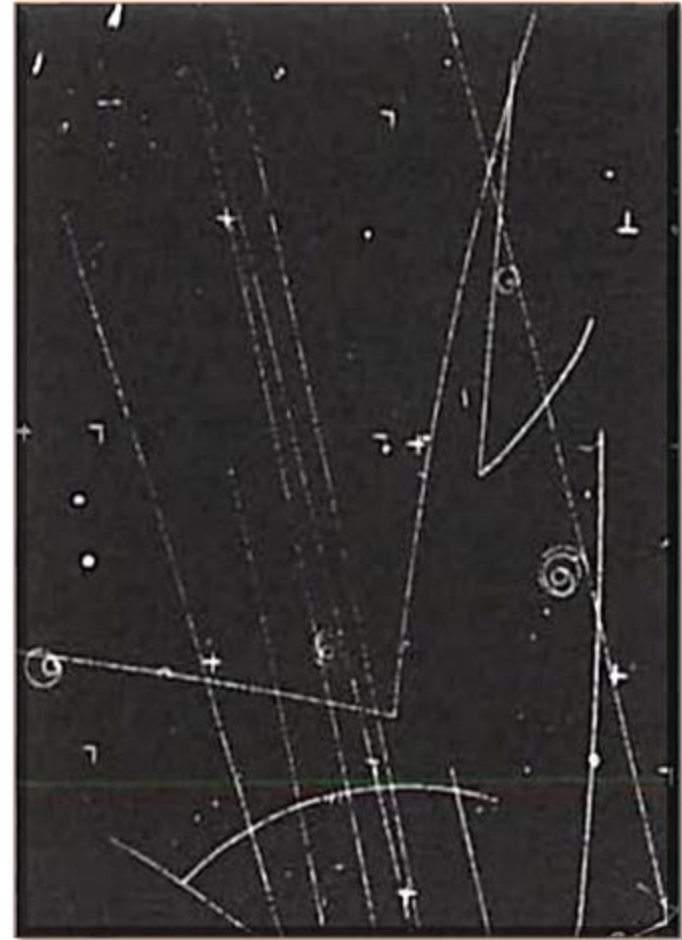


# Common Vertex Finder & Analysis Tools Updates

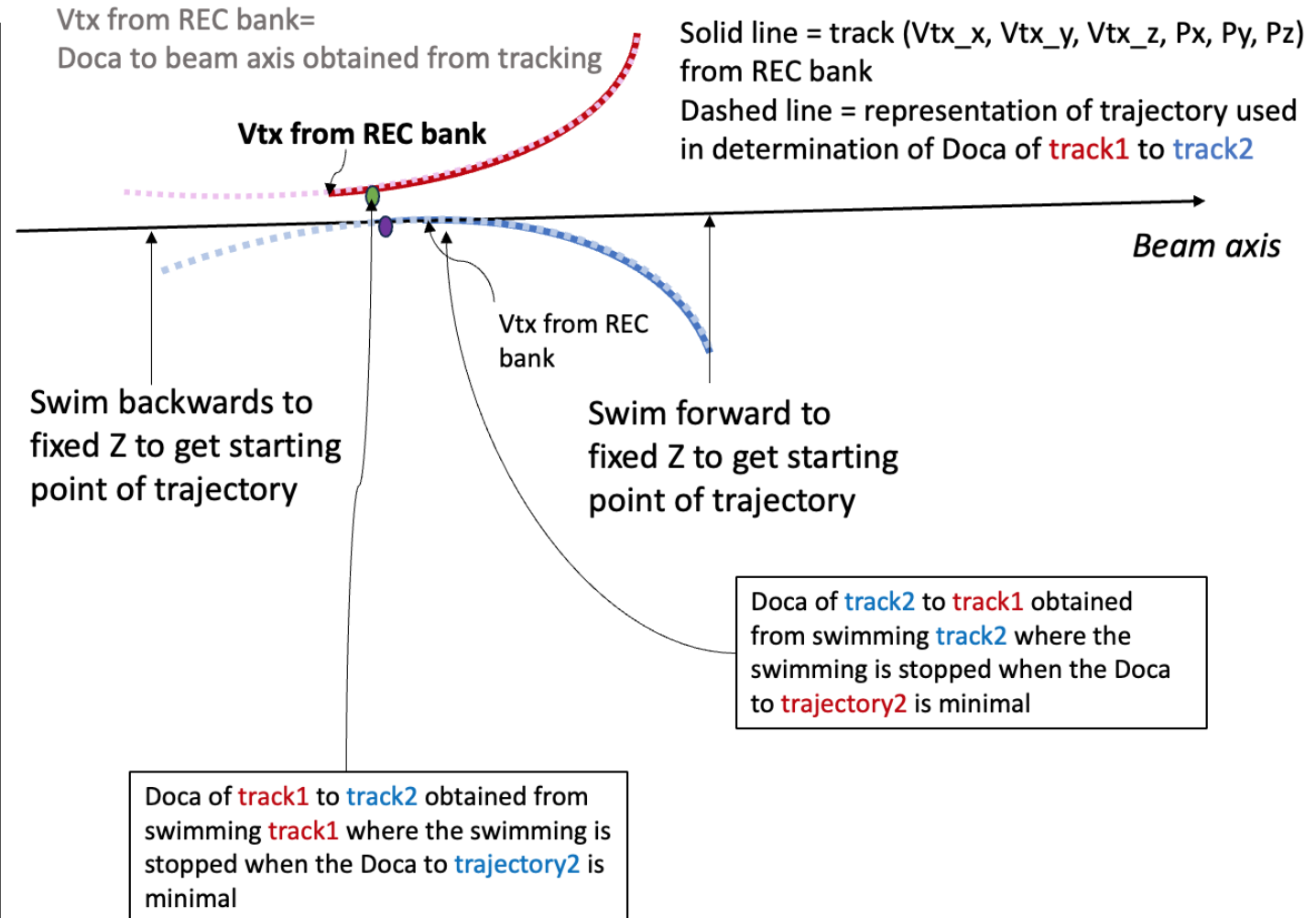
Veronique Ziegler



# Common Vertex Finder Service

- Service included in coatjava release
- Available for cooking
- Minimal impact on processing time

1. For each track
  1. Swim backwards to fixed Z to get starting point of trajectory
  2. Swim forward to fixed Z to get starting point of trajectory
2. Compute Doca of track2(1) to track1(2) obtained from swimming track2(1) where the swimming is stopped when the Doca to trajectory2(1) is minimal
3. Compute r as the distance between the so-obtained doca points of each track



