

# A framework to generate high quality animations of HEP events

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# Summary

- Objectives
- Python code for Blender
- ALICE Open Data
- Animation display

# Objectives

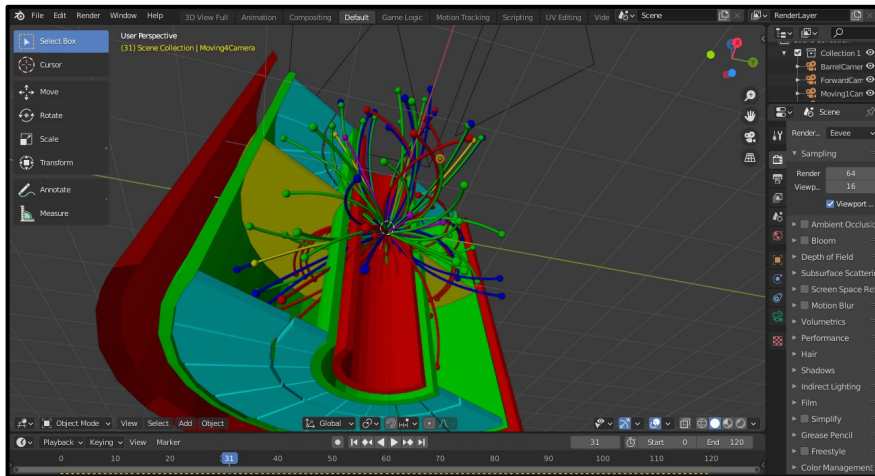
- Generate HEP animations  
→ outreach and education
  
