ATLAS, CMS and ALICE: LHC runs II and III

Konstantinos Kousouris

National Technical University of Athens

November 10, 2023, NKUA

RECFA visit to Greece - Open Session

Overview

Participation in ATLAS

- National Technical University of Athens (NTUA)
- Aristotle University of Thessaloniki (AUTh)
- National and Kapodistrian University of Athens (NKUA)
- Demokritos ATLAS group (NCSR)
- University of West Attica (UNIWA)
- Hellenic Open University (HOU)

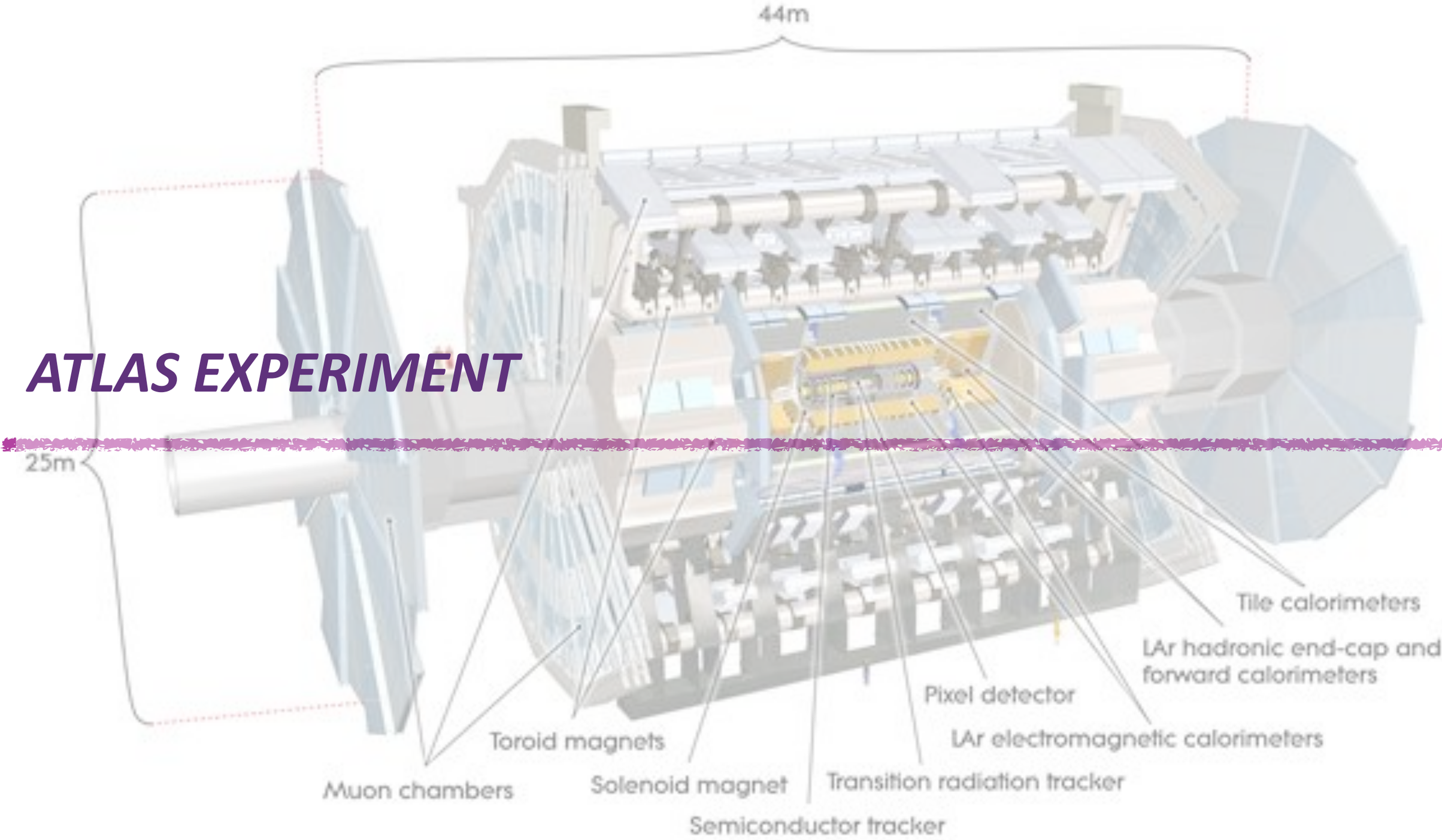
Participation in CMS

- National and Kapodistrian University of Athens (NKUA)
- National Technical University of Athens (NTUA)
- University of Ioannina (UOI)
- Demokritos CMS group (NCSR)

Participation in ALICE

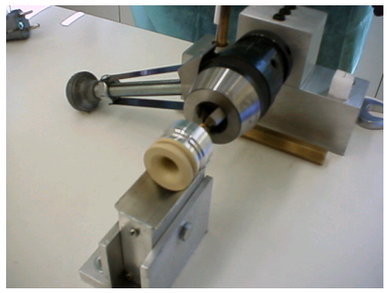
- National and Kapodistrian University of Athens (NKUA)

ATLAS EXPERIMENT

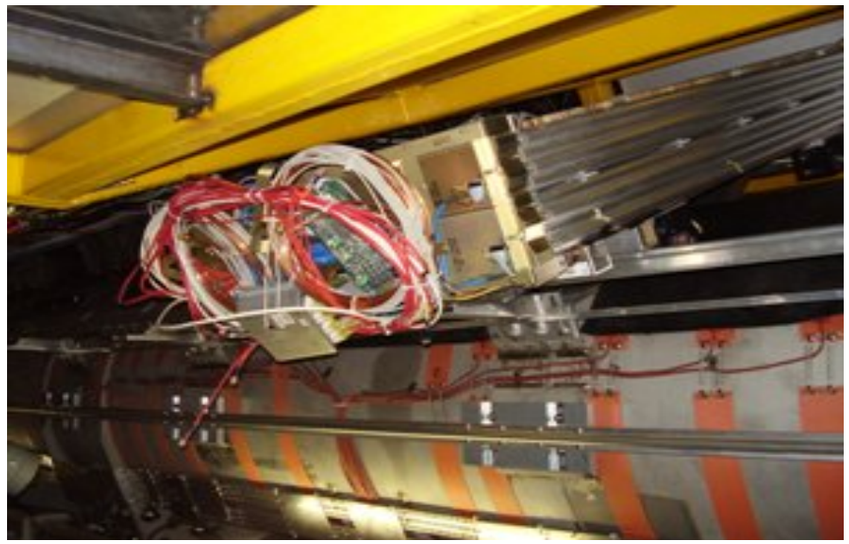


ATLAS Greece: Historical Overview

Tube wiring

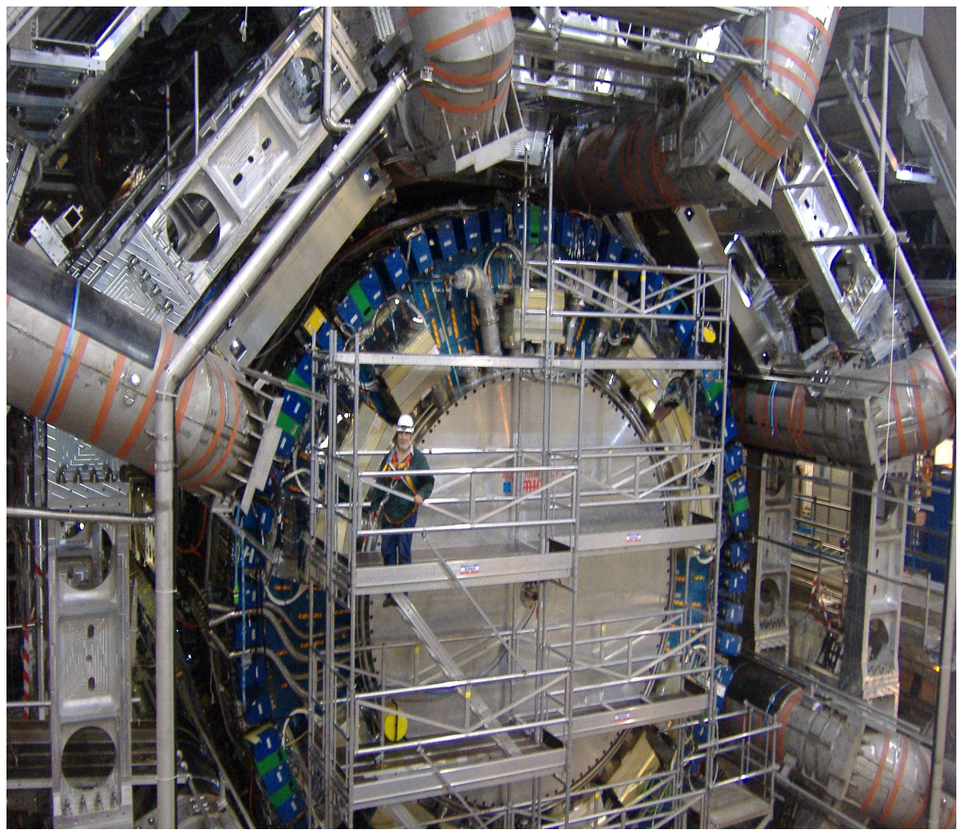


Construction, test and commissioning of 128 Barrel Inner Small (BIS) MDT precision Chambers of the ATLAS Muon Spectrometer



Current Participation
Total FTEs: 37.4 (out of which PhD 19)

22 Researchers (17 permanent, 5 Post-Doc)
19 PhD students
Currently 11 Master students
Currently 16 Undergraduates
1 Technician



ATLAS Greece: NTUA

Present ATLAS-NTUA group composition:

Theo Alexopoulos (Prof.)
Evangelos Gazis (Prof. emeritus)
Yannis Kopsalis (Assis. Prof.)
Stavros Maltezos (Prof. emeritus)

NTUA Technical Staff for NSW integrations & commisioning

1. K. Iakovidis (Mechanical Eng.)
2. N. Agapiou (Technician)
3. G. Athanasiadis (Mechanical Engineer)
4. C. Bakalis (Applied Physicist)
5. A. Vgenopoulos (Electrical Engineer)
6. C. Kitsaki (applied Physicist)
7. I. Fragkos (General Engineer)
8. A. Giokaris (Applied Physicist)
9. P. Gkountoumis (Electronics Engineer)
10. N. Karagianopoulos (Technician)
11. E. Karentzos (Applied Physicist)
12. E. Koulouris (Applied Physicist)
13. C. Kourkoutis (Electrical Engineer)
14. E. Lampardaki (Technician)
15. P. Lopez Macia (Physicist)
16. M. Natsios (Physicist)
17. C. Paraskevopoulos (Applied Physicist)
18. M. Perganti (Applied Phycisist)
19. P. Tzanis (Applied Physicist)
20. S. Tzanos (Applied Physicist)
21. G. Statharas (Technician)
22. K. Patrinos (Ph.D Physicist, Laboratory Teaching Staff)

Current Ph.D. students:

1. P. Tzanis (done, CERN fellow)
2. C. Paraskevopoulos (done, INFN Frascati)
3. M. Perganti
4. N. Kanellos
5. E. Andreadaki
6. G, Koutelieris
7. Y. Drivas-Koulouris
8. M. Arampatzi

Past PhD students since 2012 in chronological order

1. Ch. Tsarouchas (Swiss Re, CH)
2. E. Mountricha (Credit Swiss, CH)
3. F. Antoniou (CERN)
4. G. Iakovidis (BNL, USA)
5. S. Leontsinis (U. of Zurich)
6. K. Karakostas (Computing, GR)
7. T. Argyropoulos (CERN)
8. N. Gazis (ESS)
9. N. Karastathis (Credit Swiss. CH)
10. K. Ntekas (UCI, USA)
11. P. Gkountoumis (UCI, USA)
12. A. Koulouris (fellow CERN)
13. E. Karentzos (Freiburg, GE)
14. E. Adamidi (ATHENA institute, GR)
15. S. Kostoglou (CERN)
16. A. Xydou (EPFL, CH)
17. C. Bakalis (SLAC-Stanford, USA)
18. C. Kitsaki (just graduated)

Recent Contribution Areas

- NSW: design and implementation of the Detector Control System (DCS).
- Design, implementation and maintenance of Muon MDT chambers DCS.
- NSW: Micromegas commissioning.
- NSW: Micromegas Integration.
- NSW: Design, fabrication, production, testing of MM-L1DDC, sTGC-L1DDC, rimL1DDC readout cards, LowVoltageDistribution (LVDB) cards, and Clean Clock card.
- NSW: Design of the NSW gas system, galeak validation of all micromegas modules & sectors during integration & commissioning.
- NSW: Radiation hard studies of frontend and readout electronics in Greece (Tandem, Demokritos).
- NSW: Micromegas modules Testbeam and irradiation.

ATLAS Greece: AUTh, HOU

Current Members

- C. Petridou, Prof. emeritus, AUTh
- D. Sampsonidis, Prof. AUTh
- K. Kordas, Prof. AUTh
- S. Tzamarias, Prof. AUTh
- S. Argyropoulos, Assoc. Prof. AUTh
- C. Lampoudis, Assist. Prof. AUTh
- A. Leisos, Assoc. Prof. HOU, Patras
- K. Bachas, Assoc. Prof. UoTh, Lamia & AUTh

- A. Tsirigotis, Senior Researcher HOU, Patras
- D. Iliadis, Senior Researcher HOU, Patras
- M. Tsopoulou, Post-Doctoral researcher AUTh
- E. Kasimi, Post-Doctoral researcher AUTh

- A. Tsiamis, PhD cand. AUTh
- A. Marantis, PhD cand. HOU
- A. Vgenopoulos, PhD cand. AUTh
- I. Aggelis, PhD cand. AUTh
- S. Merianos, PhD cand. AUTh
- D. Amperiadou, PhD cand. AUTh
- A. Mamaras, PhD cand. AUTh

Recent Contribution Areas

- NSW : LM2-Micromegas Construction
- NSW: Micromegas commissioning
- Muon software: CSC reconstruction, MT code, NSW simulation, ACTS project
- Muon digitization, reconstruction, geometry, performance
- SM Physics: Z+jets, Zbb, 4l lineshape, Diboson: Production, Polarization, VBS
- Indirect Searches for NP, EFT interpretation, Combination of results
- Higgs: High mass HZZ(llvv)
- Exotics: HDBS-DBL: W', ZZd, ZdZd
- DiHiggs: HHbbγγ

Completed PhDs, MScs in ATLAS (2004-

- A. Krepouri MSc, PhD AUTh 2004
- K. Bachas PhD AUTh 2008
- A. Petridis PhD AUTh 2010
- L. Sotiropoulou PhD AUTh 2014
- I. Nomidis MSc, PhD AUTh 2012
- V. Kouskoura MSc, PhD AUTh 2013
- D. Iliadis MSc, PhD AUTh 2014
- C. Gentsos MSc, PhD AUTh 2016
- A. Gaitatzis PhD AUTh 2018
- D. Sampsonidou MSc, PhD AUTh 2020
- I. Maznas MSc, PhD AUTh 2021
- I. Maniatis MSc, PhD AUTh 2021
- I. Karkanias PhD AUTh 2021
- M. Tsopoulou MSc, PhD AUTh 2022
- K. Paraschou MSc, PhD AUTh 2022
- E. Kasimi MSc, PhD AUTh 2023

ATLAS Greece: NKUA

Current Members

- C. Kourkoumelis, Prof. Emeritus, NKUA
- D. Fassouliotis, Prof. NKUA
- I. Gkialas, Prof. Univ. of Aegean
- S. Angelidakis, Post-doctoral researcher, NKUA
- L. Fountas, PhD candidate, Univ. of Aegean
- K. Sioulas, PhD candidate, NKUA
- N. Kamaras, MSc candidate, NKUA
- Six undergraduate students

Recent Contribution Areas

- NSW electronics quality assurance
- Micromegas commissioning
- Muon software
- Muon reconstruction & performance
- Higgs Physics
- Exotics and LLPs

PhDs, MScs in ATLAS

- K. Nikolopoulos MSc, PhD 2010
- N. Vranjes PhD (joint with Belgrade) 2011
- A. Antonaki MSc, PhD 2012
- K. Iordanidou MSc, PhD 2015
- A. Kourkoumeli-Charalambidi PhD 2015
- N. Tsirintanis PhD 2016
- S. Angelidakis MSc, PhD 2016
- P. Bellos MSc, PhD 2020

ATLAS Greece: NCSR, UNIWA

Demokritos ATLAS Group (full member since 2017)

Current group composition

Researchers

Georgios Fanourakis (Emeritus)
Theo Geralis (Team representative)
Georgios Stavropoulos
Andreas Psallidas

Doctoral/Master Students

Olga Zormpa (PhD)
Elena Kanellaki (Master)

Technician (Electronics)

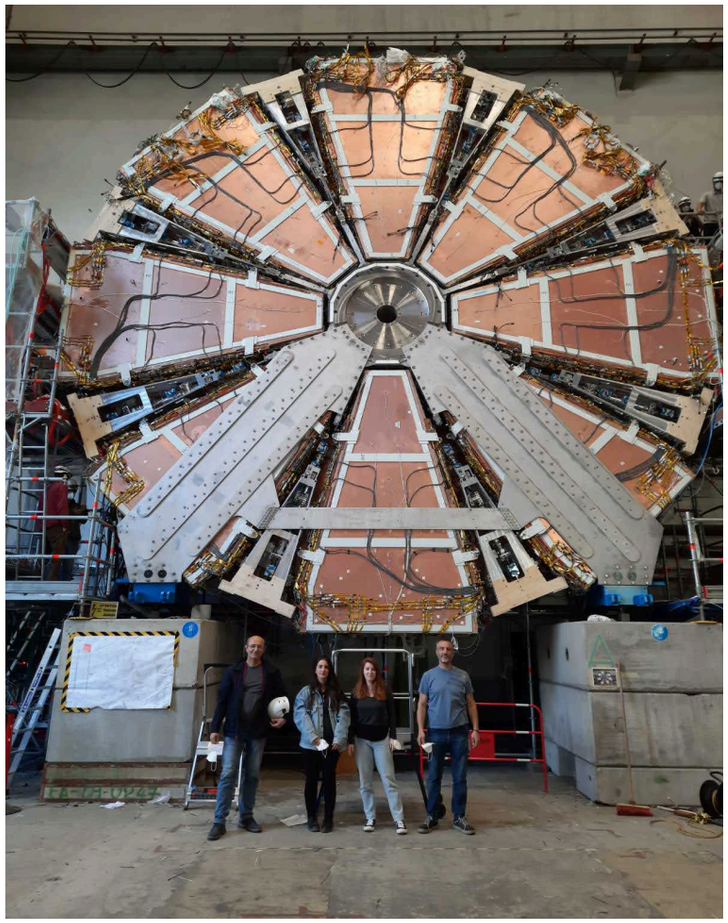
Yannis Kiskiras

Practical work (about 2-3/year)

Argiris Kerezis, Univ. of Ioannina
Ilias Alexopoulos, Univ. of Athens

Previously members

Maria Myrto Prapa (2021)
Kostas Damanakis (Master - 2019)
Olga Zormpa (Master - 2019)



University of West Attica (UNIWA) ATLAS GROUP

2016 – 2019: Co-operation with ATLAS NKUA group
2019 – now : ATLAS Technical Associate Institute

Current Members

- Stathis Kyriakis-Bitzaros (Prof.)
- Katerina Zachariadou (Prof.)
- Ioannis Mesolongitis (PhD student, CERN fellow)
- F. Kolitsi (MsC student)

Diploma Theses

- Nontas Politis (2019)
- Nikolaos Stouras (2023)
- Ioannis Stamoulos (2023)

Group Research Activities (2017 – 2023)

- Irradiation of the VMM asic and relevant electronics
- sTGC detector Commissioning/integration
- The sTGC Trigger repeaters, design and construction
- The sTGC Trigger Commissioning
- Gif++ sTGC detector Irradiation studies
- The sTGC Trigger Integration
- Muon software development
- Precision Z-mass measurement analysis

Contribution Areas

Muon Phase-I Upgrade: NSW electronics

- L1DDC for Micromegas and sTGC detectors design and testing
- Micromegas commissioning
- Micromegas integration

Muon Phase-II Upgrade: RPC electronics

- Quality testing of ~1900 DCT boards for the RPC detectors readout
- Trigger algorithms of Muon Barrel Sector Logic board.

