ServiceX: On-Demand Data Transformation and Delivery for the Present and HL-LHC Era

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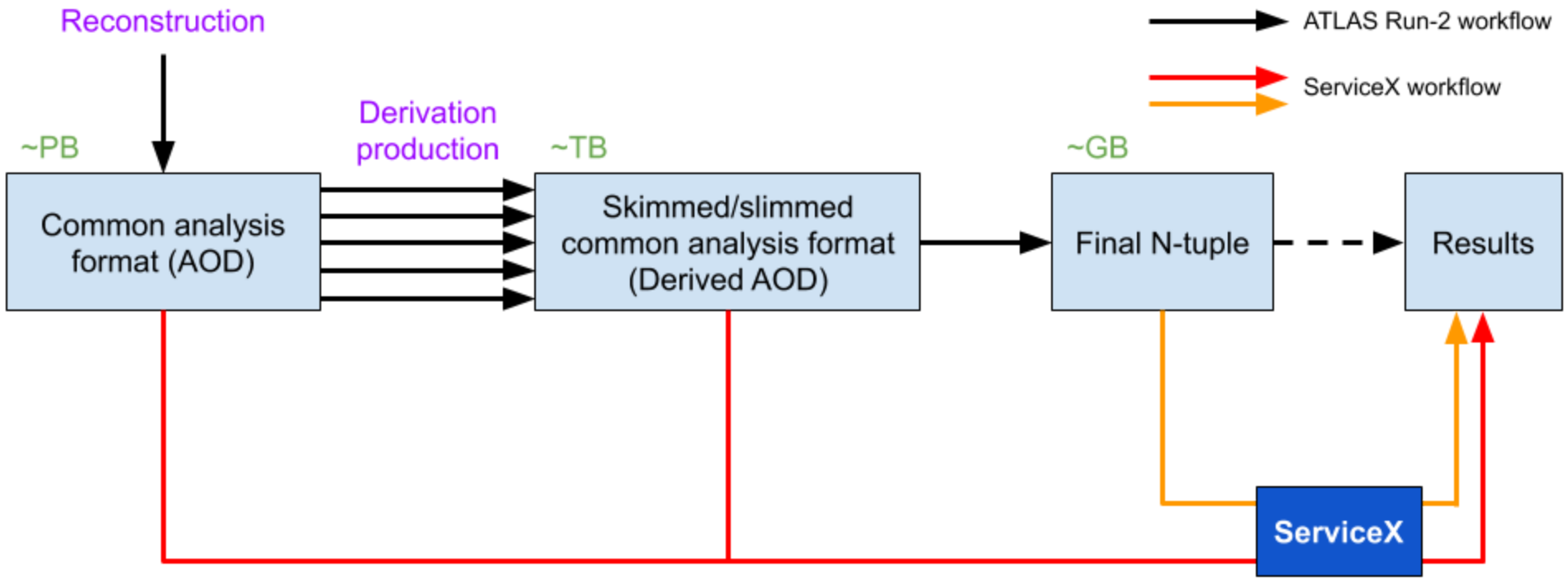
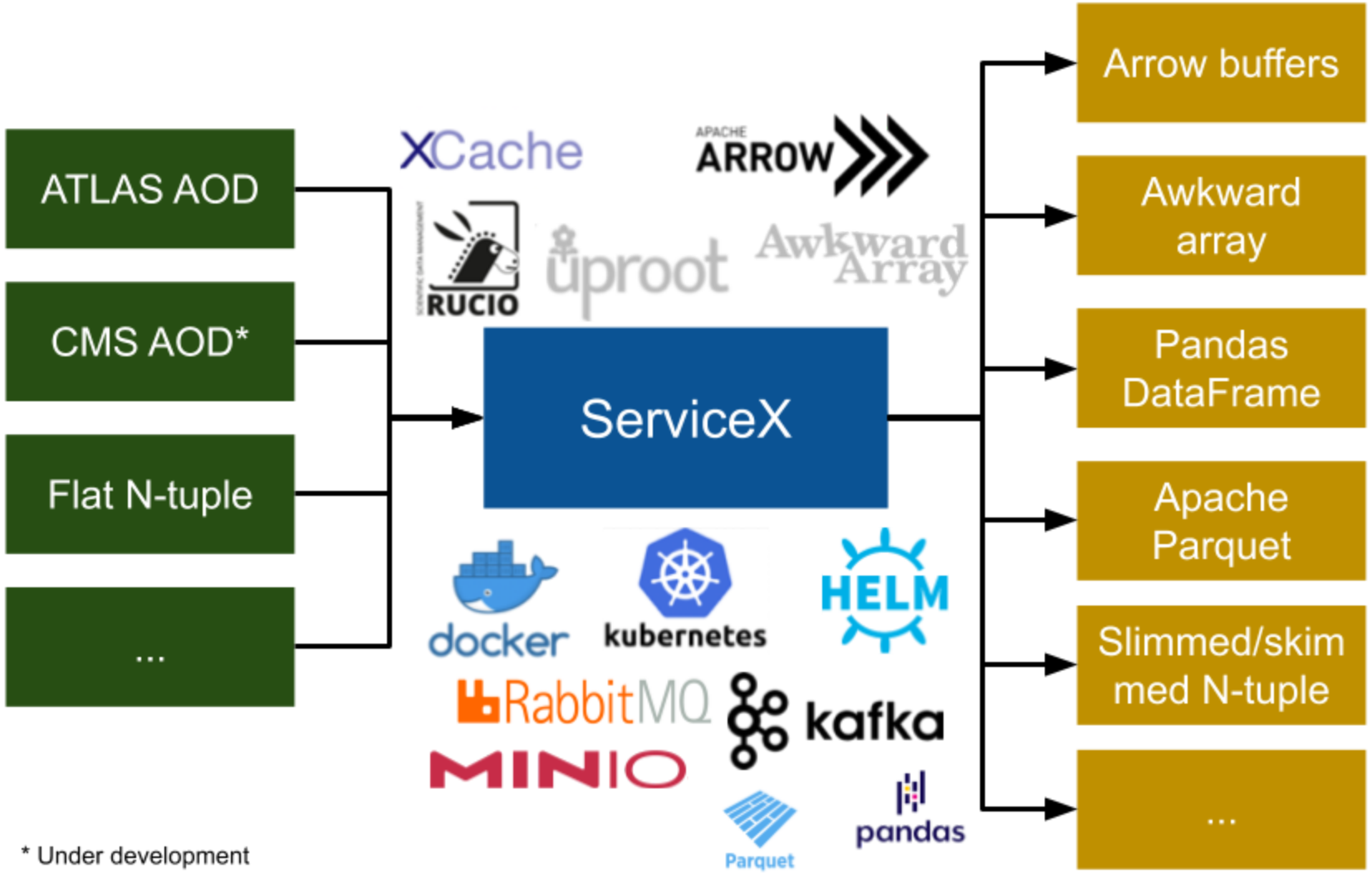
What is ServiceX?

