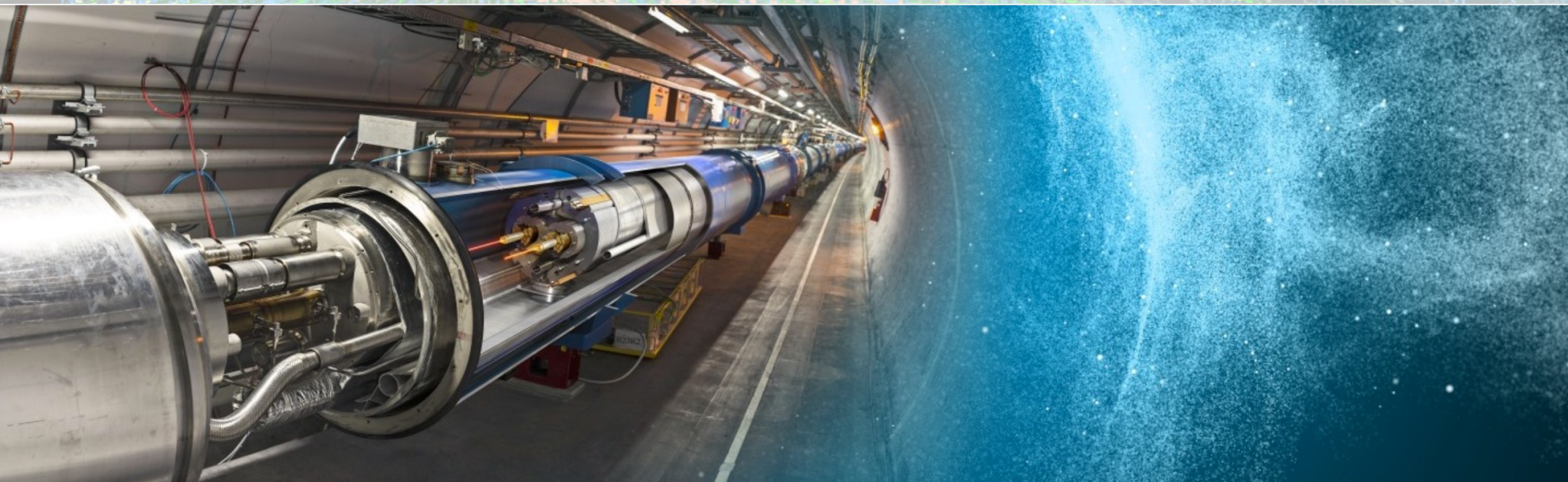
ATLAS Canada Status Report

P. Krieger, University of Toronto

(on behalf of ATLAS Canada)

IPP 50th Anniversary Celebration, May 2022



The Large Hadron Collider at CERN

- **The world's highest-energy collider**
  - Likely to remain at the energy-frontier for at least another two decades
  - High priority project for US, European and Canadian HEP communities
- **More than 1000 scientific ATLAS publications (published or submitted)**
- **Run-2 operation: 139 fb^{-1} recorded at 13 TeV (2015-18)**
  - Opened a new window for searches and SM physics (relative to Run-1)
    - Now 140 papers with full Run-2 dataset (312 based on partial Run-2 datasets)
  - Design luminosity exceeded by a factor of 2 (will be the same for Run-3)
- **Increase to 13.6 TeV planned for Run 3, with upgraded detector**
  - Significant contributions to those Phase-1 upgrades
  - Extensive and expanded physics program including new topics
  - Maximum LHC energy is 14 TeV. After that, planned improvements are associated with an increase of the collision rate (luminosity):
    - Accommodating such increases is the goal of the ATLAS upgrade program
- **We are playing leading roles in two ATLAS Phase-2 upgrade projects**
  - Recent changes to long-term schedule for LS3 and Run 4

The Large Hadron Collider at CERN

Cross-section increases

Channel	13.6 / 13 TeV	14 / 13.6 TeV
H (ggF)	7%	6%
HH	11%	7%
tt	11%	6%
ttH	13%	7%
tttt	19%	11%
SUSY stop (1.2–1.5 TeV)	20–30%	14–19%
Z' (5–6 TeV)	50–70%	30–40%
QBH (9.5 TeV)	250%	100%

Physics program

- Higgs and SM Physics
  - Including new di-Higgs effort
- Searches for BSM physics
  - Including new focus on long-lived particles (and related trigger and tracking improvements)
- Recognized as high priority in the SAP 2022 Long Range Plan

- **Increase to 13.6 TeV planned for Run 3, with upgraded detector**
  - Significant contributions to those Phase-1 upgrades
  - Extensive and expanded physics program including new topics
  - Maximum LHC energy is 14 TeV. After that, planned improvements are associated with an increase of the collision rate (luminosity):
    - Accommodating such increases is the goal of the ATLAS upgrade program
- **We are playing leading roles in two ATLAS Phase-2 upgrade projects**
  - Recent changes to long-term schedule for LS3 and Run 4

ATLAS / LHC Schedule Issues

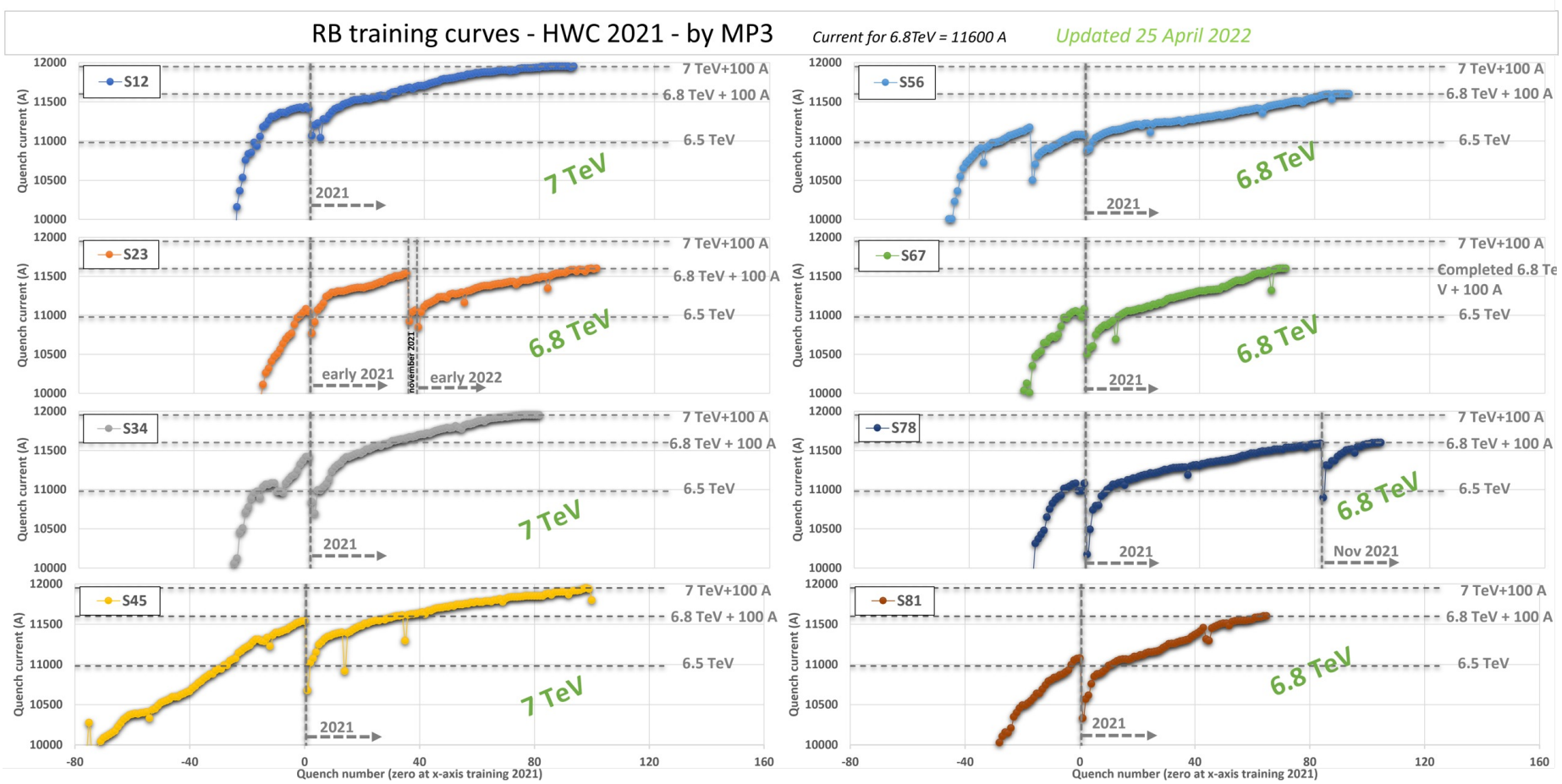
- **Significant delays in Phase-2 upgrade projects (both ATLAS and CMS)**
  - Some COVID-related, but not exclusively
  - Technical issues for both ATLAS and CMS
- **Both ATLAS and CMS requested a one-year delay in the start of LS3 and a six month increase in its duration, to three years (2026-2029)**
- **CERN announced a new schedule at the end of January 2022**

Run-3 will go to the end of 2025

LS3 will be three years, ending in Jan 2029

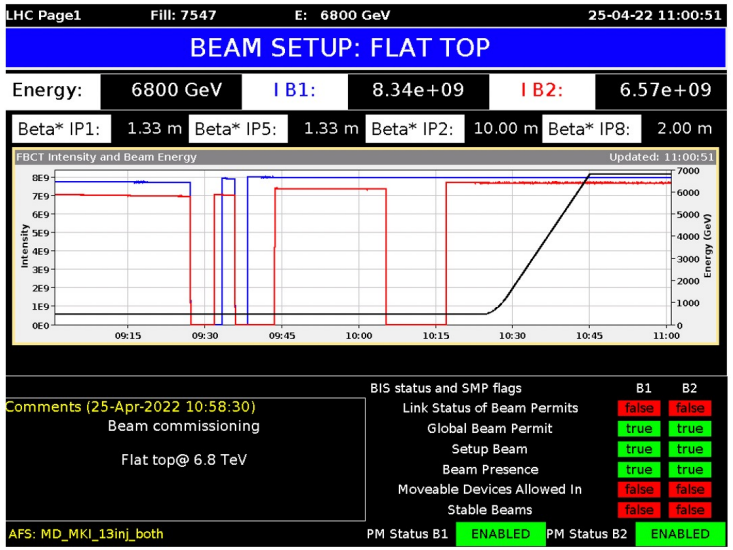
Run-3 Center-of-Mass Energy

- **Decision by CERN in June 2021 to fix $\sqrt{s}$ to 13.6 TeV for Run-3**
  - Based on risk (available spare dipoles and time if another warm-up needed)
- **Magnet training to 6.8 TeV completed (final sector S23) on Apr 11, 2022**
  - See [LHCP2022 talk by Mike Lamont]



Operations Ramp-up

- **Pilot beam in Oct 2021**
  - Parasitic beam splashes
  - Useful for (re)commissioning effort
- **First 6.8 TeV beams 22 April**
- **Dedicated beam splashes in Apr/May**



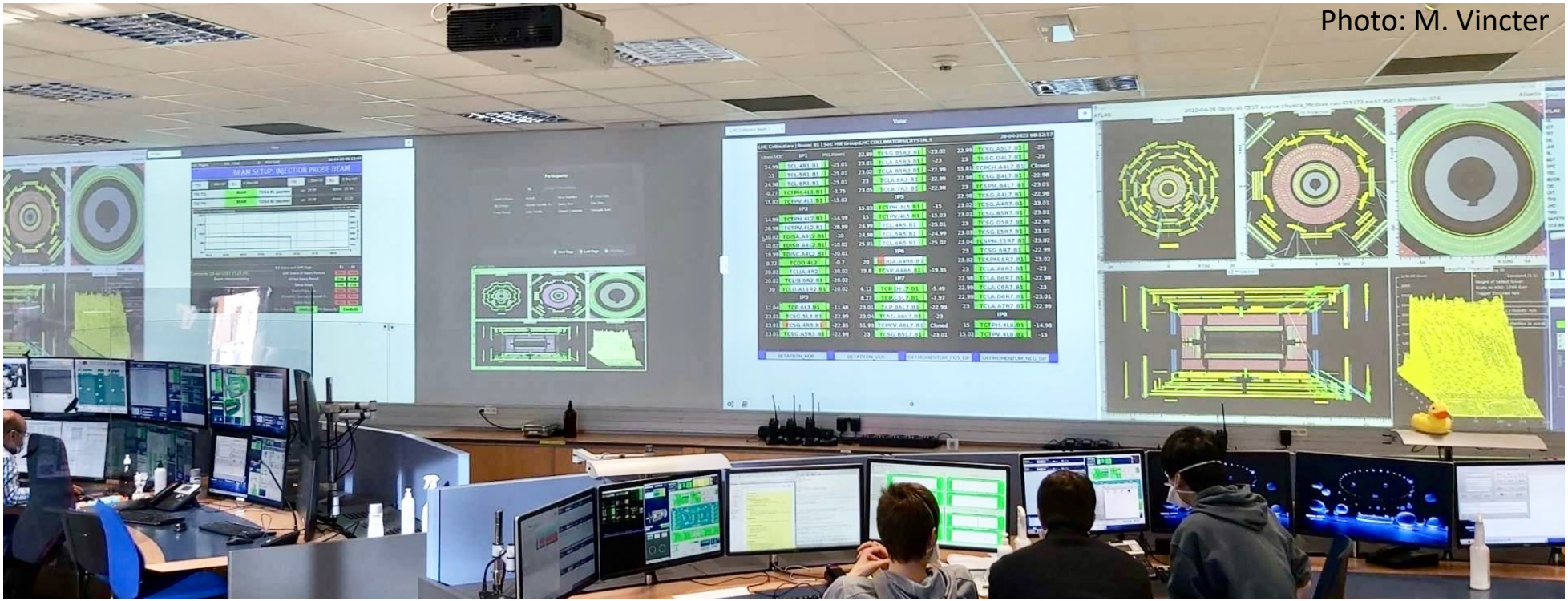
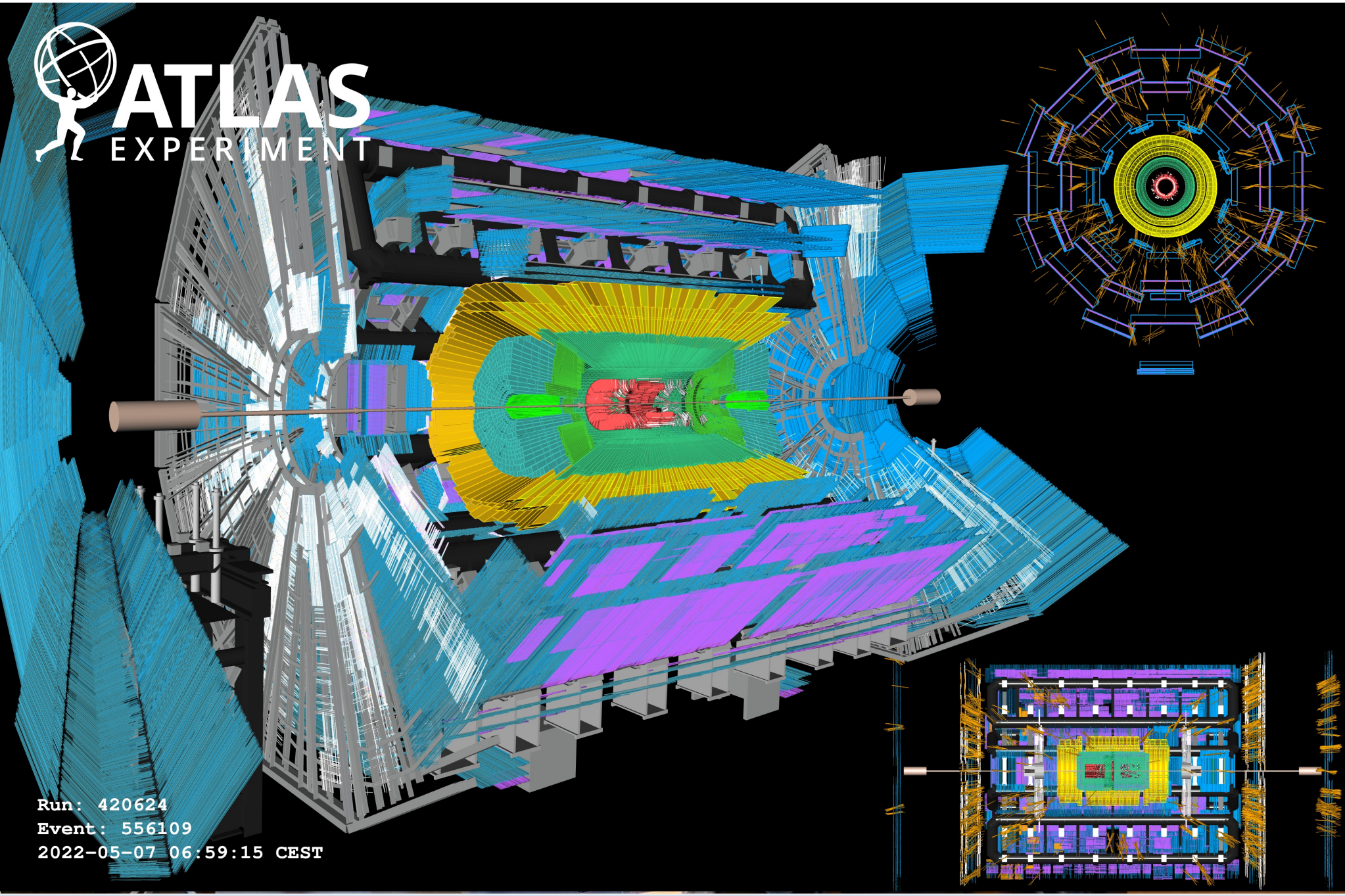