ATLAS Greece: Recent Contributions

NSW Construction & Commissioning

- NSW: LM2-Micromegas Construction
- NSW: Detector Control System (DCS)
- NSW: Micromegas commissioning
- NSW: Micromegas Integration
- NSW: Design, fabrication, production, testing of MM-L1DDC, sTGC-L1DDC, rimL1DDC readout cards, and LowVoltageDistribution (LVDB) cards, Clean clock card
- NSW: Design of the NSW gas system
- NSW: Radiation hard studies of frontend and readout electronics
- NSW: Micromegas modules Testbeam and irradiation
- NSW: Irradiation of the VMM asic and relevant electronics
- NSW: sTGC Trigger repeaters, design and construction
- NSW: sTGC Trigger Commissioning
- NSW: Gif++ sTGC detector Irradiation studies
- NSW: sTGC detector Commissioning/integration
- NSW: Online monitoring tools in ATLAS Trigger/DAQ (Grafana, Gnam)
- NSW: Alti TTC pattern generator

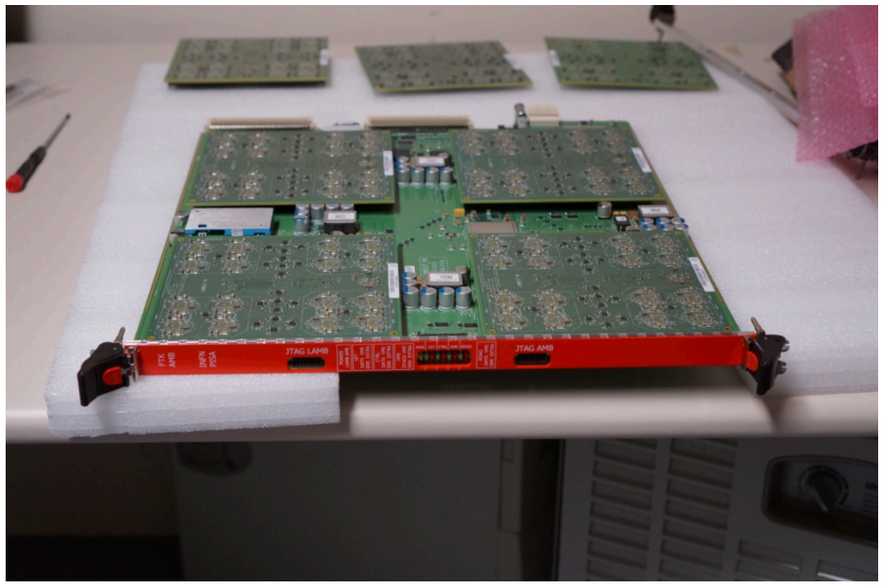
Software, Muon Performance, Data Analysis

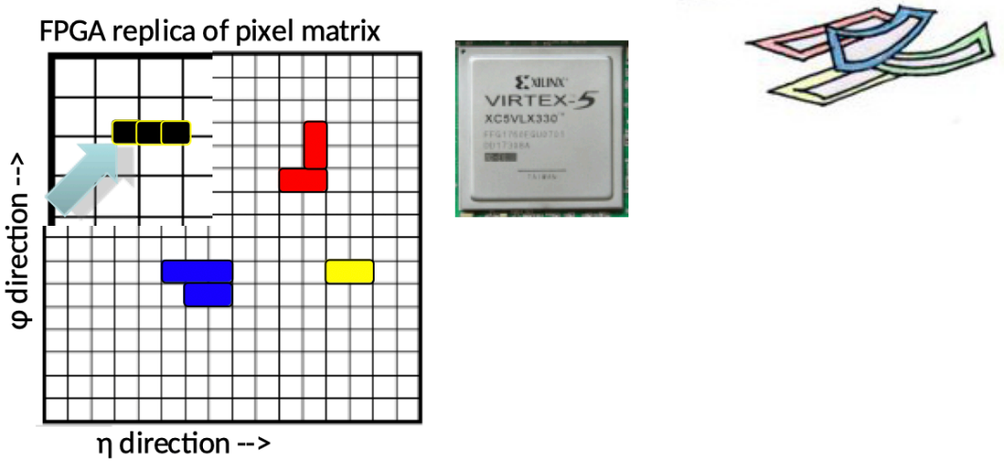
- Muon software development: CSC reconstruction, Multi-Threaded(MT) migration, MT Muon reconstruction & validation, NSW simulation
- Muon digitization, reconstruction, geometry, performance, alignment redesign-implementation
- NSW: readout geometry, alignment, cabling map, MM clustering in high radiation
- Phase II : GeoModel XML description
  ->ACTS project: Muon reconstruction Migration
- B-Physics
- SM Physics: Z-mass precision measurement, Z+jets, Zbb, 4l lineshape, Diboson: Production, Polarization, VBS
- Indirect Searches for NP, EFT interpretation, Combination of results
- Higgs: H->4ℓ (couplings, differential, width), high mass search (H->4ℓ, ℓℓqq, ℓℓνν)
- Exotics: HDBS-DBL: W', Z', ZZd, ZdZd, LLPs
- DiHiggs: HHbbγγ

ATLAS Greece: Recent Contributions

AUTh-ATLAS Contribution to the FTK (Fast TracKer) Project

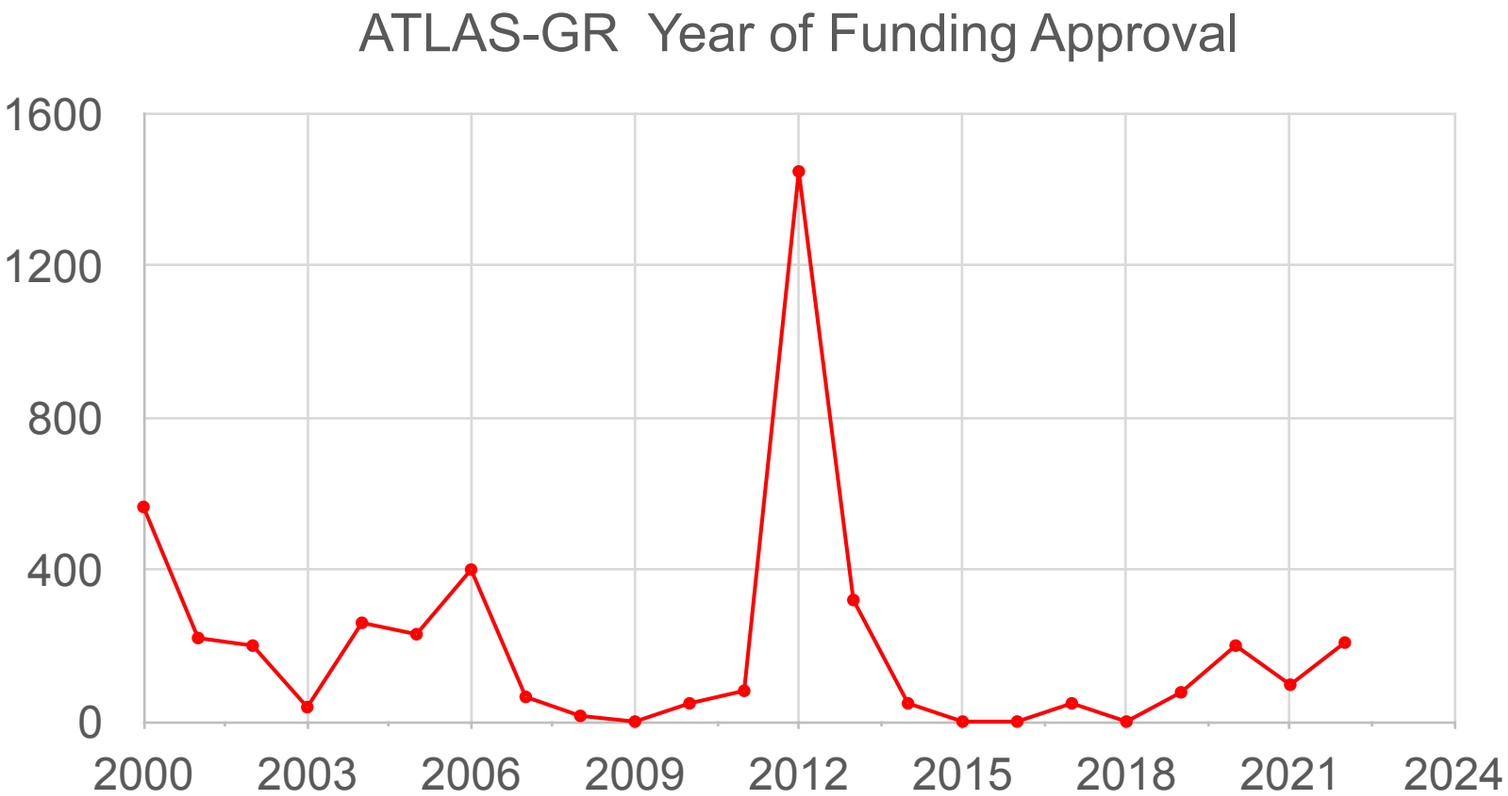
- "Fast TracKer" (FTK) : a Hardware *pre-processor* for the High-Level Trigger of ATLAS Run3
- Designed to find and measure tracks of charged particles in all events (100 kHz) accepted by the L1 trigger
- Patten-matching in dedicated "AM" ASICs (Associative Memories).
- Track fitting and all other tasks in FPGAs.
- R&D on Fast Tracker for Hadron Colliders funded by EU IAPP grant FP7 324318 (1.5M euros total, 322k at AUTh)
- Group delivered Clustering firmware, AM tests, bit-accurate simulations, Monitoring of AM boards, tests of boards and system commissioning, etc.
- At the end, FTK was not pursued for the ATLAS Run3 trigger
- FTK TDR (2013) : CERN-LHCC-2013-007 , ATLAS-TDR-021-2013
- Final FTK paper (2021): "The ATLAS Fast TracKer system", 2021 JINST 16 P07006





ATLAS Greece: Funding

EPET II	500 k	2000-2003
Diakr China	15 k	2000-2003
PENED	200 k	2000-2002
GSRI	70 k	2001-2002
IST(CrossGrid).	150 k	2002-2005
TMR(EU)	50 k	2002-2003
Diakr China	17 k	2004-2005
HERAKLEITOS(NSRF)	33 k	2004-2007
AUTh(GRID)	6 k	2003-2005
EPAN	100 k	2005-2008
FP6-RTN	400 k	2006-2010
IST (AIDA)	50 k	2007-2008
HERAKLEITOS(NSRF)	33 k	2010-2013
THALES	600 k	2012-2015
ARISTEIA	242 k	2012-2015
IAPP(FTK)	320 k	2013-2016
GSRI	90 k	2020-2023
EDBM103	60 k	2020-2021
Diakr Russia	20 k	2001-2004
ELKE	20 k	2000-2006
EPAN	130 k	2005-2008
Diakr Serbia	15 k	2010-2011
THALES	170 k	2012-2015
GSRI.	30 k	2019-2021
H.F.R.I.	190 k	2022-2025
Kripis, GSRT.	20 k	2017-2018
GSRI	50 k	2020-2023
ELKE	60 k	2021-2024
HERAKLEITOS(NSRF)	32 k	2003-2006
EPAN	120 k	2004-2006
PYTHAGORAS(NSRF)	80 k	2004-2007
NTUA	10 k	2004-2006
NTUA	15 k	2008-2010
HERAKLEITOS(NSRF)	33 k	2011-2013
FP7-AIDA	48 k	2011-2015
ARISTEIA	436 k	2012-2015
ELIDEK	28 k	2017-2020
EDBM103	37 k	2021-2023
NTUA	18 k	2022-2023
ΕΛ.ΙΔ.Ε.Κ	47 k	2019-2021



ATLAS Greece: Coordination Positions

- Outreach Coordinator (*C. Kourkoumelis 2012 - 2014*)
- Muon Speakers Committee Member (*C. Kourkoumelis 2015 - 2021*)
- MM (NSW) surface commissioning (D. Fassouliotis 2019 - 2020)
- Muon Detector Performance Group sub-Coordinator for the integration of the NSW geometry and alignment (*S. Angelidakis 2021 - today*)
- Co-convener of the Efficiency subgroup of ATLAS MCP (*S. Angelidakis 2022-2023*)
- Co-convener of the ATLAS MCP (*S. Angelidakis 2023 - today*)
- ATLAS Muon Software Coordinator (*G. Stavropoulos 2021 - today*)
- ATLAS Muon Steering group (*G. Stavropoulos 2021 - today*)
- NSW Trigger Coordinator (*T. Geralis 2021 - today*)
- NSW Electronics Steering group (*T. Geralis 2017 - today*)
- Vertical Slice Laboratory responsible (*T. Geralis 2022 - today*)
- Speakers Committee Member (*K. Kordas 2020 - 2022*)
- SCAB Member (*C. Petridou 2019 - 2021*)
- International Computing Board Member (*D. Sampsonidis, 2012 - today*)
- Collaboration Advisor Group Member (*C. Kourkoumelis 2006 - 2010*)
- B-Physics Convener (*C. Petridou 2008 - 2010*)
- PubCom Member (*C. Petridou 2008 - 2010*)

- National Contact Physicist (*D. Samsonidis, 2023 - today*)
- National Contact Physicist (*E. Gazis, 2005 - 2023*)
- Upgrade Advisory Board Member (*D. Samsonidis, 2023 - today*)
- Upgrade Advisory Board Member (*E. Gazis, 2015 - 2023*)

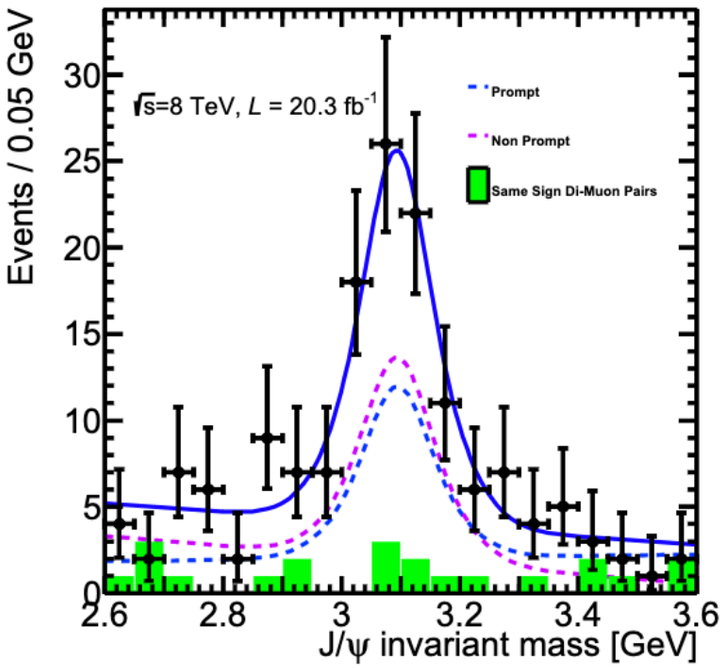
- NSW Electronics Steering (*T. Alexopoulos 2017 - 2023*)
- Muon DCS coordinator (*T. Alexopoulos 2016 - 2019*)
- Muon DCS coordinator (*C. Paraskevopoulos 2022 - today*)
- NSW DCS coordinator (*T. Alexopoulos 2016 - 2020*)
- NSW DCS coordinator (*P. Tzanis 2021 - 2022*)
- NSW commissioning coordination (*E. Koulouris 2019-2022*)
- Micromegas integration co-coordinator (*T. Alexopoulos 2015 - 2022*)
- Micromegas Analysis co-coordinator (*T. Alexopoulos 2016 - 2019*)
- Micromegas represetative in Muon SG (*T. Alexopoulos 2022 - today*)
- Micromegas testbeam co-coordinator (*T. Alexopoulos 2015 - 2019*)
- NSW services coordinator in commission (*K. Iakovidis 2019 - 2022*)
- NSW Steering group (*T. Alexopoulos 2017 - 2023*)

ATLAS Greece: Publications & Physics

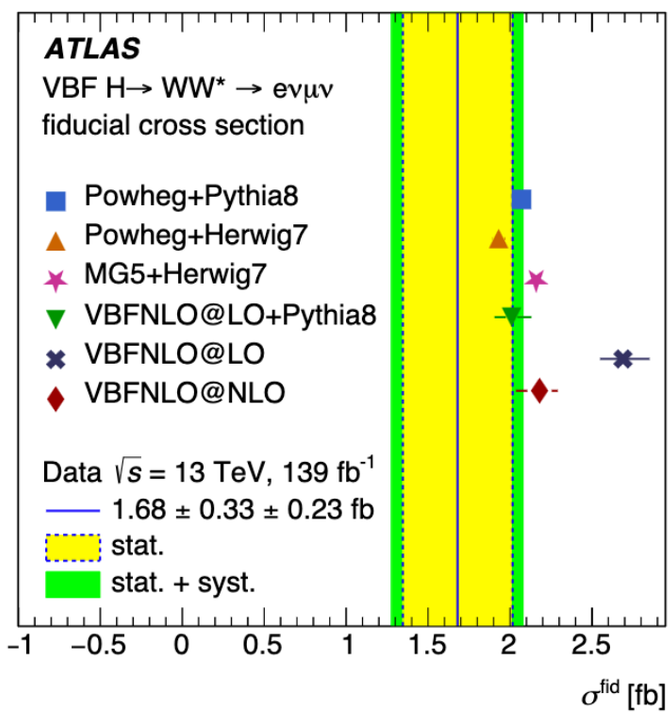
Run 1, 2 Physics (highlights)

- Higgs first observation
- First observation of the associated production of Z boson with prompt and non-prompt J/ψ
- Measurement of the production of the J/ψ and ψ(2S) mesons and study of the decay $\chi_b \rightarrow J/\psi J/\psi$
- B hadron rare decays, Spin and parity of the higgs in the WW^*
- Higgs boson production in the $WW^* \rightarrow \ell\nu\ell\nu$ decay channel through VBF mechanism

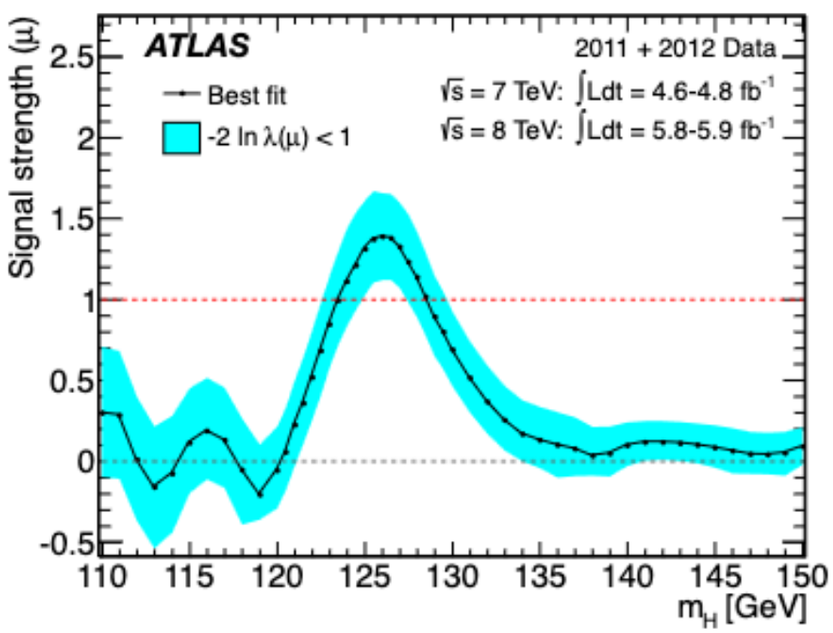
First observation of the associated production of Z boson with prompt and non-prompt J/ψ



Higgs boson production in the $WW^* \rightarrow \ell\nu\ell\nu$ decay channel through VBF mechanism

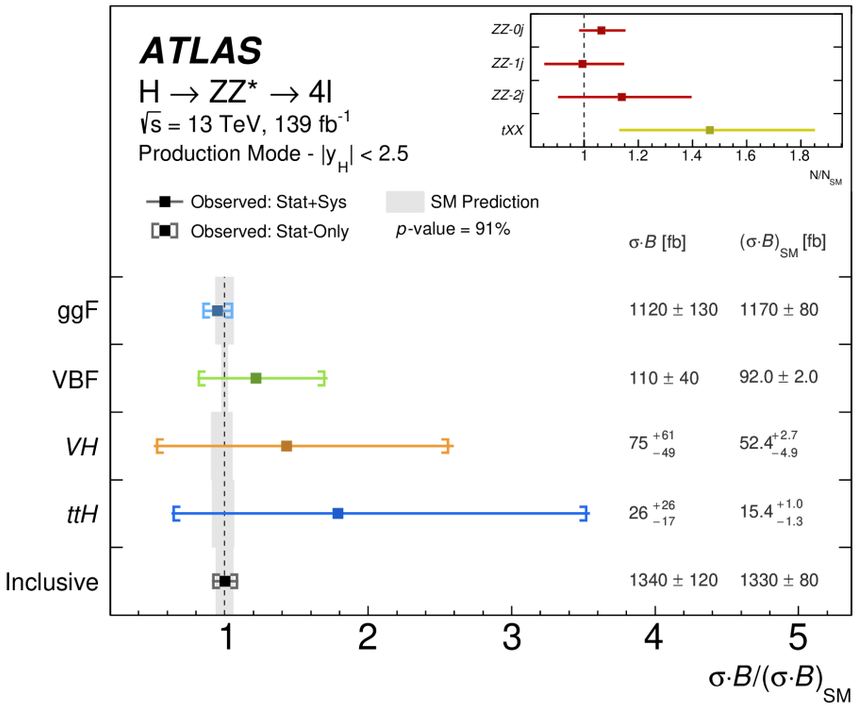


Higgs first observation



ATLAS Greece: Publications & Physics

Run 2 Physics (highlights)

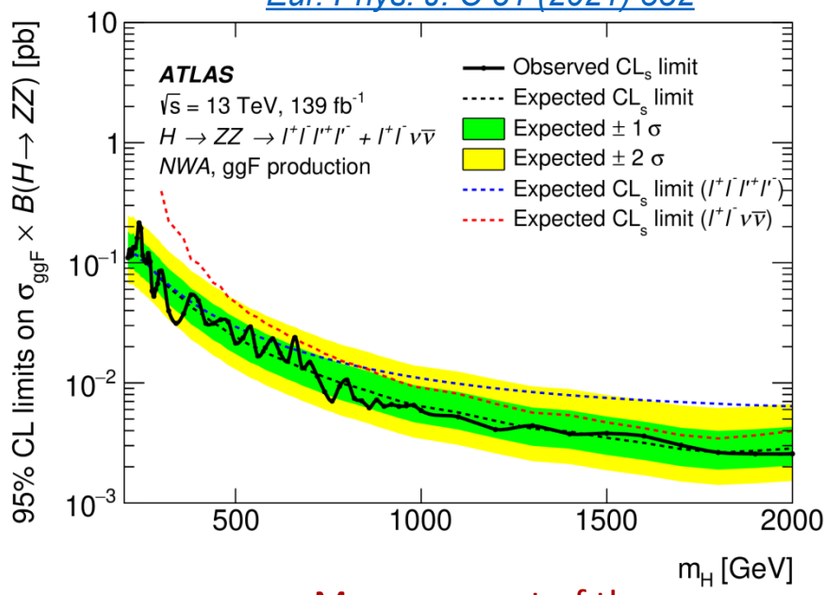


Measurement of Higgs-boson couplings

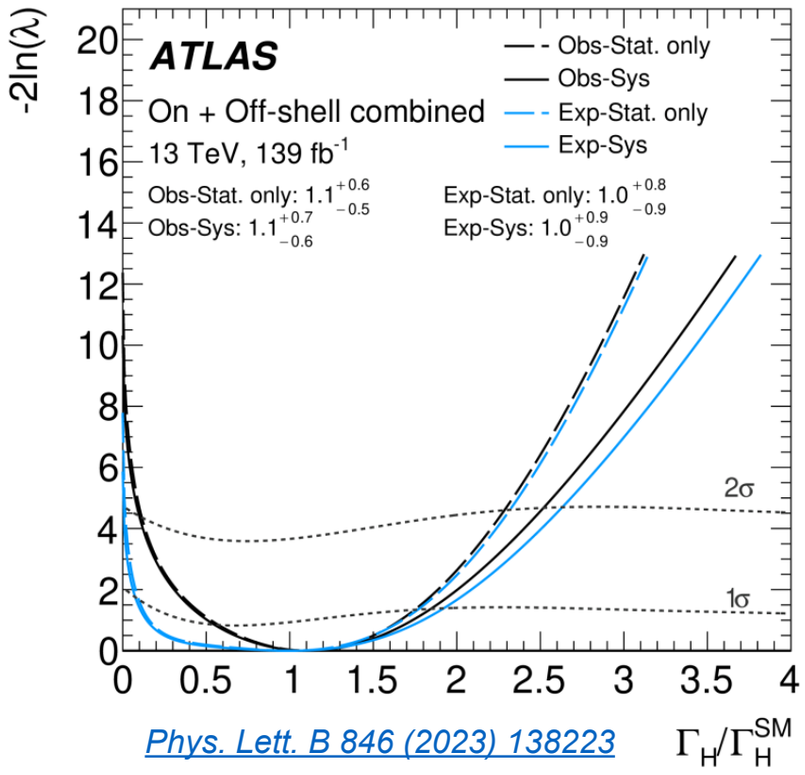
Eur. Phys. J. C 80 (2020) 957

Search for a high mass Higgs boson in the H → ZZ channel

Eur. Phys. J. C 81 (2021) 332



Measurement of the Higgs-boson width



Phys. Lett. B 846 (2023) 138223

Name	ATLAS
Publications with direct contribution from the teams	80
Conf_Notes (preliminary results) with direct contribution from the teams	42
Pub_Notes with direct contribution from the teams	14
Detector related publications	*60*
Planned publications	*7*
Total	**203**

