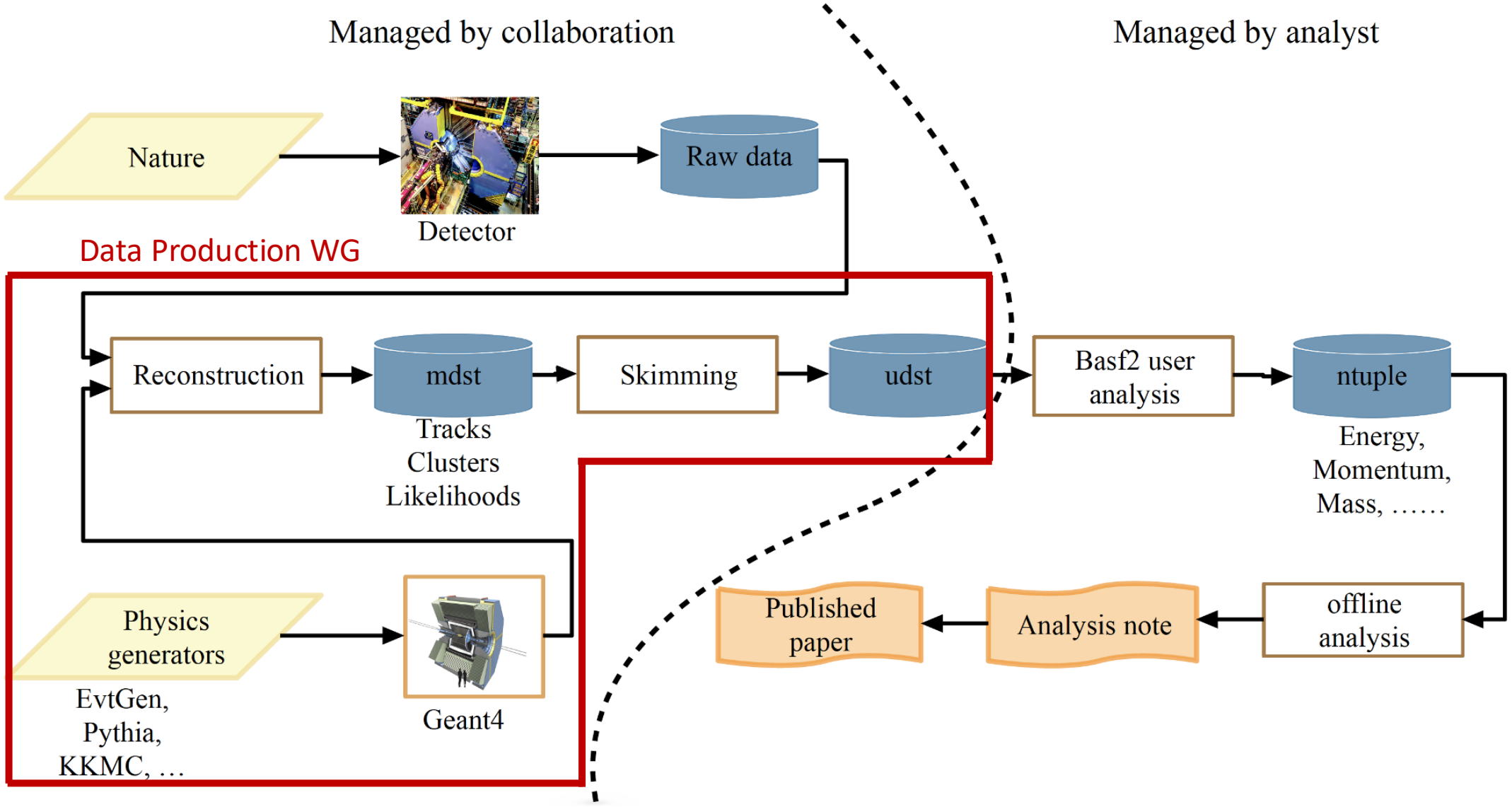
Real Data, Generic MC, and Signal MC Products

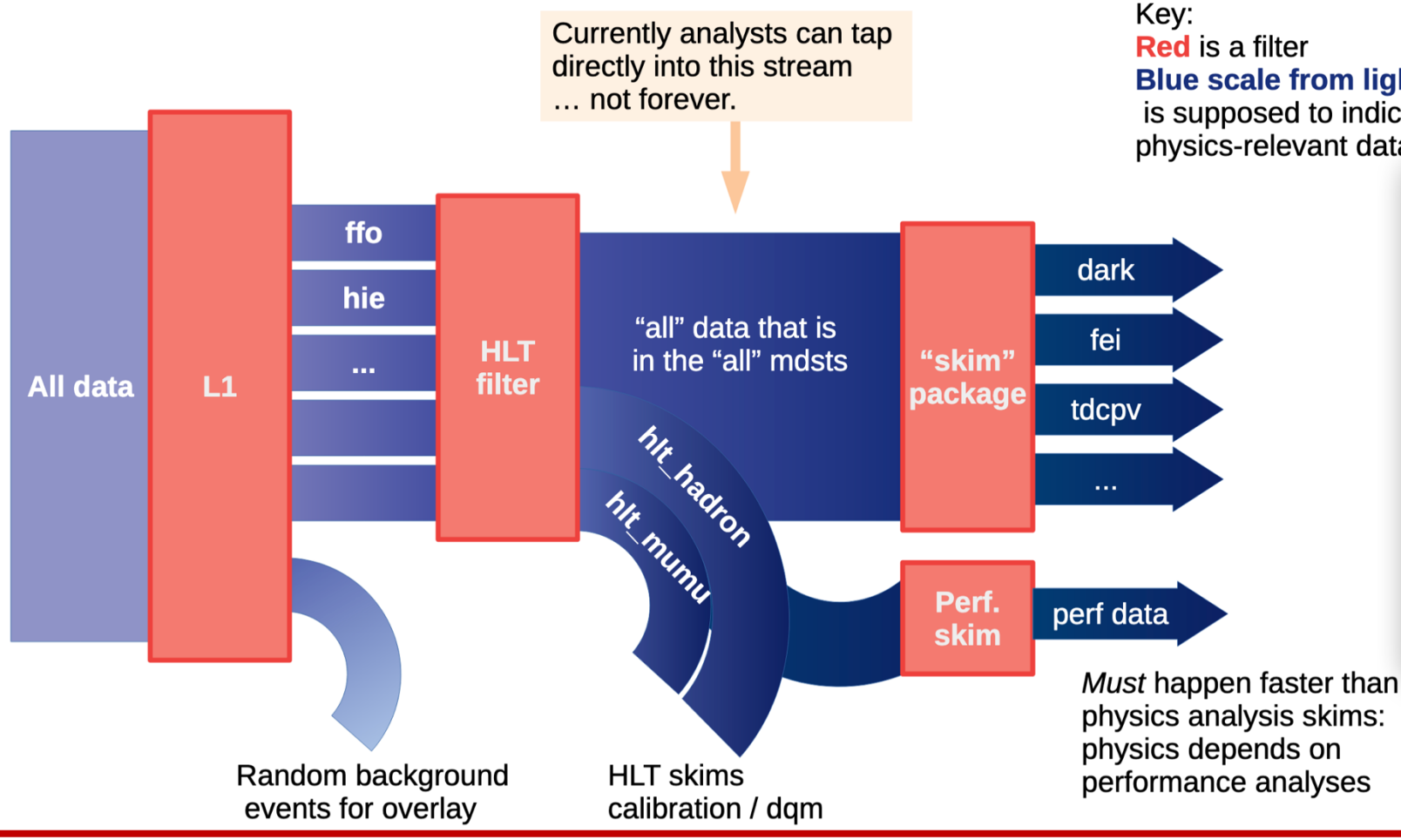
李洋
吉林大学

Winter School 2026 for Belle II China Group
@东南大学
15 Nov. 2026

The Big Picture



Data Flow



Notes:

