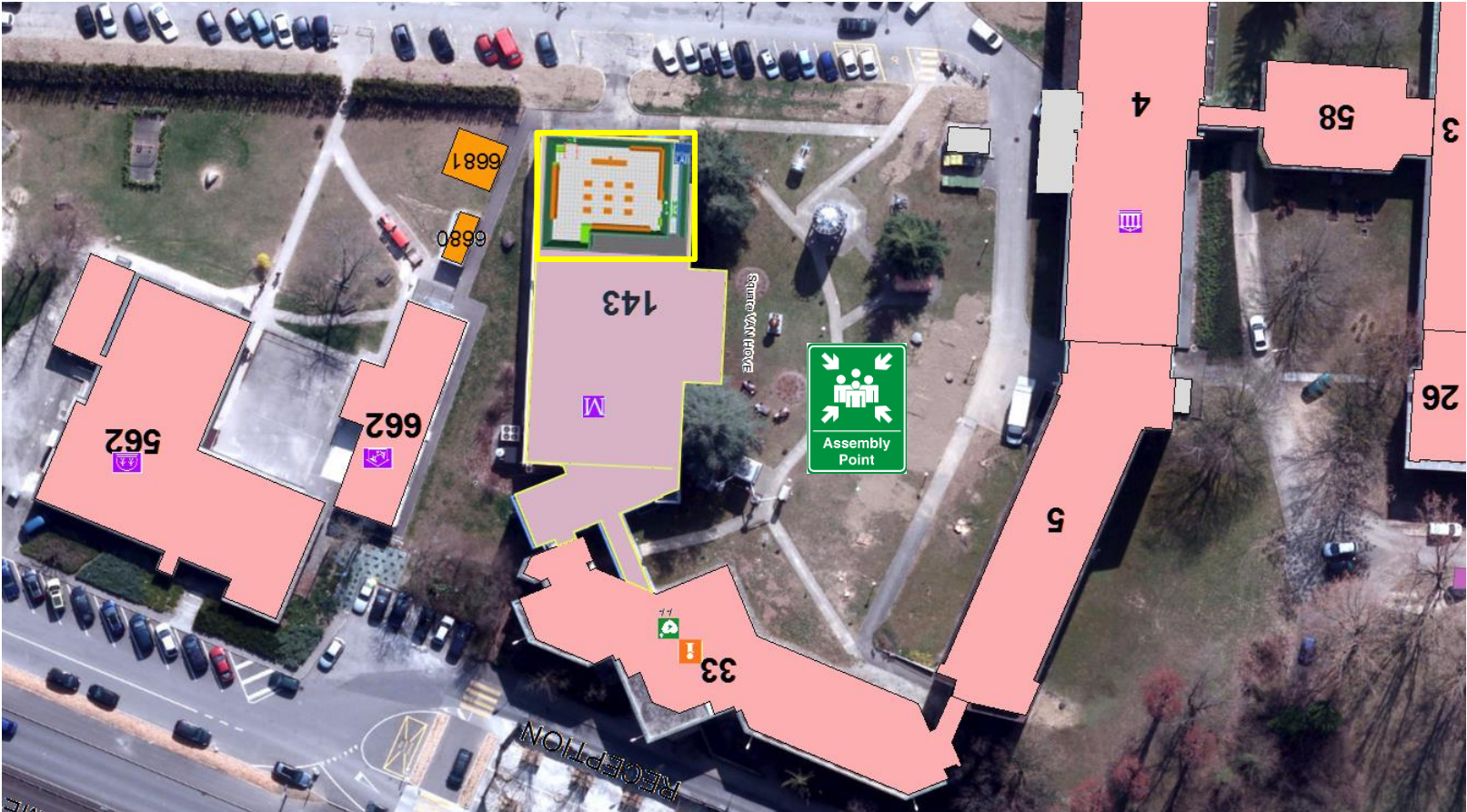
To avoid collisions, please place your bags and jackets in the designated shelf!



# Emergency exits

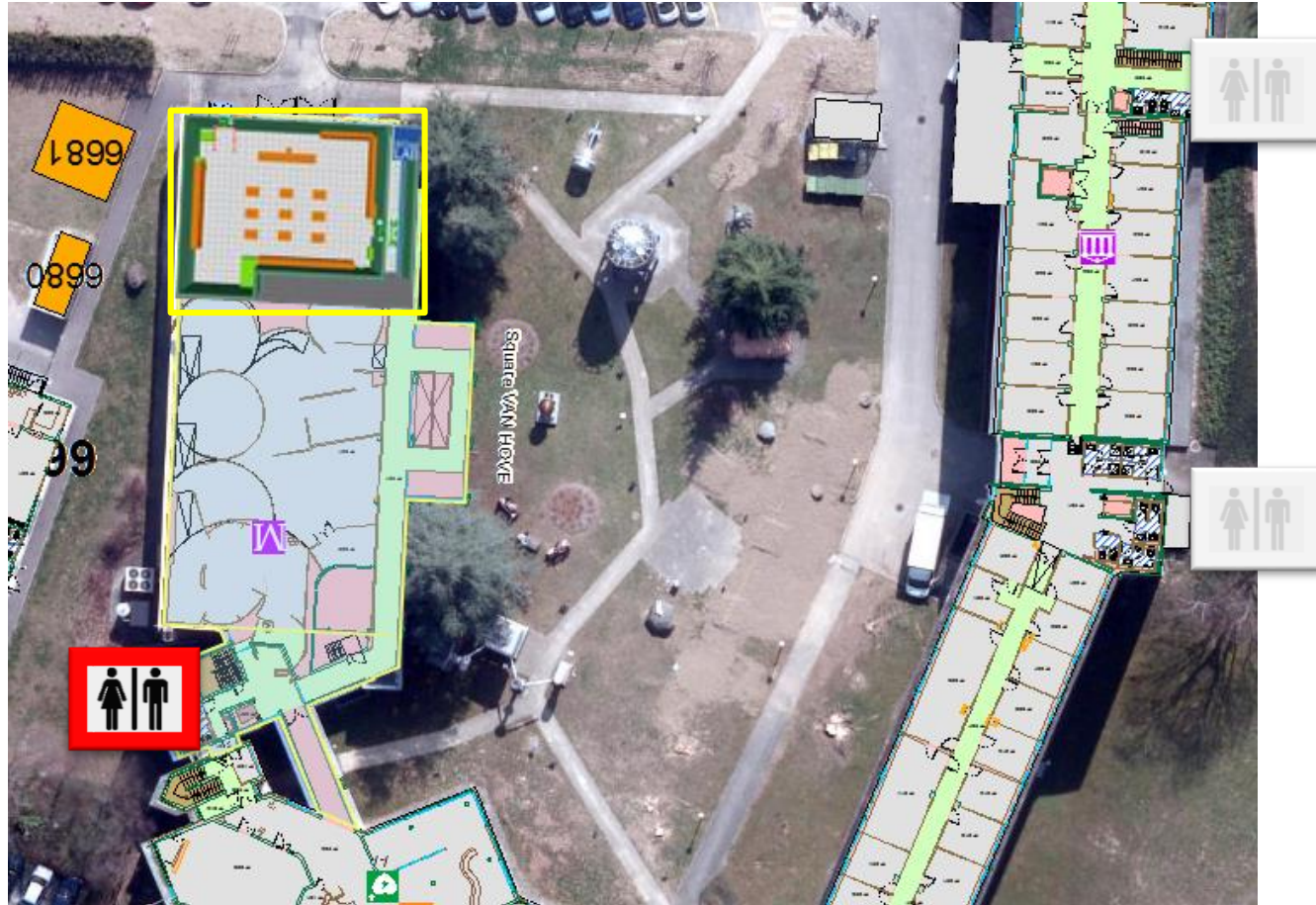


# Assembly point





# Rest rooms



# Cloud Chamber Workshop

# Outline

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

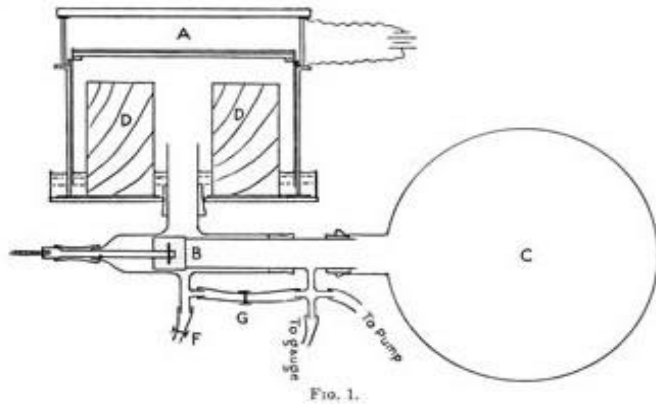


History

# 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.

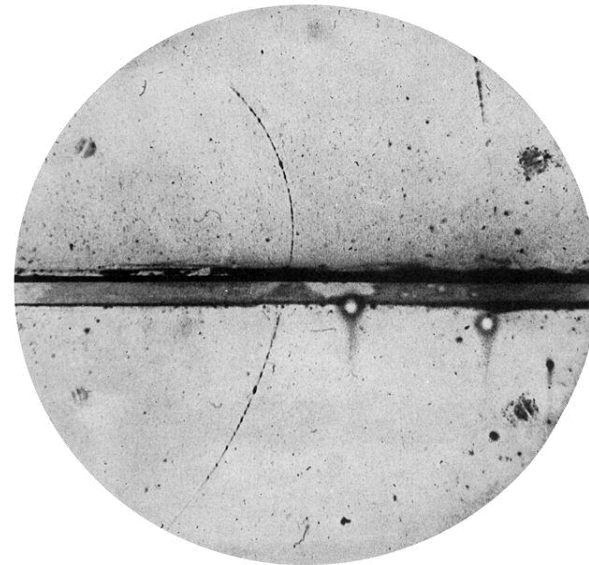


A diagram of Wilson's apparatus. The cylindrical cloud chamber ('A') is 16.5cm across by 3.4cm deep.

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).

