ATLAS Group Status Report.

80th DESY Physics Research Committee meeting

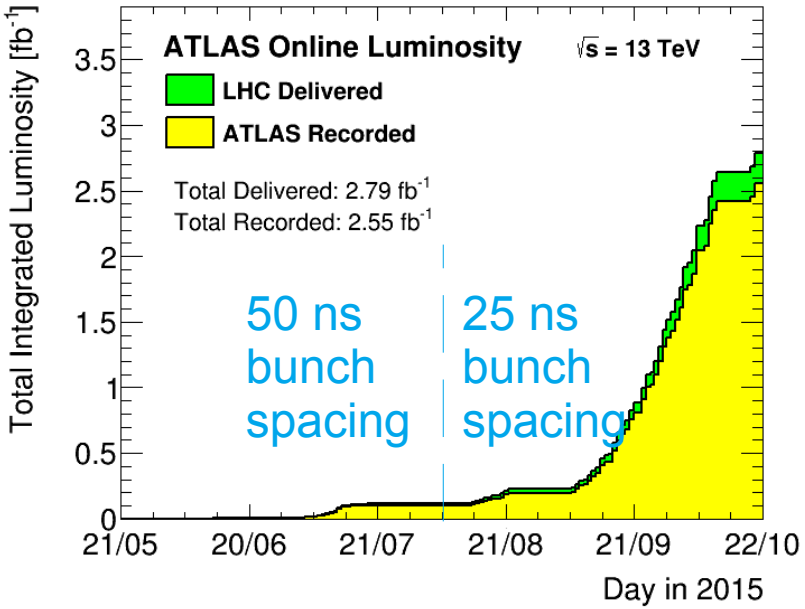
ATLAS Group
Hamburg
October 22nd, 2015

Kristin Lohwasser
on behalf of the ATLAS Group

DESY

ATLAS data taking at $\sqrt{s}$ = 13 TeV

- Restart for Run 2 provided **plenty of challenges:**
  - IBL/pixel commissioning
  - Using Ar instead of Xe in parts of Transition Radiation Tracker (TRT)
  - LAr 4-sample readout
  - New muon chamber readout
- Overall data-taking ε = 91%
- Peak luminosity: 4.6 x 10^{33} $cm^{-2}s^{-1}$



ATLAS pp run: June-August 2015										
Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
98.5	99.7	100	99.1	100	100	99.3	100	100	100	99.6

Luminosity weighted relative detector uptime (in percent).

- ATLAS successfully moved to 25ns bunch spacing
  - > 2.5 fb^{-1} of physics data recorded

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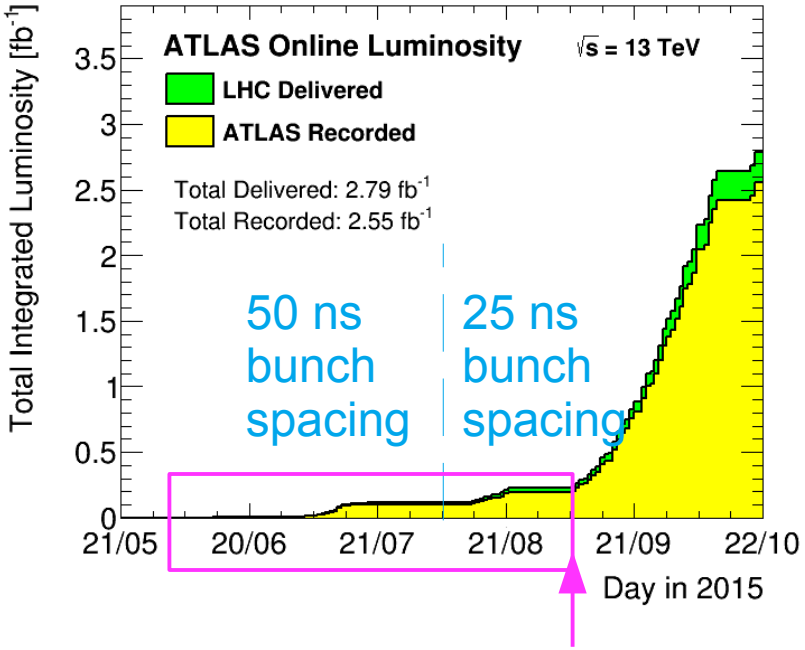

Already exciting physics results available

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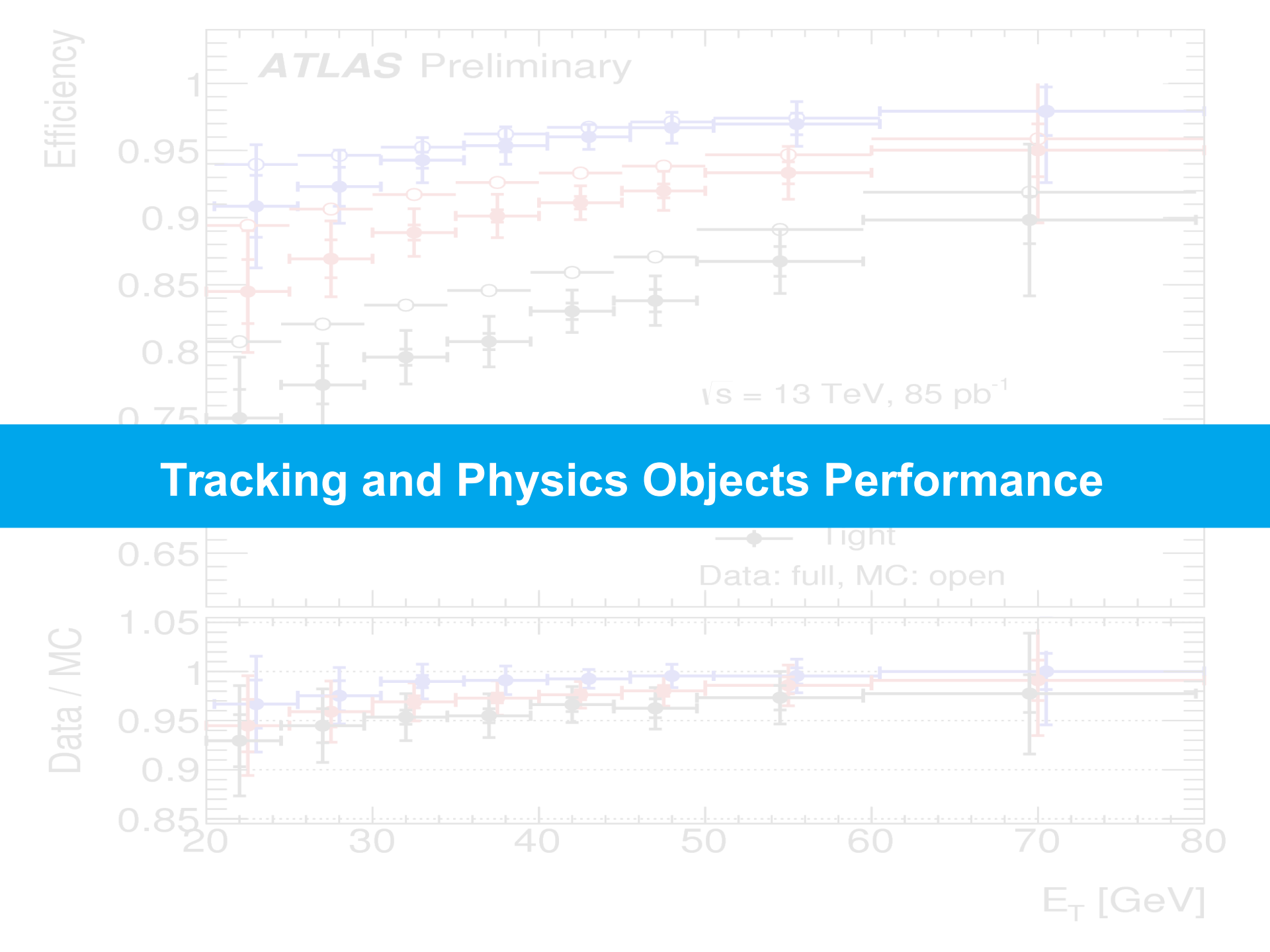
Strong contributions from DESY group to ATLAS

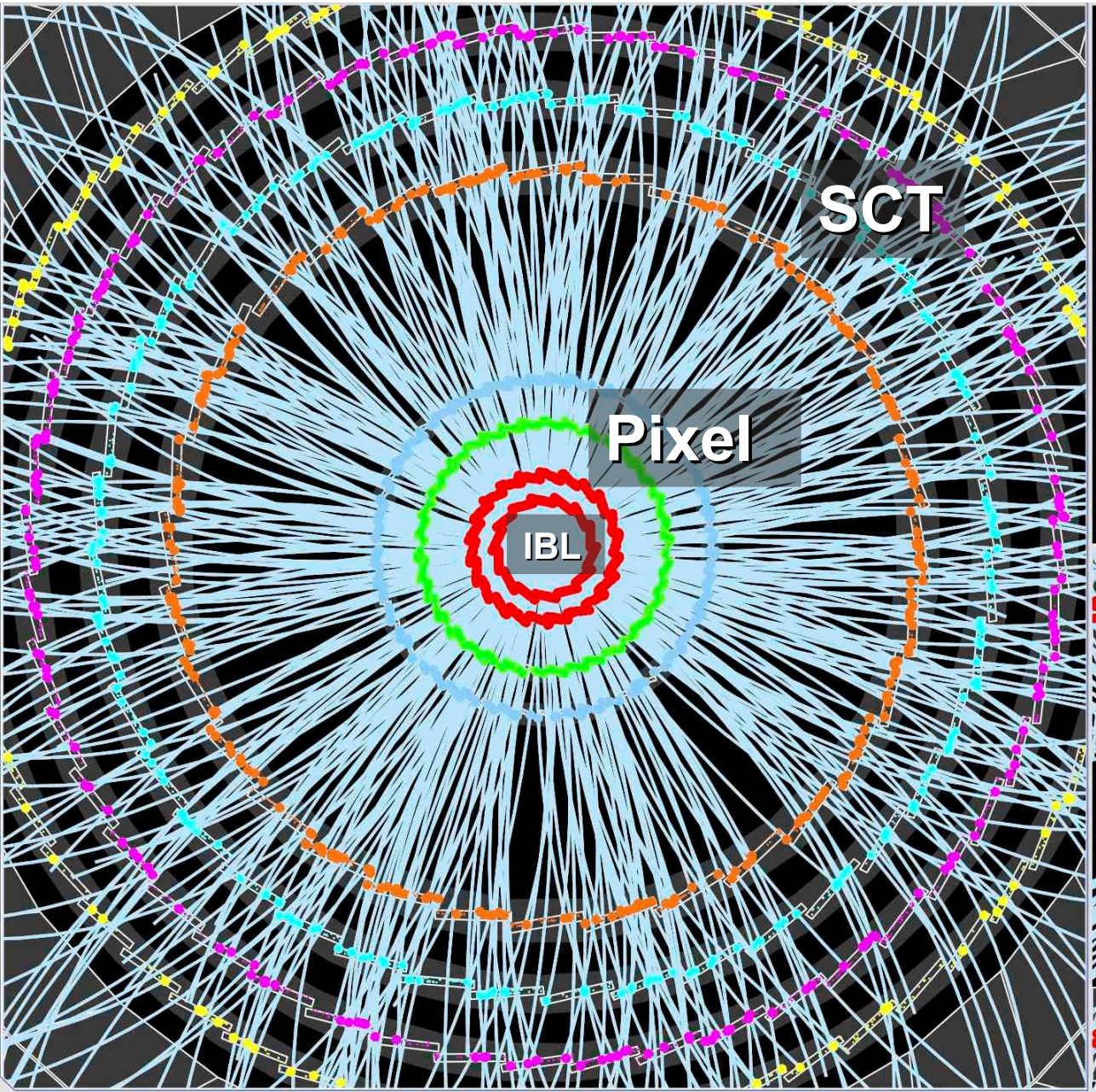
- Performance studies
- Physics analysis
- Detector upgrade for the High Luminosity LHC (HL-LHC)