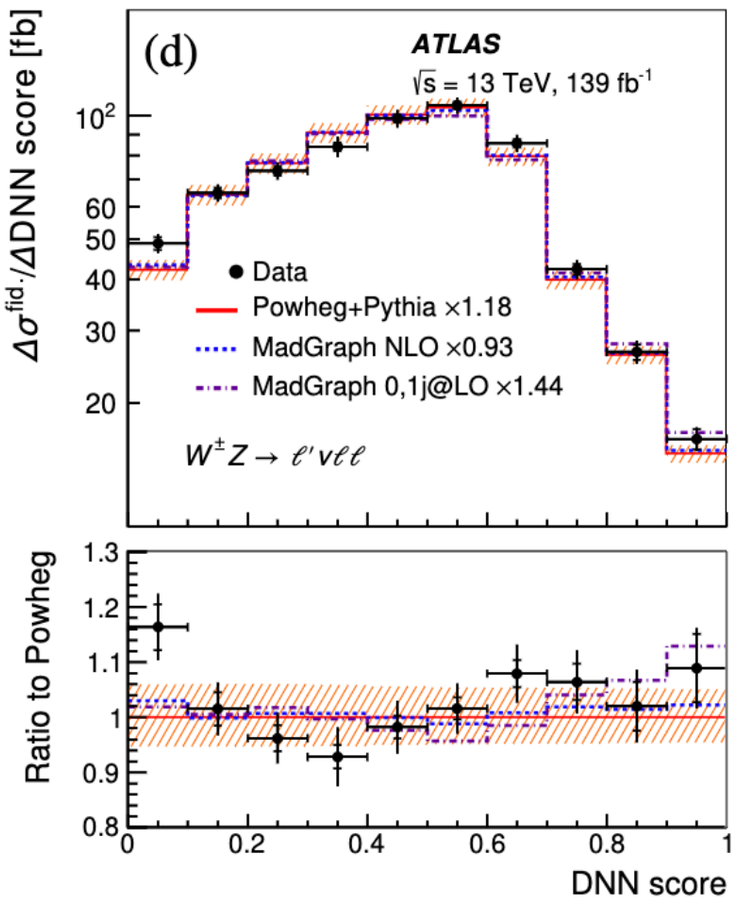
ATLAS Greece: Publications & Physics

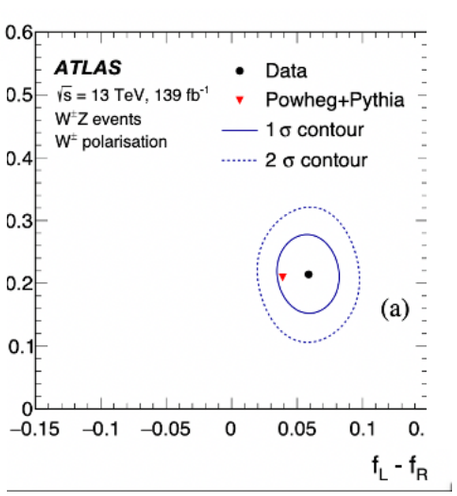
Run 2 Physics (highlights)

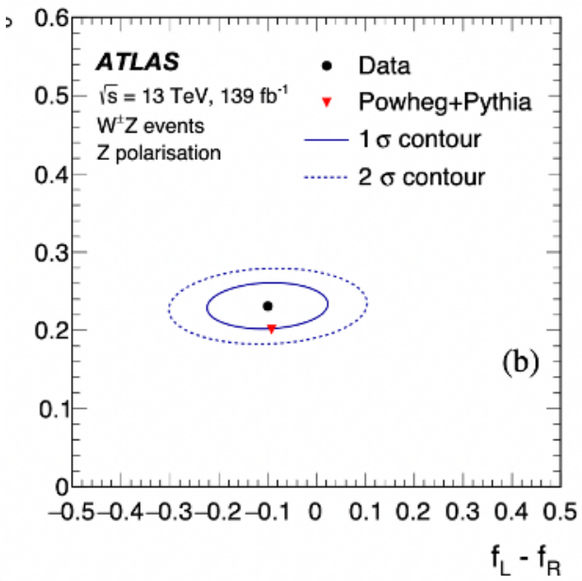
WZ polarization measurements

The presence of a W boson and a Z boson with a simultaneous longitudinal polarisation observed with significance of 7.1 standard deviations

Individual helicity fractions for W & Z in WZ fully leptonic states

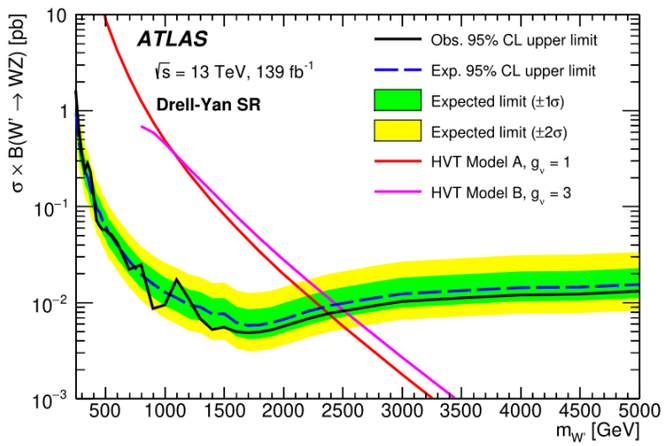




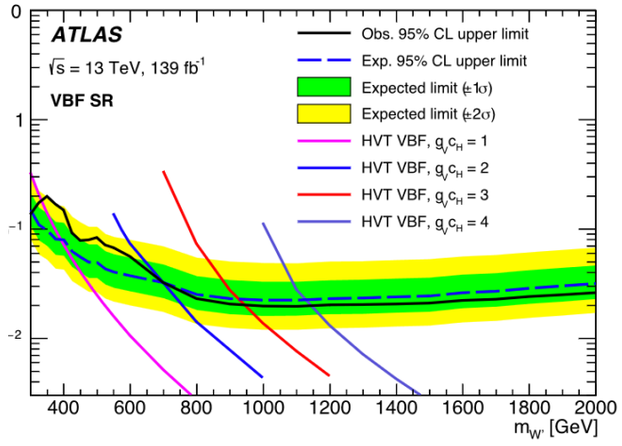


Direct Searches for New Physics In Di-boson channels

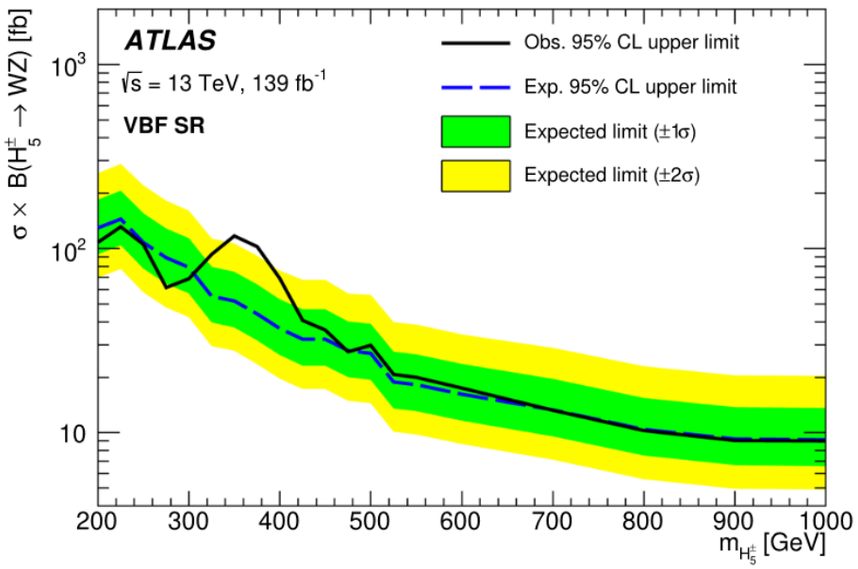
W' -> WZ
DY-production



W' -> WZ
VBF-production



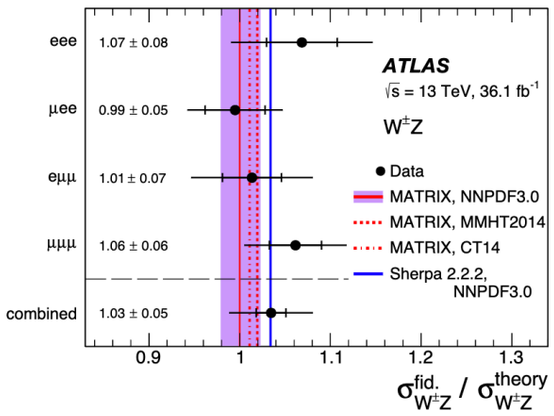
$H_5^{\pm}$ -> WZ



ATLAS Greece: Publications & Physics

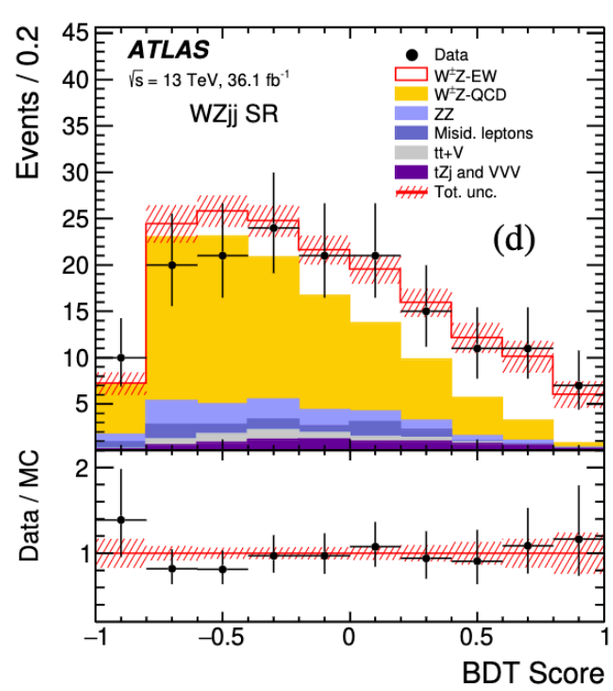
Run 2 Physics (highlights)

Precision measurements for the WZ fully leptonic production cross section a 13 TeV

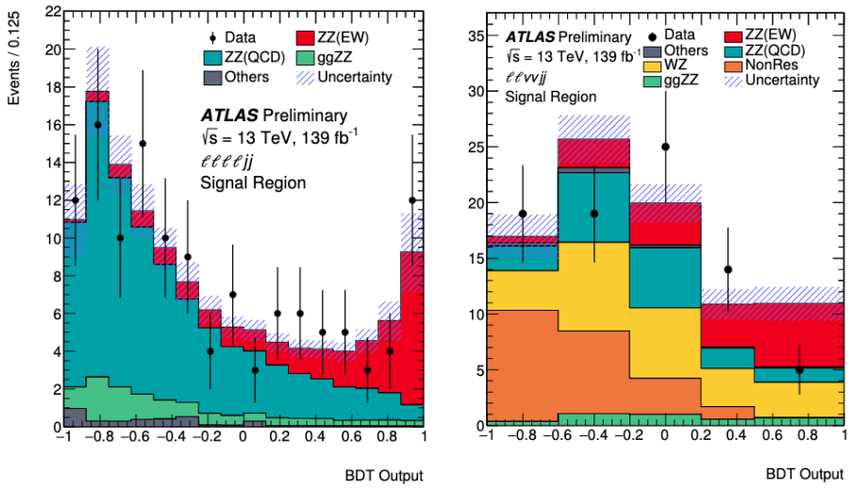


WZ jj EWK observation

EWK production of W± Z bosons in association with two jets is measured with observed with a significance of 5.3 standard deviations

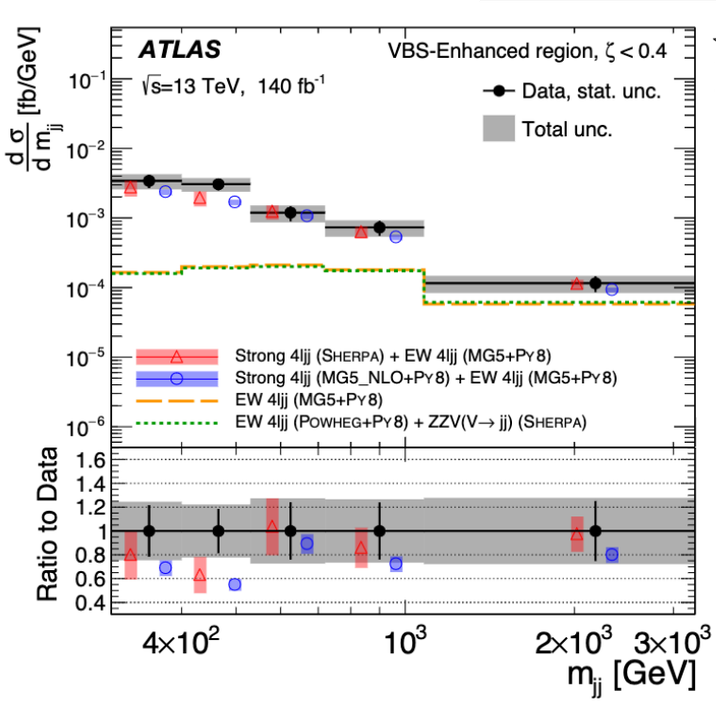


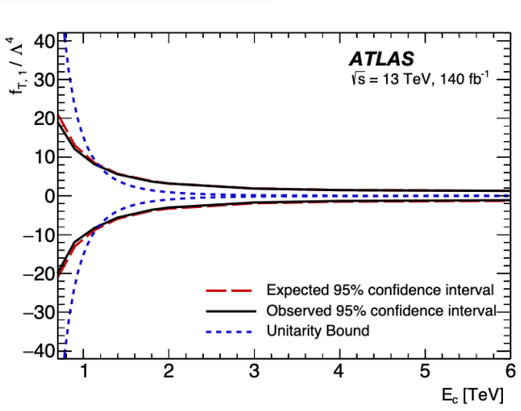
ZZ jj EWK observation



EWK production in ZZjj is observed combining the 4ljj and 2l2vjj channels, with a significance of 5.5 standard deviations

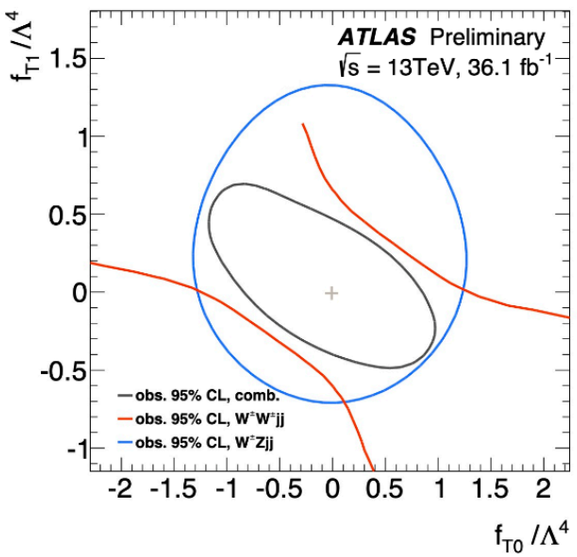
ZZ jj Differential cross section in the fully leptonic channel (VBS-enhanched region)





Wilson coefficient	$\lvert\mathcal{M}_{d8}\rvert^2$ Included	95% confidence interval [TeV^{-4}] Expected	Observed
$f_{T,0}/\Lambda^4$	yes	[-0.98, 0.93]	[-1.00, 0.97]
	no	[-23, 17]	[-19, 19]
$f_{T,1}/\Lambda^4$	yes	[-1.2, 1.2]	[-1.3, 1.3]
	no	[-160, 120]	[-140, 140]

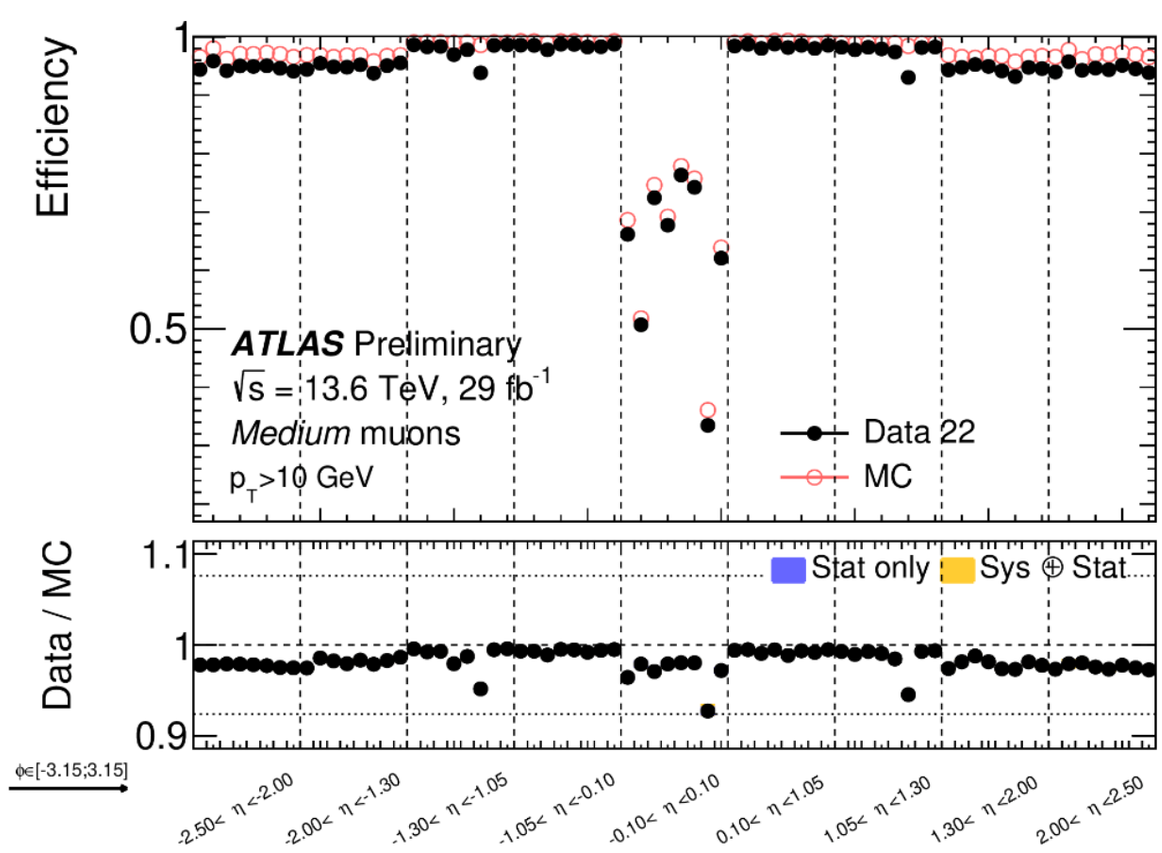
EFT interpretation: Combination results of WWjj and WZjj channels 95% CL on quartic couplings



