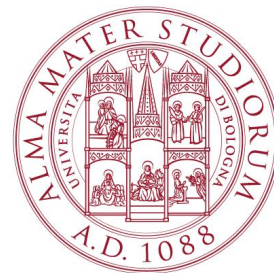


p-p femtoscopy in Run3 pp collisions in ALICE

Neelima Agrawal

Femto-Workshop meeting
23 Jan 2023



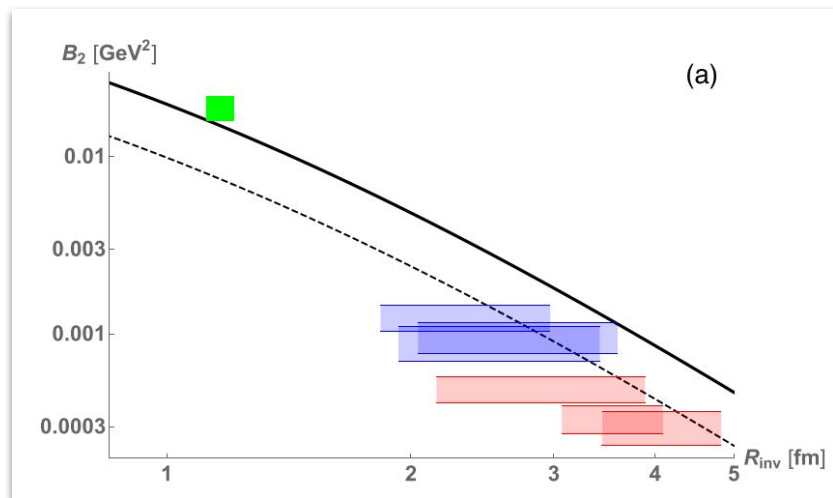
Motivation: femtoscopy

- Our main goal is to use the **coalescence models** to extract the information on nuclei/anti-nuclei formation processes. For these models, it is **important to know the emission source size**
- For example, the **coalescence factor** for a **Deuteron formation** can be calculated as - (F.Bellini, et al, *PRC 103, 014907 (2021)*)

$$B_2(p) \approx \frac{2(2s_d + 1)}{m(2s_N + 1)^2} (2\pi)^3 \int d^3\mathbf{r} |\phi_d(\mathbf{r})|^2 \mathcal{S}_2(\mathbf{r}).$$

Related to the probability to form a (anti)nucleus from nucleons

Femtoscopic correlation function



- Our interest is to measure **emission source size and anti-nuclei production for the same event classes** in pp @13.6 TeV and 900 GeV

Motivation: femtoscopy

- Our interest is to study with coalescence model the formation of **(anti-)He³**
- We are willing to perform the Femtoscopy measurements on proton and deuteron in Run3 data, as **(anti-)He³ = (anti)p + (anti)d**
- It needs two candidate: (anti)p & (anti)d
- Exists a track-track correlation task inside O2-CF framework under FemtoDream package
- Started with proton candidate, e.g **p-p (anti-p - anti-p) correlation** and obtained the Correlation function distributions for Run3 dataset in **pp@900 GeV (pilot beam) and 13.6 TeV data**
- Waiting for good PID for deuteron, will be added to the task at later stage for **(anti-)He³** study
- We use the standard way to define the correlation function from the experiment,
 $C(k^*) = \text{same event pair relative momentum distribution} / \text{mixed event pair relative momentum distribution}$

Analysis details: Event and track selection

- **Event Selection**

- $V_z \leq 10$ cm
- sel8 cuts (Event selection decision based on collision time provided by T0A & T0C (TVX))

- **Track selection: for proton candidate**

- charged track, +ve charge, -ve
- Transverse momentum: 500 MeV to 4.05 GeV
- Pseudorapidity, $|\eta| < 0.8$
- Min TPC cluster: > 80
- min crossed rows/findable cluster: 0.8
- crossed TPC rows: > 70
- TPC shared cluster: not selected
- no ITS cluster selection
- no ITS cluster in the inner barrel selection
- $DCA_{xy} < 0.1$ cm
- $DCA_z < 2$ cm

Bitmask from **CutCulator**: 168072266 (168072265)

Analysis details: PID and analysis parameters

- **PID selection**

- information from TPC and TOF
- 3σ selection
- $p_T \leq 1000$ MeV - TPC only
- $p_T > 1000$ MeV - combined TOF with TPC

