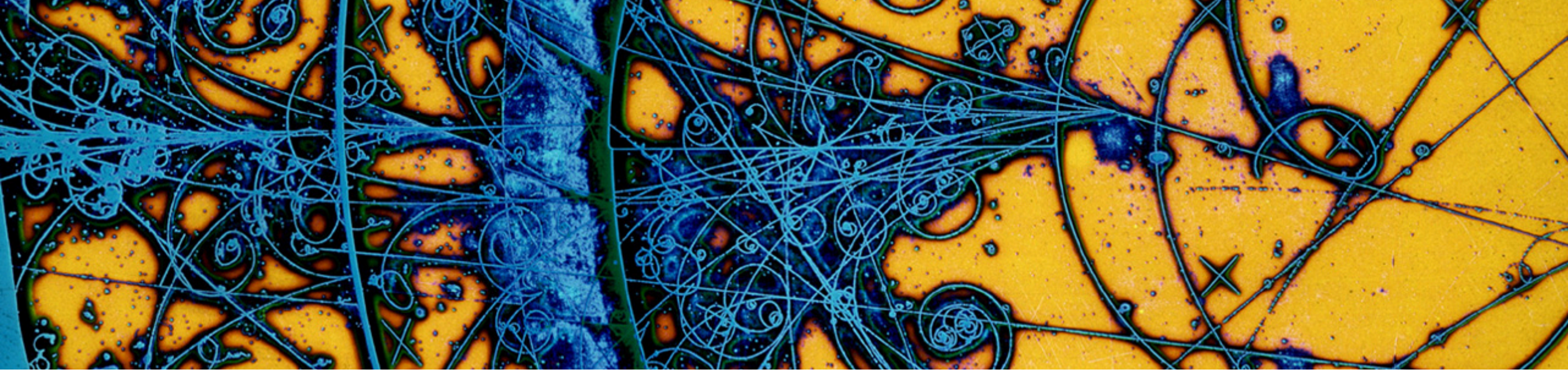

DIRACX HACKATHON · 1 JULY 2026

DiracX production system

Chris Burr

CERN

Image: CERN-EX-66954B © 1998–2026 CERN

Introduction

- These slides aim to build a common understanding of:
  - What a production is?
  - How a production is split into transformations?
  - How to make use of these blocks in your own workflows.

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- These slides aim to build a common understanding of:
  - What a production is?
  - How a production is split into transformations?
  - How to make use of these blocks in your own workflows.
- After the hackathon, an Architecture Design Review (ADR) will be prepared early in summer.
  - Once agreed upon, start development!

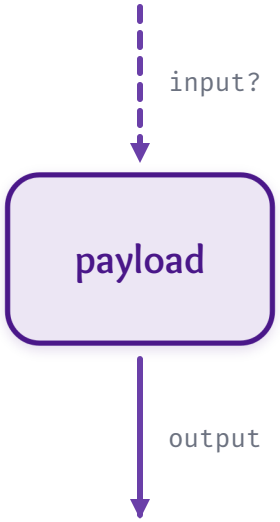
DIRAC vs DiracX

- Here I show the intended production system in DiracX.
- The underpinnings are almost identical to the DIRAC Transformation System.
  - With lots of little tweaks based on experience and lessons learned.

Basic Workflow Management in DiracX

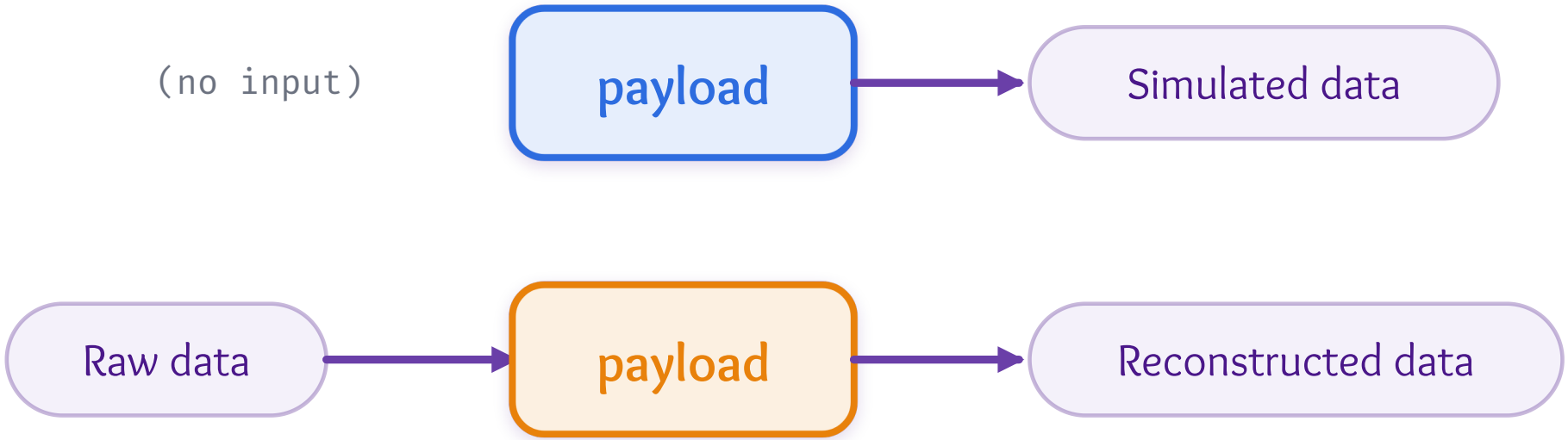
Start with the basics

- We have a black box that:
  - Might have input(s)
  - Produces output(s)
- For now we ignore any source of parallelism