- hlt_hadron is about 10% of "all" data
- About 50% of analysis skims run on hlt_hadron, the rest run on "all" data

hlt_hadron = at least 3 "good" tracks [pt>0.2 GeV, d0<2 cm, abs(z0)<4 cm] and NOT Bhabha-like

Data Production Wiki Home

Primary goal: Smooth, timely production of data and MC samples for physics analysis and other studies

https://gitlab.desy.de/belle2/data-production/data/-/wikis/home

Belle II / Data Production / dataprod / Wiki / **Data Production Wiki Home**

Data Production Wiki Home

Edit

Last edited by **Stefano Lacaprara** 4 days ago

Data Production Wiki Home page

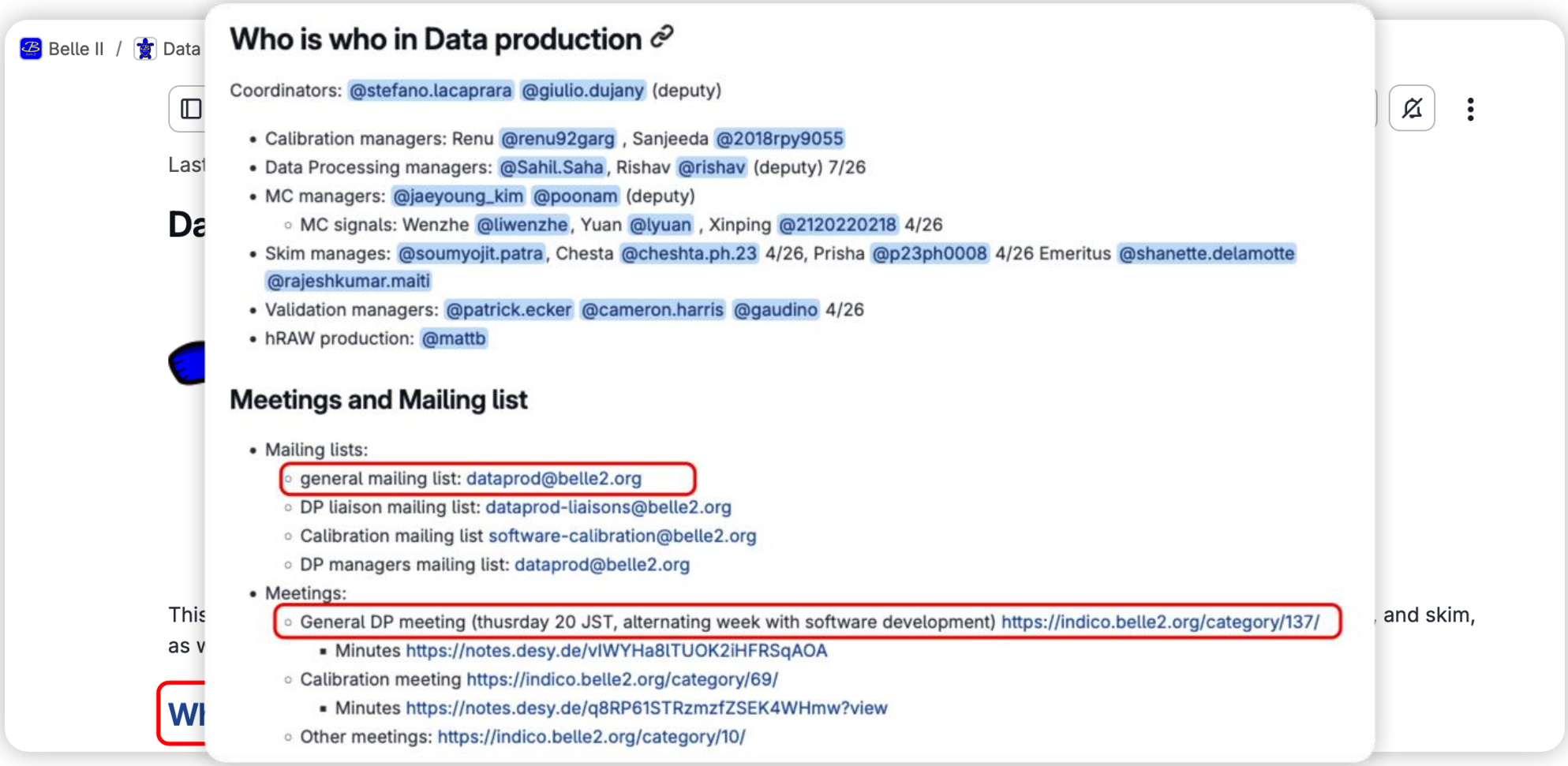
This page and the following contains information about data production activities. Here you can find how to access data, MC, and skim, as well as monitoring pages for the ongoing campaign.

Who's who and contacts

Data Production Wiki Home

Primary goal: Smooth, timely production of data and MC samples for physics analysis and other studies

https://gitlab.desy.de/belle2/data-production/data/-/wikis/home



Belle II / Data

Who is who in Data production

Coordinators: @stefano.lacaprara @giulio.dujany (deputy)

- Calibration managers: Renu @renu92garg , Sanjeeda @2018rpy9055
- Data Processing managers: @Sahil.Saha , Rishav @rishav (deputy) 7/26
- MC managers: @jaeyoung_kim @poonam (deputy)
  - MC signals: Wenzhe @liwenzhe , Yuan @lyuan , Xinping @2120220218 4/26
- Skim manages: @soumyojit.patra , Chesta @cheshta.ph.23 4/26, Prisha @p23ph0008 4/26 Emeritus @shanette.delamotte @rajeshkumar.maiti
- Validation managers: @patrick.ecker @cameron.harris @gaudino 4/26
- hRAW production: @mattb

Meetings and Mailing list

- Mailing lists:
  - general mailing list: dataprod@belle2.org
  - DP liaison mailing list: dataprod-liaisons@belle2.org
  - Calibration mailing list software-calibration@belle2.org
  - DP managers mailing list: dataprod@belle2.org
- Meetings:
  - General DP meeting (thusrday 20 JST, alternating week with software development) https://indico.belle2.org/category/137/
    - Minutes https://notes.desy.de/vlWYHa8lTUOK2iHFRSqAOA
  - Calibration meeting https://indico.belle2.org/category/69/
    - Minutes https://notes.desy.de/q8RP61STRzmzfZSEK4WHmw?view
  - Other meetings: https://indico.belle2.org/category/10/

Data Format

In general, Belle II output is stored in ROOT files containing various subsets of dataobjects, dbobjects, nTuples, etc

RAW: un-processed, un-calibrated output of the detector

hRAW: same as RAW, but only for events passing a given HLT filter or skim

- Use RAW data to reconstruct tracks, showers, etc. to get a **data summary table (DST)**

cDST: calibration data summary table

- cDST contain RAW data and additional dataobjects useful for calibration

mDST: mini data summary table

- Controlled version of a DST
- only a subset of available processed DataObjects are included
- sufficient information for analysis use

