WHAT'S NEW IN TRACKING ?

A summary of the ATLAS Inner Detector Tracking Workshop 2025

Daniel Werner
DESY SM Meeting

03.06.2025

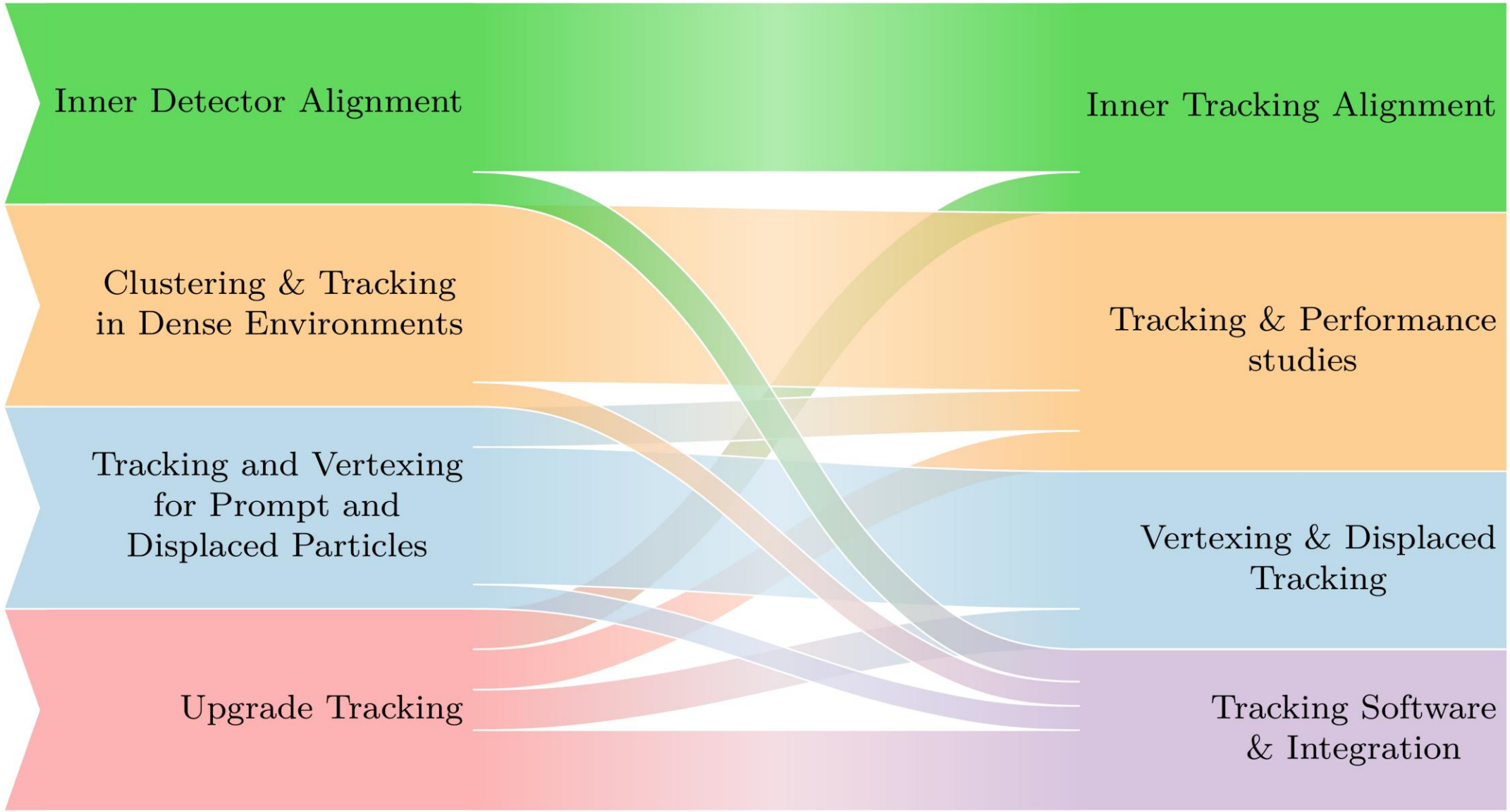
HELMHOLTZ

Overview

Agenda and Slides on Indico

- Day 1
  - Restructuring of subgroups
  - TVPD report
  - CTIDE report
- Day 2
  - ID and Itk status
  - Upgrade Tracking report
- Day 3
  - Alignment report
- Hands-on-Sessions

New Structure of Tracking Group



TVPD Activity report

Link to Slides

TVPD Activity report

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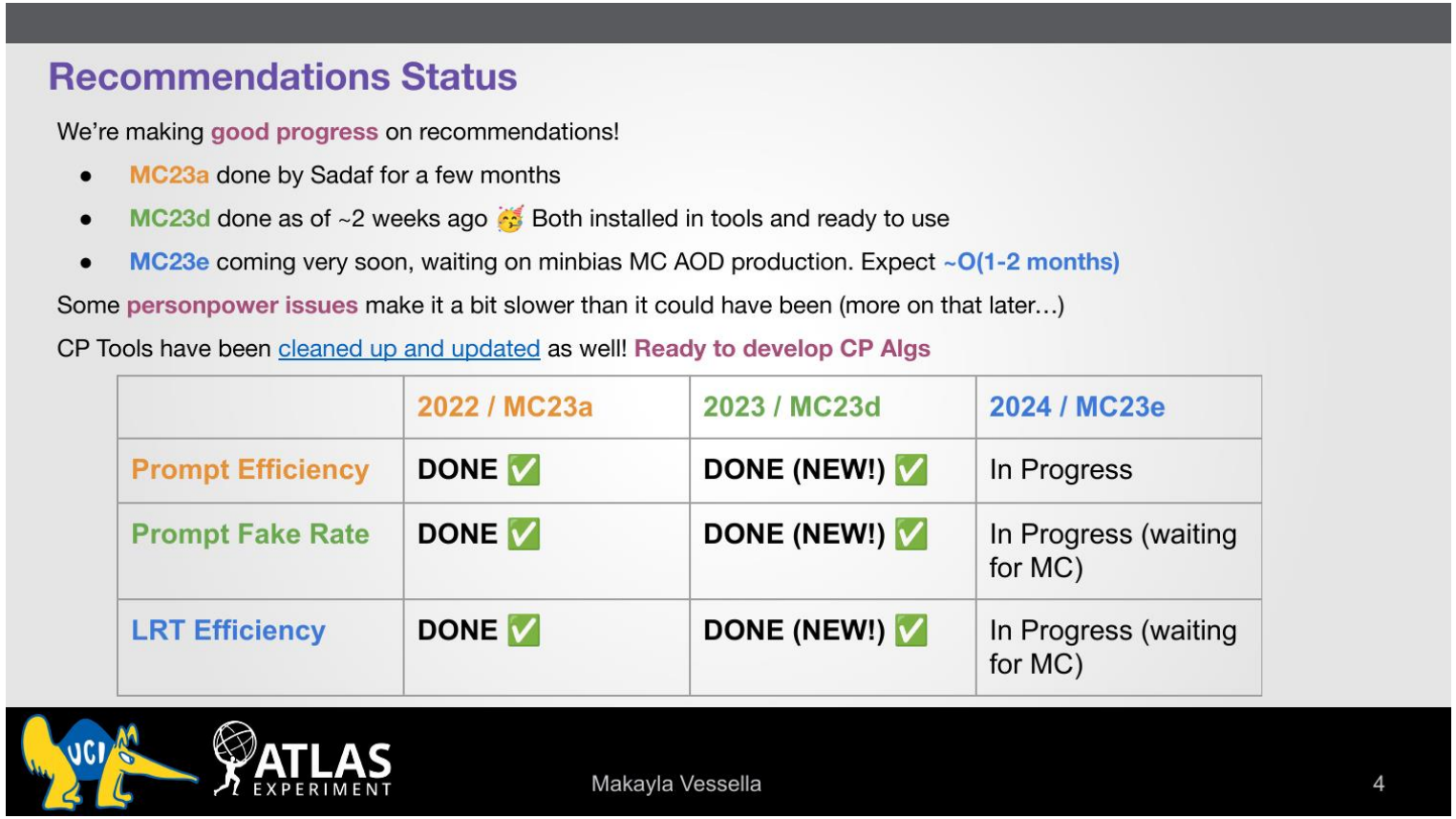
- New Recommendations



Recommendations Status

We're making **good progress** on recommendations!

- **MC23a** done by Sadaf for a few months
- **MC23d** done as of ~2 weeks ago 🥳 Both installed in tools and ready to use
- **MC23e** coming very soon, waiting on minbias MC AOD production. Expect **~O(1-2 months)**

Some **personpower issues** make it a bit slower than it could have been (more on that later…)

CP Tools have been cleaned up and updated as well! **Ready to develop CP Algs**

	2022 / MC23a	2023 / MC23d	2024 / MC23e
Prompt Efficiency	**DONE** ✅	**DONE (NEW!)** ✅	In Progress
Prompt Fake Rate	**DONE** ✅	**DONE (NEW!)** ✅	In Progress (waiting for MC)
LRT Efficiency	**DONE** ✅	**DONE (NEW!)** ✅	In Progress (waiting for MC)

UCI ATLAS EXPERIMENT Makayla Vessella 4

TVPD Activity report

Link to Slides

- New Recommendations
  - Issue with Fake rates in 2022

Recommendations Status

Prompt Fake Rate – MC23a/2022

Sadaf discovered that in 2022 data, the fake rate is NOT suppressed by Tight Primary as in all previous Run1+2. ***Very surprising and concerning!***

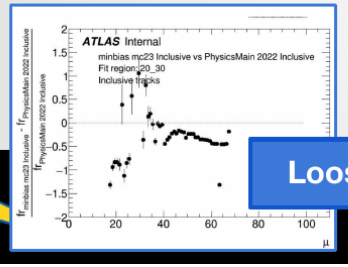
Some difficulties in selecting "fake free" linear fit as mu determination is… interesting at low mu for Run 3 even with strict GRL.

- End of fills etc., I checked on DQ side and nothing unusual, what we get is what we get…
- Already start to get contamination by the time we have stats

While very concerning, ultimately, this can't impact the tight recommendation as **already set at 100% drop rate** in the filter tool.

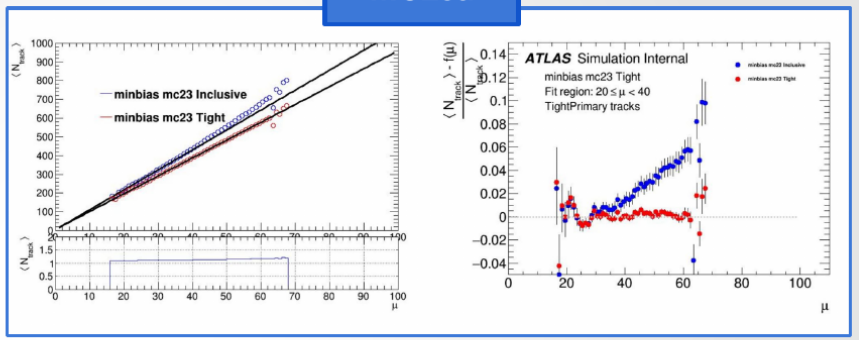
- Can't go higher as can't exactly **drop more fake tracks than exist** in the MC

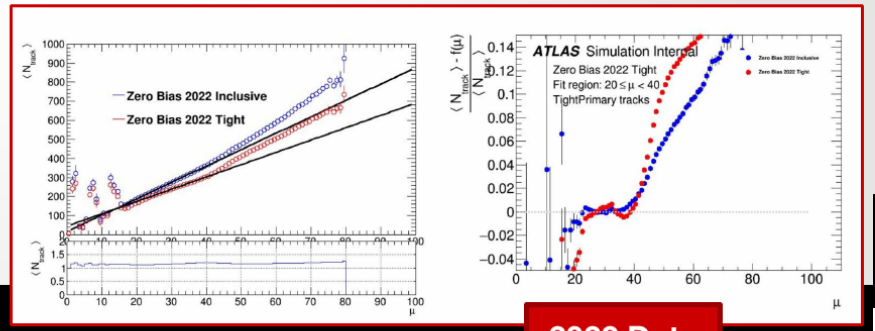
Determine inclusive/loose recommendation at 40% uncertainty – much more than Run 2.