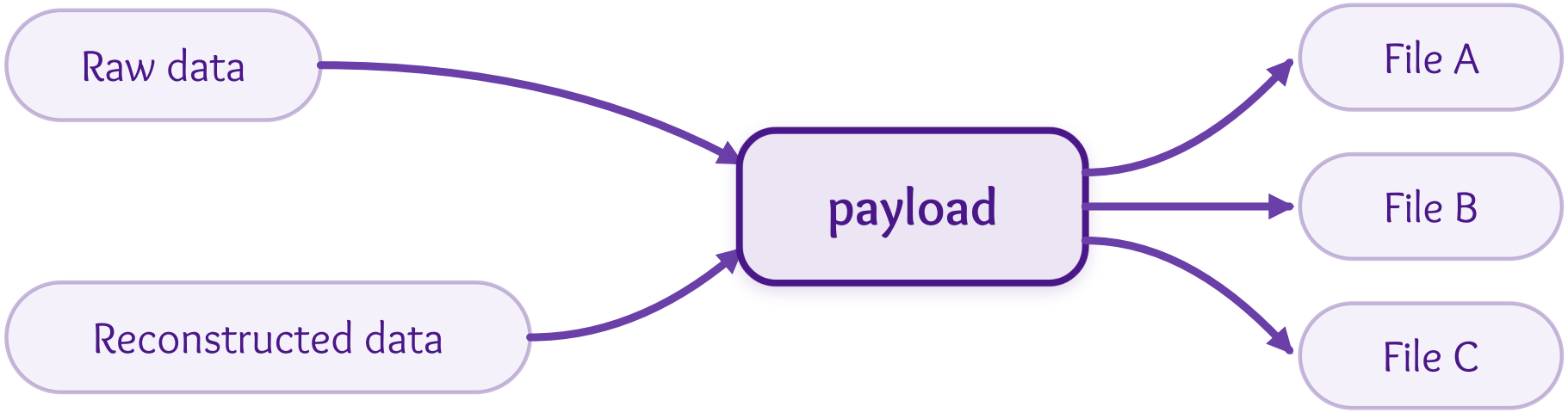
Start with the basics

Simple case: a simulation and a reconstruction



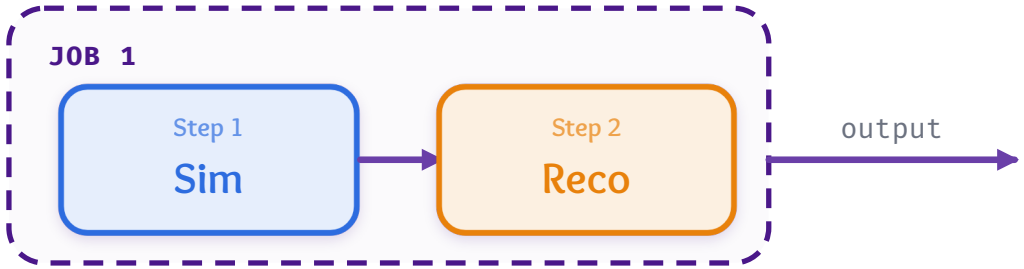
Start with the basics

More complex: correlated inputs, many outputs



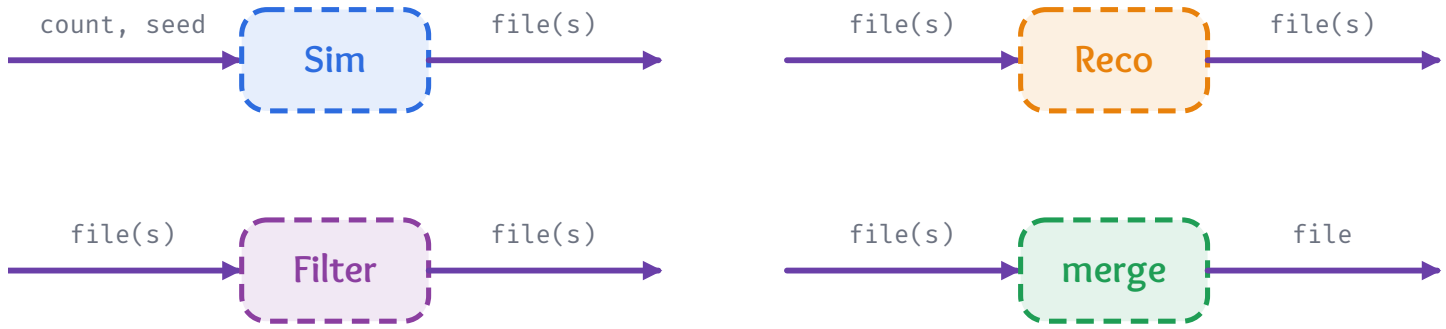
Two steps, one job

- Start with **one job** running two steps end-to-end:
  - **Sim:** simulate events - input is `count`, `seed`
  - **Reco:** reconstruct — processes Sim's output
- A step describes **how to run one program** (a command-line tool).