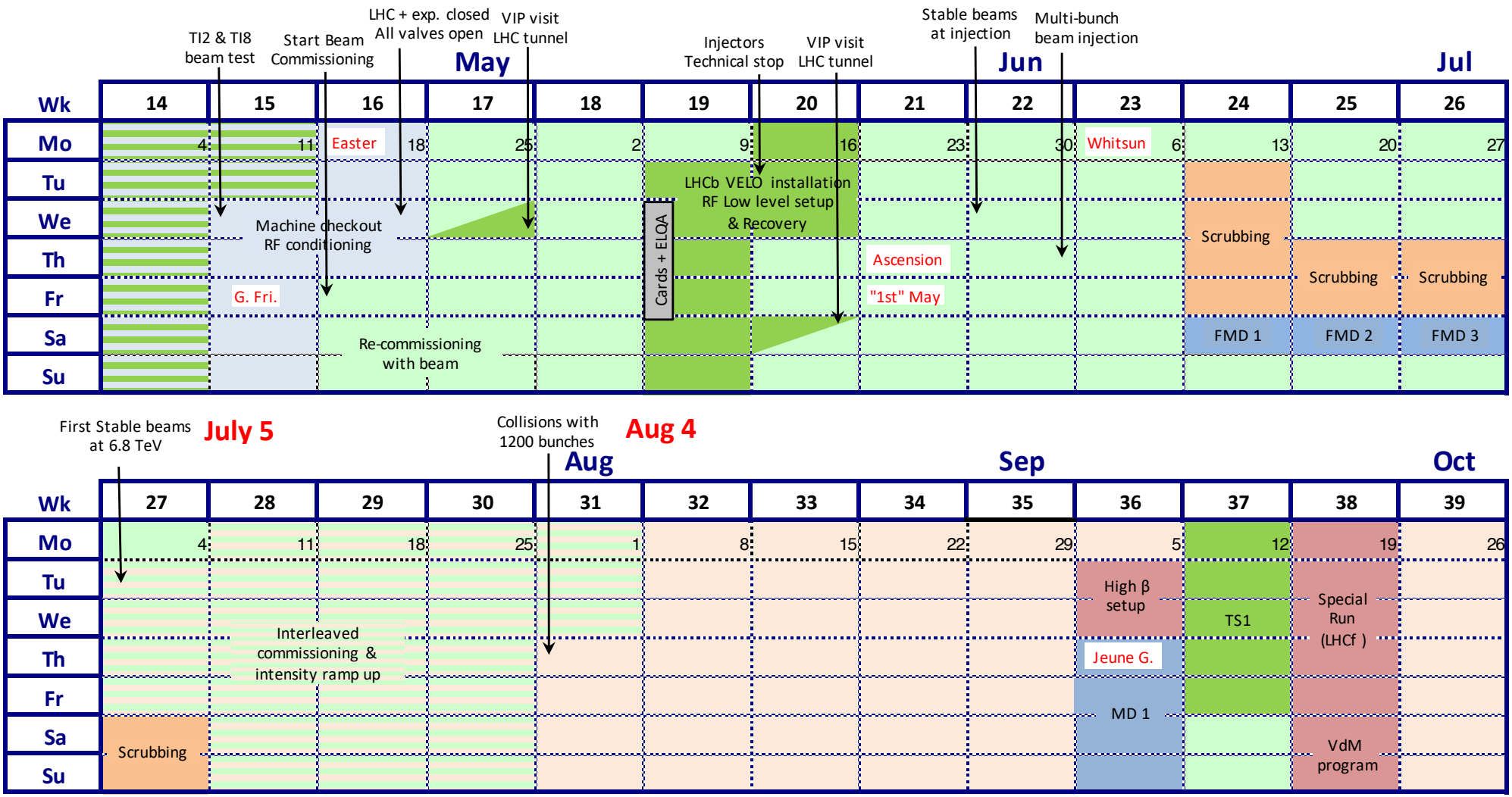
Photo: M. Vincter

Beam Splash (07 May)



Near-term Run-3 Schedule

[LHCC 2022 Schedule]



Near-term Run-3 Schedule

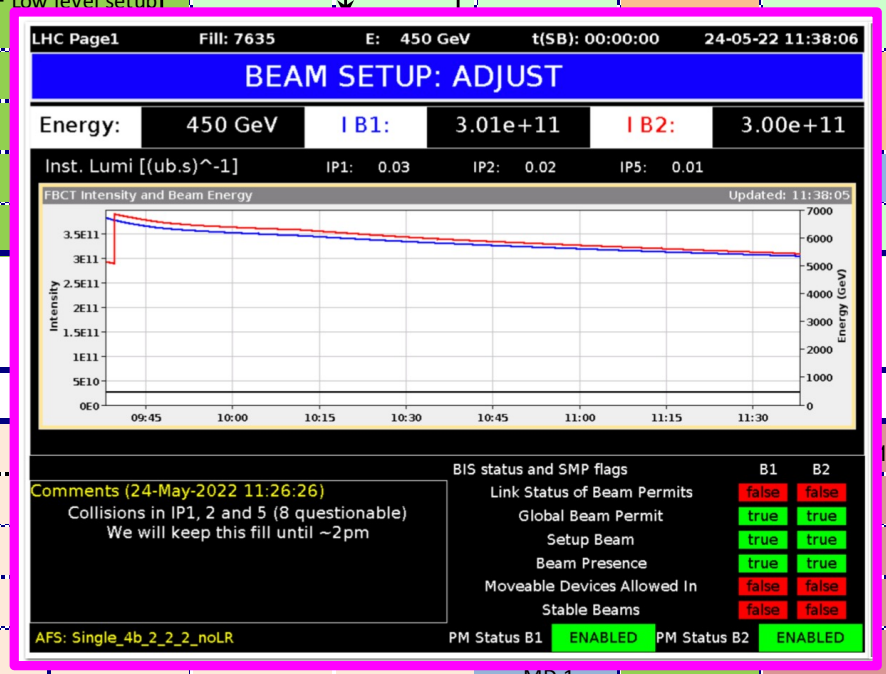
Frequent new milestones: May 24

First 900 GeV Collisions

LHCC 2022 Schedule

TI2 & TI8 beam test
Start Beam Commissioning
LHC + exp. closed All valves open
VIP visit LHC tunnel
Injectors Technical stop
VIP visit LHC tunnel
Stable beams at injection
Multi-bunch beam injection

Wk	14	15	16	17	18	19	20	21	22	23	24	25	26
				May					**Jun**				**Jul**
Mo	4	11	Easter 18	25	2	9	16	23	30	Whitsun 6	13	20	27
Tu						LHCb VELO installation RF Low level setup							
We		Machine checkout RF conditioning				Cards + ELOA							
Th													Scrubbing
Fr		G. Fri.											
Sa			Re-commissioning with beam										FMD 3
Su													



First Stable beams at 6.8 TeV
July 5
Collisions with 1200 bunches
Aug 4

Wk	27	28	29	30	31	32							39
					Aug								**Oct**
Mo	4	11	18	25	1							19	26
Tu													
We		Interleaved commissioning & intensity ramp up											
Th													
Fr										MD 1			
Sa	Scrubbing											VdM program	
Su													

ATLAS Canada Collaboration

Founded in 1992: M. Lefebvre, UVic

Spokespersons: R.S. Orr, U of T 1994–2007

R. McPherson, IPP/UVic 2007-2015

Alberta
Carleton
McGill
Montréal
SFU
Toronto
TRIUMF
UBC
Victoria
York

Current Management

Spokesperson, PI (2015 –): P. Krieger, U of T

Deputy: B. Vachon, McGill

Physics Coord: D. Gillberg, Carleton

Computing Coord: I. Trigger, TRIUMF

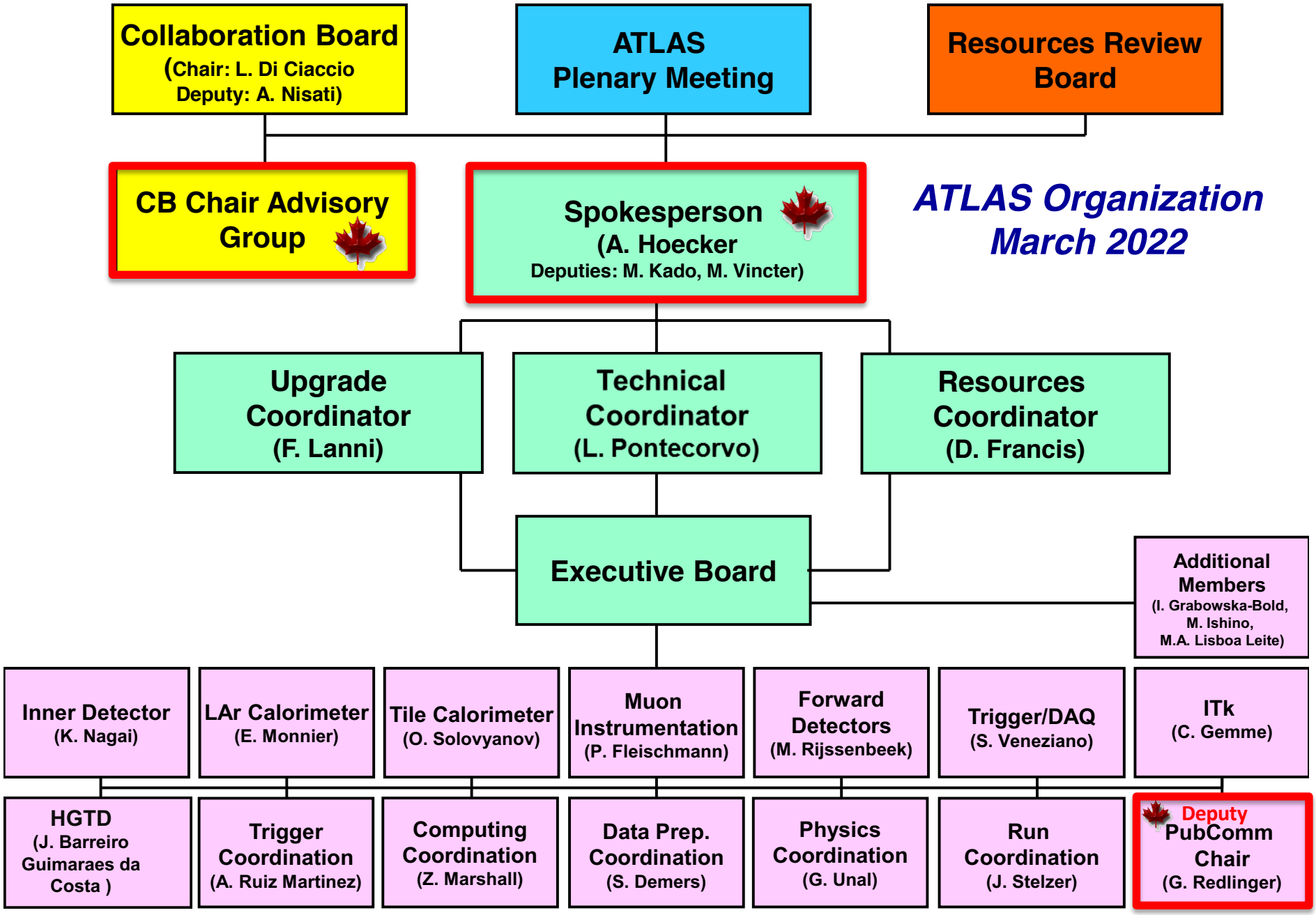
42 University/Lab faculty (36.7 FTE in 2022-23)

40 Postdocs, 85 GS (Oct 2021), ≈ 20 UG students/year

Plus engineers and technicians (some MRS funded)

Group includes 6 IPP Research Scientists (4.5 FTE)

ATLAS Collaboration Management



ATLAS Canada Roles

We continue to be well represented at all levels in the ATLAS Collaboration

- **Canadians playing key roles in ATLAS and the ATLAS Physics program**
  - *Current/Recent: Deputy Spokesperson, Physics Coordinator, Physics Group Conveners (Exotics), Performance Group Conveners (Jet/ETmiss, Tracking), MC Production Coordinator, Collaboration Board Advisory Group*
  - Also Physics and Performance Sub-group Conveners
  - Operations: subsystem Run Coordinators during Run-2: detector experts, computing; many activities continue during LS2 and into Run-3
  - Publications Committee, Speakers Committee, Authorship Committee
  - Beyond ATLAS (current):
    - Chair of LHCC Computing Resources Scrutiny Group (C-RSG)
    - Convenor, LHC EFT Working Group
- **Canada well represented in Phase-1 and Phase-2 upgrade projects**
  - Both technical leadership and management roles
    - Including leadership of sTGC part of the Muon NSW project
  - Phase-1 upgrades now being commissioned

ATLAS Canada Collaboration

Investigators		ATLAS Research FTE		
		2022-23	2023-24	2024-25
Justin Albert	Victoria	50%	50%	50%
Jean-François Arguin	Montréal	100%	100%	100%
Georges Azuelos	Montréal/TRIUMF	100%	100%	100%
Alain Bellerive	Carleton	100%	100%	100%
François Corriveau	McGill/IPP	80%	80%	80%
Claire David	York	50%	50%	50%
Matthias Danninger	SFU	75%	75%	75%
Colin Gay	UBC	100%	100%	100%
Dag Gillberg	Carleton	100%	100%	100%
Douglas Gingrich	Alberta/TRIUMF	100%	100%	100%
Kevin Graham	Carleton	90%	90%	90%
Jesse Heilman	Carleton	100%	100%	100%
Nigel Hessey	TRIUMF	100%	100%	100%
Nikolina Ilic	IPP/Toronto	75%	70%	70%
Richard Keeler	Victoria	100%	100%	100%
Thomas Koffas	Carleton	100%	100%	100%
Robert Kowalewski	Victoria	50%	50%	50%
Peter Krieger	Toronto	100%	100%	100%
Michel Lefebvre	Victoria	100%	100%	100%
Claude Leroy	Montréal	100%	100%	100%
Alison Lister	UBC/CRC	100%	100%	100%
Jean-Pierre Martin	Montréal	50%	50%	50%
Robert McPherson	Victoria/IPP	100%	100%	100%
Robert Orr	Toronto	100%	100%	100%
James Pinfold	Alberta	70%	70%	70%
Steven Robertson	McGill/IPP	25%	0%	0%
Heather Russell	Victoria	70%	70%	70%
Pierre Savard	Toronto/TRIUMF	100%	100%	100%
Pekka Sinervo	Toronto	50%	25%	0%
Randy Sobie	Victoria/IPP	70%	70%	70%
Oliver Stelzer-Chilton	TRIUMF	100%	100%	100%
Bernd Stelzer	SFU	100%	100%	100%
Max Swiatlowski	TRIUMF	100%	100%	100%
Reda Tafirout	TRIUMF	100%	100%	100%
Wendy Taylor	York	100%	100%	100%
Richard Teuscher	Toronto/IPP	100%	100%	100%
Isabel Trigger	TRIUMF	100%	100%	100%
William Trischuk	Toronto	100%	100%	100%
Brigitte Vachon	McGill	100%	100%	100%
Michel Vetterli	SFU/TRIUMF	100%	100%	100%
Manuella Vincter	Carleton	100%	100%	100%
Andreas Warburton	McGill	60%	60%	60%
Total		**36.7**	**36.1**	**35.9**

Starting new three-year grant cycle

last project grant (submitted Fall 2017) signed by 38 investigators: some have dropped off for this request.