# Common Vertex Finder

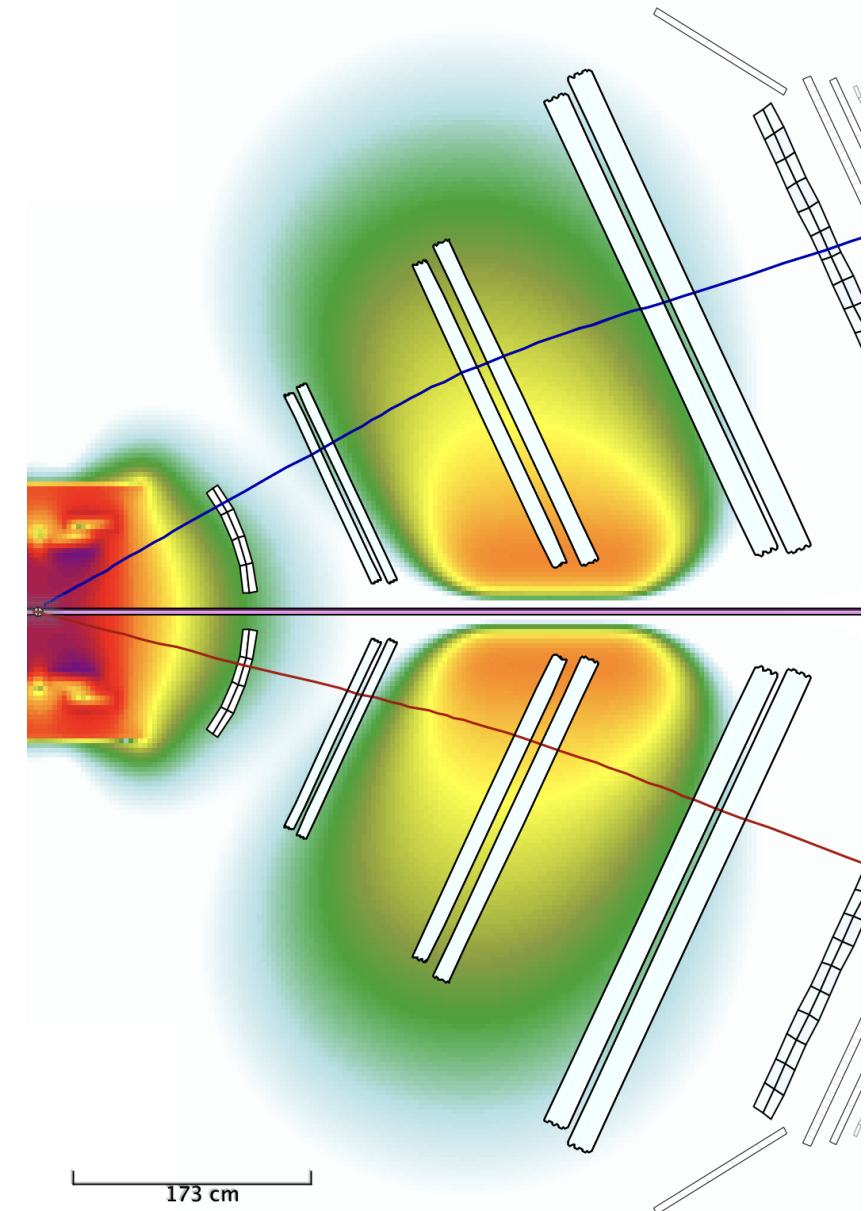
REC::Track								
next prev seq # 2 true # 2								
	NDF	detector	hbindx	index	pindex	q	sector	status
0	30	6	0	0	0	-1	1	1
1	28	6	1	1	1	1	3	4

REC::VertDoca																		
next prev seq # 2 true # 2																		
	index1	index2	r	x	y	z	x1	y1	z1	cx1	cy1	cz1	x2	y2	z2	cx2	cy2	cz2
0	0	1	0.57050	0.12416	-0.65620	-0.60546	0.02383	-0.92134	-0.57386	2.22140	0.13434	5.01505	0.22449	-0.39106	-0.63707	-1.13472	1.39699	3.02662