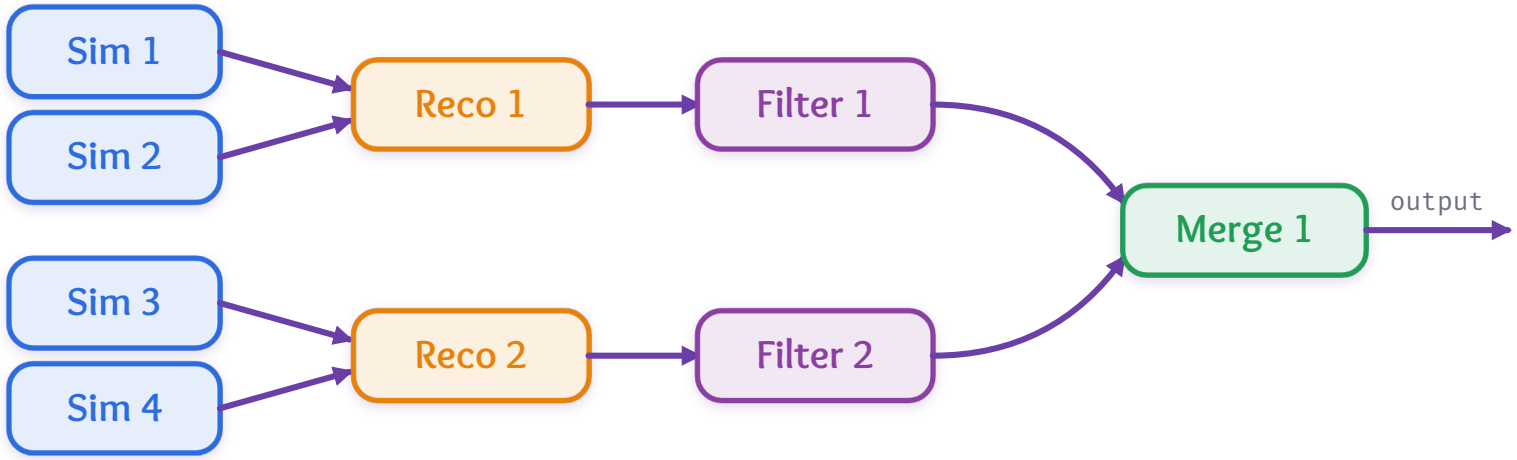
Splitting things up

- One job hits limits — **disk, CPU time, memory.**
- Split into steps which are abstract building blocks



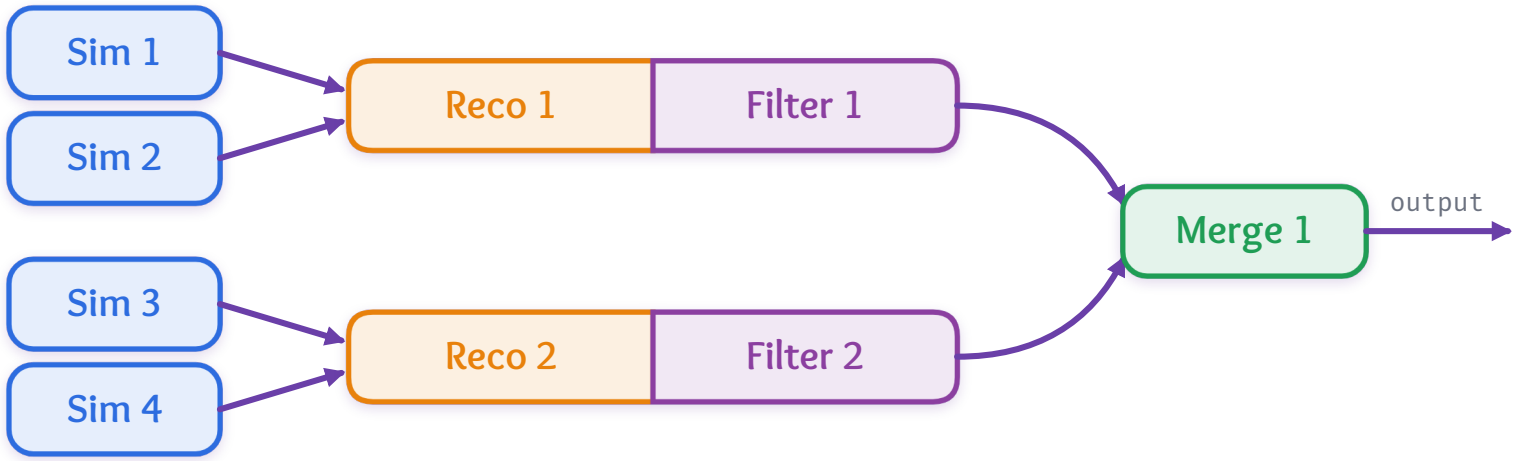
Parallelising the work

- **Many Sim jobs** feed each **Reco** → **Filter** branch.
- The branches **merge** into the final output.
- Each block in the diagram is a job