42 investigators signed the new request

7 new investigators:

Jesse Heilman*	Carleton (Jul 2018)
Nikolina Ilic**	IPP/Toronto (Mar 2019)
Kevin Graham	Carleton (senior researcher)
Claire David**	York (August 2019)
Matthias Danninger*	SFU (Sep 2019)
Max Swiatlowski	TRIUMF (Oct 2019)
Heather Russell*	Victoria (Sep 2021)

* Previously an ATLAS-Canada RA

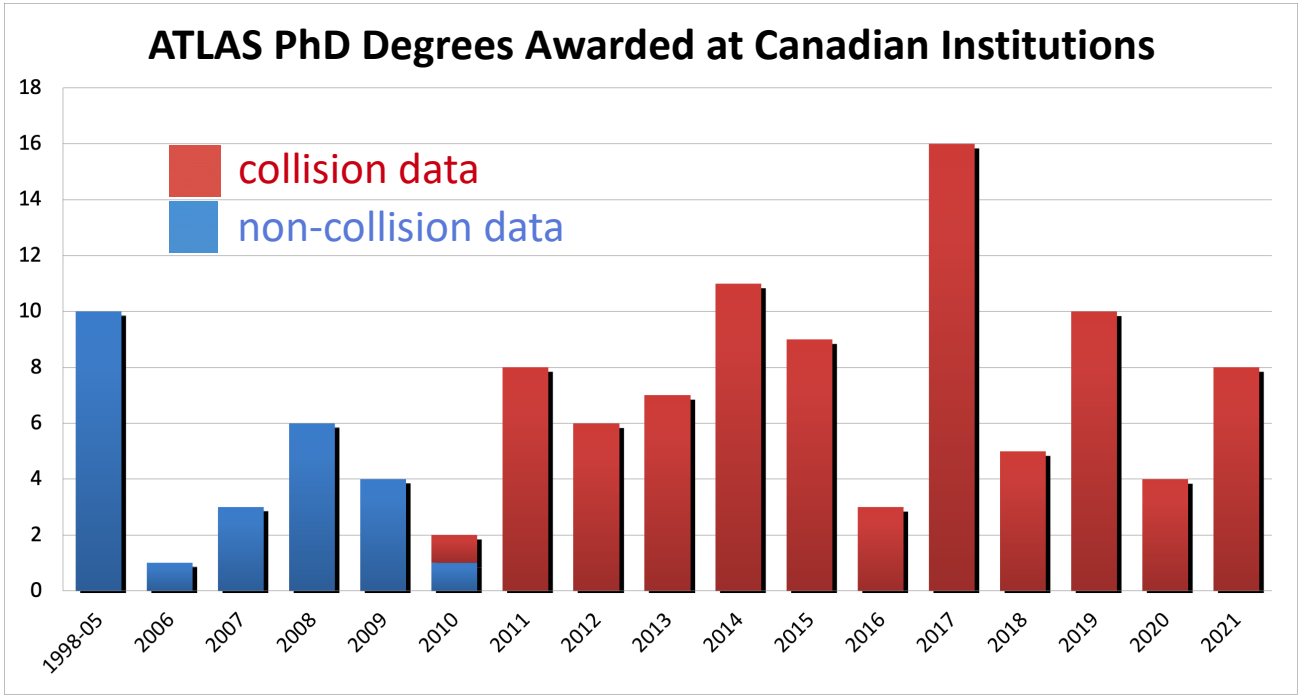
** Previously an ATLAS-Canada PhD student

These new investigator bring new expertise into the ATLAS-Canada Physics program

ATLAS Canada HQP

Training of Highly Qualified Personnel

- 117 PhDs awarded on ATLAS (May 2022)
  - 92 with collision data (Run 1, Run 2)
- More than 120 RAs have been trained within ATLAS Canada
- A number of ATLAS-Canada alumni (students, postdocs) hired into Canadian faculty positions in recent years (not only in collider physics)



4 PhD completions so far in 2022

22% to women (1998-22)
26% over last five years

First ATLAS-Canada diversity survey carried out in fall 2021

HQP Recognition in ATLAS

ATLAS 2020 Outstanding Achievement Awards

- ATLAS Canada PhD student (Vincent Wong, UBC): TRT DAQ upgrades
- 1 award to ATLAS Canada RA (Adriana Milic, U of T): LAr calorimeter operations
- 1 award to Clement Camincher (now a Victoria RA): LAr calorimeter operations

ATLAS Outstanding Achievement Award

Awarded by ATLAS Management every two years

ATLAS 2021 PhD Thesis Awards

- Jackson Burzynski (SFU) was one of the six winners

https://atlas.cern/discover/collaboration/awards

HQP Recognition in ATLAS

ATLAS 2022 Outstanding Achievement Awards

2022 outstanding achievement awards announced by email on Wednesday May 26

These include (**ATLAS-Canada members and Institutes highlighted**)

Bingxuan Liu (SFU), **Matthias Danninger (SFU)**, John Stupak, **Robin Newhouse (UBC)**, Giuliano Gustavino, **Jackson Carl Burzynski (SFU)**

*** For outstanding contributions to the integration of large-radius tracking into the standard ATLAS reconstruction**

Artur Coimbra, Aimilianos Koulouris, Luigi Longo, Alexander Naip Tuna, **Rimsky Alejandro Rojas Caballero (Victoria)**, Olga Zormpa, Chiara Arcangeletti, Rongkun Wang, Liang Guan, Siyuan Sun, Emanuele Romano, **Estel Perez Codina (TRIUMF)**, **Alam Toro (TRIUMF)**, **Gerardo Vasquez (Victoria)**, Camila Pazos, Giada Mancini, Polyneikis Tzanis

*** For outstanding contributions to the completion of the NSW integration and surface commissioning within the LS2 schedule**

ATLAS 2021 PhD Thesis Awards

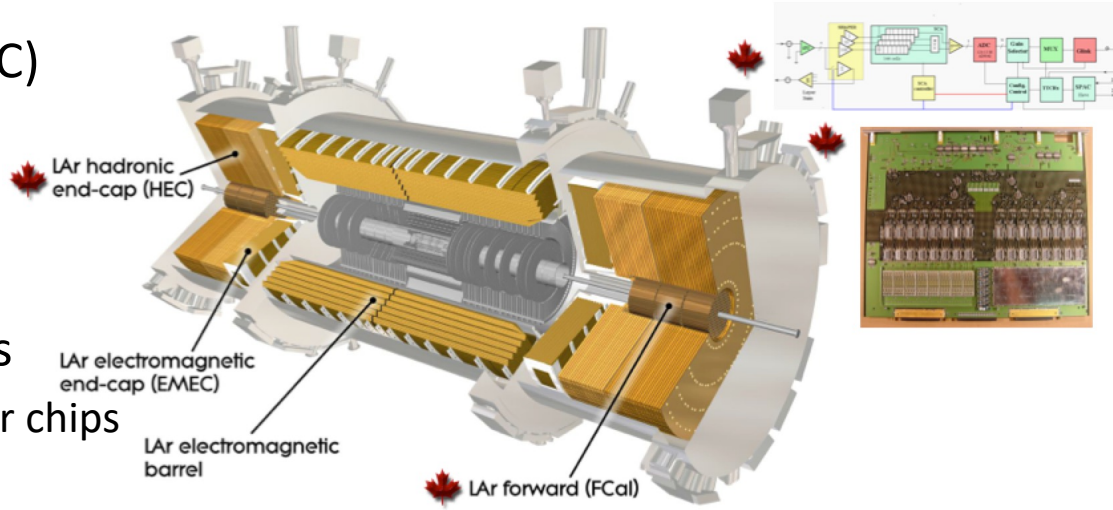
- Jackson Burzynski (SFU) was one of the six winners

https://atlas.cern/discover/collaboration/awards

Canadian Hardware Contributions to ATLAS

Canadian hardware contributions to ATLAS

- Hadronic Endcap calorimeter (HEC)
  - Two of four wheels
- Hadronic Forward calorimeter
  - All four modules
- Liquid argon front-end electronics
  - Switched capacitor array controller chips
- Liquid argon calorimeter endcap signal feed-throughs



Also a $40M Canadian contribution to the LHC and a contribution to the HL-LHC

- ATLAS Tier-1 and Tier-2 Computing facilities
- High-level trigger (HLT) processors
- Diamond Beam Conditions Monitor (also used for luminosity)
- MediPix / TimePix for cavern background monitoring, luminosity
- LUCID luminosity monitor and upgrade in LS1 (2013-2015)
- Diamond Beam Monitor (telescope) installed in LS1 (2013-2015)
- Inner Detector (TRT) readout
- ATLAS Forward Protons (AFP) – installation completed in 2016/17 shutdown
- *LAr Phase-1 trigger electronics, Muon New Small Wheels*

LHC/HL-LHC Schedule / ATLAS upgrade planning

- New Pixel insertable b-layer (IBL): DBM
- Consolidation of LAr calorimeter LVPS
- LUCID upgrade

Completed

Phase-1 Upgrades

- sTGC for Muon New Small Wheel
- Liquid Argon Calorimeter trigger electronics

Completed

Phase-2 Upgrades

- New ATLAS Inner Tracker (ITk)
- Liquid Argon Calorimeter readout electronics (FE, BE)

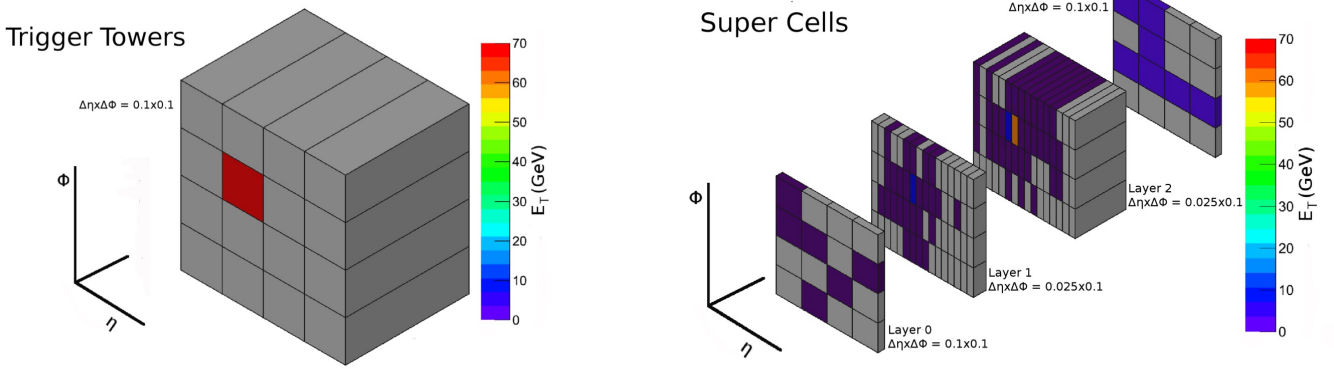
In progress

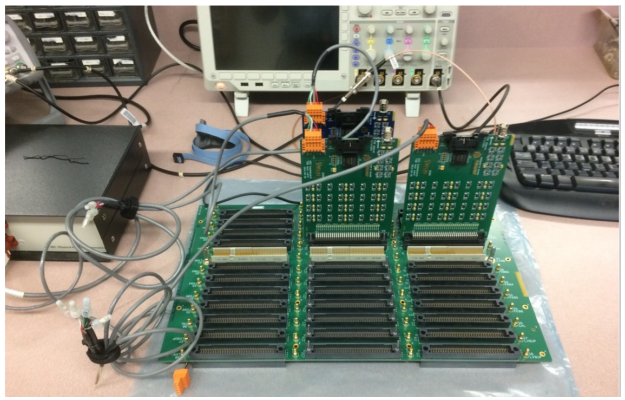
Main ATLAS Canada shutdown / upgrade activities

Phase-1 Upgrades: LAr Calorimeter Electronics

- **Key component of the ATLAS trigger strategy for Run-3**
- **Improve granularity of information supplied to the L1 trigger**
  - Provide additional background suppression (higher granularity) at trigger level

existing trigger → *upgraded trigger*

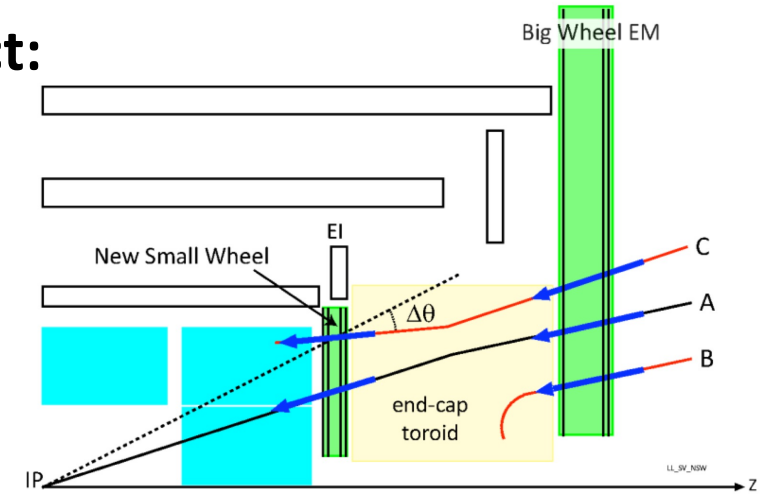


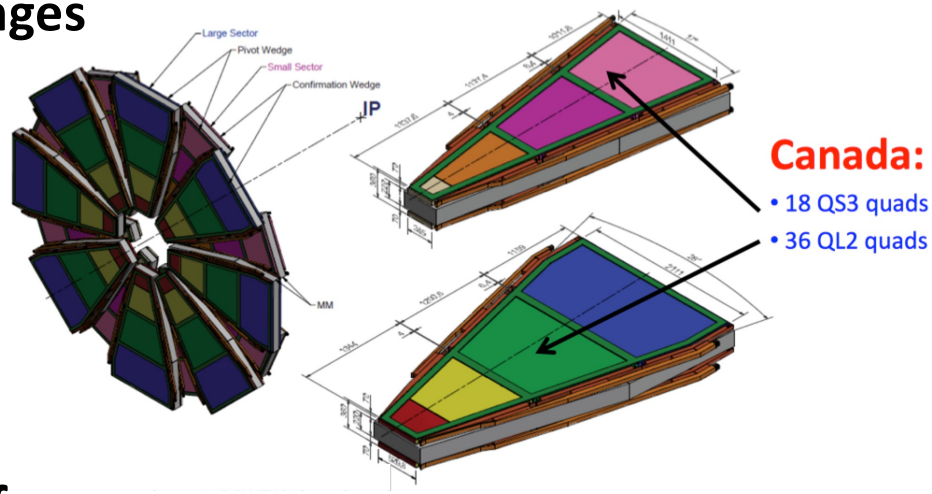


- **Implementation requires new Front-End Crate baseplanes**
- **For the HEC, these were developed and produced by TRIUMF / Victoria**
- **Installation of all LAr Phase-1 upgrades complete**
- **Commissioning in progress: *ATLAS-Canada members in leadership roles***

Phase-1 Upgrades: Muon New Small Wheel

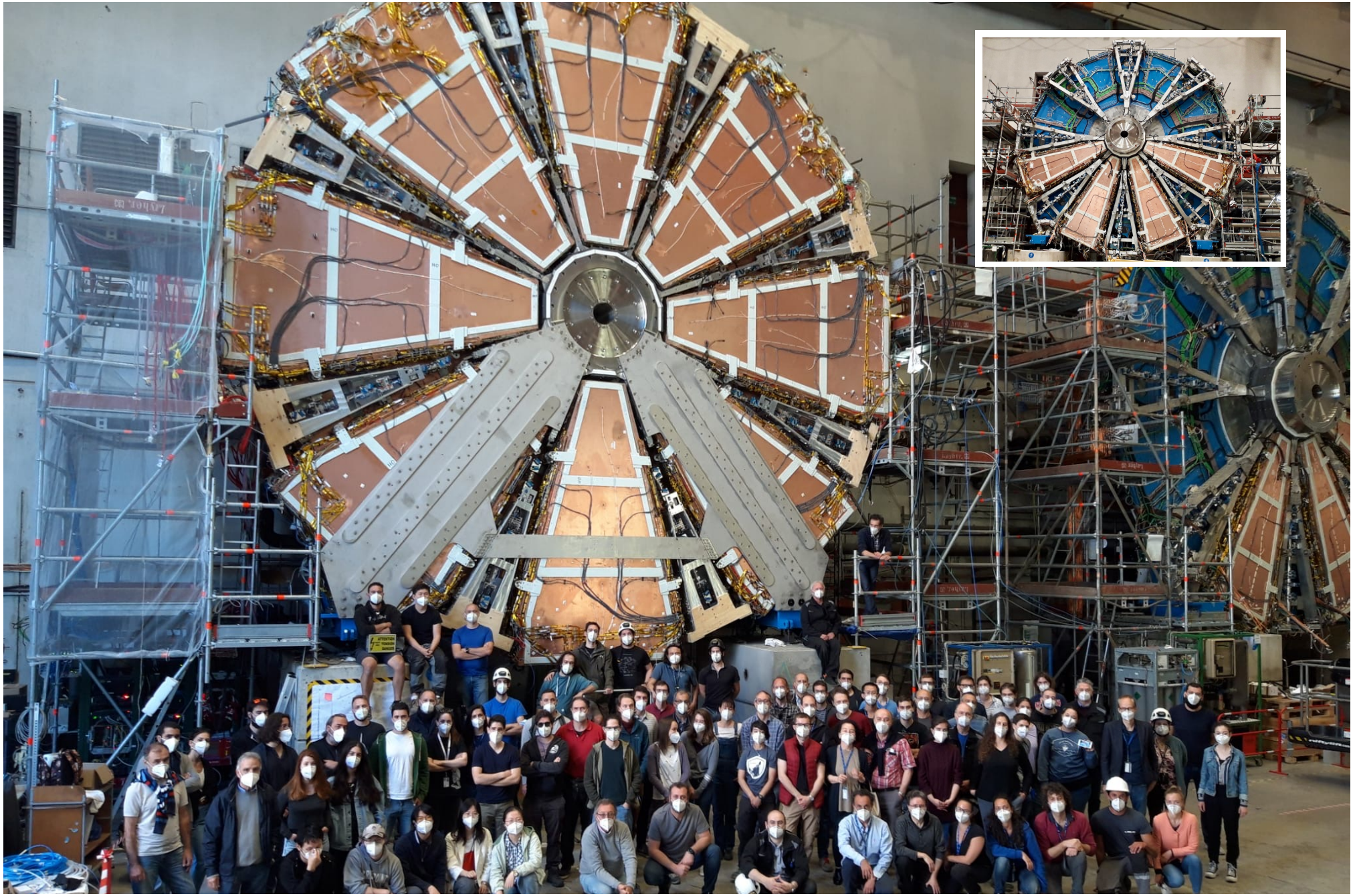
- **Key component of the Run-3 trigger (fake μ rejection with pointing)**
- **sTGC construction / testing: TRIUMF, Carleton, McGill, Victoria**
- **Leading coordination roles in NSW project:**
  - Leadership of sTGC project
  - Overall project management, schedule, finances
  - Wedge assembly at CERN
  - Software / simulation
  - Electronics / software for cosmic-ray test station
  - Production test pulser board for sTGCs
- **Complicated project with technical challenges**
  - Plus COVID-19 pandemic
  - One-year extension of LS2 allowed installation of both NSWs
  - This required a heroic effort by the international team, including many ATLAS-Canada members
- **This is the ATLAS highlight of the past few years**