Loose FR

MC23a





2022 Data

Makayla Vessella *Credit Sadaf Kadir* 10

TVPD Activity report

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  - ACTS Grid Seeder

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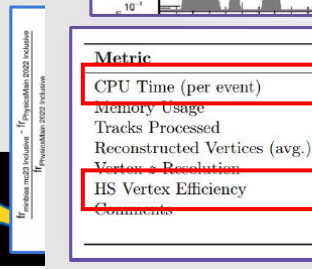


ACTS Grid Seeder in Athena

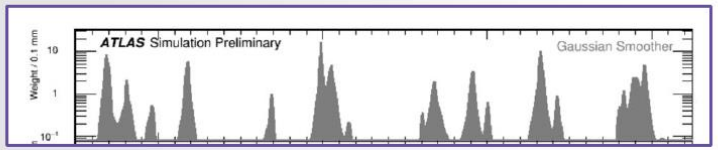
ACTS-based PV finding has been integrated into Athena since R22 – but only using the very precise **Gaussian seeder** which uses a **continuous density estim** along z

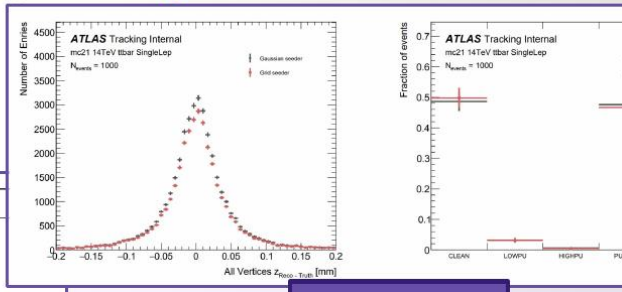
- **Very precise**, but computationally **more expensive** than some other seeding approaches

A **grid seeder** implementation also existed in ACTS, which uses **discretized bins in z and d_0** to identify seeds

- Now fully integrated into Athena by Lara and can be configured during PV reconstruction
- **~30% reduction** in **seeding CPU time** with **sub-1% reduction** in HS vertex reconstruction **efficiency**

Makes grid seeder available for **further performance studies** for Run 4! Let us know if you're interested 😁





Metric	Gaussian Seeder	Grid Seeder
CPU Time (per event)	0.45 s	0.30 s
Memory Usage	150 MB	120 MB
Tracks Processed	50,000	50,000
Reconstructed Vertices (avg.)	24.7	24.6
Vertex z-Resolution	15.2 μm	16.1 μm
HS Vertex Efficiency	99.2%	98.9%
Comments	Very precise, but higher CPU cost.	More efficient, slight loss in precision.

Run 4 ttbar

COMPLETE

Credit Lara Calic

Makayla Vessella

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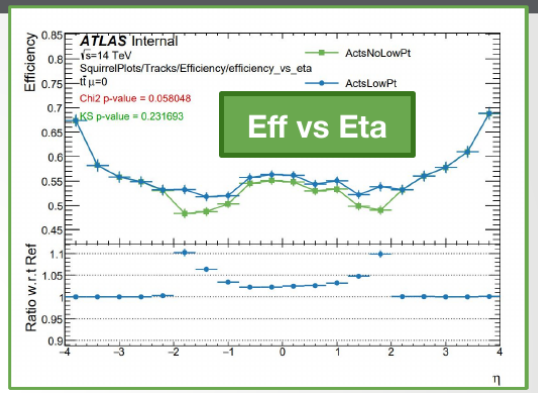
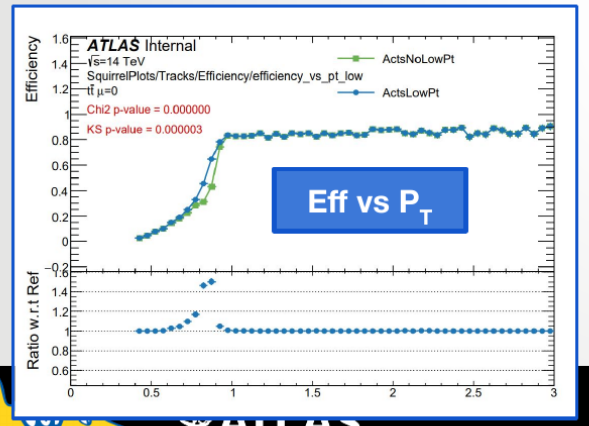
Low p_T tracking for ITk

The special **low p_T tracking** pass is already performing well in Legacy Athena for event filter workflows, but has **not yet been investigated and optimized for ACTS**

Daniel is now investigating the physics and CPU performance of the low p_T pass! Confirmed **working well** and now to evaluate and tune





ACTS track reconstruction

- **Main Pass** reconstructs most tracks from primary interaction
- **Specialized Passes** (e.g. Large Radius, Conversion, etc.)
- **LowPt Pass** focuses on low-p_T tracks in central region

$0 \le \lvert\eta\rvert < 2$	$2 \le \lvert\eta\rvert < 2.6$	$2.6 \le \lvert\eta\rvert < 4$
$\lvert d_0\rvert < 2$	$\lvert d_0\rvert < 2$	$\lvert d_0\rvert < 10$
$\lvert z_0\rvert < 200$	$\lvert z_0\rvert < 200$	$\lvert z_0\rvert < 200$
$p_T \ge 0.9$ GeV	$p_T \ge 0.4$ GeV	$p_T \ge 0.4$ GeV
$n_{hits} \le 9$	$n_{hits} \le 8$	$n_{hits} \le 7$
$n_{holes} \le 2$	$n_{holes} \le 2$	$n_{holes} \le 2$
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ATLAS EXPERIMENT

Makayla Vessella

Credit Daniel Werner

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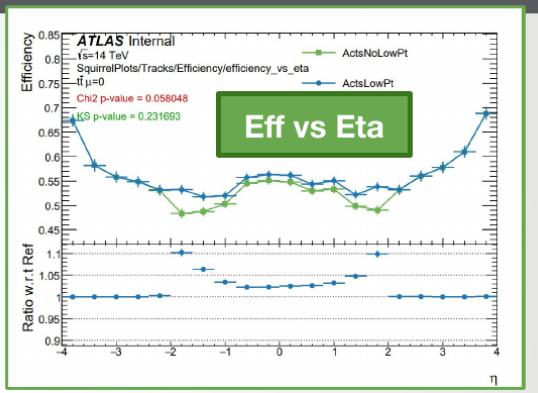

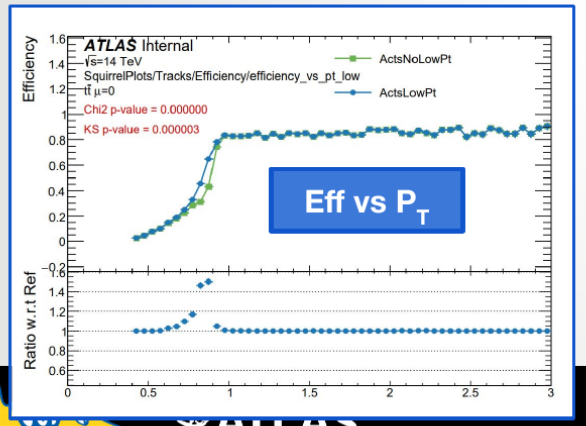

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ATLAS EXPERIMENT Makayla Vessella *Credit Daniel Werner* 16

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ACTS Grid Seeder in Athena

Low p_T tracking for ITk

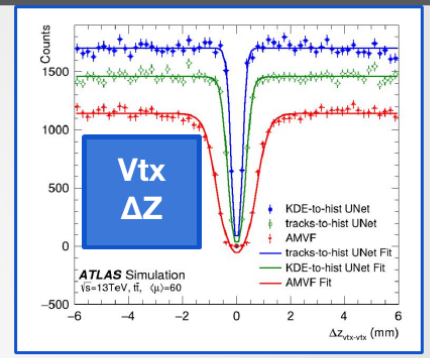
Ongoing activities: PV Finder

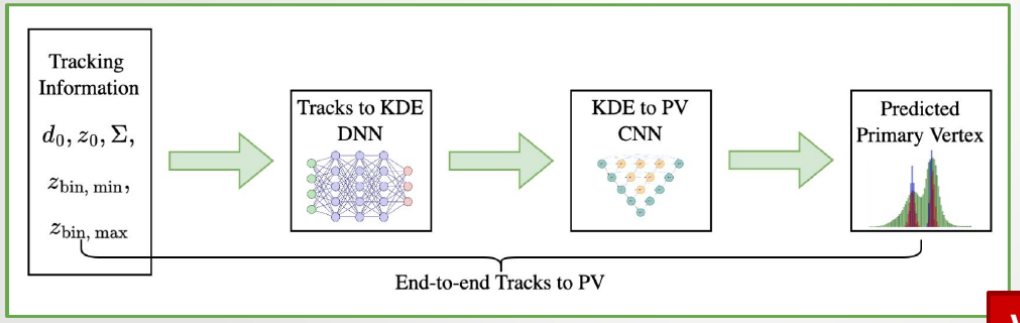
PVFinder aims to **outperform AMVF** with a **deep-learning approach** optimized for high PU environments

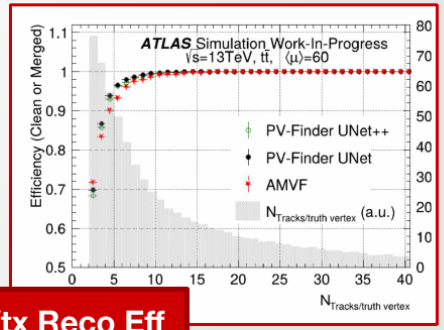
- Previous PUBNote in 2023 – great performance, but **needed optimization** for production-level speeds!

Rocky and Qi Bin have developed an updated, fully end-to-end version that eliminates the need for **hand-tuned intermediate KDE representations**

- **Tracks → KDE → PV** distribution via a combined MLP + UNet model
- **Better efficiency and resolution** than AMVF on PU=60 ttbar benchmark, and now **very fast** as well!







Vtx Reco Eff

Credit Qi Bin Lei, Rocky Garg

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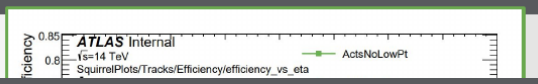

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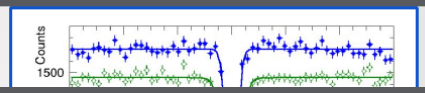


Credit Guglielmo Frattari, Jackson Burzynski, Hamza Hanif

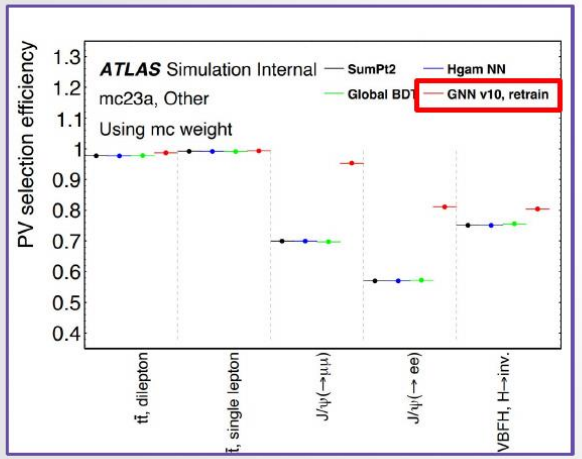
Global PV Selection: HSGN2

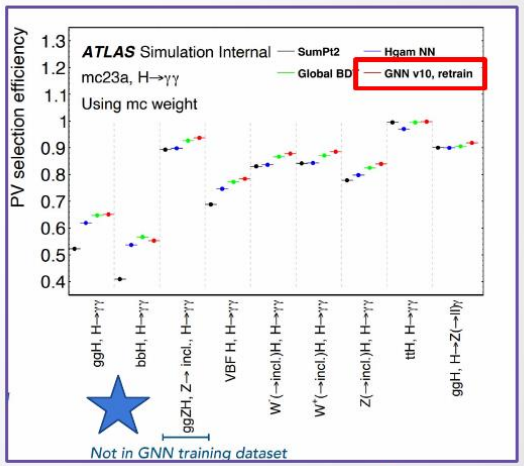
HSGN2 has **higher HS selection efficiency** than Σp_T^2 and H->yy NN across **all tested processes**, including those **not in the training set**.

- Scale of improvement **varies strongly with process**, ranging from sub 1% (as expected) for ttbar to 30+% for J/Ψ
- ***This is a game-changer!*** PC enthusiastic about the prospect of **consolidating Higgs derivations** and **improving efficiency** across the physics program

Model is now implemented in Athena and **available for preliminary testing** in (private) PHYS production when enabled

Just needs a little help getting over the finish line...





Ttbar + extras

H -> yy

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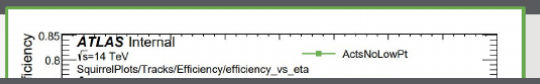

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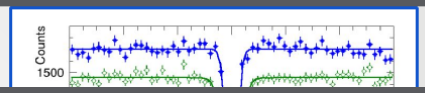

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Global PV Selection: HSGN2

HSGN

Mode

Just

Ongoing activities: HS and "hard PU" selection for ITk

HS Selection Eff vs

Wasikul is studying **alternative PV selection** for Run 4, complementary to the HSGN2 efforts!

Weighted Σp_T^2 approach previously studied and shown to be **effective for some signatures**

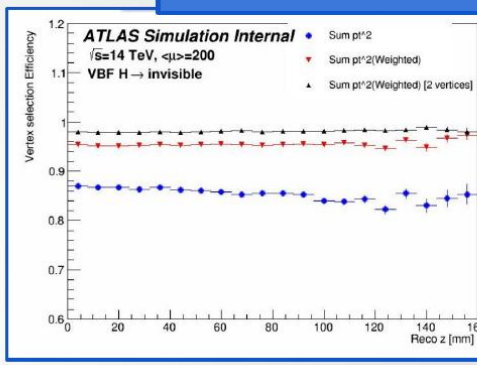
- **Downweights tracks** that **don't point to jets** and can better suppress merged PU contributions.