- List of particles kinematics → trajectories

# The code

→ Object-oriented



→ 3D Modeling software

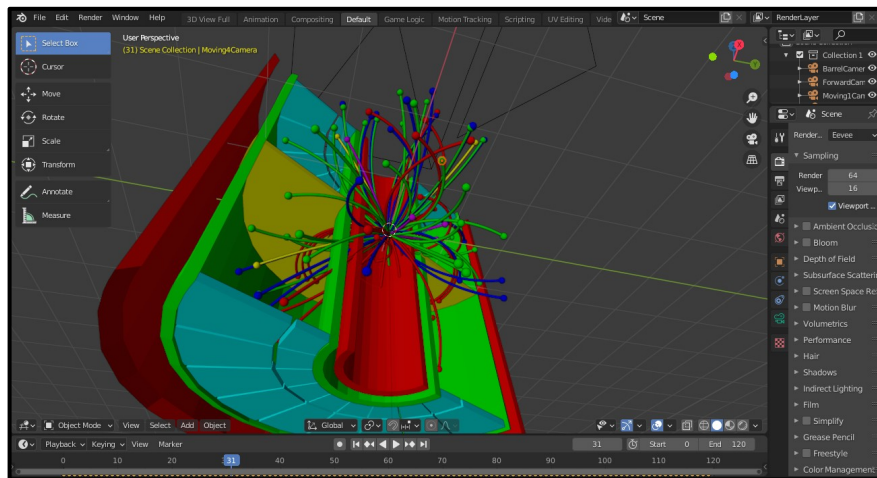


# The code

→ Object-oriented



→ 3D Modeling software



→ Detector geometries

→ Particle representation

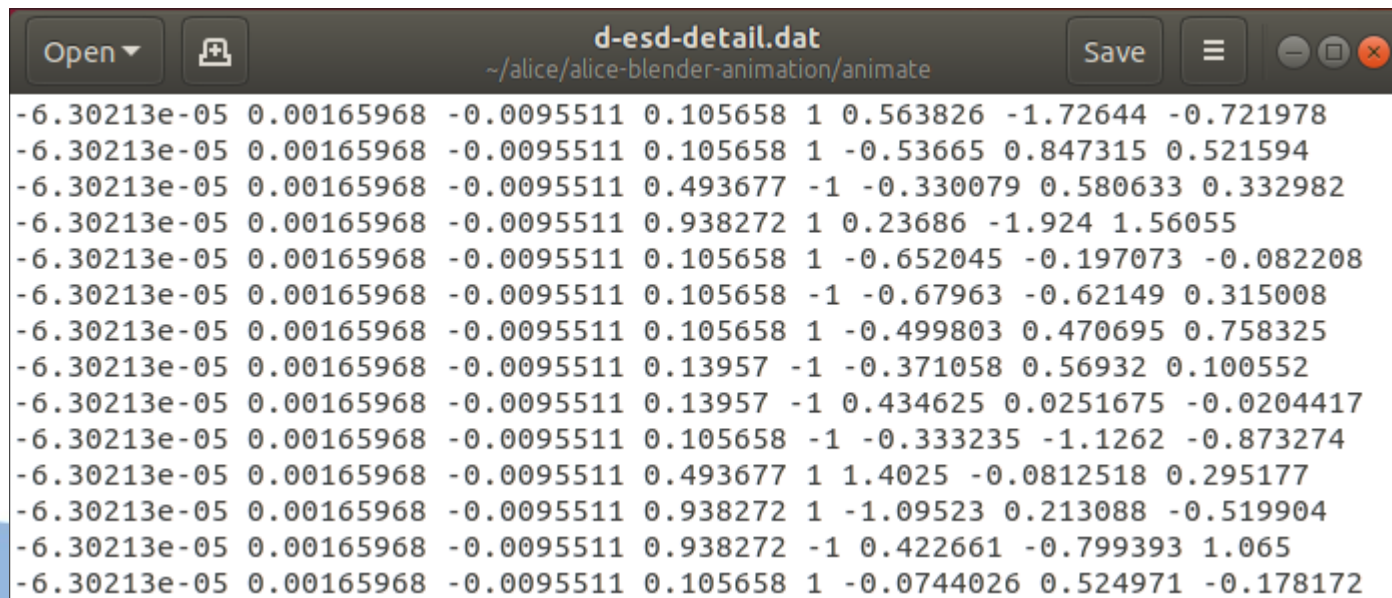
→ Different cameras

# The *animationDriver* base class

- Sets video details:
  - duration, FPS, output path, resolution
  - simulated time

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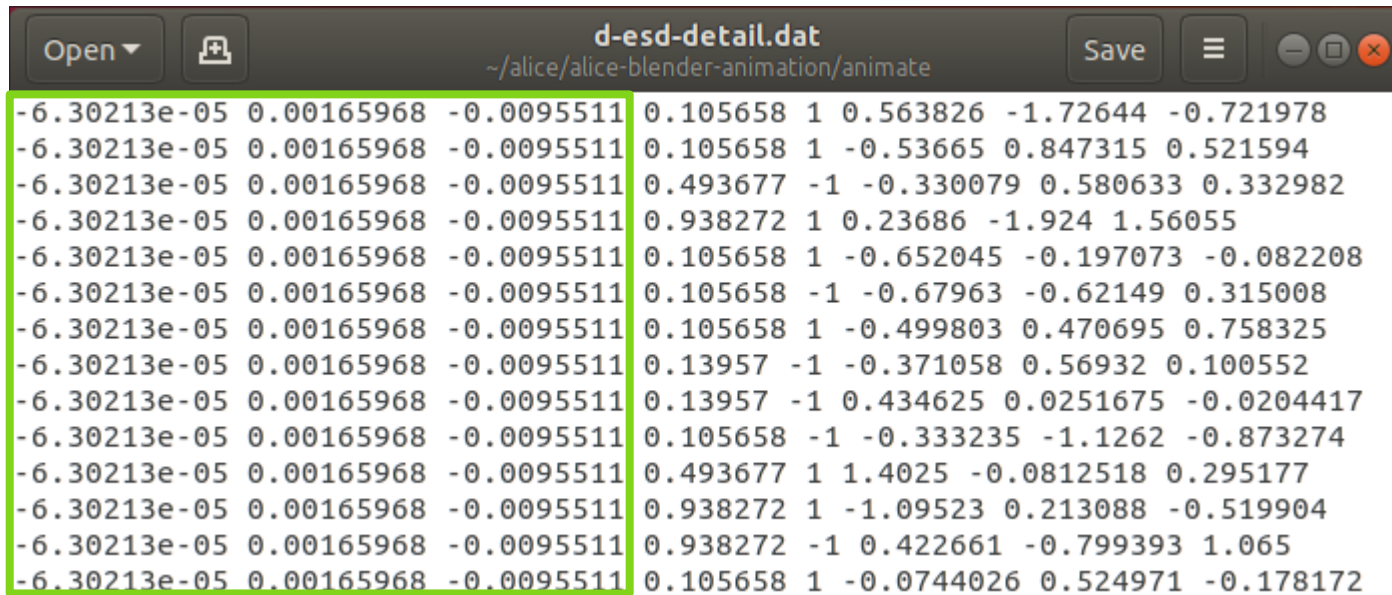