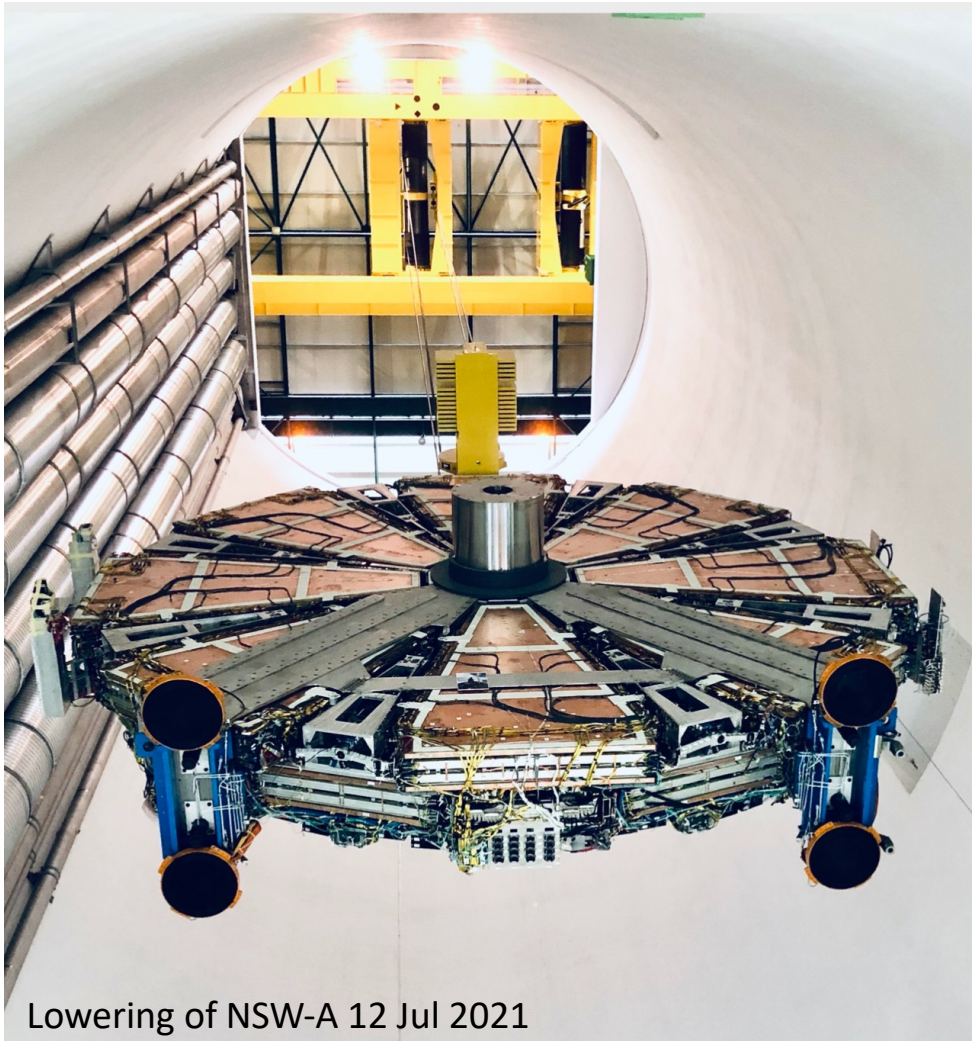


Canada: ¼ of all sTCG modules

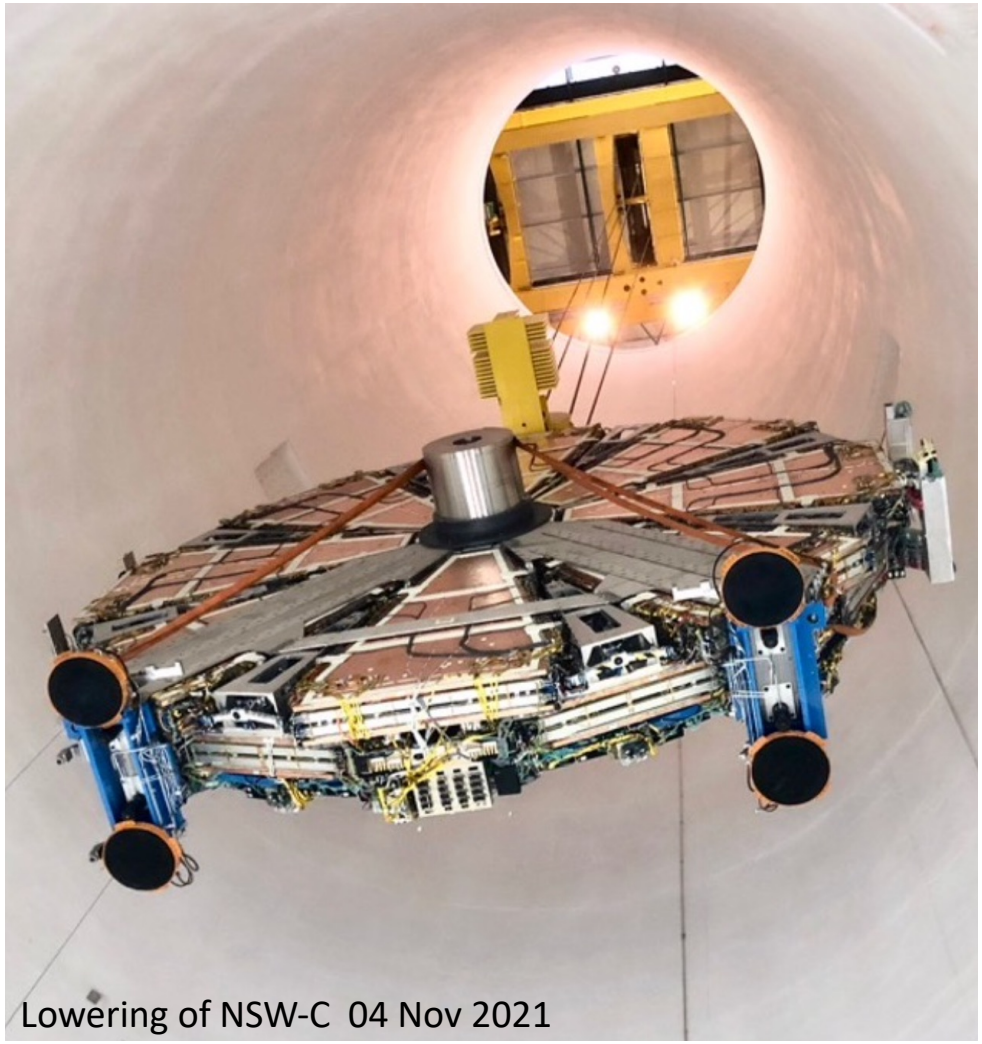
ATLAS New Small Wheel (NSW-A)



Lowering of the Muon NSW into the ATLAS Cavern



Lowering of NSW-A 12 Jul 2021

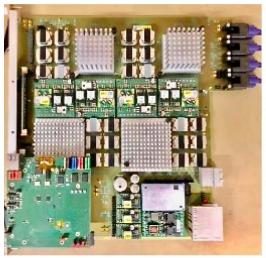


Lowering of NSW-C 04 Nov 2021

ATLAS Run-3 Trigger

eFEX

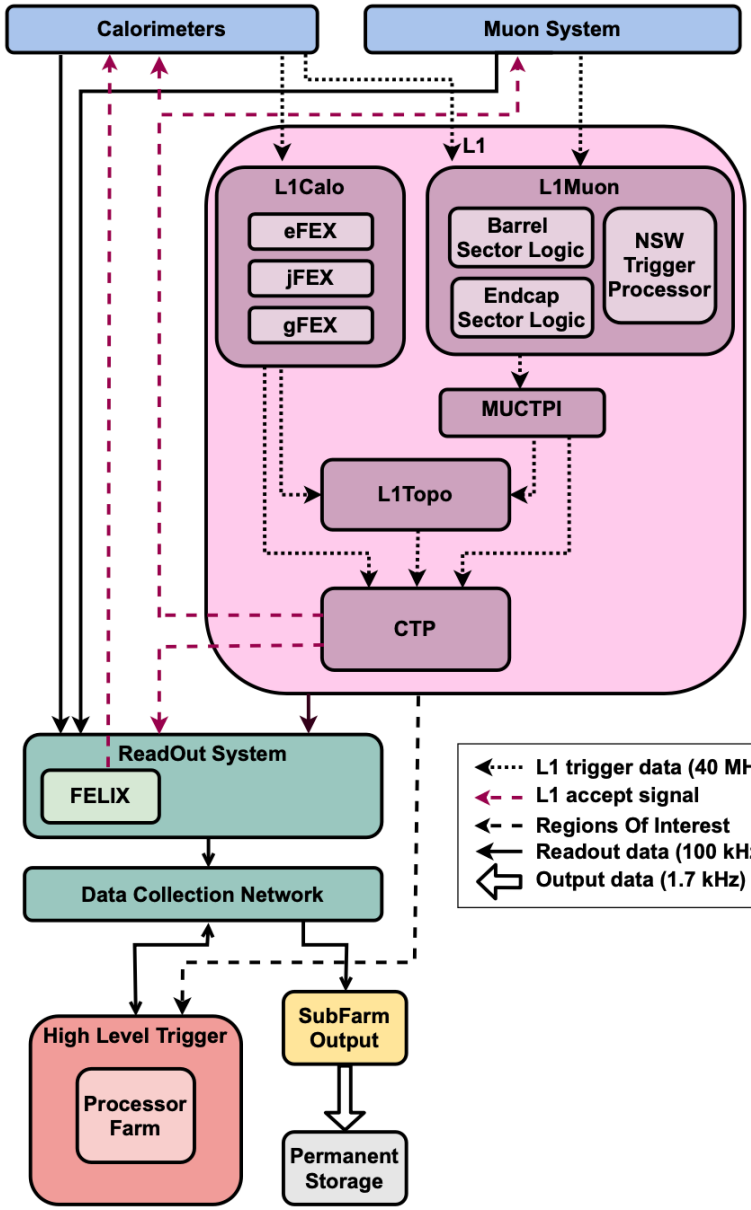
50% of eFEX boards still in production

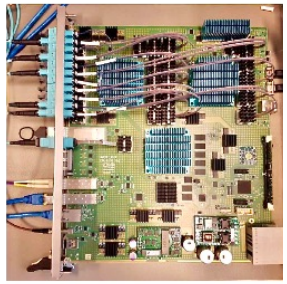


jFEX

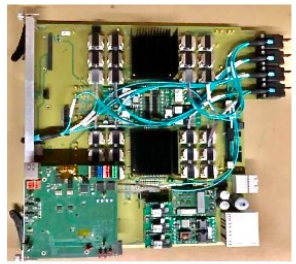
gFEX

FELIX IO card





MUCTPI



L1Topo

ATLAS Detector Readiness for Run 3

ATLAS Run-3 Detector Status (from May 2022, START OF RUN 3)

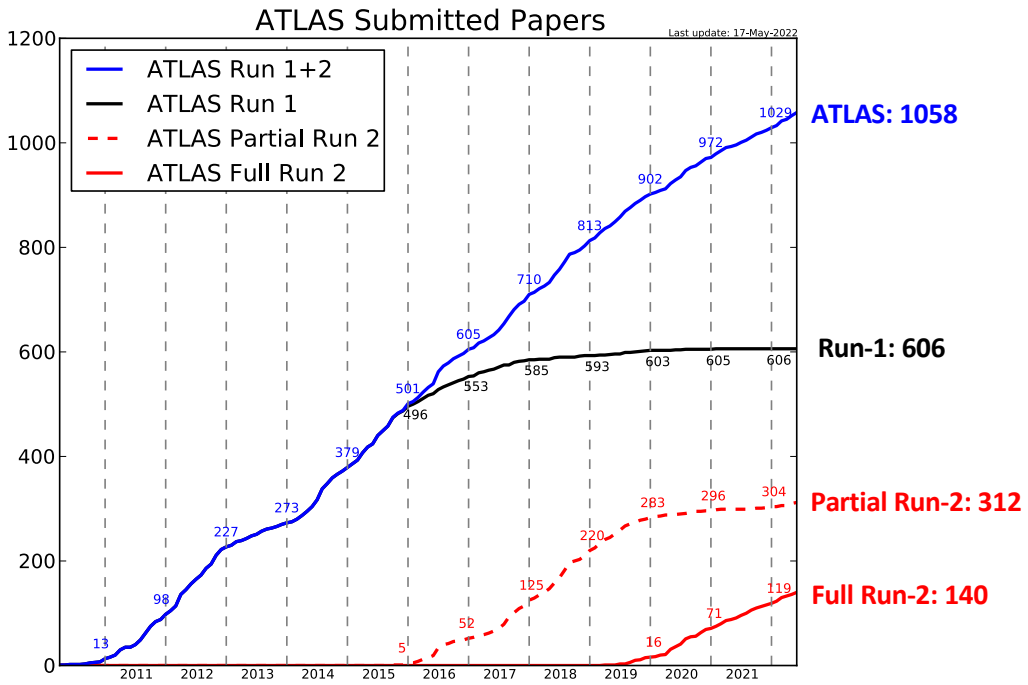
Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	92 M	96.7%
SCT Silicon Strips	6.3 M	98.3%
TRT Transition Radiation Tracker	350 k	96.6%
LAr EM Calorimeter	170 k	100%
Tile Calorimeter	5200	99.2%
Hadronic End-Cap LAr Calorimeter	5600	99.9%
Forward LAr Calorimeter	3500	99.8%
LVL1 Calo Trigger	7160	99.9%
LVL1 Muon RPC Trigger	383 k	99.8%
LVL1 Muon TGC Trigger	312 k	100%
MDT Muon Drift Tubes	344 k	99.7%
MicroMegas NSW	2.1 M	98.0%
STGC NSW	358 k	99.2%
RPC Barrel Muon Chambers	383 k	87.7%
TGC End-Cap Muon Chambers	312 k	99.4%
ALFA	10 k	100%
AFP	430 k	100%
LUCID	2x16	100%
ZDC	2x20	100%

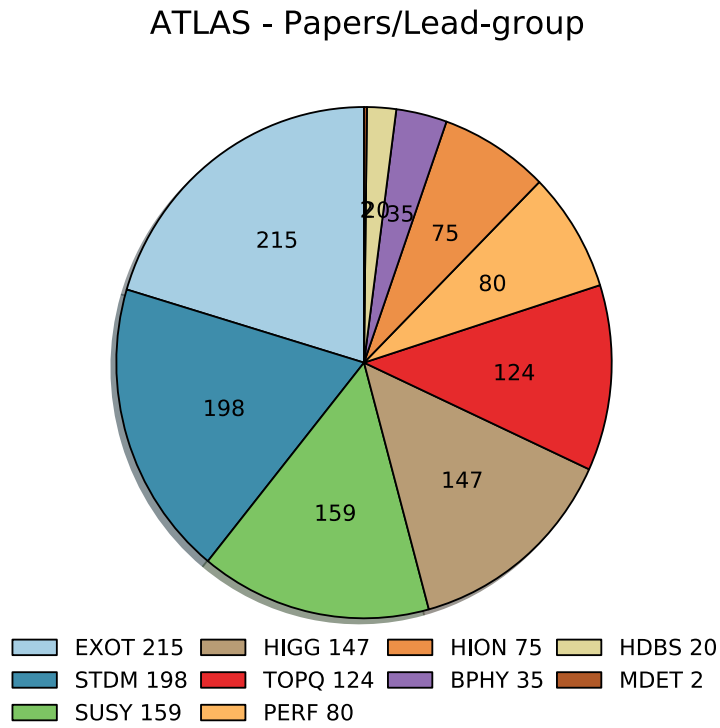
LVL1 Calo legacy only. Phase-I digital trigger will be included after commissioning is complete

ATLAS Run-2 Detector Status (from March 2019, END OF RUN 2)

Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	92 M	95.7%
SCT Silicon Strips	6.3 M	98.6%
TRT Transition Radiation Tracker	350 k	97.2%
LAr EM Calorimeter	170 k	100 %
Tile Calorimeter	5200	99.5%
Hadronic End-Cap LAr Calorimeter	5600	99.7%
Forward LAr Calorimeter	3500	99.8%
LVL1 Calo Trigger	7160	99.9%
LVL1 Muon RPC Trigger	383 k	100%
LVL1 Muon TGC Trigger	320 k	99.9%
MDT Muon Drift Tubes	357 k	99.7%
CSC Cathode Strip Chambers	31 k	93.0%
RPC Barrel Muon Chambers	383 k	93.3%
TGC End-Cap Muon Chambers	320 k	98.9%
ALFA	10 k	99.9%
AFP	430 k	97.0%

ATLAS Scientific Results: Publications





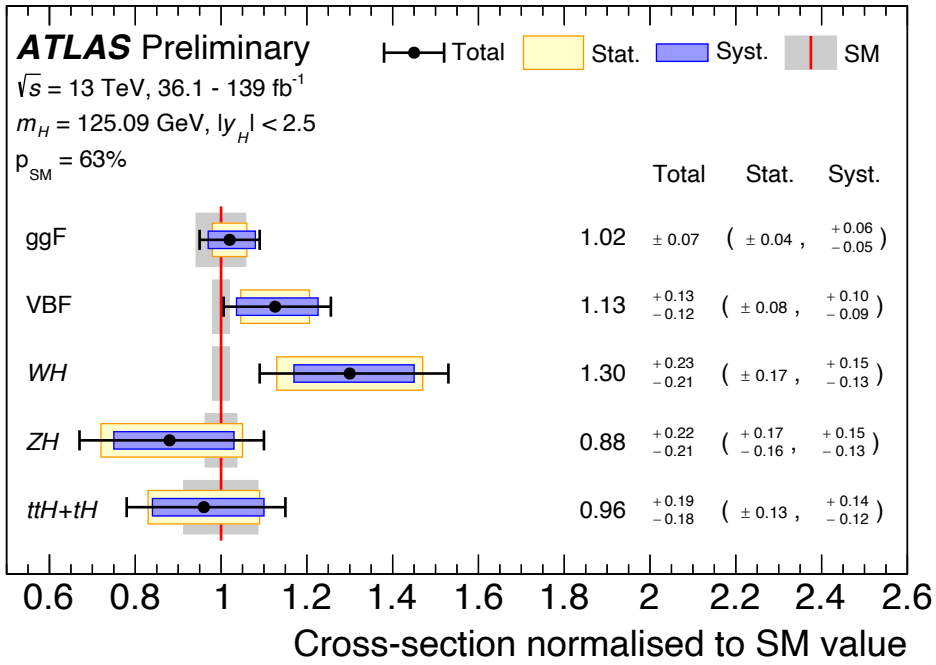
- Direct Canadian contributions to the analysis for about 30% of these (year-by-year) in particular to
  - Higgs boson studies (mass, couplings, cross-sections, diHiggs)
  - Other standard model measurements (W, Z, top….)
  - Searches for BSM physics, including growing focus on long-lived particles