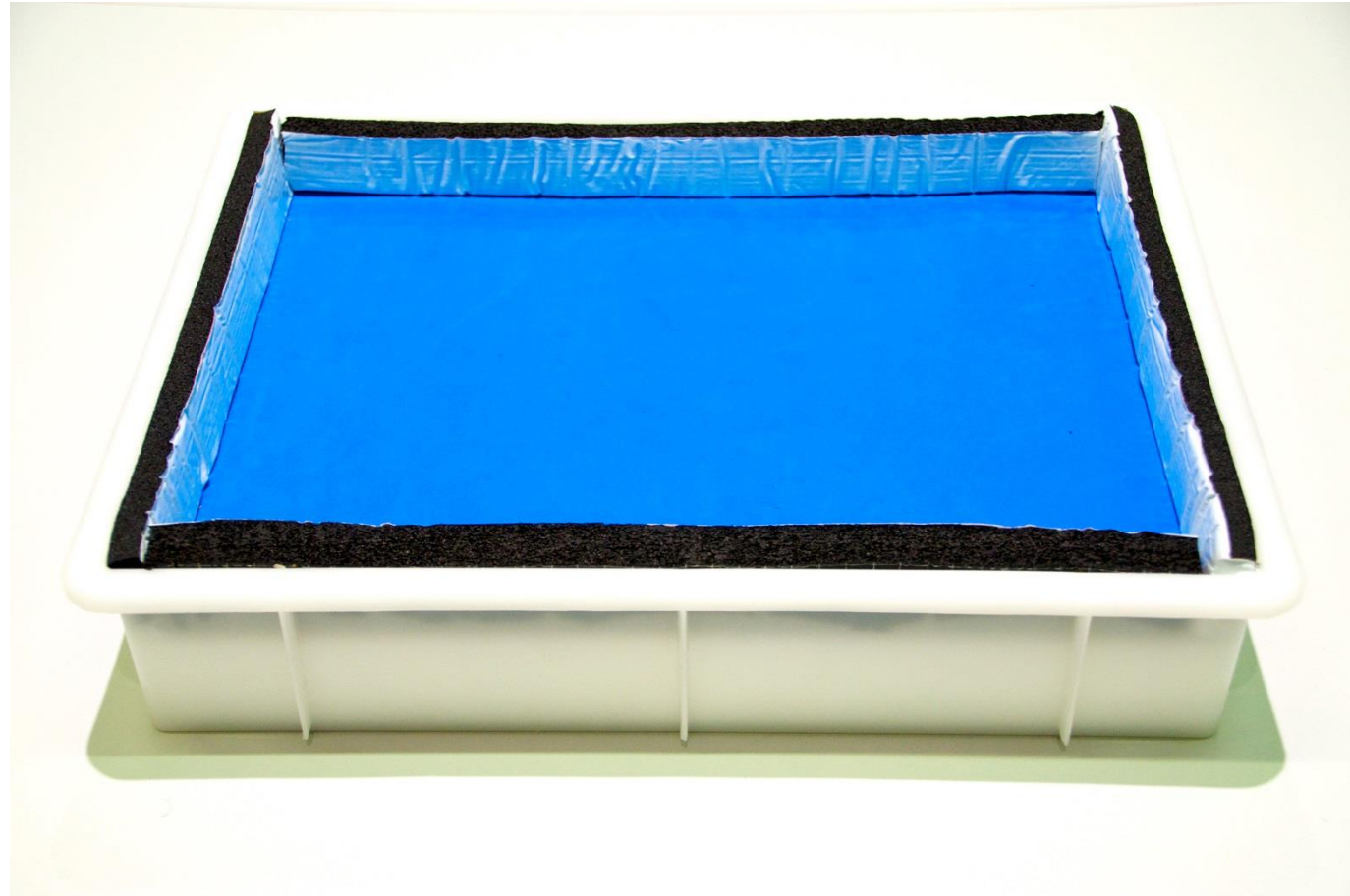
Step by step tutorial



# Build your cloud chamber - step by step



# Build your cloud chamber - step by step



# Build your cloud chamber - step by step

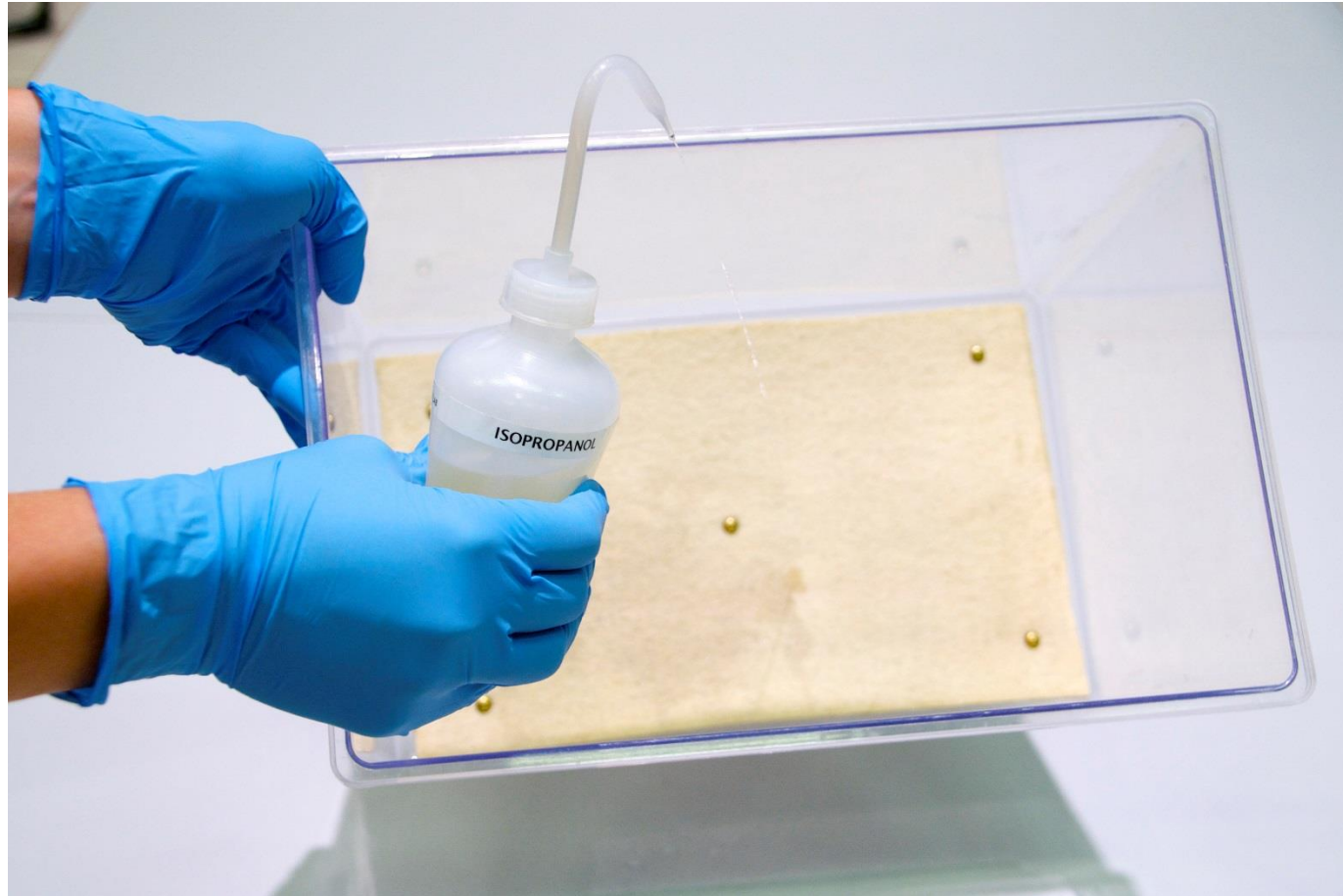




# Build your cloud chamber - step by step



# Build your cloud chamber - step by step

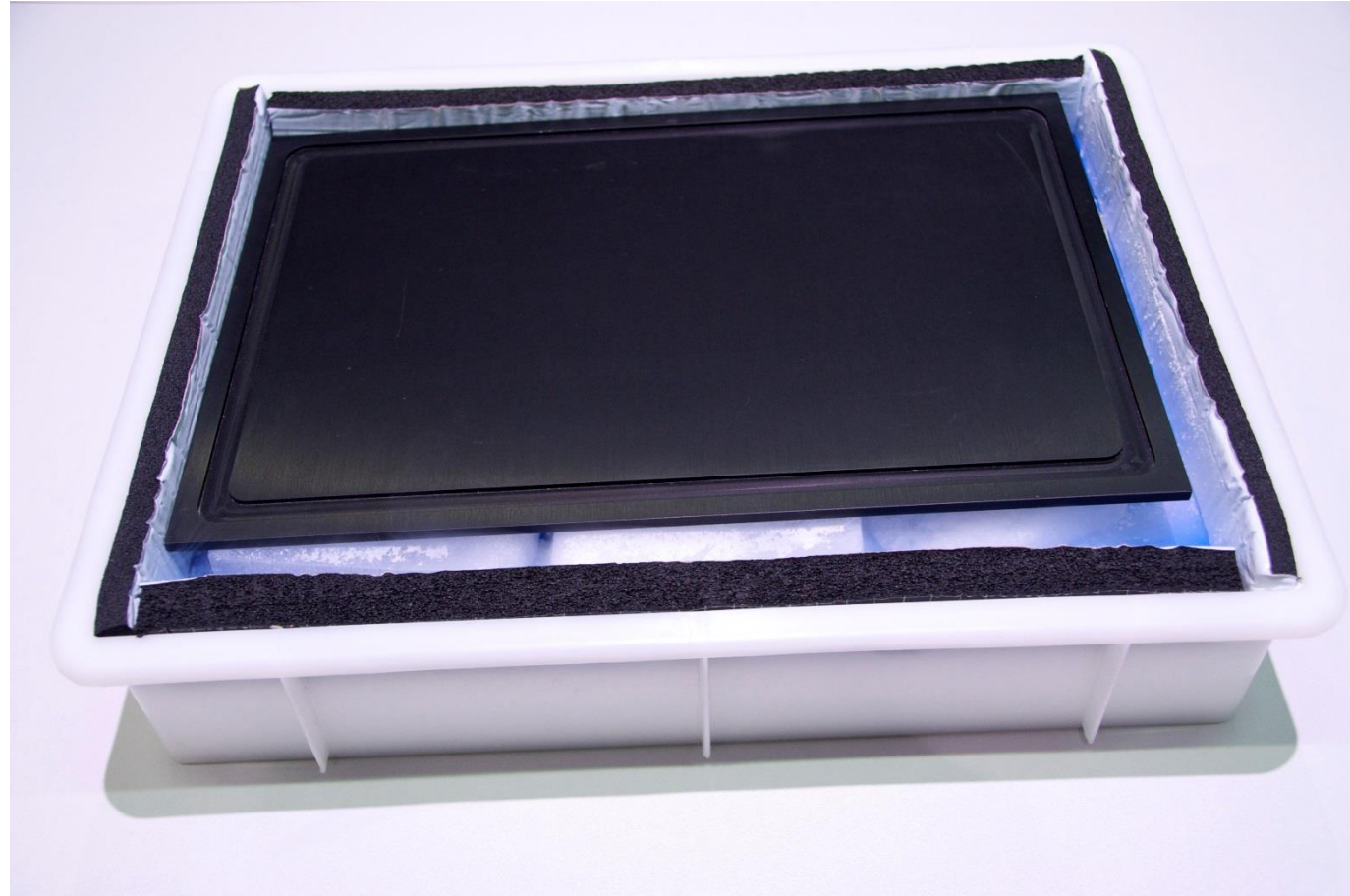


# Build your cloud chamber - step by step

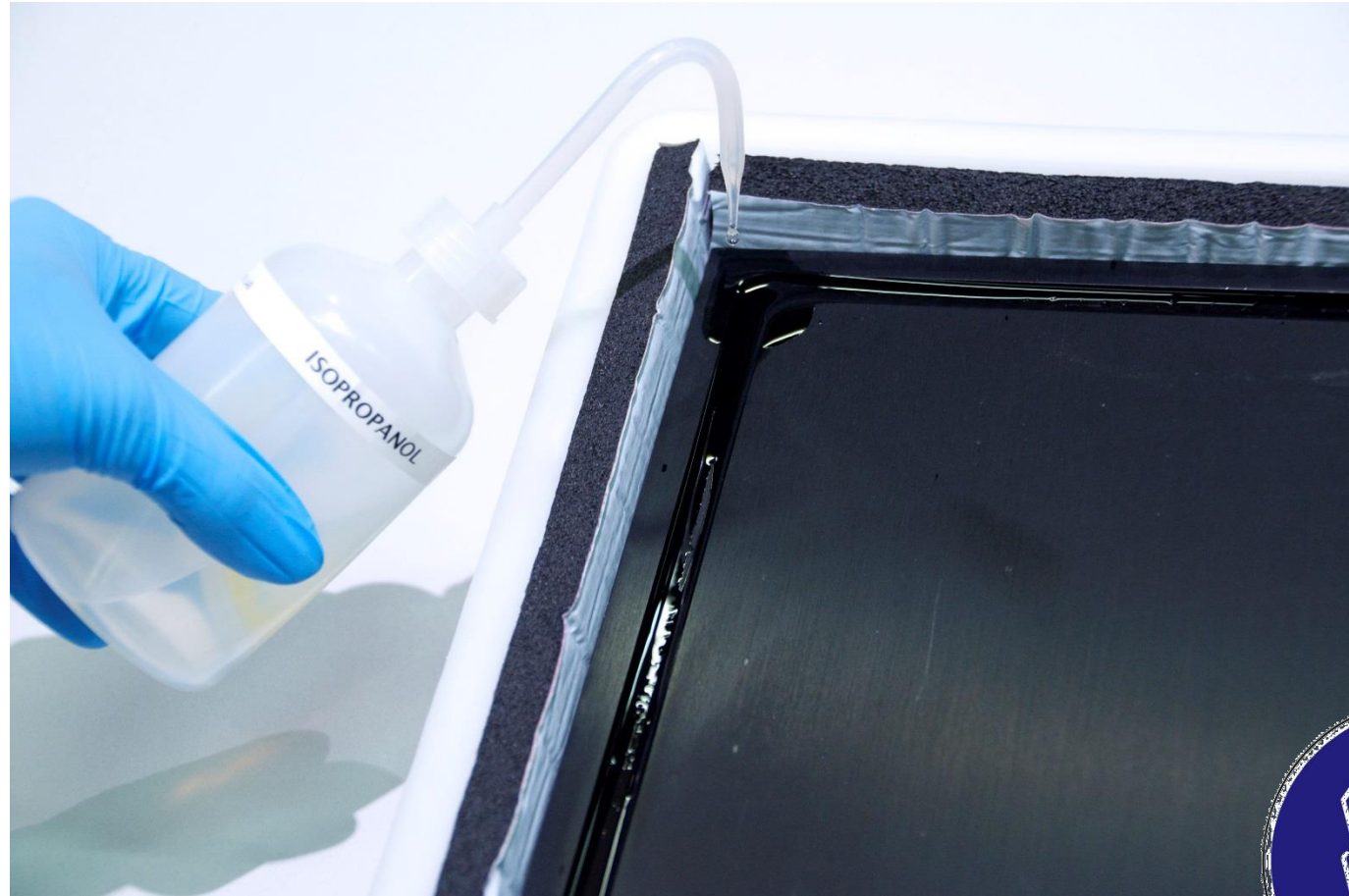