Data delivery from **grid** to **users**: Preselection and column selection, Columnar data in various formats, On-the-fly data transformation, Experiment-agnostic, On-demand delivery

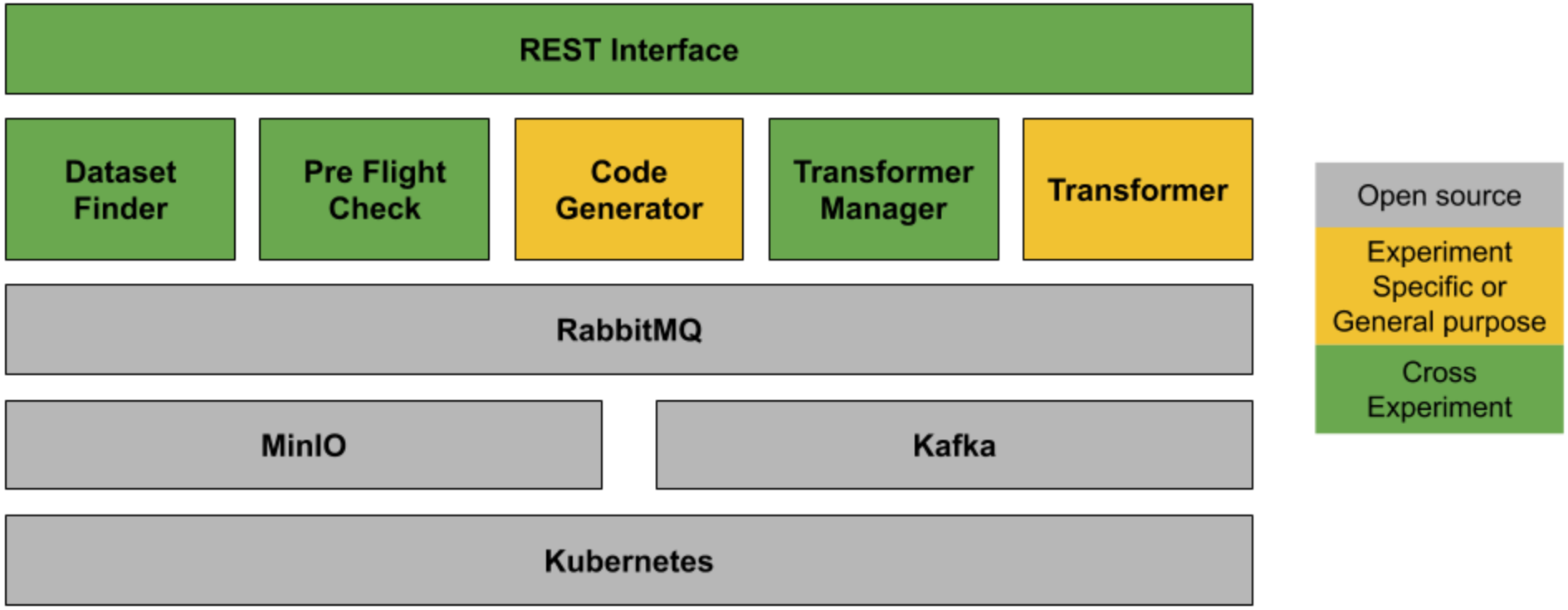


ServiceX Input/Output and Building Blocks

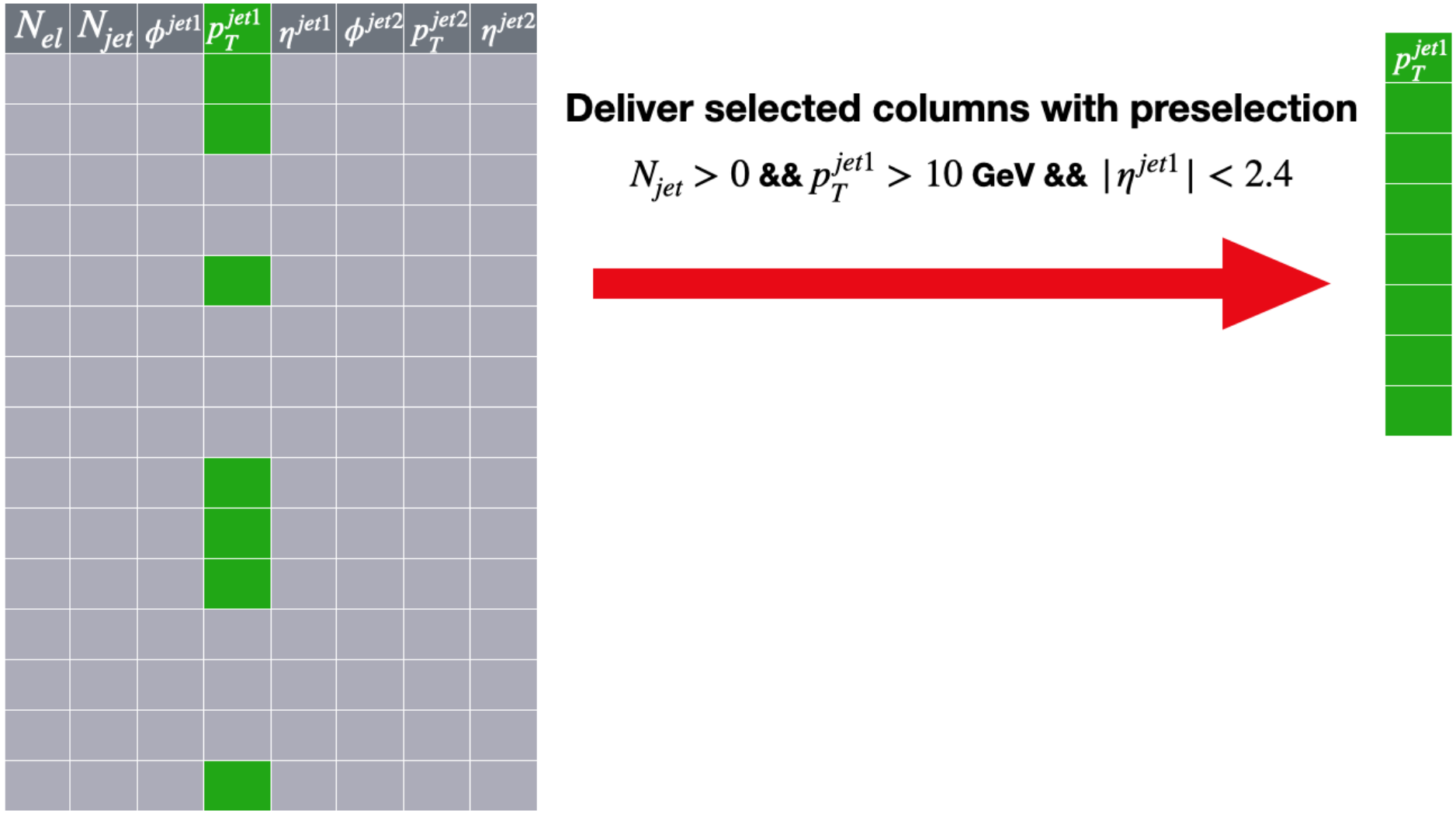


* Under development

ServiceX Backend Architecture



ServiceX Transformer



ServiceX Transformers

- Transformers ready now
    - ATLAS AOD (xAOD) Transformer
    - Uproot (flat N-tuple/CMS nanoAOD) Transformer
- Transformers under development
    - CMS AOD (mini AOD) Transformer
    - PyROOT Transformer

ServiceX Frontend Library

Client library to access ServiceX backend

- Accepts `qastle` formatted query for preselection and column selection
- Supported output: `awkward`, `pandas DF`, `parquet`, `root-file`
- Support simultaneous queries
- Start download as soon as ready
- Local caching of query data

ServiceX Frontend Library

Prerequisites

- python 3.6 or later
- `ServiceX` end points

ServiceX Frontend Library

Uproot Transformer Demo

- Input data type: Flat N-tuple
- Input data size: 76 GB (6 files)
- ServiceX deployed at SSL-RIVER cluster Kubernetes cluster
- Dataset at ATLAS Tier-2 site

Let's have a ServiceX instance for Uproot end-point

Let's have a ServiceX instance for Uproot end-point

In [ ]:

```
import servicex
dataset_uproot = "user.kchoi:user.kchoi.ttHML_80fb_ttH"
tree_name = "nominal"
uproot_transformer_image="sslhep/servicex_func_adl_uproot_transformer:develop"
s_uproot =
servicex.ServiceXDataset(dataset=dataset_uproot,image=uproot_transformer_image,
tree_name=tree_name)
```

Let's prepare a query

Let's prepare a query

In [ ]:

```
import tcut_to_qastle
query_uproot =
tcut_to_qastle.translate("lep_Pt_1>20e3&&lep_Pt_2>20e3&&lep_isolationFixedCutLo
