ARGENTINA - CHILE
Status of Latinamerican Collaborations in HEP

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UNLP - IFLP - CONICET

on behalf or Argentina and Chile
ATLAS collaboration

November 20, 2019

- 1992: International Cooperation Agreement (ICA) signed between CERN and Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET)
- Feb. 2006: ATLAS Collaboration Board approved unanimously the admission of the two groups from the Universidad Nacional de La Plata (UNLP) and of the Universidad de Buenos Aires (UBA) as new institutions. This is an important step in fostering the collaboration between CERN and Argentina.
- Oct. 2006: Memorandum of Understanding (MoU) signed between ATLAS experiment and ANPCyT - Secretaría de Ciencia, Tecnología e Innovación Productiva represented by its President, Dr. Barañao, supporting the participation of Argentinean groups in ATLAS and a contribution with High- Level-Trigger modules to the detector.
- 2007: ICA signed in 1992 is replaced by a higher-level ICA with the Government of Argentina (Secyt).
- 2009: A protocol in the context of the Cooperation Agreement ICA 2007 was signed by Dr. Barañao in 2009 for the participation of engineers of Universidad de Mar del Plata in the CERN Accelerator Department.
- Jun. 2009: The President of Argentina, Cristina Fernández de Kirchner, visited CERN.
- 2014: Visit of Dr. Jenni, founder of ATLAS and former Spokesperson, to the Minister Dr. Barañao on April 29. ATLAS Phase-1 Upgrade MoUs to be signed by the Minister and Dr. Jenni for the ATLAS experiment. Contribution with modules for the FELIX system towards the upgrade of the DataFlow.
- July 2019: Visit of Dr. Karl Jakobs, ATLAS Spokesperson. Signature of the ATLAS Phase-II Upgrade MoU by the Secretary of *Ciencia, Tecnología e Innovación Productiva* Contribution to the Global Trigger, hardware production in Argentina.

Support programs

HELEN

- The HELEN Network (2005-2009) was very helpful for the development of CERN-Argentina relations
- Instrumental for the groups of the Universidad de Buenos Aires (UBA) and the Universidad Nacional de la Plata (UNLP) to become members of the ATLAS Collaboration.

EPlanet

- The EPLANET programme within FP7 supported the exchange of scientists from Argentinean institutions (UNLP, UNMP and UBA) and other Latin American countries and Europe during the period from February 2011 to January 2016.

CLASHEP

- The 3rd CERN-Latin American School of High Energy Physics (CLASHEP), for postgraduate students working towards a PhD, was organised in Malargüe (Argentina) in 2005.
- The 10th CLASHEP took place in Cordoba (Argentina) in 2019, offering a further possibility to reinforce relations with and gain support from the local high-energy physics community.

- Universidad de Buenos Aires
- Universidad Nacional de La Plata

Current participants

4 Senior/Professors physicists

2 researches/Faculty physicists

5 PhD students (including 12 finished PhD thesis!)

3 master students

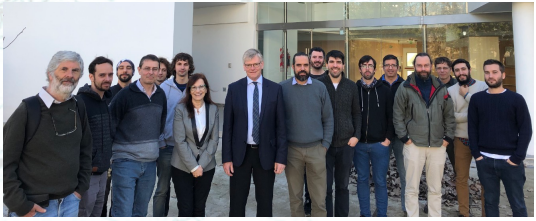
1 Professor in Computer Science

3 PhD students in Computer Science

2 engineers

2006/2007

2019 - 2020

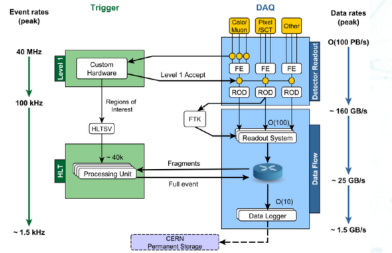


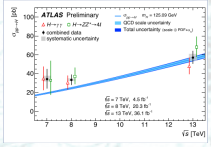
Argentina involvement in ATLAS

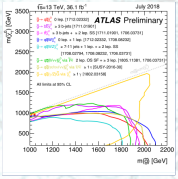
Trigger Responsibilities on Jet triggers and ElectronPhoton triggers

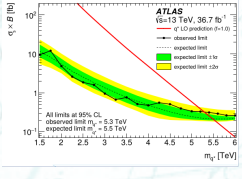
Reconstruction/IDentification Jets, electrons and Photons. Responsibilities on Photon ID, fake photons, lepton background. Jet energy calibration and Resolution (JES,JER)