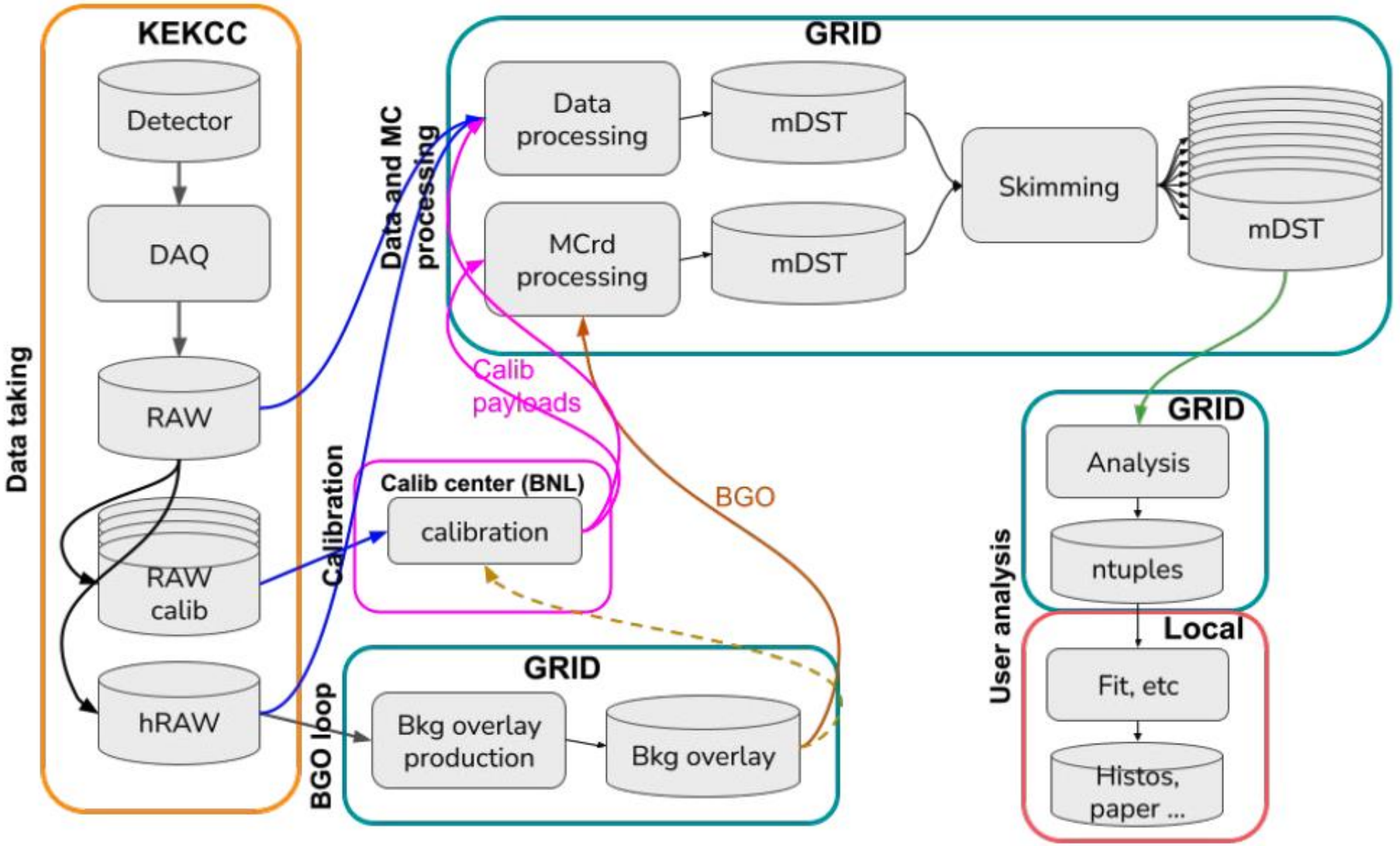
uDST: user data summary table

- mDST objects plus analysis objects (e.g. particleLists)
- Analysis skims output uDST
- **Smallest file sizes → reduces runtimes for analysis jobs**



→ Just these are relevant to analysts

Data Format


KEKCC
Detector
DAQ
RAW
RAW calib
hRAW
Data taking
GRID
Data processing
MCrd processing
mDST
mDST
Skimming
mDST
Data and MC processing
Calib payloads
BGO
Calibration
Calib center (BNL)
calibration
GRID
Bkg overlay production
Bkg overlay
BGO loop
GRID
Analysis
ntuples
Local
Fit, etc
Histos, paper ...
User analysis

(Re)Processing Data

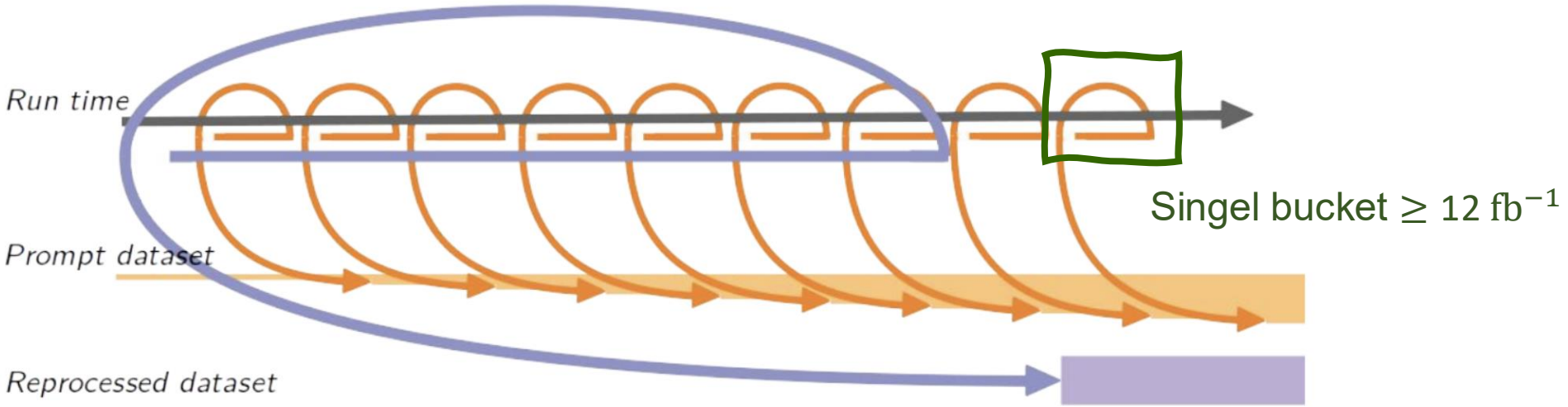
For any given data, calibration and processing happens twice:

Prompt processing:

- Automated calibration @ BNL
- Minimum luminosity: 12 fb^{-1}
- Uses hRAW as input
- All calibrations included
- Terminology: **bucketXX**
- ~ one bucket every 2 weeks of data taking
- Ideally already final calibration

Official reprocessing:

- Reprocessing @ KEKCC
- To update older data with the latest reconstruction software
- Uses cDST as input
- Only calibration with expected improvement
- Terminology: **procXX**
- ~ once/year until 2025, every other year starting from 2025



MC Production

Two types of Monte Calor (MC) production:

