Status of ATLAS at DESY

Alexander Grohsjean

77th Physics Research Committee

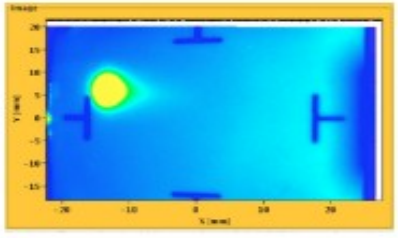
April 24th 2014

Outline

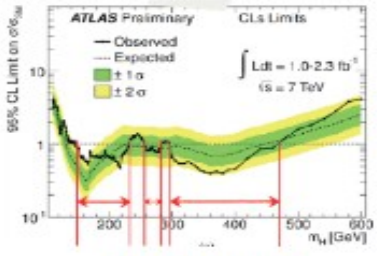
- LHC Status and Upcoming Run
- ATLAS Group
  - People and Positions
  - Activities
- Recent Highlights from Physics and Performance Groups
- Status of SCT and Detector Upgrade Activities
- ATLAS Computing and Software
- Publications
- Summary

LHC Highlights up to LS1

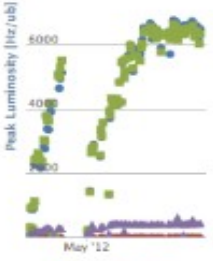
August 2008
First injection test



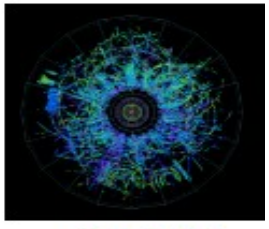
November 29, 2009
Beam back



October, 2011
3.5x10^{+33}, 5.7 fb^{-1}

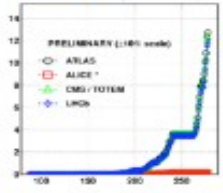


May 2012
Ramping Performance



Feb. 2013
p-Pb^{82+}
New Operation Mode

Sept. 10, 2008
First beams around



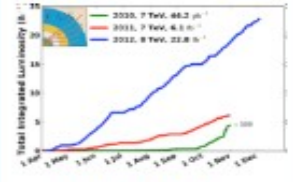
October 14, 2010
L= 1x10^{+32}
248 bunches

First Hints!!

June 28 2011
1380 bunches

1380

March 14th 2012
Restart with Beam



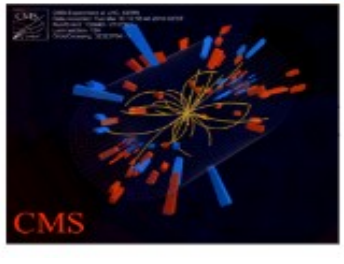
Nov. 2012
End of p^{+} Run 1

Repair and Consolidation

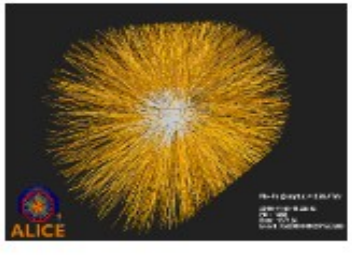
2008 | 2009 | 2010 | 2011 | 2012 | 2013

Sept. 19, 2008
Incident

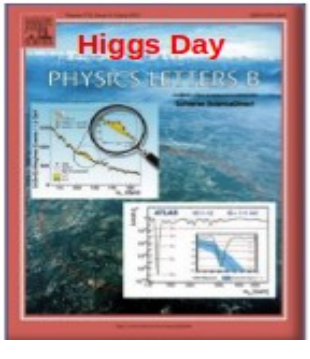
March 30, 2010
First collisions at 3.5 TeV