Focus here on just a very few specific topics

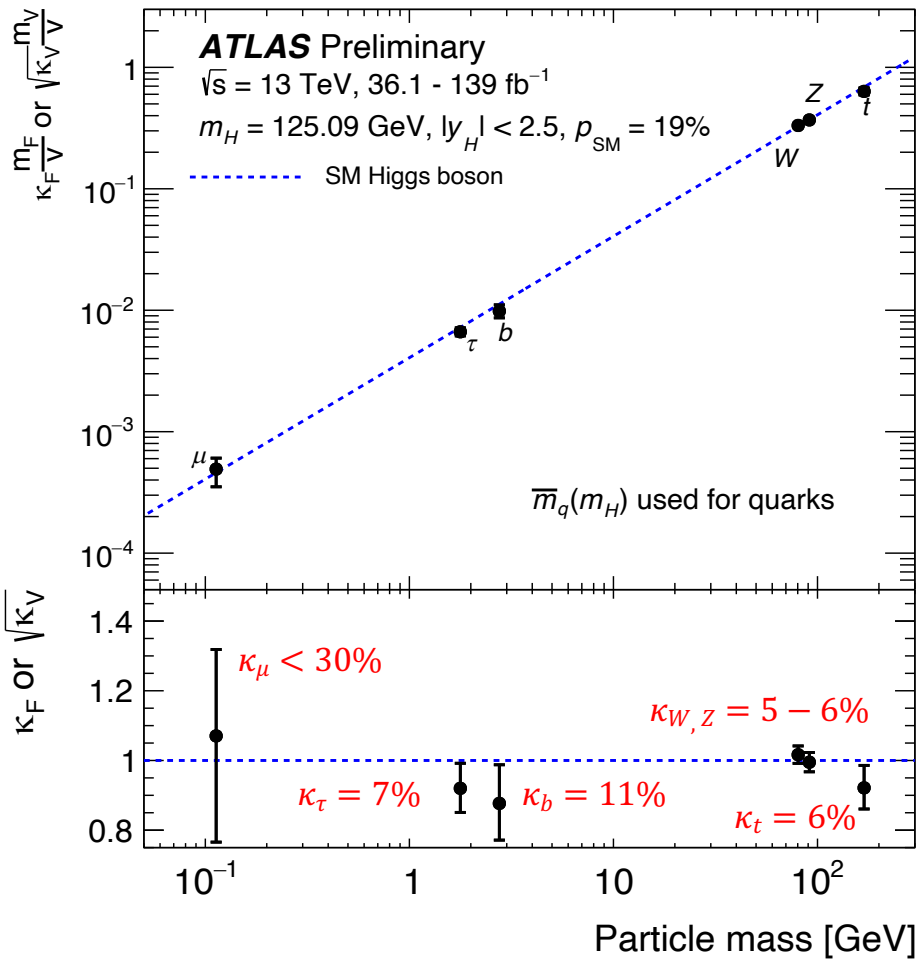
Higgs Cross-sections and Couplings

Increased precision on Higgs couplings strengths

ATLAS-CONF-2021-053



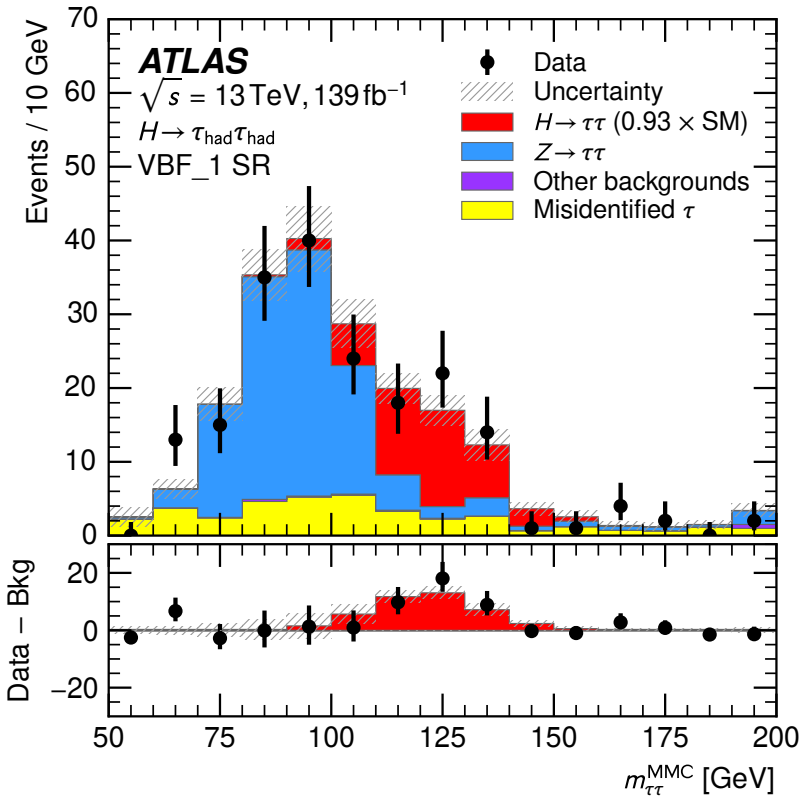
Global fit yields a signal strength measurement of **μ = 1.06 ± 0.06**

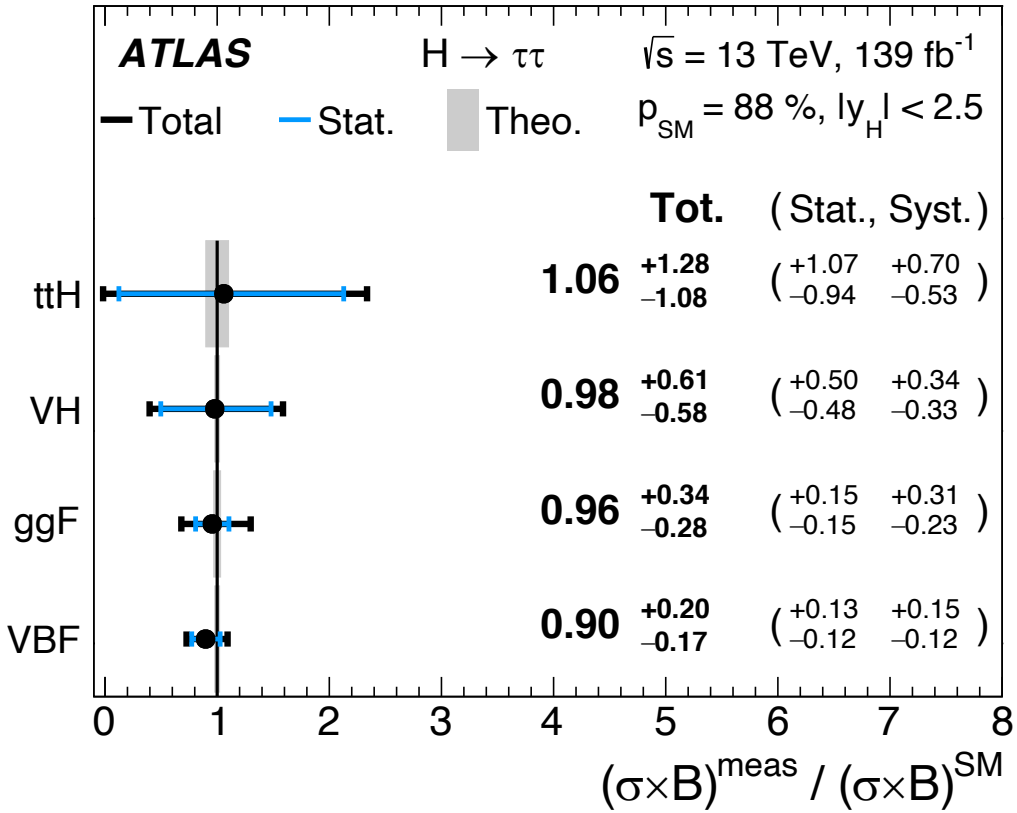


Higgs to $\tau\tau$

Updated measurement of $H \to \tau\tau$ based on full Run-2 dataset arXiv: 2201.08268

With improved statistical and systematic uncertainties



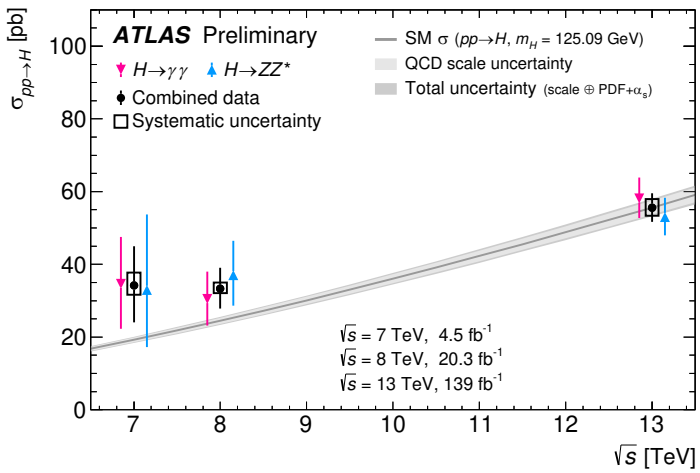


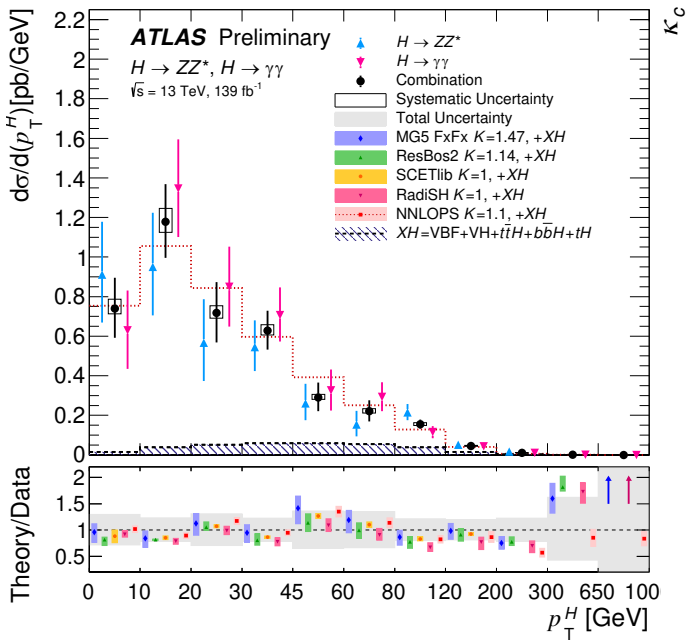
Measured production cross-section: $2.94 \pm 0.21(stat) \pm^{0.37}_{0.32}(syst)\ pb$

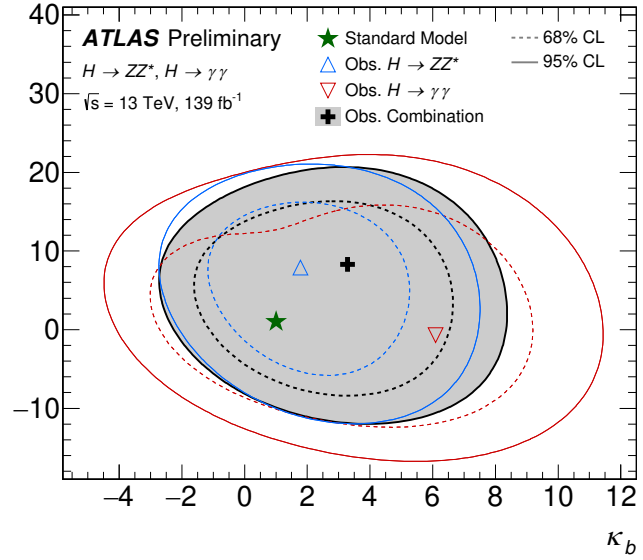
SM prediction: $3.17 \pm 0.09\ pb$

Combined Cross-section Measurements

Combined total and differential cross-sections in $H \to \gamma\gamma$ and $H \to ZZ^* \to 4\ell$







Measured total cross-section at 13 TeV: $55.5 \pm \begin{matrix}4.0\\3.8\end{matrix} pb$. Standard Model: $55.6 \pm 2.8\ pb$

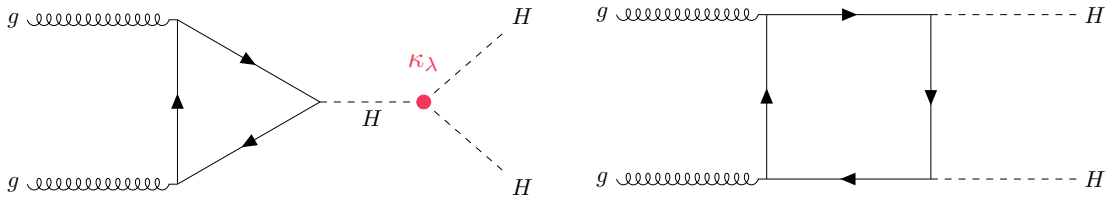
- Differential cross-sections N_{jets}, $p_{T,H}$ (shown), $|y_H|$ and $p_{T,\text{ leading jet}}$
- Constraints on charm and bottom Yukawa couplings from p_T shape only (shown)

A separate analysis excludes equal c and b Yukawa couplings at 95%CL arXiv:2201.11428

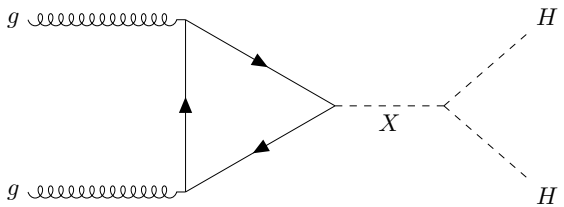
Di-Higgs (HH) Production

Also recent involvement in di-Higgs searches

Higgs self-coupling $(bb\gamma\gamma)$ arXiv: 2112.11876



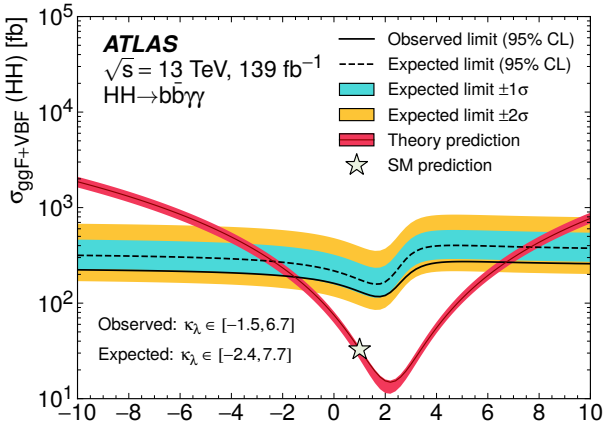
Resonant di-Higgs production $(bbbb)$ arXiv: 2202.07288

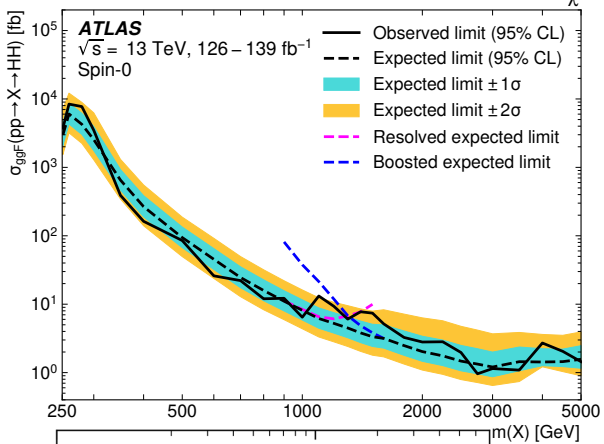


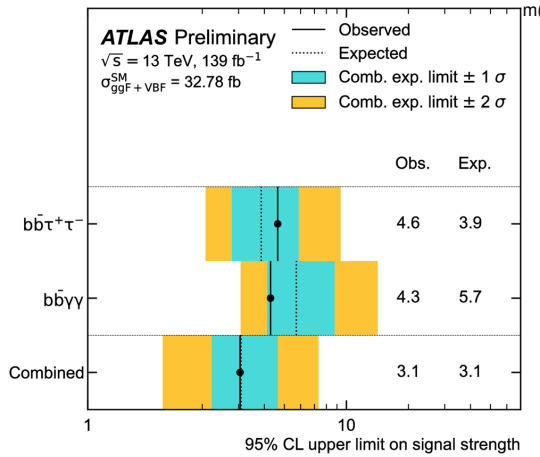
Limits also provided for case of a spin-2 mediator

Combined cross-section limits: ATLAS-CONF-2021-052

Combined cross-section limit from $bb\gamma\gamma$ and $bb\tau\tau$ reaches $3.1 \times \sigma_{SM}$







Long-Lived Particle (LLP) Searches

- **Numerous papers in recent years led by or with strong contributions from the Canadian group**
  - In particular young new investigators
  - Two recent results highlighted today

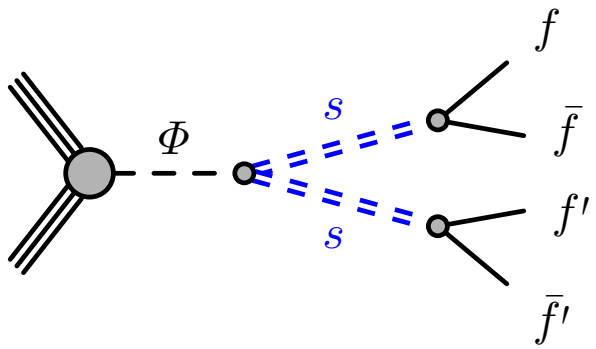
- **Strong contributions to new related analysis and reconstruction techniques, e.g.**
  - Adversarial Deep Neural Networks for signal / background separation
  - New track and secondary vertex reconstruction techniques