# Build your cloud chamber - step by step



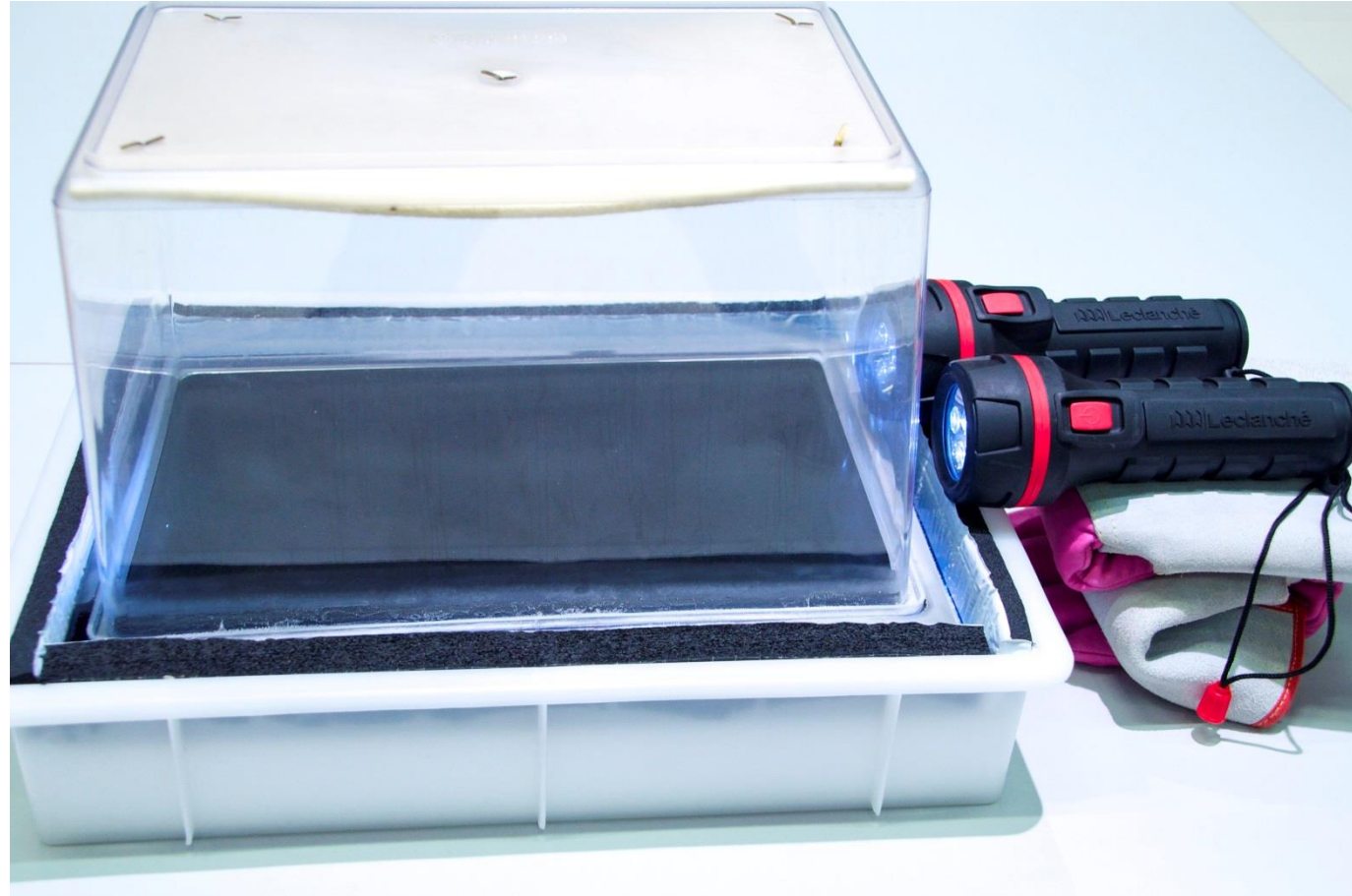
# Build your cloud chamber - step by step



# Build your cloud chamber - step by step

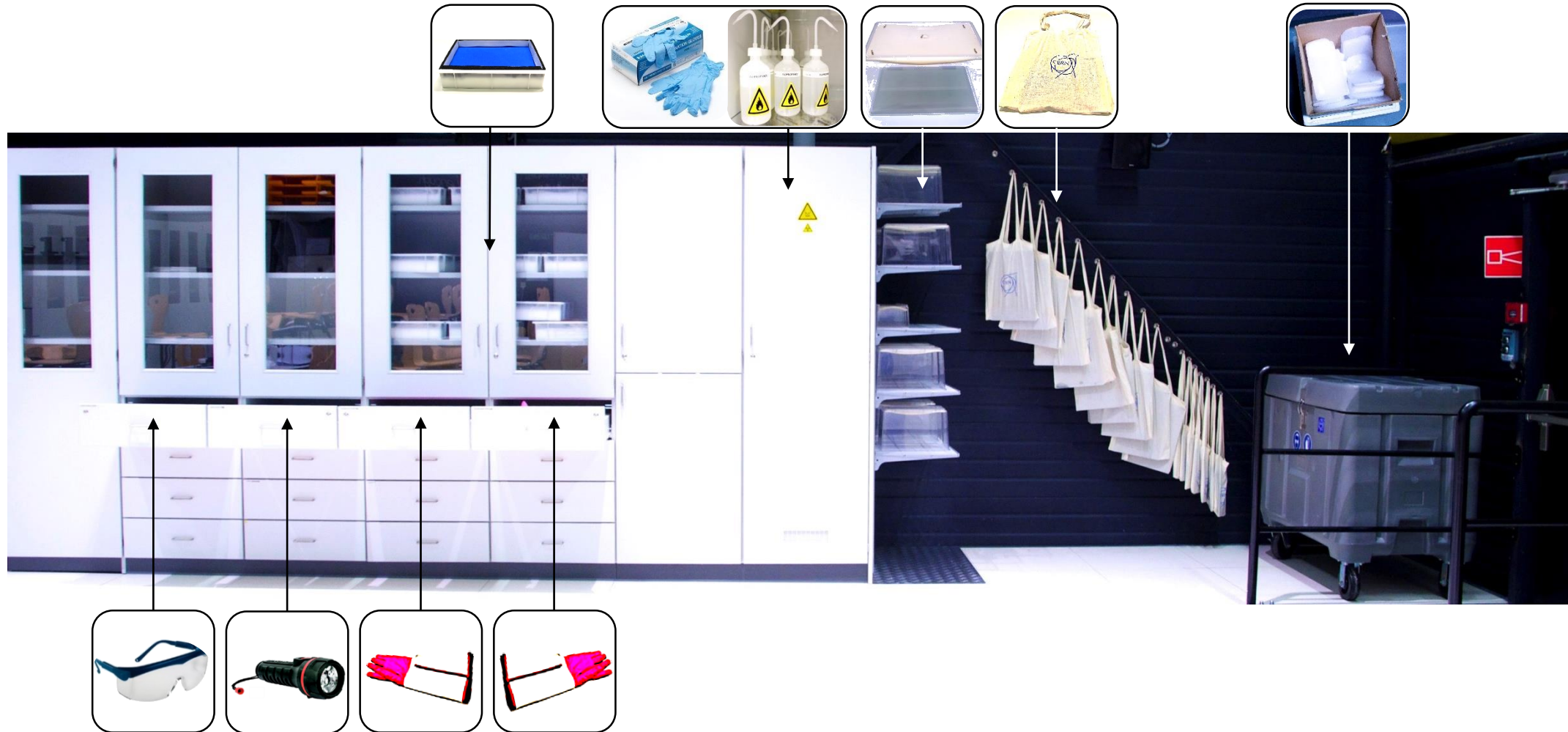


# Build your cloud chamber - step by step





# 👉 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

Whiteboard



# Additional Material

# Air Shower Simulation

## Cosmic Ray Air Shower Pictures

by H.-J. Drescher [drescher@th.physik.uni-frankfurt.de](mailto: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