But in HL-LHC environment, some events can't be resolved with just one PV and have **multiple "hard" vertices.**

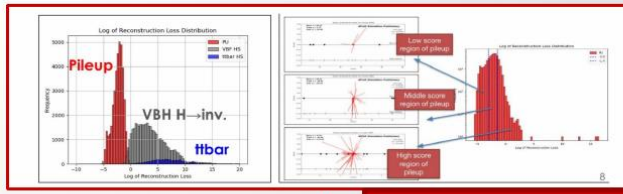
- Can we allow **2 PV candidates per event** and associate different physics objects to either?

Selecting **top 2 weighted Σp_T^2** and calling it successful if **either is within 5mm of HS** results in good efficiency

Next to investigate split vertex resolution and **anomaly detection** to identify **"non PU like"** vertices regardless of number



	Sum$_T^2$ (All events)	Sum$_T$W (All events)	Sum$_T^2$ (No split cases- events)	Sum$_T$W (No split cases- events)
R21 : Highest vertex within 5 mm	84.74%	93.96%	88.28%	95.80 %
R25 : Highest vertex within 5 mm	**86.218 %**	**95.305%**	**89.215%**	**96.66 %**
R21 : 2 Highest vertices, at least 1 vertex within 5 mm	92.52 %	97.78 %	94.32%	98.46 %
R25 : 2 Highest vertices, at least 1 vertex within 5 mm		**97.98 %**		**98.56%**



Anomaly Scores

$$\text{sumPTw} = \sum_{\text{tracks}} p_{\text{T}_w} = \sum_{\text{tracks}} p_{\text{T}}^2 \, p_{\text{T(closest jet)}}^2 \frac{1}{\Delta R} \mathbb{1}(\Delta R < 0.8) \mathbb{1}(p_{\text{T(jet)}} > p_{\text{T(threshold)}})$$

Credit Wasikul Islam

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- Highlight demands for CP algs

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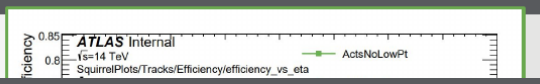

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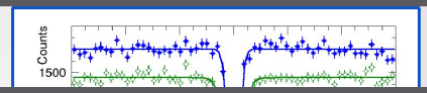

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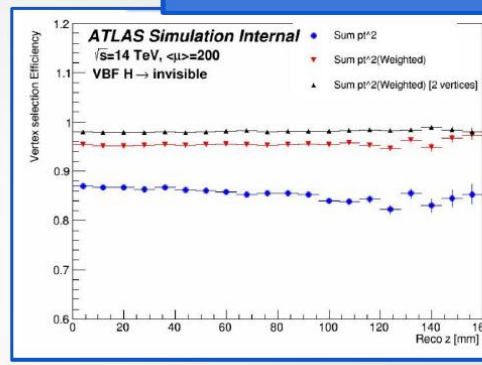

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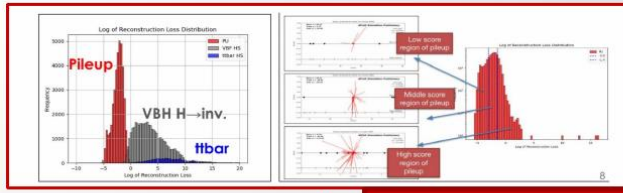


Anomaly Scores

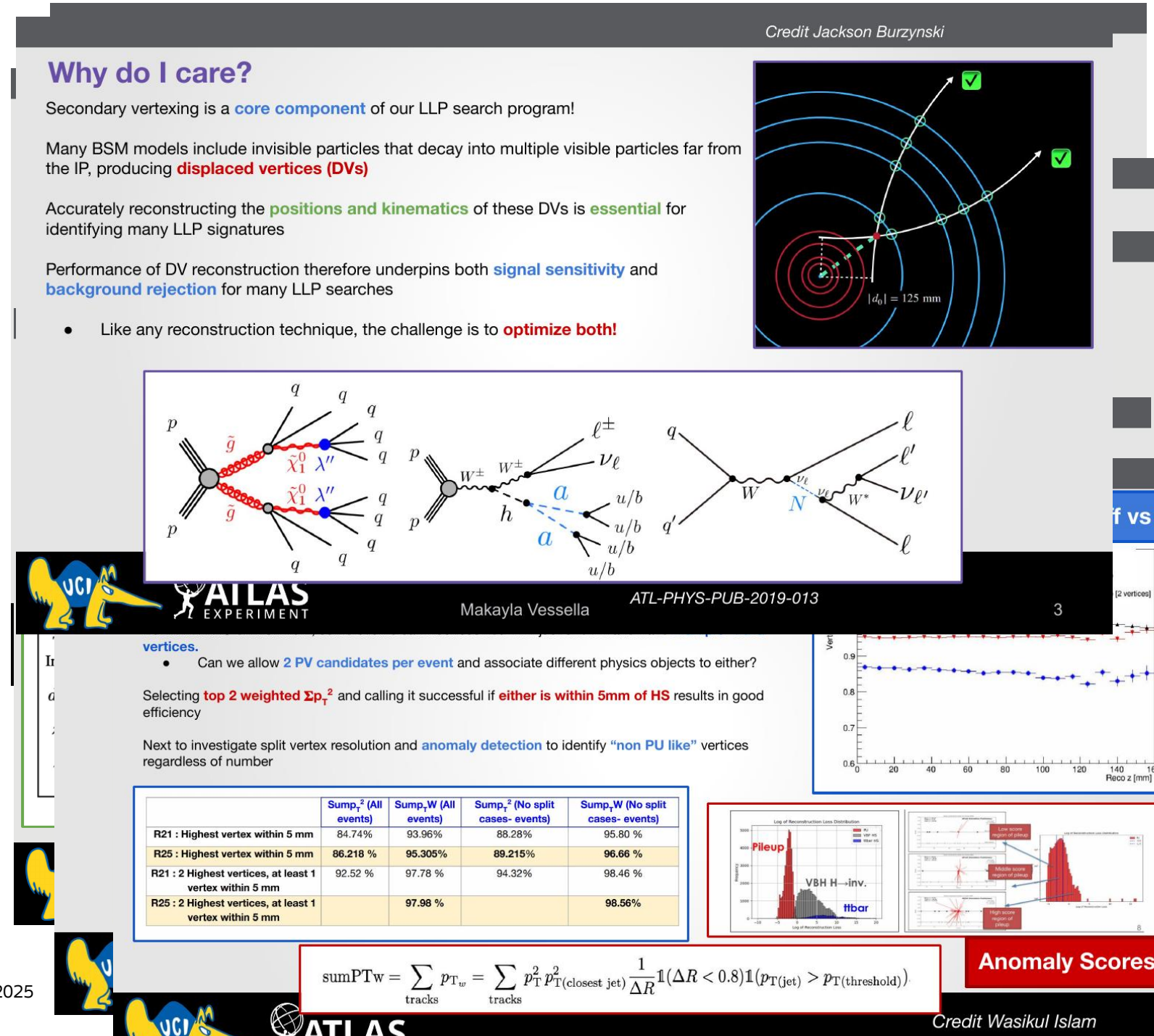
$$\text{sumPTw} = \sum_{\text{tracks}} p_{\text{T}_w} = \sum_{\text{tracks}} p_{\text{T}}^2 \, p_{\text{T(closest jet)}}^2 \frac{1}{\Delta R} \mathbb{1}(\Delta R < 0.8) \mathbb{1}(p_{\text{T(jet)}} > p_{\text{T(threshold)}})$$

Credit Wasikul Islam

TVPD Activity report

Link to Slides

- New Recommendations
  - Issue with Fake rates in 2022
- QPs
  - ACTS Grid Seeder
  - Low-pt tracking for ITk
  - LRT for Itk
- Efforts on PV finding/selection
  - New PVFinder
  - GNN approach for low activity
  - Multiple PV selection for HL-LHC
- Highlight demands for CP algs
- Dedicated presentation on Secondary Vertexing



	Sump$_T^2$ (All events)	Sump$_T$W (All events)	Sump$_T^2$ (No split cases- events)	Sump$_T$W (No split cases- events)
R21 : Highest vertex within 5 mm	84.74%	93.96%	88.28%	95.80 %
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Many BSM models include invisible particles that decay into multiple visible particles far from the IP, producing **displaced vertices (DVs)**

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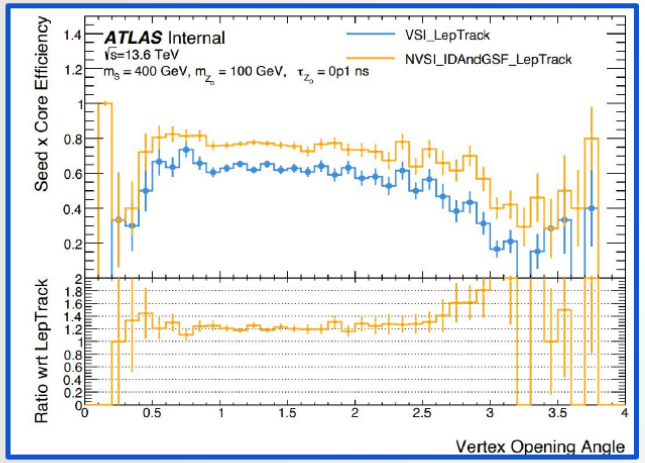

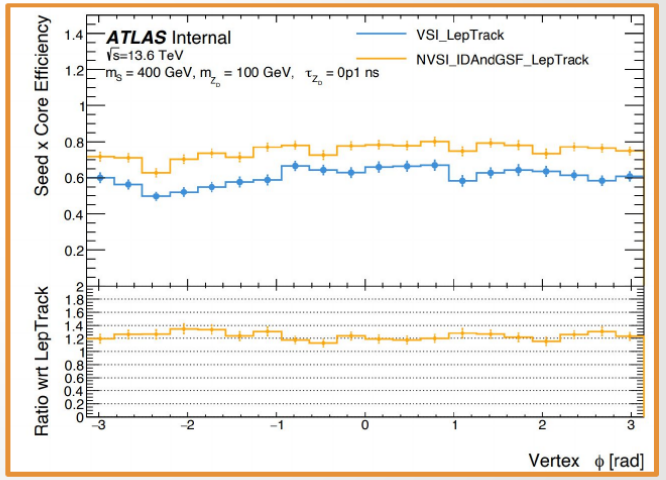

Credit Sagar Addepalli

Makayla Vessella 19

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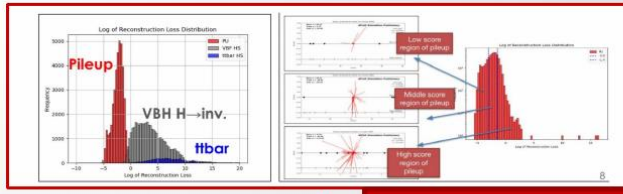

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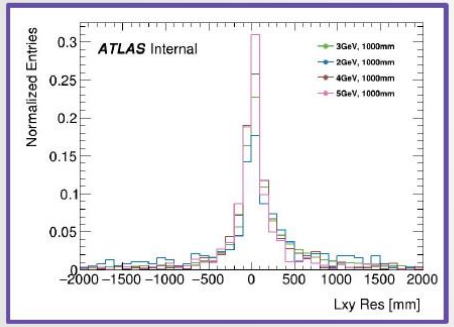
MuSAVtxFitter

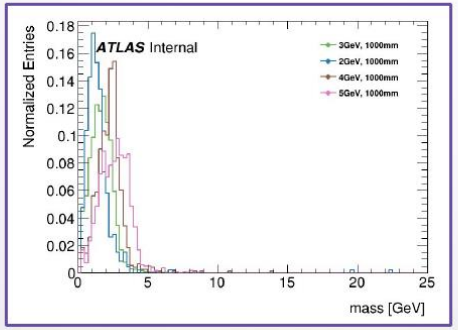
The result? Perfectly valid, **well-defined vertices** from crazy extrapolated tracks **up through the first MS layer**

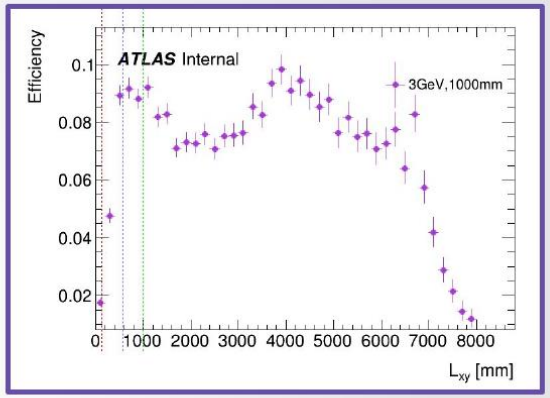
- Position resolutions **within a few 100 mm**
- Mass resolutions varying on process but **within a few GeV**