- **Analysis parameters**

Nmix: 5 events

- Vz: 2 cm bin width
- multiplicity mixing bins: [0,4,8,12,16,20,24.....100, >100]

Analysis details: Task setup, producer task

Wagon settings

Configuration **1**

Derived data

Test Statistics

Latest change by
at **10/01/23, 15:!**

Name

my_producer

Work flow name

o2-analysis-cf-femtodream-producer

Dependencies

Core Service Wagons/TimestampCreator x

Core Service Wagons/PIDTPC x

Core Service Wagons/Multiplicity_Run3_pp x

Core Service Wagons/EventSelection_Run3_pp x

Core Service Wagons/LambdaKzeroBuilder_Run3_pp x

Core Service Wagons/TrackPropagation x

Core Service Wagons/TrackSelection_Run3 x

Core Service Wagons/PIDTOFRun3 x

collisionblabla x

Analysis details: Task setup, producer task

femto-dream-producer-task			
processData	 	1	
processMC	 	0	
ConfDaughEta	 	0.8	
ConfDebugOutput	 	1	
ConfEvtOfflineCheck	 	1	
ConfEvtTriggerCheck	 	1	
ConfEvtTriggerSel	 	0	
ConfEvtZvtx	 	10	
ConfInvKaonMassLowLimit	 	0.48	
ConfInvKaonMassUpLimit	 	0.515	
ConfInvMassLowLimit	 	0	
ConfInvMassUpLimit	 	100	
ConfIsMC	 	0	

ConfIsRun3	 	1	
ConfIsTrigger	 	0	
ConfRejectITSHitandTOFMissing	 	0	
ConfRejectKaons	 	0	
ConfRejectNotPropagatedTracks	 	0	
ConfStoreV0	 	1	
ConfTrkDCAxyMax	 	0.1	
		3.5	 
ConfTrkDCAzMax	 	0.2	
		3.5	 
ConfTrkEtaMax	 	0.8	
		0.7	
		0.9	 
ConfTrkITSnClsIbMin	 	-1	
		1	 

Analysis details: Task setup, producer task

ConfTrkITSnClsMin	 	-1	-
		2	-
		4	- +
ConfTrkPIDnSigmaMax	 	3.5	-
		3	-
		2.5	- +
ConfTrkPIDnSigmaOffsetTOF	 	0	
ConfTrkPIDnSigmaOffsetTPC	 	0	
ConfTrkPtMax	 	5.4	-
		5.6	-
		5.5	- +
ConfTrkPtMin	 	0.4	-
		0.6	-
		0.5	- +
ConfTrkSign	 	-1	-
		1	- +

ConfTrkTPCcRowsMin	 	70	-
		60	-
		80	- +
ConfTrkTPCfClsMin	 	0.7	-
		0.8	-
		0.9	- +
ConfTrkTPCnClsMin	 	80	-
		70	-
		60	- +
ConfTrkTPCsClsMax	 	0.1	-
		160	- +
ConfTrkTPIDspecies	 	2	-
		4	- +
ConfV0CPAMin	 	0.9	-
		0.995	- +
ConfV0DaughCharge	 	-1	-
		1	- +

Analysis details: Task setup, producer task

ConfV0DaughDCAMin	 	0.05	-
		0.06	- +
ConfV0DaughPIDnSigmaMax	 	5	-
		4	- +
ConfV0DaughTPCnclsMin	 	80	-
		70	-
		60	- +
ConfV0DaughTPIDspecies	 	2	-
		4	- +
ConfV0DCAdaughMax	 	1.2	-
		1.5	- +
ConfV0DecVecMax	 	100	+
ConfV0PtMin	 	0.3	-
		0.4	-
		0.5	- +
ConfV0Sign	 	-1	-

Analysis details: Task setup, Train configuration

femto-dream-pair-task-track-track

processMixedEvent	 	1
processSameEvent	 	1
CfgkstarBins	 	Fixed Width Bins 1500 Min 0 Max 6
CfgkTBins	 	Fixed Width Bins 150 Min 0 Max 9
CfgmTBins	 	Fixed Width Bins 225 Min 0 Max 7.5
CfgMultBins	 	Variable Width 0,4,8,12,16,20,24,28,32,36,40,44,48,52,56,60,64,68,72,76,80,84,88,92,96,100,200,99999