November 2010
Pb^{82+} Ions



November 2011
Second Ion Run

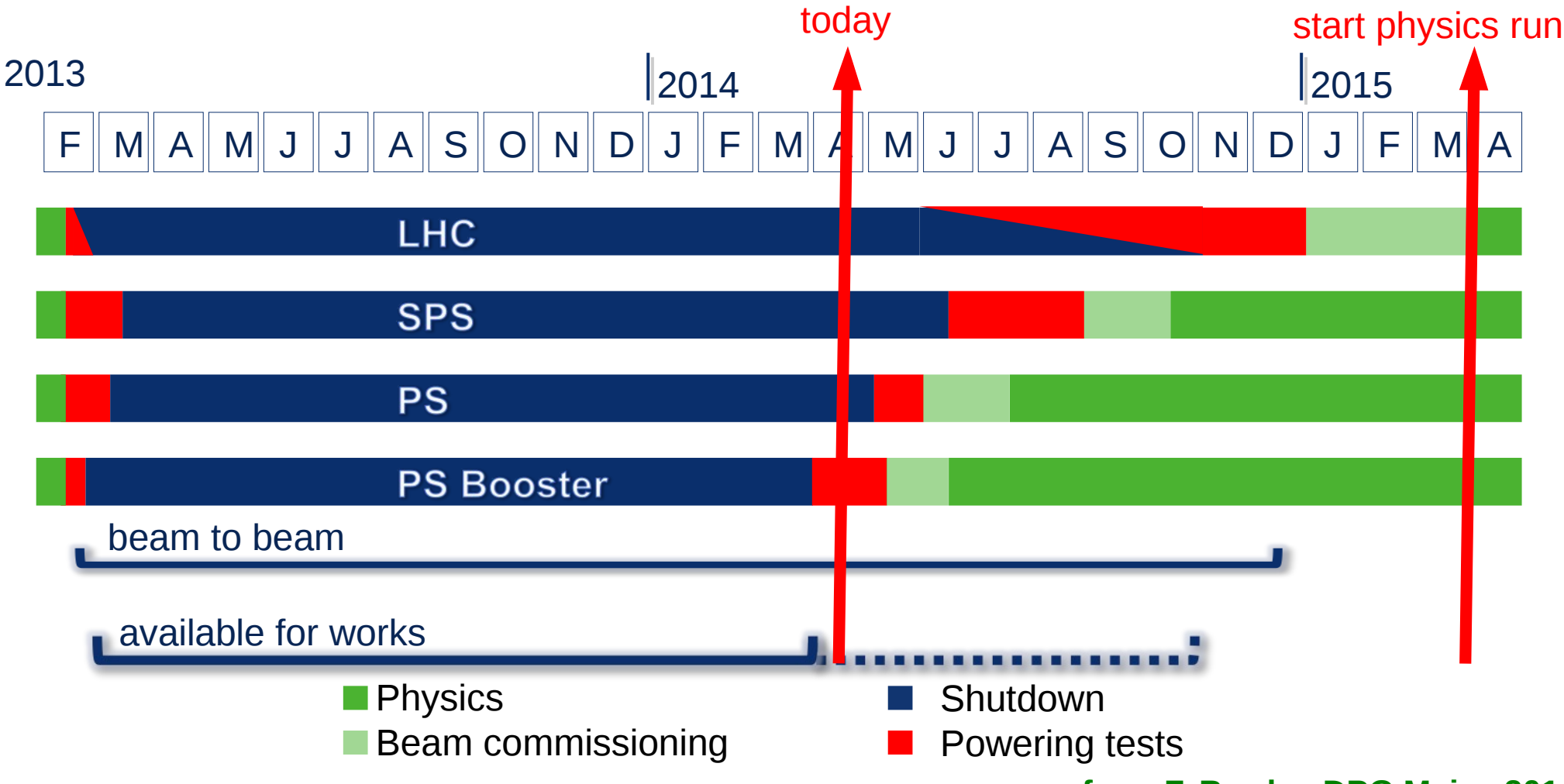


LS1

from F. Bordry, DPG Mainz 2014

Long Shutdown 1 (LS1)

- major shutdown intended to repair the magnet interconnects
- LHC injectors getting ready for hardware tests
- LHC beam commissioning beginning of 2015