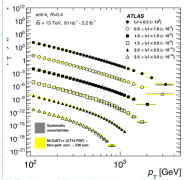
Data analysis Responsibilities on SM precision measurements. Higgs boson diphoton channel. BSM searches (SUSY with photons, extra dimensions and Dark Matter)

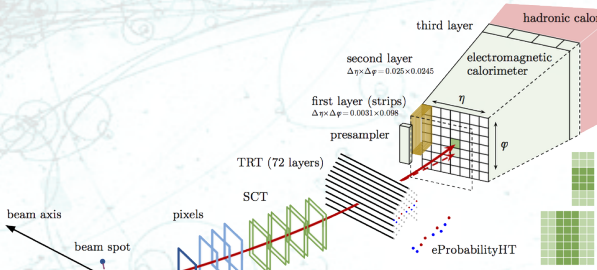


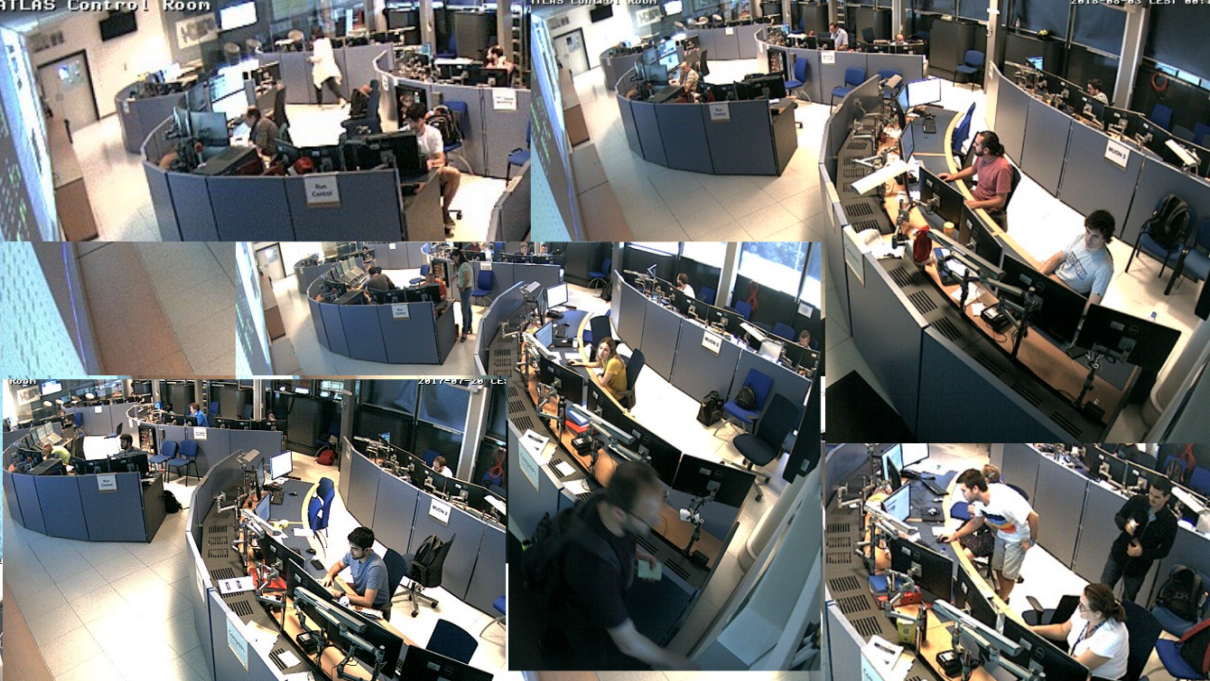











ATLAS Control Room

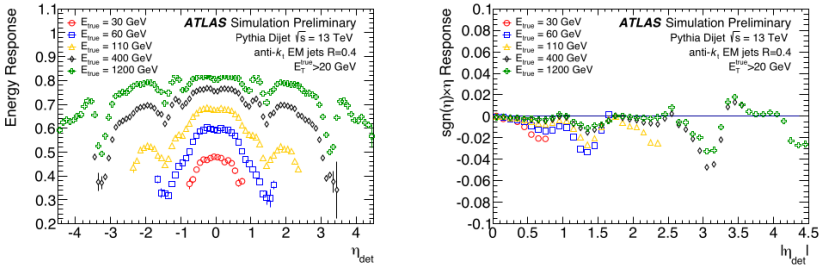


Figure: Energy response (left) and bias in the η reconstruction (right) as a function of η before calibration for EM scale anti-k_t , R=0.4 jets.