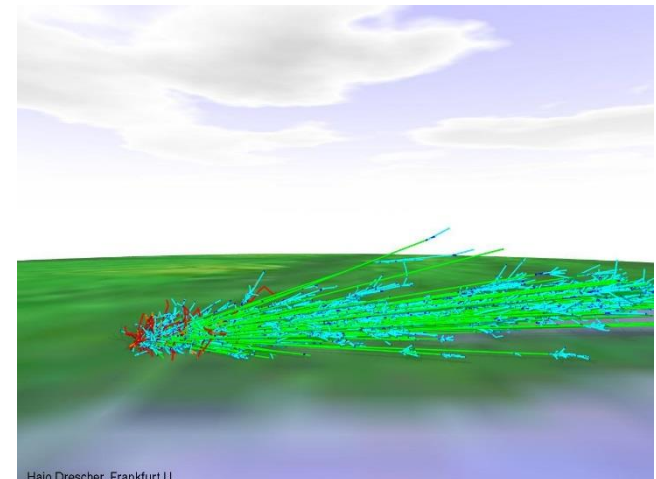
cyan:photons

red:neutrons

orange: protons

gray: mesons

green:muons



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

blue:electrons/positrons

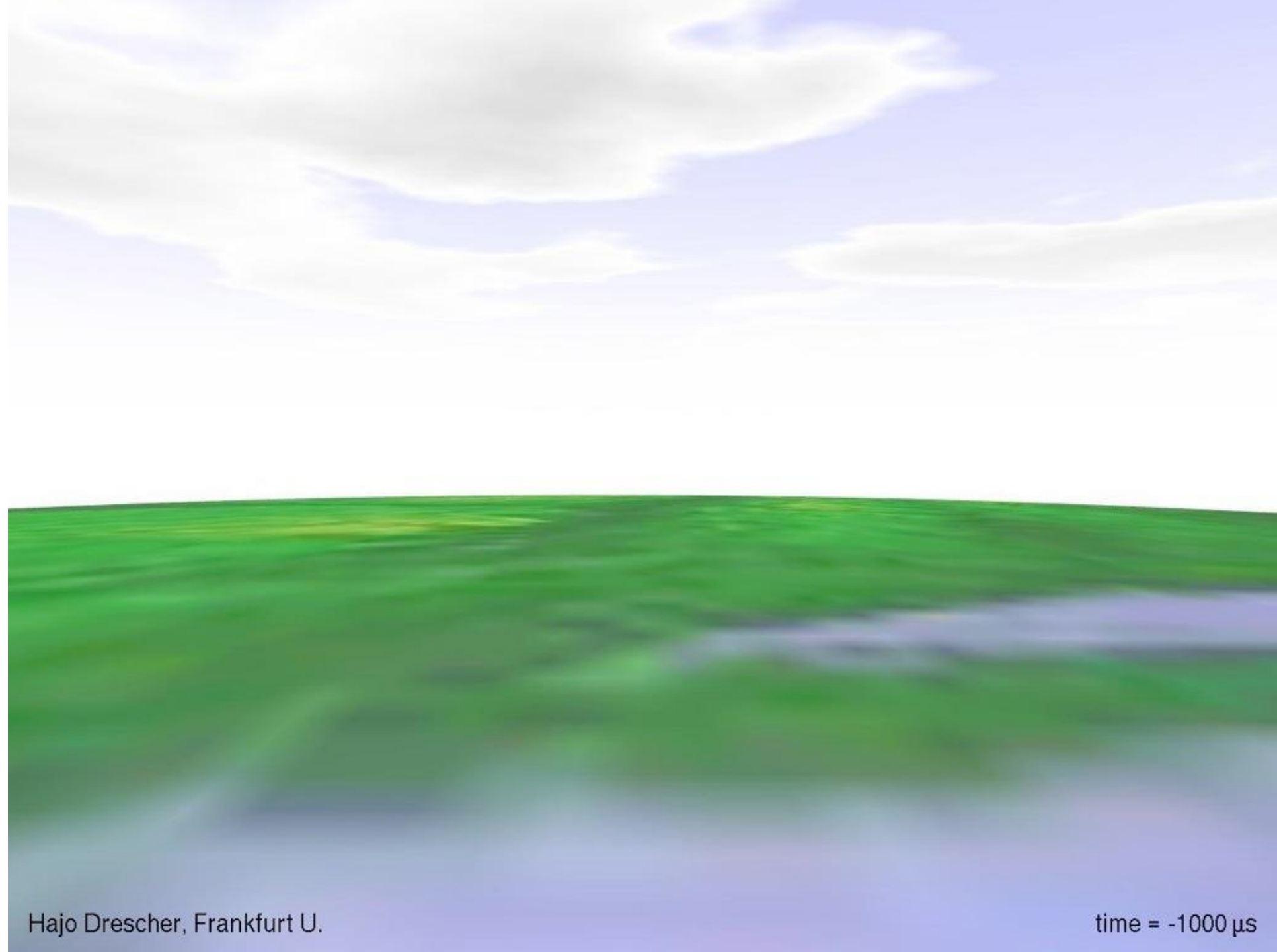
cyan:photons

red:neutrons

orange: protons

gray: mesons

green:muons



blue:electrons/positrons

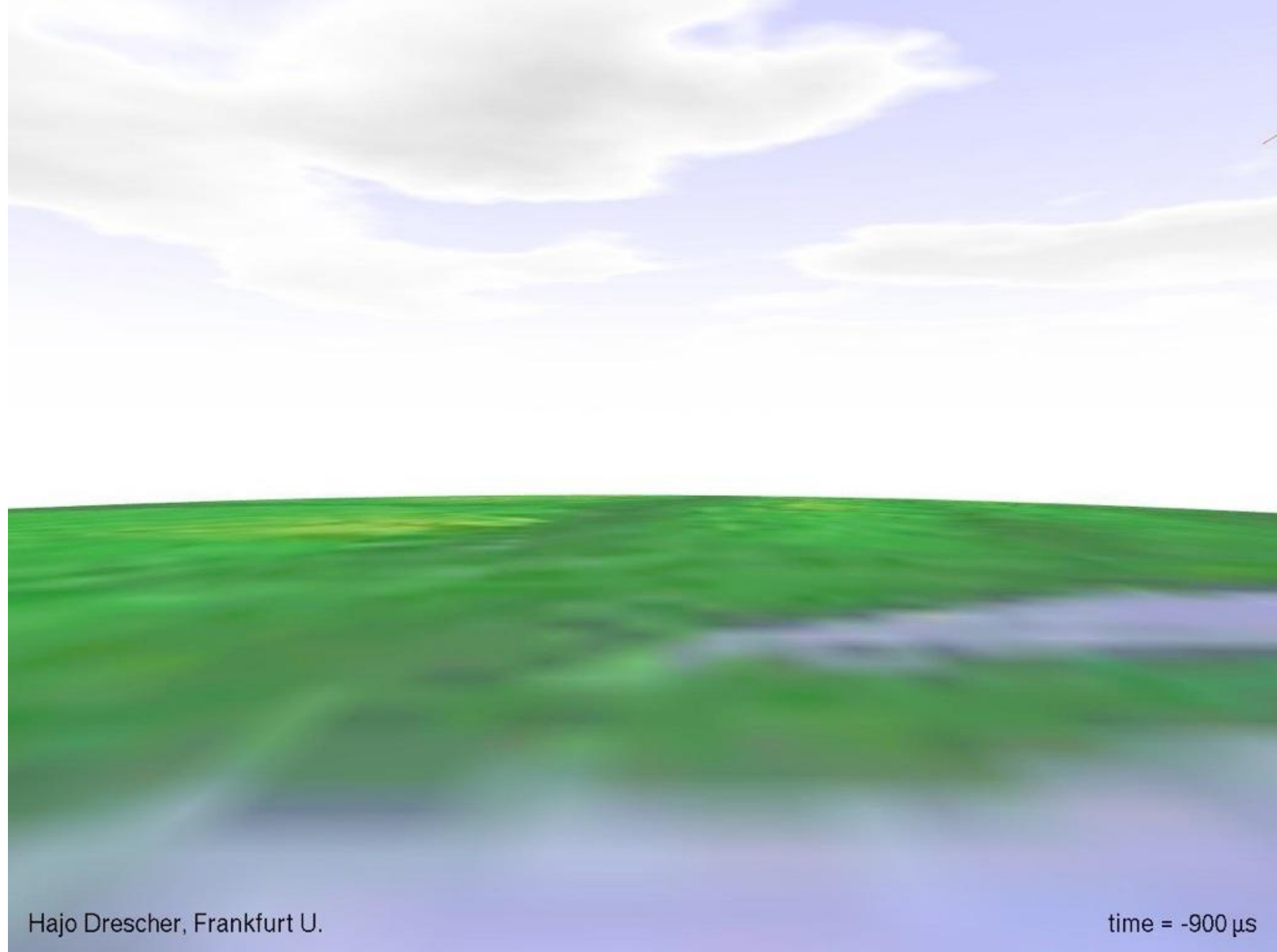
cyan:photons

red:neutrons

orange: protons

gray: mesons

green:muons





blue:electrons/positrons