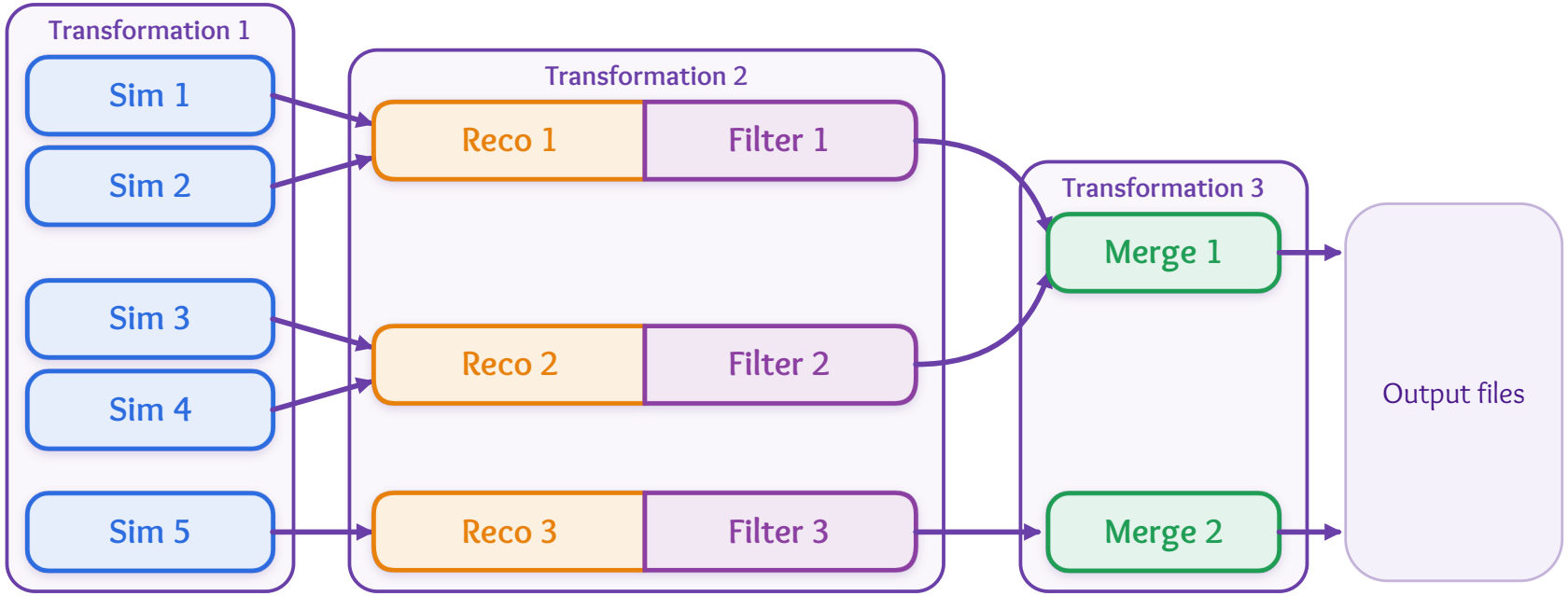
Parallelising the work

- No need to separate the **Reco** and **Filter** steps into separate jobs.
- Could be streamed between them or ran sequentially.
- This diagram repeats N times times to produce more simulation.



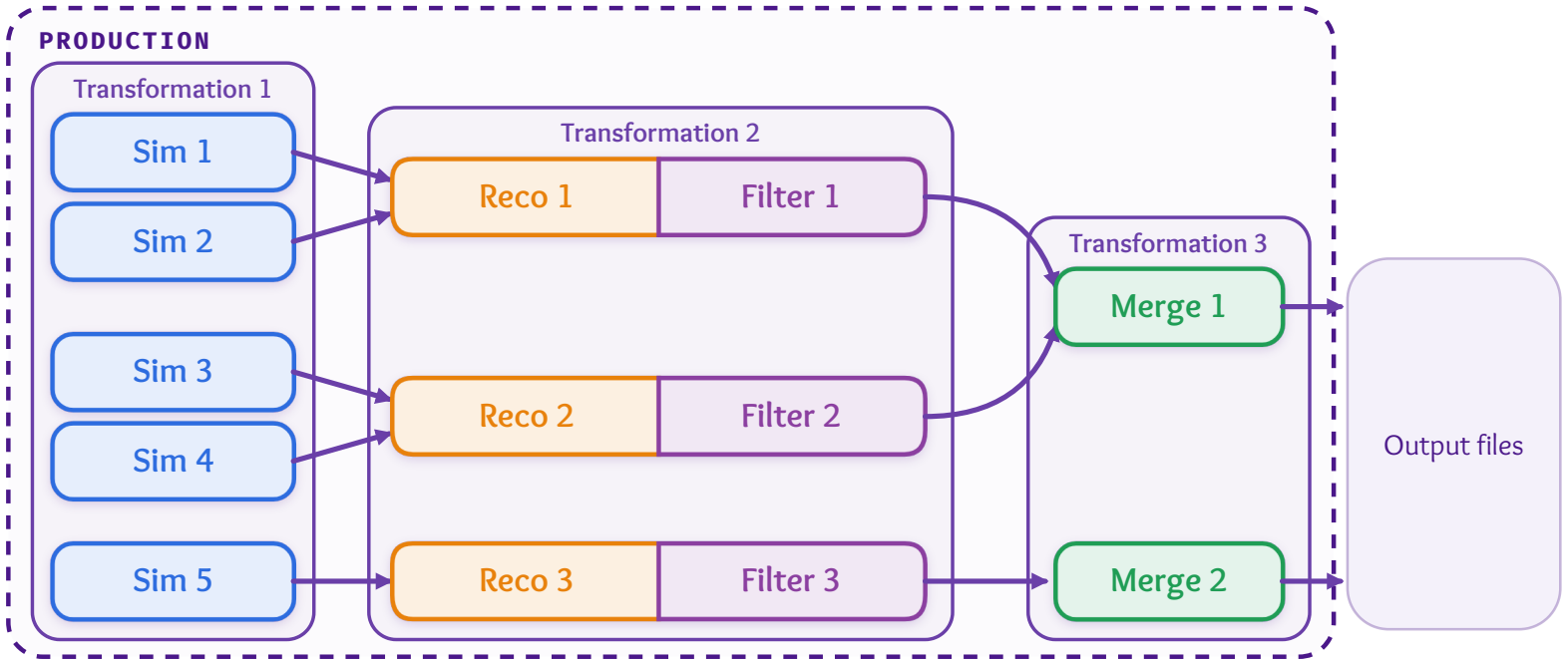
Transformation

- Transformations contain many jobs which each do the same thing
- Transformations can be chained together