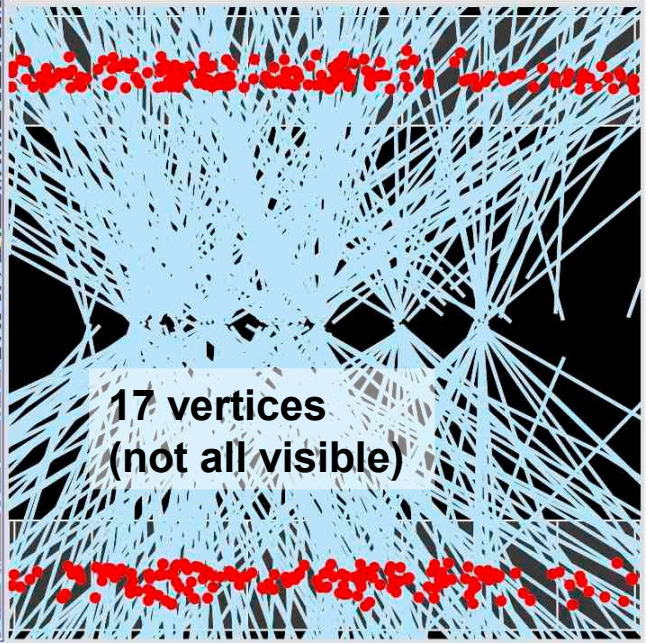
Concentrating on 13 TeV results
as well as studies with test beams and petalet progress



Tracking and Physics Objects Performance

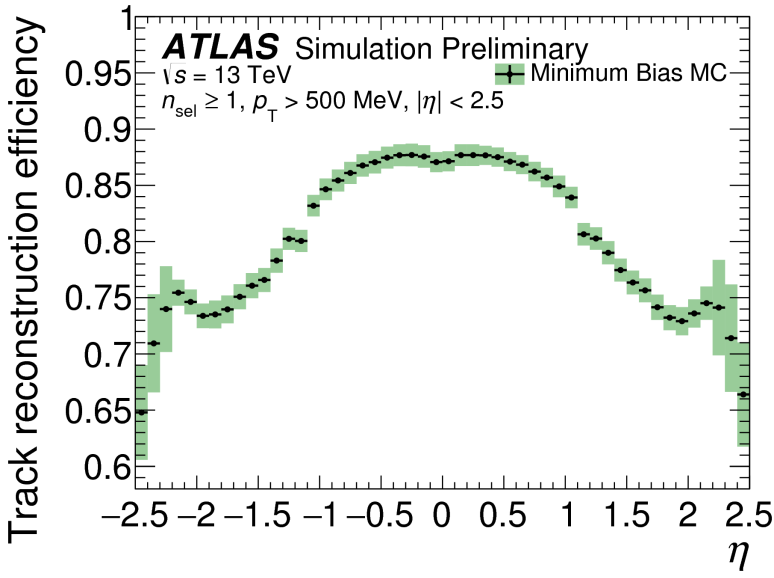
Inner Detector Tracking

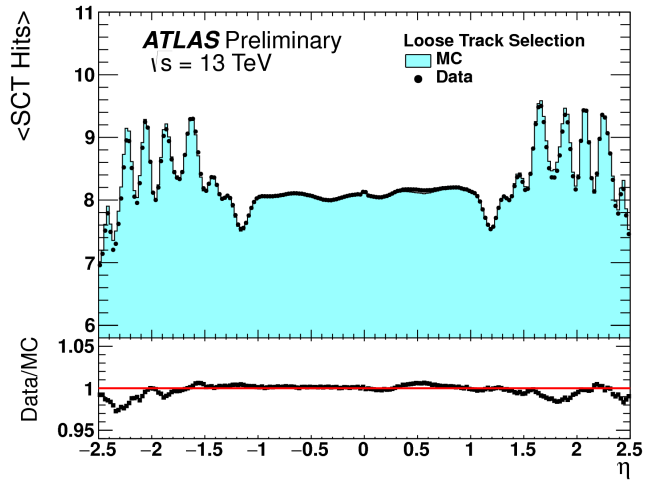


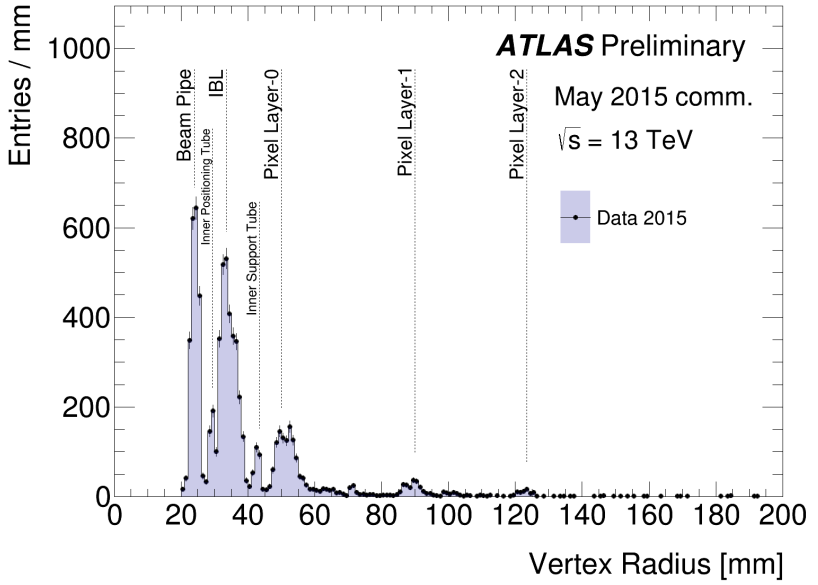


Inner Detector Tracking

- Excellent tracking performance thanks to long and careful preparation
- **High tracking efficiency of up to 90 %**
  - Crucial for many analyses
- First performance tests of ID with newly inserted IBL
- **Data generally well described**
  - Some discrepancies in end-cap region (change in geometry due to new services)
  - Improvements currently being implemented





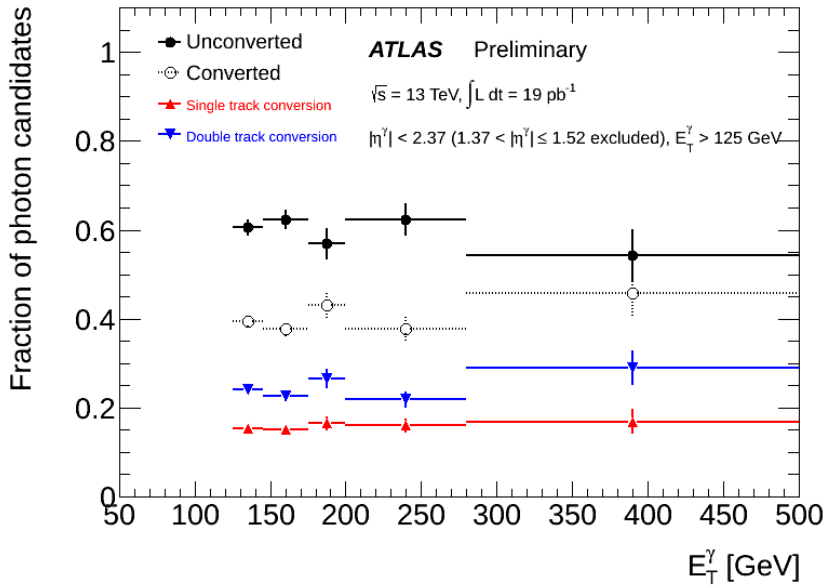


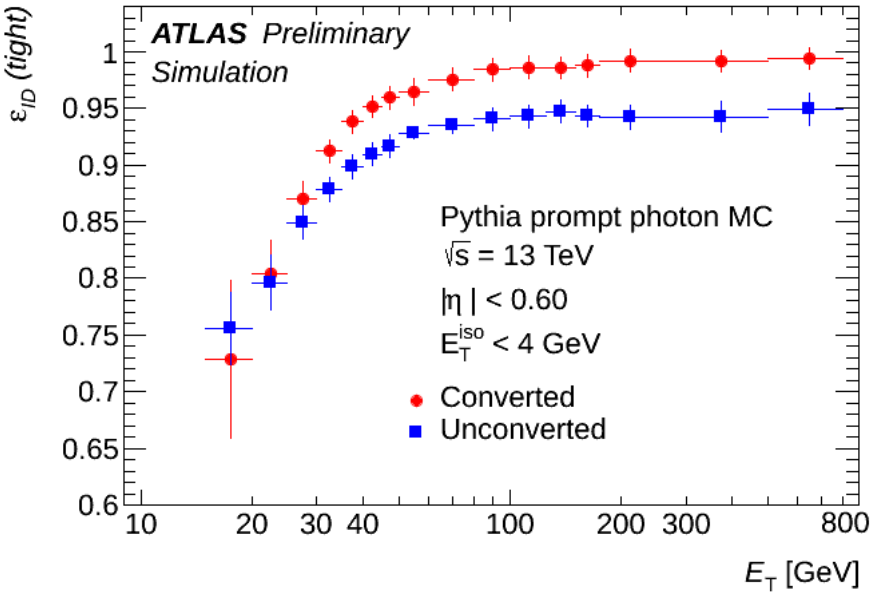
Photon Performance for Run 2

Performant and well-understood reconstruction and identification, **important for many analyses: Higgs, SM, Exotics, ...**

- Deal with higher pile-up, 25ns bunch spacing and changed detector conditions, significant updates of
  - Photon conversion reconstruction
  - Photon identification

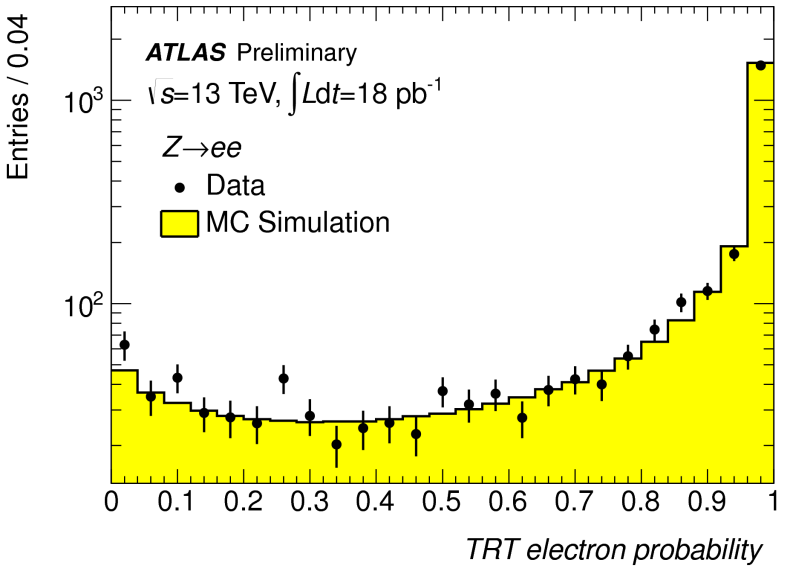
- **Measurement** of photon identification efficiency with Z→ee and extrapolation of electron to photon shower shape ongoing