- The UBA group is active in developing tools for the analysis of data with high-energy jets, the experimental signature of the production of quarks and gluons, since Run1!.
- Their work on the measurement of the jet energy resolution in Run-1 and Run-2 has been documented in a journal paper
- The contributions of the group in this area are well recognised within the ATLAS calorimeter community

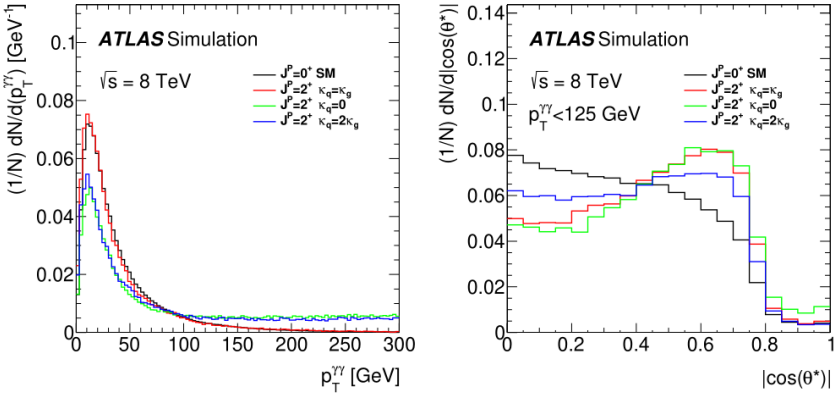


Figure: Expected distributions of kinematic variables sensitive to the spin of the resonance considered in the $H \rightarrow \gamma\gamma$ analysis, (a) transverse momentum of the $\gamma\gamma$ system $p_T\gamma\gamma$ and (b) the production angle of the two photons in the Collins-Soper frame $|cos(\theta^*)|$, for a SM Higgs boson and for spin-2 particles with three different choices of the QCD couplings

- UNLP have contributed as co-editors and analysis contacts of the supporting note and papers documenting the study of the spin and parity of the Higgs boson in di-boson decays un Run-2
- These results allowed us to exclude alternative models in favour of the SM Higgs boson hypothesis at more than 99.9 % confidence level.

H^0

$J = 0$

In the following H^0 refers to the signal that has been discovered in the Higgs searches. Whereas the observed signal is labeled as a spin 0 particle and is called a Higgs Boson, the detailed properties of H^0 and its role in the context of electroweak symmetry breaking need to be further clarified. These issues are addressed by the measurements listed below.

Concerning mass limits and cross section limits that have been obtained in the searches for neutral and charged Higgs bosons, see the sections "Searches for Neutral Higgs Bosons" and "Searches for Charged Higgs Bosons ($H^\pm$ and $H^{\pm\pm}$)", respectively.

H^0 MASS

VALUE (GeV)	DOCUMENT ID		TECN	COMMENT
125.18±0.16 OUR AVERAGE				
125.26±0.20±0.08	[1] SIRUNYAN	17AV	CMS	pp, 13 TeV, $ZZ^* \to 4\ell$
125.09±0.21±0.11	[2,3] AAD	15B	LHC	pp, 7, 8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
125.07±0.25±0.14	[3] AAD	15B	LHC	pp, 7, 8 TeV, $\gamma\gamma$
125.15±0.37±0.15	[3] AAD	15B	LHC	pp, 7, 8 TeV, $ZZ^* \to 4\ell$
126.02±0.43±0.27	AAD	15B	ATLS	pp, 7, 8 TeV, $\gamma\gamma$
124.51±0.52±0.04	AAD	15B	ATLS	pp, 7, 8 TeV, $ZZ^* \to 4\ell$
125.59±0.42±0.17	AAD	15B	CMS	pp, 7, 8 TeV, $ZZ^* \to 4\ell$

H^0 SPIN AND CP PROPERTIES

The observation of the signal in the $\gamma\gamma$ final state rules out the possibility that the discovered particle has spin 1, as a consequence of the Landau-Yang theorem. This argument relies on the assumptions that the decaying particle is an on-shell resonance and that the decay products are indeed two photons rather than two pairs of boosted photons, which each could in principle be misidentified as a single photon.