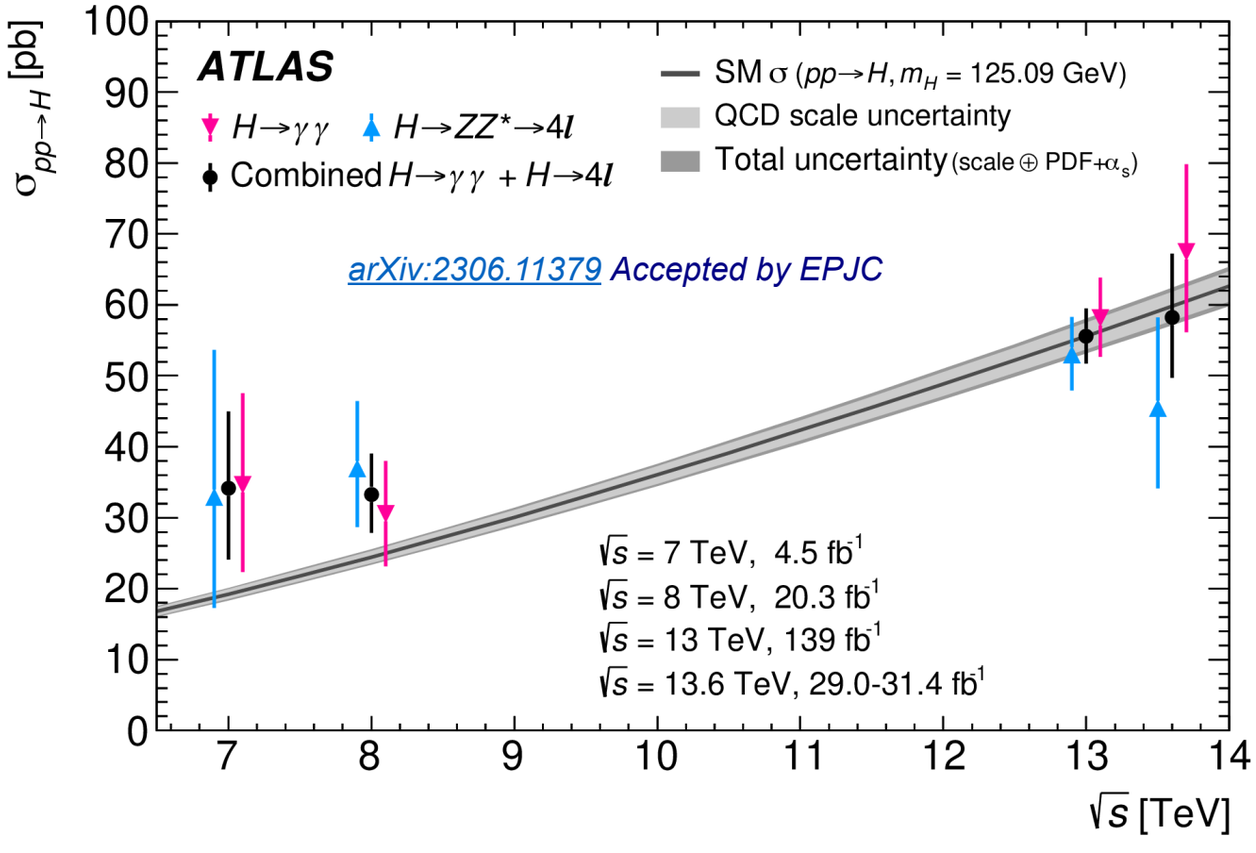
ATLAS Greece: Publications & Physics

Run 3 Physics (highlights)

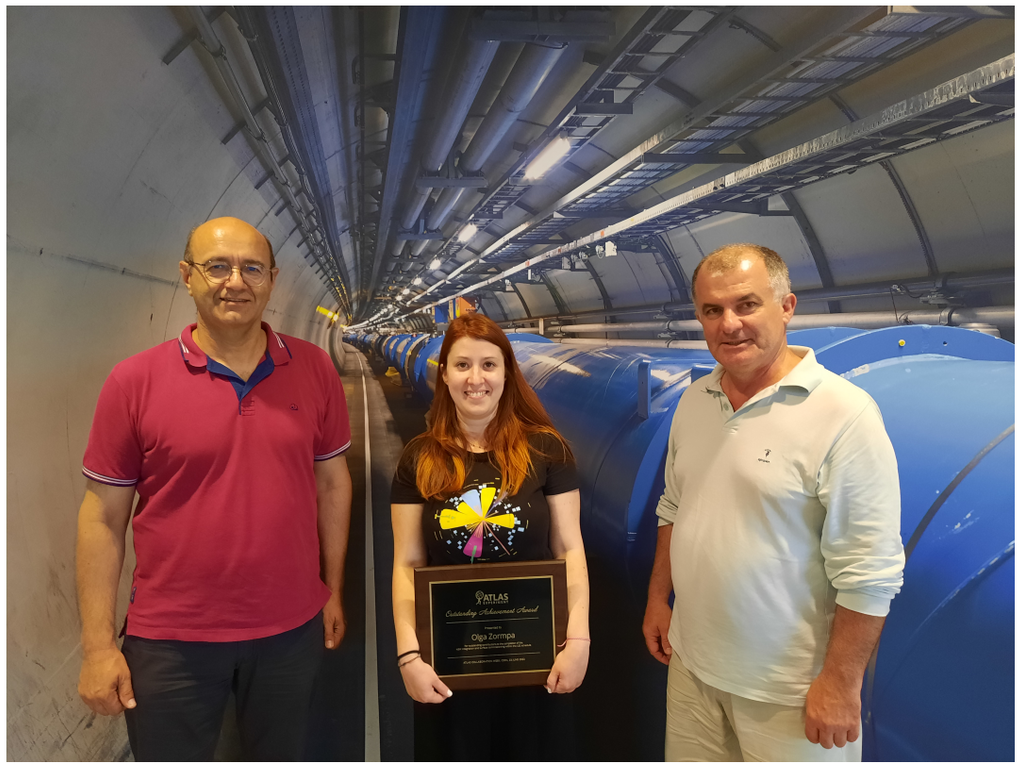
Muon efficiency measurements
& identification quality studies



Measurement of the Higgs-boson
cross-section @ 13.6 TeV



ATLAS Greece: Awards



Awards

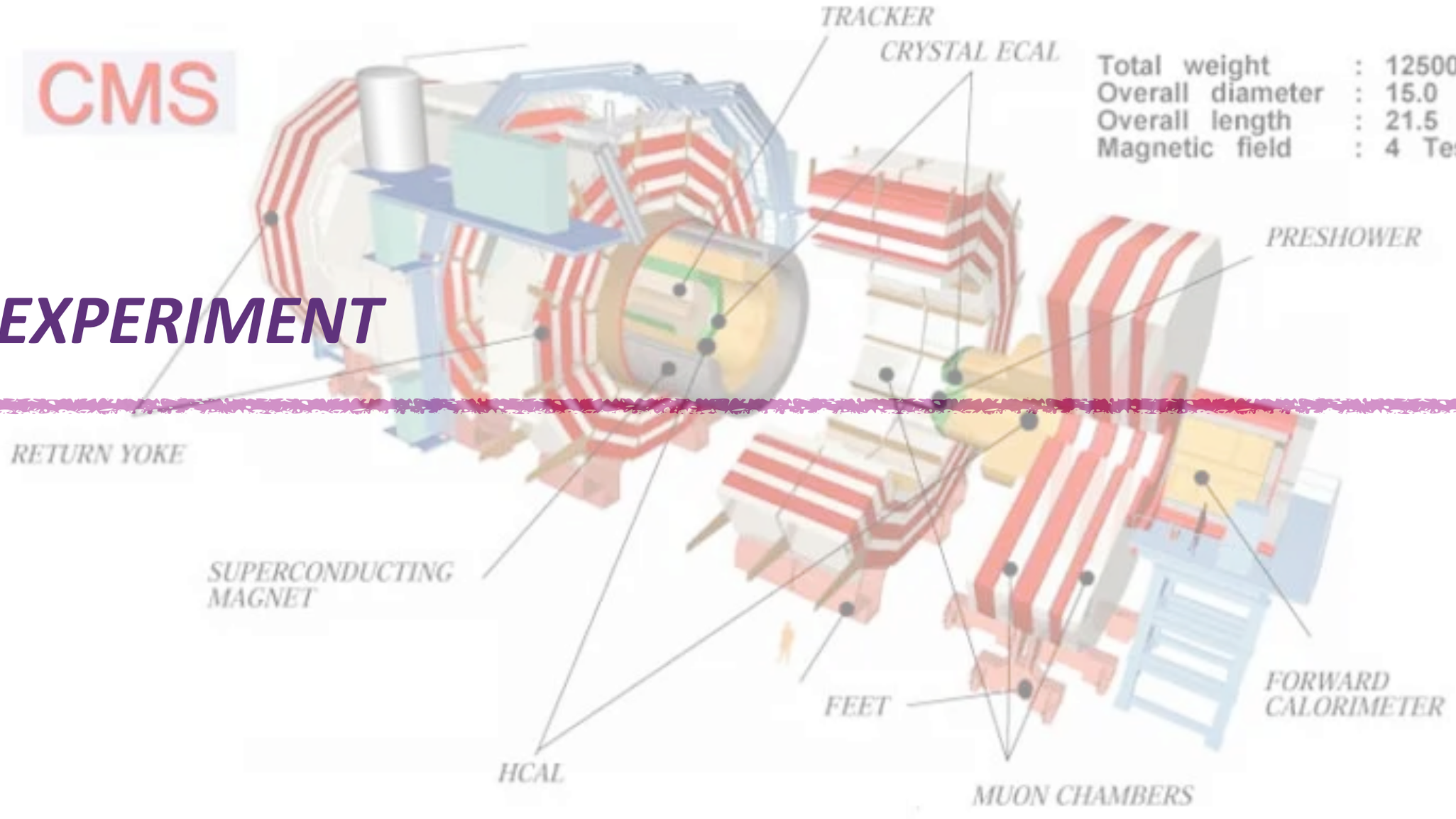
K. Bachas, 2009 Mark Virchaux Prize (PhD Thesis Award)
K. Nikolopoulos, 2010 Mark Virchaux Prize (PhD Thesis Award)
E. Mountricha, 2012 ATLAS Thesis Award

2022 Atlas Outstanding Achievement Award

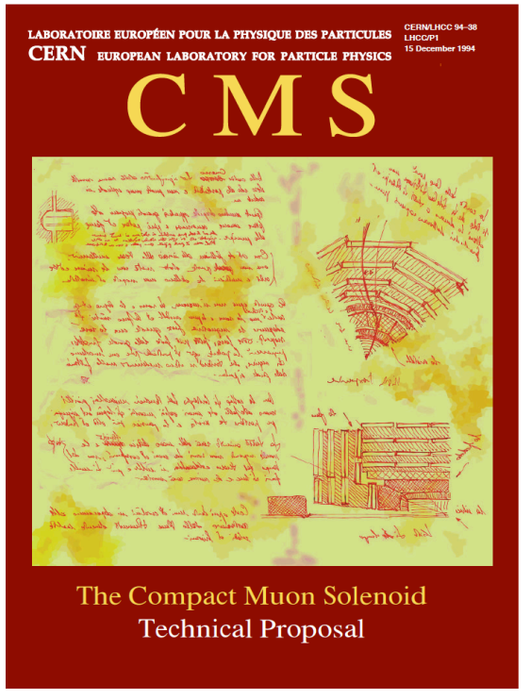
for outstanding contributions to the completion of the NSW integration and surface commissioning within the LS2 schedule

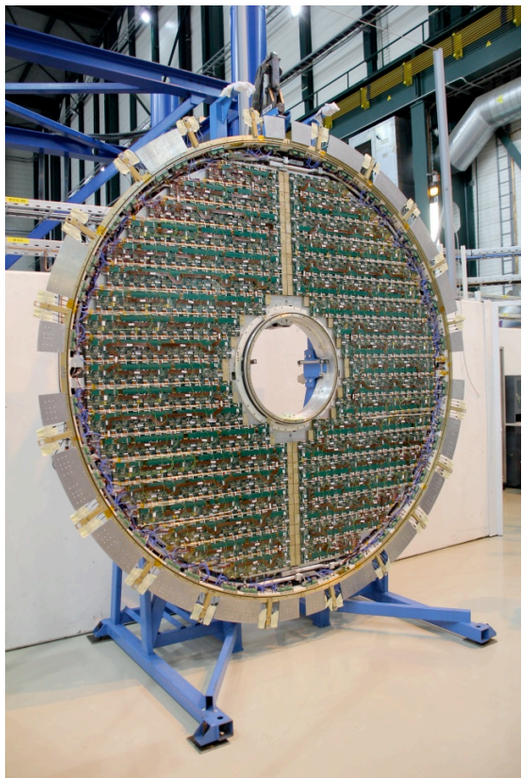
E. Koulouris
P. Tzanis
O. Zorba

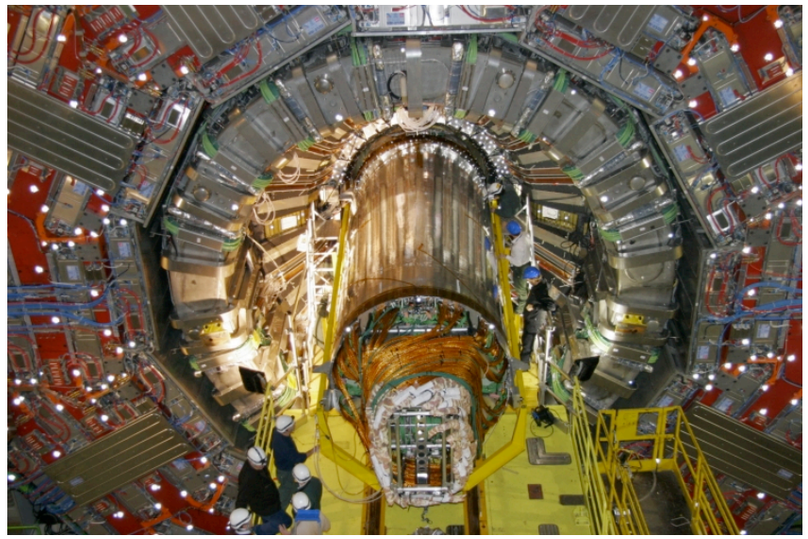
CMS EXPERIMENT



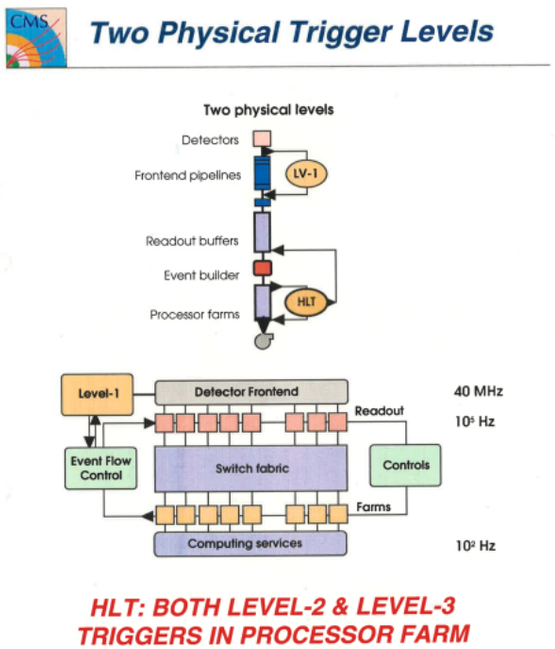
CMS Greece: Historical Overview

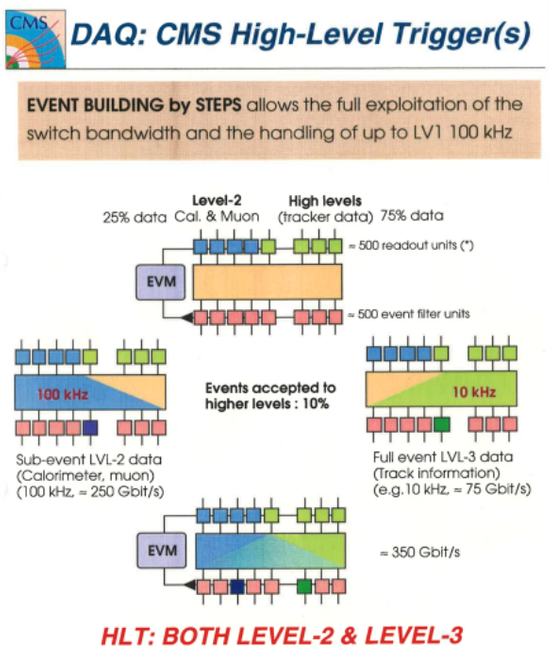






- Founding members of CMS
- ECAL Preshower
- Silicon Strip Tracker
- Castor calorimeter
- L1 Trigger
- DAQ





Current Participation

4 Institutes
15 Faculty & Researchers
5 Emeritus
2 Postdocs
16 PhD Students
19 MSc Students

CMS Greece: NKUA

Present CMS-NKUA group composition:

- **Faculty**
  - Paris Sphicas (Prof.)
  - Apostolos Panagiotou (Prof. emeritus)
  - Niki Saoulidou (Assoc. Prof.)
  - Costas Vellidis (Assoc. Prof.)
  - Kostas Theofilatos (Assoc. Prof.)

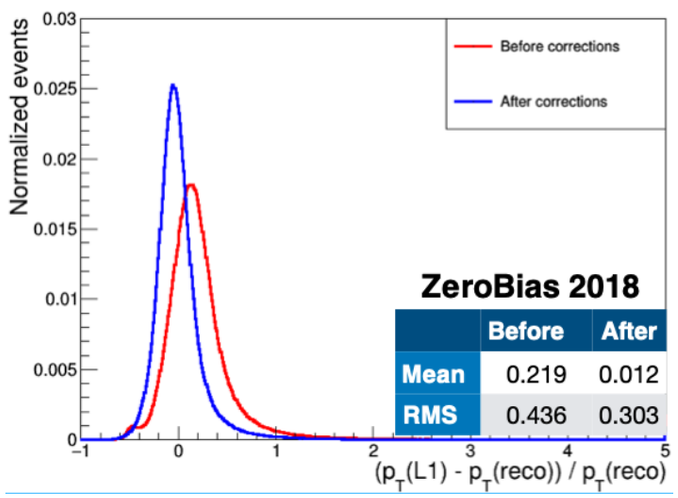
- **Postdoctoral Researchers**
  - Eirini Tziaferi
  - Ioannis Paraskevas

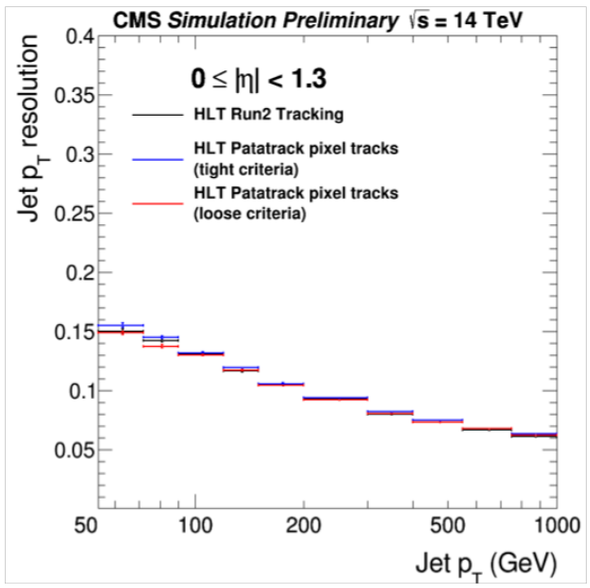
- **PhD Students**
  - Georgios Melacroinos
  - Haris Painesis
  - Ilias Zisopoulos

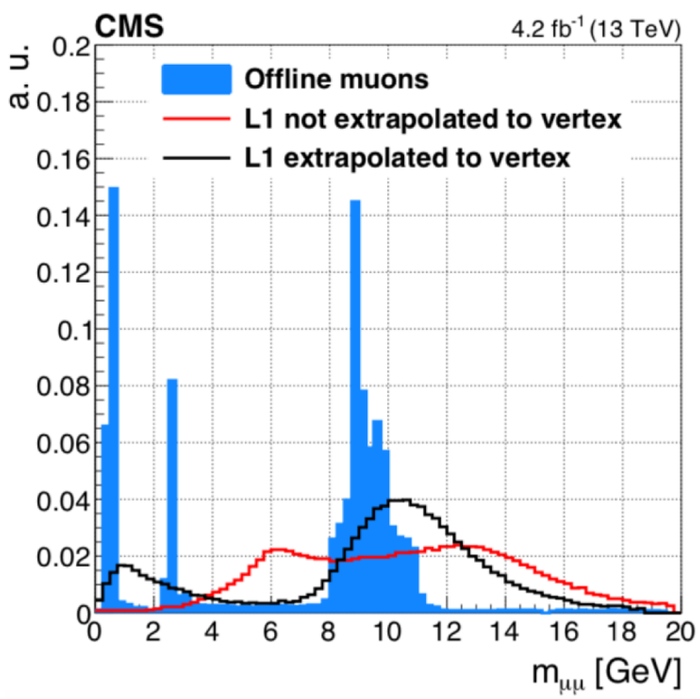
- **Students**
  - MSc: 9
  - Undergraduates: 10

Recent Contribution Areas

- Level 1 Muon Trigger (algos, firmware, hardware)
- Phase II Upgrades (Level 1 Trigger for HL-LHC)
- Physics Performance & Datasets
- Monte Carlo Generators
- Trigger Performance
- Level 1 & HLT Scouting
- Physics Analyses
  - Standard Model (Higgs: ttH, B Physics: rare decays)
  - BSM Physics (SUSY, jet resonances)







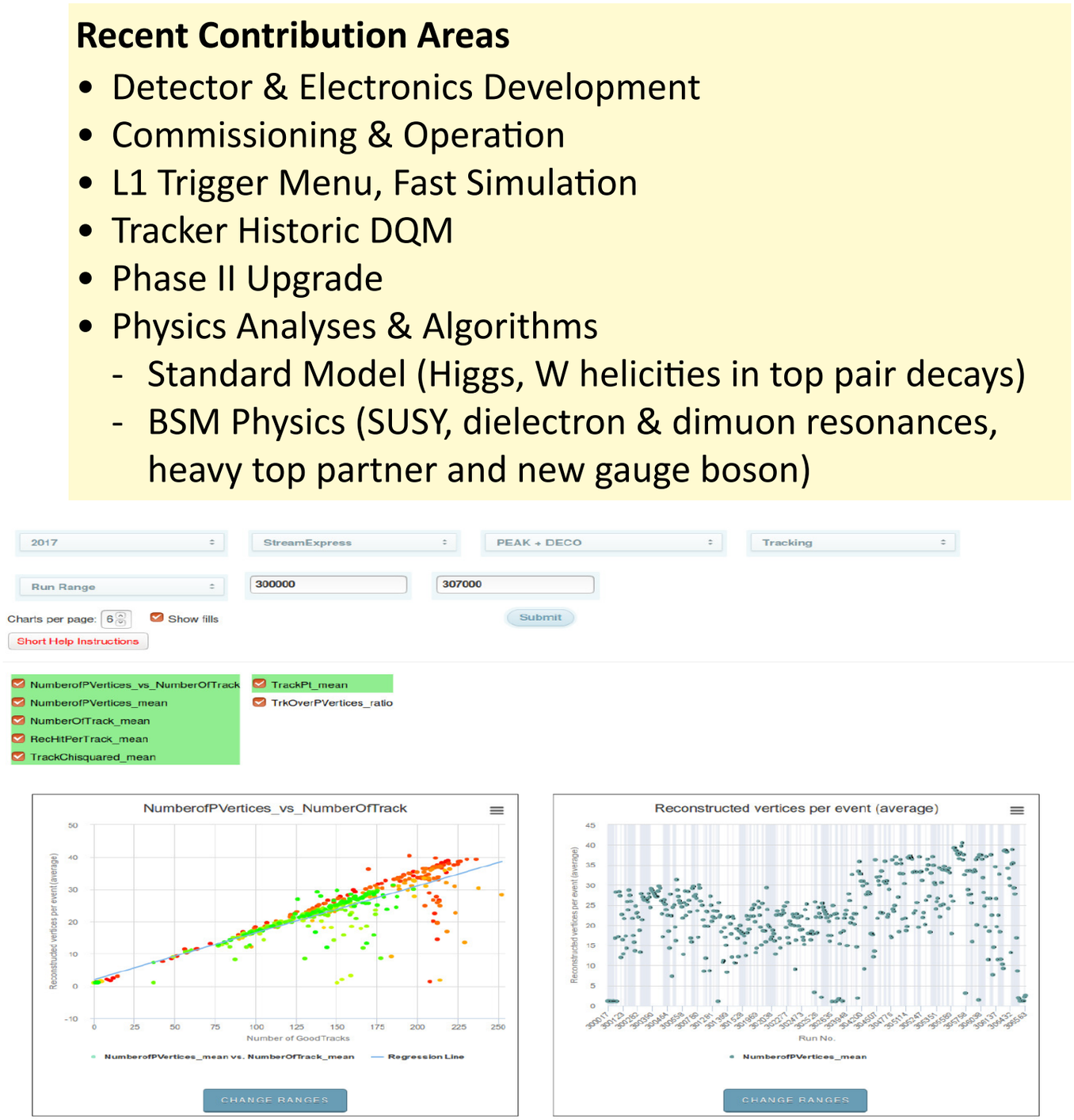
CMS Greece: NCSR

Present CMS-NCSR group composition:

- **Staff Physicists**
  - Georgios Anagnostou (Senior Researcher)
  - Georgios Daskalakis (Director of Research)
  - Aristoteles Kyriakis (Director of Research)
  - Dimitrios Loukas (Director of Research)
- **Staff**
  - Ioannis Kazas (Special Scientific Personnel)
  - Michele Barone (Administration)
- **PhD Students**
  - A. Chatziagapiou
  - A. Papadopoulos
  - A. Stakia
- **Students**
  - MSc: 1

Recent Contribution Areas

- Detector & Electronics Development
- Commissioning & Operation
- L1 Trigger Menu, Fast Simulation
- Tracker Historic DQM
- Phase II Upgrade
- Physics Analyses & Algorithms
  - Standard Model (Higgs, W helicities in top pair decays)
  - BSM Physics (SUSY, dielectron & dimuon resonances, heavy top partner and new gauge boson)



"A Historic Data Quality Monitor (HDQM) tool for the CMS Tracker Detector", EPJ Web Conf., 214 (2019) 05030, https://doi.org/10.1051/epjconf/201921405030

CMS Greece: UOI

Present CMS-UOI group composition:

- **Faculty**
  - Costas Foudas (Prof.)
  - Panagiotis Kokkas (Prof.)
  - Nikolaos Manthos (Prof. emeritus)
  - Ioannis Evangelou (Prof. emeritus)
  - Ioannis Papadopoulos (Assoc. Prof.)
  - Ioannis Strologas (Assist. Prof.)