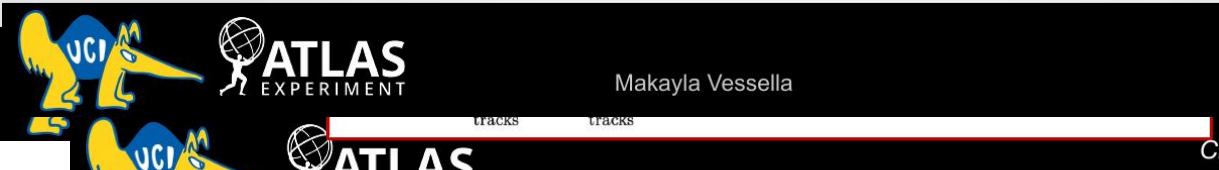
Integrated now into DAOD_LLP1 production and center of a new general LLP search using displaced HNLs and HAHM dark photons

"Crazy user" protections and I roughly share a birthday… which means…









Credit Wasikul Islam

CTIDE Activity report

Link to Slides

CTIDE Activity report

Link to Slides

- New Recommendations:
  - Impact parameter (d_0, z_0)

Thorsten Kuhl, Alessandro Sala, Wenjing Wang (link, link)

Impact parameters resolution measurements

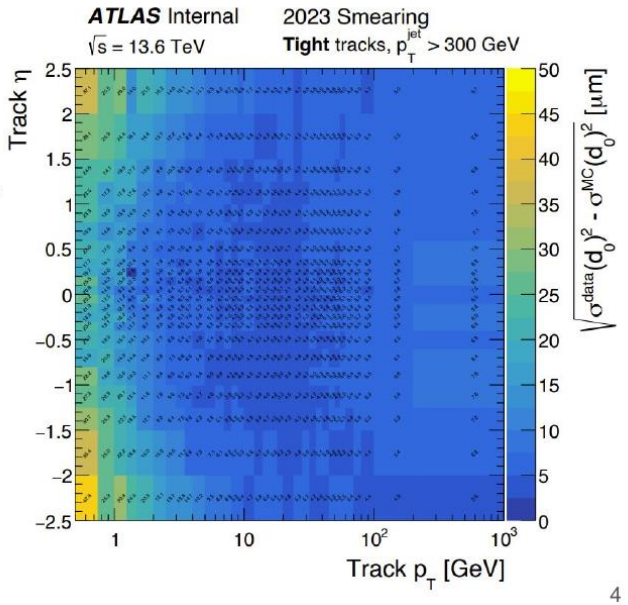
d_0 & z_0 IP resolution values measured per data-taking year, per reprocessing campaign

- Needed to account for the difference in resolution between data and MC simulations

Status of Run-3 measurements (by Alessandro Sala)

- Several results obtained: TightP & Loose WPs, jet pT < 300 GeV, jet pT > 300 GeV, 2022 & 2023 samples
- They will be released to ATLAS collaboration in the coming days (calib files available on cvmfs)
  - Jackson is helping with the updates in the InDetTrackSmearingTool (link, MR!80106)

- **See Alessandro's talk on Thursday (link) for more details**



4

CTIDE Activity report

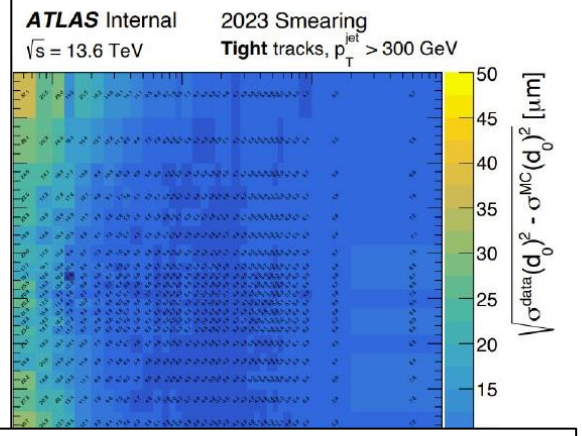
Link to Slides

- New Recommendations:
  - Impact parameter (d_0, z_0)
  - Lost Tracks (from dE/dx)

Thorsten Kuhl, Alessandro Sala, Wenjing Wang (link, link)

Impact parameters resolution measurements

r reprocessing campaign



Fiona Ann Jolly (link, link)

Fraction of lost tracks (FLost) using dE/dx

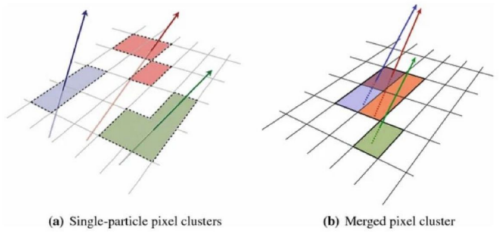
FLost → fraction of tracks that are not reconstructed, among true tracks contributing to merged clusters

Energy deposited in clusters, dE/dx → an estimate of the nr. of charged particles associated with that cluster

- Indication of track loss if cluster identified as n-particle cluster but has less than n tracks

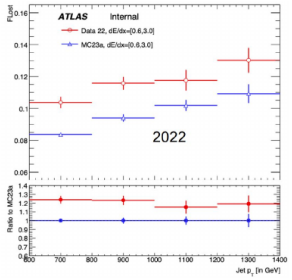
FLost measured using three dE/dx templates:

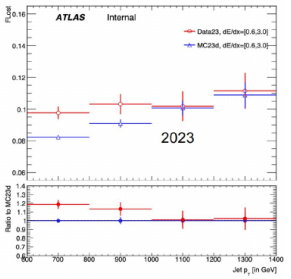
- 1-particle cluster template, using ΔR(jet, track) > 0.1
- 2-particle cluster template: convolution of one particle cluster templates (accounting for the jet pT and eta bin, in a ΔR(jet, track) < 0.05 selection)
- 3-particle cluster template recently added



- **In-situ measurement done as a function of jet pT, in both data and MC** (by Fiona Ann Jolly)
  - Eta dependency planned to be studied (not don
  - The **fit model** uses dE/dx distributions construc particle clusters

FLost → fraction of tracks that are not reconstructed, but contribute to merged cluster(s) used by another reconstructed track





- **Results obtained using 2022 and 2023 samples (2024 measurements to be done by summer time)**

Current FLost recommendations: uncertainty on fraction of lost tracks, as function of jet pT (1 number)

- 24% (link) independent of the data taking year, **independent of the jet pT, independent of jet η**

8

CTIDE Activity report

Link to Slides

- New Recommendations:
  - Impact parameter (d_0, z_0)
  - Lost Tracks (from dE/dx)
  - Fakes in jets

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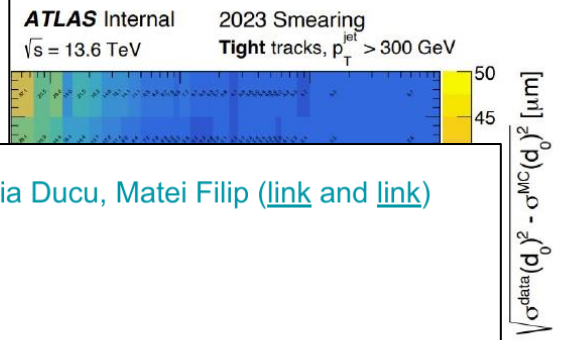
Impact parameters resolution measurements

r reprocessing campaign



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FLost me

- 1-pa
- 2-pa
  clus
  in a
- 3-pa
- **In-s**
  in b
  -
  -

Otilia Ducu, Matei Filip (link and link)

Fake tracks in the jet core

Goal: measure the modelling of fake tracks in data, in the jet core

- Deliverable: the uncertainty on the modelling of rate of fake tracks when ΔR(jet1, trk) < 0.2
- Fake tracks: reconstructed tracks that don't have the majority of their hits associated to a single charged particle
- Real and fake tracks separated in MC di-jet simulations using the truthMatchProbability variable
  - The available NN real-fake tracks discriminant tool proposed by Sam, Gabriel & co also tried
    - Still need look at the results with the latest training
- Fake rate obtained by fitting MC fraction of fakes and real tracks to data through a LLH fit
- **Some effort put to automatize the measurement: QT recently finalized** (by Matei Filip, ATLIDTRKCP-499)
  - Documentation: ATL-COM-PHYS-2025-025
- **Status: recommendations done for 2022 and 2023 data-taking (1 number), 2024 reco WIP**

10

time)

8

CTIDE Activity report

Link to Slides

- New Recommendations:
  - Impact parameter (d_0, z_0)
  - Lost Tracks (from dE/dx)
  - Fakes in jets
- Ongoing work
  - Energy loss calibration

Thorsten Kuhl, Alessandro Sala, Wenjing Wang (link, link)

Impact parameters resolution measurements

er reprocessing campaign

ATLAS Internal 2023 Smearing
$\sqrt{s}$ = 13.6 TeV Tight tracks, p_T^{jet} > 300 GeV

$\sqrt{\sigma^{data}(d_0)^2 - \sigma^{MC}(d_0)^2}$ [μm]

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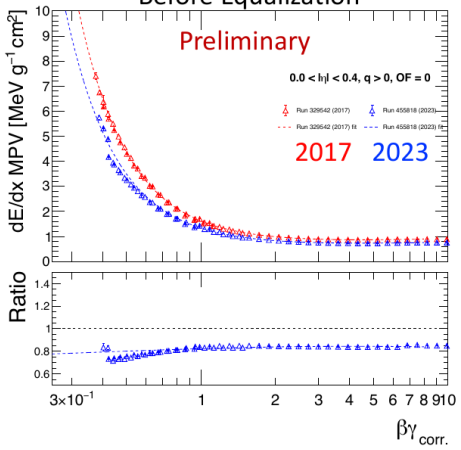
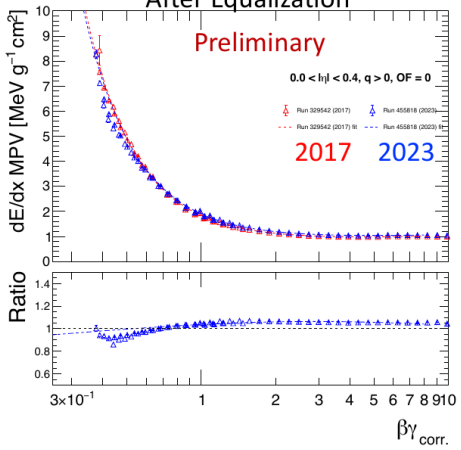
dE/dx Equalization

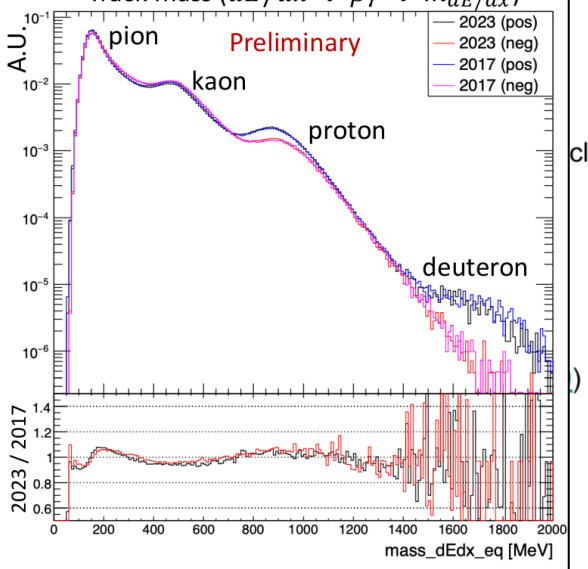
Before Equalization



After Equalization



Track mass ($dE/dx \rightarrow \beta\gamma \rightarrow m_{dE/dx}$)



- Performed Bethe-Bloch calibration with data from 2017 and 2023 low-μ runs.
  - Using very preliminary scale factors.
  - Much better agreement after equalization.
- Applied calibration to check pion, kaon, proton mass stability.
  - Separated by year and sign of track charge.
  - Decent agreement, but some interesting features to study.

$$m_{dE/dx} = \frac{p}{(\beta\gamma)_{dE/dx}}$$

Ian Dyckes MAY 20, 2025 11

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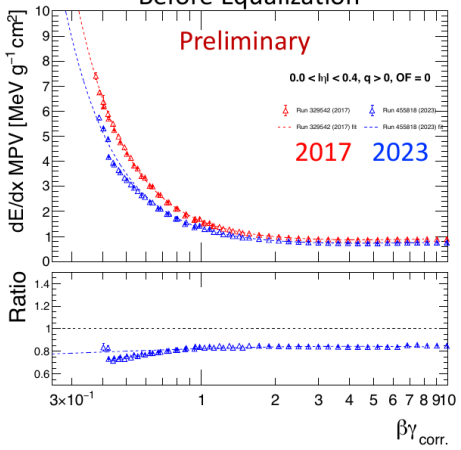