H^0 DECAY WIDTH

The total decay width for a light Higgs bo
expected to be directly observable at the
the prediction for the total width is about

Citation: M. Tanabashi et al. (Particle Data Group), Phys. Rev. D 98, 030001 (2018)

H^0 SIGNAL STRENGTHS IN DIFFERENT CHANNELS

The H^0 signal strength in a particular final state xx is given by the cross section times branching ratio in this channel normalized to the Standard Model (SM) value, $\sigma \cdot B(H^0 \to xx) \,/\, (\sigma \cdot B(H^0 \to xx))_{SM}$, for the specified mass value of H^0. For the SM predictions, see DITTMAIER 11, DITTMAIER 12, and HEINEMEYER 13A. Results for fiducial and differential cross sections are also listed below.

Combined Final States

VALUE		DOCUMENT ID		TECN	COMMENT
1.10±0.11 OUR AVERAGE					
$1.09 \pm 0.07 \pm 0.04 \pm 0.03 ^{+0.07}_{-0.06}$	[1,2]	AAD	16AN	LHC	pp, 7, 8 TeV
$1.44 ^{+0.59}_{-0.56}$	[3]	AALTONEN	13M	TEVA	$p\overline{p} \to H^0 X$, 1.96
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$1.20 \pm 0.10 \pm 0.06 \pm 0.04 ^{+0.08}_{-0.07}$	[2]	AAD	16AN	ATLS	pp, 7, 8 TeV
$0.97 \pm 0.09 \pm 0.05 ^{+0.04}_{-0.03} ^{+0.07}_{-0.06}$	[2]	AAD	16AN	CMS	pp, 7, 8 TeV
$1.18 \pm 0.10 \pm 0.07 ^{+0.08}_{-0.07}$	[4]	AAD	16K	ATLS	pp, 7, 8 TeV
$0.75 ^{+0.28}_{-0.26} ^{+0.13}_{-0.11} ^{+0.08}_{-0.05}$	[4]	AAD	16K	ATLS	pp, 7 TeV
$1.28 \pm 0.11 ^{+0.08}_{-0.07} ^{+0.10}_{-0.08}$	[4]	AAD	16K	ATLS	pp, 8 TeV
	[5]	AAD	15P	ATLS	pp, 8 TeV, cross s tion

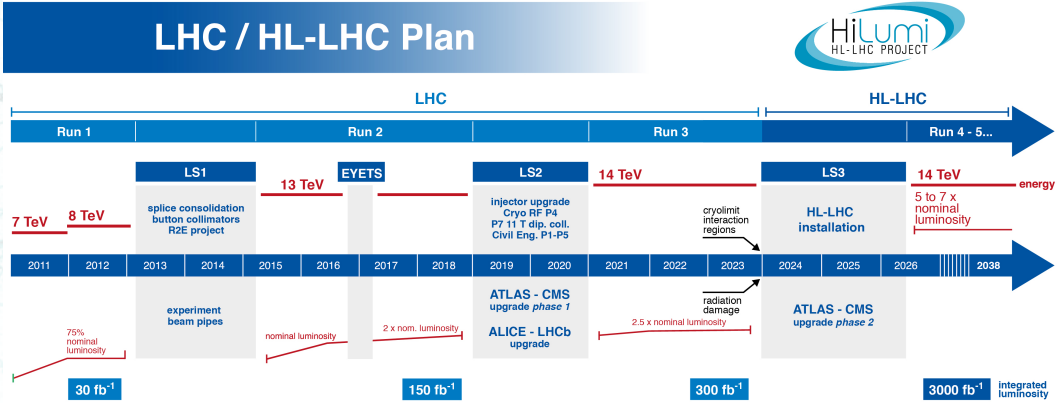
H^0 BRANCHING RATIOS

$\Gamma(e^+e^-)/\Gamma_{total}$

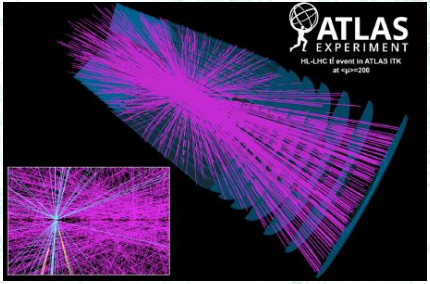
VALUE	CL%	DOCUMENT ID		TECN
$<1.9 \times 10^{-3}$	95	[1] KHACHATRY...15H		CMS

[1] KHACHATRYAN 15H use 5.0 fb^{-1} of pp collisions at $E_{cm} = 7$ TeV a

- 2019 - 2020 is LS2 to get ready for Run3: 14 TeV and higher inst luminosities → Phase-I
- The HL-LHC project is planned to begin collisions by 2026
- ATLAS will collect an integrated luminosity of 3000-4000 fb^{-1} in 10 years
- HL-LHC upgrades will happen during Long Shutdown 3 (2024-2026)