- Run service as last in YAML,
- Can be run on DST's post-processing or as part of the “cooking”
- If running stand-alone, needs MagField service

```
io-services:
  reader:
    class: org.jlab.io.clara.HipoToHipoReader
    name: HipoToHipoReader
  writer:
    class: org.jlab.io.clara.HipoToHipoWriter
    name: HipoToHipoWriter
  services:
    - class: org.jlab.clas.swimtools.MagFieldsEngine
      name: MAGFIELDS
    - class: org.jlab.rec.service.vtx.VTXEngine
      name: VTX
  configuration:
    global:
      variation: rga_fall2018
      # timestamp: 12/31/2020-00:00:00
      # triggerMask: "0x1"
      ## uncomment the following two lines for compatibility with alignments before th
      # dcMinistagger: "NOTONREFWIRE"
      # dcFeedthroughs: "OFF"
      # io-services:
      #   writer:
      #     schema_dir: "absolute-path-to-schema-folder"
      #     for example:
      #     schema_dir: "/home/clas12-1/chef/myClara/plugins/clas12/etc/bankdefs/dst"
    services:
      MAGFIELDS:
        magfieldSolenoidMap: Symm_solenoid_r601_phi1_z1201_13June2018.dat
        magfieldTorusMap: Full_torus_r251_phi181_z251_25Jan2021.dat

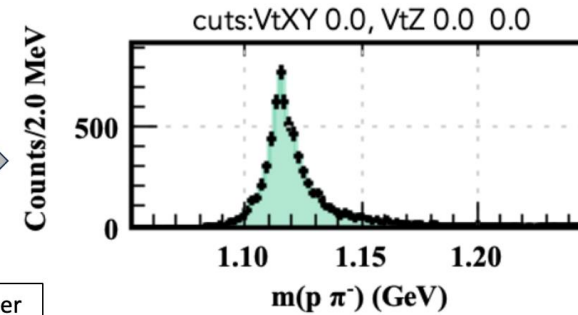
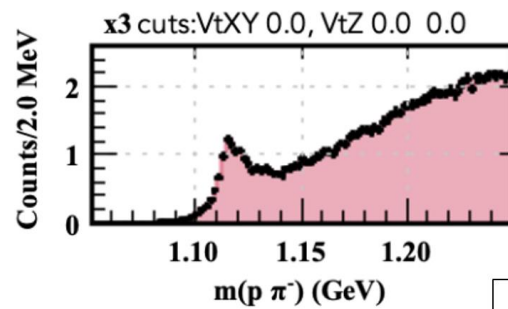
mime-types:
  - binary/data-hipo
```



# Use of Common Vertex Finder in Strangeness Production Studies with $\Lambda$ 's

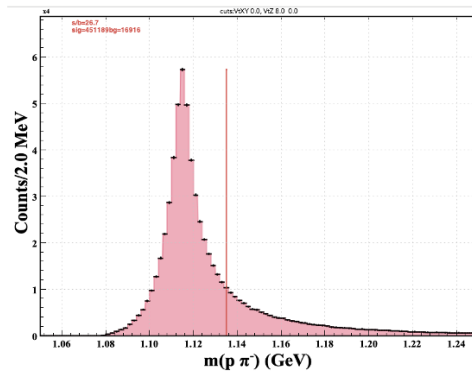
## Reconstructed $\Lambda \rightarrow p\pi^-$

- Using displaced vertex reconstruction

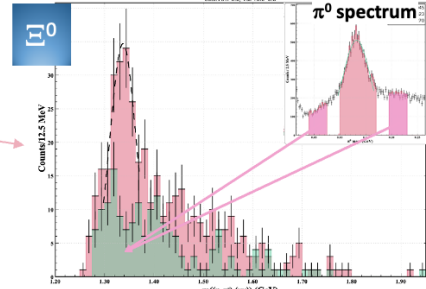
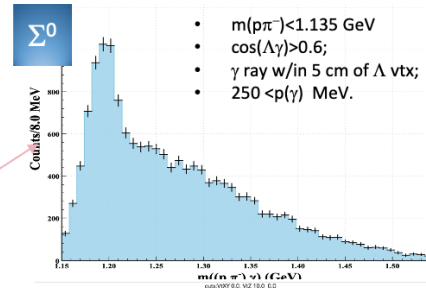


~ no loss in number of signal events

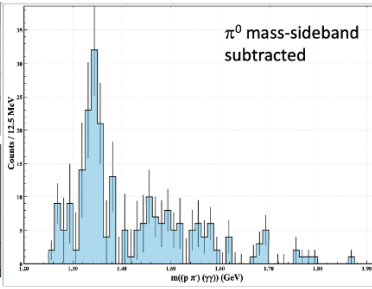
- Clean reconstructed invariant mass spectrum