➢ Generic/Inclusive MC:

https://gitlab.desy.de/belle2/data-production/data/-/wikis/home/WhoIsWho

- Produced automatically at every MC production campaigns
- They are just the typical processes which we expect to see at Belle II, such as:

$$e^+e^- \to \Upsilon(4S) \to B^+B^-\,(\text{charged}), B^0\bar{B}^0(\text{mixed})$$
$$e^+e^- \to u\bar{u}, d\bar{d}, s\bar{s}, c\bar{c}$$
$$e^+e^- \to \gamma\gamma, e^+e^-, \mu^+\mu^-, \tau^+\tau^-$$
$$e^+e^- \to e^+e^-e^+e^-, e^+e^-\,\mu^+\mu^-$$
$$e^+e^- \to hhISR\ (\pi\pi ISR, KKISR, etc.)$$

- Generated based on central decay file: DECAY_BELLE2.DEC

Group	Liaison
Semileptonic and Missing Energy Decays	Tia @tcrane Cameron @cameron.harris
Radiative & Electroweak Penguin	Nihar @ph24resch11018 (was Ihor @ihor.prudiiev)
Time Dependent CP Violation	Noah @nbrenny
Hadronic B decays	Xiang @xiangzhao (was Shu-Ping @slin)
Quarkonium	Yijia @20300200011
Charm	Rishav @rishav
Tau	Naveen @nkbelle2
Dark-sector and low multiplicity	Poonam @poonam
Performance	Giovanni @gaudino
Upgrade	Bogdan @bdkutsenko

➢ Signal MC:

- Specific to your own analysis
- **Dec files:** specify your own dec file according to the dec file naming rules
- Contact the **Data production liaison** in your working group to get started!

MC Production

Two types of MC production campaign:

Run-independent (RI)

- Easier to produce
- Use simulated background and static detector conditions
- Produced in predetermined luminosity
- Less accurate detector performance and beam backgrounds.
- Terminology: **MCXXri (MC16ri)**

Run-dependent (RD)

- More difficult to produce
- Use random trigger events from data and real conditions
- Produced in streams (1 stream = luminosity of corresponding data)
- More accurate detector performance and beam backgrounds
- Terminology: **MCXXrd (MC16rd)**

Available Data and MC

https://gitlab.desy.de/belle2/data-production/data/-/wikis/home

processing names

Release	data	MC	notes
release-08-02	proc16	MC16rd/ri	Full reprocessing of run1 data
release-08-03	PromptRel8	MCPromptRel8	Prompt processing of Run2 data up to exp 35 (2024c)
release-09-00	PromptRel9	MCPromptRel9	Prompt processing of Run2 data from exp 37 (2025c)

Available Data and MC

https://gitlab.desy.de/belle2/data-production/data/-/wikis/home

processing nam

Release	
release-08-02	
release-08-03	exp 35 (2024c)
release-09-00	exp 37 (2025c)

promptRel9/MCrdPromptRel9 campaign

This is the prompt processing of data collected in 2025/2026, and corresponding MCrd

- Prompt processing release9 2025 26
- MCrdPromptRel9 generic

proc16/MC16 campaign

- Data run1 unksimmed (xwiki)
- Data run2 unskimmed (xwiki)
- MC16rd generic
- MC16rd signals
- MC16ri generic
- MC16ri signals

Skims

- Skim home page
- Data and MC Collections (run 1&2)

Luminosity page

This is maintained by Trigger and Event Properties (TEP) WG here (under construction) Offline Luminosity Page

Data Collections

Reprocessings

proc16

proc16 (2019-2023 data - exp 7-26)

- **Proc16** (exp 12 to exp 26)
  - **Status: All chunks are done.**
  - **4S**
    - **All**
      - /belle/collection/Data/proc16_4S_all_v1
      - /belle/collection/Data/proc16_4S_all_10601400_v1
    - **Hadron**
      - /belle/collection/Data/proc16_4S_had_v1
      - /belle/collection/Data/proc16_4S_had_10601300_v1
  - **4S offres** (gbasf -n 2)
    - **All**
      - /belle/collection/Data/proc16_offres_all_v1
      - /belle/collection/Data/proc16_offres_all_10601400_v1
    - **Hadron**
      - /belle/collection/Data/proc16_offres_had_v1
      - /belle/collection/Data/proc16_offres_had_10601300_v1
  - **5S scan** (gbasf -n 2)
    - **All**
      - /belle/collection/Data/proc16_5Sscan_all_v1
      - /belle/collection/Data/proc16_5Sscan_all_10601400_v1
    - **Hadron**
      - /belle/collection/Data/proc16_5Sscan_had_v1
      - /belle/collection/Data/proc16_5Sscan_had_10601300_v1

Run2

PromptRel8

- **bucket37 (2024a data - exp30, runs 1242-2489 ~11.2/fb):**
  - Calibration done
  - **mDST** hlt_hadron done all done
  - **mDST** SystematicCombinedHadronic (**10601300**), SystematicCombinedLowMulti (**10601400**) skims done
- **bucket38 (2024a/b data - exp 30, runs 2601-3508 - ~25.4/fb)**
  - Calibration done
  - **mDST** all, hlt_hadron done
  - **mDST** SystematicCombinedHadronic (**10601300**), SystematicCombinedLowMulti (**10601400**) skims done
- **bucket39 (2024a/b data - exp 31, runs 8-174 , exp32, runs 4-136 ~17.7/fb) details on Processing 2024a-b**
  - 4S-offres
  - exp31 PXD on, exp 32 PXD off
  - Calibration done
  - **mDST** all, hlt_hadron Done
  - **mDST** SystematicCombinedHadronic (**10601300**), SystematicCombinedLowMulti (**10601400**) skims Done
- **bucket40 (2024a/b data - exp 33, runs 1-604 ~25/fb)**
  - 4S - PXD off
  - Calibration done
  - **mDST** all, hlt_hadron Done
  - **mDST** SystematicCombinedHadronic (**10601300**), SystematicCombinedLowMulti (**10601400**) skims Done
- **bucket41 (2024a/b data - exp 33, runs 605-1323 ~24.3/fb)**
  - 4S - PXD off
  - Calibration done
  - **mDST** all, hlt_hadron Done
  - **mDST** SystematicCombinedHadronic (**10601300**), SystematicCombinedLowMulti (**10601400**) skims Done
- **Collection for run2: bucket37-42 - exp 30-35**
  - **mDST all:**
    - **/belle/collection/Data/exp30_to_exp35_all_4S_v1**
    - **/belle/collection/Data/exp30_to_exp35_all_4Soffres_v1**
  - **mDST hadron**
    - **/belle/collection/Data/exp30_to_exp35_had_4S_v1**
    - **/belle/collection/Data/exp30_to_exp35_had_4Soffres_v1**

Luminosity page: https://gitlab.desy.de/belle2/performance/trigger-event-properties/tep-wiki-page/-/wikis/Offline-Luminosity-Page

Data Collections

PromptRel9

Beam Energy	Content	Collection name
4S	All mDST	/belle/collection/Data/prompt_rel9_25c_26ab_4S_all_v2
4S	hadron mDST	/belle/collection/Data/prompt_rel9_25c_26ab_4S_hadron
4S_offres	all mDST	/belle/collection/Data/prompt_rel9_25c_26ab_4S_offres_all
4S_offres	hadron mDST	/belle/collection/Data/prompt_rel9_25c_26ab_4S_offres_hadron
4S	SystematicCombinedLowMult	/belle/collection/Data/prompt_rel9_25c_26ab_4S_all_10601401 /belle/collection/Data/prompt_rel9_25c_26ab_4S_all_10601400
4S	SystematicsCombinedHadronic	belle/collection/Data/prompt_rel9_25c_26ab_4S_hadron_10601300
4S_offres	SystematicCombinedLowMult	/belle/collection/Data/prompt_rel9_25c_26ab_4S_offres_all_10601401
4S_offres	SystematicsCombinedHadronic	/belle/collection/Data/prompt_rel9_25c_26ab_4S_offres_hadron_10601300