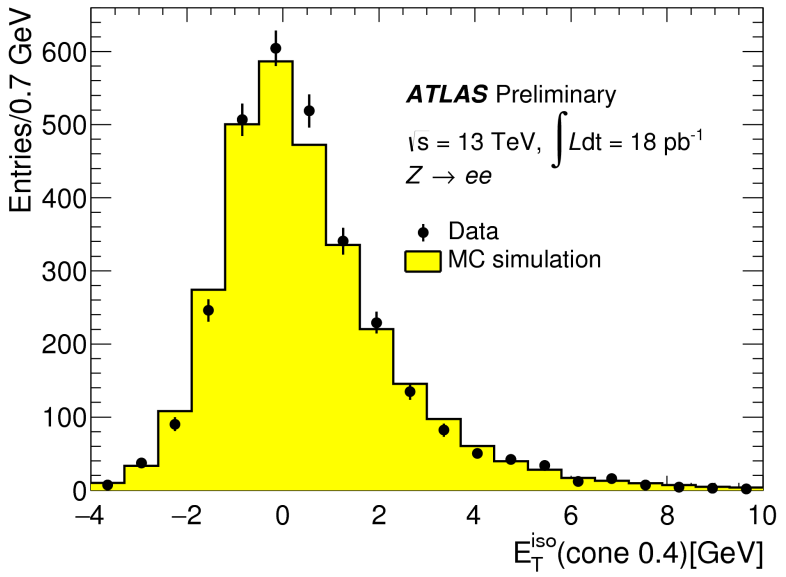




Validation of Electron Identification Variables

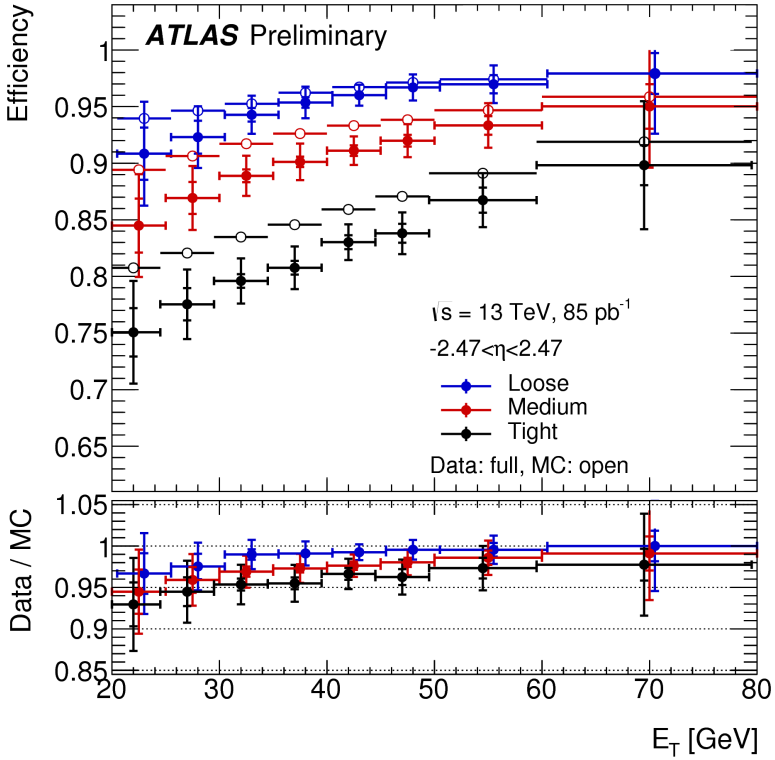
- Changes to detector and reconstruction in Run 2 introduced **changes to electron reconstruction and identification**
  - Parts of TRT operated with Ar instead of Xe: Improved LH probability to mitigate effects
  - Important check of impact of 25 ns running and increased pile-up on isolation energy
- **Performance validated** with very first data (L=18 pb^{-1}) using Z → ee events with background subtraction to ensure good data/MC agreement
- Good description of electron variables by MC simulation
- Important confirmation of performance at the start of Run 2

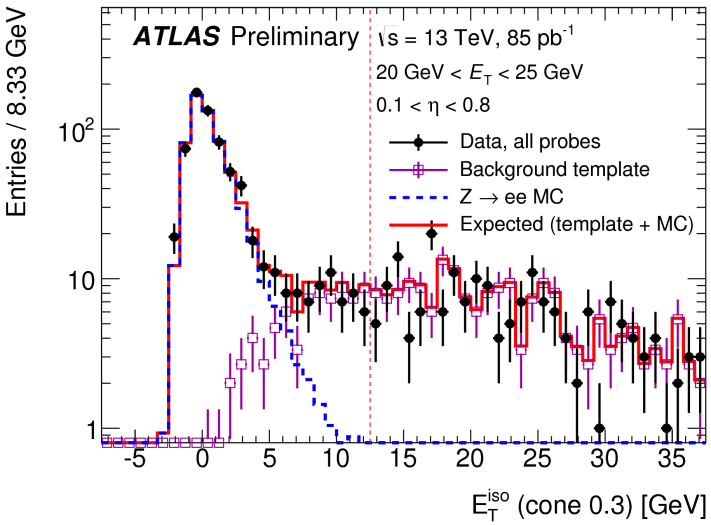




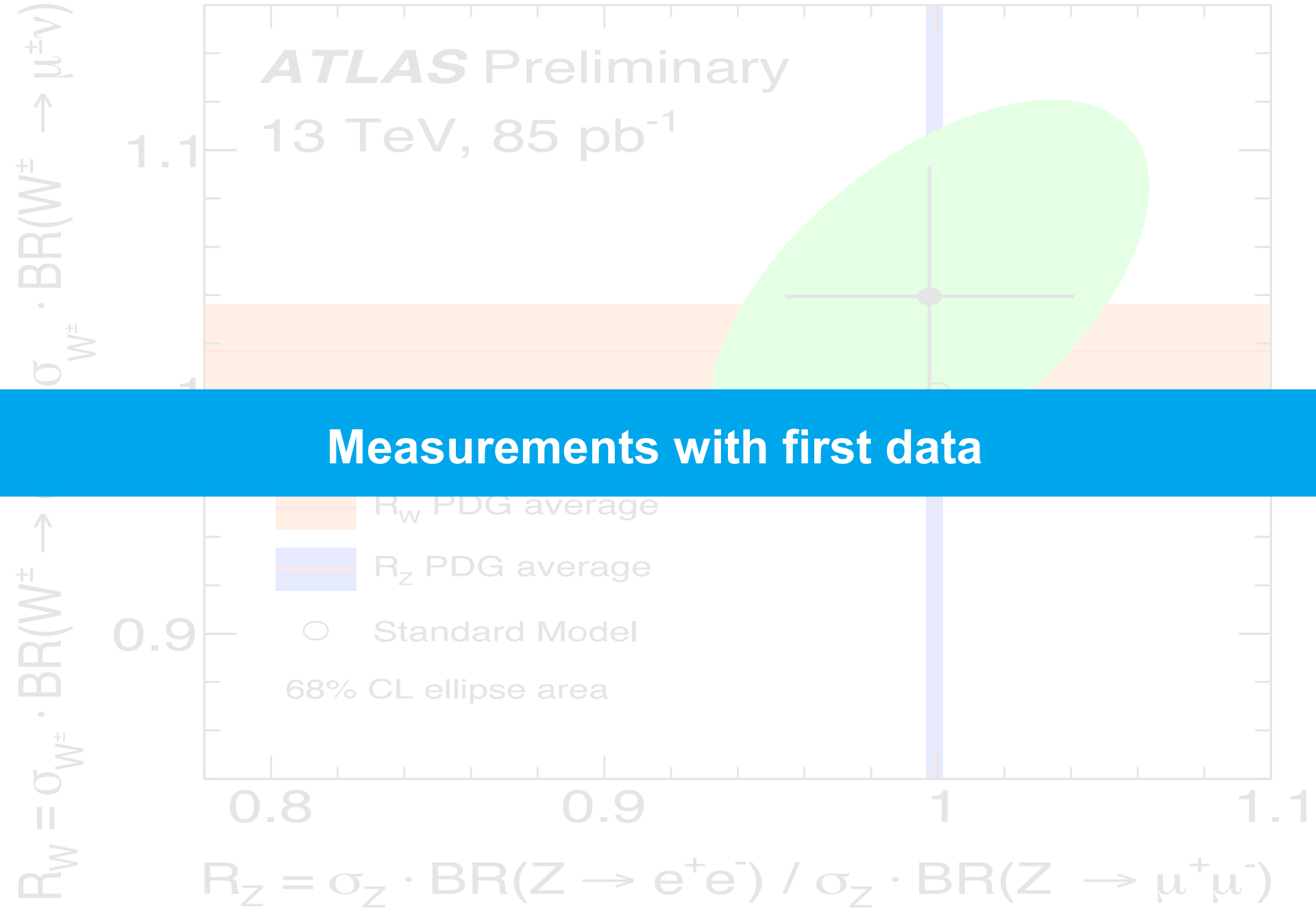
Electron Performance

- Run 2 electron identification (ID) uses **likelihood identification**
  - Improves background rejection by ~50% compared to cut-based ID tuned to same efficiency
- Compiled recommendations for electron **treatment in very first data**
  - Evaluation based on 2012 results and comparison with updated MC simulations
  - Allows for searches with very first data