CfgVtxBins	 	Variable Width -10,-8,-6,-4,-2,0,2,4,6,8,10																					
ccfgNspecies	 	2																					
cfgCutTable	 	<table border="1"> <thead> <tr> <th></th> <th>#</th> <th>MaxPt</th> <th>PIDthr</th> <th>nSigmaTPC</th> <th>nSigmaTPCTOF</th> <th>MaxP</th> </tr> </thead> <tbody> <tr> <td>PartOne</td> <td>5.5</td> <td>1</td> <td>3</td> <td>3</td> <td></td> <td>100</td> </tr> <tr> <td>PartTwo</td> <td>5.5</td> <td>1</td> <td>3</td> <td>3</td> <td></td> <td>100</td> </tr> </tbody> </table>		#	MaxPt	PIDthr	nSigmaTPC	nSigmaTPCTOF	MaxP	PartOne	5.5	1	3	3		100	PartTwo	5.5	1	3	3		100
	#	MaxPt	PIDthr	nSigmaTPC	nSigmaTPCTOF	MaxP																	
PartOne	5.5	1	3	3		100																	
PartTwo	5.5	1	3	3		100																	
ConfCPRPlotPerRadii	 	0																					
ConfCutPartOne	 	1344578122																					
ConfCutPartTwo	 	1344578122																					
ConfIsCPR	 	1																					
ConfIsSame	 	0																					
ConfNEventsMix	 	5																					
ConfPDGCodePartOne	 	2212																					

Analysis details: Task setup, Train configuration

ConfPDGCodePartTwo			2212
ConfPIDnSigmaMax			3.5
			3
			2.5
ConfPIDPartOne			1
ConfPIDPartTwo			1