Luminosity page: https://gitlab.desy.de/belle2/performance/trigger-event-properties/tep-wiki-page/-/wikis/Offline-Luminosity-Page

Data Collections

PromptRel9

Beam Energy	Content	Collection name
4S	All mDST	/belle/collection/Data/prompt_rel9_25c_26ab_4S_all_v2
4S	hadron mDST	/belle/collection/Data/prompt_rel9_25c_26ab_4S_hadron
4S_offres	all mDST	/belle/collection/Data/prompt_rel9_25c_26ab_4S_offres_all
4S_offres		n
4S		
4S	SystematicsCombinedHadronic	belle/collection/Data/prompt_rel9_25c_26ab_4S_hadron_10601300
4S_offres	SystematicCombinedLowMult	/belle/collection/Data/prompt_rel9_25c_26ab_4S_offres_all_10601401
4S_offres	SystematicsCombinedHadronic	/belle/collection/Data/prompt_rel9_25c_26ab_4S_offres_hadron_10601300

```
gbasf2 xxx -i /belle/collection/Data/xxx
```

Luminosity page: https://gitlab.desy.de/belle2/performance/trigger-event-properties/tep-wiki-page/-/wikis/Offline-Luminosity-Page

Generic MC Collections

- Run 1 Collections(correct exp18 is already included)
  - 4S
    - Systematic Skim
      - Skim Hadronic
      - Skim Low Multiplicity
  - 4S_offres
    - Systematic Skim
      - Skim Hadronic
      - Skim Low Multiplicity
  - 5S
    - Systematic Skim
      - Skim Hadronic
      - Skim Low Multiplicity

MC16rd

- Run 2 Collections
  - 4S
    - Systematic Skim
      - Skim Hadronic
      - Skim Low Multiplicity
  - 4S_offres
    - Systematic Skim
      - Skim Hadronic
      - Skim Low Multiplicity

4S

```
mumu: /belle/collection/MC/MC16rd_proc16_mumu_Run1_4S_v2 (Luminosity: 1429.2255372102 /fb)
ccbar: /belle/collection/MC/MC16rd_proc16_ccbar_Run1_4S_v2 (Luminosity: 1429.2260694781999 /fb)
ddbar: /belle/collection/MC/MC16rd_proc16_ddbar_Run1_4S_v2 (Luminosity: 1429.2255372102 /fb)
eeee: /belle/collection/MC/MC16rd_proc16_eeee_Run1_4S_v2 (Luminosity: 357.30605607325 /fb)
uubar: /belle/collection/MC/MC16rd_proc16_uubar_Run1_4S_v2 (Luminosity: 1429.2260694781999 /fb)
eemumu: /belle/collection/MC/MC16rd_proc16_eemumu_Run1_4S_v2 (Luminosity: 357.30605607325 /fb)
hhISR: /belle/collection/MC/MC16rd_proc16_hhISR_Run1_4S_v2 (Luminosity: 357.30651738205 /fb)
mixed: /belle/collection/MC/MC16rd_proc16_mixed_Run1_4S_v2 (Luminosity: 1428.5181494222 /fb)
ee: /belle/collection/MC/MC16rd_proc16_ee_Run1_4S_v2 (Luminosity: 35.730605607325 /fb)
ssbar: /belle/collection/MC/MC16rd_proc16_ssbar_Run1_4S_v2 (Luminosity: 1429.2255372102 /fb)
gg: /belle/collection/MC/MC16rd_proc16_gg_Run1_4S_v2 (Luminosity: 714.6122567030999 /fb)
taupair: /belle/collection/MC/MC16rd_proc16_taupair_Run1_4S_v2 (Luminosity: 1429.2260694781999 /fb)
llXX: /belle/collection/MC/MC16rd_proc16_llXX_Run1_4S_v2  (Luminosity: 1429.2260694781999 /fb)
charged: /belle/collection/MC/MC16rd_proc16_charged_Run1_4S_v2  (Luminosity: 1429.2260694781999 /fb)
```

4S

```
uubar: /belle/collection/MC/MC16rd_prompt_uubar_Run2_4S_v1 (Luminosity: 517.110308788 /fb)
ccbar: /belle/collection/MC/MC16rd_prompt_ccbar_Run2_4S_v1 (Luminosity: 517.1110491 /fb)
gg: /belle/collection/MC/MC16rd_prompt_gg_Run2_4S_v1 (Luminosity: 258.54511677200003 /fb)
ee: /belle/collection/MC/MC16rd_prompt_ee_Run2_4S_v1 (Luminosity: 12.927255838600002 /fb)
charged: /belle/collection/MC/MC16rd_prompt_charged_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
eemumu: /belle/collection/MC/MC16rd_prompt_eemumu_Run2_4S_v1 (Luminosity: 129.272495663 /fb)
llXX: /belle/collection/MC/MC16rd_prompt_llXX_Run2_4S_v1 (Luminosity: 517.110308788 /fb)
mixed: /belle/collection/MC/MC16rd_prompt_mixed_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
mumu: /belle/collection/MC/MC16rd_prompt_mumu_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
taupair: /belle/collection/MC/MC16rd_prompt_taupair_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
ddbar: /belle/collection/MC/MC16rd_prompt_ddbar_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
ssbar: /belle/collection/MC/MC16rd_prompt_ssbar_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
eeee: /belle/collection/MC/MC16rd_prompt_eeee_Run2_4S_v1 (Luminosity: 129.259974796 /fb)
hhISR: /belle/collection/MC/MC16rd_prompt_hhISR_Run2_4S_v1 (Luminosity: 95.824143 /fb)
```

Generic MC Collections

- Run 1 Collections(correct exp18 is already included)
  - 4S
    - Systematic Skim
      - Skim Hadronic
      - Skim Low Multiplicity
  - 4S_offres
    - Systematic Skim
      - Skim Hadronic
      - Skim Low Multiplicity
  - 5S
    - Systematic Skim
      - Skim Hadron
      - Skim Low Mu

MC16rd

gbasf2 xxx -i /belle/collection/MC/MC16rd_xxx

- Run 2 Collections
  - 4S
    - Systematic Skim
      - Skim Hadronic
      - Skim Low Multiplicity
  - 4S_offres
    - Systematic Skim
      - Skim Hadronic
      - Skim Low Multiplicity