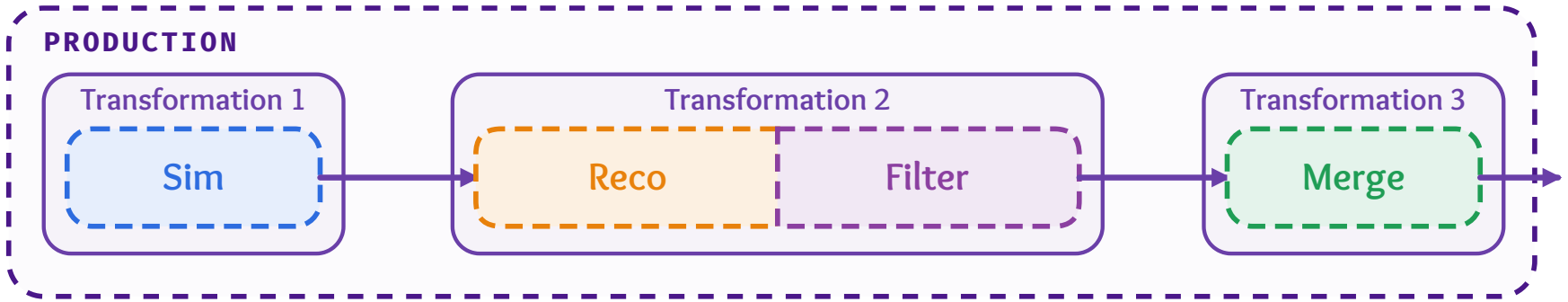
Productions

- A Production groups one or more transformations together
  - Might also include data management transformations (e.g. archive output to tape)
  - I'll come to those later



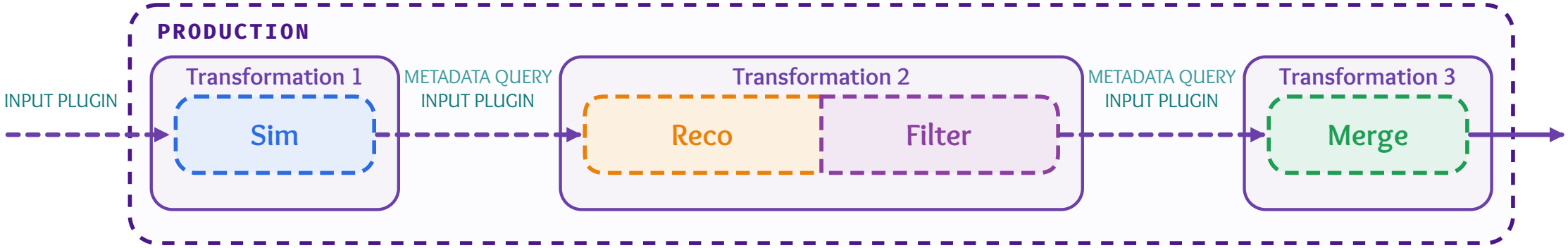
Becoming abstract again

- When defining a transformation the jobs don't exist
  - In workflow management terms, they form a dynamic DAG



Connecting it all together

- Each transformation has an **input plugin**: controls when to create tasks
- Transformations with input data have an **metadata query**



Transformation state

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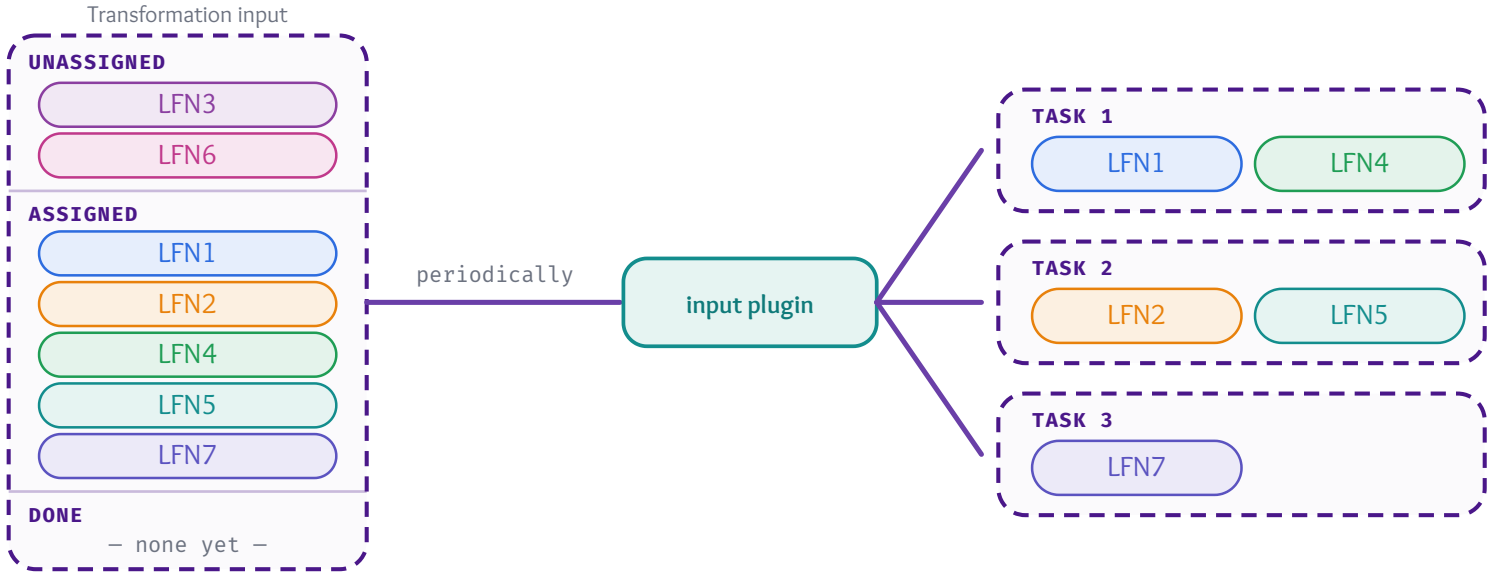
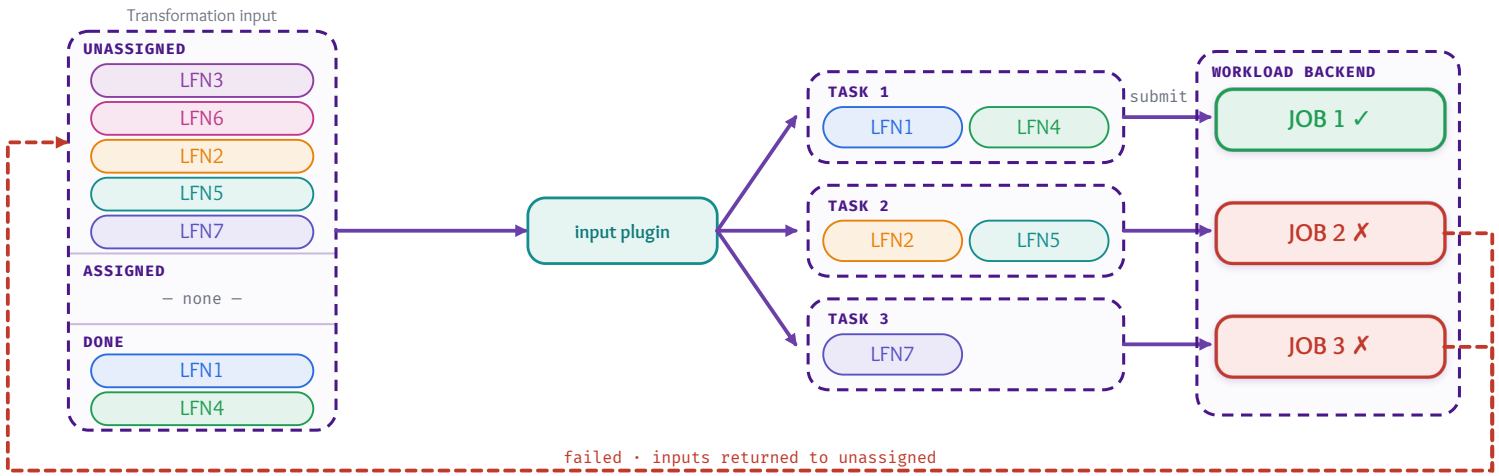
- Periodically uses the **input plugin** to decide when to create a **task**
- One or more **transformation input(s)** are assigned to a **task**