ose_0 && abs(Mlll012-91.2e3)>15e3","lep_Pt_1, lep_Pt_2")
# print(query_uproot)
```

Now request for a delivery

Now request for a delivery

In [ ]:

```
1 out_uproot = s_uproot.get_data_pandas_df(query_uproot)
2 # out_uproot = s_uproot.get_data_parquet(query_uproot)
```

Let's check the output

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In [ ]:
```
1 print(out_uproot)
```

You can now interface the output for ML, hist fitting, or just plotting

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In [ ]:

```
1 import matplotlib.pyplot as plt
2 plot = plt.hist(out_uproot.lep_Pt_1, bins=100, range=(15e3, 200e3))
```

ServiceX Frontend Library

ATLAS AOD Transformer Demo

- Input data type: ATLAS xAOD
- Input data size: 74 GB (17 files)
- ServiceX deployed at UChicago Kubernetes cluster
- Dataset at ATLAS Tier-2 site

Let's have a ServiceX instance for xAOD end-point

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In [ ]:

```
1 dataset_xaod =
"mc15_13TeV:mc15_13TeV.361106.PowhegPythia8EvtGen_AZNLOCTEQ6L1_Zee.merge.DAOD_S
TDM3.e3601_s2576_s2132_r6630_r6264_p2363_tid05630052_00"
2 xaod_transformer_image="sslhep/servicex_func_adl_xaod_transformer:v0.4"
3 s_xaod =
servicex.ServiceXDataset(dataset=dataset_xaod,image=xaod_transformer_image)
4
5 query_xaod = "(call ResultTTree (call Select (call SelectMany (call
EventDataset (list 'localds:bogus')) (lambda (list e) (call (attr e 'Jets')
'AntiKt4EMTopoJets'))) (lambda (list j) (/ (call (attr j 'pt')) 1000.0))) (list
'JetPt') 'analysis' 'junk.root')"
```

Now request for a delivery

Now request for a delivery

In [ ]:

```
out_xaod = s_xaod.get_data_pandas_df(query_xaod)
# out_xaod = s_xaod.get_data_awkward(query_xaod)
# out_xaod = s_xaod.get_data_rootfiles(query_xaod)
```