from F. Bordry, DPG Mainz 2014

LHC Consolidation Status

from F. Bordry, DPG Mainz 2014

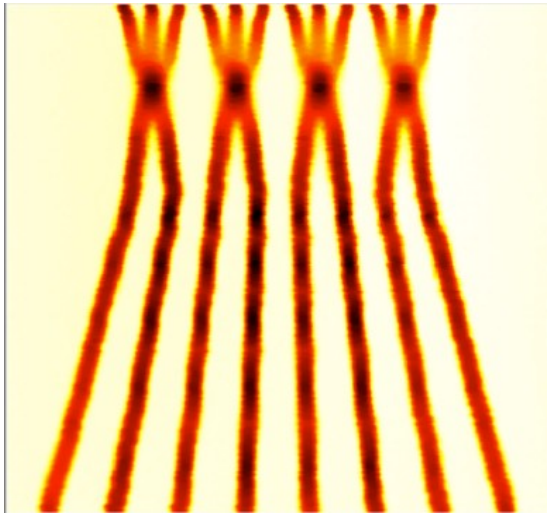
LHC Consolidation Status

from F. Bordry, DPG Mainz 2014

Expectations after Long Shutdown 1

- 18 months of data taking until mid of 2018
- at least 6.5 TeV per beam:
  - decision towards 7 TeV according to magnet training
- brighter beams due to new injector beam production scheme
- 25 ns bunch spacing
- maximum luminosity of ~1.6x10^{34}cm^{-2}s^{-1}

batch compression and merging and splitting (BCMS)



	Number of bunches	Intensity per bunch	Transverse emittance	Peak luminosity	Pile up	Int. yearly luminosity
25 ns BCMS	**2508**	**1.15 × 10^{11}**	**1.9 μm**	**1.6×10^{34} cm^{-2}s^{-1}**	**~43**	**~42 fb^{-1}**

from F. Bordry, DPG Mainz 2014

People and Positions

Physics and Performance

Alexander Glazov	SM physics group convener
Thorsten Kuhl	Generator physics group convener
Kerstin Tackmann	Electron/photon performance group convener
Ewelina Lobodzinska	SM MC coordinator
Alexander Grohsjean	Top MC modeling convener, Top LHC working group generator contact
Elisabeth Petit	Photon ID coordinator
Kristin Lohwasser	Electron ID coordinator
Stefano Camarda	PDF forum convener
Pavel Starovoitov	PDF forum convener

Detector Operations and Upgrade

Karl-Heinz Hiller	ALFA subdetector coordinator
Ingrid-Maria Gregor	ITK strip project leader
Ingo Bloch	Module activity coordinator
Marcel Stanitzki	CMOS sensors coordinator
Pavel Starovoitov	TileCalorimeter noise description group convener

Computing

Nick Styles	ID software coordinator
Ewelina Lobodzinska	MC software coordinator
David South	Reprocessing coordinator
Voica Radescu	Conditions database coordinator