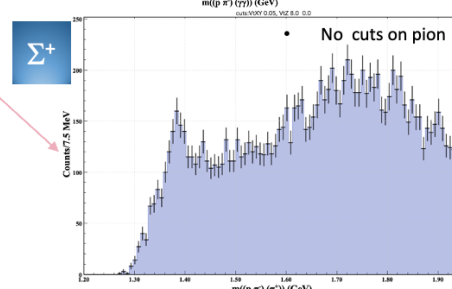
+  $\gamma$



+  $\pi^0$



+  $\pi^+$



















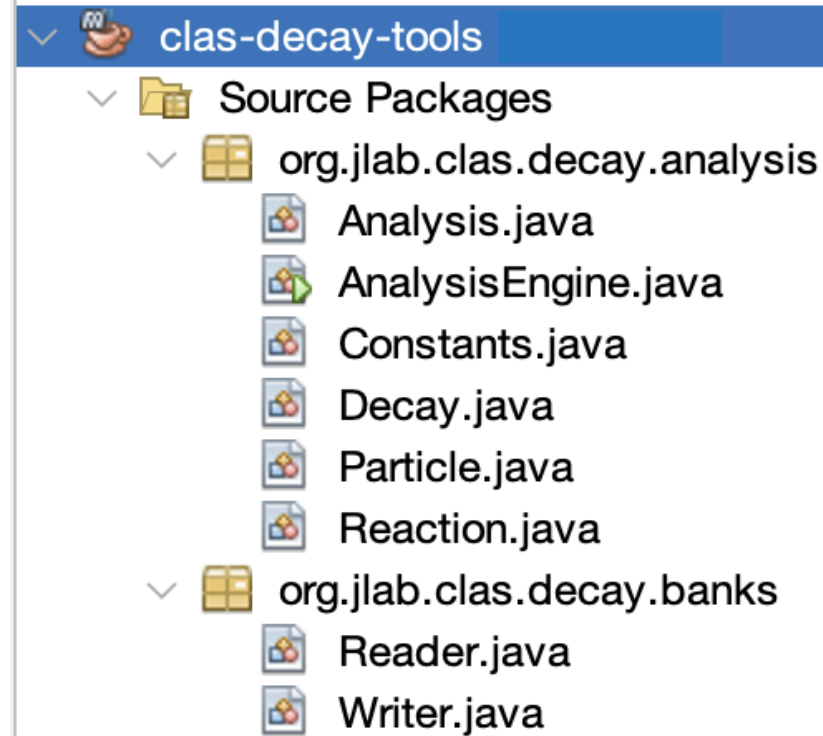
- No cuts on pion

- Study hyperons properties with higher precision  
→ decay products track parameters at decay vertex

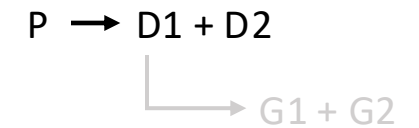
# Analysis Tool to Reconstruct Decays

Look In:  common-tools

- >  clara-io
- >  clas-analysis
- >  clas-decay-tools
- >  clas-detector
- >  clas-geometry
- >  clas-io
- >  clas-jcsg
- >  clas-logging
- >  clas-math
- >  clas-physics
- >  clas-reco
- >  clas-tracking
- >  clas-utils
- >  cnuphys
- >  coat-lib
- >  swim-tools



- Tool to store information of reconstructed decays



- Reads reconstructed 2-track common vertex bank (REC::VertDoca)
  - Doca
  - Corrected momentum at vertex
  - Common vertex
  - PID
- If REC::VertDoca bank non-existent, runs common vertex finder algorithm

# Decays Output Bank Rows Layout



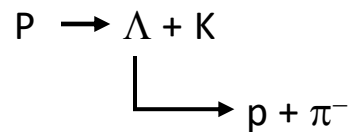
Rows ordering:

- P
- D1
- G1
- G2
- K

Track combinations:

- 2 charged tracks ✓
- 1 charged track + 1 neutral tracks
- 2 neutral tracks

E.g



	idx	ndau	dau1idx	dau2idx	pid
0	200	2	100	4	999
1	100	2	1	3	3122
2	1	0	0	0	2212
3	3	0	0	0	-211
4	4	0	0	0	321