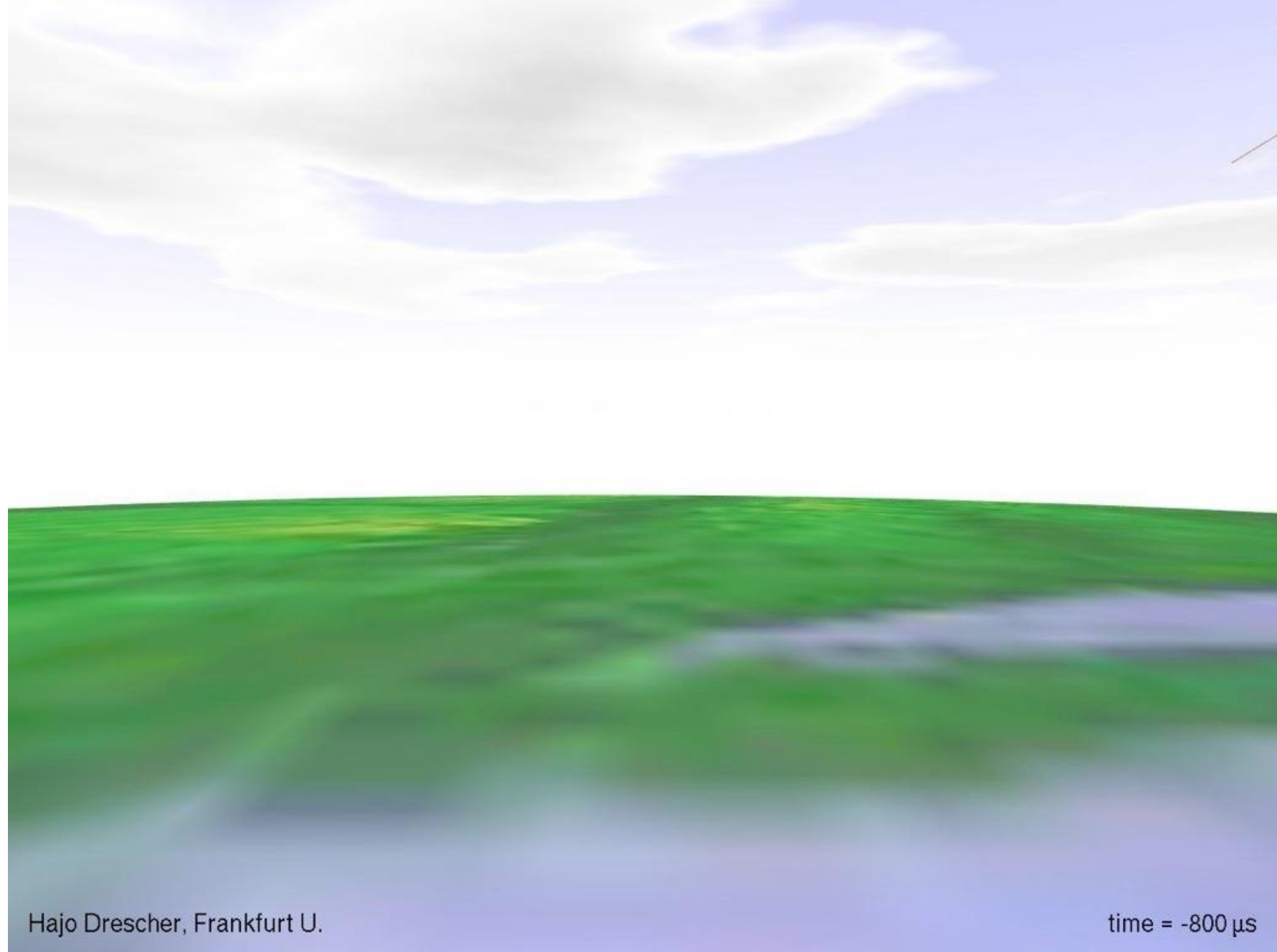
cyan:photons

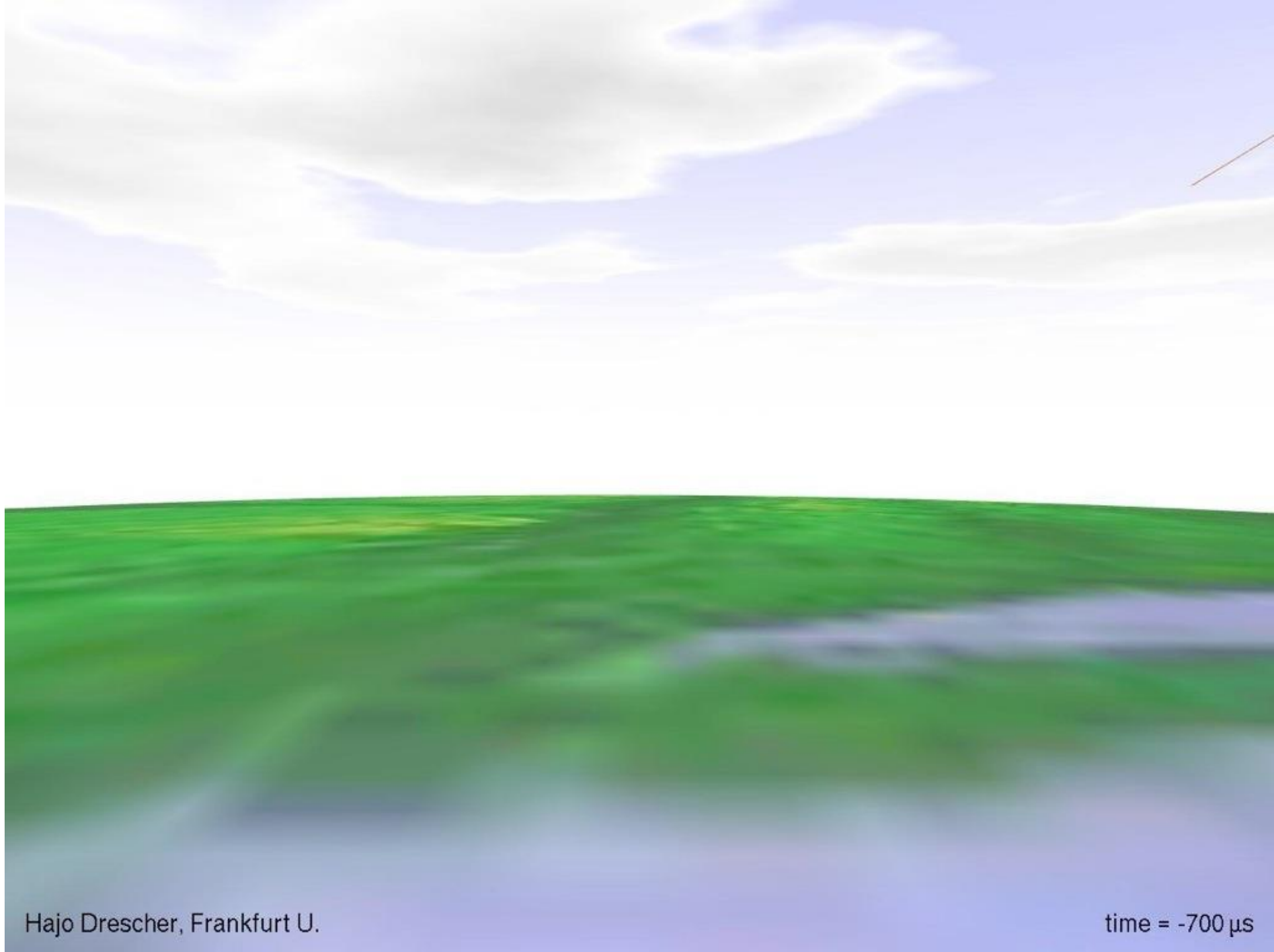
red:neutrons

orange: protons

gray: mesons

green:muons





blue:electrons/positrons

cyan:photons

red:neutrons

orange: protons

gray: mesons

green:muons

blue:electrons/positrons

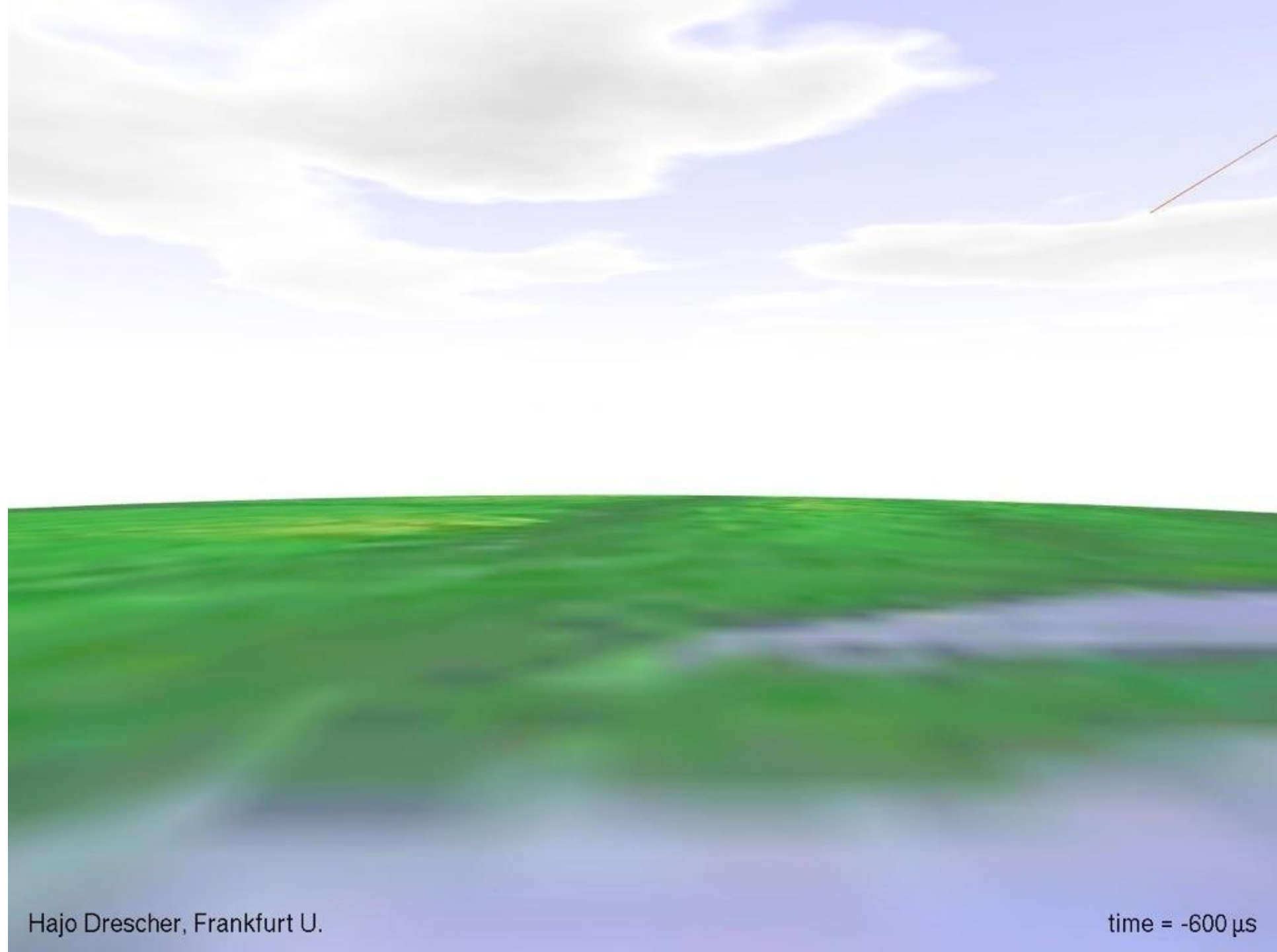
cyan:photons

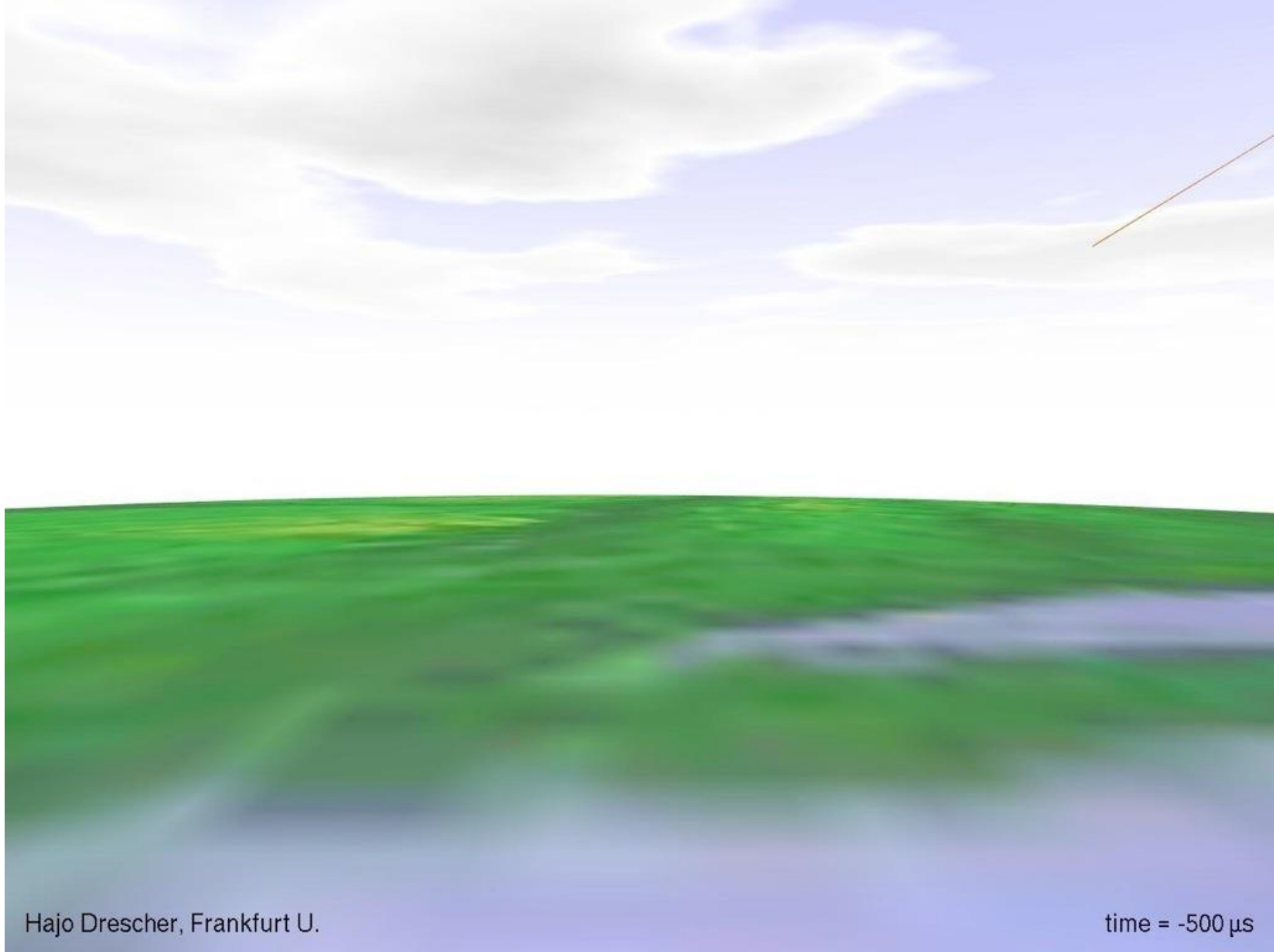
red:neutrons

orange: protons

gray: mesons

green:muons





blue:electrons/positrons

cyan:photons