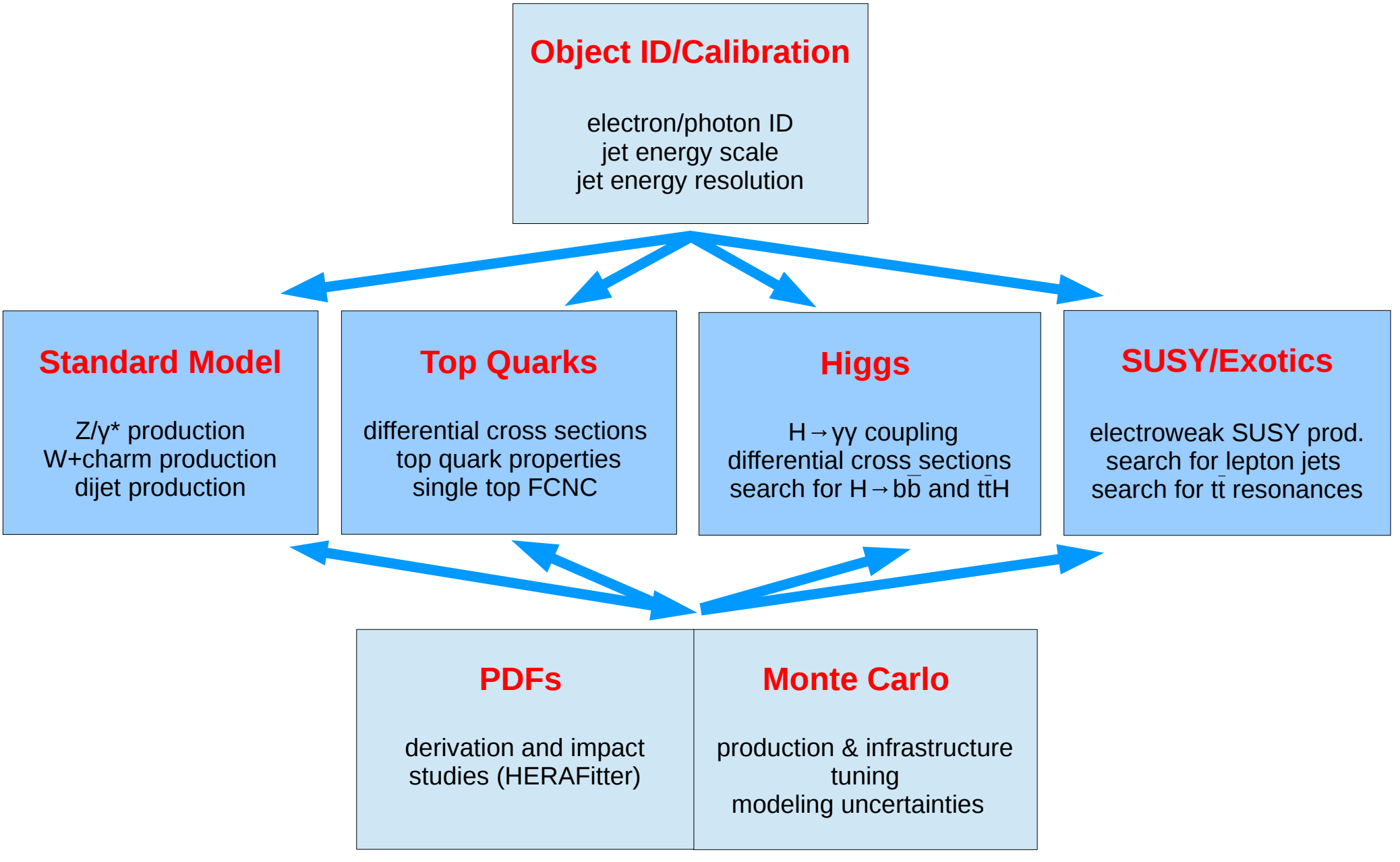
General Management and Boards

Michael Medinnis	Chair of speakers committee advisory board
Judith Katzy	Speakers committee
Klaus Moenig	Panel for operations task sharing

total of 62 members:

14 physicist staff
2 YIGs
21 fellows
19 PhD students
6 support staff

DESY ATLAS - Physics and Performance



DESY ATLAS - Detector Operations and Upgrade

Current Detector

ALFA

commissioning
calibration
measurement

SCT

monitoring
calibration
digitisation

Upgrade

Insertable B Layer
(Phase 0)

test beam for prototypes
fibre procurement & QA

Fast Track Trigger
(Phase 1)