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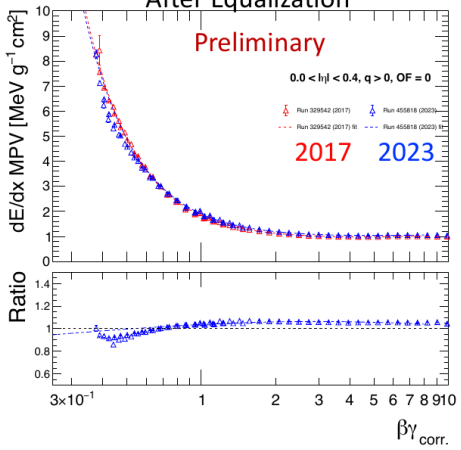

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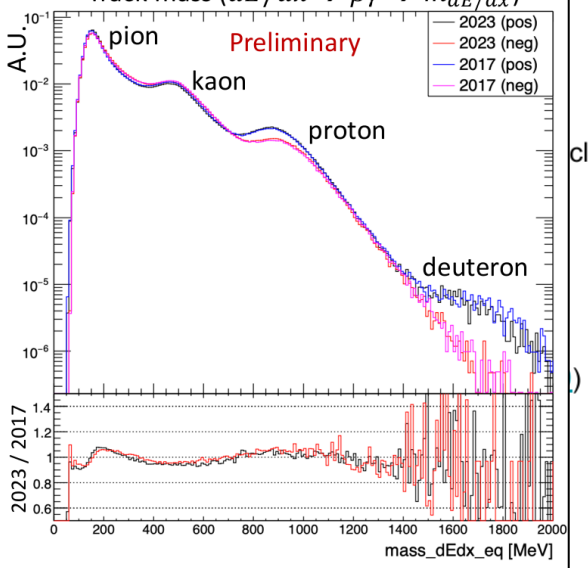

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Ian Dyckes MAY 20, 2025 11

10

8

ID and ITk status

Link to Slides for ID and ITk

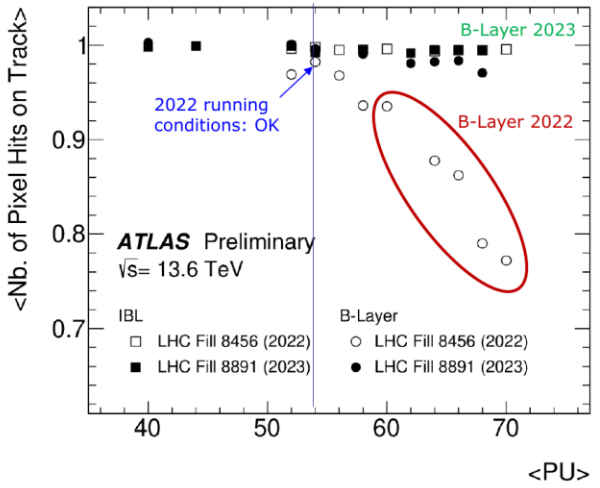
ID and ITk status

Link to Slides for ID and ITk

- Status of ID
  - Ongoing work to keep performance

Pixel Readout Performance

- The readout performance can be affected by **Single Event Effects**, and by **limitations in bandwidth and buffer sizes**. A continuous effort has been made to limit the effects on the performance.
- Test Fill in 2022: LHC is able to increase the instantaneous luminosity above $2.1 \times 10^{33} cm^{-2} s^{-1}$ without running into thermal issues in the arcs.
- ATLAS target conditions were raised accordingly for Run 3: first to a pile-up of 60 and then to 64 in 2024, at trigger rates above 90 kHz. 2025?
- Challening conditions for Pixel Readout Performance, especially for B-Layer!



- *Readout improvements prepared during LS2*

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ID and ITk status

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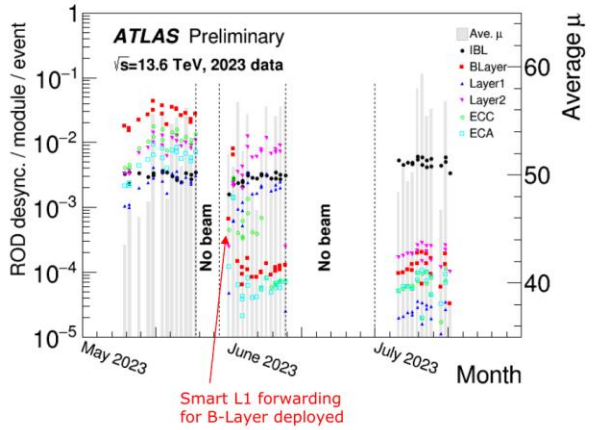
Pixel Readout Performance

Desynchronisation I

- The Pixel modules can only buffer 16 events, and transmit events with maximum 160 Mbit/second to the off-detector ROD/BOC system. The bandwidth usage depends on the hit occupancy, i.e. (very) large events take longer (too long) to transmit. Once a trigger has been missed, the module event data will be out of sync with the rest of ATLAS until the next Event Counter Reset/ECR.
- A mechanism to reset the backend electronics and the FE chips at each ECR had been implemented already in Run 2.
- In 2023, a new ROD firmware was deployed which keeps track of the number of pending triggers for each module. A module that is already handling the maximum number of triggers, will not receive a new trigger. The firmware will instead insert a dummy fragment into the data stream, keeping track of the trigger IDs („Smart L1 forwarding"). Instead of seconds of data, only single events are lost. This is clearly visible in the number of ROD level desynchronisation errors.



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ID and ITk status

Link to Slides for ID and ITk

- Status of ID
  - Ongoing work to keep performance
  - Increasing module failure

Pixel Readout Performance

Desynchronisation I

Detector working fraction

- Pixel Detector non-working fraction (end of 2024):
  - 1.1% IBL (5 out of 448 frontends)
  - 6.0% outer layers (104/1744 modules)
- Total number of disabled modules increases slowly with time.
- Two major recoveries:
  - ~30 modules recovered in LS2 by replacing optoboards with dead VCSEL channels
  - 6 Layer 1 modules with one problematic readout link recovered in 2024 by going to half readout speed (i.e. from 2 to 1 link)
- **Failures inside the detector volume are inaccessible.**

% Disabled

Layer	2018	2023	2024
B-Layer	6.2	5.2	7.3
Layer 1	5.8	4.4	3.6
Layer 2	4.8	6.3	7.4
Disks	5.2	4.5	5.2
Pixel Total	**5.4**	**5.3**	**6.0**
IBL (Frontends)	0.7	0.9	1.1

almost 99% working fraction in IBL
and 94% working fraction in the outer Layers

Average μ

9

21.05.2025 Kerstin Lantzsch (University of Bonn) 11

ID and ITk status

Link to Slides for ID and ITk

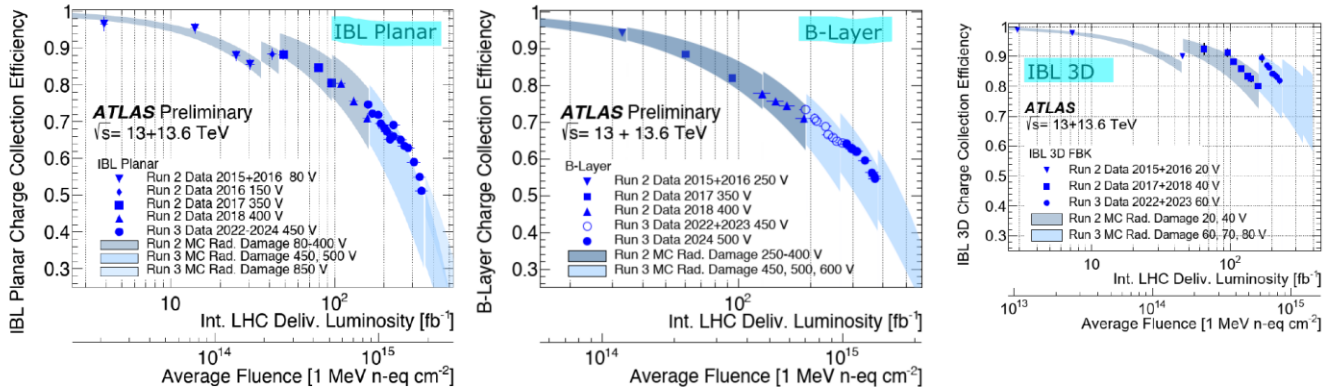
- Status of ID
  - Ongoing work to keep performance
  - Increasing module failure
  - Decreased charge collection

Pixel Readout Performance

Desynchronisation I

Detector working fraction

Charge Collection Efficiency



- About 30% of original Charge Collection Efficiency (CCE) at the end of Run 3 for IBL planar sensors and B-Layer
- Response of IBL 3D sensors at the same fluence shows a better behaviour in terms of CCE
- Discontinuities in the simulation band are due to HV changes.
- Number of hits on track affected to a significantly lesser degree than charge: expect loss of 2-3% of hits on track from today until the end of Run 3. → B-Layer holes will affect tight tracks
- Keeping the IBL performance up is critical

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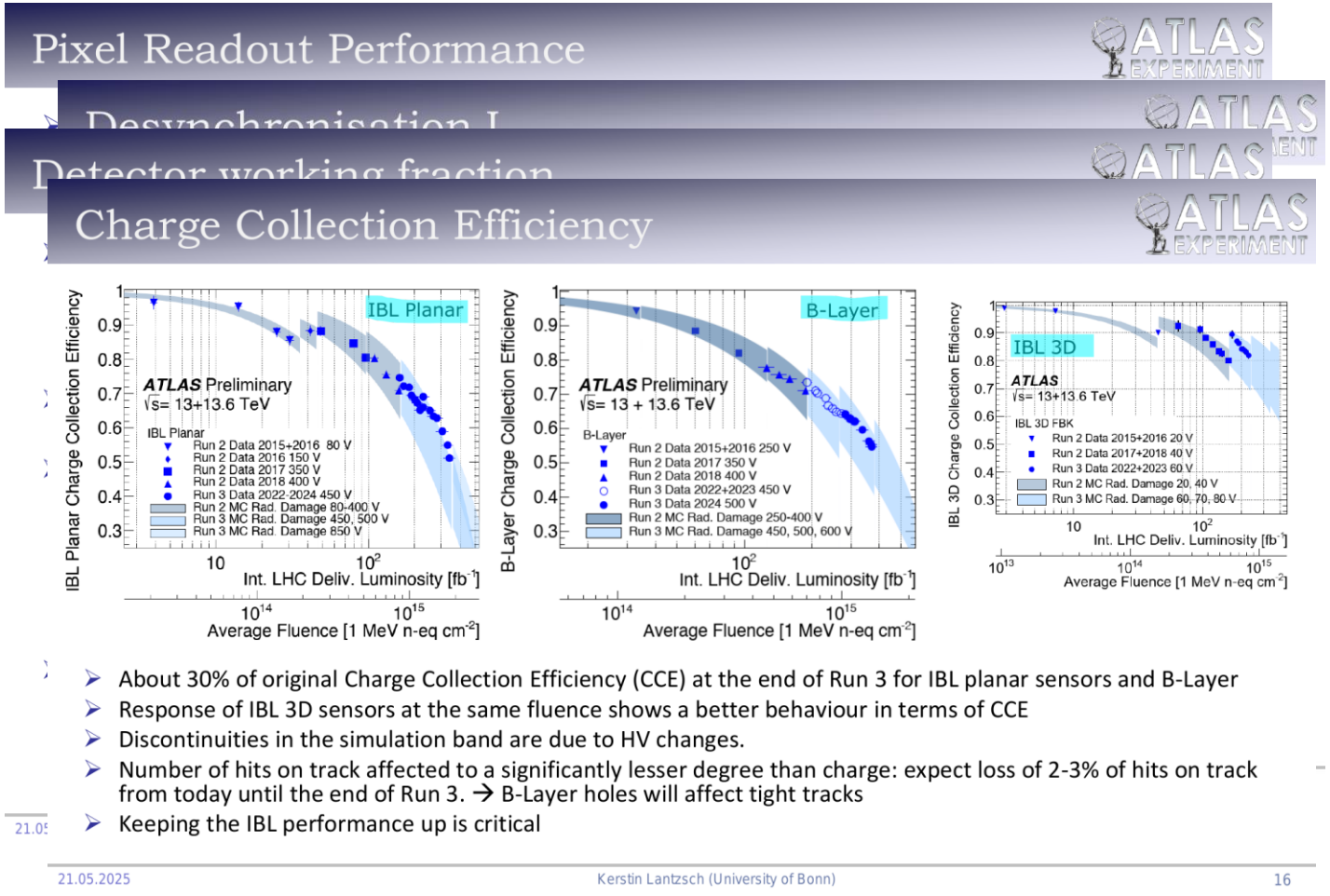
ID and ITk status

Link to Slides for ID and ITk

- Status of ID
  - Ongoing work to keep performance
  - Increasing module failure
  - Decreased charge collection
- Production of ITk
  - Multiple schedules