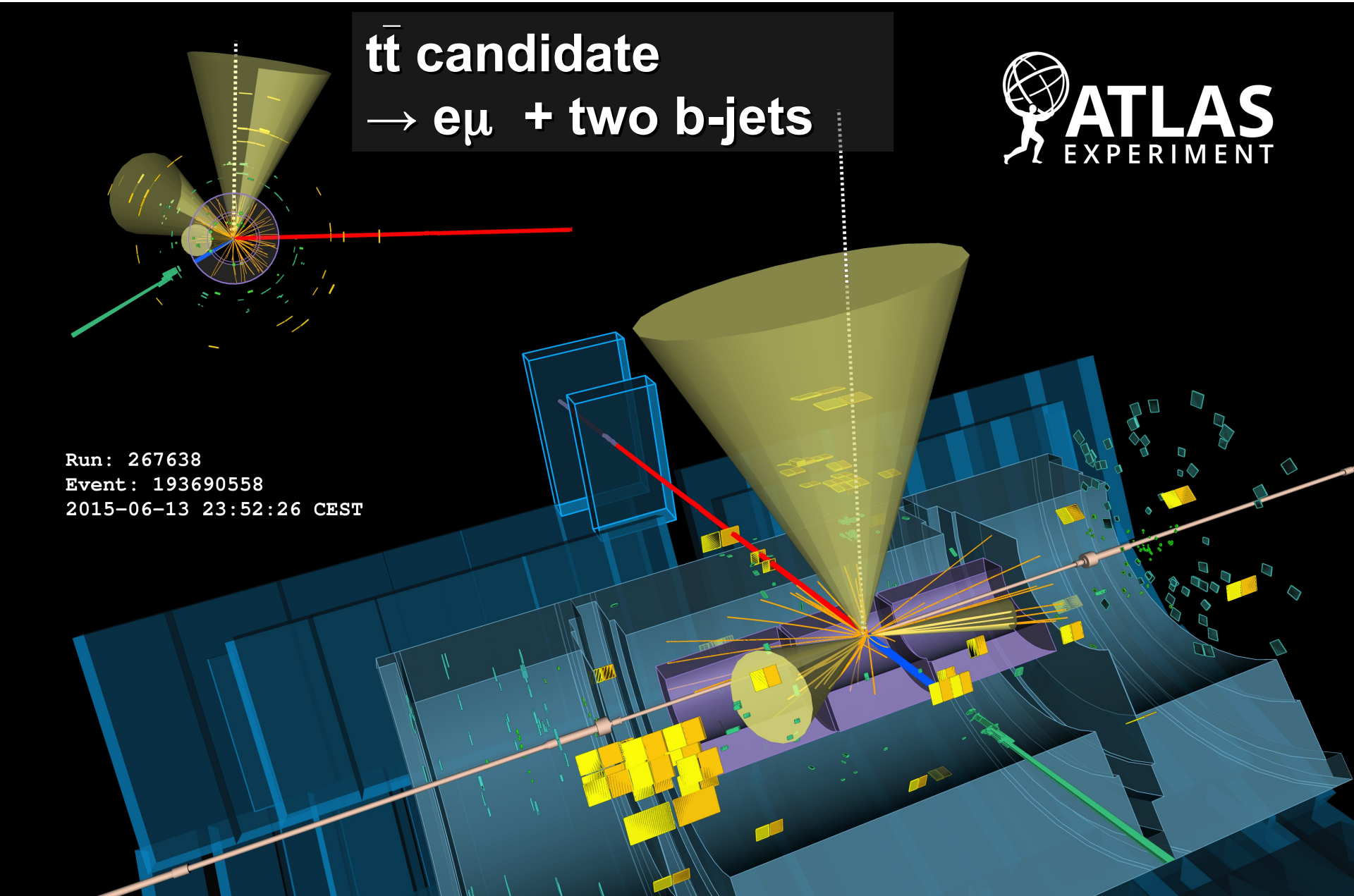


- Data-to-MC efficiency **correction factors for first cross section measurements** in 2015 extracted with Z→ee tag-and-probe
  - Measured with 2% uncertainty reduced to 0.5% when properly treating uncorrelated uncertainties



Measurements with first data

A Top-Antitop event in 13 TeV collisions

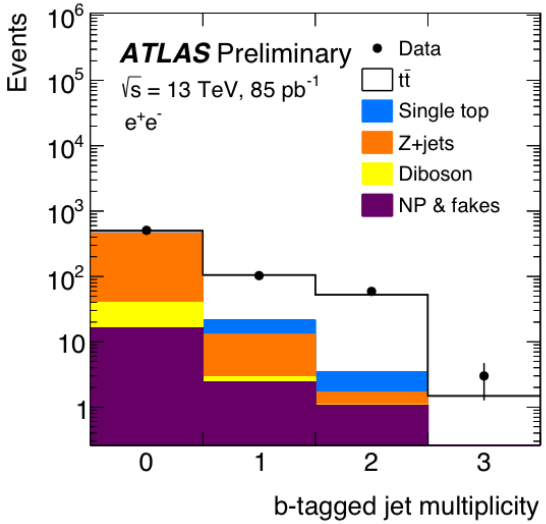


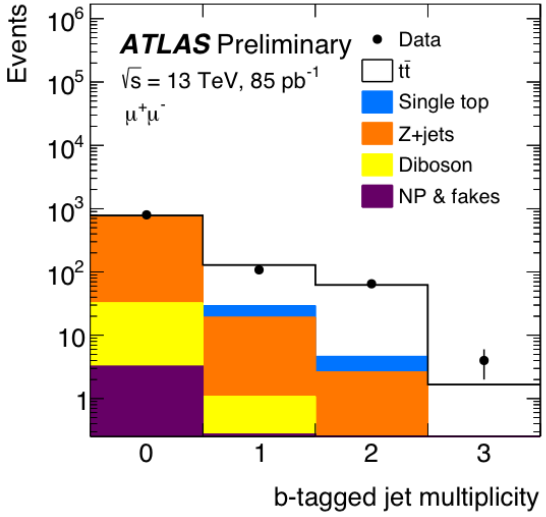
Total Top Cross Section Measurement at $\sqrt{s}$ = 13 TeV

- Total cross section measurement performed in **dilepton same flavour final state**
- **Cross sections and b-tagging efficiencies simultaneously extracted in a combined fit** using one and two b-tag regions
- Results

ee	824 ± 88 (stat) ± 91 (syst) ± 82 (lumi) pb
$\mu\mu$	683 ± 74 (stat) ± 76 (syst) ± 68 (lumi) pb
ee and $\mu\mu$ combined	749 ± 57 (stat) ± 79 (syst) ± 74 (lumi) pb

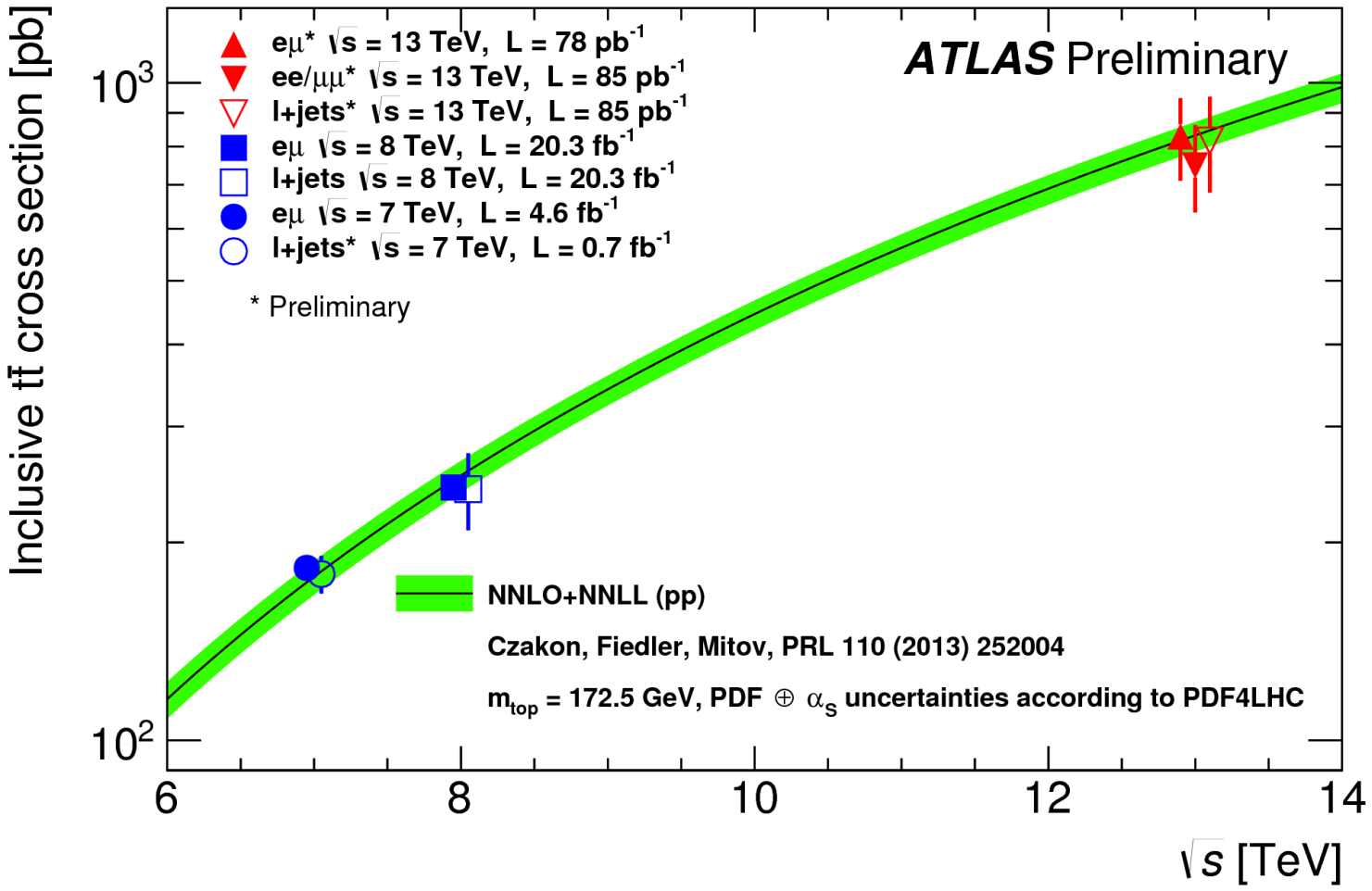
- **Total uncertainty 16%** compared to 14% (eμ) and 17% (l+jets),
- dominated by luminosity (10%)





Total Top Cross Section Measurement at $\sqrt{s}$ = 13 TeV

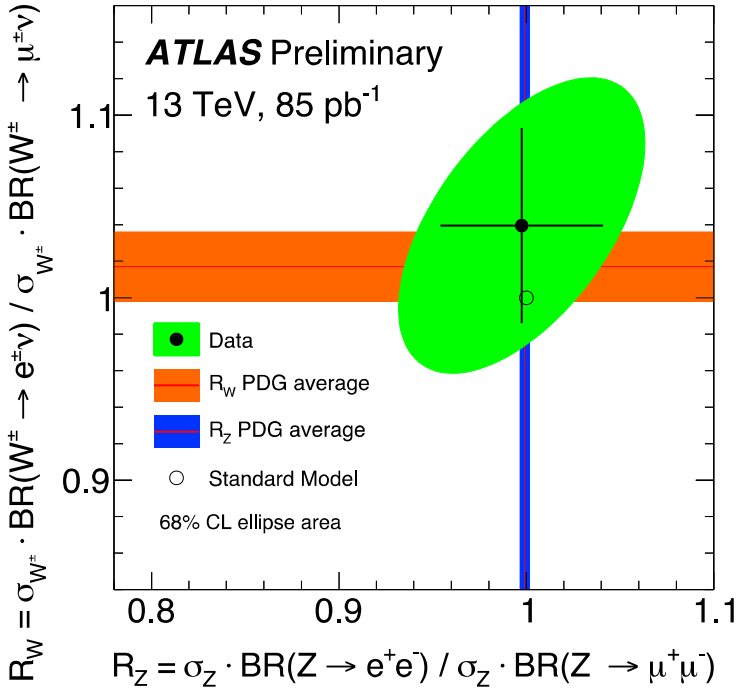
- Consistent with Standard Model expectation