...

py	pz	r	vx	vy	vz
0.22372	4.11822	1.10521	0.23421	-0.2929	-0.0894
0.37817	3.31521	0.69567	0.51442	-0.5953	-0.4573
-0.01355	2.21961	0.0	0.70460	-0.7271	-0.7171
0.39171	1.09560	0.0	0.32424	-0.4635	-0.1976
-0.15444	0.80301	0.0	-0.04599	0.00949	0.27857



# Bank Structure

```
{
  "name": "DECAYS::Particle",
  "group": 900,
  "item" : 11,
  "info": "Reconstructed Particle Information",
  "entries": [
    {"name": "idx", "type": "S", "info": "particle idx"},
    {"name": "pid", "type": "I", "info": "particle id in LUND conventions"},
    {"name": "emc", "type": "F", "info": "particle mass constrained energy"},
    {"name": "erec", "type": "F", "info": "reconstructed particle energy"},
    {"name": "e", "type": "F", "info": "analysis particle energy (sum of constrained energies of daughters"},
    {"name": "ovx", "type": "F", "info": "x component of the vertex at the production vertex (cm)"},
    {"name": "ovy", "type": "F", "info": "y component of the vertex at the production vertex (cm)"},
    {"name": "ovz", "type": "F", "info": "z component of the vertex at the production vertex (cm)"},
    {"name": "px", "type": "F", "info": "x component of the momentum (GeV)"},
    {"name": "py", "type": "F", "info": "y component of the momentum (GeV)"},
    {"name": "pz", "type": "F", "info": "z component of the momentum (GeV)"},
    {"name": "upx", "type": "F", "info": "x component of the uncorrected momentum at the vertex (GeV)"},
    {"name": "upy", "type": "F", "info": "y component of the uncorrected momentum at the vertex (GeV)"},
    {"name": "upz", "type": "F", "info": "z component of the uncorrected momentum at the vertex (GeV)"},
    {"name": "vx", "type": "F", "info": "x component of the vertex (cm)"},
    {"name": "vy", "type": "F", "info": "y component of the vertex (cm)"},
    {"name": "vz", "type": "F", "info": "z component of the vertex (cm)"},
    {"name": "r", "type": "F", "info": "distance between helices for 2-particle decay (cm)"},
    {"name": "charge", "type": "B", "info": "particle charge"},
    {"name": "mass", "type": "F", "info": "particle mass (GeV)"},
    {"name": "umass", "type": "F", "info": "particle uncorrected mass (GeV)"},
    {"name": "ndau", "type": "B", "info": "number of daughters"},
    {"name": "dau1idx", "type": "S", "info": "daughter 1 idx"},
    {"name": "dau2idx", "type": "S", "info": "daughter 2 idx"},
    {"name": "dau3idx", "type": "S", "info": "daughter 3 idx"},
    {"name": "det", "type": "B", "info": "det=0 for central, det=1 for forward tracker"}
  ]
}
```

Look In: hipo4

alert.json	dcnn.json	htcc.json	rtpc.json
band.json	decays.json	ltcc.json	tof.json
bmt.json	ecal.json	mc.json	urwell.json
bst.json	event-ai.json	neuralnetwork.json	
cnd.json	event.json	raster.json	
cvt.json	fmt.json	README.md	
data.json	ft.json	recoil.json	
dc.json	header.json	rich.json	