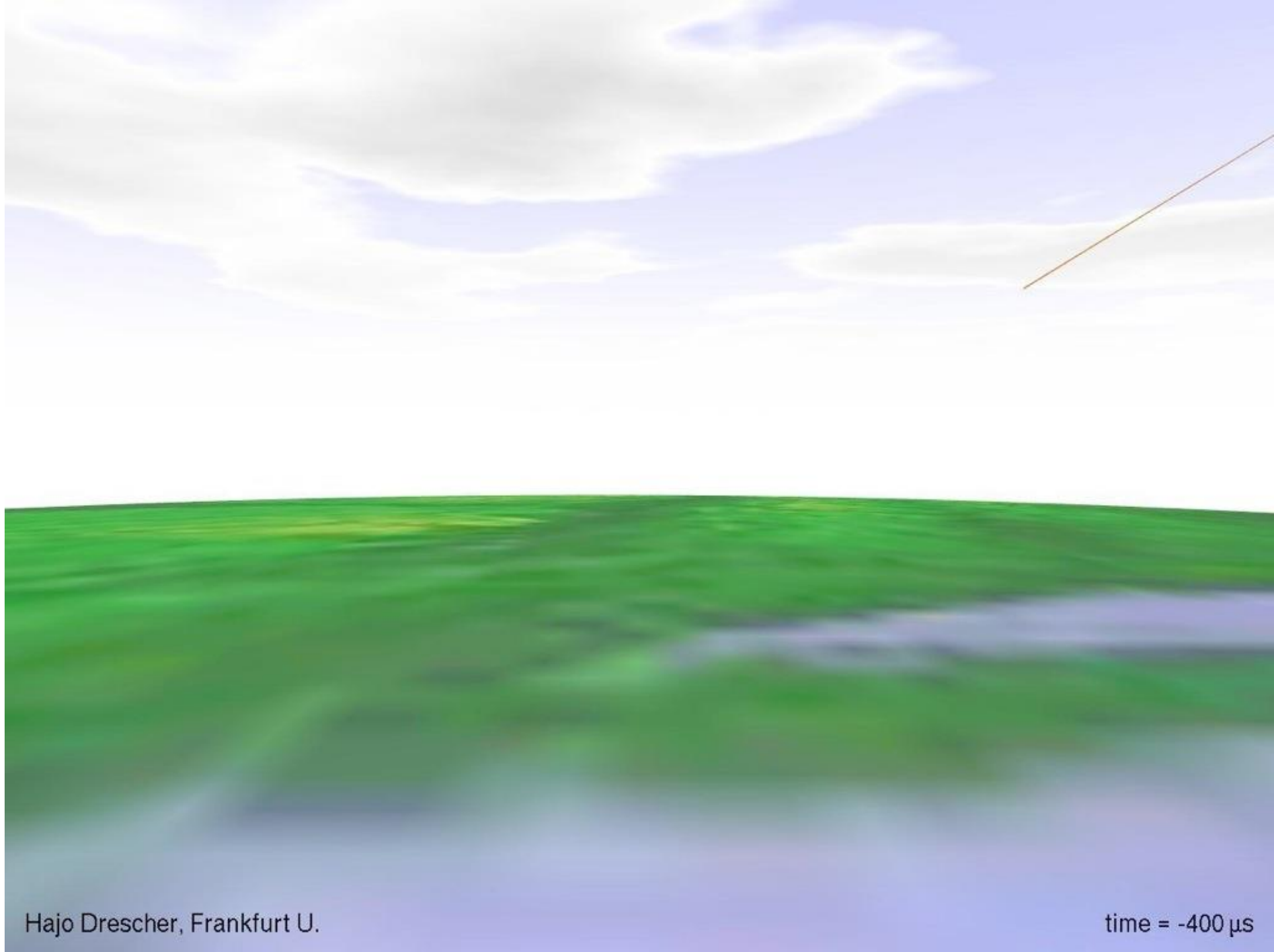
red:neutrons

orange: protons

gray: mesons

green:muons





blue:electrons/positrons

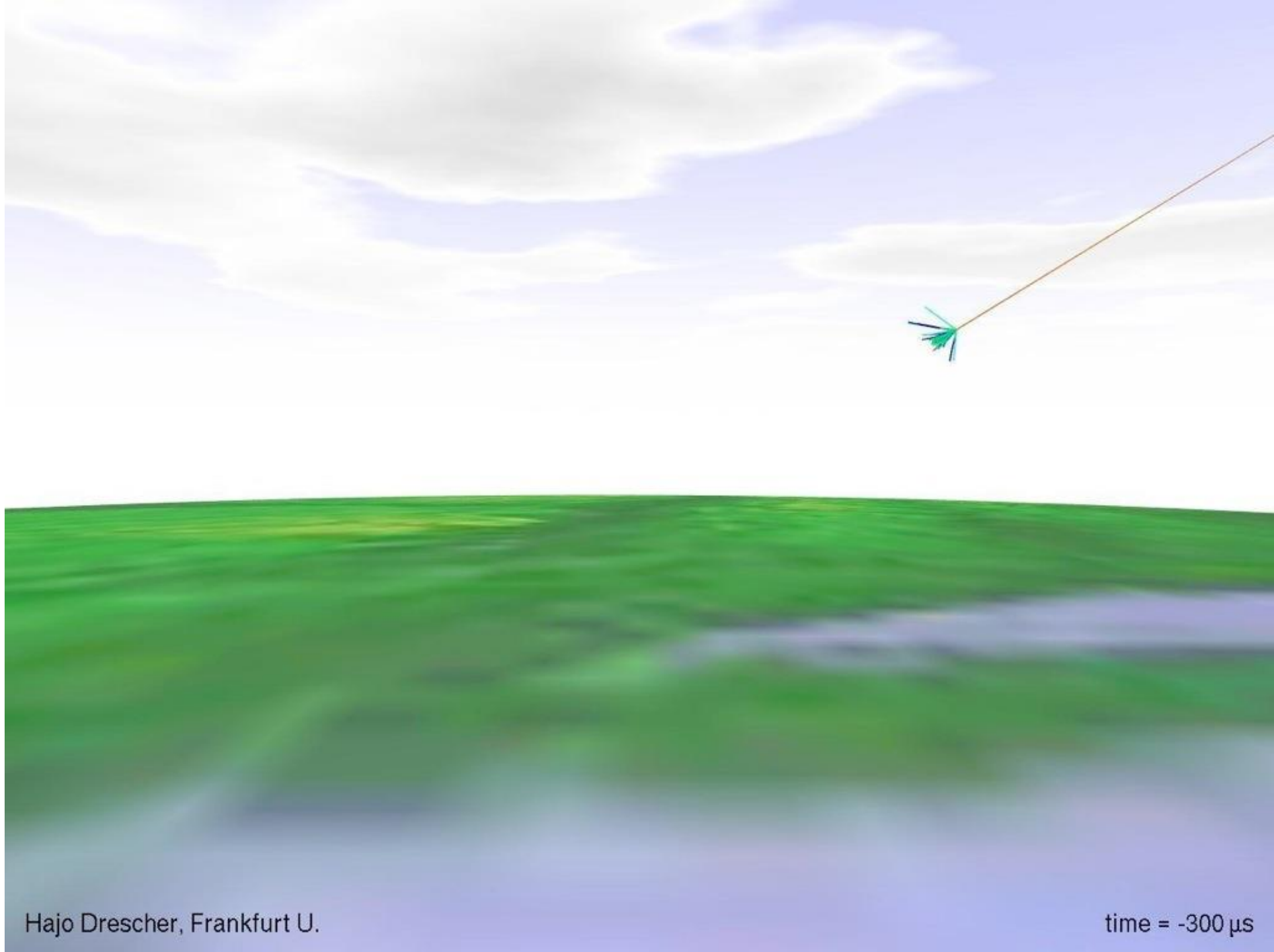
cyan:photons

red:neutrons

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blue:electrons/positrons

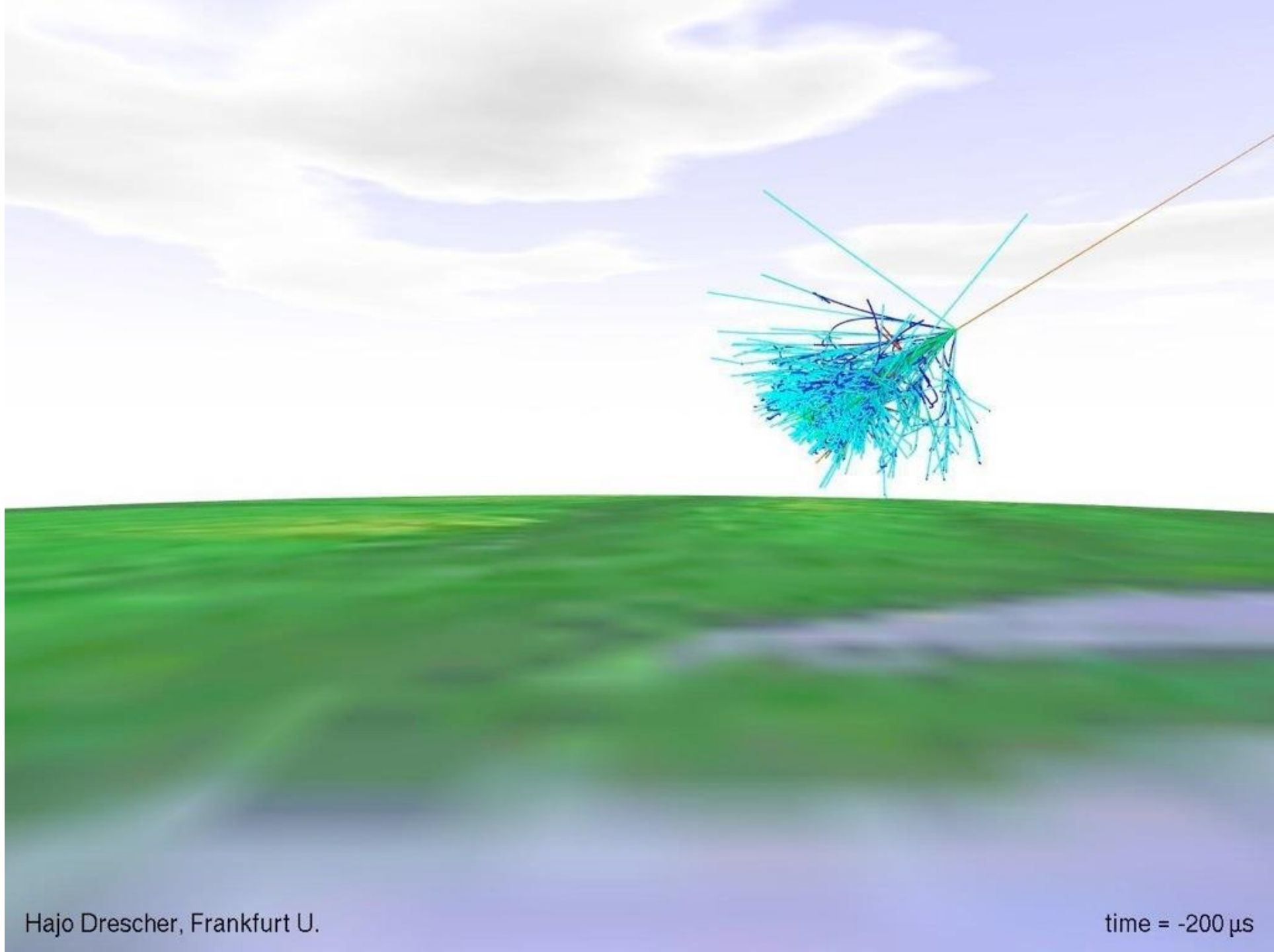
cyan:photons

red:neutrons

orange: protons

gray: mesons

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blue:electrons/positrons

cyan:photons

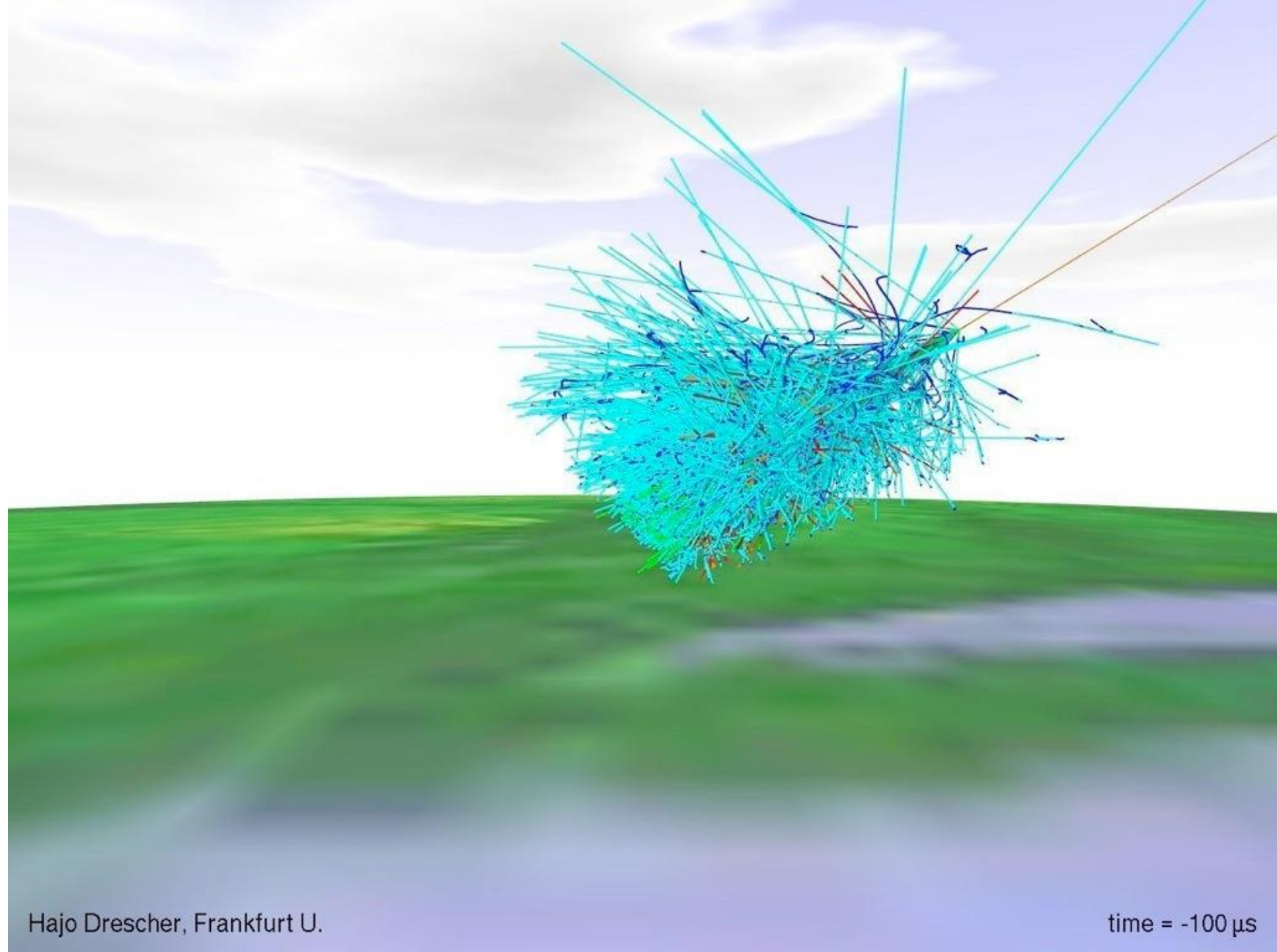