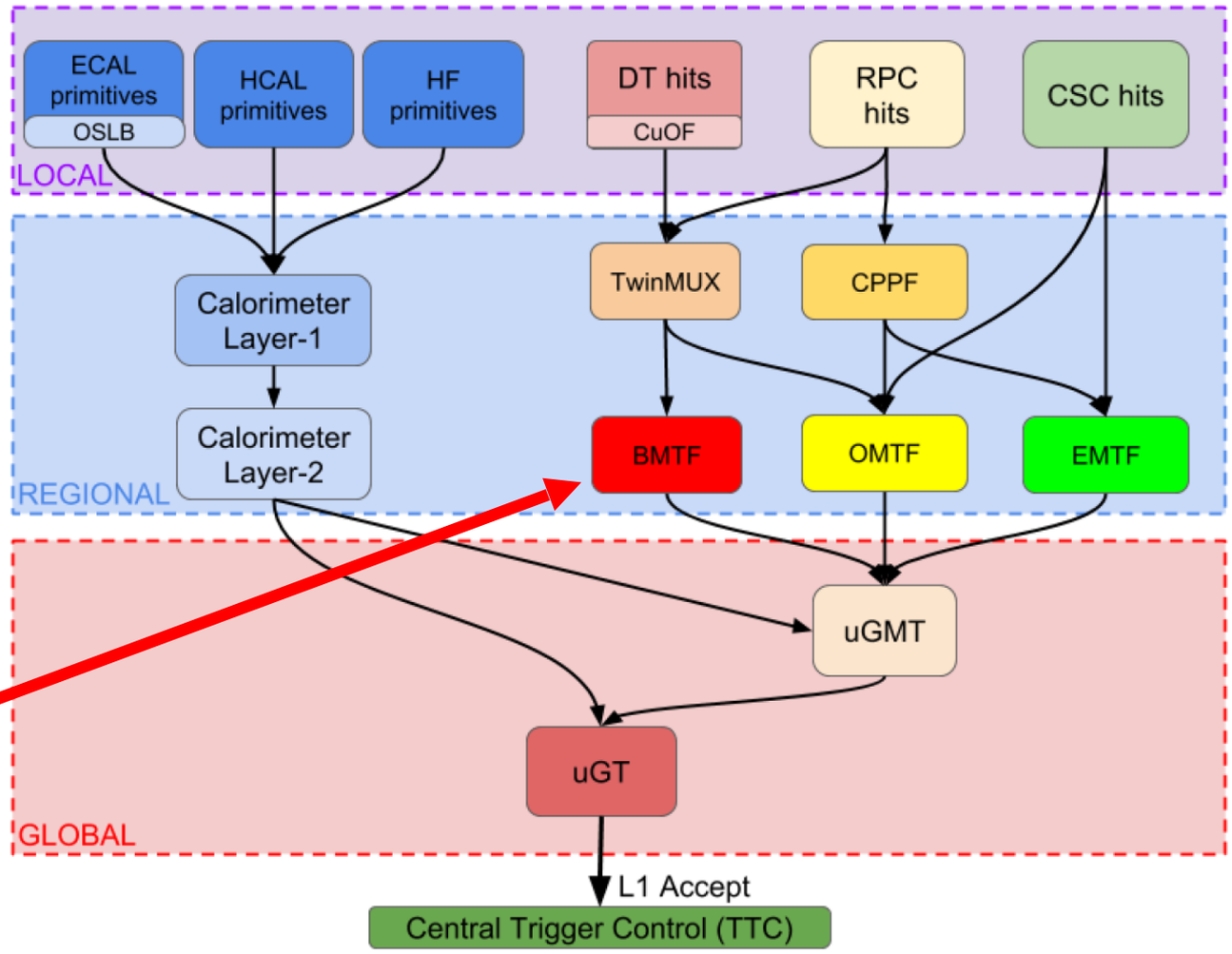
- **PhD Students**
  - K. Adamidis
  - P. Katsoulis
  - P. Kosmoglou
  - I. Bestigianos
  - A. Ziaka

- **Students**
  - MSc: 6

Universities of Ioannina, Athens (GR) and UCLA (US) are currently responsible for the Barrel Muon Track Finder (BMTF) within the CMS Muon Trigger.

Recent Contribution Areas

- Level 1 Muon Trigger
- Level Trigger Menu
- Phase II Upgrade
- Physics Analyses
  - Standard Model (Jet cross sections, measurement of strong coupling constant, parton distribution functions)
  - BSM Physics (new phenomena with high jet multiplicity)



CMS Greece: NTUA

Present CMS-NTUA group composition:

- **Faculty**
  Yorgos Tsipolitis (Prof.)
  Konstantinos Kousouris (Assoc. Prof.)
  Georgia Karapostoli (Assist. Prof.)

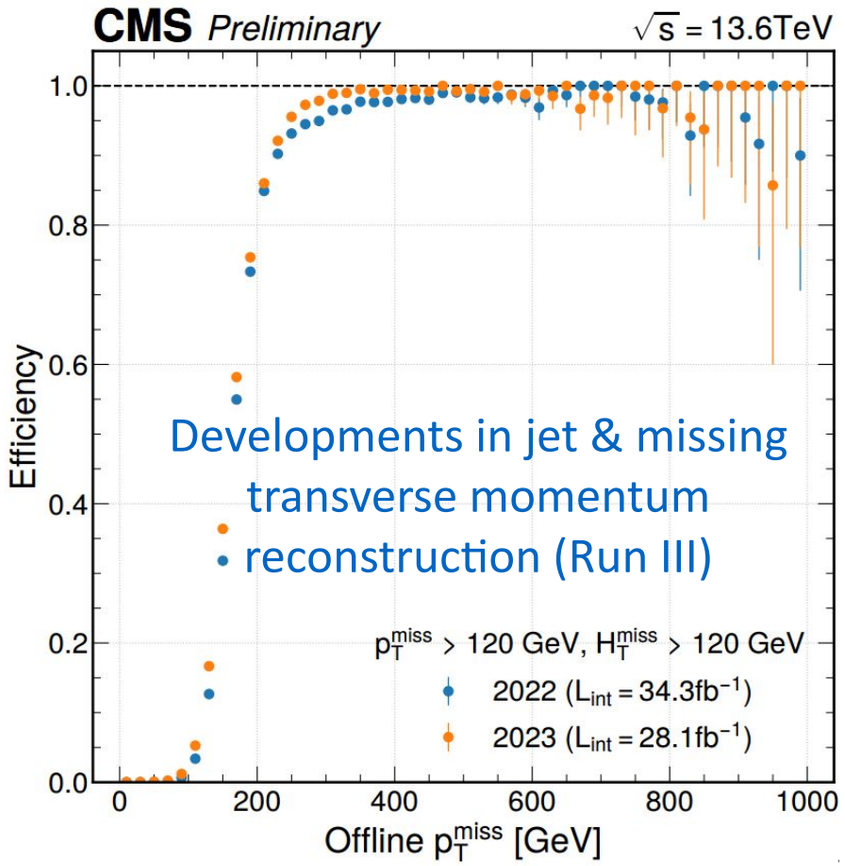
- **PhD Students**
  I. Papakrivopoulos (2023)
  G. Bakas (2023)
  A. Zacharopoulou
  T. Chatzistavrou
  E. Siamarkou

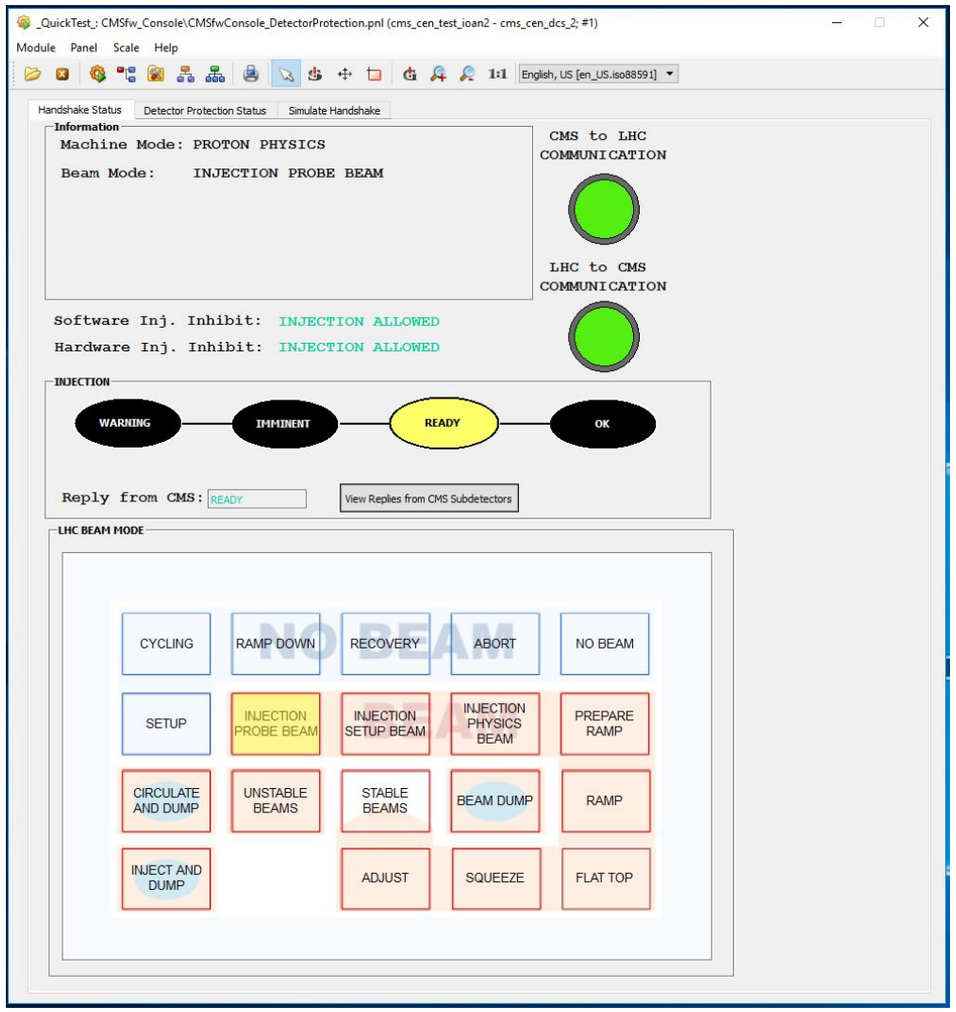
- **Students**
  MSc: 3
  Undergraduates: 3

Recent Contribution Areas

Became full member in 2016

- Central CMS DCS
- Phase II Upgrade (DCS for HGCAL)
- Jets and MET High Level Triggers
- Hadronic Jet Propties
- Physics Analyses
  - Standard Model (Top quark production, Top quark properties, Associated Production Wbb)
  - BSM Physics (Exotic Higgs Decays)





CMS Greece: Recent Contributions

Detectors, Trigger, Software, Objects

- Phase 2 Upgrade
- L1 Muon Trigger
- L1 Trigger Menu
- Jets & MET Trigger
- Tracker DQM
- Central DCS
- Physics Performance & Datasets
- Jet identification, calibration & properties
- Trigger DQM
- Monte Carlo generators
- Fast Simulation

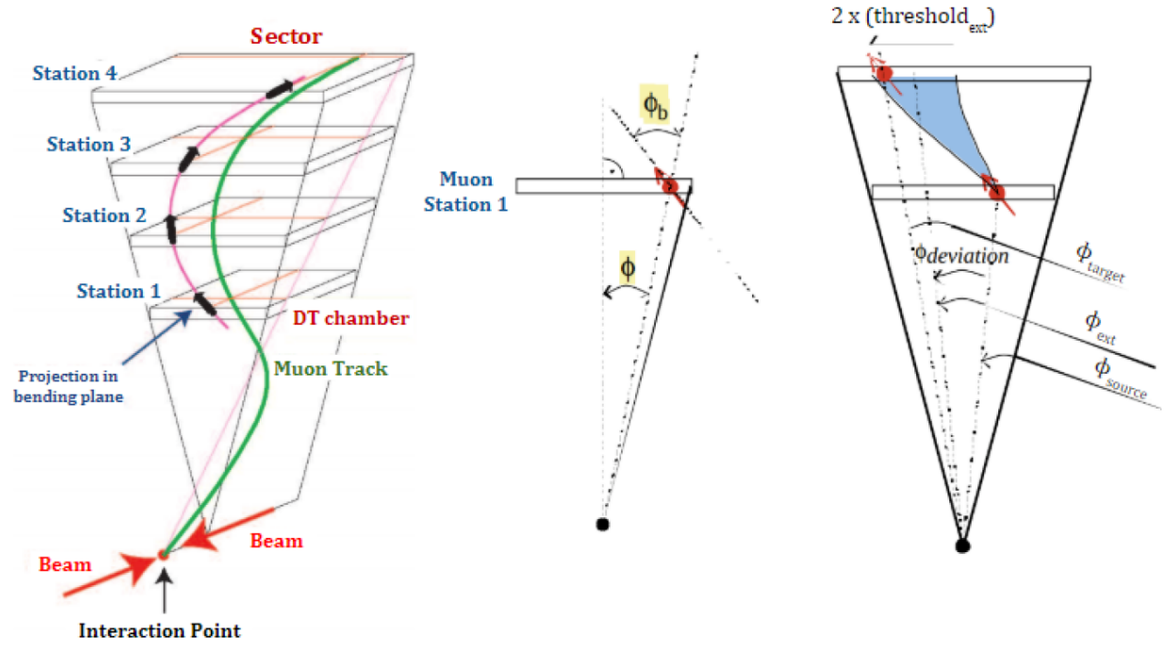
Data Analyses

- **Standard Model Physics**
  - QCD with jets
  - Top production
  - Top Properties
  - Higgs production
  - B physics: rare decays
- **Beyond the Standard Model Physics**
  - Search for dijet resonances
  - Search for multijet resonances
  - Search for dilepton resonances
  - Search for SUSY
  - Search for heavy top partner and new gauge boson
  - Search for exotic Higgs decays

CMS Greece: Recent Contributions

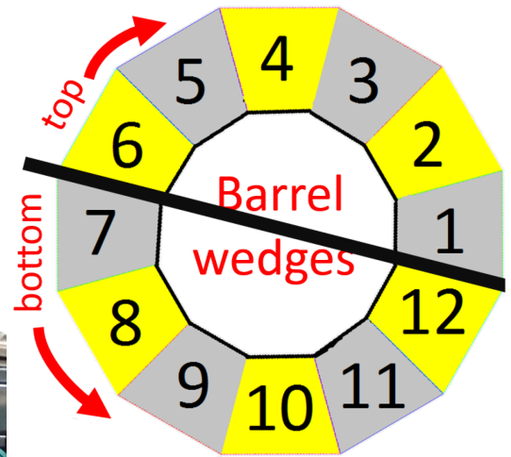
The Level-1 Trigger Barrel Muon Track Finder Project

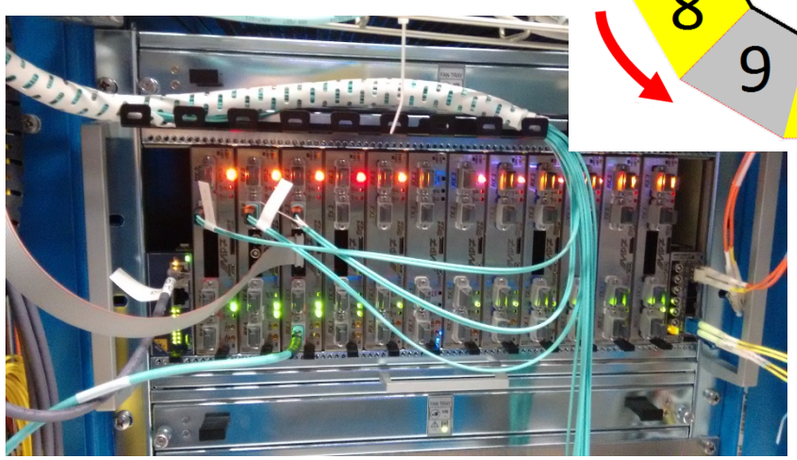
- The Level-1 BMTF was designed and commissioned as part of the CMS Phase-1 Upgrades.
- Greek Responsibilities: System hardware and commissioning, algorithm firmware, algorithm validation, online, offline and DQM software, offline analysis of the data.
- **R&D started in 2012 and BMTF was successfully commissioned on time in May 2016.**



- BMTF constructed and commissioned on schedule/budget and performed as expected: The Barrel Muon Trigger efficiency is 95% with a rate reduction of ~50% relative to the legacy system (RUN-1).
- 5% loses originate from 3% detector geometrical acceptance (gaps)and 2% due to hadron punch through in the first station.

BMTF @ P5





- BMTF Consists of 12 MP7 L1-Trigger processors, each assigned to one of the twelve 30^{o}-muon detector wedges.
- Each MP7 receives stub data from the assigned wedge and the two neighboring wedges. The stub data for each MP7 is received via 30 10GBps fibers.
- Each processor sends to the global muon trigger up to 3 muon candidates (36 in total) via one 10 G fiber.