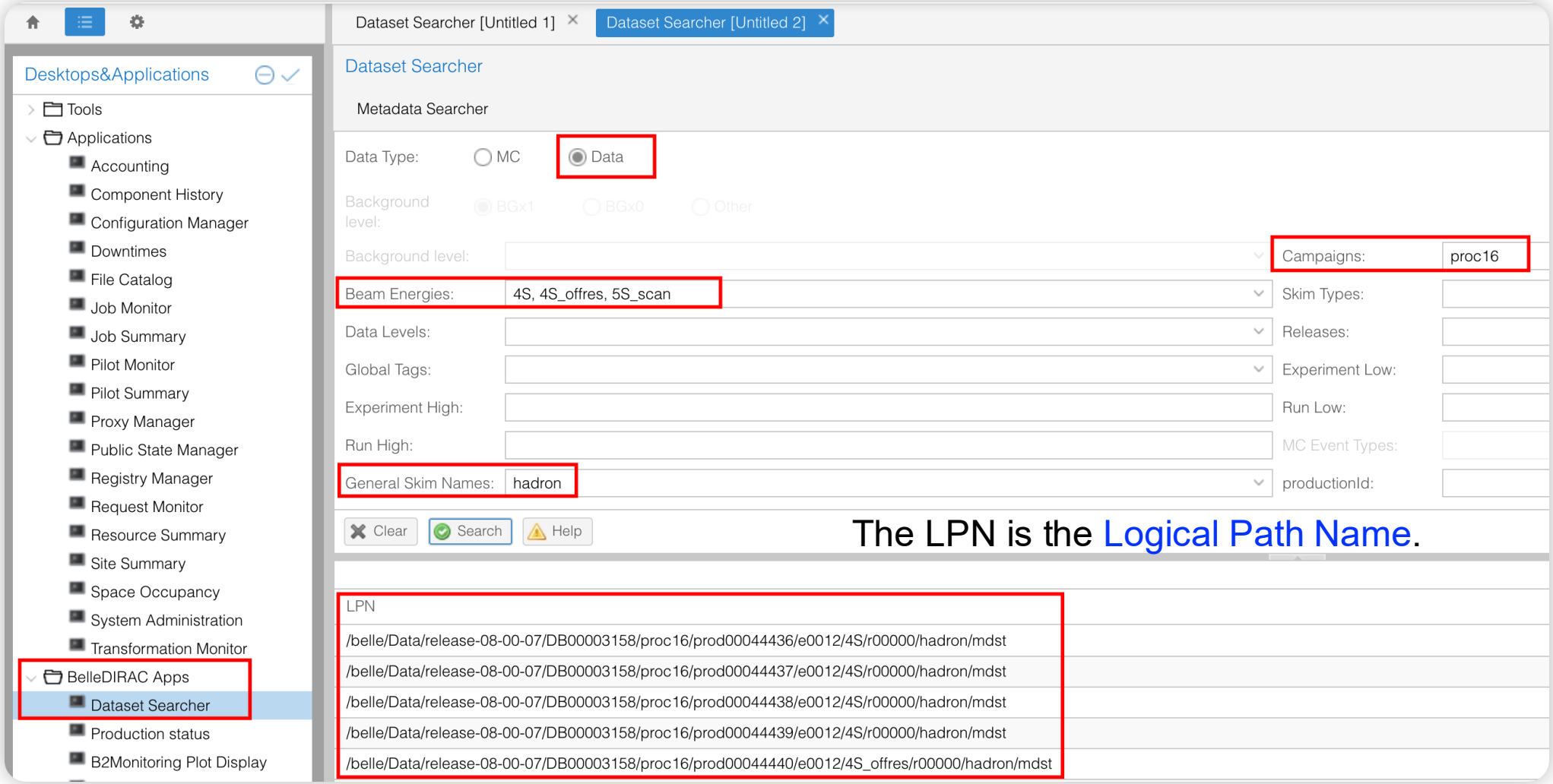
4S

```
mumu: /belle/collection/MC/MC16rd_proc16_mumu_Run1_4S_v2 (Luminosity: 1429.2255372102 /fb)
ccbar: /belle/collection/MC/MC16rd_proc16_ccbar_Run1_4S_v2 (Luminosity: 1429.2260694781999 /fb)
ddbar: /belle/collection/MC/MC16rd_proc16_ddbar_Run1_4S_v2 (Luminosity: 1429.2255372102 /fb)
eeee: /belle/collection/MC/MC16rd_proc16_eeee_Run1_4S_v2 (Luminosity: 357.30605607325 /fb)
uubar: /belle/collection/MC/MC16rd_proc16_uubar_Run1_4S_v2 (Luminosity: 1429.2260694781999 /fb)
eemumu: /belle/collection/MC/MC16rd_proc16_eemumu_Run1_4S_v2 (Luminosity: 357.30605607325 /fb)
hhISR: /belle/collection/MC/MC16rd_proc16_hhISR_Run1_4S_v2 (Luminosity: 357.30651738205 /fb)
mixed: /belle/collection/MC/MC16rd_proc16_mixed_Run1_4S_v2 (Luminosity: 1428.5181494222 /fb)
ee: /belle/collection/MC/MC16rd_proc16_ee_Run1_4S_v2 (Luminosity: 35.730605607325 /fb)
ssbar: /belle/collection/MC/MC16rd_proc16_ssbar_Run1_4S_v2 (Luminosity: 1429.2255372102 /fb)
gg: /belle/collection/MC/MC16rd_proc16_gg_Run1_4S_v2 (Luminosity: 714.6122567030999 /fb)
```

```
uubar: /belle/collection/MC/MC16rd_prompt_uubar_Run2_4S_v1 (Luminosity: 517.110308788 /fb)
ccbar: /belle/collection/MC/MC16rd_prompt_ccbar_Run2_4S_v1 (Luminosity: 517.1110491 /fb)
gg: /belle/collection/MC/MC16rd_prompt_gg_Run2_4S_v1 (Luminosity: 258.54511677200003 /fb)
ee: /belle/collection/MC/MC16rd_prompt_ee_Run2_4S_v1 (Luminosity: 12.927255838600002 /fb)
charged: /belle/collection/MC/MC16rd_prompt_charged_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
eemumu: /belle/collection/MC/MC16rd_prompt_eemumu_Run2_4S_v1 (Luminosity: 129.272495663 /fb)
llXX: /belle/collection/MC/MC16rd_prompt_llXX_Run2_4S_v1 (Luminosity: 517.110308788 /fb)
mixed: /belle/collection/MC/MC16rd_prompt_mixed_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
mumu: /belle/collection/MC/MC16rd_prompt_mumu_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
taupair: /belle/collection/MC/MC16rd_prompt_taupair_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
ddbar: /belle/collection/MC/MC16rd_prompt_ddbar_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
ssbar: /belle/collection/MC/MC16rd_prompt_ssbar_Run2_4S_v1 (Luminosity: 517.1133067279999 /fb)
eeee: /belle/collection/MC/MC16rd_prompt_eeee_Run2_4S_v1 (Luminosity: 129.259974796 /fb)
hhISR: /belle/collection/MC/MC16rd_prompt_hhISR_Run2_4S_v1 (Luminosity: 95.824143 /fb)
```

Data Searcher

https://dirac.cc.kek.jp:8443/DIRAC/



Signal MC

How to generate signal MC samples?

✓ Select the decay process you want to study and write the decay card (.dec file).

```
# EventType: 1211432002
# Descriptor: [B+ -> J/psi [-> mu+ mu-] pi0 [-> gamma gamma] K+]
# NickName: Bu_JpsipiK_mumu
# Documentation: B -> charmonium decays.
# Tested: Yes
# PhysicsWG: Charmonium
# Responsible: Kirill Chilikin
# Email: chilikin@lebedev.ru
# Cuts: None
# Date: 20220601
#
# This decay model is intended for phase-space-dependent efficiency
# determination. All exclusive decays have the PHSP distributuion.
# Do not use it for one-dimensional analyses without proper reweighting.

Alias pi0sig pi0

Decay Upsilon(4S)
0.5 B+sig B- VSS;
0.5 B-sig B+ VSS;
Enddecay

Decay B+sig
1.0 J/psisig pi0sig K+ PHOTOS PHSP;
Enddecay

CDecay B-sig

Decay J/psisig
1.0 mu+ mu- PHOTOS PHSP;
Enddecay

Decay pi0sig
1.0 gamma gamma PHSP;
Enddecay

End
```