The screenshot shows a text editor window titled "d-esd-detail.dat" with the path "~/alice/alice-blender-animation/animate". The window contains a list of 15 rows of physics data, each with 9 columns of numerical values. The values are: -6.30213e-05, 0.00165968, -0.0095511, 0.105658, 1, 0.563826, -1.72644, -0.721978, -0.53665, 0.847315, 0.521594, -0.330079, 0.580633, 0.332982, 0.23686, -1.924, 1.56055, -0.652045, -0.197073, -0.082208, -0.67963, -0.62149, 0.315008, -0.499803, 0.470695, 0.758325, -0.371058, 0.56932, 0.100552, 0.434625, 0.0251675, -0.0204417, -0.333235, -1.1262, -0.873274, 1.4025, -0.0812518, 0.295177, -1.09523, 0.213088, -0.519904, 0.422661, -0.799393, 1.065, -0.0744026, 0.524971, -0.178172.

```
Open ▾ [Icon] d-esd-detail.dat Save [Menu] [Close] [Maximize] [Minimize]
~/alice/alice-blender-animation/animate
-6.30213e-05 0.00165968 -0.0095511 0.105658 1 0.563826 -1.72644 -0.721978
-6.30213e-05 0.00165968 -0.0095511 0.105658 1 -0.53665 0.847315 0.521594
-6.30213e-05 0.00165968 -0.0095511 0.493677 -1 -0.330079 0.580633 0.332982
-6.30213e-05 0.00165968 -0.0095511 0.938272 1 0.23686 -1.924 1.56055
-6.30213e-05 0.00165968 -0.0095511 0.105658 1 -0.652045 -0.197073 -0.082208
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-6.30213e-05 0.00165968 -0.0095511 0.105658 -1 -0.333235 -1.1262 -0.873274
-6.30213e-05 0.00165968 -0.0095511 0.493677 1 1.4025 -0.0812518 0.295177
-6.30213e-05 0.00165968 -0.0095511 0.938272 1 -1.09523 0.213088 -0.519904
-6.30213e-05 0.00165968 -0.0095511 0.938272 -1 0.422661 -0.799393 1.065
-6.30213e-05 0.00165968 -0.0095511 0.105658 1 -0.0744026 0.524971 -0.178172
```

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- Sets video details:
  - duration, FPS, output path, resolution
  - simulated time
- Derived class *dataDriver*:
  - reads relevant physics data



The screenshot shows a text editor window titled "d-esd-detail.dat" with the path "~/alice/alice-blender-animation/animate". The window contains a list of 14 rows of physics data. The first three columns of each row are highlighted with a green border. The data is as follows:

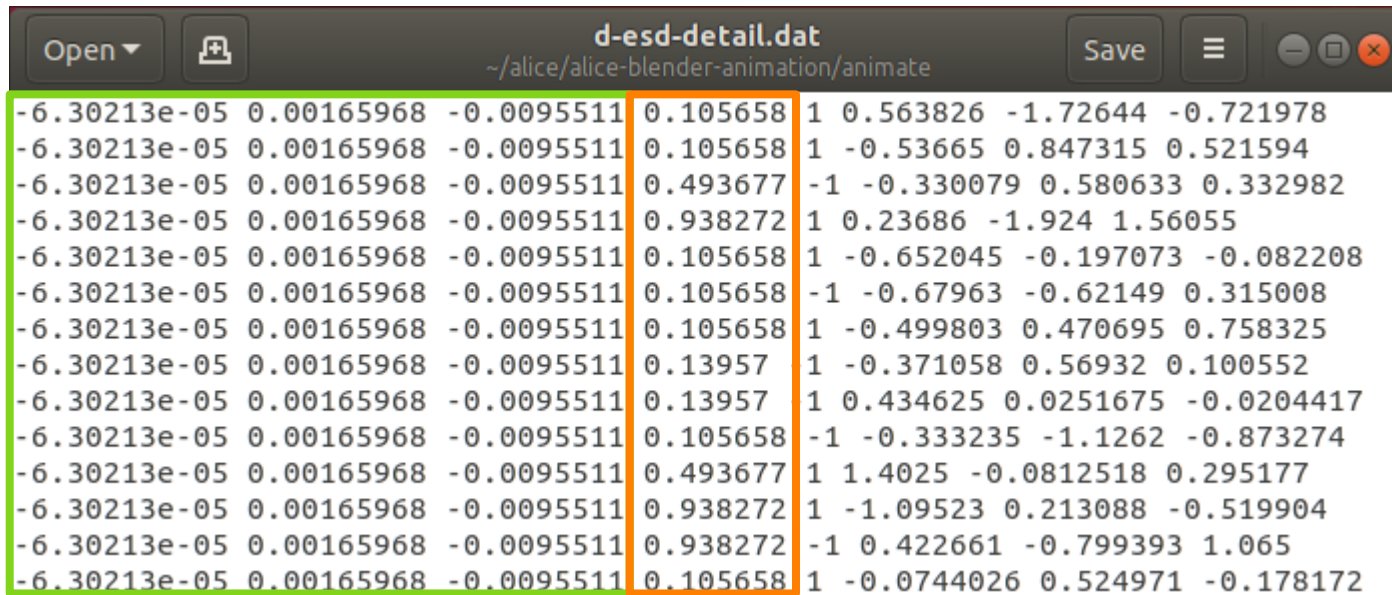
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	0.563826	-1.72644	-0.721978
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	-0.53665	0.847315	0.521594
-6.30213e-05	0.00165968	-0.0095511	0.493677	-1	-0.330079	0.580633	0.332982
-6.30213e-05	0.00165968	-0.0095511	0.938272	1	0.23686	-1.924	1.56055
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	-0.652045	-0.197073	-0.082208
-6.30213e-05	0.00165968	-0.0095511	0.105658	-1	-0.67963	-0.62149	0.315008
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	-0.499803	0.470695	0.758325
-6.30213e-05	0.00165968	-0.0095511	0.13957	-1	-0.371058	0.56932	0.100552
-6.30213e-05	0.00165968	-0.0095511	0.13957	-1	0.434625	0.0251675	-0.0204417
-6.30213e-05	0.00165968	-0.0095511	0.105658	-1	-0.333235	-1.1262	-0.873274
-6.30213e-05	0.00165968	-0.0095511	0.493677	1	1.4025	-0.0812518	0.295177
-6.30213e-05	0.00165968	-0.0095511	0.938272	1	-1.09523	0.213088	-0.519904
-6.30213e-05	0.00165968	-0.0095511	0.938272	-1	0.422661	-0.799393	1.065
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	-0.0744026	0.524971	-0.178172