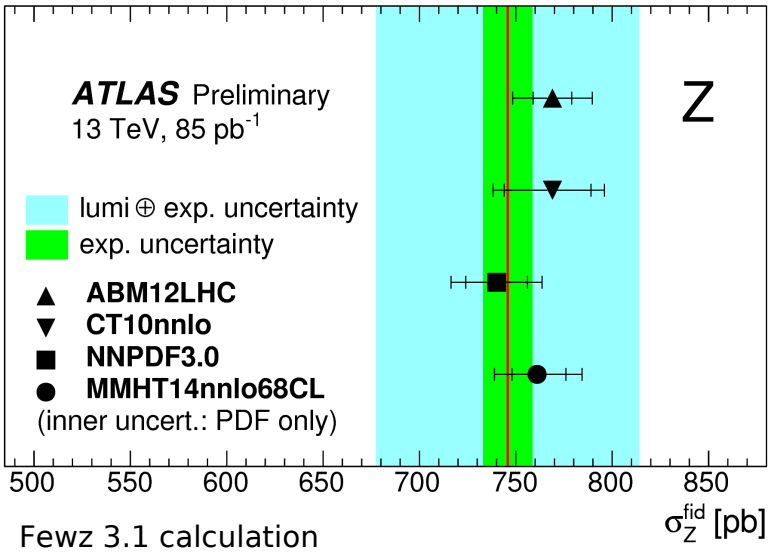


W,Z@13 TeV: Cross Section Measurements

- First measurement of fiducial cross sections for W and Z production

- **Test of lepton universality:**
  Ratios of the electron and muon channel measurements agree with Standard Model expectations





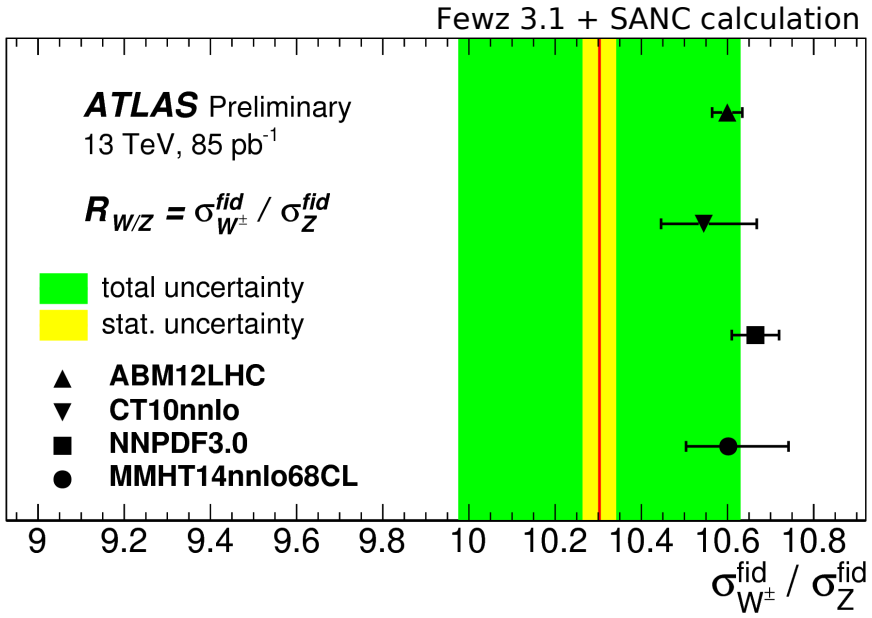
Fewz 3.1 calculation

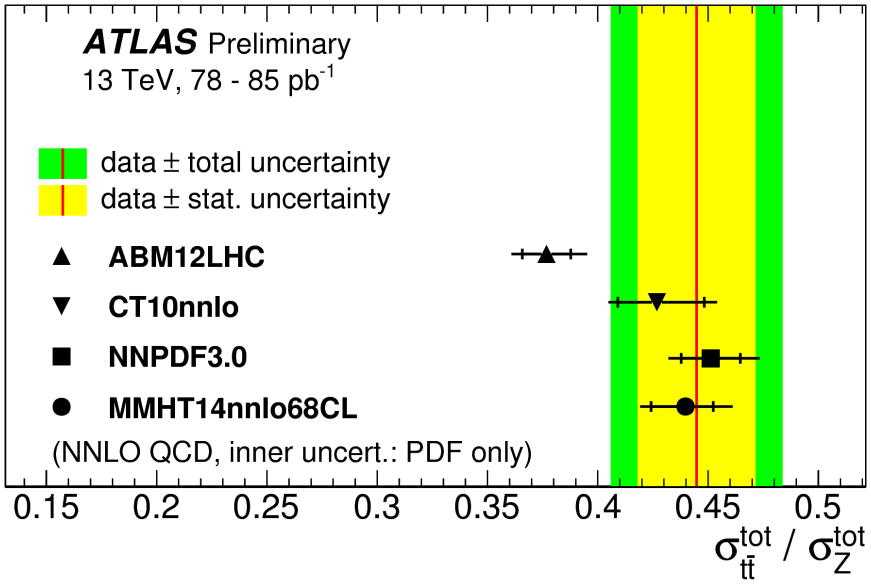
- Combination of electron and muon channel

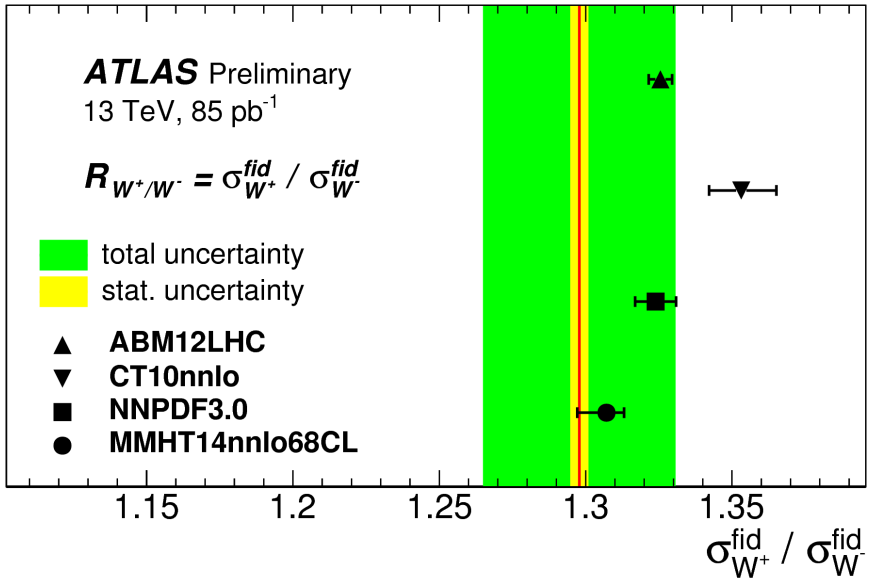
- **All new parton distribution functions in good agreement with data**

Improving Sensitivity: Ratio Measurements

- Ratios of measured cross sections benefit from cancellations of uncertainties, especially luminosity, and **constrain different parton distributior**
- $R_{W\pm/Z}$: strange-quark
- $R_{W+/W-}$: $u_v - d_v$ valence-quark difference
- $R_{t\bar{t}/Z}$: gluon distribution
- Measurements agree with most PDFs which include LHC Run 1 data