red:neutrons

orange: protons

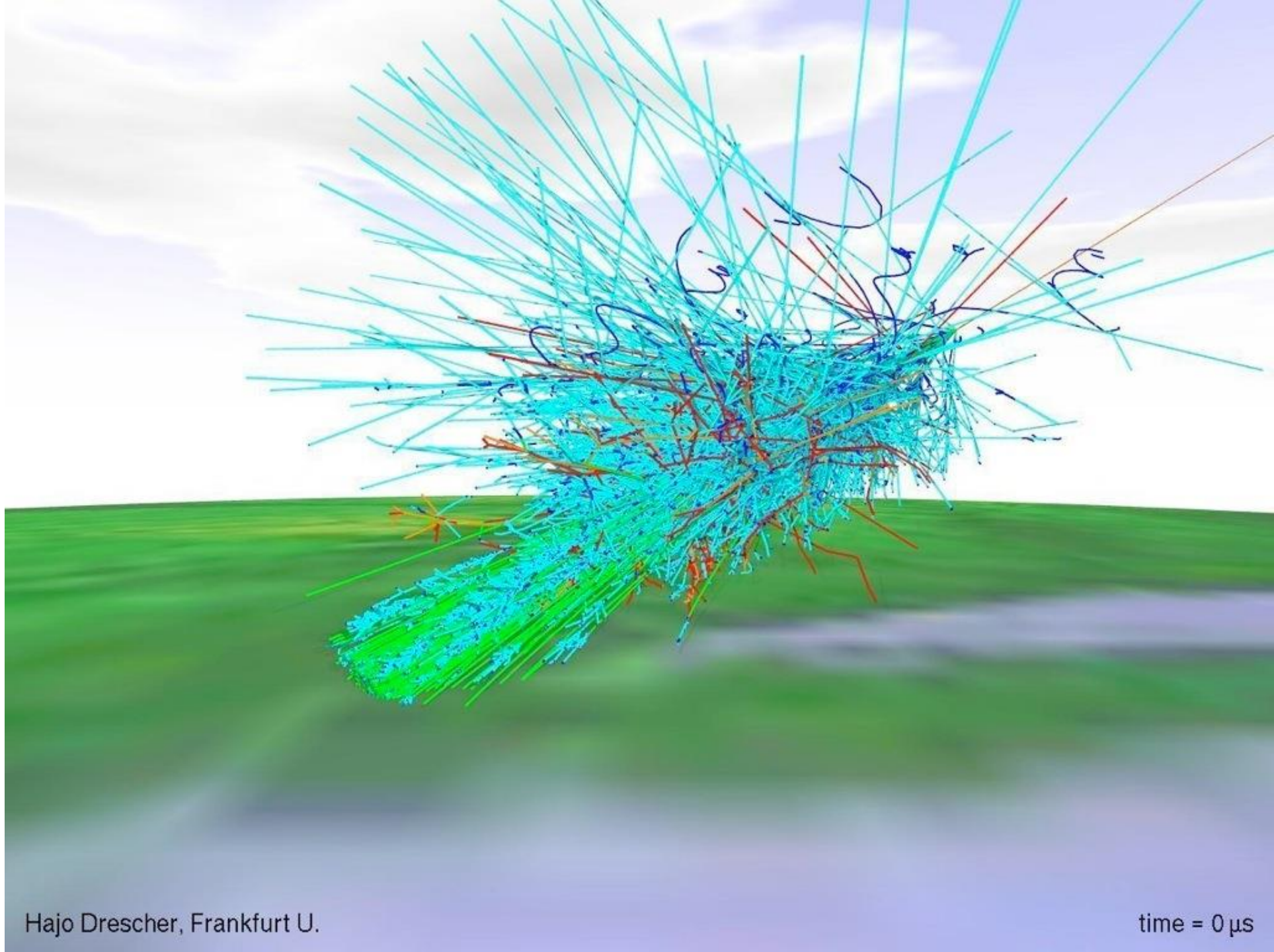
gray: mesons

green:muons

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







blue:electrons/positrons

cyan:photons

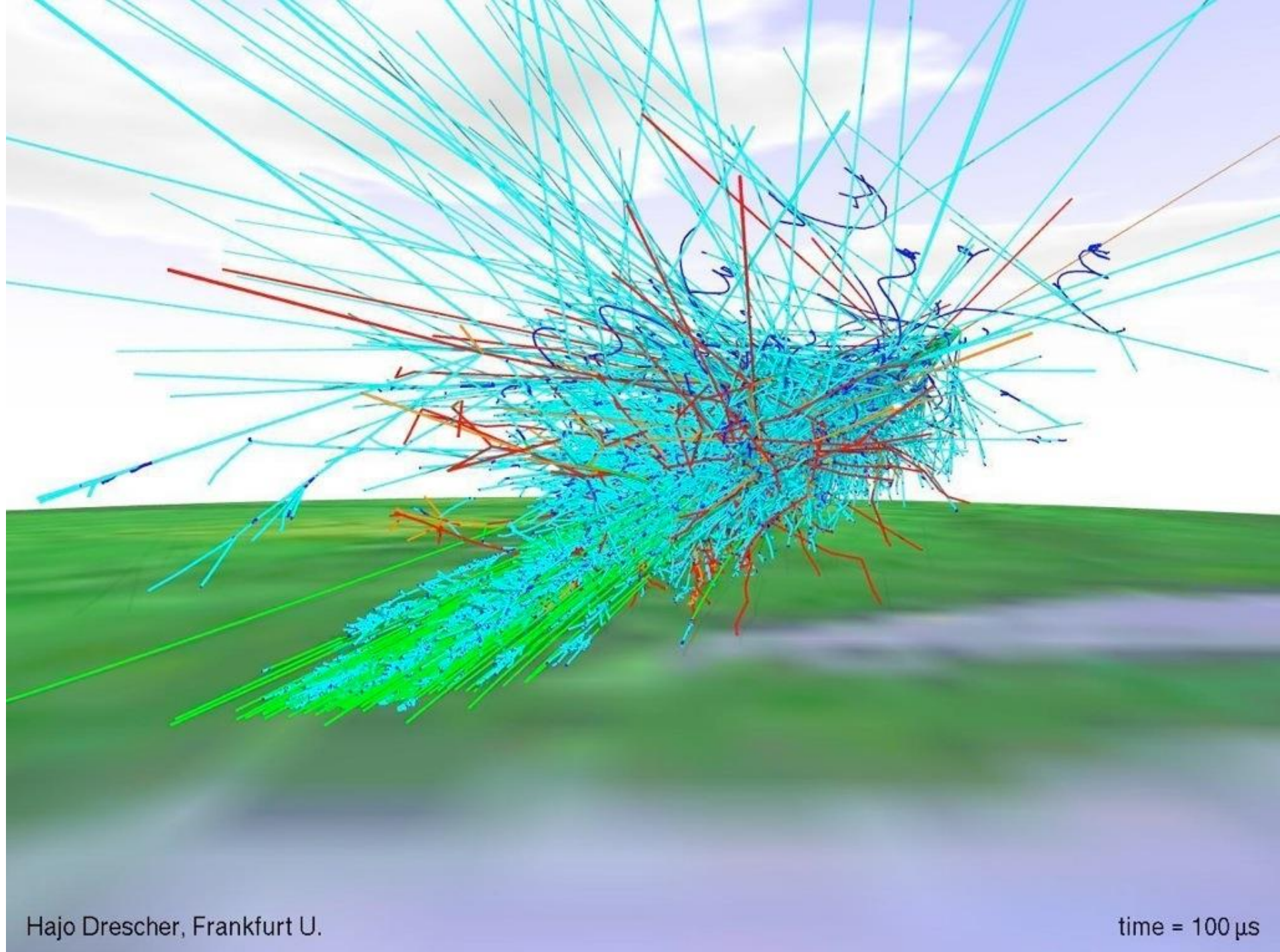
red:neutrons

orange: protons

gray: mesons

green:muons





blue:electrons/positrons

cyan:photons

red:neutrons

orange: protons

gray: mesons

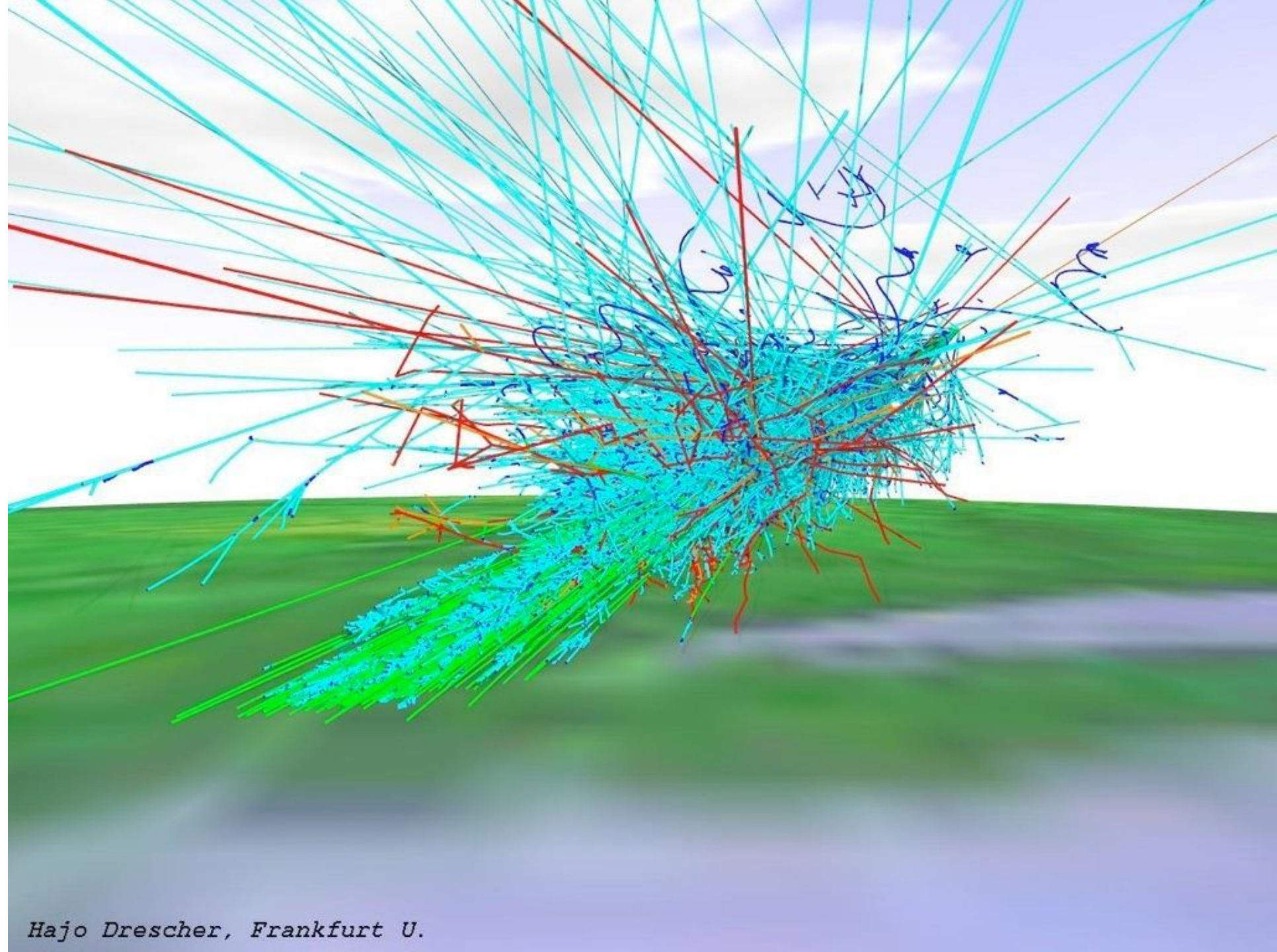
green:muons

Hajo Drescher, Frankfurt U.