Initial x,y,z (m)



# The *animationDriver* base class

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d-esd-detail.dat									
~/alice/alice-blender-animation/animate									
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	0.563826	-1.72644	-0.721978		
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	-0.53665	0.847315	0.521594		
-6.30213e-05	0.00165968	-0.0095511	0.493677	-1	-0.330079	0.580633	0.332982		
-6.30213e-05	0.00165968	-0.0095511	0.938272	1	0.23686	-1.924	1.56055		
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-6.30213e-05	0.00165968	-0.0095511	0.105658	-1	-0.333235	-1.1262	-0.873274		
-6.30213e-05	0.00165968	-0.0095511	0.493677	1	1.4025	-0.0812518	0.295177		
-6.30213e-05	0.00165968	-0.0095511	0.938272	1	-1.09523	0.213088	-0.519904		
-6.30213e-05	0.00165968	-0.0095511	0.938272	-1	0.422661	-0.799393	1.065		
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Initial x,y,z (m)

mass  
(GeV/c<sup>2</sup>)

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- Sets video details:
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Initial x (m)	Initial y (m)	Initial z (m)	mass (GeV/c <sup>2</sup> )	charge				
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	0.563826	-1.72644	-0.721978	
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	-0.53665	0.847315	0.521594	
-6.30213e-05	0.00165968	-0.0095511	0.493677	-1	-0.330079	0.580633	0.332982	
-6.30213e-05	0.00165968	-0.0095511	0.938272	1	0.23686	-1.924	1.56055	
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	-0.652045	-0.197073	-0.082208	
-6.30213e-05	0.00165968	-0.0095511	0.105658	-1	-0.67963	-0.62149	0.315008	
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-6.30213e-05	0.00165968	-0.0095511	0.13957	1	0.434625	0.0251675	-0.0204417	
-6.30213e-05	0.00165968	-0.0095511	0.105658	-1	-0.333235	-1.1262	-0.873274	
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-6.30213e-05	0.00165968	-0.0095511	0.938272	1	-1.09523	0.213088	-0.519904	
-6.30213e-05	0.00165968	-0.0095511	0.938272	-1	0.422661	-0.799393	1.065	
-6.30213e-05	0.00165968	-0.0095511	0.105658	1	-0.0744026	0.524971	-0.178172	

Initial x,y,z (m)

mass charge  
(GeV/c<sup>2</sup>)

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→ Sets video details:

- duration, FPS, output path, resolution
- simulated time

→ Derived class *dataDriver*:

- reads relevant physics data

Initial x, y, z (m)	mass (GeV/c <sup>2</sup> )	charge	Initial p <sub>x</sub> , p <sub>y</sub> , p <sub>z</sub> (GeV/c)
-6.30213e-05	0.00165968	-0.0095511	0.105658 1 0.563826 -1.72644 -0.721978
-6.30213e-05	0.00165968	-0.0095511	0.105658 1 -0.53665 0.847315 0.521594
-6.30213e-05	0.00165968	-0.0095511	0.493677 -1 -0.330079 0.580633 0.332982
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-6.30213e-05	0.00165968	-0.0095511	0.105658 1 -0.0744026 0.524971 -0.178172