ID and ITk status

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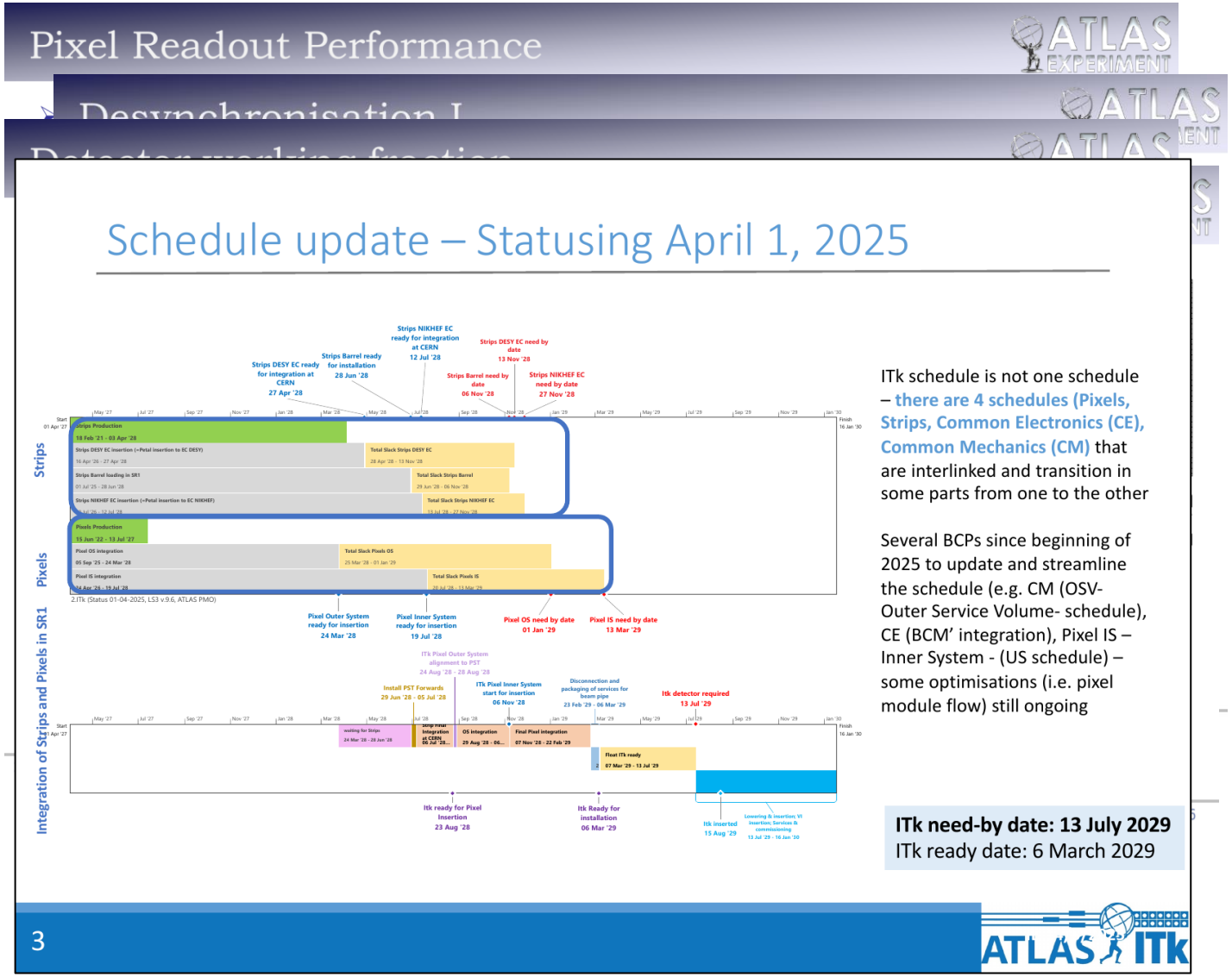
  - Ongoing work to keep performance
  - Increasing module failure
  - Decreased charge collection
- Production of ITk
  - Multiple schedules
  - “Still” 4 months slack



ID and ITk status

Link to Slides for ID and ITk

- Status of ID
  - Ongoing work to keep performance
  - Increasing module failure
  - Decreased charge collection
- Production of ITk
  - Multiple schedules
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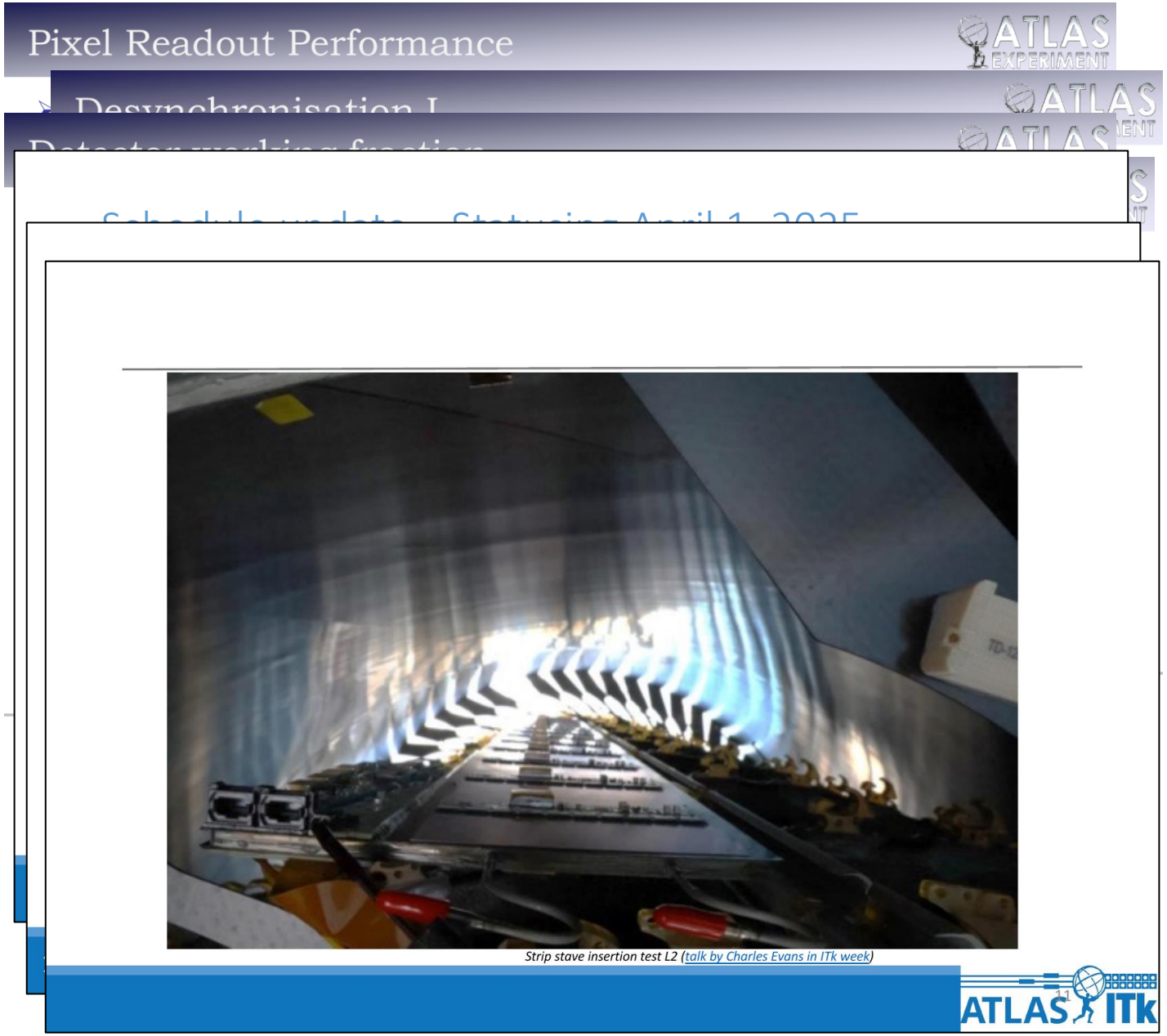

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  - First strip insertion to barrel passed
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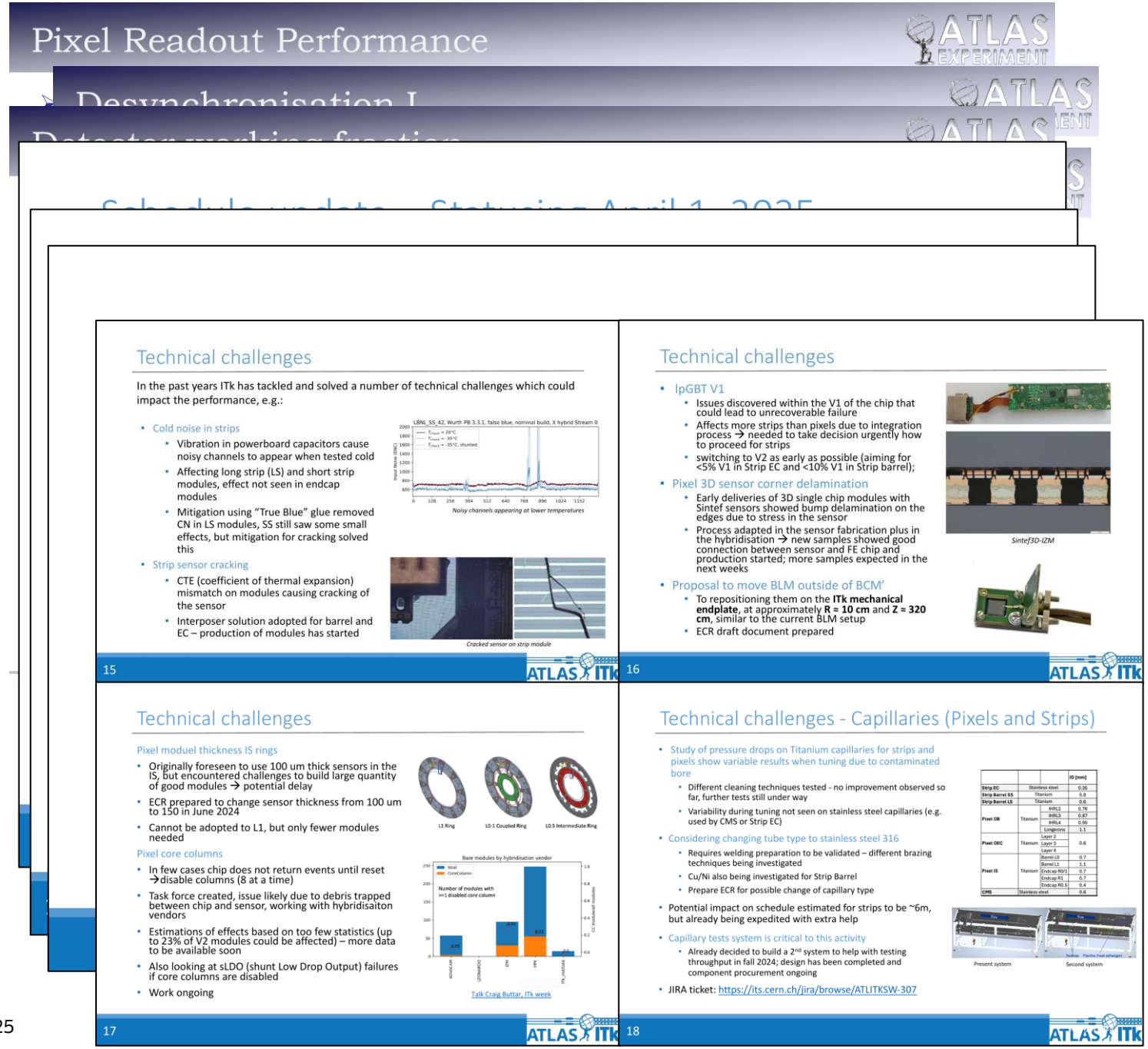