CMS Greece: Funding

Project Title	Funding source	Amount (€)	Period
Discovery Hubs with Jets at CMS HUBSwJETS@CMS (tentative)	*"Seal of Excellence" from ERC Advanced Grant, awaiting final decision on 1M national funding from HFRI-NIARCHOS*	*1000 k*	*2024-2026*
Enhancing physics selectivity for exotic Higgs searches with novel trigger and reconstruction techniques in the CMS experiment	HFRI	187 k	2023-2025
Standard Model and Beyond with the CMS Experiment at LHC	HFRI	200 k	2020-2024
DiJets as a tool for search for New Physics at the Large Hadron Collider	HFRI	200 k	2020-2023
Measurement of top quark mass in pp collisions at 13 TeV in CMS	NTUA	18 k	2019-2023
DeTANet (Development of Detectors, High-Tech Electronics & their Applications)	ESPA	245 k	2019-2023
Exploring the Visible and Invisible Universe: Technology - Specialization - Innovation	KRIPIS-II	54 k	2018-2019
Experimental Particle Physics with the CMS experiment at the Large Hadron Collider (LHC) - 1	SNF Research Excellence Grant	200 k	2017-2022
Experimental Particle Physics with the CMS experiment at the Large Hadron Collider (LHC) - 2	SNF Research Excellence Grant	200 k	2017-2022
AMVA4NewPhysics, (2015-2019): PI of the node IASA	Horizon 2020 MSCA ITN	195 k	2015-2019
Beyond the Standard Model at the LHC. BSM-at-LHC	GSRT	400 k	2013-2016
Exploring the Visible and Invisible Universe with Accelerators and Innovative Detectors	KRIPIS-I	168 k	2012-2016
Search for new physics with the ATLAS and CMS experiments at the LHC. NewPhysAtLHC	Ministry of Education	520 k	2012-2016
TAU	TECHNOLOGY/THEPIS/0609(BE)/18	137 k	2012-2016
GENESIS@LHC	THALIS	160 k	2012-2015

HFRI: Hellenic Foundation For Research and Innovation; **SNF**: Stavros Niarchos Foundation
GSRT: General Secretariat for Research and Technology (nowadays: **GSRI**)

CMS Greece: Coordination Positions

- **L1 Positions (Management)**
  - Deputy Spokesperson, Physics Coordinator, PubComm Chair, Project Manager of Computing/Physics/Trigger (*P. Sphicas,* 2001 - 2016)
  - Trigger Upgrade Project Manager, L1 Trigger Coordinator, Track Trigger Review Panel, Trigger Resource Manager (C. Foudas, 2010 - 2020)
- **L2 Positions**
  - HCAL Detector Performance Group (*G. Karapostoli,* 2021 - 2022)
  - Exotic Physics Analysis Group (*N. Saoulidou*, 2019 - 2021)
  - CMS Trigger Coordination Group (*G. Karapostoli,* 2015 - 2017)
  - Standard Model Physics Analysis Group (*K. Theofilatos,* 2015 - 2017)
  - Physics Data and Monte Carlo Group (*K. Kousouris,* 2016 - 2017)
  - Jets and Missing Transverse Energy Group (*K. Kousouris,* 2014 - 2016)
  - Standard Model Physics Analysis Group (*K. Kousouris,* 2012 - 2014)
- **L3 Positions**
  - Jets and MET Trigger Subgroup (*T. Hatzistavrou*, 2023 - today)
  - Level 1 Trigger Phase 1 Muon Subgroup (*I. Paraskevas*, 2023 - today)
  - Level 1 Trigger Muon Subgroup (*C. Vellidis*, 2020 - today)
  - Exotica New Physics Searches with Jets Subgroup (*E. Tziaferi*, 2021 - 2023)
  - HCAL Trigger Subgroup (*G. Karapostoli*, 2017-2021)
  - TOP Quark Pair Cross Section Subgroup (*K. Kousouris*, 2017-2019)
  - Standard Model Physics with Jets Subgroup (*P. Kokkas*, 2015 - 2017)
  - Exotica New Physics Searches with Jets Subgroup (*N. Saoulidou*, 2014 - 2017)
  - Standard Model Vector Boson Plus Jets Subgroup (*K. Theofilatos*, 2013 - 2015)
  - Standard Model Physics with Jets Subgroup (*N. Saoulidou*, 2012 - 2014)
  - Jets & MET Jet Algorithms Subgroup (*N. Saoulidou*, 2011 - 2013)
  - Vector Boson Task Force Subgroup (*G. Daskalakis*, 2010 - 2011)
  - Jets & MET Jet Energy Calibration Subgroup (*K. Kousouris*, 2009 - 2011)

Collaboration-wide Committees

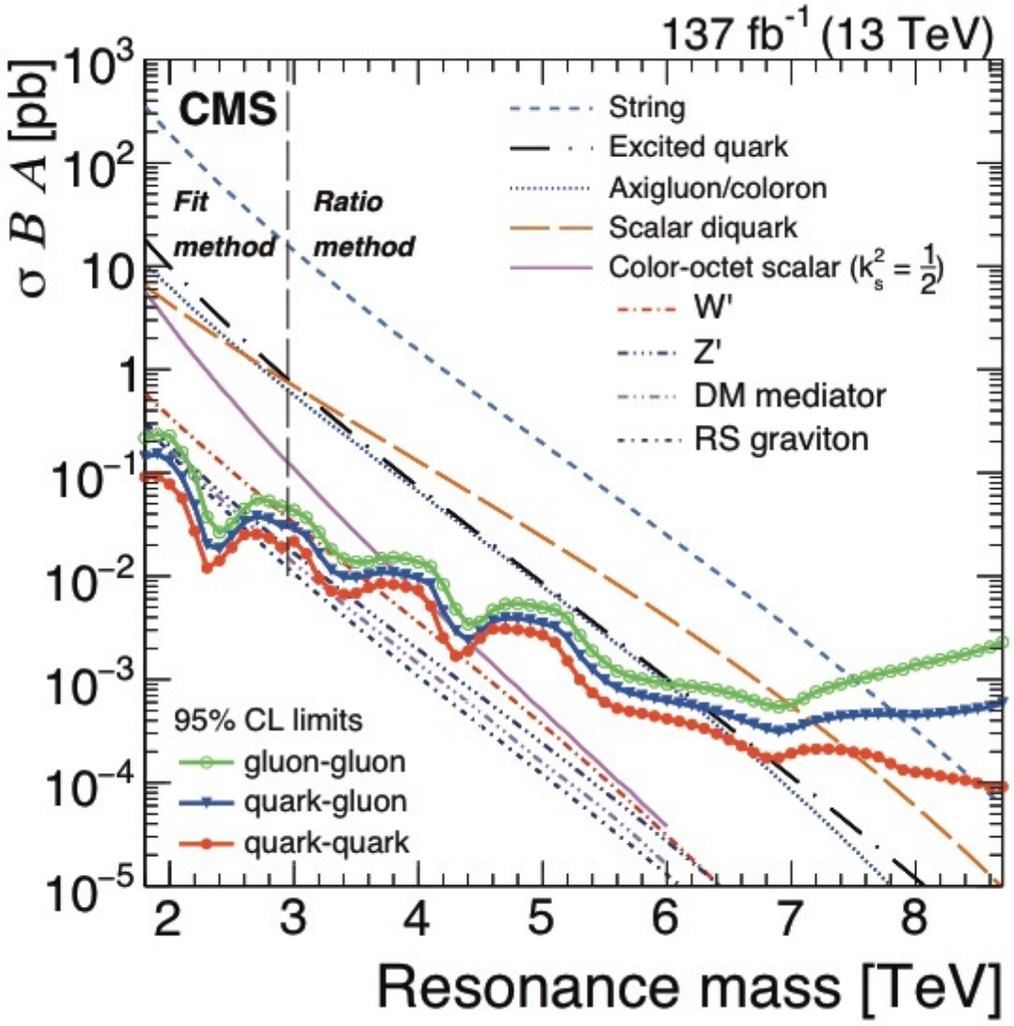
- EXO group PubComm board member (*N. Saoulidou*)
- Conference Committee member (*N. Saoulidou*)

CMS Greece: Publications & Physics

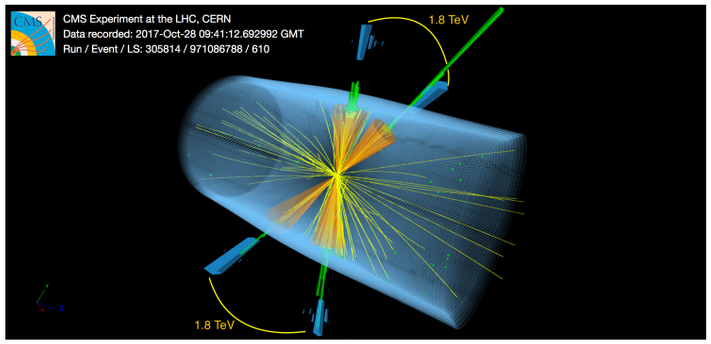
Run 2 Physics (highlights)

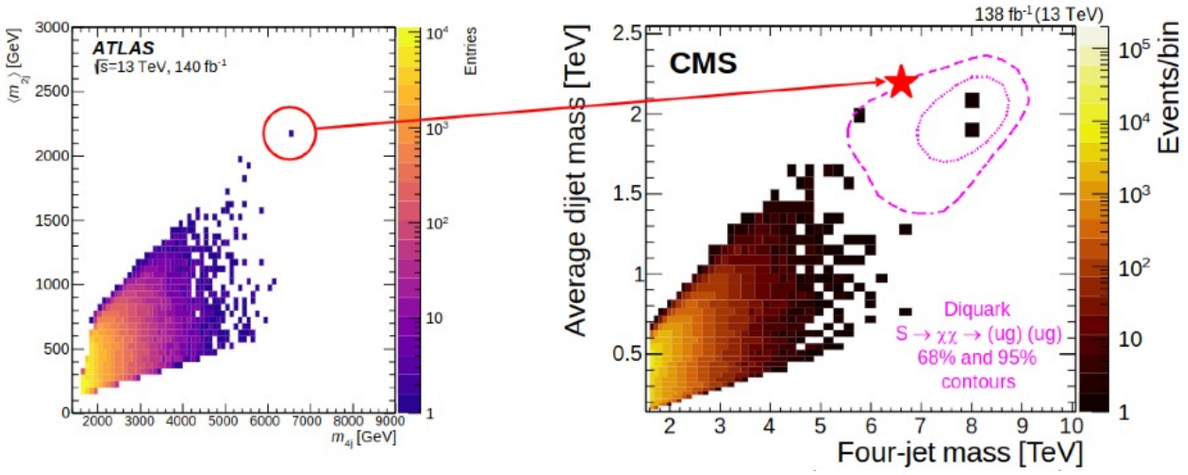
BSM with jets

Dijet bumb hunt



Four jets





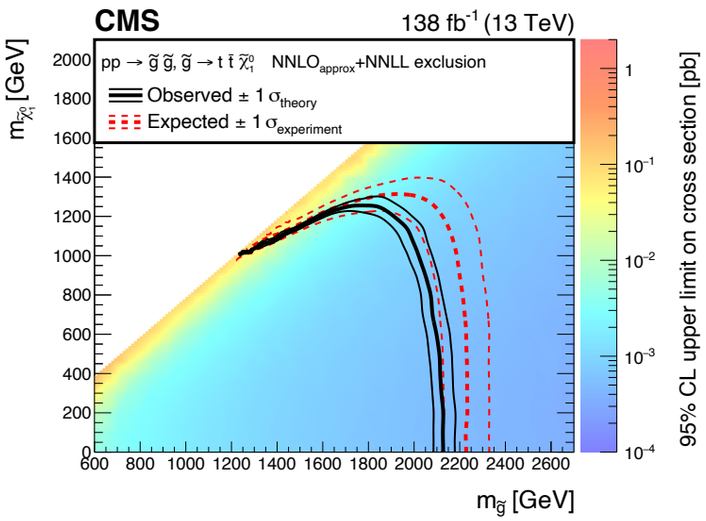
CMS Greece: Publications & Physics

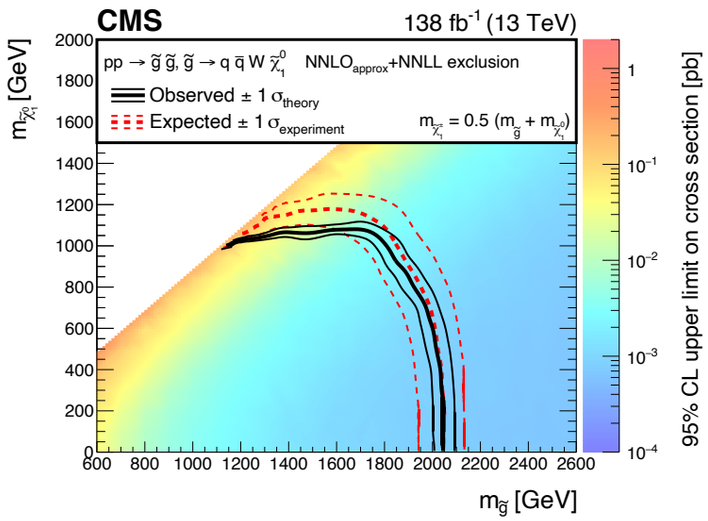
Run 2 Physics (highlights)

SUSY

high-mass SUSY

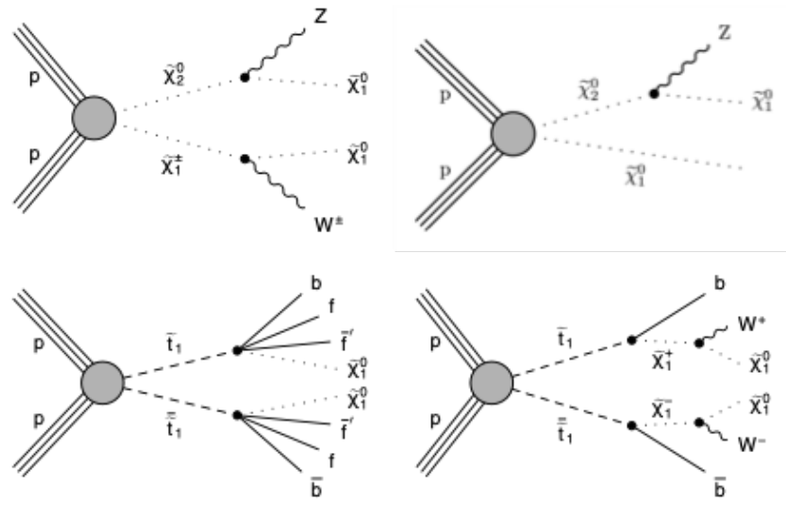
- First searches for natural SUSY
- High-mass gluinos (T1tttt/ T5qqqqWW)



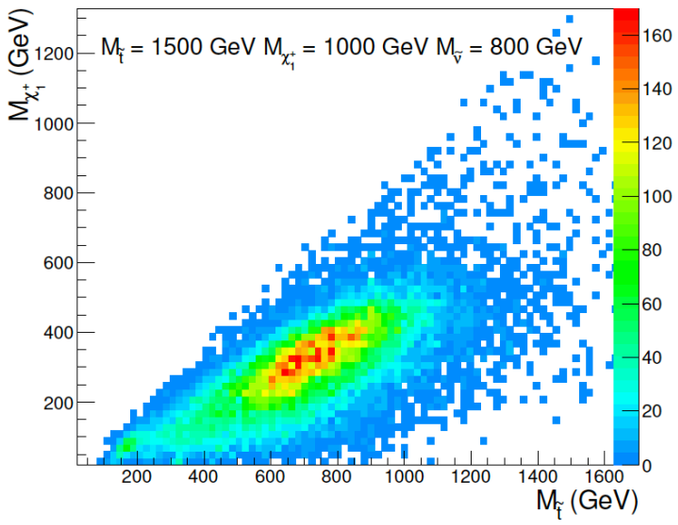


SUSY searches

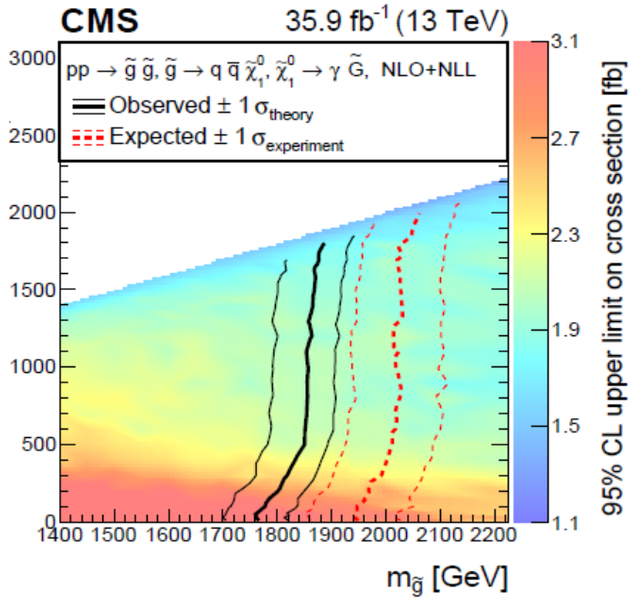
Low-mass SUSY, search for compressed mass spectra (mNLSP ~mLSP); stop, charginos; first limits on higgsinos

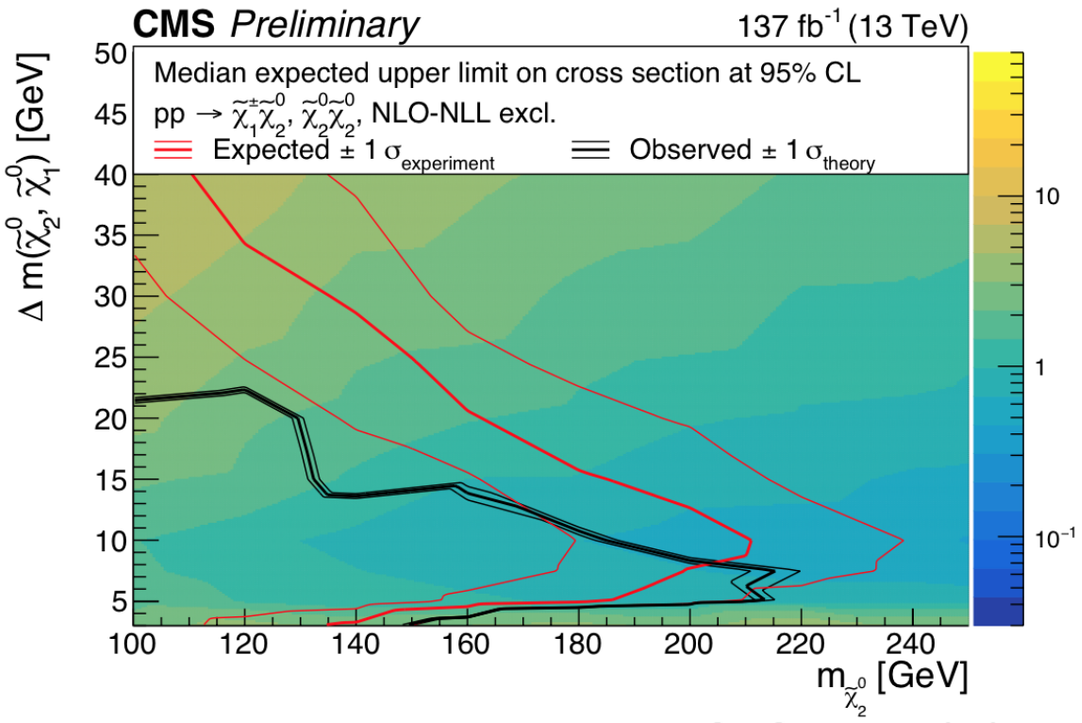


Bump hunting for final states with **2 invisible** particles



General **G**auge-**M**ediated **SUSY** in final states with γ and MET





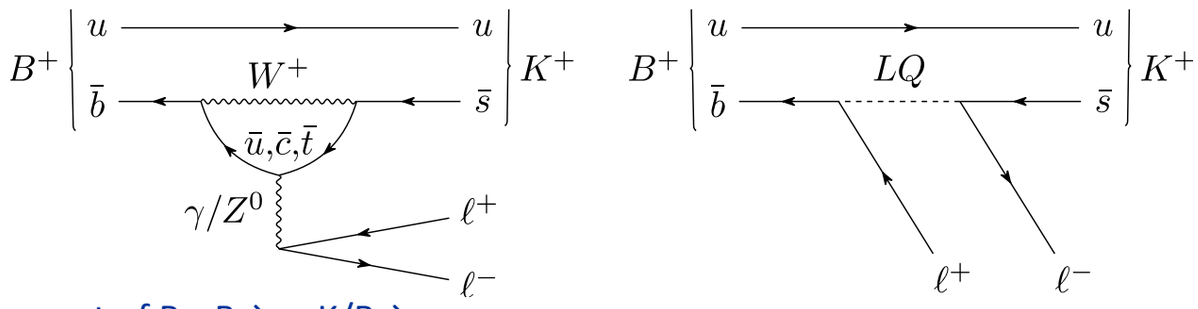
CMS Greece: Publications & Physics

Run 2 Physics (highlights)

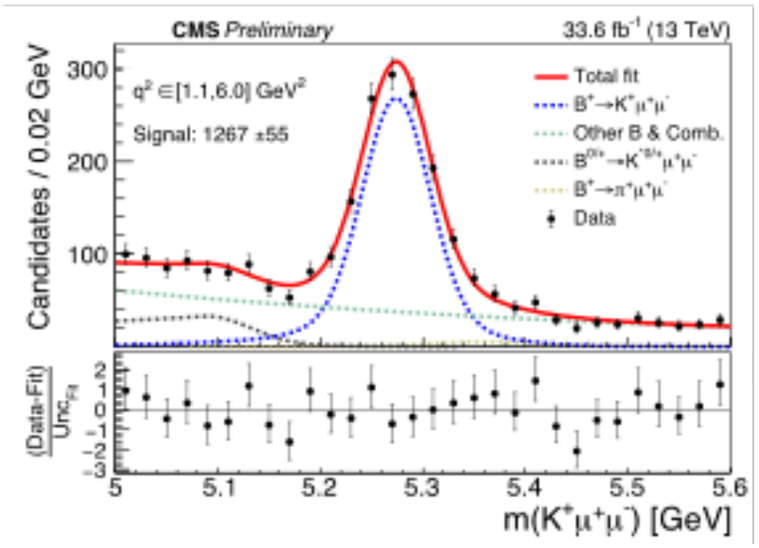
SM

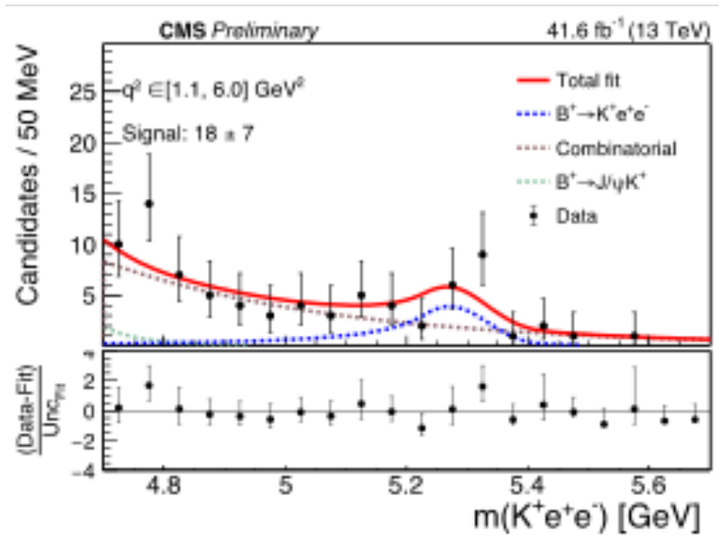
B physics: rare decays

- Following LFV hints from LHCb: set up special B parking program (2018)