Initial x, y, z (m)

mass charge  
(GeV/c<sup>2</sup>)

Initial p<sub>x</sub>, p<sub>y</sub>, p<sub>z</sub>  
(GeV/c)

# The *particle* base class

- Stores basic information of particles
  - position, charge, mass

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- Defines its type
  - electron, pion, muon, proton, kaon

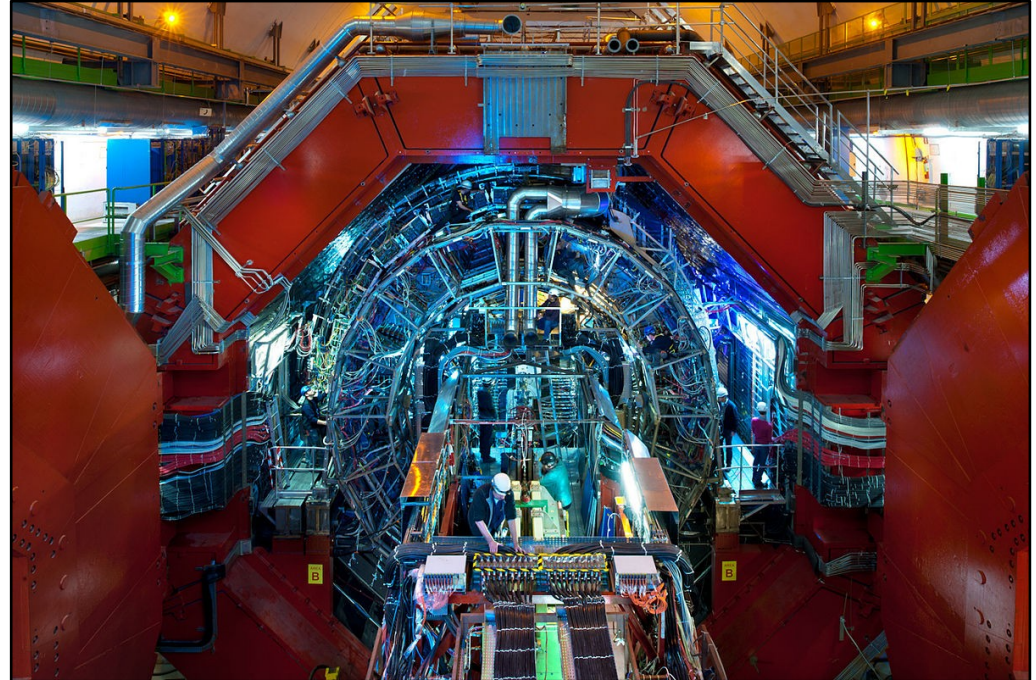
# The *particle* base class

- Stores basic information of particles
  - position, charge, mass
- Defines its type
  - electron, pion, muon, proton, kaon
- Derived class *ParticlePropagator*:
  - helix track propagation
  - near center of ALICE detector