- Stand the 5-7 $10^{34}/\text{cm}^2/\text{s}$ instantaneous luminosity is beyond the capabilities of the current detectors
- Replace several parts (like full inner detector!) to achieve a robuster, faster, radiation harder and lighter detector.
- Goal : have the same-or better-performances in HL-LHC harsh conditions than in Run2
- Upgrade: fruit of permanent feedback between physics requirements and detectors' component design



- Protect against high fluencies. Needs more radiation hard eletronics design.
- Mitigate pileup rates and occupancy
- Keep low p_{T} requirements for main triggers
- Guarantee precise measurements up to large rapidity
- Lighten the detector, dropping material

Many complex analysis on real time at hardware trigger

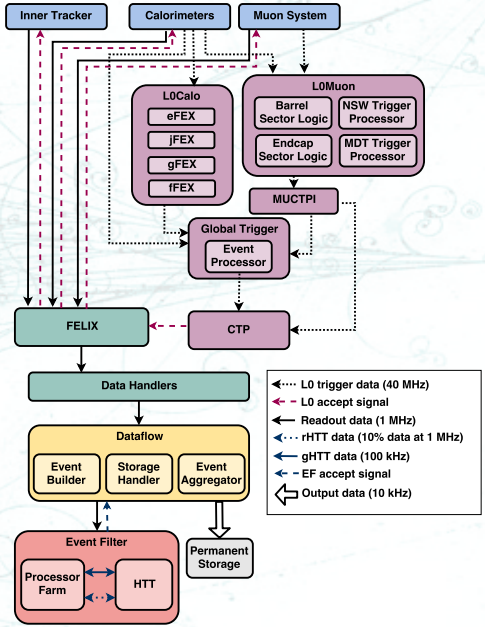
Among other aspects

- L0 Calo will include electron FeatureExtractor (eFEX), jet (jFEX), global (gFEX) and forward jet (fFEX), all implemented in FPGA hardware
- Global trigger will replace current L1-Topo, get inputs from L0 Calo and muons to make a decision
- Common hardware, specialized firmware
- Access to full calorimeter data

Not just TDAQ needs to be updated

Upgrade of LAr electronics

- The LAr calorimeters themselves are expected to operate reliably during the HL-LHC data-taking period
- But the current electronics is not compatible with operations at HL-LHC
- All front-end and back-end electronics will be replaced



Phase-II Argentina involvement:

Global trigger

- We joint the effort to collaborate in development of HW/FW for the Global Trigger
- Hiring and engineer (CPA-CONICET) to full time contribute on this R&D effort
- Will build hardware in Argentina, once Phase-II production starts. What and how much each institution builds is under discussion with the ATLAS collaboration, final decision during this year.
- We will need to be able to produce and build multi-layer high speed boards with high-end FPGAs
- We will be responsible of R&D and production of a module of signal distribution (local industries play a role here)

New facility at new Institute building

- Electronics Lab at IFLP equipped with a specific electronics lab for this project (and future ones)
- Clean room facilities at UBA for prototype, hardware and circuits mounting tests

New responsibilities

- Joint effort with Oregon for Global Trigger algorithm developments for trigger signature and FW release management

- The Universidad Federico Santa María (UFSM) in Valparaiso and the Pontificia Universidad Católica de Chile (PUCC) in Santiago have strengthened their contacts with CERN through EPLANET programme and its precursor HELEN (2005-2009), sending students to work in ATLAS and on related theoretical subjects.
- Both institutions signed agreements with the ATLAS Collaboration during the visit of President Michelle Bachelet in June 2007. A joint Chilean team from PUCC and UTFSM became a member of ATLAS in 2007. The Comisión Chilena de Energía Nuclear (CCHEN) participates in experiments at the ISOLDE Facility.
- With the signature of the Memorandum on Cooperation (MoC) for the CLIC Detector and Physics Study (CLICdp), in September 2013, the Pontificia Universidad Católica de Chile became partner of the CLICdp Collaboration.
- The 4th CERN-Latin American School of High Energy Physics (CLASHEP) took place in Viña del Mar in 2007.
- Rectors of participating and other large universities from Chile visited CERN in 2018, further stressing the country's interest in cooperation.