    Just recognized by 2022 ATLAS Outstanding achievement award

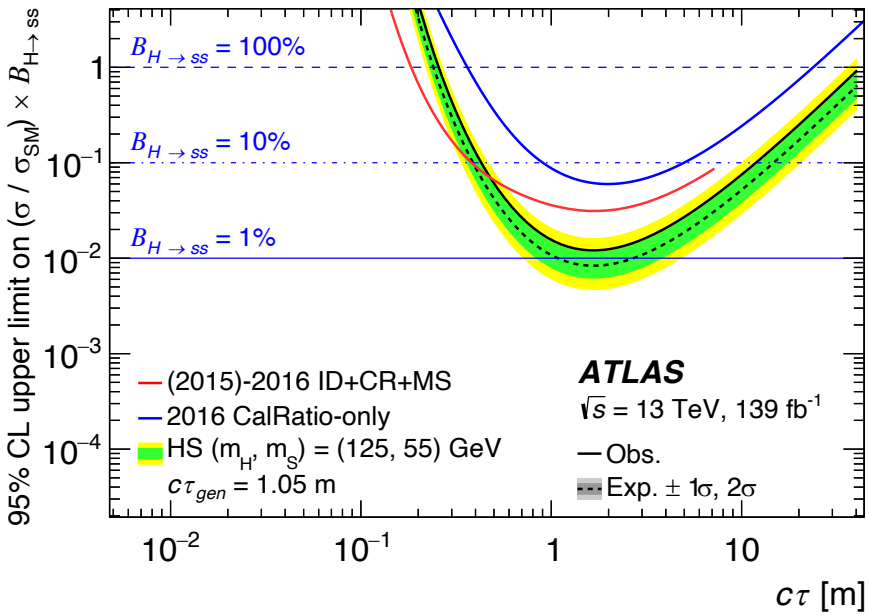
- **Leadership roles in related Physics and Performance groups**
  - Leadership of ATLAS combined performance tracking group
  - Leadership of ATLAS Exotics physics working group
  - Leadership of Exotics subgroup on unconventional signatures

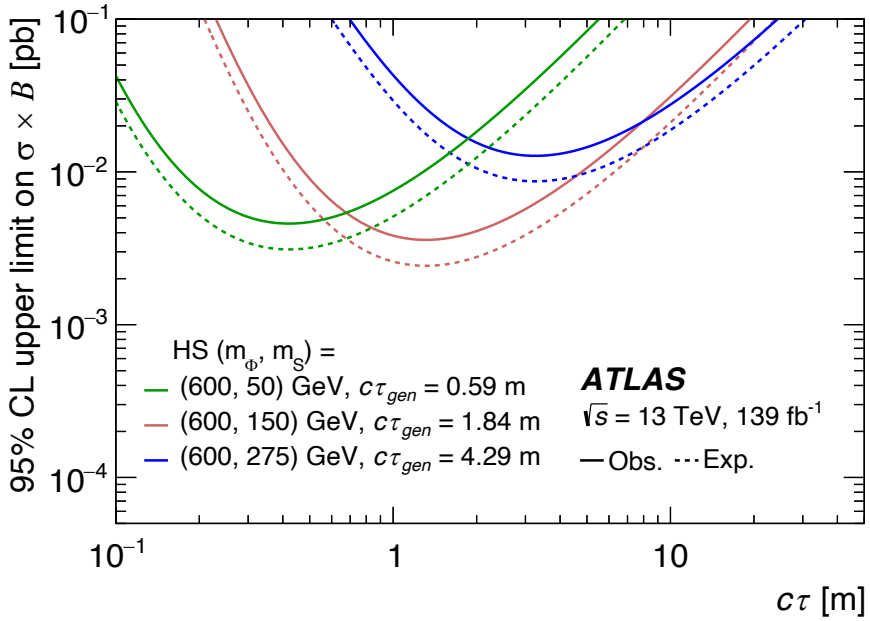
Long-Lived Particle (LLP) Searches

Search for neutral LLPs decaying into displaced hadronic jets arXiv: 2203.01009



Interpretations in term of (left) searches for Higgs decays to two scalars and (right) hidden sector models where Φ is not the SM Higgs boson

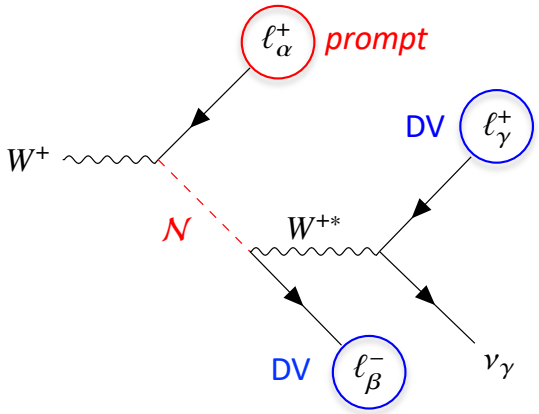


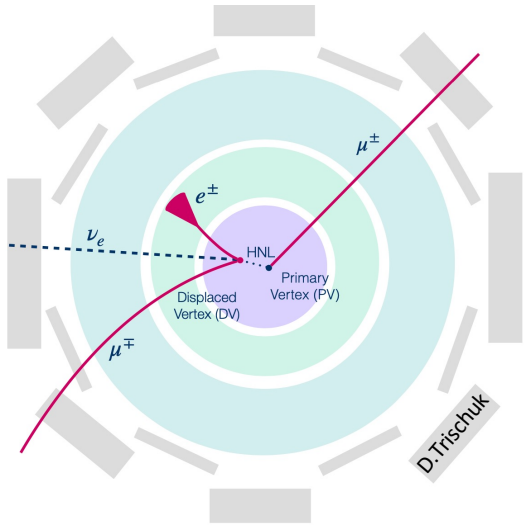


Long-Lived Particle (LLP) Searches

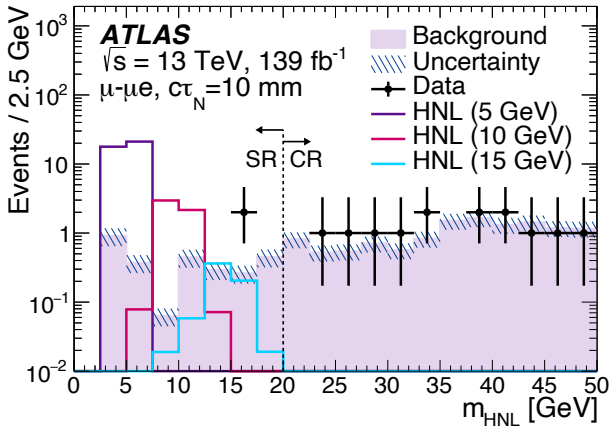
Displaced Vertex Search for Heavy Neutral Leptons

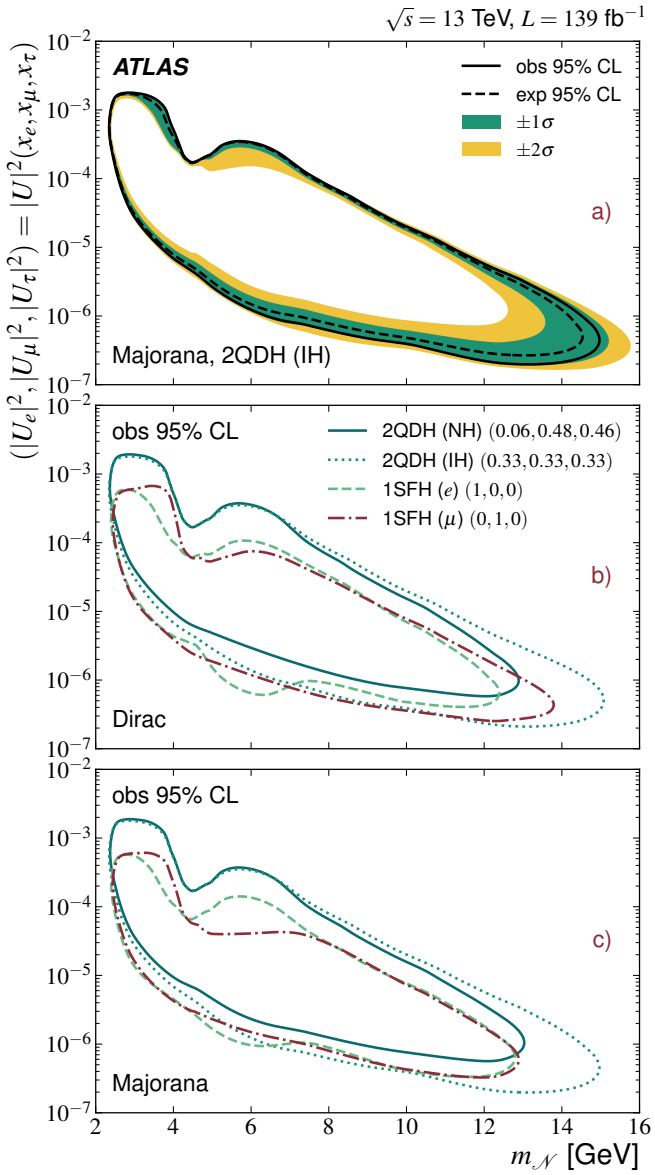
aXiv:2204:11988





- Six signal regions:
  - $eee, e\mu\mu, ee\mu$
  - $\mu ee, \mu\mu\mu, \mu e\mu$
- Limits for both normal and inverted hierarchies (for 2QDH model)
- Dominique Trischuk (UBC) won the 2022 CAP PPD thesis prize for her work on this analysis





.....and many other results

ATLAS-Canada Student talks at 2022 CAP Congress

- ***Relative luminosity measurement and long-term stability studies with ATLAS-TPX network during LHC Run-2***: Muhammad Usman (Université de Montreal)
- ***Measurement of the W Boson Drell-Yan Angular Coefficients with the ATLAS detector***: Alexander Bachiu (Carleton)
- ***Measurements of the production cross section for the collinear emission of a Z boson from a jet in pp collisions at 13 TeV with the ATLAS detector***: Alexandre Laurier (Carleton)
- ***Search for multiquark states decaying to neutral strange particles: $K0_S$ and Λ0 (or $\Lambda0^-$)***: Antara Paul (McGill)
- **Most precise measurement of the top-quark pair production cross-section in the single-lepton channel**: Sahibjeet Singh (U of T)
- ***Search for single production of a vector-like T quark decaying into a Higgs boson and top quark with fully hadronic final states using the ATLAS detector***: Joel Foo (U of T)
- ***Projection studies of non-resonant Higgs boson pair production in the bbbb final state at the HL-LHC using the ATLAS detector***: Colm Sam (UBC)
- ***Displaced Vertex Search for Heavy Neutral Leptons with the ATLAS Detector***: Dominique Trischuk (UBC) [**PPD thesis prize talk**]

Also four Invited ATLAS talks at CAP Congress

ATLAS at the High Luminosity LHC

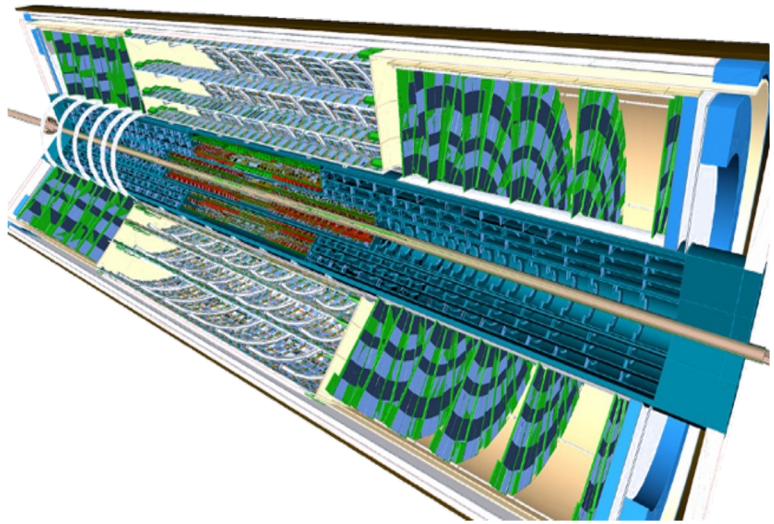
- **Proposed instantaneous luminosity of 7.5×10^{34} cm^{-2}s^{-1} ($\mu \approx 200$)**
  - Needed for the desired (×10) increase in integrated luminosity
    - Rate and accumulated dose causes problems for some detector subsystems
    - Need for pileup suppression becomes crucial issue for detector upgrades
- **Proposed L0 trigger scheme with rate of 1MHz is incompatible with existing tracker and calorimeter readout electronics:**
  - **Calorimeter on- and off-detector electronics must be entirely replaced**
  - **Tracker to be entirely replaced by a new all-silicon tracker, the ITk**
    - Pixels at low radius, strips at higher radius.
      - Coverage out to $|\eta| = 4.0$ (from 2.5 for current inner tracker)
    - 160 m^2 of silicon. Almost half the cost / effort of Phase-2 upgrades
- **Also other upgrades: Canada involved only in the ones just described**
  - We have multiple technical leadership & management roles in both projects
  - Involvement of industry in some tasks
  - Local infrastructure at production sites in place
    - Entering pre-production phase for ITk

For more details than I can include here, see the talk by Richard Teuscher later today

Inner Tracker Upgrade (ITk)

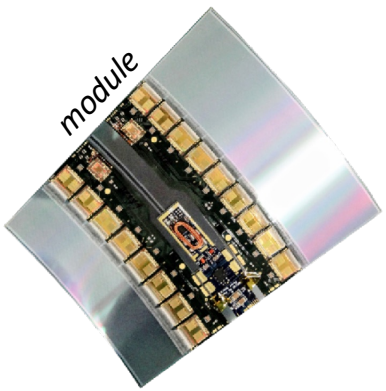
Canadian Contributions include

- 50% of hybrids (module readout) for the Endcaps Strips system
- All silicon-strip modules for  "petals"
  - These make up the endcap disks
  - Canada will produce 84 of these, or about 20%
- Silicon sensor QA (50%) and QC
- ASIC probing and dicing (50%)

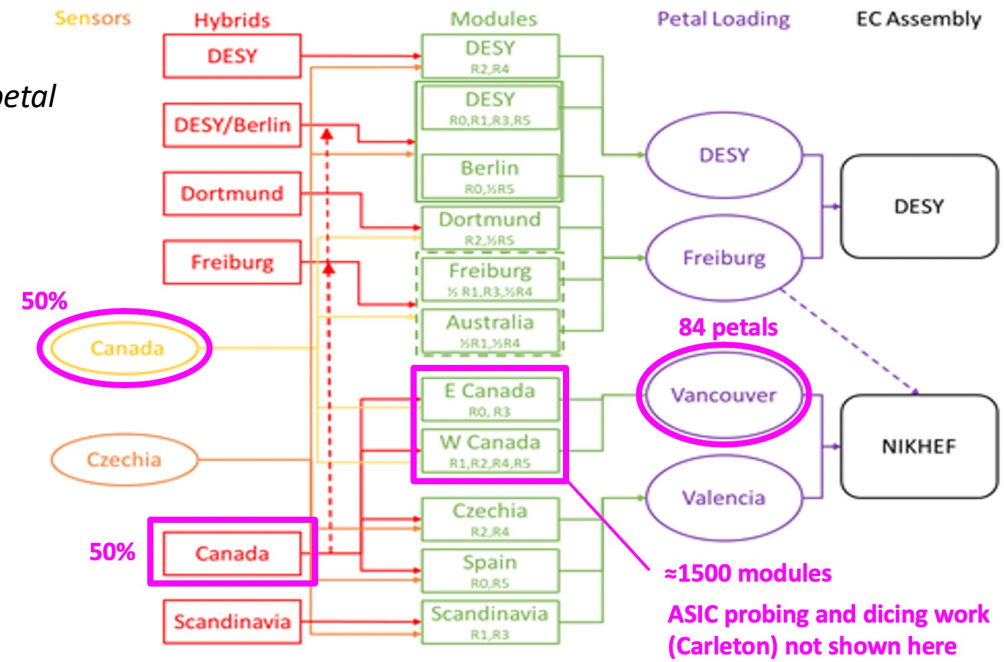


hybrid

module



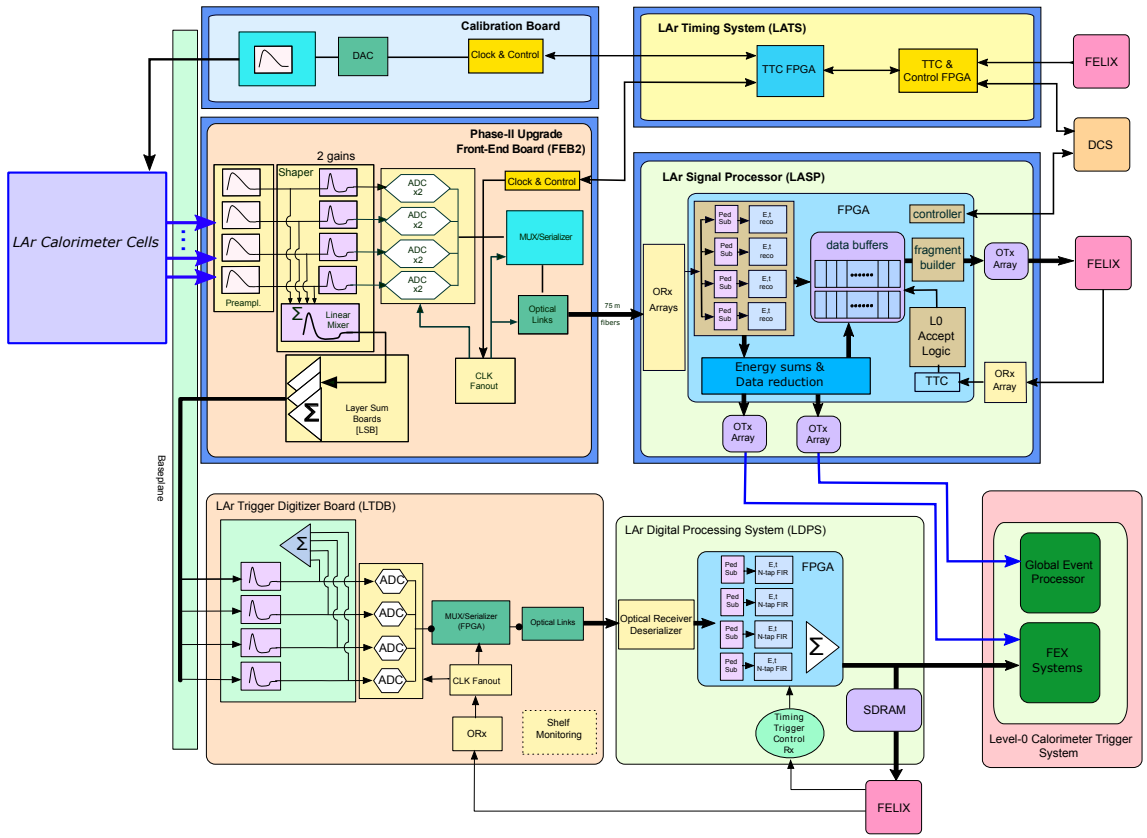
petal



Canadian CFI-funded infrastructure in place. Now entering preproduction phase

Phase-2 LAr Calorimeter Upgrades

- **Digitize and stream calorimeter data from new on-detector electronics to new off-detector electronics at 40MHz**
- **As already done for the new Phase-1 digital trigger which will remain in place for the HL-LHC era**