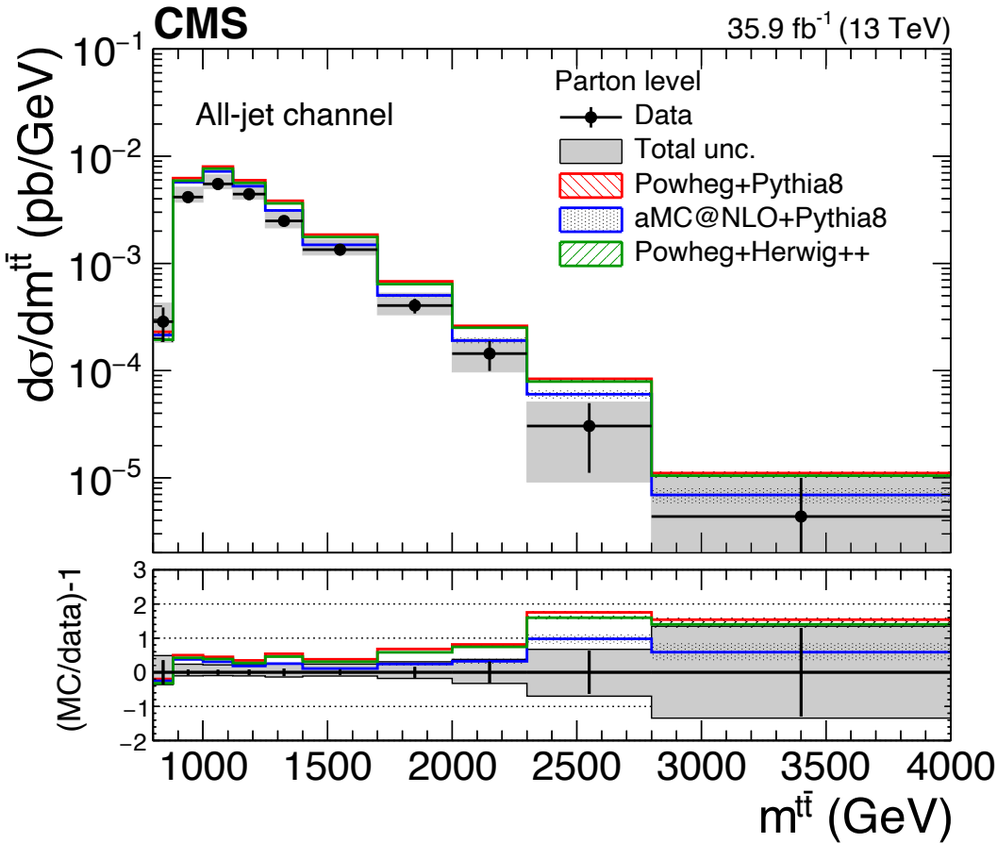


- Measurement of R_K=B→μμK/B→e





Boosted top-anti-top production

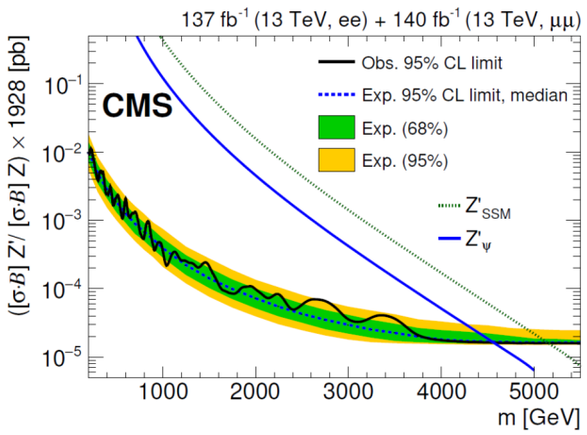


CMS Greece: Publications & Physics

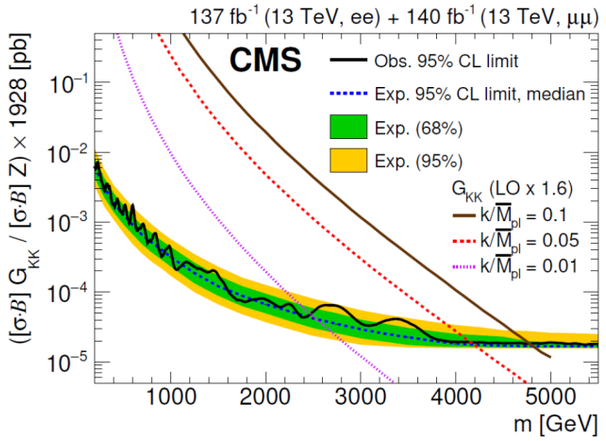
Run 2 Physics (highlights)

EXOTICS BSM

Spin-1 **Z'→e⁺e⁻ , μ⁺μ⁻ Searches** Spin-2



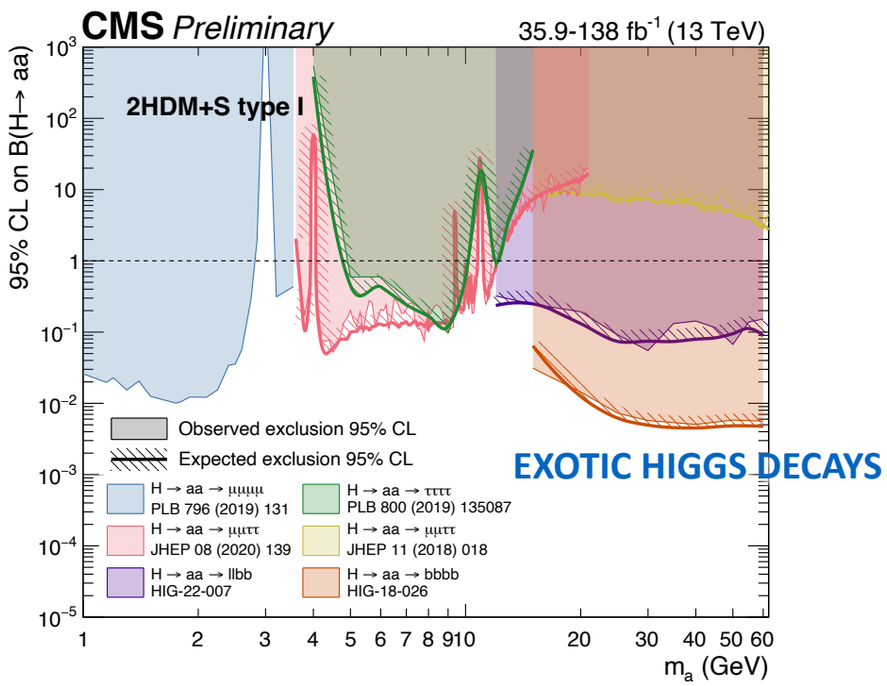
Channel	Z'_{SSM} Obs. [TeV]	Z'_{SSM} Exp. [TeV]	Z'_{ψ} Obs. [TeV]	Z'_{ψ} Exp. [TeV]
e e	4.72	4.72	4.11	4.13
$\mu^+\mu^-$	4.89	4.90	4.29	4.30
e e + $\mu^+\mu^-$	5.15	5.14	4.56	4.55



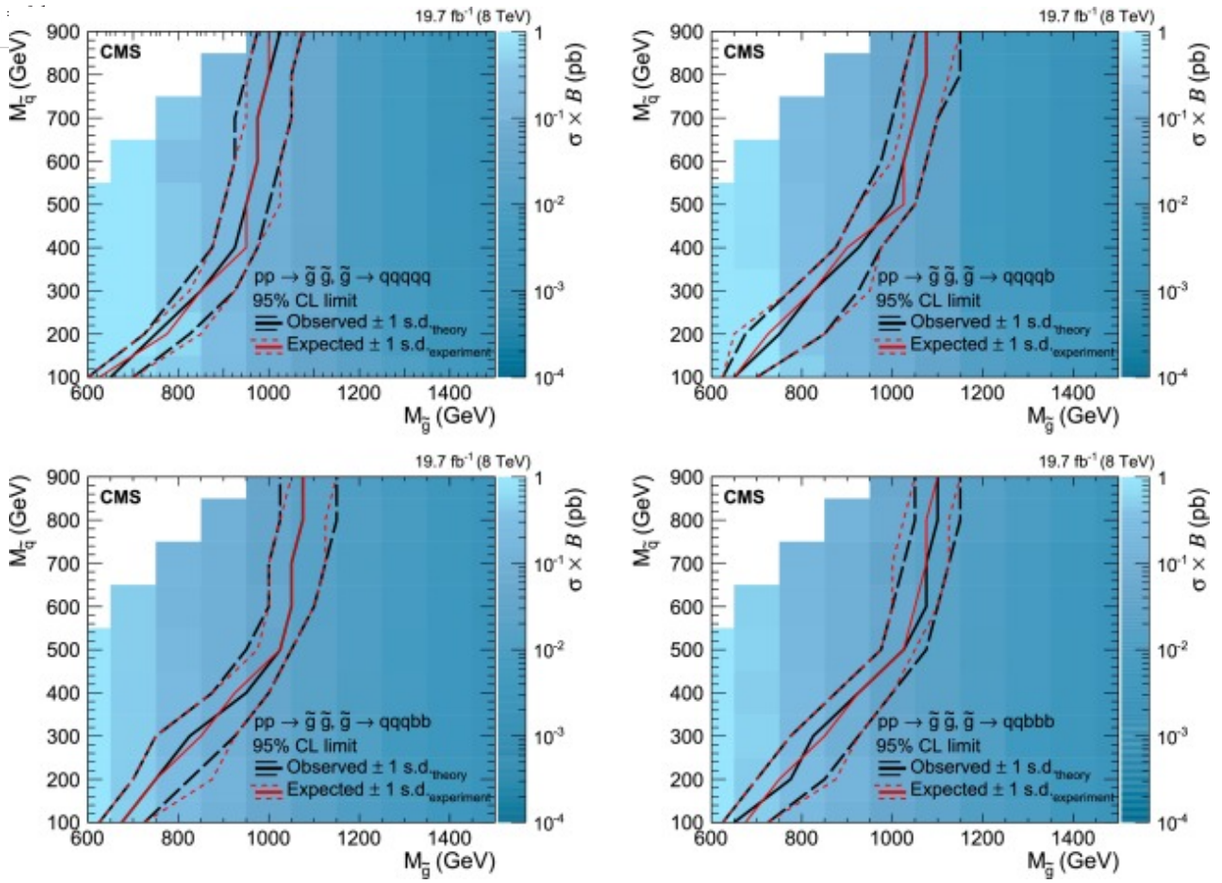
Channel	$k/\overline{M}_{Pl} = 0.01$ Obs. [TeV]	$k/\overline{M}_{Pl} = 0.01$ Exp. [TeV]	$k/\overline{M}_{Pl} = 0.05$ Obs. [TeV]	$k/\overline{M}_{Pl} = 0.05$ Exp. [TeV]	$k/\overline{M}_{Pl} = 0.1$ Obs. [TeV]
e e	2.16	2.29	3.70	3.83	4.42
$\mu^+\mu^-$	2.34	2.32	3.96	3.96	4.59
e e + $\mu^+\mu^-$	2.47	2.53	4.16	4.19	4.78

Search for new phenomena in events with high jet multiplicity and low missing transverse momentum

Phys. Lett. B 770 (2017) 257



EXOTIC HIGGS DECAYS

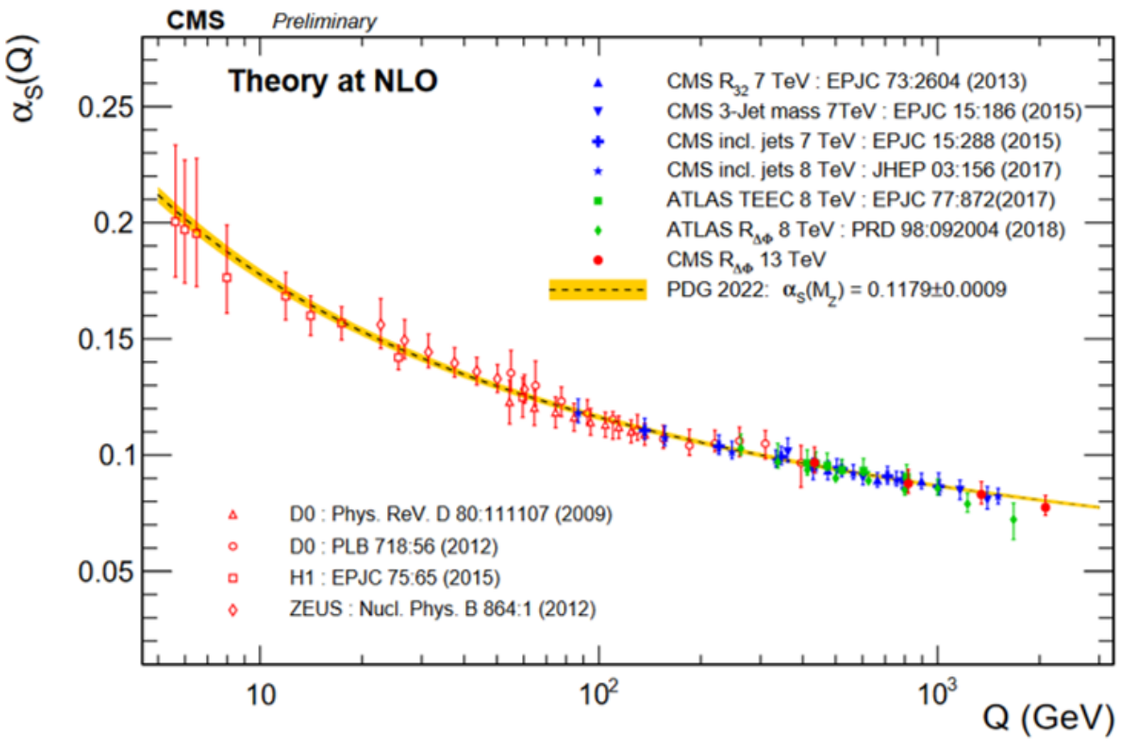


CMS Greece: Publications & Physics

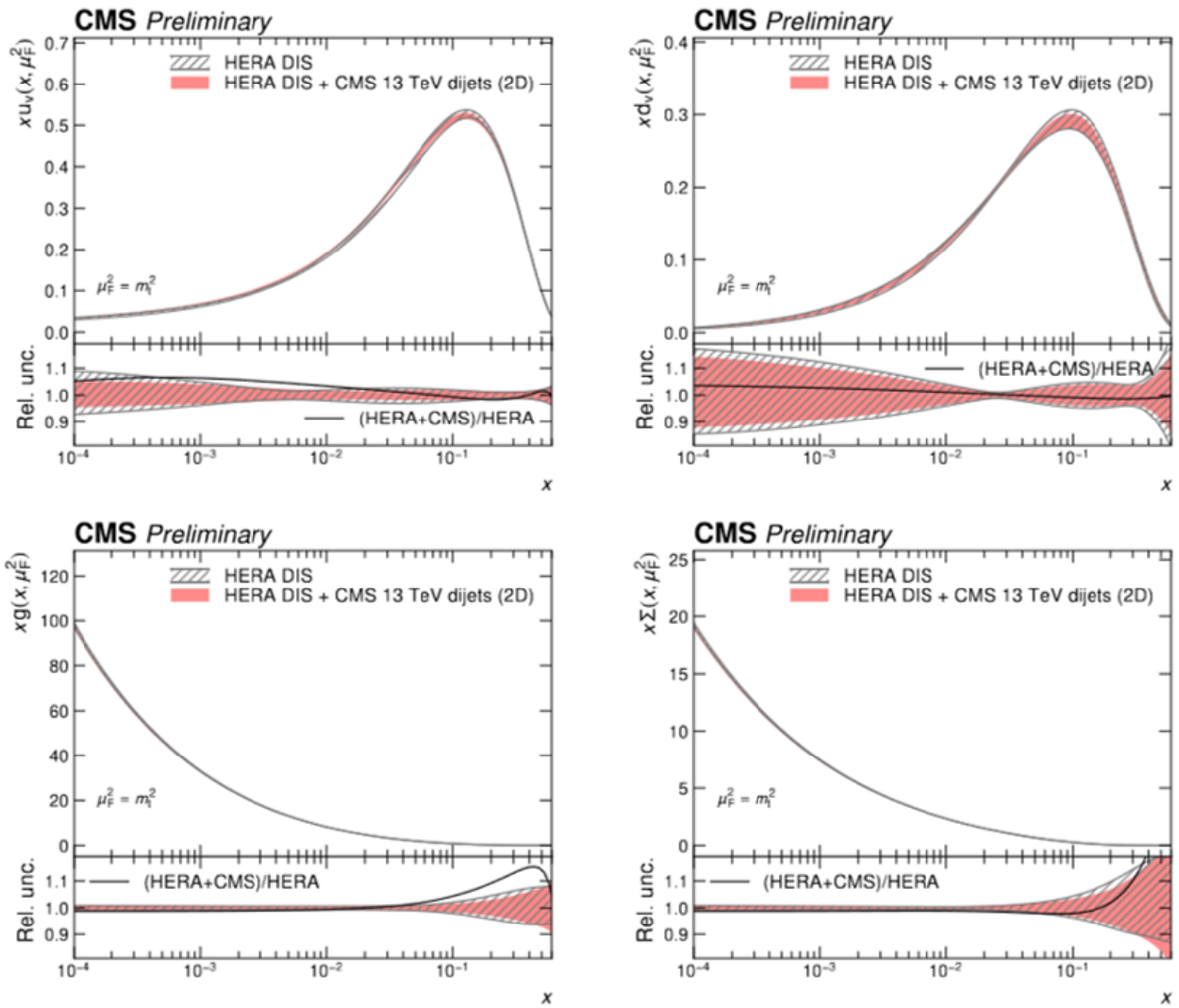
Run 2 Physics (highlights)

QCD

- **Measurement of strong coupling a_S**
- **Papers**
  - Phys. Lett. B 702 (2011) 336
  - Eur. Phys. J. C73 (2013) 2604
  - Eur. Phys. J. C (2015) 75:288)
  - CMS PAS SMP-22-005 (2023)



- **Parton Distribution Functions constraints**
- **Papers**
  - Eur. Phys. J. C (2015) 75:288)
  - CMS PAS SMP-21-008 (2022)



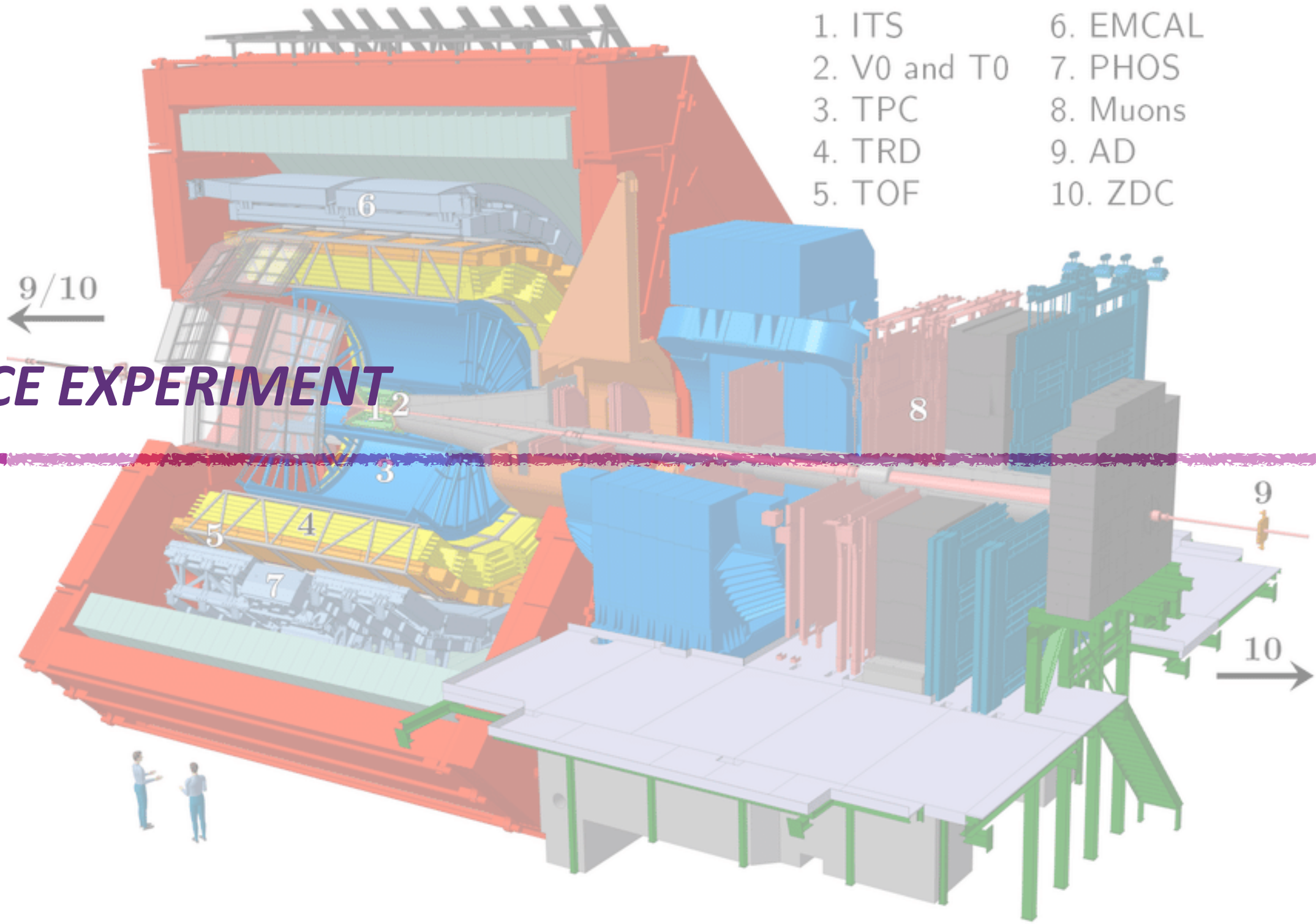
CMS Greece: Awards

AWARDS

Theodoros Chatzistavrou (2022) - *For his sustained dedication to HLT upgrade studies, including the use of MTD precision timing in jets and pile up subtraction techniques.*

Ioannis Papakrivopoulos (2020) - *For his excellent development and integration work on the Detector Control System and the online web services.*

ALICE EXPERIMENT



ALICE Greece: NKUA

Present ALICE-NKUA group composition:

- **Faculty**
  Maria Vasileiou (Assoc. Prof.)
  Martha Spyropoulou-Stassinaki (Prof. emeritus)
  Paraskevi Ganoti (Senior Researcher)

- **PhD Students**
  Maria Barlou

- **Students**
  MSc: 1
  Undergraduates: 2

Ex members

Prof. Aggelos Petridis†
Dr. Anastasia Belogianni
Panos Christakoglou (PhD)
Christos Tagridis (MSc)
Paraskevi Tsoumaki (MSc)
Gerasimos Farantatos (MSc)
Michail Fraguiadakis (MSc)
Filimon Roukoutakis (MSc)
Eftichios Cheiladakis (MSc)
Maria Barlou (MSc)
21 Diploma Students

Funding
Participation in the DeTANet Project

Recent Contribution Tasks

- Design, construction and commissioning at CERN of a High Voltage Distribution System for the ALICE TRD Phase II Upgrades (Level 1 Trigger for HL-LHC)
- Development and installation at CERN of the Control Software (DCS) for the HVDS of the TRD Monte Carlo Generators
- Design and development of a platform for the online monitoring of the ALICE detectors
- Study of the central detectors particle identification efficiency and the event-by-event particle ratios
- Development of a method for the pions and kaons identification via their weak decay (kink topology)
- Study of strange particle production in p-p, p-Pb, Xe-Xe and Pb-Pb collisions
- Multiplicity dependence study of strange hadron production in pp collisions with ALICE
- Study of hadronic resonance production in p-p, p-Pb, Xe-Xe and Pb-Pb collisions
- Neutral meson identification with the ALICE EMCAL
- Measurement of the transverse momentum spectra and nuclear modification factors of identified charged hadrons in p-Pb and Pb-Pb collisions with ALICE
- Study of the centrality dependence of charged hadrons nuclear modification factor in Pb-Pb collisions.