CHILE - Involvment

EXPERIMENTS

- ATLAS
- ALICE
- CLICdp
- ISOLDE

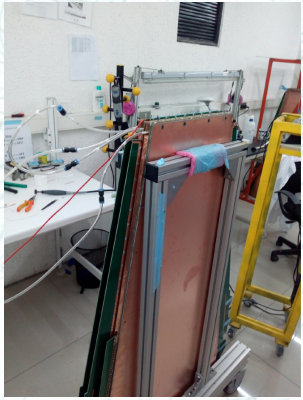
Computing WLCG: Tier 2

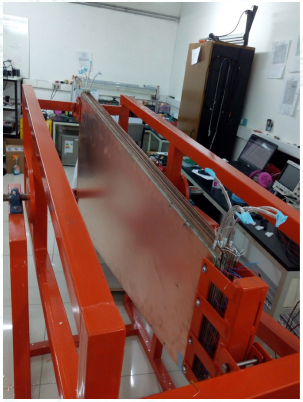
Institutions.cl

- more than 50 users, 7 authors in ATLAS
- CCHEN Comision Chilena de Energia Nuclear, Santiago
- Departamento de Fisica Federico Santa Maria Technical University, Valparaiso
- Federico Santa Maria Technical University (UTFSM), Valparaiso
- Pontifical Catholic University of Chile, Santiago
- Universidad Andres Bello, Santiago
- Universidad de Talca, Talca
- University of Chile, Santiago

Current Activities:

- Tau Lepton trigger
- Analysis: triple Higgs coupling y and BSM Higgs searches
- Hardware: Phase-I upgrade of muon spectrometer. Building and testing with cosmic muons, the *small Thin Gap Chambers* (sTGC)





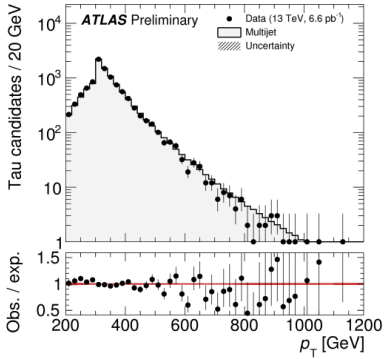


Figure: Transverse momentum distribution of hadronic tau lepton candidates. Comparison of Run-2 Monte Carlo simulation and pp 2015 collision data at $\sqrt{s} = 13$ TeV taking with ATLAS detector

- The PUC group has contributed to the performance work of the ATLAS experiment in the area of online and offline hadronic tau lepton reconstruction.
- A PUC researcher was in charge of an independent derivation of dedicated Tau Energy Scale (TES) calibration constants and functions
- This calibration compensates for two effects, pile-up and the remnant mismatch between truth and reconstructed taus.

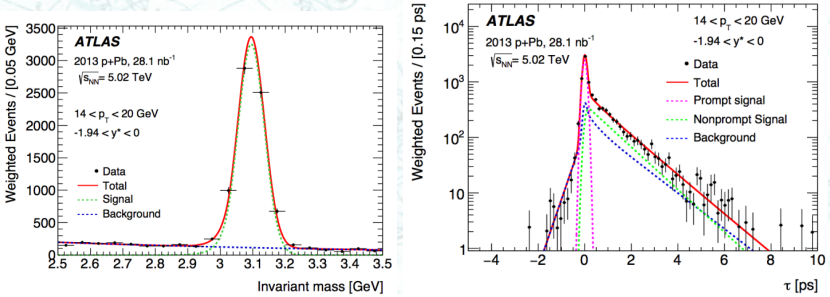


Figure: Distributions of dimuon invariant mass and pseudoproper time of weighted J/Ψ candidates in a representative interval of J/Ψ transverse momentum and center-of-mass rapidity. The projection of the function resulting from a two-dimensional unbinned maximum-likelihood fit is also shown

- The UTFSM provided the driving force behind the study of J/Ψ meson production in proton-lead scattering at a proton-nucleon center-of-mass energy of $\sqrt{s_{NN}} = 5.02$ TeV

Argentina and Chile within ATLAS collaborations

Key contributions to ATLAS since Run1 (and before)

- Argentina and Chile had important impact on ATLAS physics program
- From Trigger, Software, Physics Analysis, Searches, Precision Measurements and performance
- Support from programs like HELEN and EPlanet were fundamental for this

Present and Future

- Moving towards (in addition) contributing with Hardware to ATLAS and its upgrades:

  Chile: Phase-I, sTGC, muon spectrometer upgrade

  Argentina: Global trigger, - Phase-II (HL-LHC)