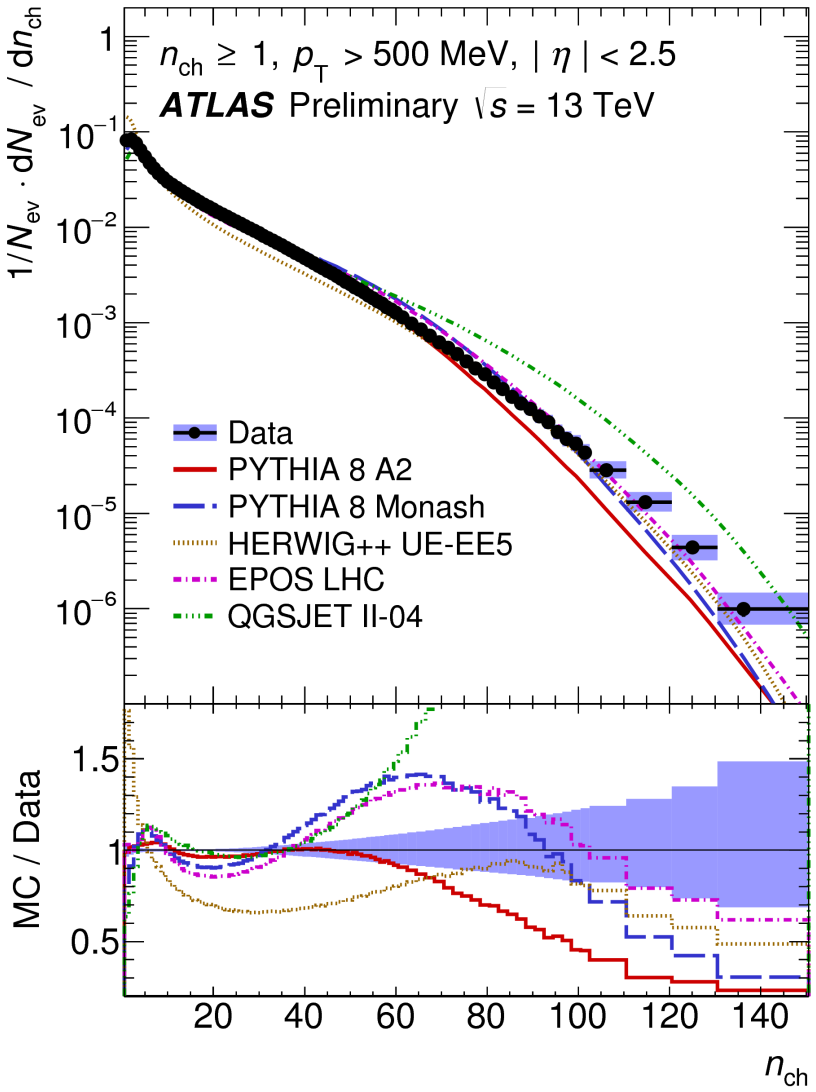


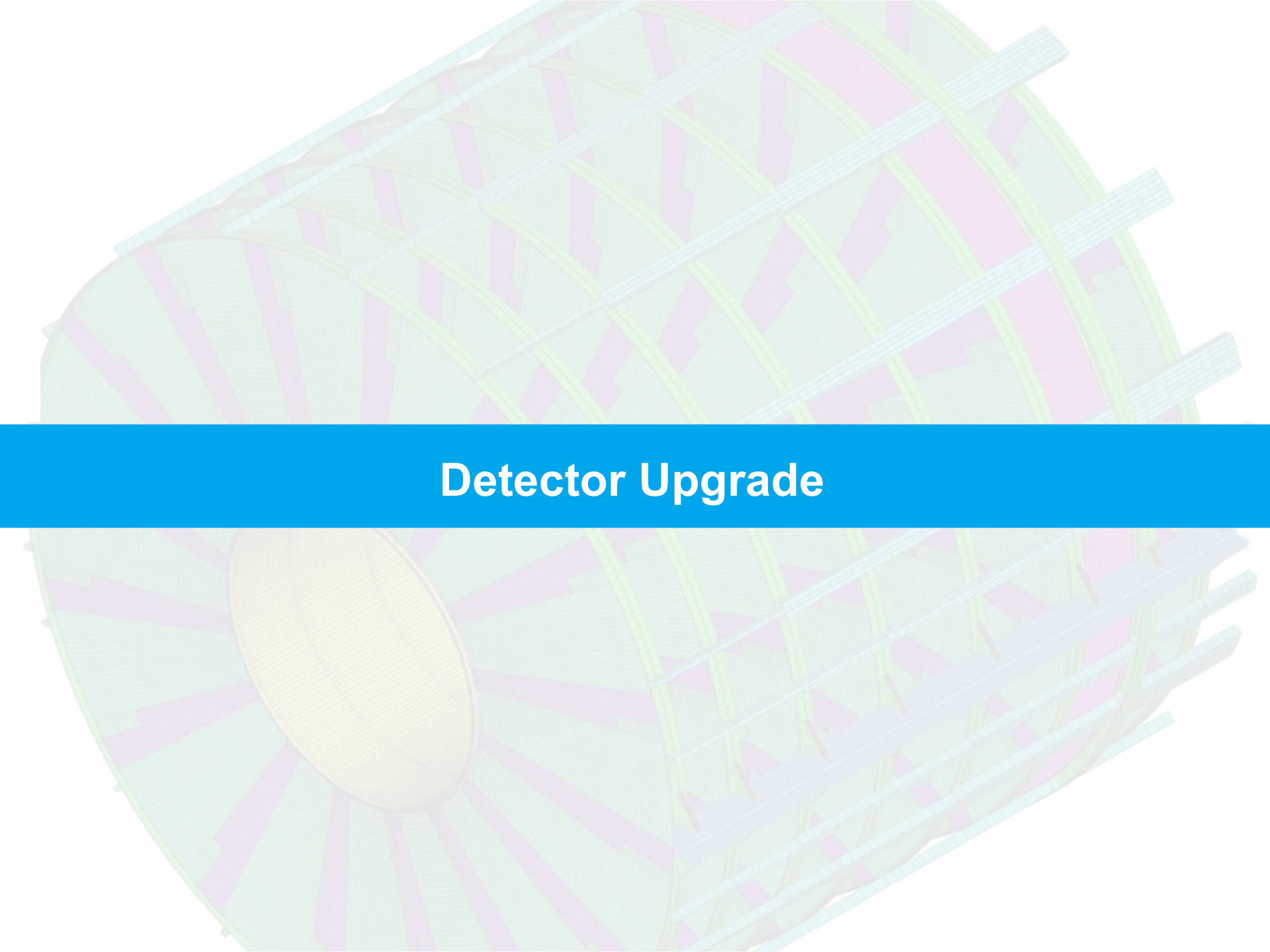




Minimum Bias Analysis

- Measurement of
  - Transverse momentum
  - Pseudorapidity
  - Charged particle multiplicity
  - Mean transverse momentum
- Charged particles selected with $p_T > 500$ MeV and $|\eta| < 2.5$
- Room for improvement in most of the models
- **ATLAS tune with 7 TeV agrees surprisingly well up to $n_{ch} = 55$**
- Scaling with energy

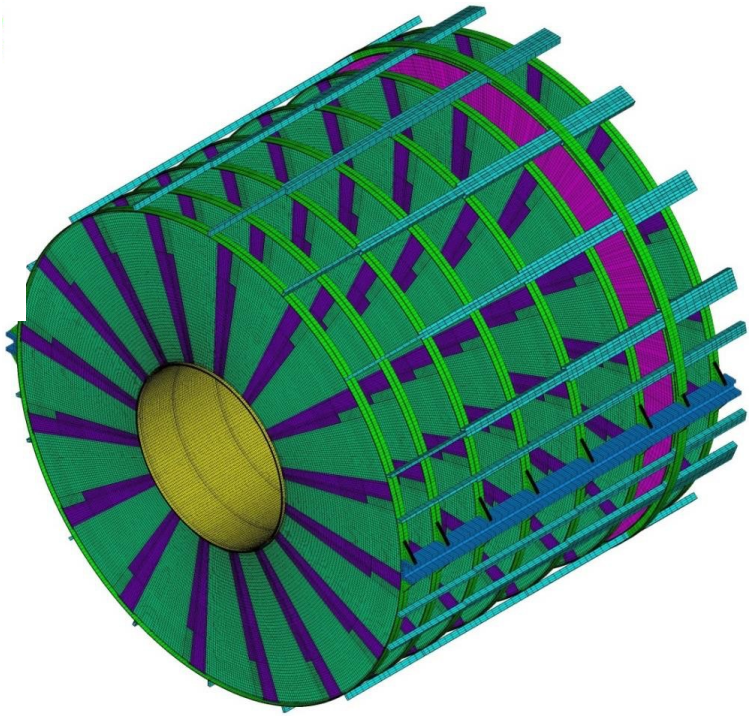




Detector Upgrade

ATLAS Phase II Upgrade – Silicon Strip End Cap

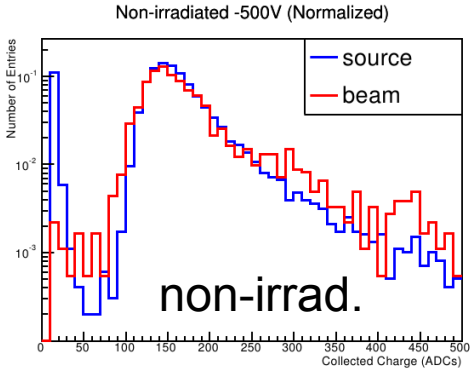
- Target: assemble one of two strip end-caps for ATLAS ITk at DESY
- R&D goals at DESY:
  - Radiation hard sensors
  - Electrical modules
  - Small scale structures (Petalet)
  - Full scale prototypes
- Evaluation and HL-LHC qualification of current and alternative materials
- Integration of results obtained from R&D into detector design

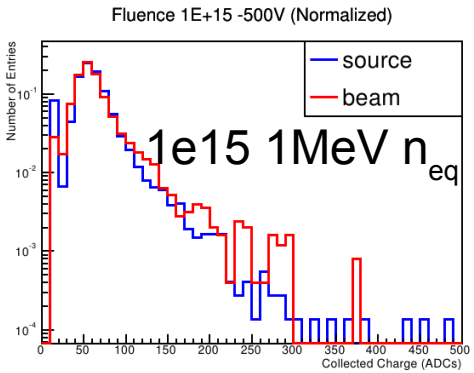


Sensor: Charge Collection Efficiency

- Impact of radiation damage on charge collection efficiency of silicon microstrip test sensors for HL-LHC ATLAS with extreme radiation levels
  - Neutron irradiation in Ljubljana reactor
  - Most samples annealed 80 min @ 60°C

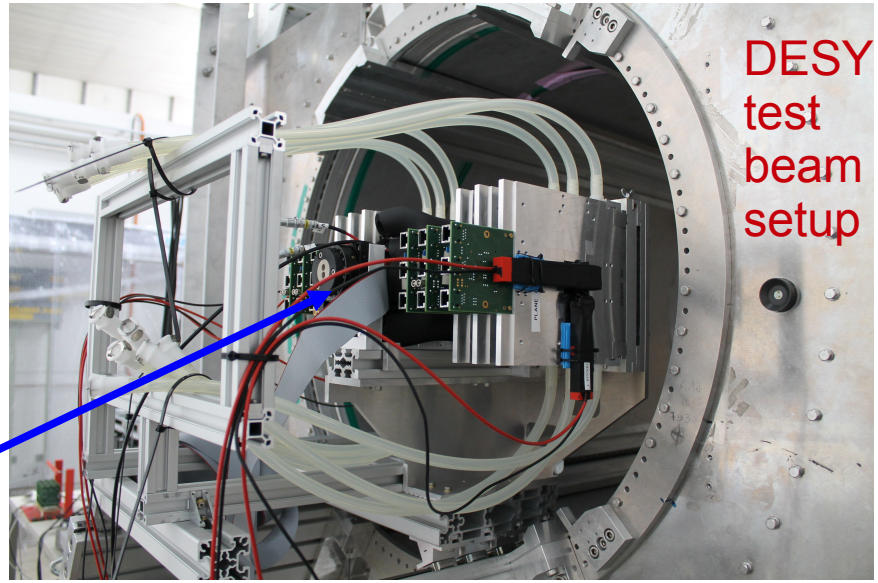
Collected charge





Measurements carried out with radiation source (Sr90) and test beam (4.4 GeV electrons) for comparison

Good agreement in charge distributions, slightly wider clusters for source measurements (as expected)

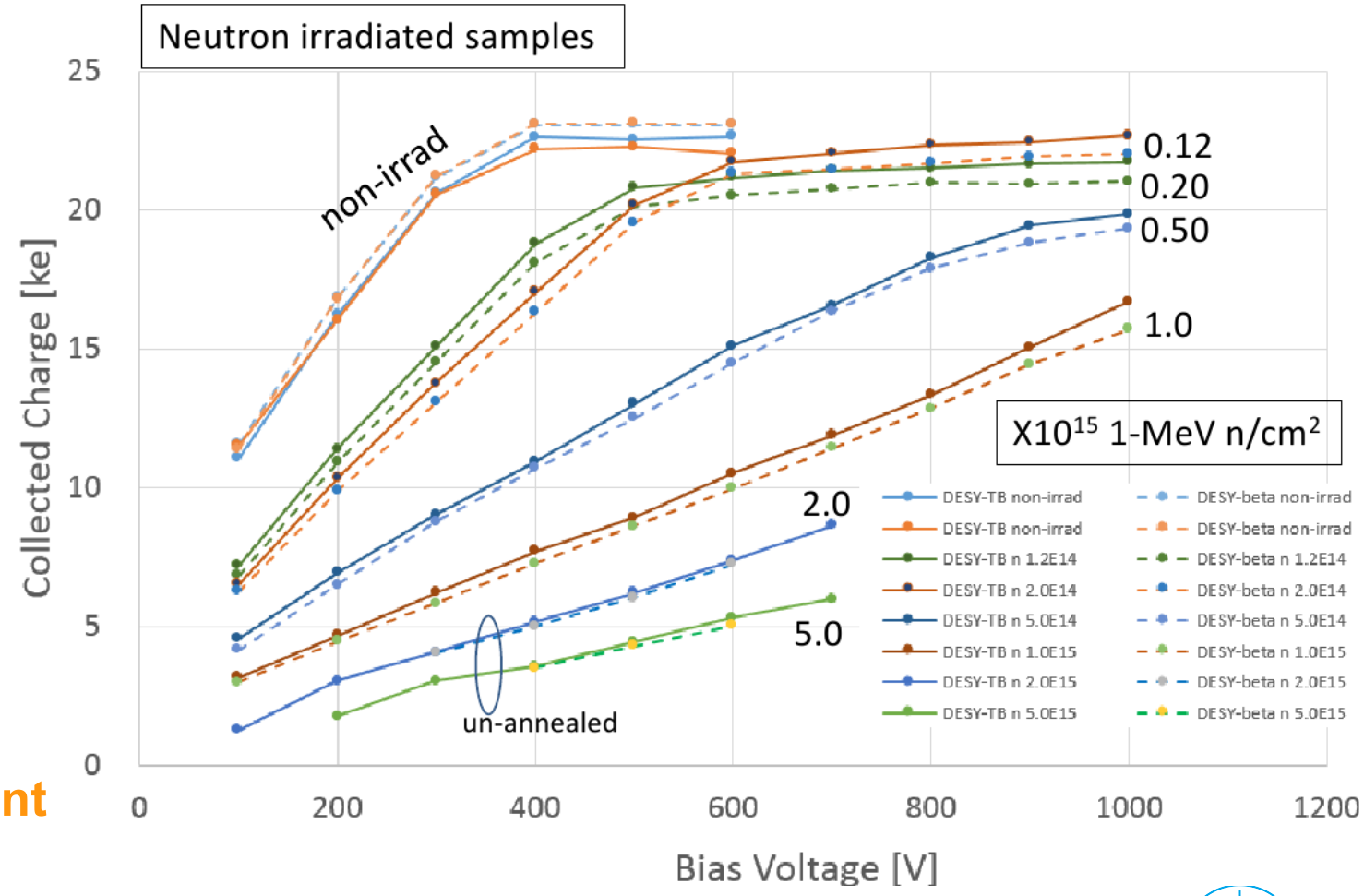


Sensor: Charge Collection Efficiency

Comparison between CCE results with radiation source (Sr90) and in test beam (4.4 GeV electrons)