Coordination Positions

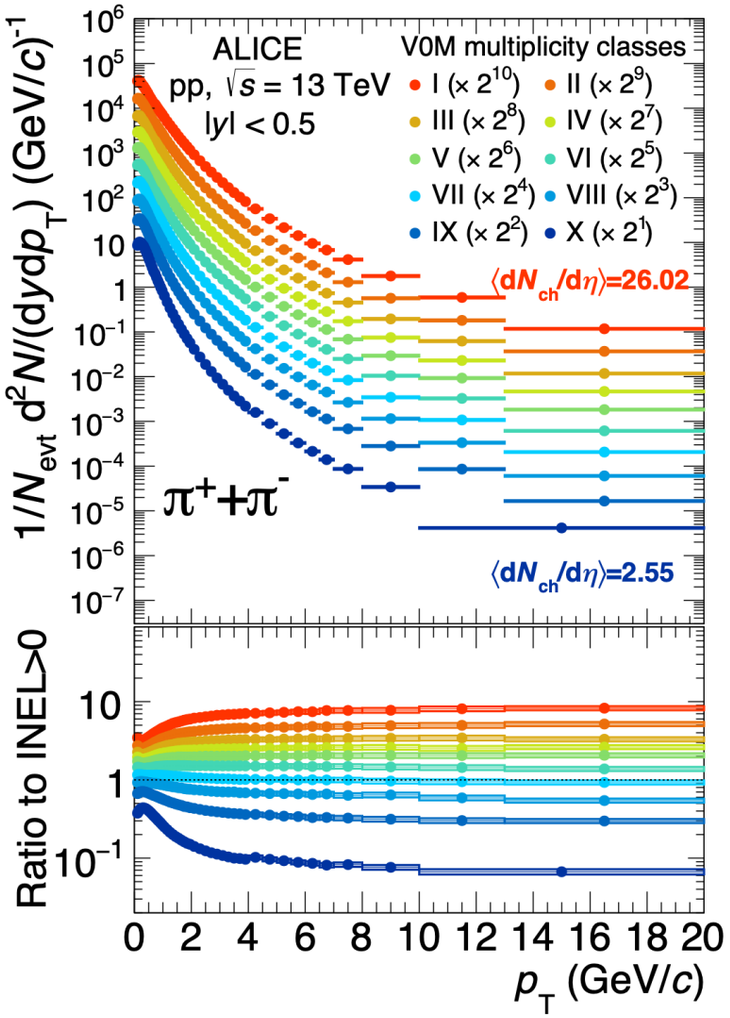
M. Vasileiou: Member of the Collaboration, Resources and Computing Boards
P. Ganoti: Member of the Conference Committee (2021 - today)
Run Manager (2017 - 2018)

ALICE Greece: NKUA Publications & Physics

Run 2 Physics (highlights)

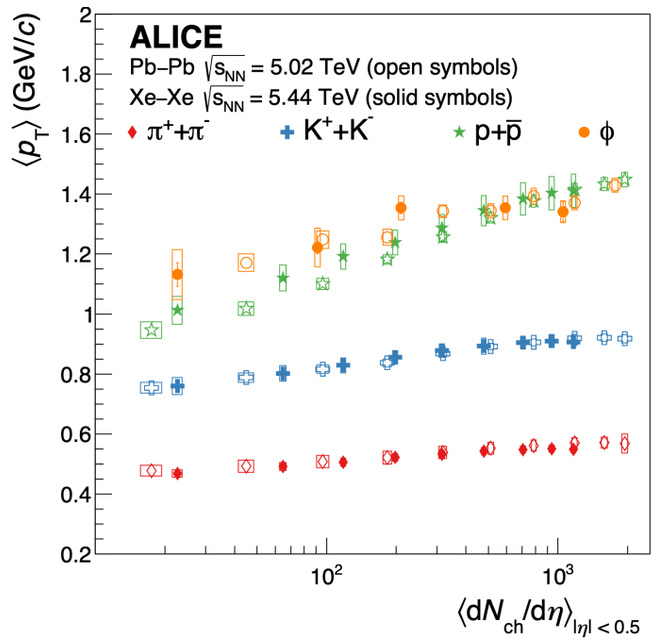
Identified particle spectra

Eur. Phys. J. C 80 (2020) 693



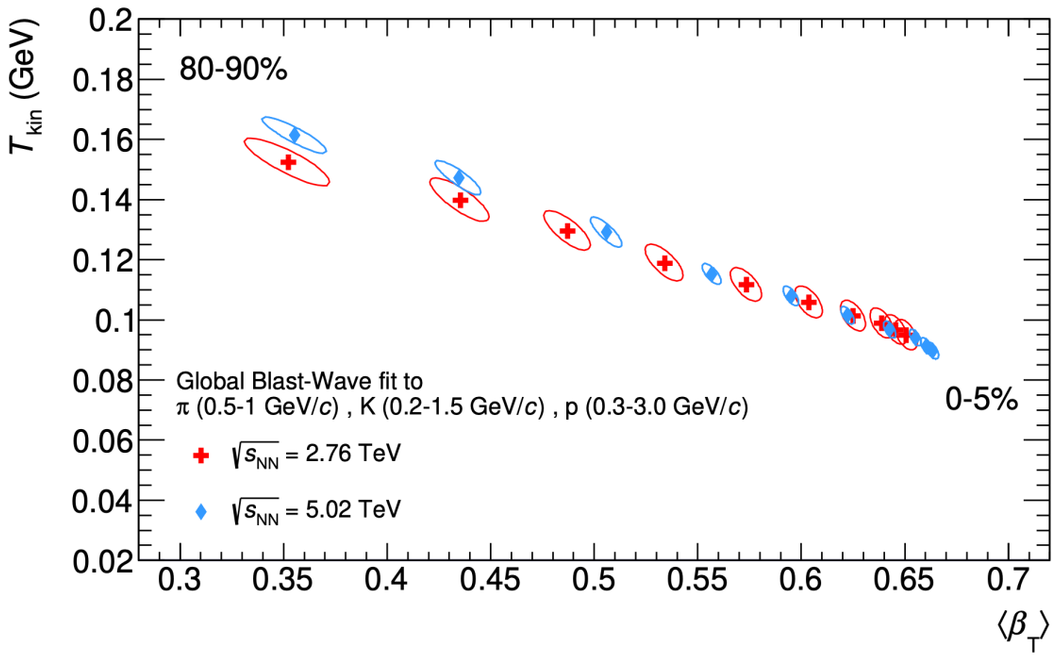
Hardening of the spectra with increasing charged-particle multiplicity → **Radial flow in small systems** (thought so far that it exists only in heavy-ion collisions)

Eur.Phys. J.C 81 (2021) 7, 584



Comparison of Pb-Pb and Xe-Xe collisions: **Radial flow** is entirely driven by the **multiplicity** and not by the collision geometry

Phys.Rev.C 101 (2020) 4, 044907



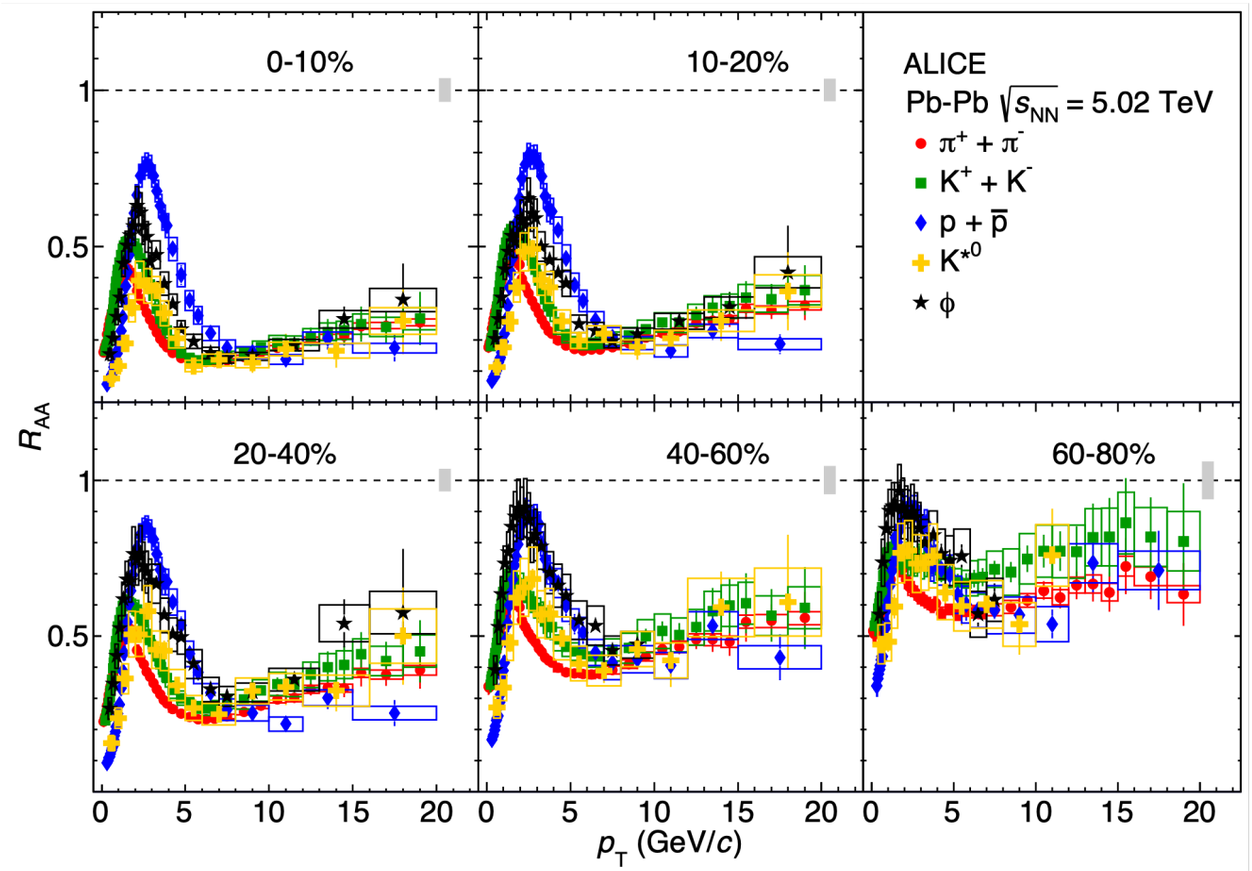
- Indication of **more rapid expansion** with **increasing multiplicity**
- Consistent with the **expectation of a shorter-lived fireball in peripheral collisions**

ALICE Greece: NKUA Publications & Physics

Run 2 Physics (highlights)

Nuclear modification factors

Phys.Rev.C 106 (2022) 3, 034907



Low p_T: $p_T < 2$ GeV/c

K*^{0} R_{AA} values are the smallest for central collisions → rescattering effects

Intermediate p_T: $2 < p_T < 8$ GeV/c

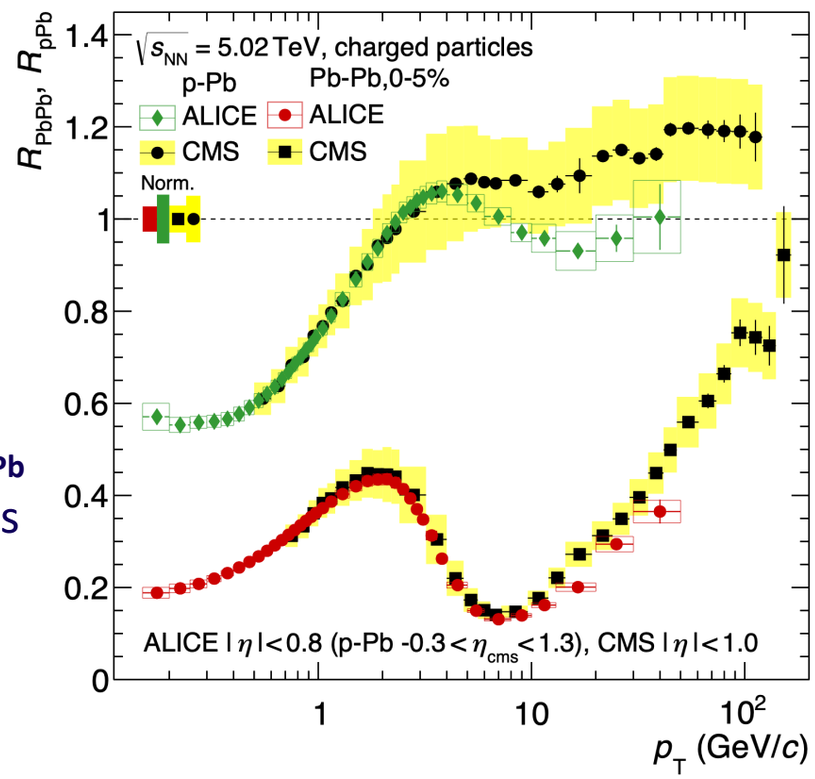
- hint of mass ordering among mesons → indication of radial flow
- higher R_{AA} values for proton → indicates baryon-meson ordering

High p_T : $p_T > 8$ GeV/c

- Similar suppression for different light-flavour hadrons → NO flavour (u,d,s) dependence

- Relative particle composition at high p_T remains the same as in vacuum

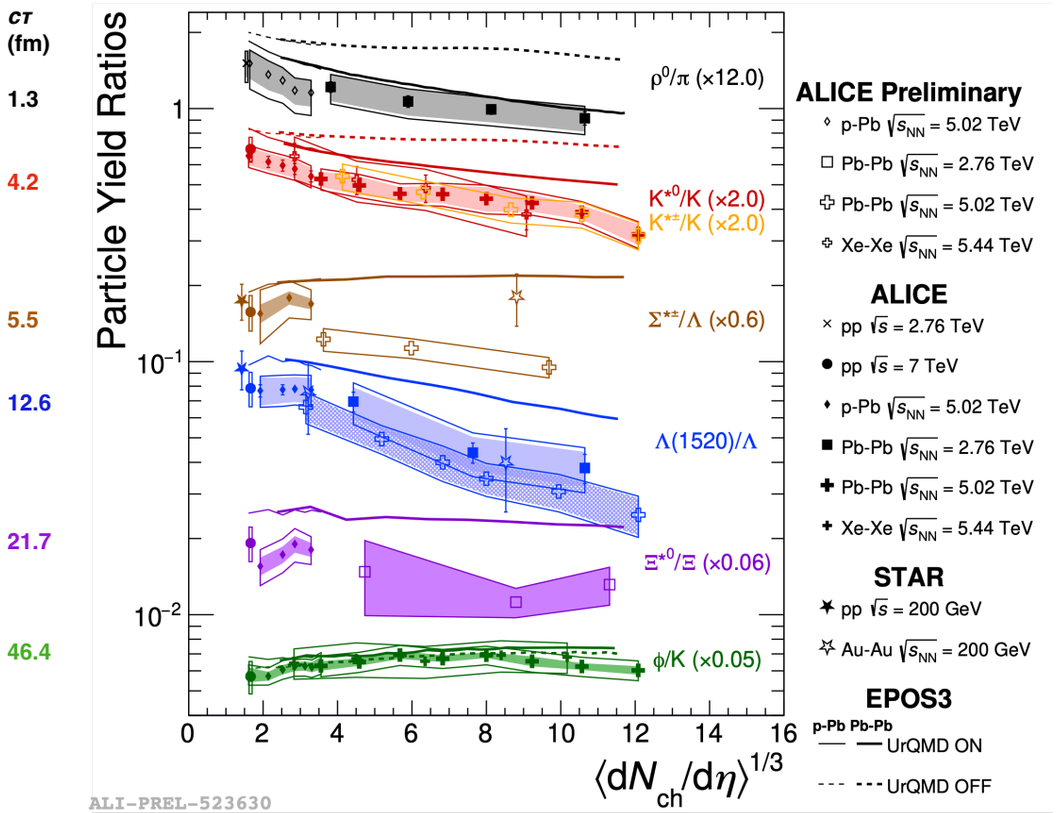
JHEP 11 (2018) 013



Good **agreement** -**within 1.5σ**- between the two experiments for both $R_{Pb\text{-}Pb}$ and $R_{p\text{-}Pb}$ taking into account the current uncertainties

ALICE Greece: NKUA Publications & Physics

Strangeness in Run 2

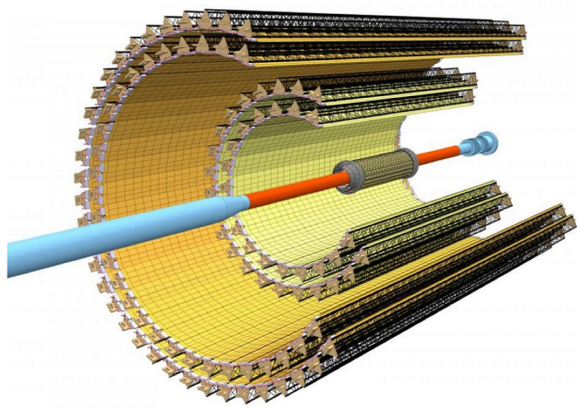


- **ρ⁰/π, K*⁰/K**: Ratio decreases with increasing multiplicity → Evidence of rescattering
- **Σ*±/Λ, Λ(1520)/Λ in Pb-Pb:** Suppression of both resonances.
- **Ξ*⁰/Ξ, ϕ/K** : no significant multiplicity dependence across the different collision systems (longer-lived compared to the others)

Strangeness in Run 3

ITS2 for Run 3

- 7 layers of Monolithic Active Pixel Sensors
- 10 m² with 12·10¹² pixels
- Low material budget
  - inner barrel 0.35% X_0/layer
  - outer barrel 1% X_0/layer

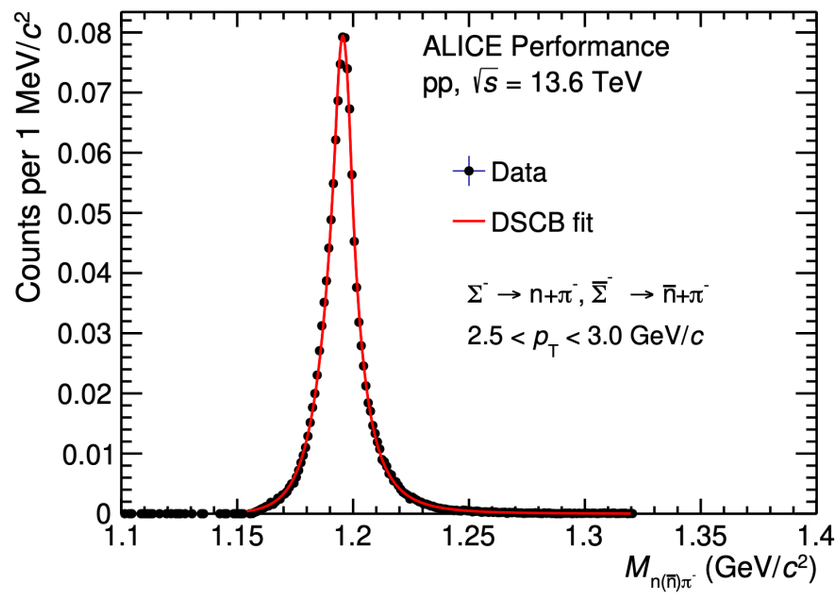


Use of the kink topology for **strange baryon identification** (used extensively for kaons in Runs 1 & 2)

Strange particles decaying to one charged and one neutral daughter (**kink topology**), can be identified with ITS2 + TPC

First measurement of **Σ⁻ baryon** in ALICE (perf. plot at QM2023)

Method can be used for other strange hadrons (and hypertriton!)



Summary

Overview

- Greek teams have been **founding members** of ATLAS, CMS & ALICE, with **continuous presence** for more than 25 years.
- Greek teams have been actively involved in **major hardware projects** and are key contributors in physics analyses.
- Members of Greek teams have systematically served on **coordination positions**, disproportionally to the available budget and number of people involved!

Personnel

- 29 faculty and staff members, 8 Prof. emeritus, ~10 Postdocs, ~30 PhDs and many graduate and undergraduate students.
- During the past decade new faculty and staff hirings have not matched the retirements (but the loss of positions has become somewhat moderated since 2020)

Synergies

- Synergies between Greek teams are actively sought for, in particular on major hardware projects.
- Joint physics analyses are also frequent.
- Greek teams collaborate closely with institutes from abroad, both on hardware and on physics projects

Funding

- Funding is highly irregular and intermittent, based on almost random calls. Nevertheless, individual proposals have had significant success through excellence and innovation.
- Absence of systematic state funding does not allow for mid and long term budget planning.
- Major obstacle for important commitments.
- NCSR funding for Postdocs and PhD students stopped in 2012.

Achievements during LHC Runs 2 & 3

- Greek teams in all three major experiments have managed to deliver and fulfill their commitments.
- A rich physics program is being pursued, balanced between SM measurements and BSM searches.