# ALICE detector



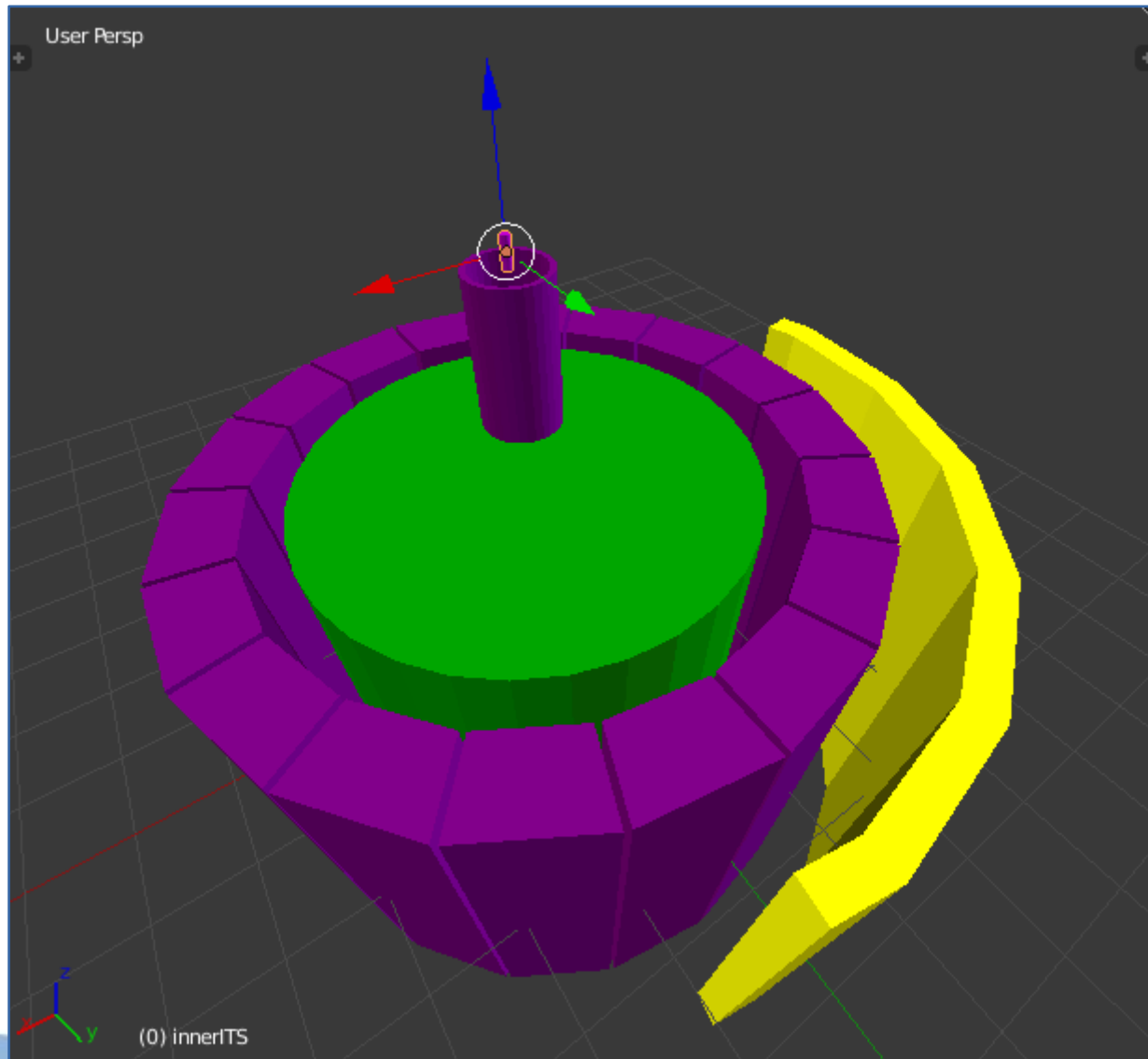
# ALICE



→ A Large Ion Collider Experiment

→ Quark-gluon plasma

# ALICE geometry





# Getting the data



CERN Open Data Portal



## Filter events

ALICE × root × PbPb ×

Include on-demand datasets

Filter by type

- Dataset 6
- Collision 6

Filter by experiment

- ALICE 6

Filter by year

- 2010 6

Filter by file type

- root 6

Filter by collision type

- PbPb 6
- pp 8

Filter by collision energy

- 2.76TeV 6

# Getting the data



CERN Open Data  
Portal



## Select sample

### LHC2010h\_PbPb\_ESD\_138275

Pb-Pb ESD data sample at the collision energy of 2.76 TeV per nucleon pair from RunH of 2010. Run period from run number 138275....

Dataset Collision ALICE

### LHC10h\_PbPb\_ESD\_139038

Pb-Pb ESD data sample at the collision energy of 2.76 TeV per nucleon pair from RunH of 2010. Run period from run number 139038....

Dataset Collision ALICE

### LHC10h\_PbPb\_ESD\_139465

Pb-Pb ESD data sample at the collision energy of 2.76 TeV per nucleon pair from RunH of 2010. Run period from run number 139465...

Dataset Collision ALICE

### LHC10h\_PbPb\_ESD\_139173

Pb-Pb ESD data sample at the collision energy of 2.76 TeV per nucleon pair from RunH of 2010. Run period from run number 139173....

Dataset Collision ALICE

### LHC10h\_PbPb\_ESD\_139437

Pb-Pb ESD data sample at the collision energy of 2.76 TeV per nucleon pair from RunH of 2010. Run period from run number 139437....

Dataset Collision ALICE

# Getting the data

## Choose ESD file



CERN Open Data  
Portal

### List of files

AliESDs.root	378.8 MB	
AliESDs.root	410.2 MB	
AliESDs.root	386.4 MB	

« < 815 816 817 818 819 > »

## Description

Pb-Pb ESD data sample at the collision energy of 2.76 TeV per nucleon pair from RunH of 2010. Run period from run number 139437.