Data set: LHC22f, pass2, pp@13.6 TeV

- **Data set:**

Energy: pp@13.6 TeV,

Reco pass: pass2

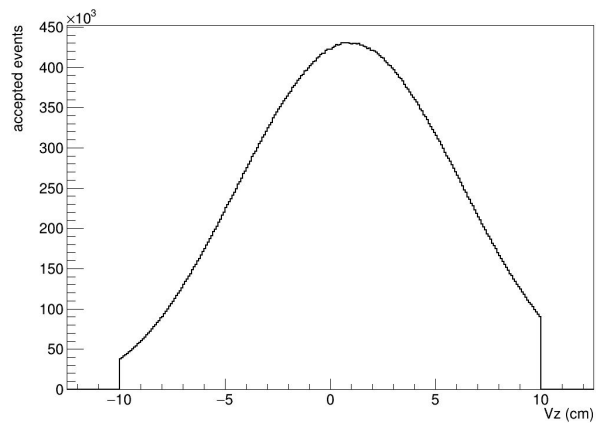
1. **LHC22f_pass2**

Runlist: 520259, 520294, 520471, 520472, 520473

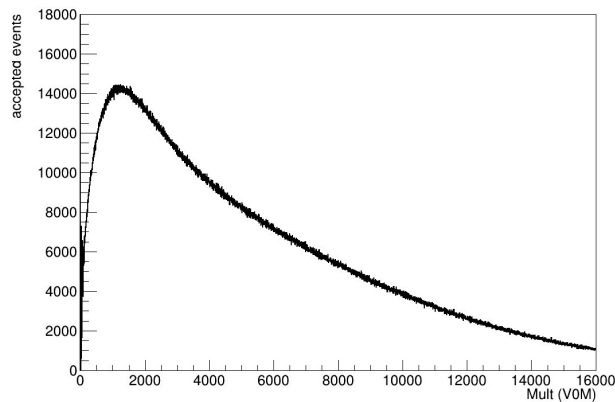
~ **62.76M** events selected

- **Total ~62.76M** events

Event QA: LHC22f, pass2, pp@13.6TeV

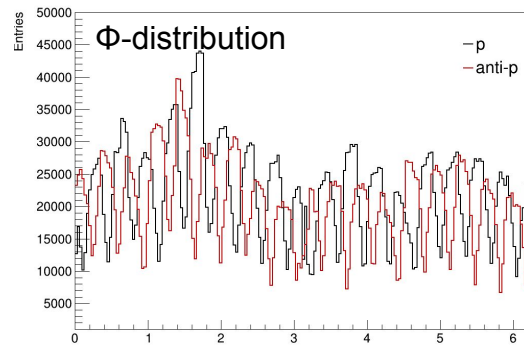
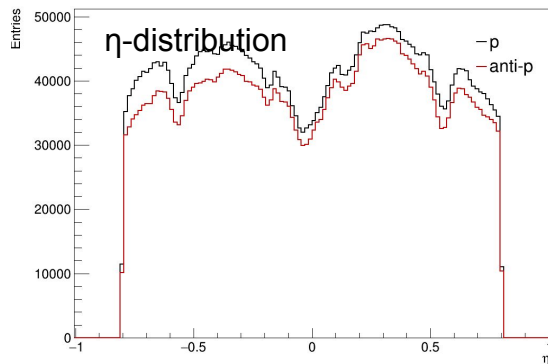
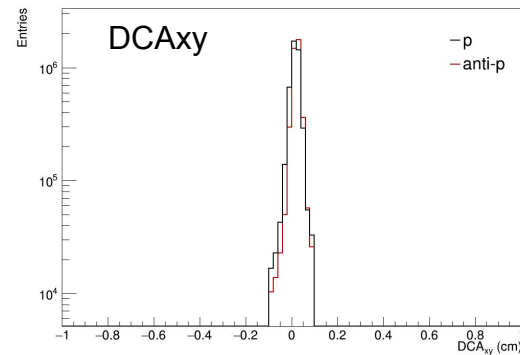
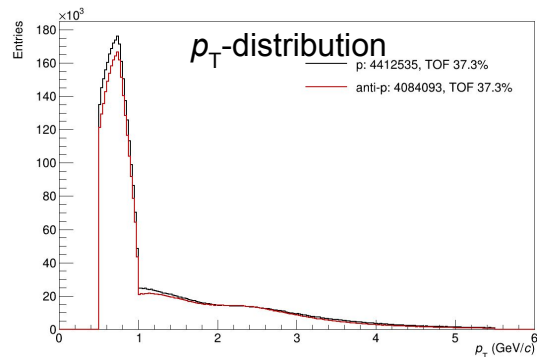


Total selected events: 62.76M

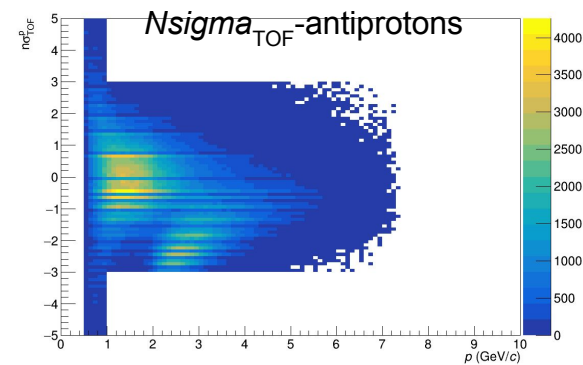
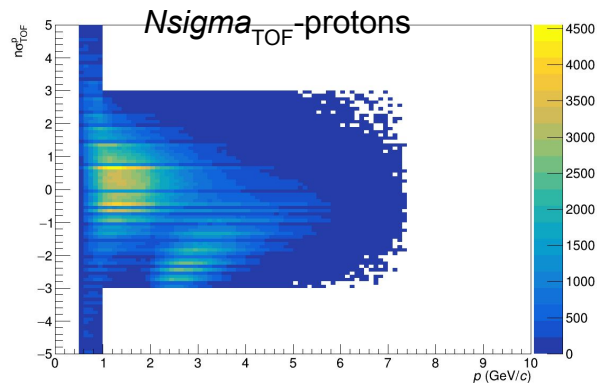
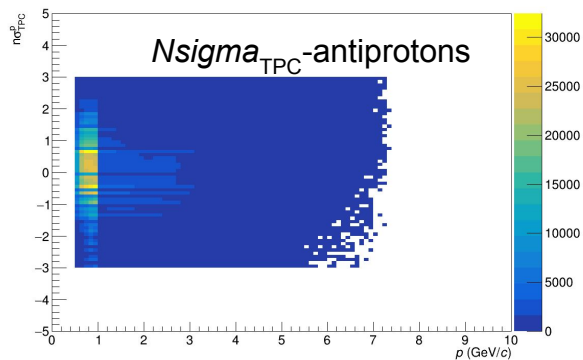
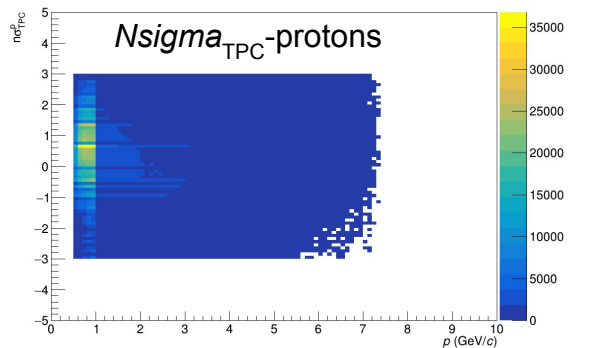