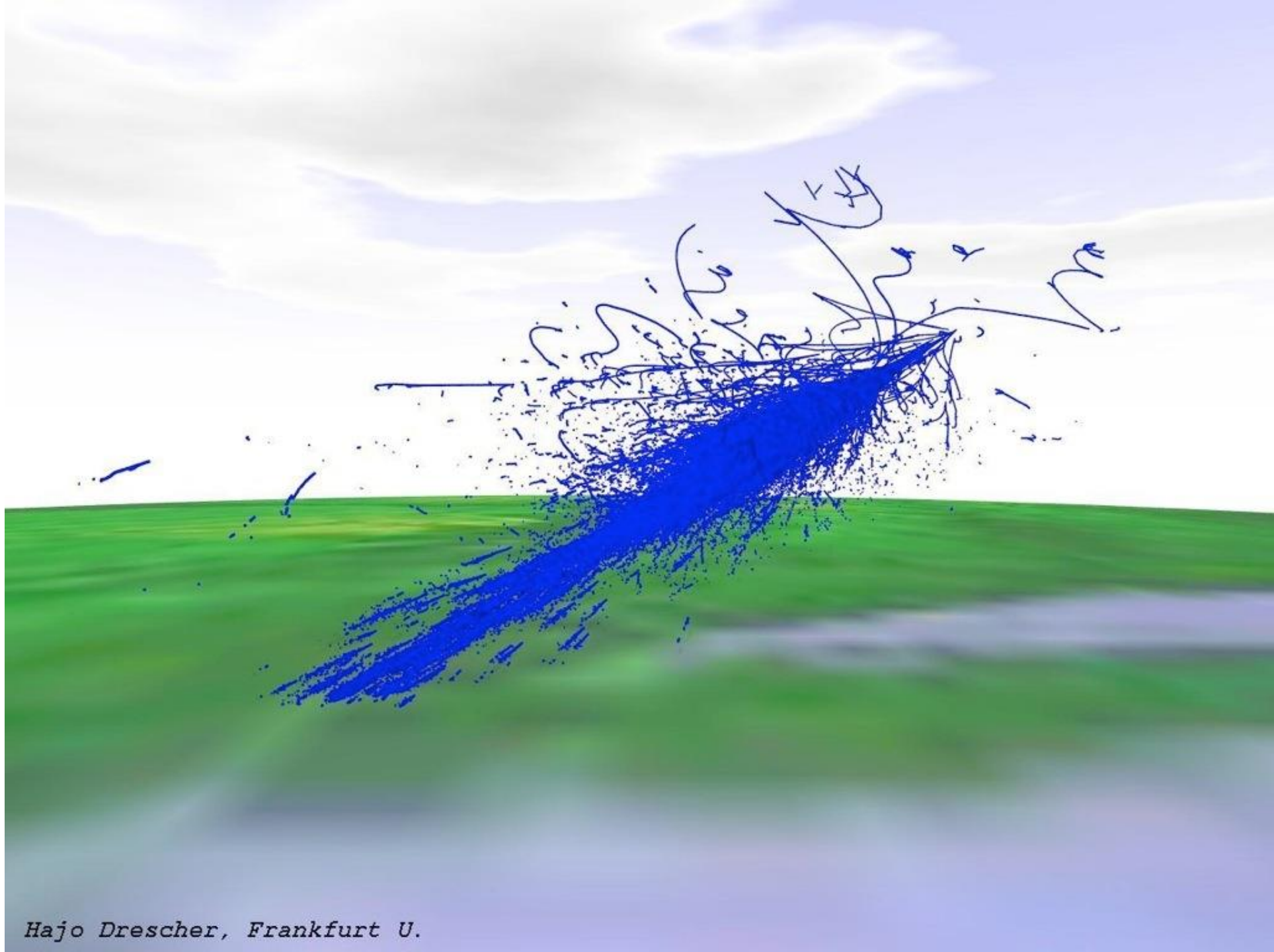
time = 100  $\mu$ s



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



*Hajo Drescher, Frankfurt U.*



blue:electrons/positrons

cyan:photons

red:neutrons

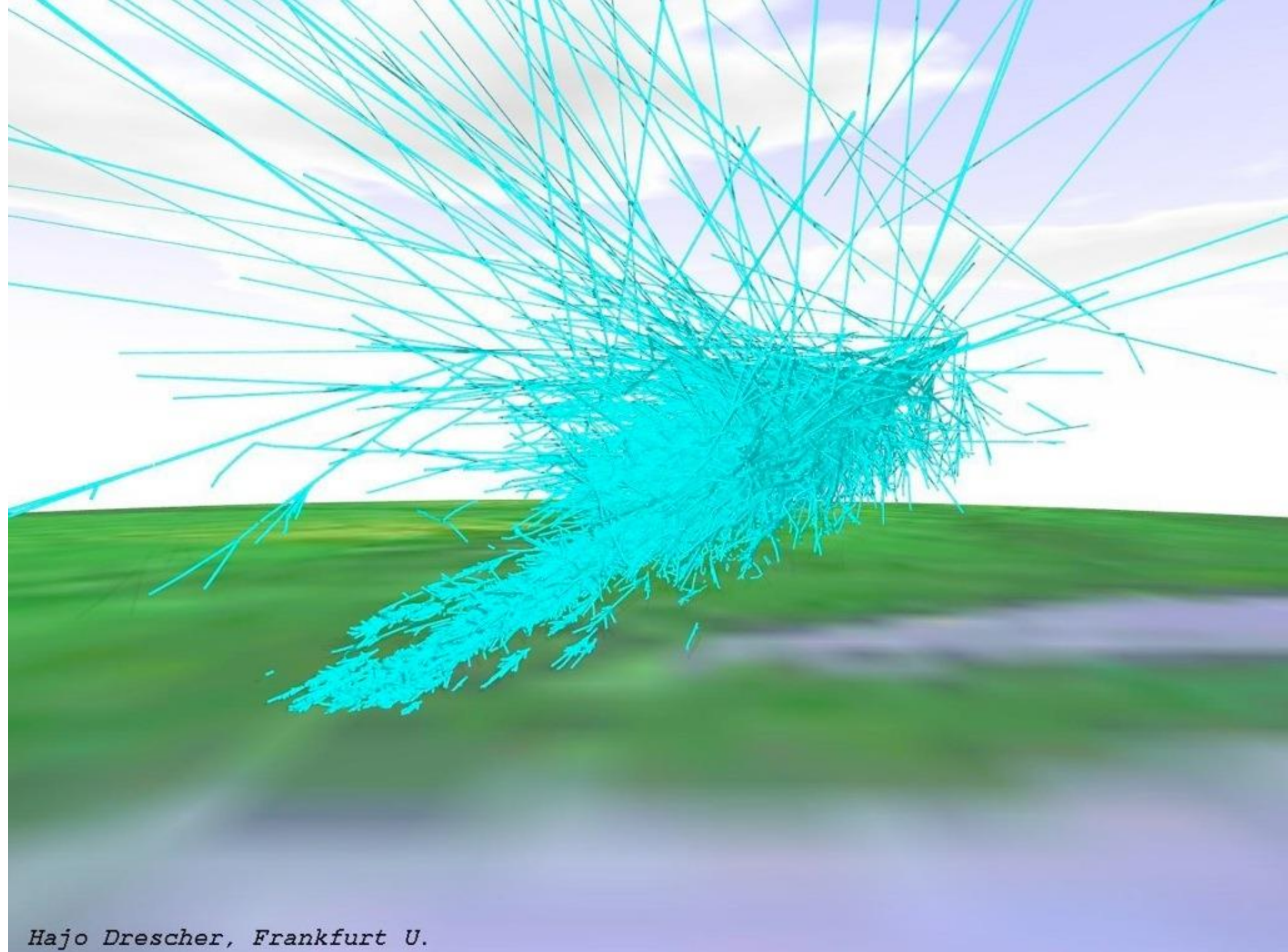
orange: protons

gray: mesons

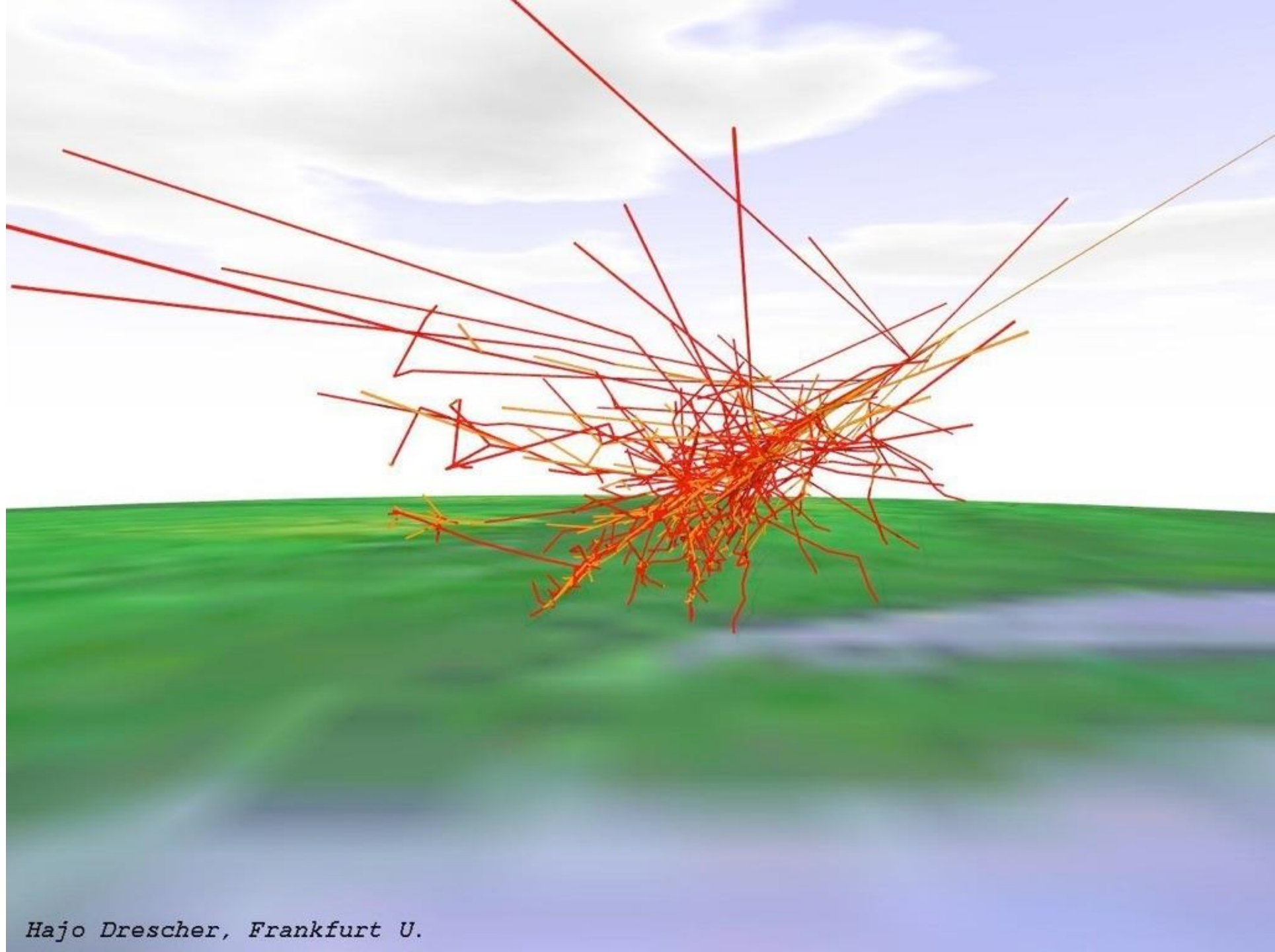
green:muons



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



*Hajo Drescher, Frankfurt U.*



blue:electrons/positrons

cyan:photons

red:neutrons

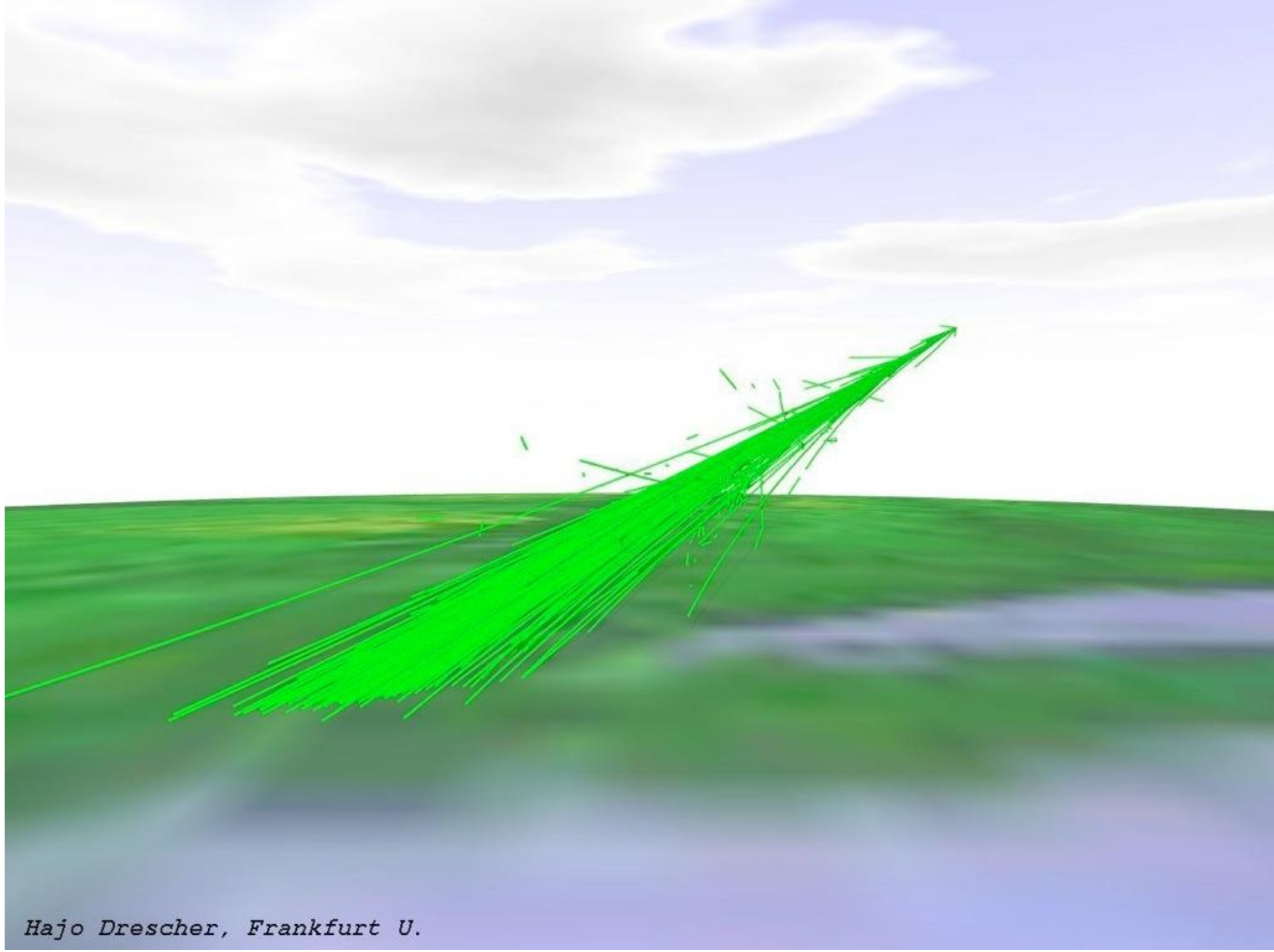
orange: protons

gray: mesons

green:muons

*Hajo Drescher, Frankfurt U.*





blue:electrons/positrons

cyan:photons

red:neutrons

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green:muons