# DECAYS Service YAML File

```
io-services:
  reader:
    class: org.jlab.io.clara.HipoToHipoReader
    name: HipoToHipoReader
  writer:
    class: org.jlab.io.clara.HipoToHipoWriter
    name: HipoToHipoWriter
services:
  - class: org.jlab.clas.swimtools.MagFieldsEngine
    name: MAGFIELDS
  - class: org.jlab.clas.decay.analysis.AnalysisEngine
    name: DECAYS
  - class: org.jlab.clas.decay.analysis.AnalysisEngine
    name: DECAYS2
configuration:
  global:
    variation: rga_fall2018
#   timestamp: 12/31/2020-00:00:00
#   triggerMask: "0x1"
io-services:
  writer:
    compression: 2
#   schema_dir: "absolute-path-to-schema-folder"
#   for example:
    schema_dir: "/Users/ziegler/BASE/Analysis/Analysis/coatjava/etc/bankdefs/hipo4/"
services:
  MAGFIELDS:
    magfieldSolenoidMap: Symm_solenoid_r601_phi1_z1201_13June2018.dat
    magfieldTorusMap: Full_torus_r251_phi181_z251_25Jan2021.dat
  DECAYS:
    pass: "1"
    decays: "3122:2212:-211:0:1.05:1.75"
  DECAYS2:
    pass: "2"
    decays: "996:3122:22:0:1.05:11.0"
mime-types:
  - binary/data-hipo
```

D1 → G1 + G2

P → D1 + D2

Uses PDG codes:

D1:G1:G2:G3:P lower mass: P upper mass

P:D1:D2:D3:P lower mass: P upper mass

- 3-body decay → still needs validation



# Grapes Updates

- New skim for analyses using reconstructed  $\Lambda \rightarrow p \pi^-$  events
- Lambda events filtering (Yuri Gotra):

Lambda skims are separated based on the following cuts:

- 1) No **RECFT::Particle** bank, trigger electron in **REC::Particle** bank, , particles with PID=2212 and -211 are present
- 2) Trigger electron in **RECFT::Particle** bank, particles with PID=2212 and -211 are present
- 3) First (trigger) particle in **REC::Particle** bank is not electron (positron or pion), particles with PID=2212 and -211 are present

In RG-A Spring 2018 inbending the combined size of 3 skims is 8.5% (50 nA runs)

In RG-A Spring 2018 outbending the combined size of 3 skims is 13% (40 nA runs)

YAML:

- class: org.jlab.jnp.grapes.services.LambdaWagon  
name: LAMBDA1
- class: org.jlab.jnp.grapes.services.LambdaWagon  
name: LAMBDA2
- class: org.jlab.jnp.grapes.services.LambdaWagon  
name: LAMBDA3

configuration:

services:

LAMBDA1:

id: 1

forward: 11:2212:-211:X+:X-:Xn

LAMBDA2:

id: 2

tagger: 11:2212:-211:X+:X-:Xn

LAMBDA3:

id: 3

noetrig: 11:2212:-211:X+:X-:Xn

[REC::Particle]										
pid :	-11	2212	0	2112	2112	2112	2112	2112	2112	22
status :	-2231	4100	2000	2010	2010	2010	4130	4100	2010	2010
charge :	1	1	1	0	0	0	0	0	0	0

wagon #1

[RECFT::Particle]										
pid :	11	-211	11	11	2212	211	22			
status :	2221	2220	1110	-1110	2100	2100	2010			
[REC::Particle]										
pid :	11	-211	11	11	2212	211	22			
status :	-2221	2220	1110	1110	2100	2100	2010			
charge :	-1	-1	-1	-1	1	1	0			

wagon #2

[REC::Particle]										
pid :	211	-211	11	211	22	22	22	2112		
status :	-2200	2210	1110	2230	2020	2010	2010	2010		
charge :	1	-1	-1	1	0	0	0	0		

wagon #3

# Summary and Outlook

- Common Vertex Finder service available in current release used for cooking – should be included in data processing YAML
- Decays reconstruction service available
  - Sequential decays (multiple sequential decays still in development)
  - Combinations of charged tracks validated
    - Used for Lambda analyses I presented at previous meetings
  - Combinations of charged+neutral or neutral+neutral tracks → validations needed
  - 3-body decays implemented → validations needed
  - Most analyses that would use the Decays service need combination of charged tracks → test using other channels besides  $\Lambda$ 's. Used for Beam Spot calibration analysis (Derek Holmberg).
- Lambda skim in trains – to be included in upcoming data cooking(s)