Upgrade Tracking report

Link to Slides

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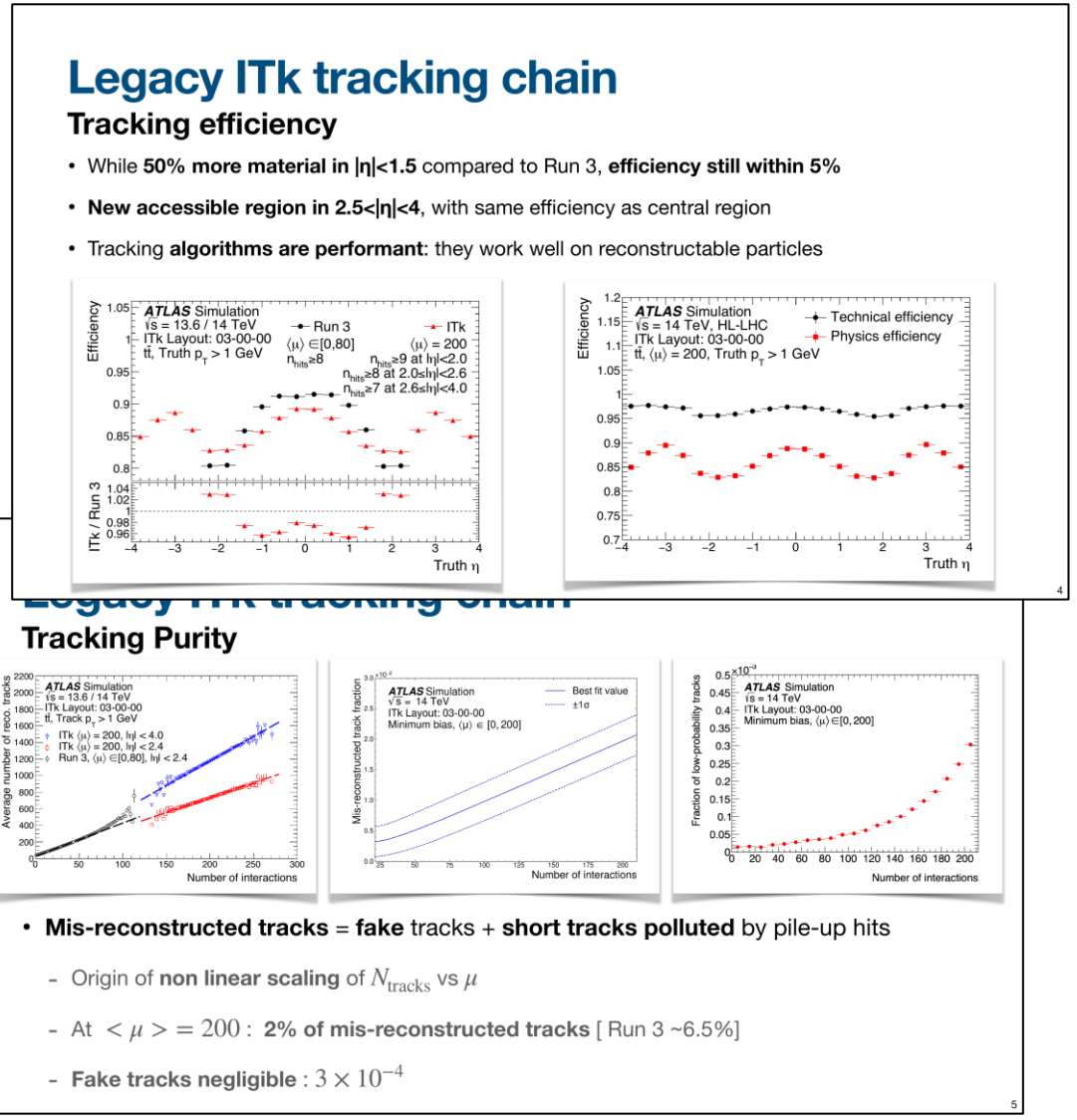
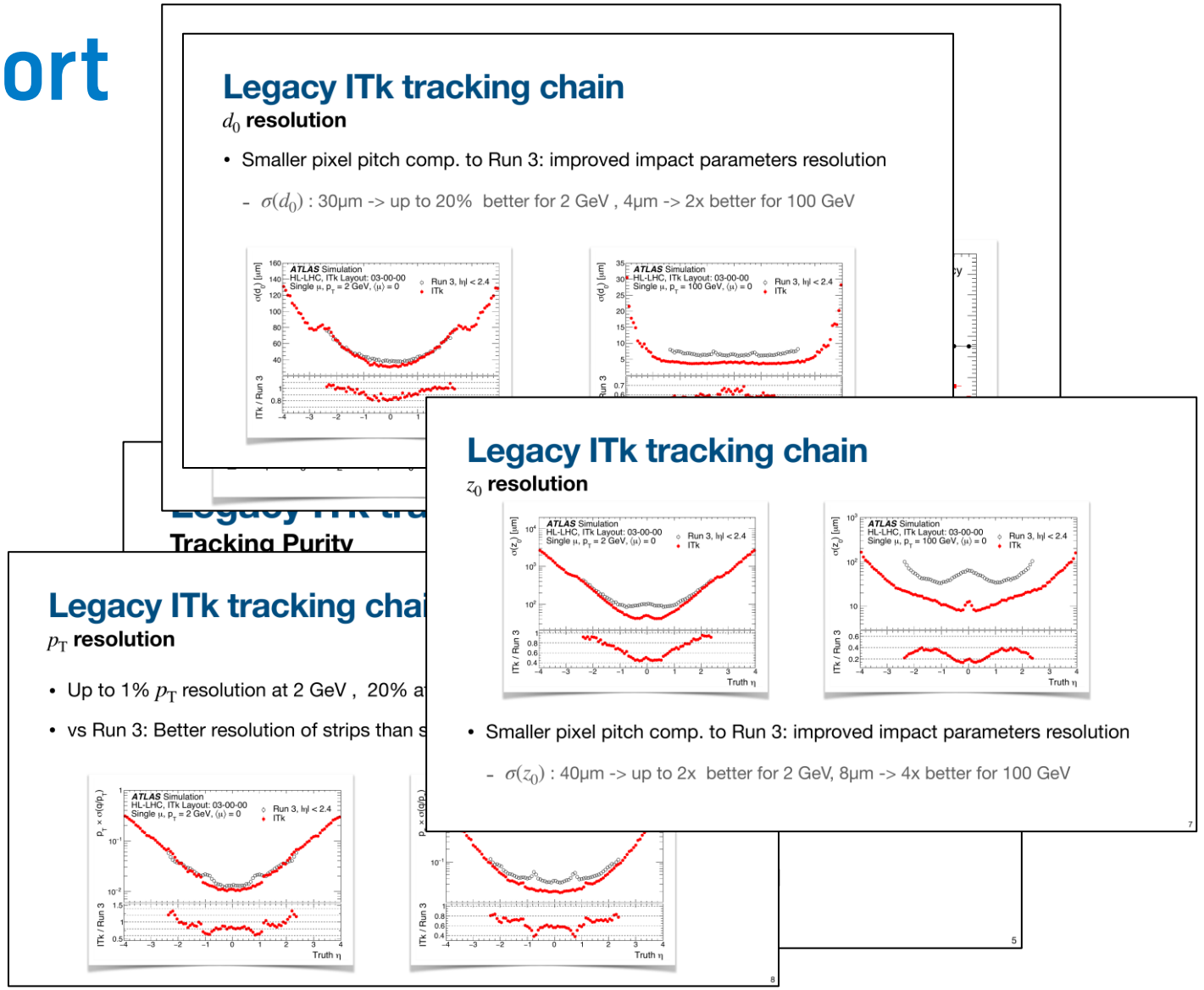
- Legacy ITk tracking
  - High Efficiency
  - Low Fake rate



Upgrade Tracking report

Link to Slides

- Legacy ITk tracking
  - High Efficiency
  - Low Fake rate
  - Good resolution



Upgrade Tracking report

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  - High Efficiency
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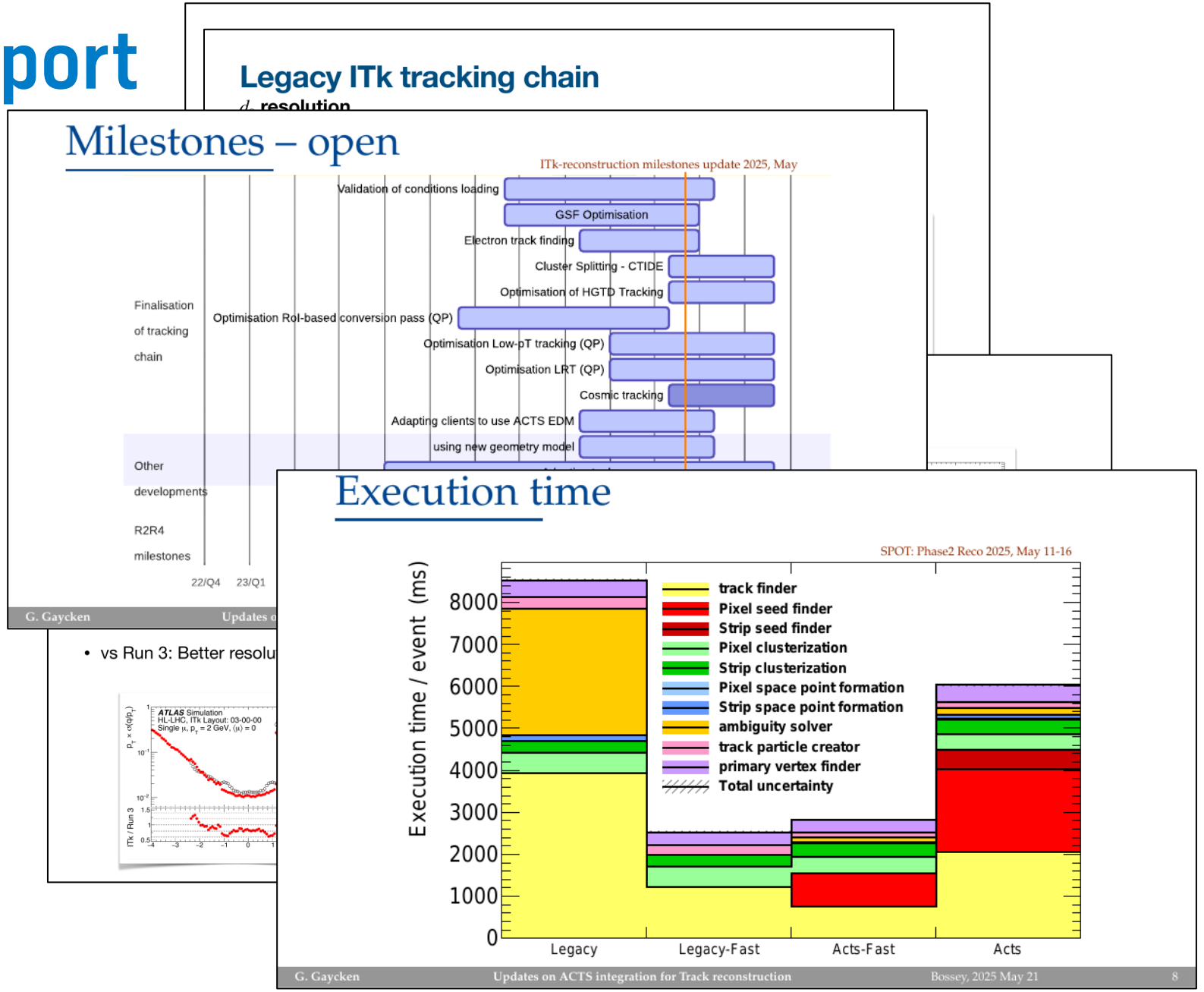
- ACTS integration
  - Implemented fast versions



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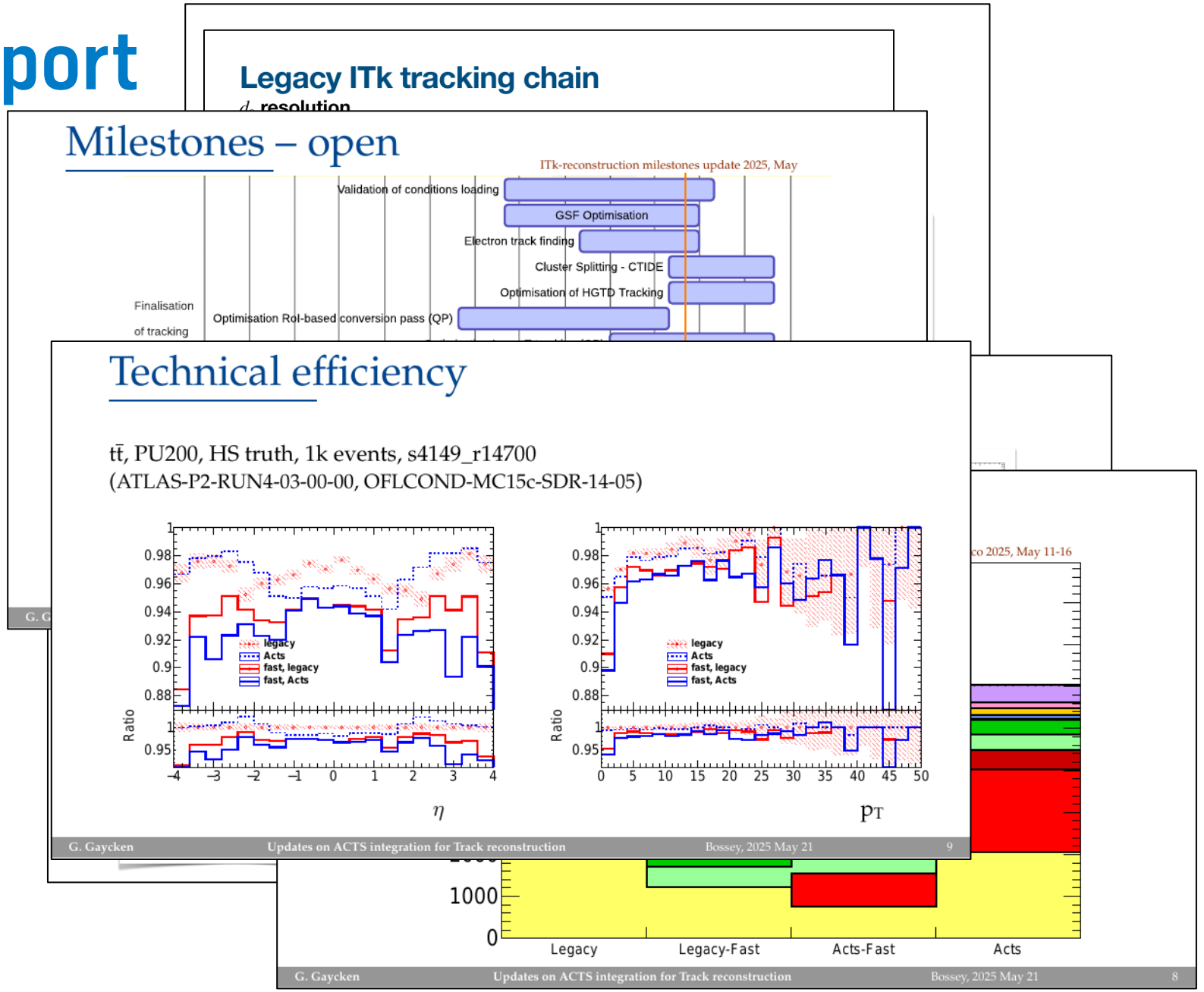