Multiplicity: V0M

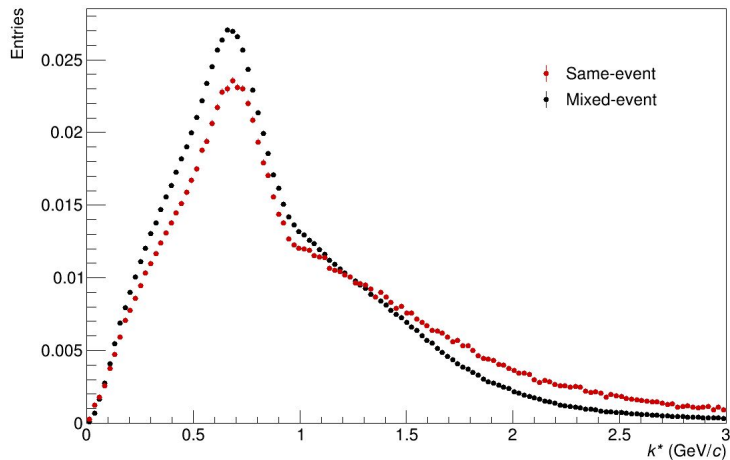
Proton QA: LHC22f, pass2, pp@13.6TeV



Proton QA: LHC22f, pass2, pp@13.6TeV



p-p, k^* dist: LHC22f, pp@13.6TeV

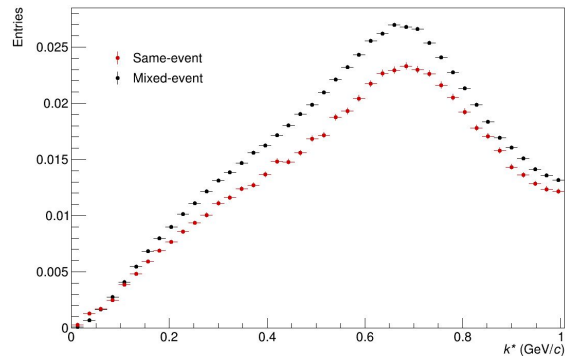


$$k^* = \frac{1}{2} \cdot |\mathbf{p}_1^* - \mathbf{p}_2^*|$$

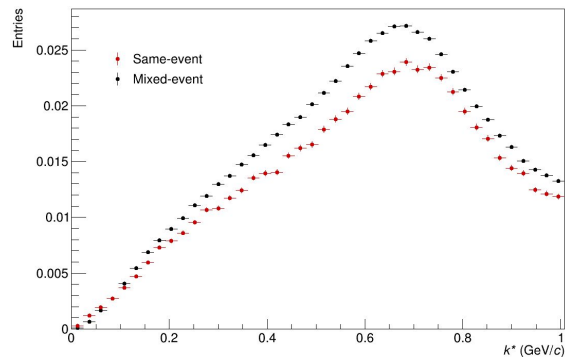
With $\mathbf{p}_1^*$, $\mathbf{p}_2^*$ = momentum of 1st and 2nd particle in pair rest frame