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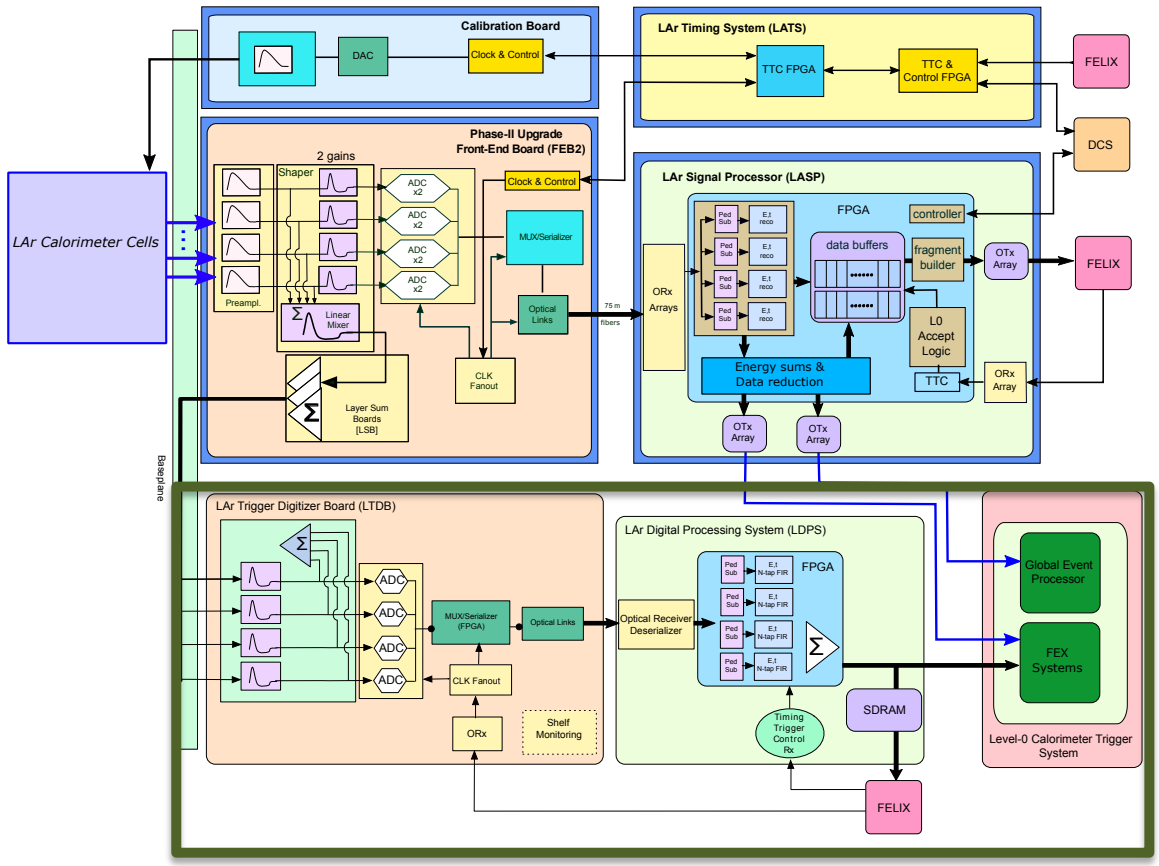

Phase-1 digital trigger (being commissioned)

Phase-2 LAr Calorimeter Upgrades

- **Digitize and stream calorimeter data from new on-detector electronics to new off-detector electronics at 40MHz**
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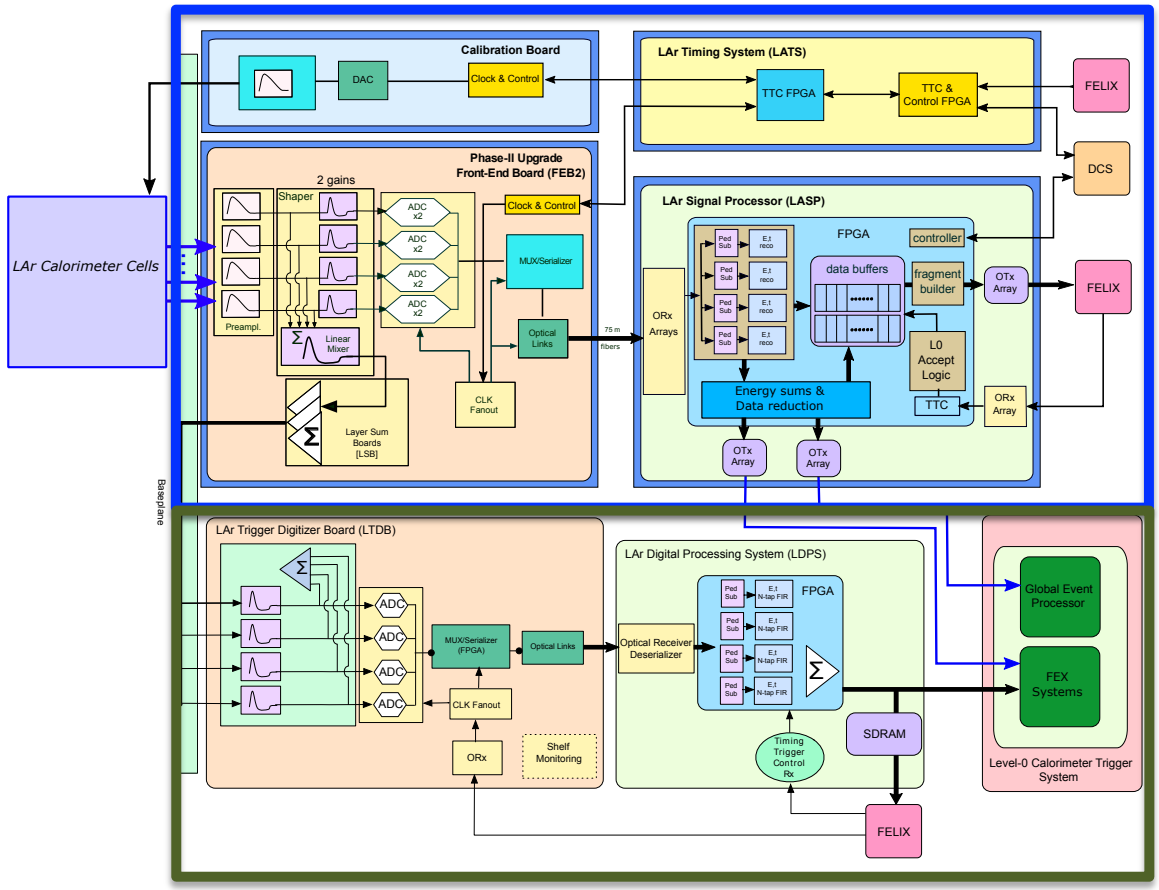
Phase-2 readout path



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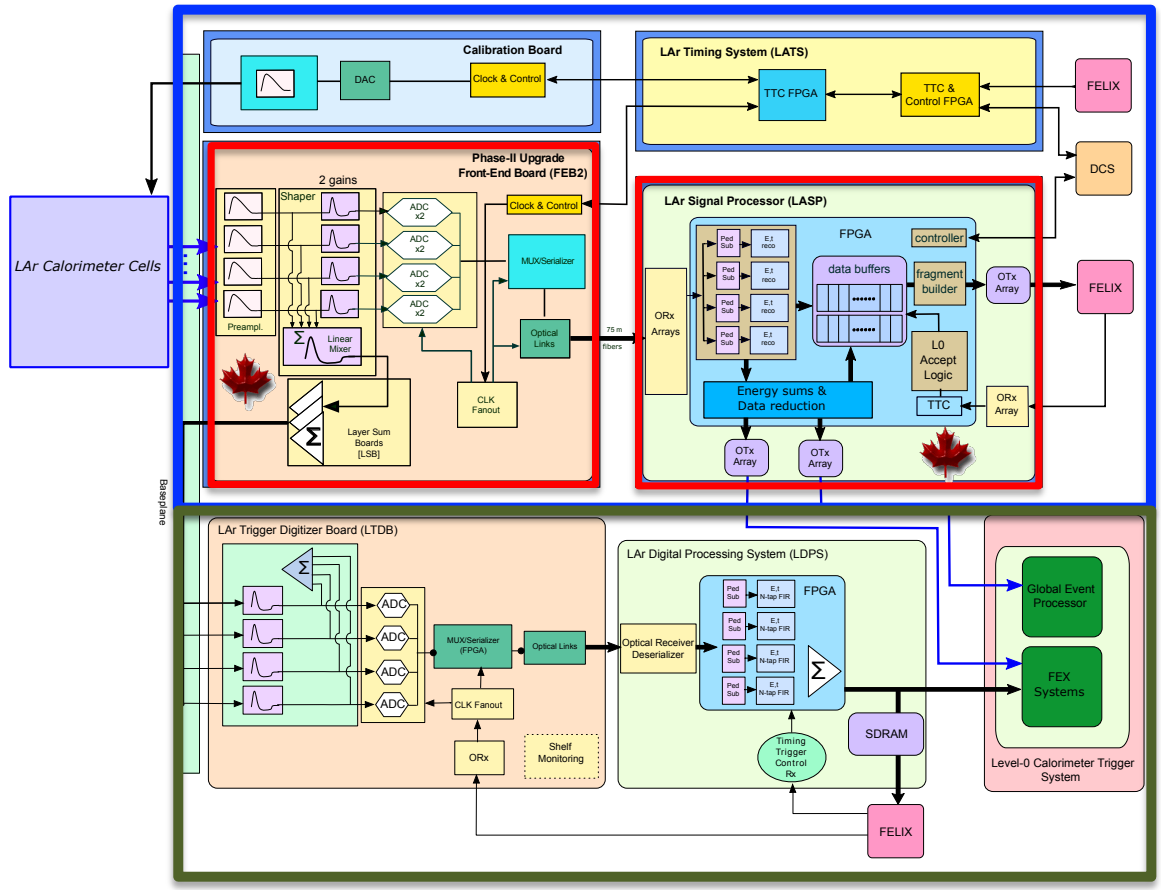
Phase-2 LAr Calorimeter Upgrades

- **Digitize and stream calorimeter data from new on-detector electronics to new off-detector electronics at 40MHz**
- **As already done for the new Phase-1 digital trigger which will remain in place for the HL-LHC era**
- **Strong contributions to:**
  - HEC readout ASIC
  - LASP board design/testing
    - Including algorithms for energy and timing reconstruction
  - LASP firmware

Phase-2 readout path



Phase-1 digital trigger (being commissioned)

Phase-2 LAr Calorimeter Upgrades

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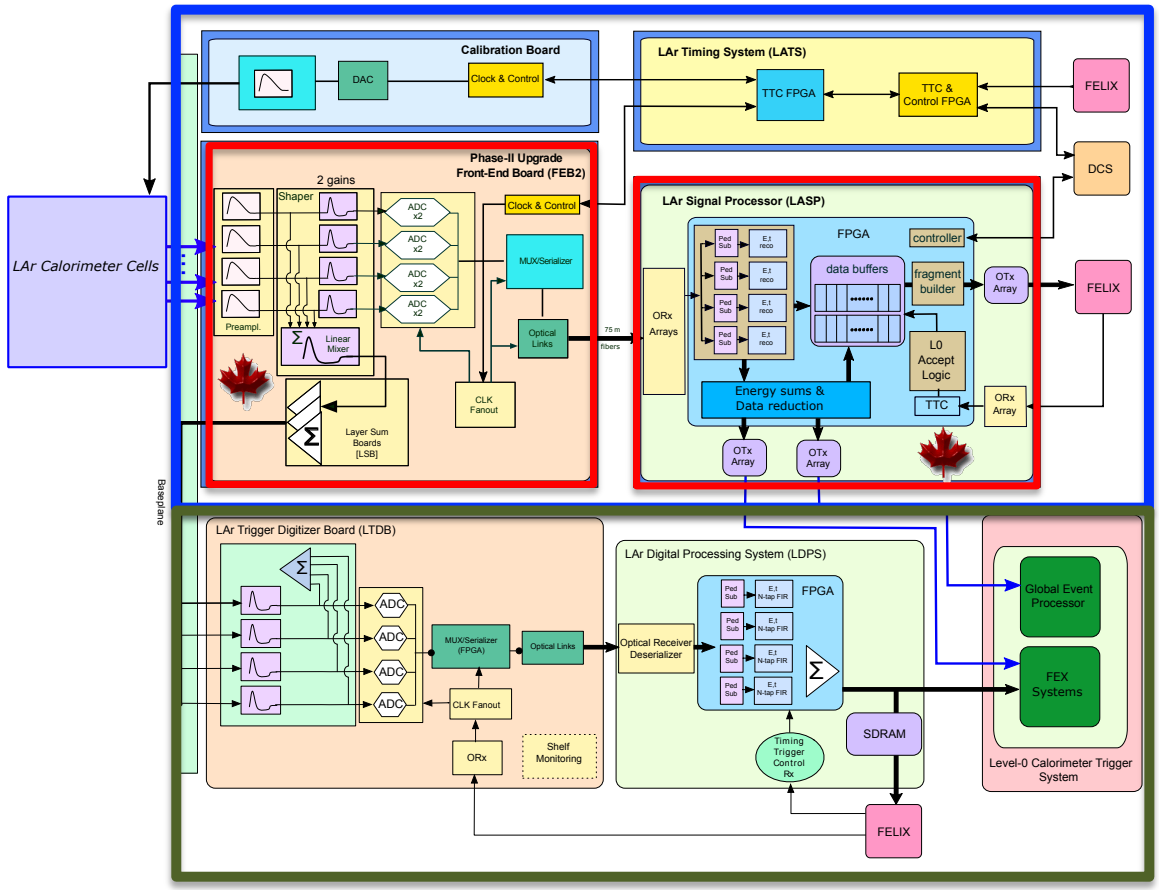
- **Strong 🍁 contributions to:**
  - HEC readout ASIC
  - LASP board design/testing
    - Including algorithms for energy and timing reconstruction
  - LASP firmware

Nearing end of ASIC prototyping (including for 🍁 HEC ASIC)

Phase-2 readout path



Phase-1 digital trigger (being commissioned)

Summary

- **Growing ATLAS Canada collaboration with continued strong HQP training**
  - Canadian group successfully engaged in all aspects of ATLAS
    - Important and visible roles in the Collaboration
    - Physics output (analysis, review, physics group & sub-group convenors, etc.)
    - Detector operations (run coordinators for multiple subsystems), computing
      - Did not discuss these today, but such roles have continued through LS2
    - Strong participation and leadership roles in detector upgrade activities
    - Also outreach
- **Successful completion of Phase-1 detector upgrades during LS2**
  - Focus now turns to commissioning of these new subsystems
- **Phase-2 upgrade work progressing, but delayed relative to past schedule**
  - Technical and COVID-related delays addressed by new long-term schedule
  - A large part of our current effort, that I did not have time to discuss today
- **Run-3 starting at (slightly) increased center-of-mass energy of 13.6 TeV**

All collaborations activities, including operations and Phase-2 upgrades may be affected by actions to be taken in response to the Russian invasion of Ukraine. Mitigation strategies are under investigation.