$B^+ \to K^+\pi^0(\to \gamma\gamma)J/\psi(\to \mu^+\mu^-)$

1211432002.dec

EventType:https://software.belle2.org/development/sphinx/decfiles/doc/event_type.html#flag-descriptions

evt.pdl: https://gitlab.desy.de/belle2/software/basf2/-/blob/main/framework/particledb/data/evt.pdl?ref_type=heads

"b2help-particles"

```
*-----------------------------------------------------------------------------------------------------------------------------------
* 5/10/2013 Updated by R. Godang. The format and convention are based on the current evt.pdl and PDG 2012
*----------
*                name                              id      mass/GeV       width/GeV max_Dm/GeV 3*charge 2*spin  lifetime*c/mm   PythiaId
*----------
* Charmed baryons
* Data from P.A. Zyla et al. (Particle Data Group), to be published in Prog. Theor. Exp. Phys. 2020, 083C01 (2020).
*-----------------------------------------------------------------------------------------------------------------------------------
add  p Particle  Lambda_c+                      4122     2286.46e-3             0             0     3     1  6.0677993e-02      4122
add  p Particle  anti-Lambda_c-                -4122     2286.46e-3             0             0    -3     1  6.0677993e-02     -4122
add  p Particle  Lambda_c(2593)+               14122     2592.25e-3         2.6e-3         14e-3     3     1             0         0
add  p Particle  anti-Lambda_c(2593)-         -14122     2592.25e-3         2.6e-3         14e-3    -3     1             0         0
* The Lambda_c(2625) width limit is Gamma < 0.97 MeV (90% C. L.). The width is set to 0.
add  p Particle  Lambda_c(2625)+                4124     2628.11e-3             0             0     3     3             0         0
add  p Particle  anti-Lambda_c(2625)-          -4124     2628.11e-3             0             0    -3     3             0         0
add  p Particle  Sigma_c++                      4222     2453.97e-3        1.89e-3         10e-3     6     1             0      4222
add  p Particle  anti-Sigma_c--                -4222     2453.97e-3        1.89e-3         10e-3    -6     1             0     -4222
```

All decay cards: https://gitlab.desy.de/belle2/software/basf2/-/tree/main/decfiles/dec?ref_type=heads

Generic decay card: DECAY_BELLE2.DEC

Signal MC

✓ Choose the appropriate event generator

BELLE2-NOTE-PH-2015-006

Generator	Main Usage
EvtGen	B, D, τ, etc. decay chains
KKMC	$e^+e^- \to \mu^+\mu^-, \tau^+\tau^-, q\bar{q}, \nu\bar{\nu}$
PHOKHARA 9.1	ISR processes
TREPS	Two-photon process
BABAYAGA.NLO	Bhabha and digamma
TAUOLA	Tau decays in EvtGen
PYTHIA 8.209	Quark fragmentation and inclusive decays
PHOTOS	Radiative corrections for hadron decays

For examples for usages of these generators:

https://gitlab.desy.de/belle2/software/basf2/-/tree/main/generators/examples?ref_type=heads

Signal MC

- ✓ Simulation and reconstruction

```
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
# Descriptor: charged

#############################################################
# Steering file for official MC production of early phase 3
# 'charged' samples with beam backgrounds (BGx1).
#
# September 2020 - Belle II Collaboration
#############################################################

import basf2 as b2
import generators as ge
import simulation as si
import reconstruction as re
import mdst as mdst
import glob as glob

decfile = b2.find_file('./1211432002.dec')

# background (collision) files
bg = glob.glob('./*.root')
# background if running locally
bg_local = glob.glob('/group/belle2/dataprod/BGOverlay/early_phase3/release-08-00-03/overlay/BGx1/set0/*root')

# set database conditions (in addition to default)
b2.conditions.prepend_globaltag("release-08-00-09")

# create path
main = b2.Path()

# specify number of events to be generated
main.add_module("EventInfoSetter", expList=1003, runList=0, evtNumList=100)

# generate events from decfile
main.add_module('EvtGenInput', userDECFile=decfile)

# detector simulation
si.add_simulation(main, bkgfiles=bg_local)

# reconstruction
re.add_reconstruction(main)

# Finally add mdst output (file name overwritten on the grid)
mdst.add_mdst_output(path=main, filename="mdst.root")

# process events and print call statistics
b2.process(path=main)
print(b2.statistics)
```

This is the steer script for generating Run1 signal MCri events. For scripts that generate other processes, you can find them in the data production repository.

https://gitlab.desy.de/belle2/data-production/mc

Only basf2 release versions can produce MC samples.

Note that the signal reconstruction efficiency, the parameters of the signal shape, and other related quantities must be determined using the officially produced **MCrd samples**.

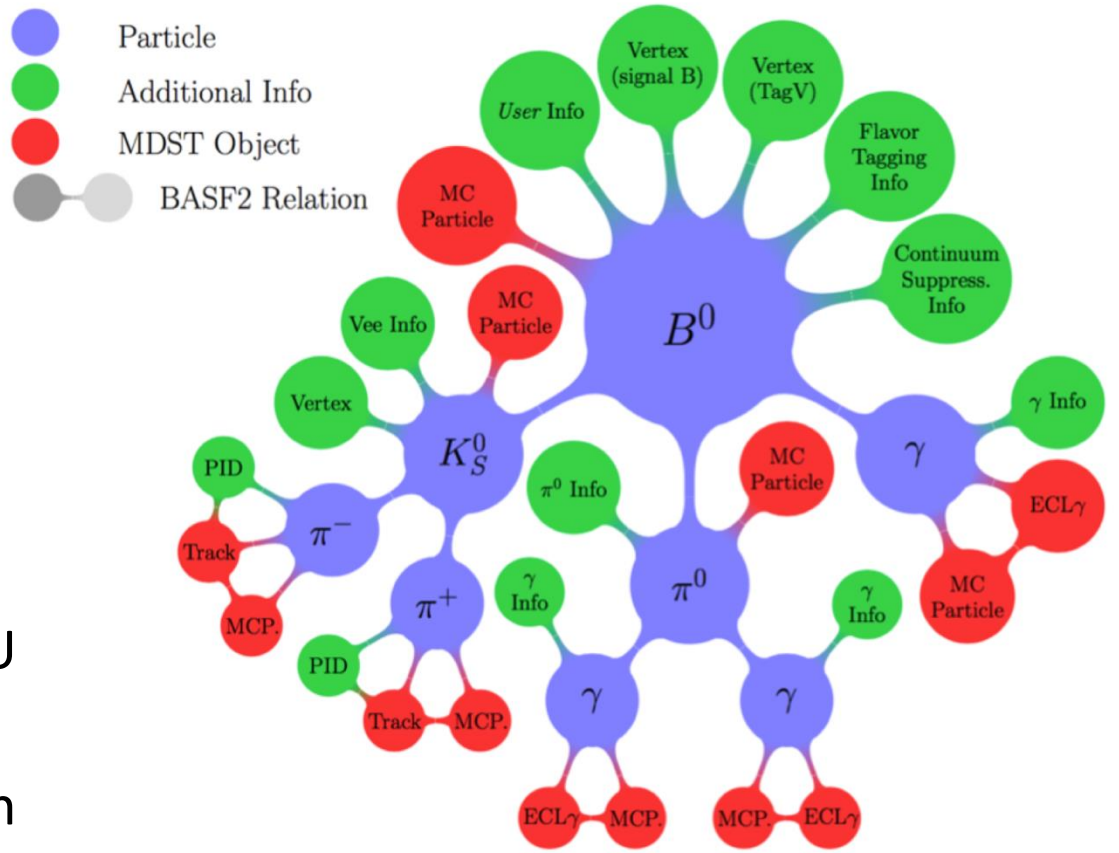
Skim

Skims are meant to provide analysis-oriented MC and data in reduced sizes

Skim home page

✓ Produced as **udst** = mdst information + analysis-level information

- Particle objects: which links particle hypotheses with tracks, neutral clusters, and particle identification information
- Vertex fit results
- Information from full B and D reconstruction, Continuum suppression and other complex algorithms



That means more information in smaller files!