$$k^* \in [0.24, 0.34] \text{ GeV}$$

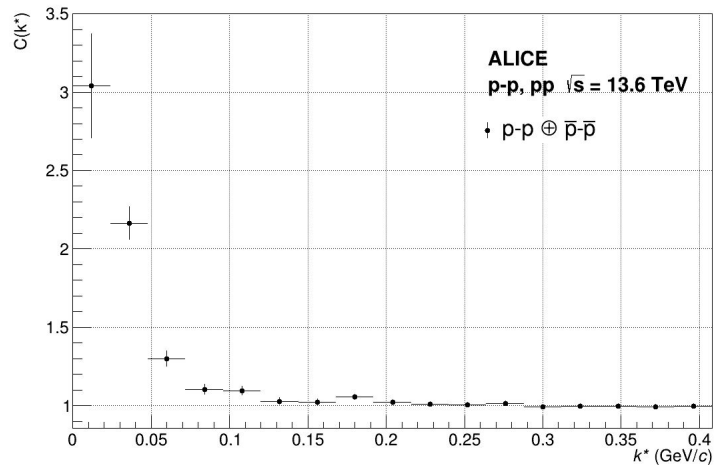
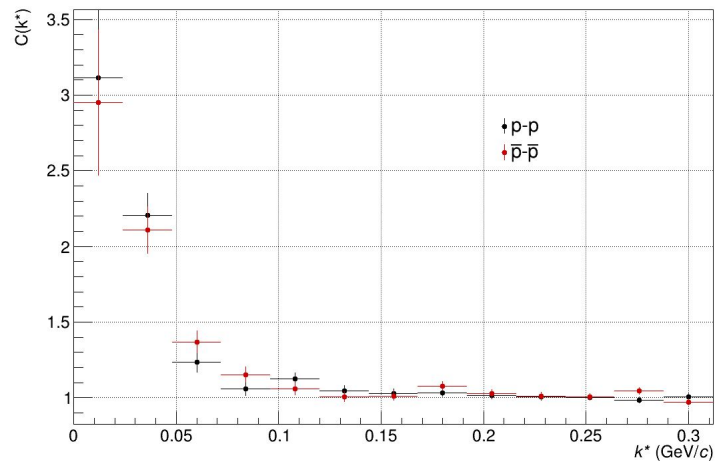
Proton case



Antiproton case



pp correlation function: LHC22f, pp@13.6 TeV



Summary

- Using a dedicated track QA task (o2-analysis-cf-femtodream-debug-track) in the hyperloop task
- mixing part of the events: finer multiplicity bins than default
- Improved PID on protons from TPC and TOF information in apass2 compared to apass1 data
- Waiting for pass2 of the whole run 2 data set for improved tracking and PID information
- Please provide your feedback on the analysis and analysis setup

Backup

Data set: LHC22t, pp@13.6 TeV

- **Data set:**

Energy: pp@13.6 TeV,

Reco pass: pass1

1. **LHC22t_pass1_subset**

Runlist: 529690

~ **2.4B** events selected

- **Total ~2.4B** events

Data set: LHC22p, pp@13.6 TeV

- **Data set:**

Energy: pp@13.6 TeV,

Reco pass: pass1

1. **LHC22p_pass1**

Runlist: 528597, 528602, 528604, 528617, 528781, 528782, 528783, 528784, 528798, 528801

~ **28B** events selected

- **Total ~28B** events

Data set: LHC22r, pp@13.6 TeV

- **Data set:**

Energy: pp@13.6 TeV,

Reco pass: pass1

1. **LHC22r_pass1_subset**

Runlist: 529341

~ **1.465B** events selected

- **Total ~1.465B** events

Data set: LHC22q, pp@13.6 TeV

- **Data set:**

Energy: pp@13.6 TeV,

Reco pass: pass1

1. **LHC22q_pass1**

Runlist: 528991, 528997, 529035

~ **37.365M** events selected

- **Total ~37.365M** events

Data set: LHC22o, pp@13.6 TeV

- **Data set:**

Energy: pp@13.6 TeV,

Reco pass: pass1

1. **LHC22o_pass1_test**

Runlist: 527671, 527690, 527694, 527731, 527734, 527736, 527777

~ **23.23B** events selected

- **Total ~23.23B** events

Data set: LHC22f, pp@13.6 TeV

- **Data set:**

Energy: pp@13.6 TeV,

Reco pass: pass2

1. **LHC22f_pass2**

Runlist: 520259, 520294, 520471, 520472, 520473

~ **62.76M** events selected

- **Total ~62.76M** events

Data set: LHC22m, pp@13.6 TeV

- **Data set:**

Energy: pp@13.6 TeV,

Reco pass: pass1

1. **LHC22m_pass1_subset**

Runlist: 523393, 523397

~ **4.23B** events selected

- **Total ~4.23B** events