Backup

Short and Long-term Integrated Luminosity Targets

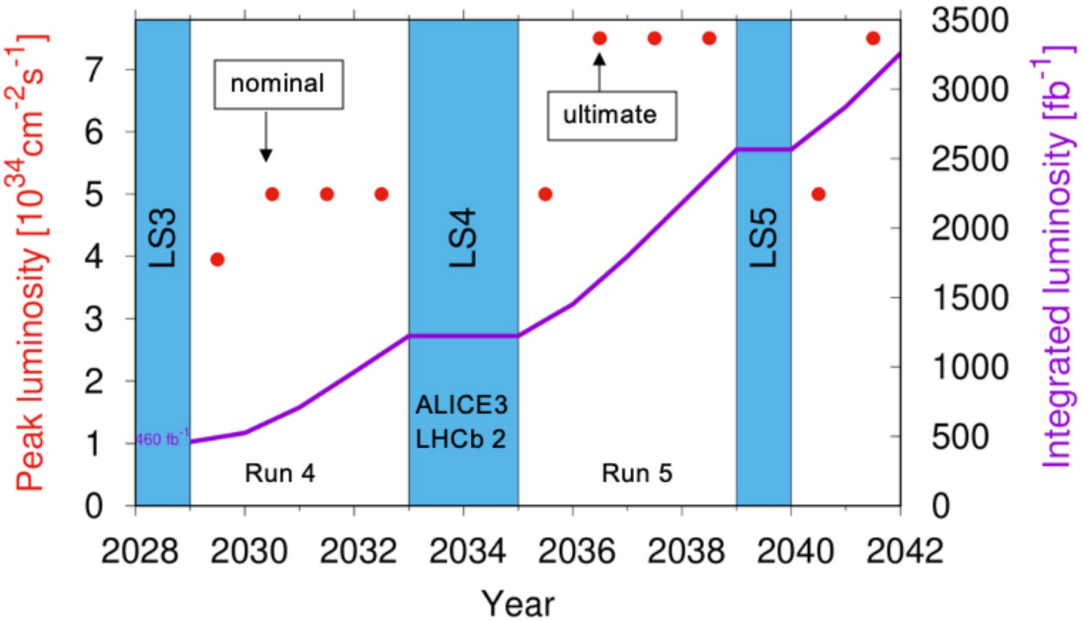
Run 3: LHCP2022 talk by Mike Lamont

Calendar Year	2022	2023 - 2025
Machine Efficiency	30%	40%
Number of OP days	71	130
Bunch population [1e11]	1.4	1.8
Collisions at IP1 & IP5	2736	2484
Normalized emittance [um]	1.8	2.5
Levelling time [h]	10.7	13.3
Integrated luminosity/year [/fb]	33	86

ATLAS and CMS levelled at ~2.0 $\times 10^{34}$

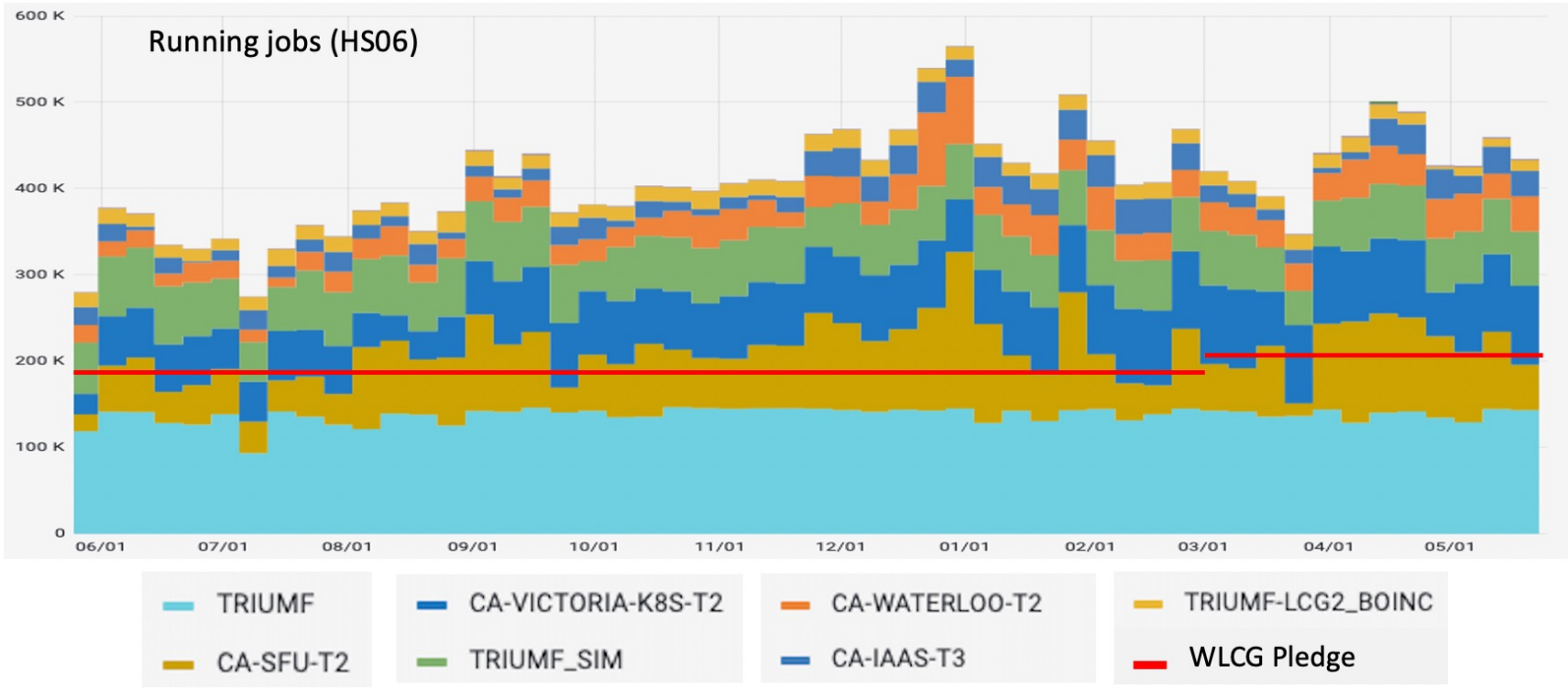
- Estimates robust v. beam parameters
- ~290 fb^{-1} estimate, target 250 fb^{-1}

Preliminary (optimistic) schedule of HL-LHC



Fabiola Gianotti: https://indico.cern.ch/event/1106493/

ATLAS Canada Computing



- **Canadian contributions to ATLAS computing exceed WLCG pledge**
  - "TRIUMF" Tier-1 computing at SFU, Tier-2 computing via shared resources
- **Most recent hardware refresh via award in CFI 2020 IF competition**
- **Proposal for next stage being submitted to current IF competition**
  - Again via SFU, but now with envelope share from other ATLAS-Canada institutions
- **ATLAS Roadmap for HL-LHC Computing updated Feb 2022**

ATLAS Canada Diversity Survey Fall 2021

- **Anonymous surveys sent separately to four distinct groups**
  - Investigators: 86% participation rate
  - PDF/RA + Technical: 40% participation rate
  - Current Graduate Students: 46% participation rate
  - Recent Undergraduate students: 24% participation rate
- **NSERC Guidelines**

> **Important**: Trainee demographic data **is not requested** or required to assess impacts resulting from consideration of equity, diversity and inclusion in the research and training environment.

- **Following slide intended to give a sense of what groups are represented in ATLAS Canada, without specific numbers**
- **Questions taken from U of T Faculty of Arts & Science EDI survey**
  - Slightly modified in one case, to improve anonymity
  - Run by non-ATLAS U of T Staff member
  - Results provided to ATLAS-Canada are statistics per question: no correlations

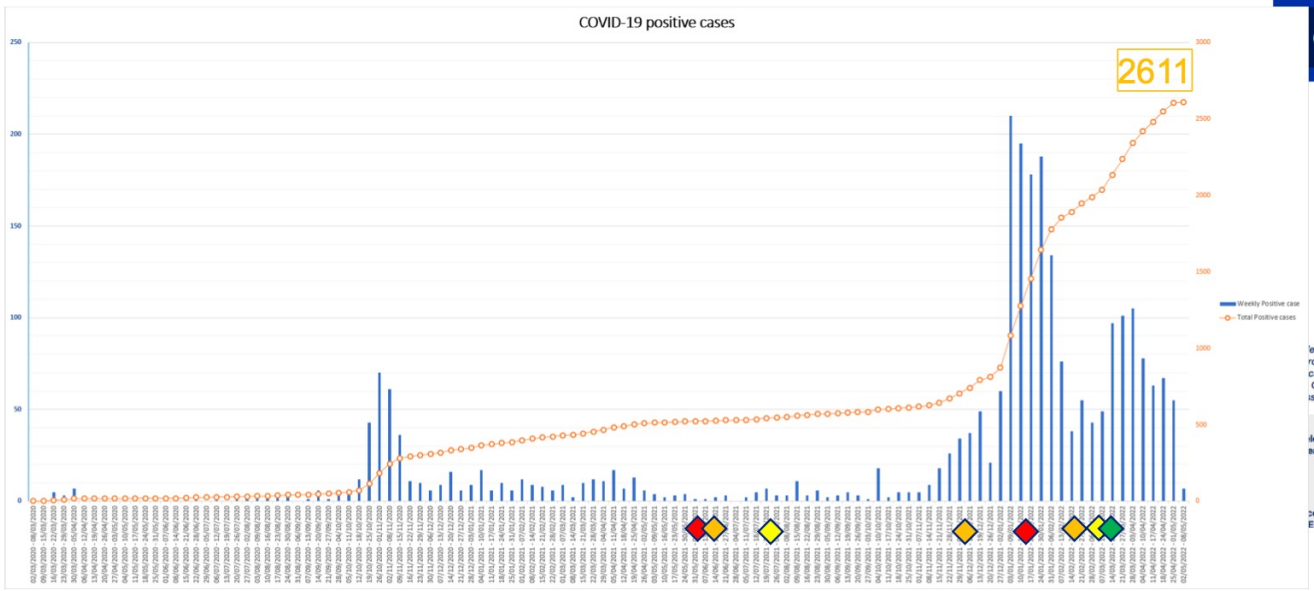
ATLAS Canada Diversity Survey Fall 2021

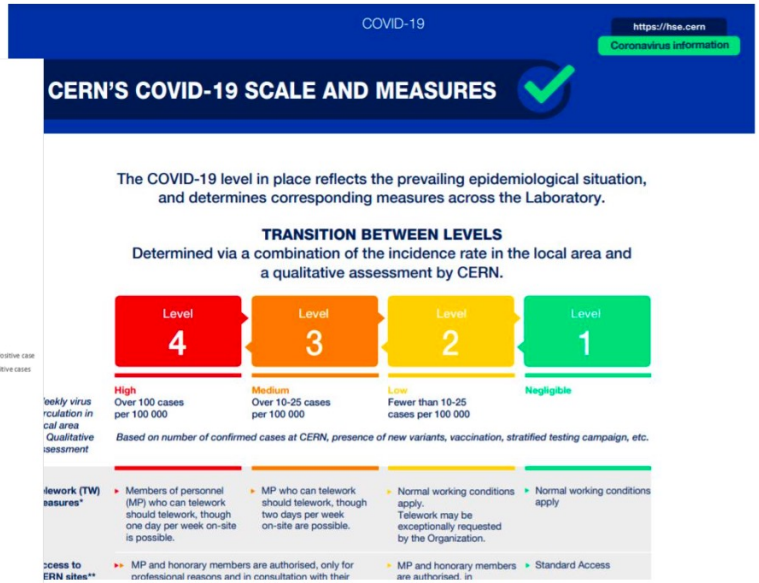
- **Response categories with at least one member (highest to lowest)**
  - Gender Identity:
    - *Man, Woman, Trans, Non-binary, Two-spirit, an Identity not listed*
  - Racial/Ethnic background:
    - *White, Prefer not to answer, Chinese, South Asian, Latin American, Black, Prefer to self identify, Multi-racial, West-Asian, Indigenous, Southeast-Asian, Japanese, Arab*
  - In general, diversity increases as age decreases
- **We plan to update survey results on a regular basis, to monitor progress in addressing representation from equity-deserving groups**

COVID Update from CERN

LHCP talk by J. Mnich

Covid Cases at CERN (Personnel + Contractors)





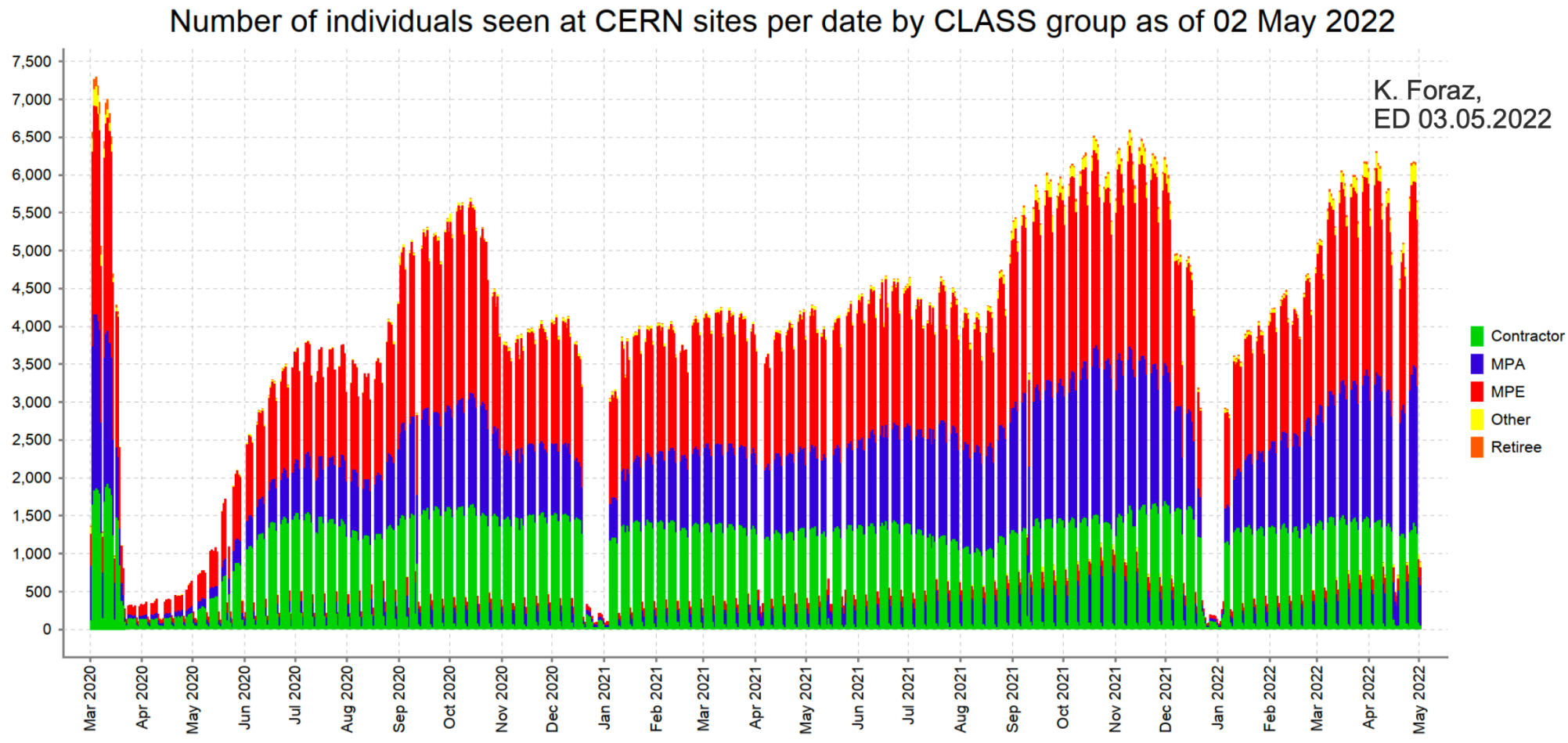
Xmas break

14.03.2022 Green level (with some additional measures)

COVID Update from CERN

LHCP talk by J. Mnich

Access statistics



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16.05.2022

J. Mnich | LHCP 2022

CERN Remarks on Russian War on Ukraine

LHCP talk by J. Mnich

Russian War on Ukraine

The Russian military aggression against Ukraine contradicts CERN values and CERN condemns this war in the strongest possible terms!

Measures taken by CERN Council:

Statement from 25 March:
https://home.cern/news/news/cern/cern-council-takes-further-measures-response-invasion-ukraine

In response to the military invasion of Ukraine by the Russian Federation, the 23 Member States of CERN today decided to:

- suspend the participation of CERN scientists in all scientific committees of institutions located in the Russian Federation and the Republic of Belarus, and vice versa;
- suspend or, failing that, cancel all events jointly arranged between CERN and institutions located in the Russian Federation and the Republic of Belarus;
- suspend the granting of contracts of association as associated members of the CERN personnel to any new individuals affiliated to home institutions in Russia and Belarus.

CERN Remarks on Russian War on Ukraine

LHCP talk by J. Mnich

Measures taken by CERN Council

Regarding relations with the Joint Institute for Nuclear Research (JINR), with which CERN holds reciprocal Observer status, the CERN Council decided:

- to suspend the participation of CERN scientists in all JINR scientific committees, and vice versa;
- to suspend or, failing that, cancel all events jointly arranged between CERN and JINR;
- that CERN will not engage in new collaborations with JINR until further notice;
- that the Observer status of JINR at the Council is suspended and CERN will not exercise the rights resulting from its Observer status at JINR, until further notice.

Council have asked for more information with a view to making a decision in June on the possible suspension of international coooperation agreements

LHCP talk by J. Mnich

Risks Associated with the War Against Ukraine

Russian, Belarussian and Ukrainian institutes are strong and important partners in the CERN programme

- Close to 7% of the members of the LHC collaborations are from institutes in Russia (incl. JINR)
- They are essential for the operation of the experiments
  Most critical examples:
  - ALICE: Fast Interaction Trigger, Photon Spectrometer, …
  - ATLAS: Inner Detector, Tile Calo, TDAQ, Technical Coordination, …
  - CMS: HCAL, CSC, BRIL, Technical Coordination,…
  - LHCb: Muon systems, ECAL, HCAL, ..
- More than 100 scientists, engineers and technicians are crucial for the operation of the four detectors

Members from Russian institutes in the LHC collaborations

	Total	Russia (incl. JINR)		JINR	
ALICE	1942	167	8.5%	34	1.7%
ATLAS	5917	364	6.2%	147	2.5%
CMS	5365	306	5.4%	88	1.6%
LHCb	1500	148	9.9%	0	0%
Sum	**14724**	**985**	**6.7%**	**269**	**1.8%**

Collaborators essential for the operation of the LHC experiments

	Russia (incl. JINR)	JINR
ALICE	20	5
ATLAS	44	15
CMS	34	10
LHCb	15	0
Sum	**113**	**30**

Recall the **HUGE** contributions Russian, JINR (also Belarussian, Ukrainian) technicians, engineers and physicists made to the construction and operation of the detectors