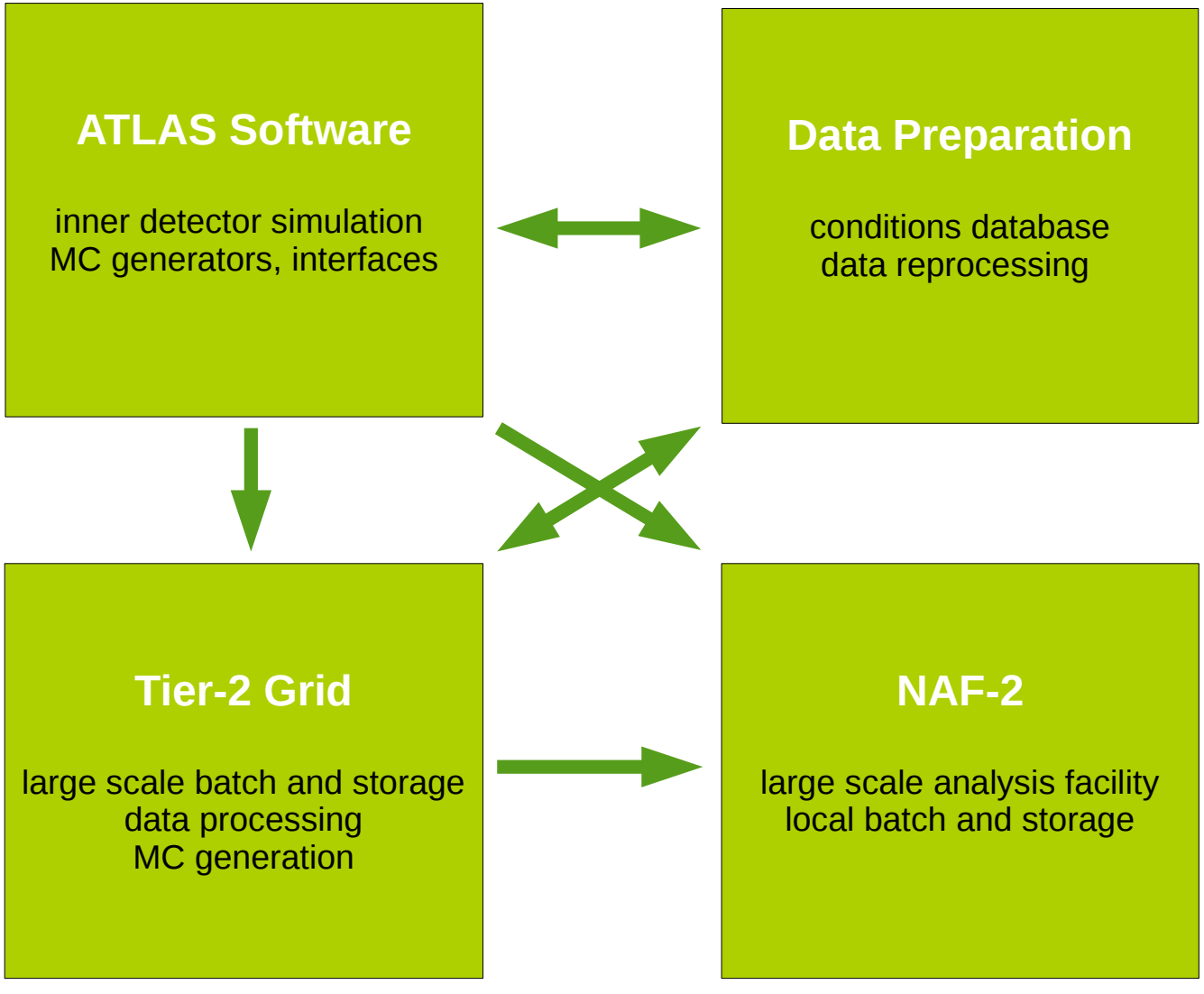
simulation
optimisation

Tracker Endcap
(Phase 2)

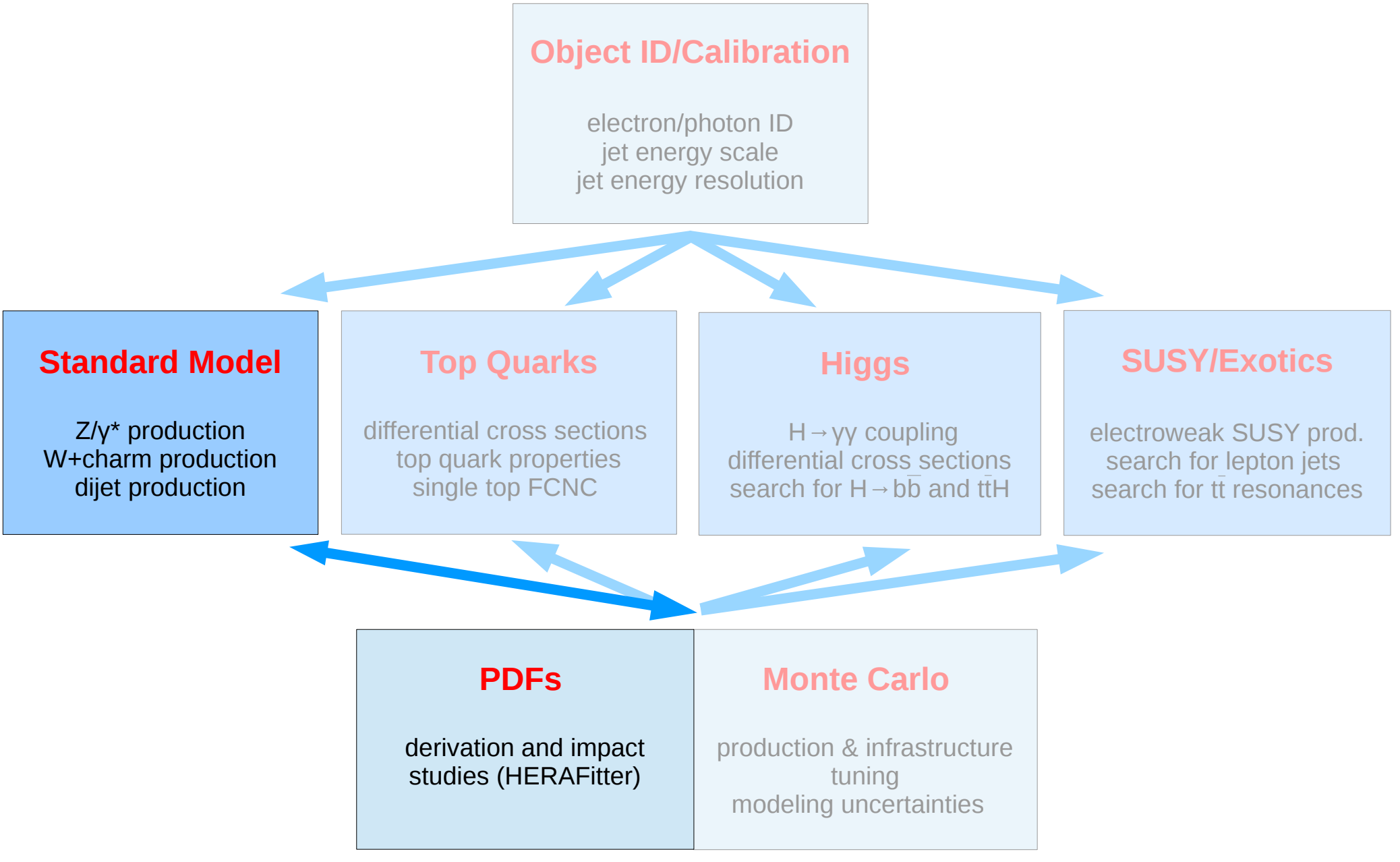
R&D “Petal 2014”
sensor studies
electronics
mechanics
upgrade simulation