Upgrade Tracking report

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- Legacy ITk tracking
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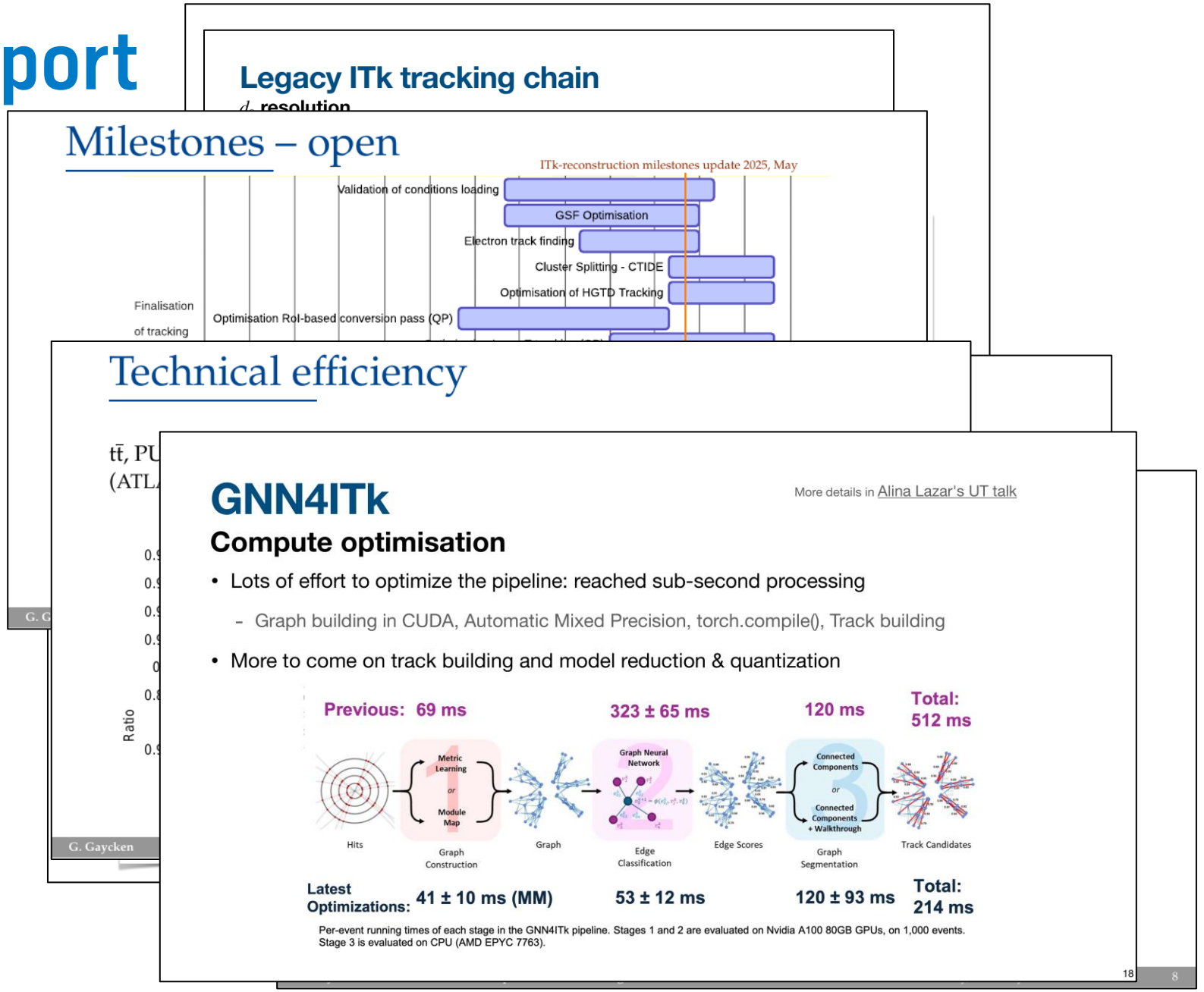
  - Slightly lower Performance and Efficiency
- GNN4ITk workflow
  - Improved Performance
  - Effort to run on FPGAs



ID Alignment report

Link to Slides

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- Existing Alignment calibration is working
  - Keep code up-to-date
  - New web monitor

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Alignment in the calibration loop

What is happening during data taking

- As initial geometry, the previous year realigned geometry is used
- At the start of each run, the L1 alignment is performed for three blocks of 20 LBs
- Afterwards, the L1 alignment is performed each 100 LBs

Current status of calibration loop

- It is working! (from tzcontzole01 of tasktype “idalignreco”)

Run Nr	Task Name	User	taskID	Type	Status	Total	Done	Run.	Proc.	TBD	Abrt.	Failed
498182	data25_13p6TeV.00498182.calibration_IDCalib.merge.RAW.Iter0.rel23_c0…	idalign	3193511	idalignreco		51	12	31	0	8	0	0
498088	data25_13p6TeV.00498088.calibration_IDCalib.merge.RAW.Iter3.rel23_c0…	idalign	3193470	idalignreco	FINISHED	111	111	0	0	0	0	0
498088	data25_13p6TeV.00498088.calibration_IDCalib.merge.RAW.Iter2.rel23_c0…	idalign	3193311	idalignreco	FINISHED	111	111	0	0	0	0	0
498088	data25_13p6TeV.00498088.calibration_IDCalib.merge.RAW.Iter1.rel23_c0…	idalign	3193290	idalignreco	FINISHED	111	111	0	0	0	0	0
498088	data25_13p6TeV.00498088.calibration_IDCalib.merge.RAW.Iter0.rel23_c0…	idalign	3193200	idalignreco	FINISHED	111	111	0	0	0	0	0
498075	data25_13p6TeV.00498075.calibration_IDCalib.merge.RAW.Iter3.rel23_c0…	idalign	3193278	idalignreco	FINISHED	626	626	0	0	0	0	0
498075	data25_13p6TeV.00498075.calibration_IDCalib.merge.RAW.Iter2.rel23_c0…	idalign	3193210	idalignreco	FINISHED	626	626	0	0	0	0	0
498075	data25_13p6TeV.00498075.calibration_IDCalib.merge.RAW.Iter1.rel23_c0…	idalign	3193112	idalignreco	FINISHED	626	626	0	0	0	0	0

But …

- Using deprecated release 23
- Highly non-trivial to setup the production code from scratch again
- Current production code not part of athena

ID Alignment report

Link to Slides

- Existing Alignment calibration is working
  - Keep code up-to-date
  - New web monitor
- Starting work to prepare for ITk
  - Simulate misalignment to validate calibration (Xilin's talk)

Nicolas Styles, Hannah Herde, Noemi Calace, Krisztian Peters, Xilin Wang 王熙临

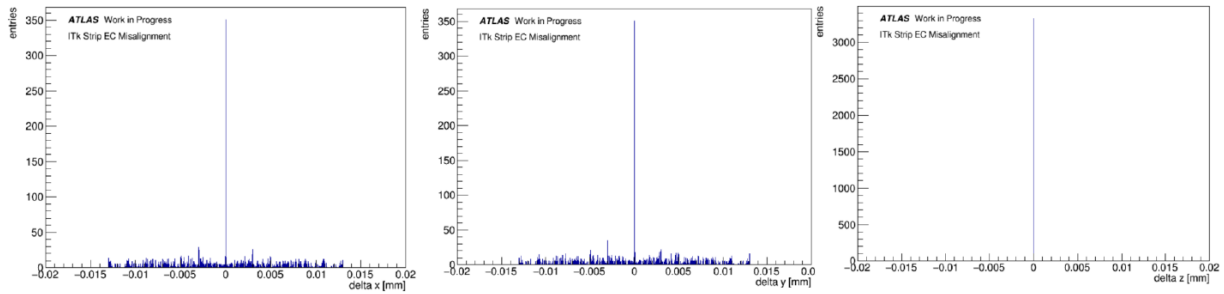
22.

HEL

Test on Strip Endcap

customized misalignment --- assignment

- With RunExEngineTestITk.py
- Check misalignment in global frame
- Plot script: New.cc



Hands-on-project

Accessing tracks and their systematics via CP Algorithms

Overview

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Accessing tracks and their systematics via CP Algorithms

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  - `InDetTrackSmearingTool (d0, z0)`
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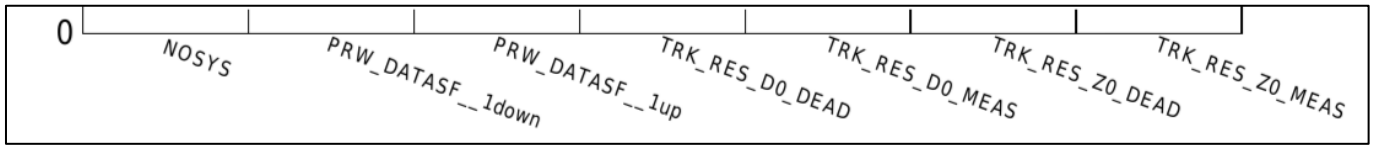

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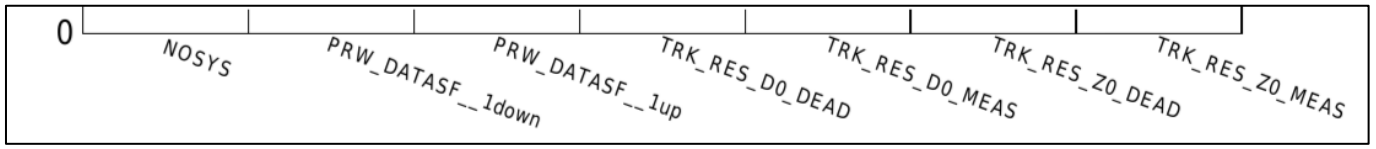

ToDo

- Pass options to Smearing
- Try adding selection tool

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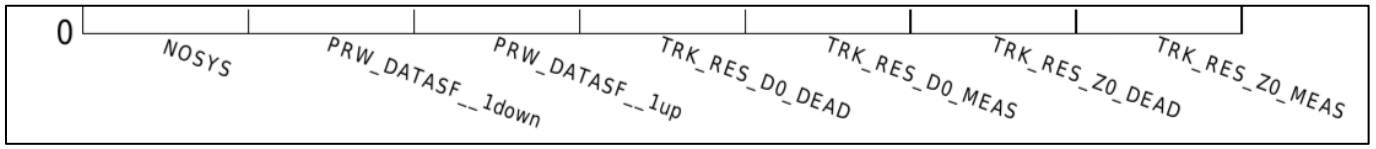

ToDo

- Pass options to Smearing
- Try adding selection tool
- (Split block into calibration and working point)
- (Check whether to combine with other tools/algs)
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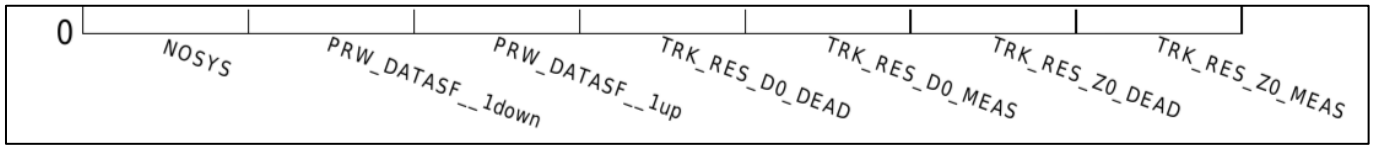

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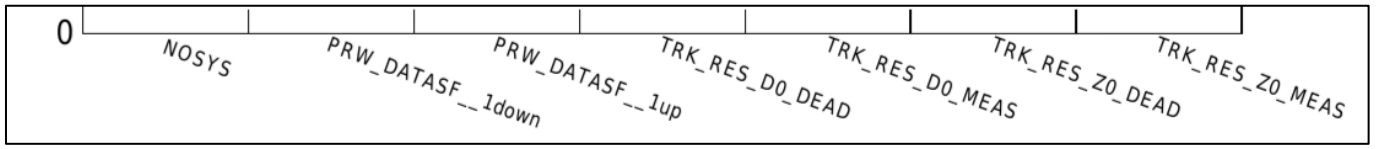

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Many thanks to Makayla !!!

Thank you for your attention!