## Dataset characteristics

**882159** events. **4093** files. **1.6 TB** in total.

# Processing ALICE data

ALIROOT



Macros

```
d-esd-detail.dat
~/alice/alice-blender-animation/animate
Save
-6.30213e-05 0.00165968 -0.0095511 0.105658 1 0.563826 -1.72644 -0.721978
-6.30213e-05 0.00165968 -0.0095511 0.105658 1 -0.53665 0.847315 0.521594
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-6.30213e-05 0.00165968 -0.0095511 0.105658 1 -0.0744026 0.524971 -0.178172
```

Data as text

# Workflow

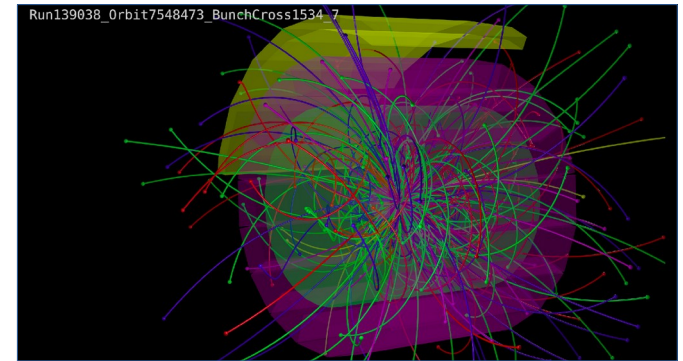
Events data



`workflow_sketch.sh`



Results

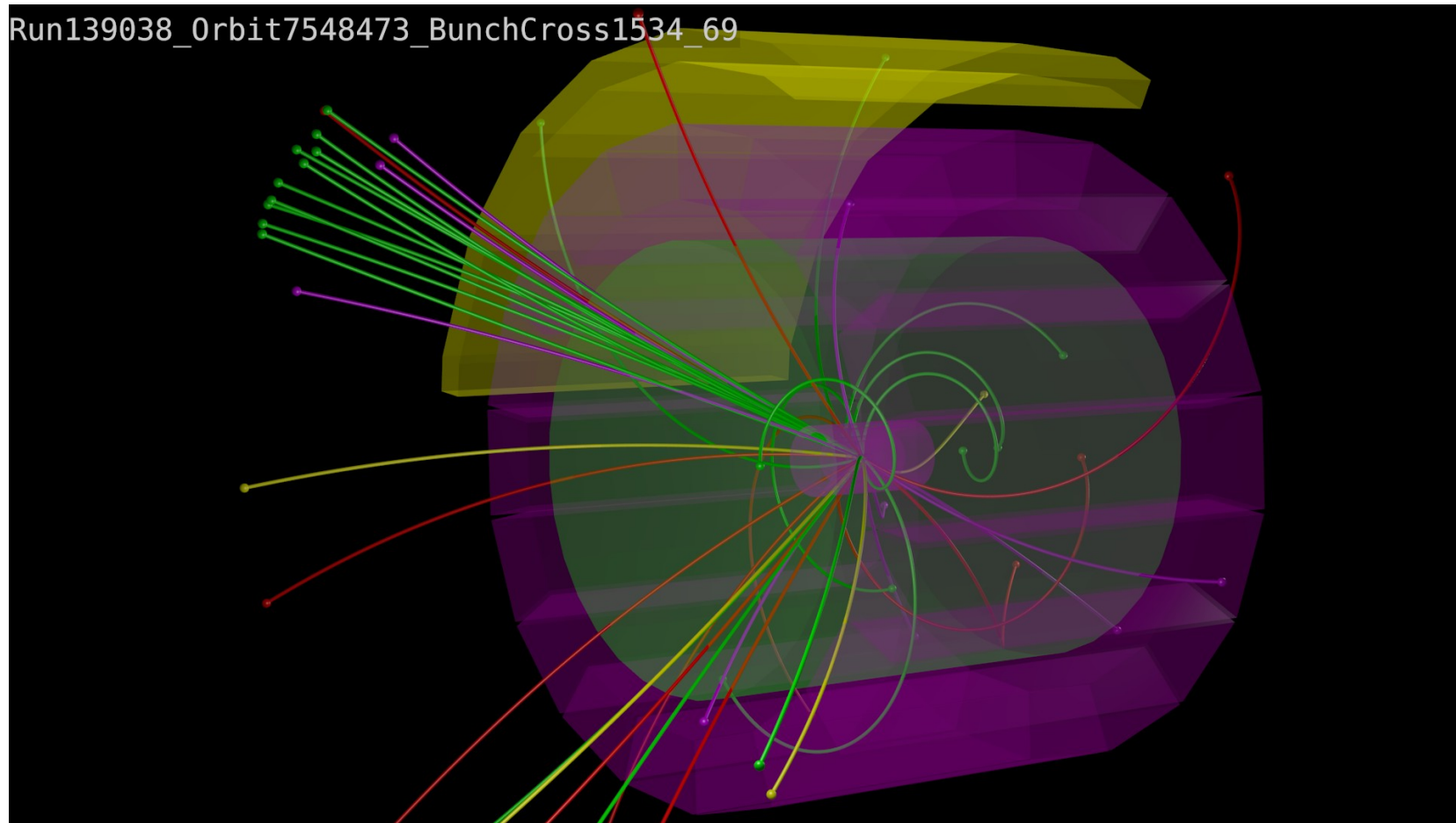


Media

→ Custom use options