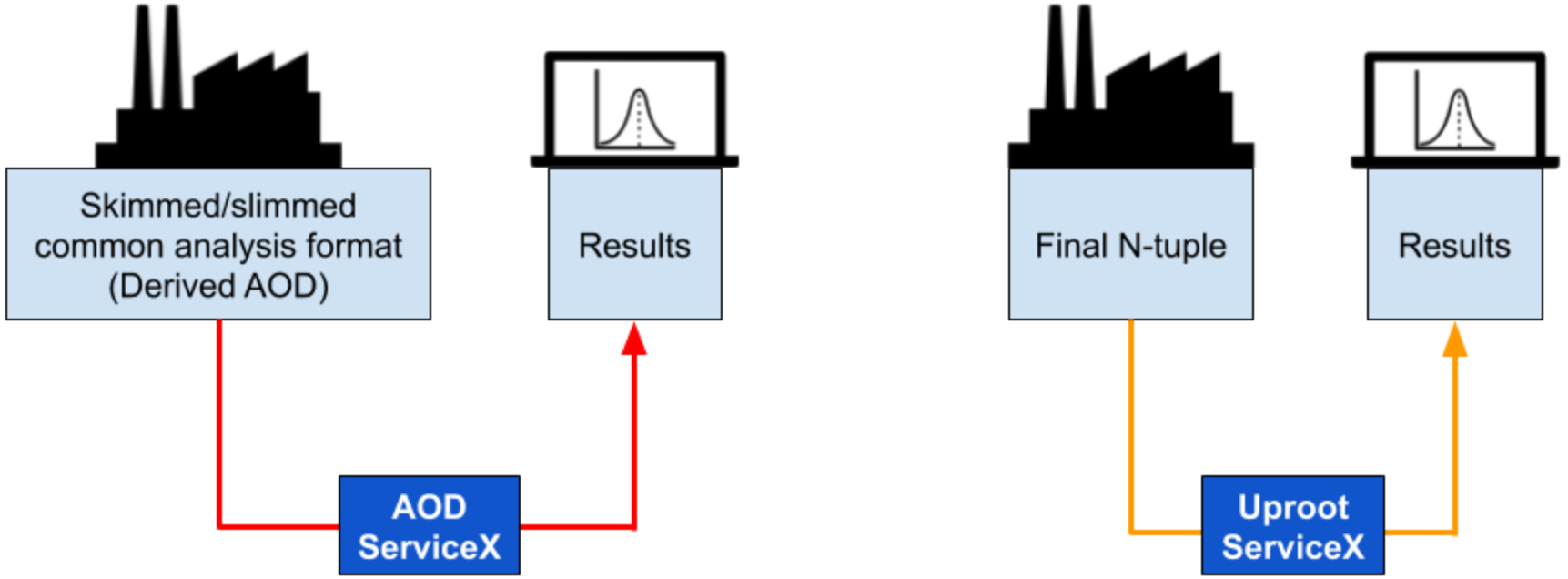
Let's check the output

Let's check the output

In [ ]:

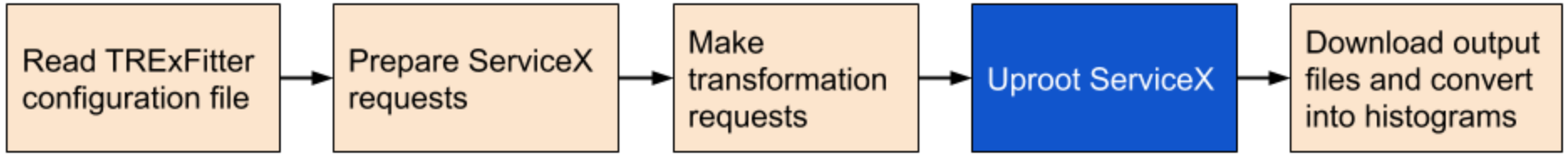
```
1 print(out_xaod)
```

ServiceX workflow



ServiceX Use case - ServiceX for TRExFitter

- TRExFitter is a framework for binned template profile likelihood fits
- Generating input histograms from ROOT N-tuples can be quite expensive for large N-tuples
- Workflow of ServiceXforTRExFitter



➡ No local storage need and easy to scale

ServiceX Use case - ServiceX for NtupleMaker

- A custom PyROOT tranformer to slim/skim ROOT TTree and add new columns (or branches) like a 4-vector reconstructed top
- Not a primary use case of ServiceX, but shows potential adaptability of ServiceX

Very close to the public release of ServiceX!

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Useful Links

- ServiceX documentation
- GitHub repos
    - Try ServiceX
    - ServiceX Frontend
    - qastle language
    - TCut to qastle wrapper