test beam

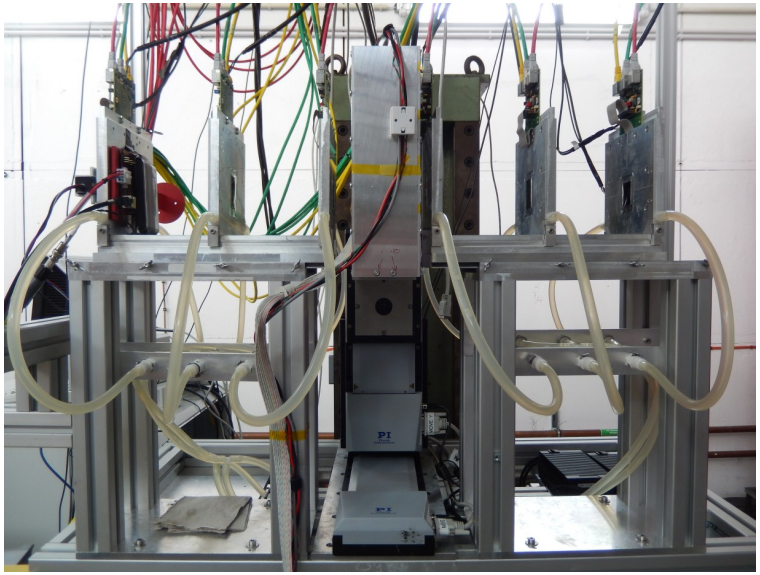
source



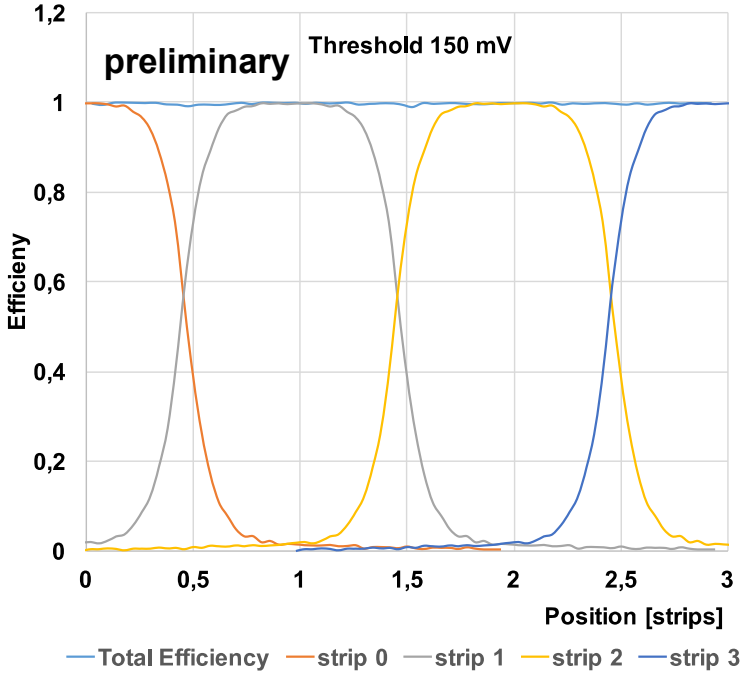
Very consistent results!

ITk Strip Test Beam

- Beam tests critical for understanding the performance of the sensors and readout electronics for the ATLAS tracker upgrade.
  - Tests for the ITk strip detector were performed at the DESY electron test beam, using the DATURA telescope, from 4 – 17 of May.
  - Very successful run with all data-taking objectives met.
- **DESY group strongly involved in all steps from data taking to analysis**

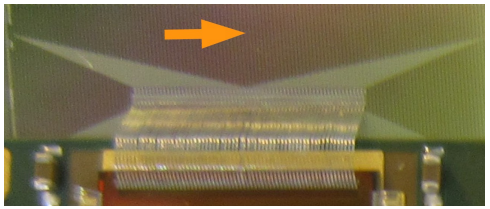


ITK Mini-Module installed in telescope



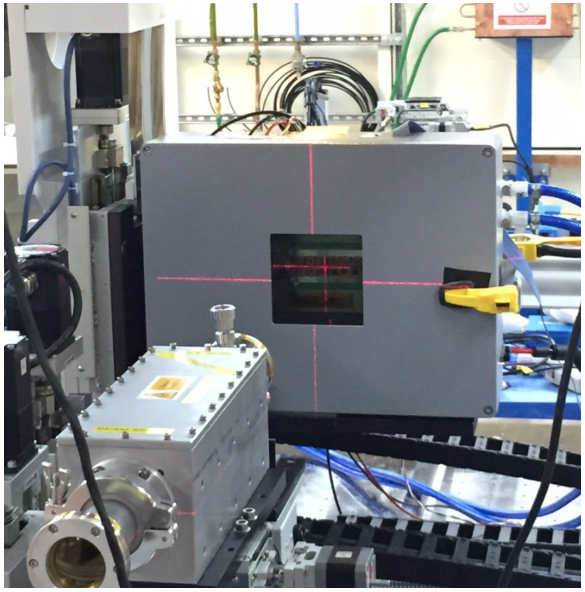
Test Beam at Diamond Facility

- Testbeam in June in collaboration with Glasgow/RAL at the Diamond light source (synchroton delivering 3 GeV photon beam with 2 µm width)
  - Ideal conditions to investigate fine structures on the sensors
  - Measurements of alternative sensor layouts
  - Important to study feasibility of using embedded layouts in ITk

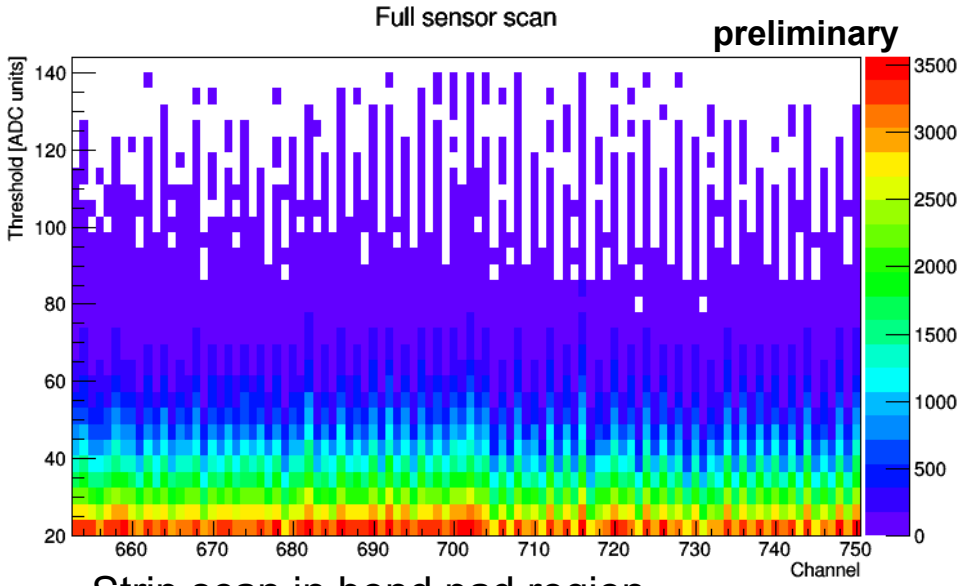


Strip scan on embedded bond pads

- **Successful testbeam with a strong DESY contribution**



Alignment of ITK module in testbeam



Strip scan in bond pad region

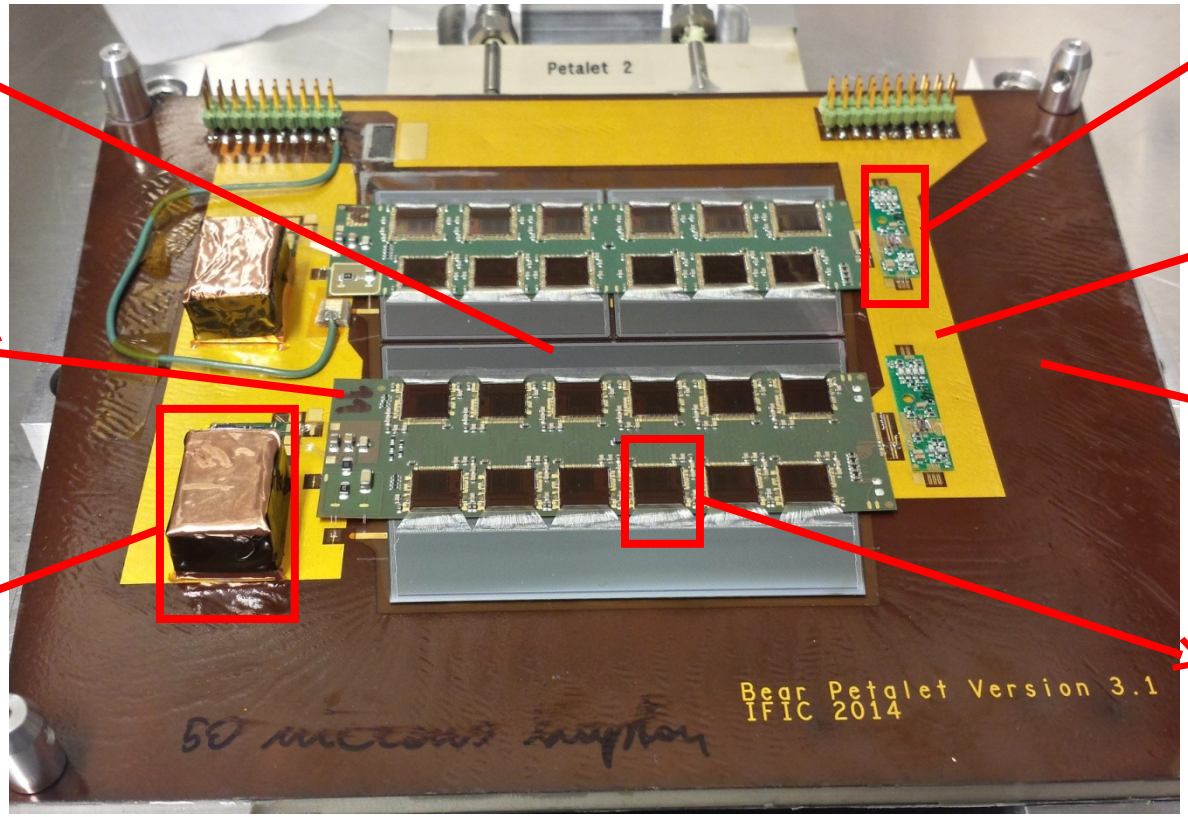
A DESY Petalet

- Petalet hybrids and modules assembled and tested in Zeuthen
- Petalet cores manufactured in Hamburg (two petalet flavors)
- Electrical petalets assembled and tested in Hamburg