- This allows for preprocessing that reduces the CPU requirements for the analysis.
- Your grid jobs on skimmed samples will finish much more quickly!

Use uDST for FEI based analysis!!

Flagged Skim Approach

Starting with proc16 and MC16 campaign a Flagged skim approach is used.

- **Merged** different skims into groups
- Add a **flag** to each event according to the skim, to identify the skim within the group
- Produce **mDST** output

For more details: slides, slides-1

- **Why?**
- Reduce the amount of work
- Exploit the large overlap between the skims
- Make submissions faster and lighter

```
ma.inputMdstList(filelist=infile, path=path)
ma.applyEventCuts(
        'eventExtraInfo(passes_mySkim)==1',
        path=path)
```

- **How to use?**
- Need to add the flag selection when you make the ntuples

Use mDST for your analysis, if not FEI based!!

Analysis Skim

https://xwiki.desy.de/xwiki/bin/view/BI/Belle%20II%20Internal/Data Production WebHome/Skim main page/Skim Information for Analysts/

Physics WG	Sphinx Links (documentation)	Gitlab Links (skim scripts)	Other useful links
BtoCharm	btocharm	btocharm.py	
BtoCharmless	btocharmless	btocharmless.py	
TDCPV	tdcpv	tdcpv.py	
EWP	ewp	ewp.py	
Charm	charm	charm.py	
Quarkonium	quarkonium	quarkonium.py	
SL + Missing Energy	fei leptonic semileptonic	fei.py leptonic.py semileptonic.py	WG1 Skimming Advice and Resources
Dark and Low Multiplicity	dark lowMulti	dark.py lowMulti.py	
Tau	taupair	taupair.py	
Systematics & Lepton ID Performance	systematics	systematics.py	

```
289 class InclusiveLambda(BaseSkim):
290     """
291     **Reconstructed decay:**
292
293     * :math:`\\Lambda \\to p \\pi^-` (and charge conjugate)
294
295     **Selection criteria:**
296
297     Cuts on proton:
298
299     * ``protonID > 0.1``
300
301     Cuts on Lambda:
302
303     * ``cosAngleBetweenMomentumAndVertexVector > 0.75``
304     * ``flightDistance/flightDistanceErr > 0.``
305     * ``0.5 < p_proton/p_Lambda < 1.25 GeV/c``
306
307     """
```

```
ma.inputMdstList(filelist=infile, path=path)
ma.applyEventCuts('eventExtraInfo(passes_InclusiveLambda)==1', path=path)
```

Analysis Skim

https://gitlab.desy.de/belle2/data-production/skim/skim16

Flagged skim (f-skim) produced in the campaign

List of the flagged skim produced in this campaign, HLT-skim used as input, processed MC-types:

f-skim name	f-skim code	HLT skim	MC-types
f_SLME_p1	71000100	all	`Main`
f_EWP_p1	72000100	all	`Main`
f_TDCPV_p1	73000100	hadron	`Main`
f_TDCPV_p2	73000200	hadron	`Main`
f_bhadronic_p1	74000100	hadron	`Main`
f_bhadronic_p2	74000200	hadron	`Main`
f_quarkonium_p1	75000100	all	`Main` + `LowMult` + `Excited`
f_charm_p1	77000100	all	`Main`
f_dark_p1	78000100	all	`Main` + `LowMult`
f_tau_p1	79000100	all	`Main` + `LowMult`

The list of single skims present in each f-skim can be found in the `officialConfigFiles/flaggedSkim.yaml` file of this repository.

The definition of the MC-types is the following:

MC-Type group	Individual MC-types
`Main`	`charged`, `mixed`, `uubar`, `ddbar`, `ssbar`, `ccbar`, `taupair`
`LowMult`	`ee`, `mumu`, `gg`, `eemumu`, `eeee`, `llXX`, `hhISR`
`Excited`	`BstarBstar`, `BstarB`

Where can we find these skim samples?

You can find the exact location of your skim collections running the (gbasf2) command:

$ gb2_ds_search collection --list_all_collections /belle/collection/MC/* | grep "S16_" | grep "{f-skim-code}" [MC]

$ gb2_ds_search collection --list_all_collections /belle/collection/Data/* | grep "S16_" | grep "{f-skim-code}" [data]

```
(base) [liy@cw07 ~] gb2_ds_search collection --list_all_collections /belle/collection/MC/* | grep "S16_" | grep "77000100"
/belle/collection/MC/S16_MC16rd-proc16_4S_offres_udstau_skim_77000100_v1
/belle/collection/MC/S16_MC16rd-prompt_4S_ccbar_skim_77000100_v1
/belle/collection/MC/S16_MC16rd-prompt_4S_offres_ccbar_skim_77000100_v1
/belle/collection/MC/S16_MC16rd-prompt_4S_Budstau_skim_77000100_v1
/belle/collection/MC/S16_MC16rd-prompt_4S_offres_udstau_skim_77000100_v1
/belle/collection/MC/S16_MC16rd-proc16_4S_Budstau_skim_77000100_v2
/belle/collection/MC/S16_MC16rd-proc16_5S_scan_Budstau_skim_77000100_v2
/belle/collection/MC/S16_MC16rd-proc16_5S_scan_ccbar_skim_77000100_v2
/belle/collection/MC/S16_MC16rd-proc16_4S_ccbar_skim_77000100_v2
/belle/collection/MC/S16_MC16rd-proc16_4S_offres_ccbar_skim_77000100_v2
```

```
(base) [liy@cw07 ~] gb2_ds_search collection --list_all_collections /belle/collection/Data/* | grep "S16_" | grep "77000100"
/belle/collection/Data/S16_prompt_4S_skim_77000100_v1
/belle/collection/Data/S16_prompt_4S_offres_skim_77000100_v1
/belle/collection/Data/S16_proc16_4S_offres_skim_77000100_v2
/belle/collection/Data/S16_proc16_4S_skim_77000100_v2
/belle/collection/Data/S16_proc16_5S_scan_skim_77000100_v2
```

You can also access the skim LPNs via the DIRAC interface at https://dirac.cc.kek.jp:8443/DIRAC/

Summary

- ✓ The data and MC samples used for physics analysis are provided by the Data Production Work Group. You can find the collections for submitting grid jobs on the Data Production WebHome.
- ✓ To improve the processing efficiency of your jobs, you should run skimmed samples. If the existing skims are not suitable for your analysis, please contact the DP liaison to have a skim created for you.
- ✓ Signal MC samples are also produced by the DP liaison of each physics group. Please contact him/her to have the signal MC samples generated for you.
- ✓ At the early stage of an analysis, we usually generate signal MCri samples for debugging analysis scripts.
- ✓ let's try to generate the signal MCri samples!

KEKCC: /home/belle/liy/group2_2022/Winter_School/MCri

$$\Omega_c^0 \to \pi^+ \Omega(2012)^- \to \pi^+ \Xi^0 K^-$$

1. source /cvmfs/belle.cern.ch/tools/b2setup release-08-01-10
2. ./sub.sh

Thank you for your attention!