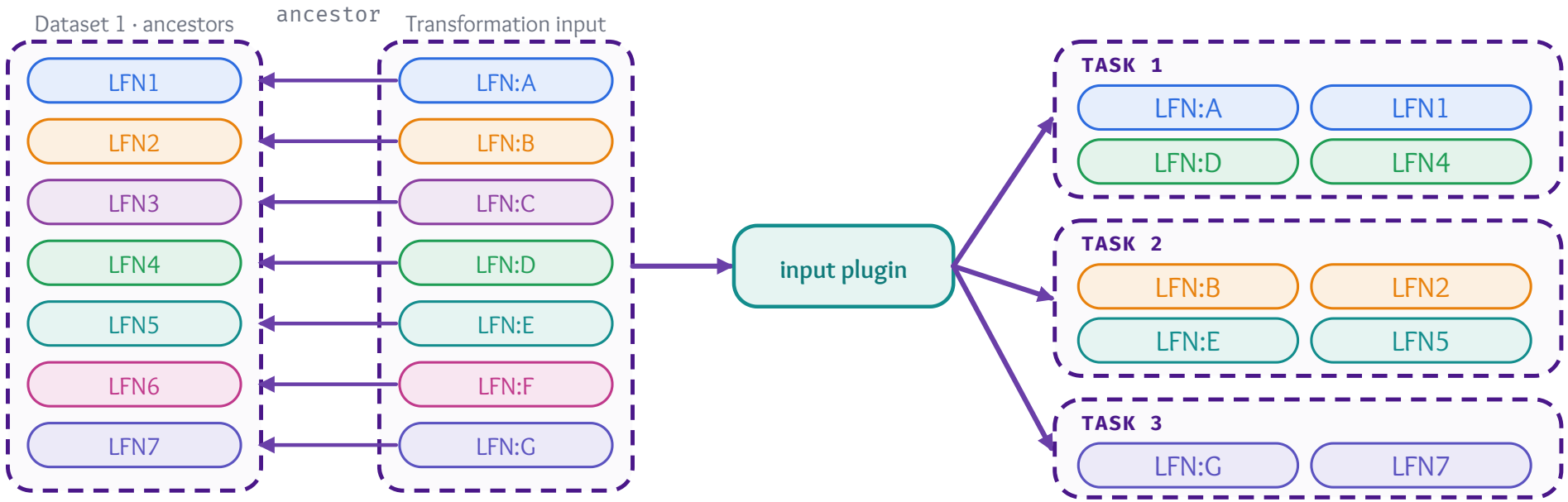
Transformation tasks

- A transformation's **task** is submitted to a backend
- **Tasks** are not retryable -> added back to the pool of unassigned **transformation input(s)**
  - An input is only ever successfully processed by one **task**
- Next time the **input plugin** is run, a new **task** might be created
  - Potentially with different inputs



Grouping correlated inputs

- The **input plugin** can inject additional inputs
- For example also include an ancestor file



Data management transformations

- The other side of the transformation system is data management.
  - Two primitives: **Copy** and **Delete**
  - Tasks know the final data distribution state you want to obtain