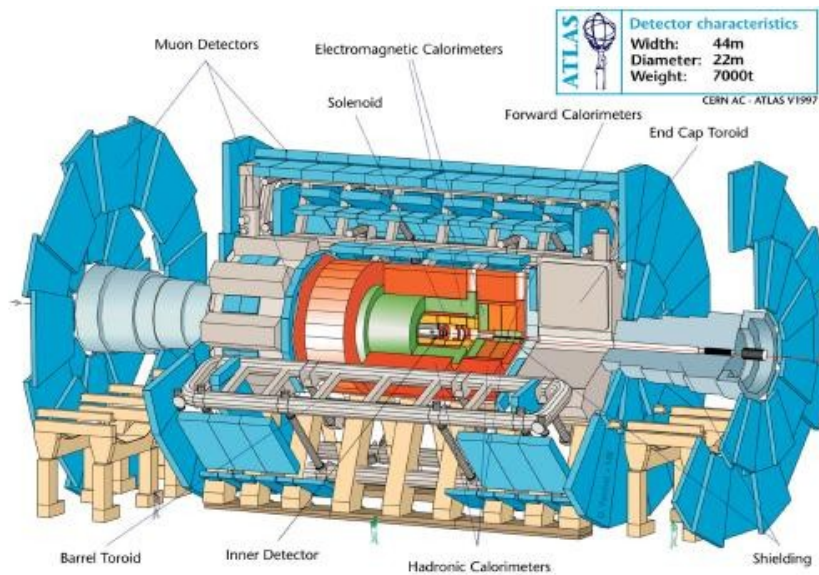
# Running Examples

→ Minimum Average  $P_z$  (z-momentum)



# Room for improvement

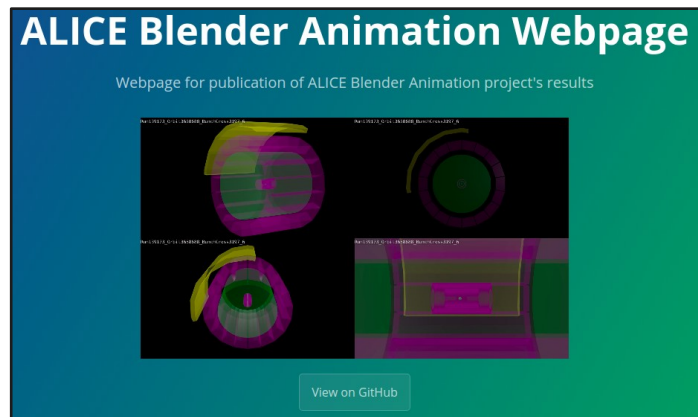
- Secondary vertexing and decays
- Pythia and Hijing generators
- Animate events from different experiments



# How can *you* use it?

→ Search for existing animations

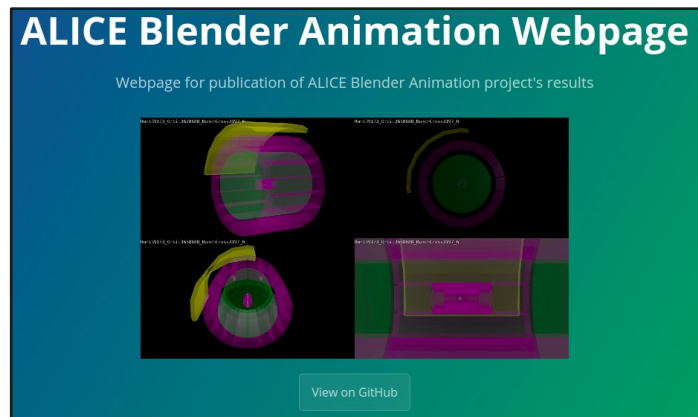
→ <https://animalicedata.github.io/sampleanimations/>





# How can *you* use it?

- Animate your own selected events
- Search for existing animations
  - <https://animalicedata.github.io/sampleanimations/>



- Modify software to match your needs
  - GNU General Public License



Open Science