Si microstrip sensors: n-on-p, 2 rows of 768 strips

Hybrid boards: Low mass PCBs

DC-DC converters: Provide common LV



BCCs: Digital control of in/out signals

Bus tape: flexible, low mass

Petalet core: Low mass CF-based core

ABCN25 readout ASICs: 250 nm

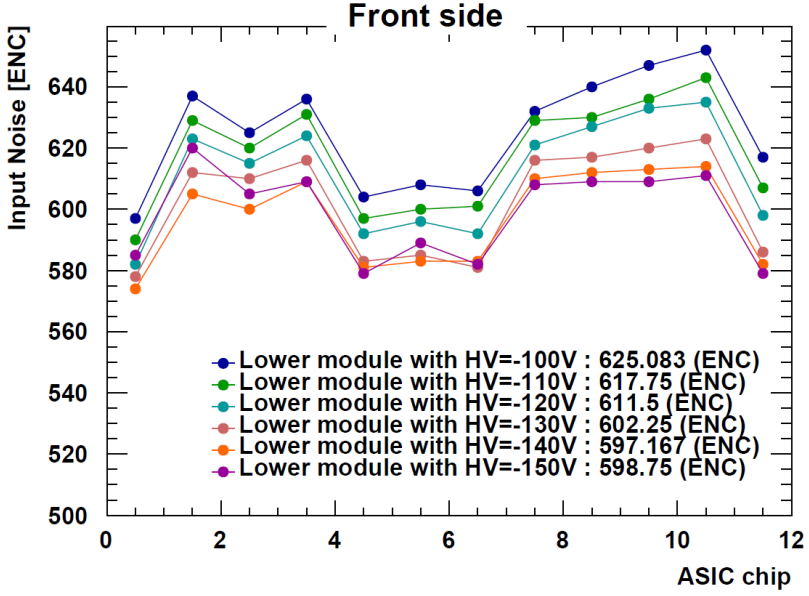
Simultaneous Readout of Both Petalet Sides

- All sensors fully depleted at 150 V
- Almost negligible increase in noise with regard to each side tested independently, related to increased temperature due to higher power dissipation

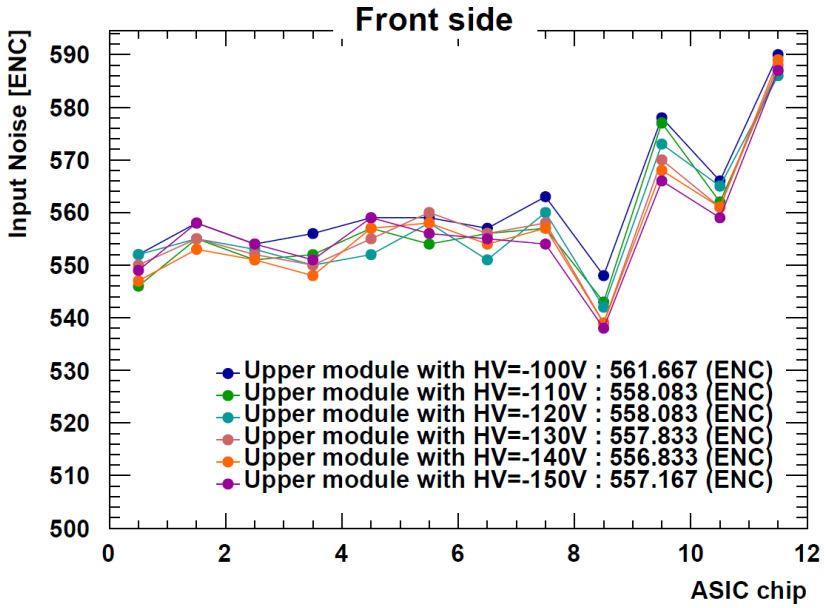
Next steps: dynamic performance, systematic study of grounding and shielding configurations

- **Excellent performance so far!**

Lower module



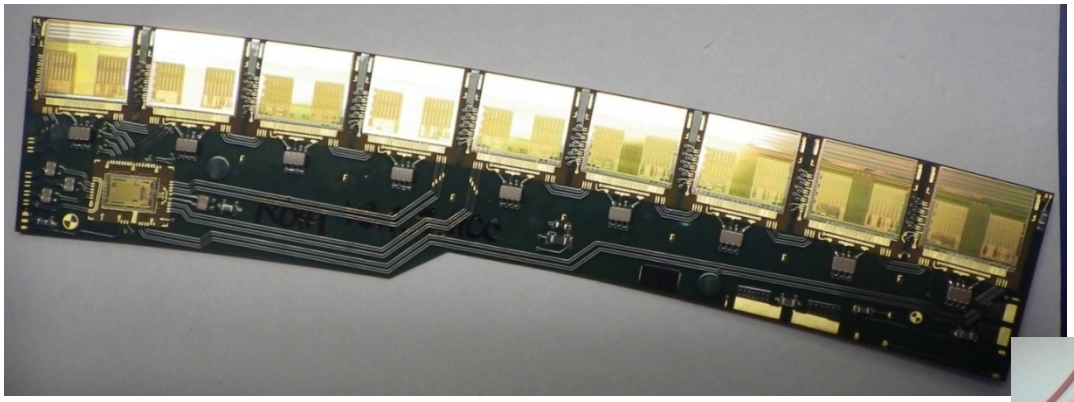
Upper module

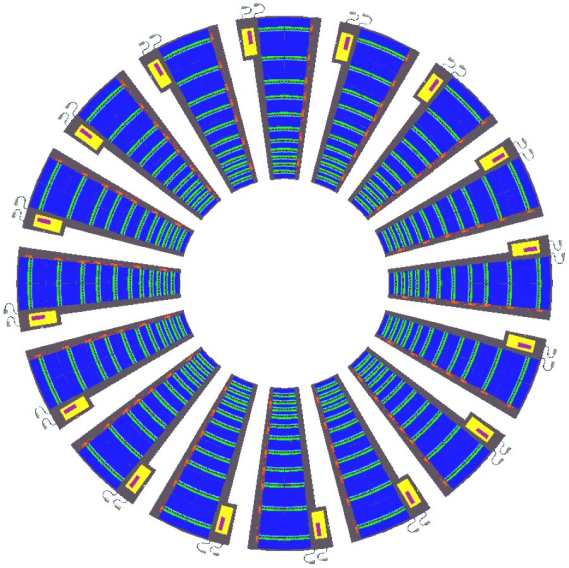


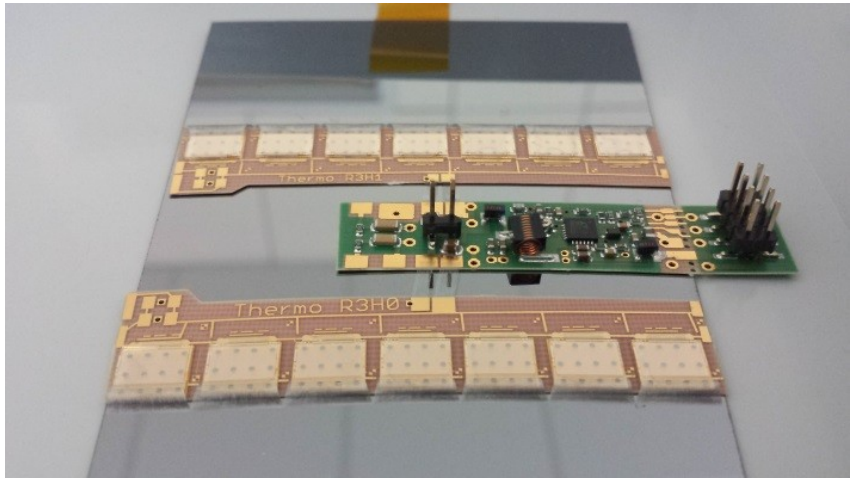
Similar good performance on the back side

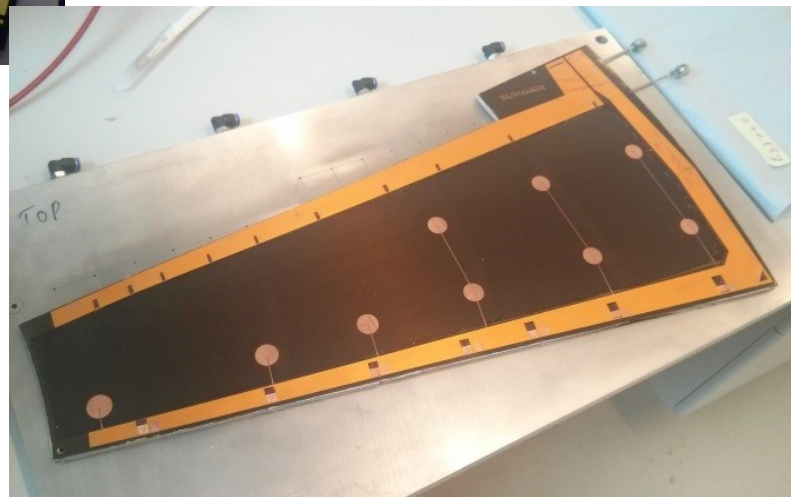
Towards a Petal

- Prototypes for new readout chips coming just now
- Thermo-mechanical petal prototype being produced
- Investigation of automated module placement tools









Summary

- **First successful measurements made at $\sqrt{s}$ = 13 TeV**
- Made possible by careful work on performance issues
- Valuable insight into the workings of the Standard Model
  - Results to constrain minimum bias models
  - Measured W, Z and top quark production
  - Tested parton distribution functions
- Preparations for the HL-LHC ongoing with very good progress
- **Strong participation of the DESY group in many fields**

General Review of Group Activities

- Operation
  - ALFA
  - Semi Conductor Tracker (SCT)
- Detector upgrade
  - Fast Track Trigger (FTK, Phase 1)
  - Inner Tracker Upgrade (Phase 2)
  - Test Beam Telescope
- Computing and Software
  - Tier 2, NAF
  - Data Reprocessing Coordination
  - Inner Detector Tracking Software
  - Management of ATLAS MC software
  - Frozen showers
- Physics objects performance
  - Electron/photon
  - Tracking
- ATLAS data analyses
  - Standard Model: W/Z/DY production, WW production, (diphoton+) jet production, Minimun Bias
  - Top: tt resonances, tt+jets production, top properties, single-top FCNC, tt+Higgs
  - Higgs: SM H→γγ, BSM Higgs, H->Zγ
  - Generator & PDFs: production and validation (HepMCAnalysis), new generator setups, generator tuning, impact studies and fits of PDFs
  - Exotics: dark matter searches, lepton-jets, Graviton →γγ
  - Brand new: SUSY