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- Similarities to workload management transformations:
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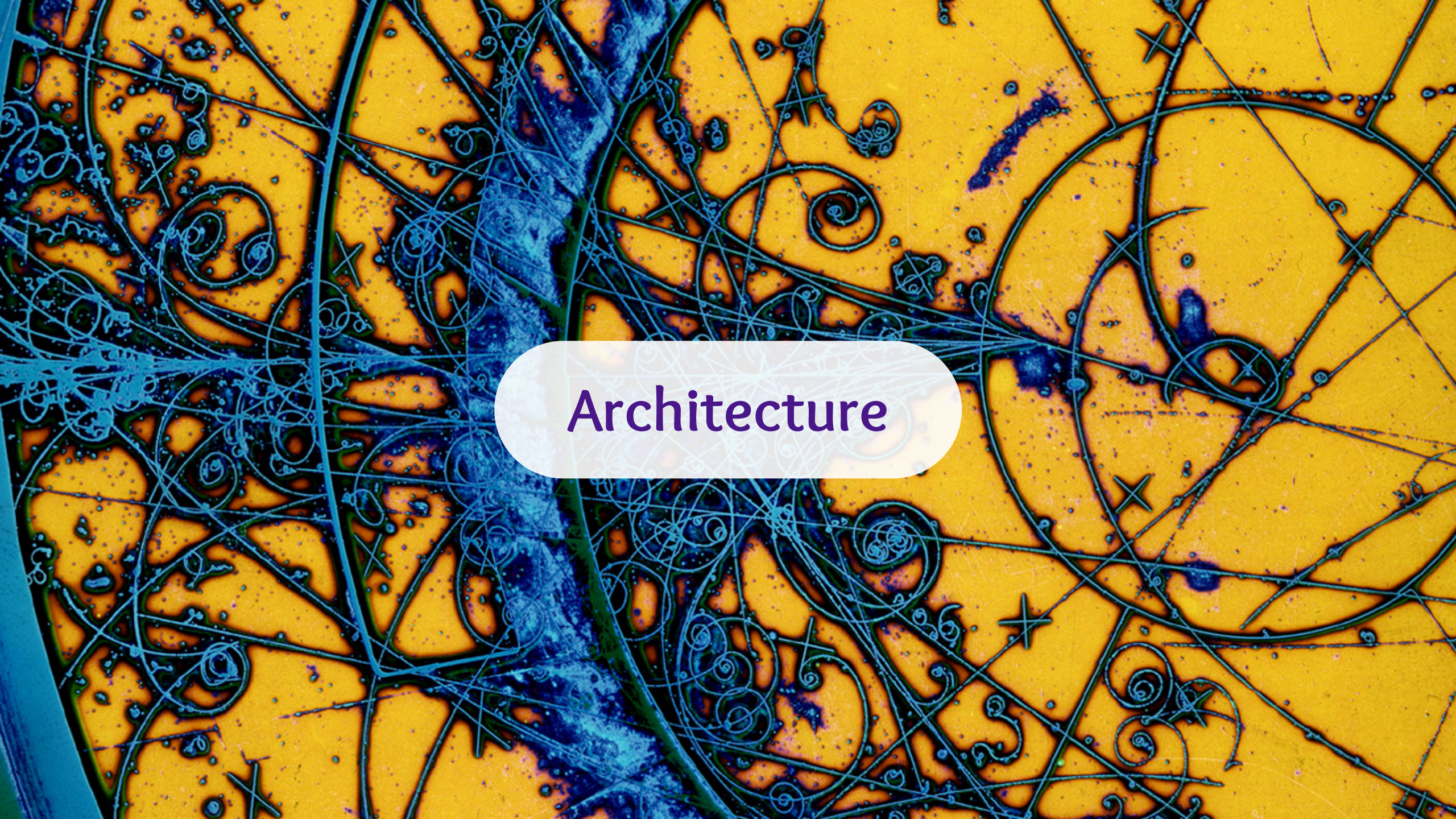
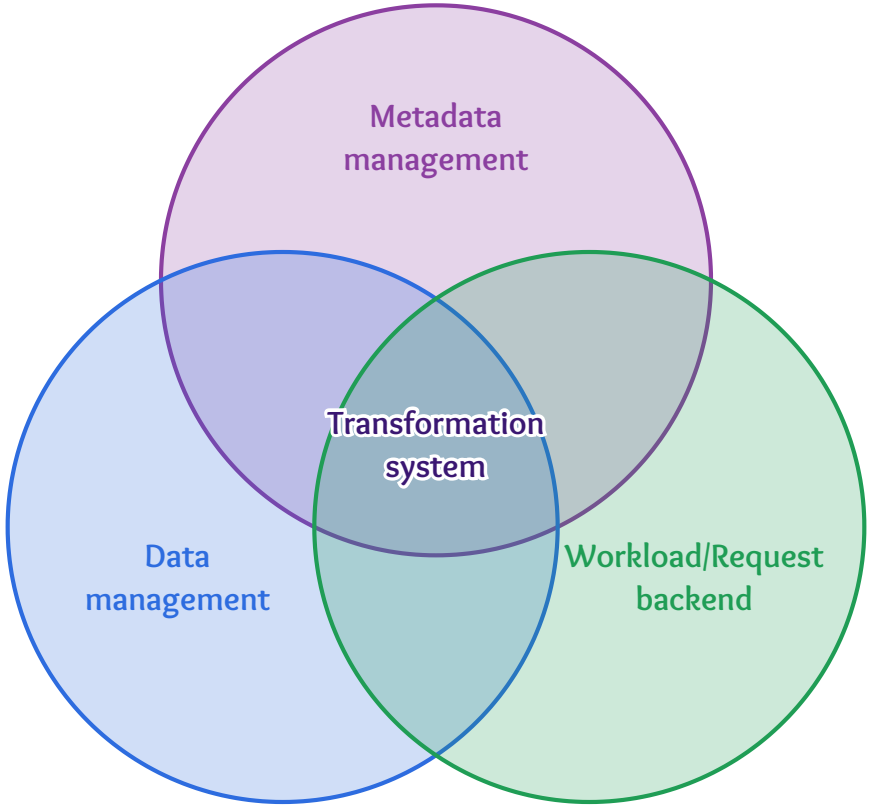
- The other side of the transformation system is data management.
  - Two primitives: **Copy** and **Delete**
  - Tasks know the final data distribution state you want to obtain
- Similarities to workload management transformations:
  - Input metadata query to create tasks
  - Tasks have input LFNs
- Differences:
  - No Jobs (uses Requests instead)
  - No CWL
  - No "output"



Architecture

The three components of the transformation system



Metadata management

- Extremely experiment specific
- Basics:
  - Steers what LFNs are picked up by a transformation†
  - Output of transformations are registered
- Can also provide:
  - ancestry information for correlated input
  - descendent information for additional safety checks

† LFNs can be added manually for special cases.

Data management

- Provides information about
  - LFN availability
  - Available storage at sites

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  - Available storage at sites
- Example uses of transformation **input plugins:**
  - Group LFNs to all have replicas at the same locations
  - Don't create tasks for LFNs that are at locations with downtime

Workload/Request backend

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- For workload transformations:
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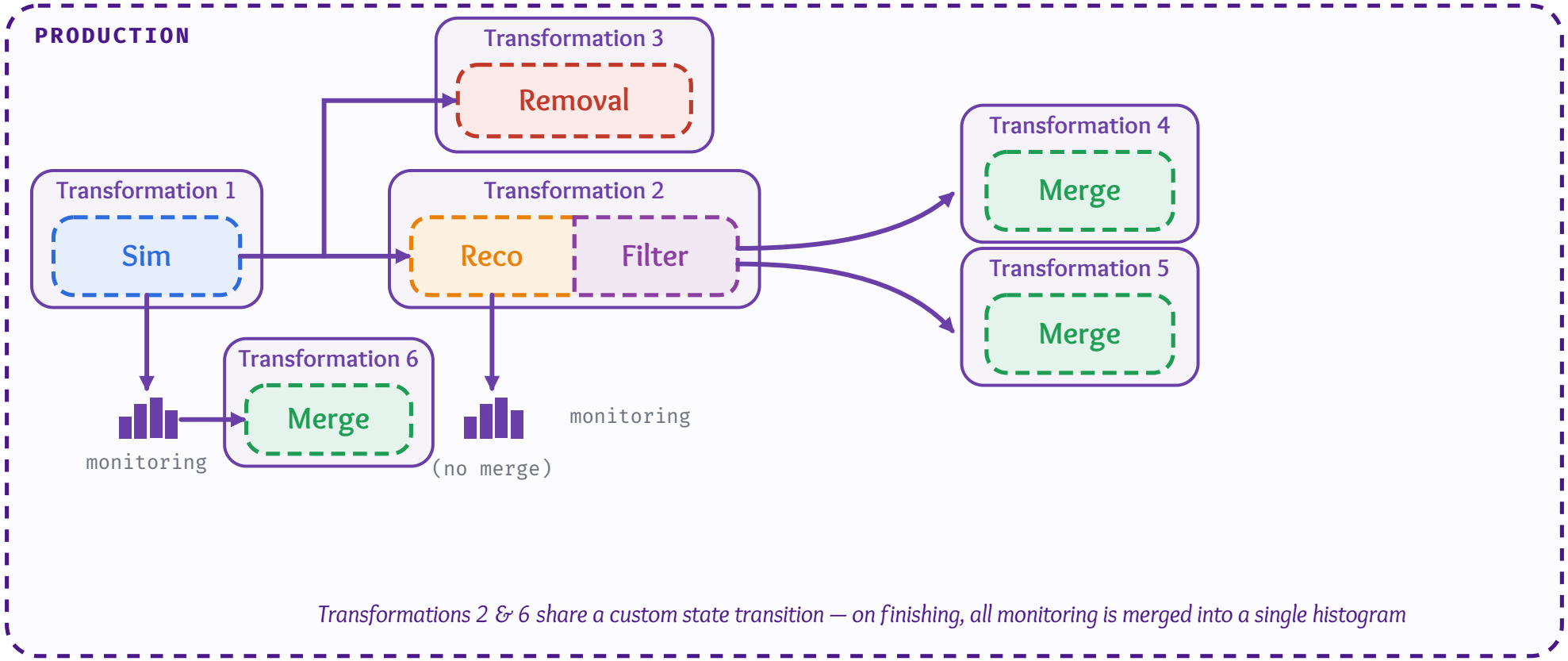
- For data management transformations this is handled by **Requests**

Wrapping up

Putting it all together



Higher level concepts

- Here I've only talked about the low-level system
- Examples in LHCb:
  - "Analysis productions": CHEP-2026
  - "mc-requests" and "LbMCSubmit": CHEP-2023 and CHEP-2024
  - Fluka simulations: FLUKA.CERN collaboration meeting

"Analysis Productions" model: Declaring workflows

- The idea is to have a high-level declarative way of declaring any workflow
- With a escape hatch to allow for deeper customization
- Or just write a DIRAC workflow directly (mostly for expert users)

```
sim-version: 09
name: My Analysis
WG: Charm
samples:
  - event-types:
      - 23103006
      - 27165175
      - 30000000
    data-types:
      - 2016
      - 2017
      - 2018
    num-events: 2_500_000
    fast-mc:
      redecay: yes
```

"Analysis Productions" model: Submission

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We won't have time for this now, at the next workshop...

Questions?