DESY Test Beam

DESY ATLAS – Computing



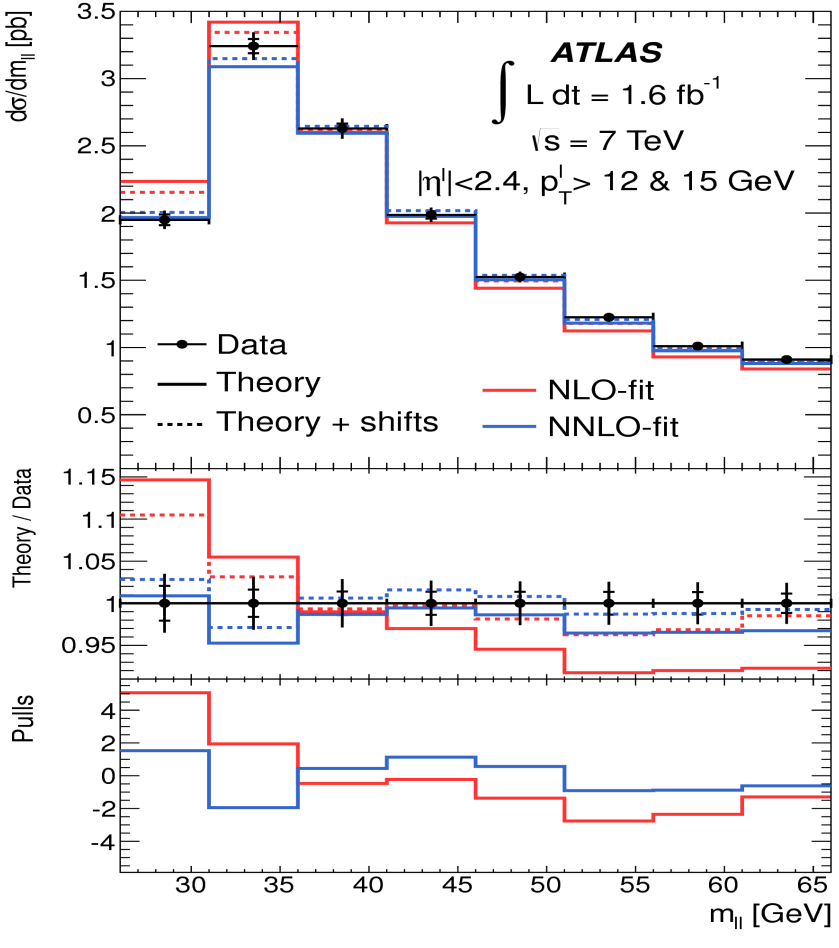
DESY ATLAS - Physics and Performance



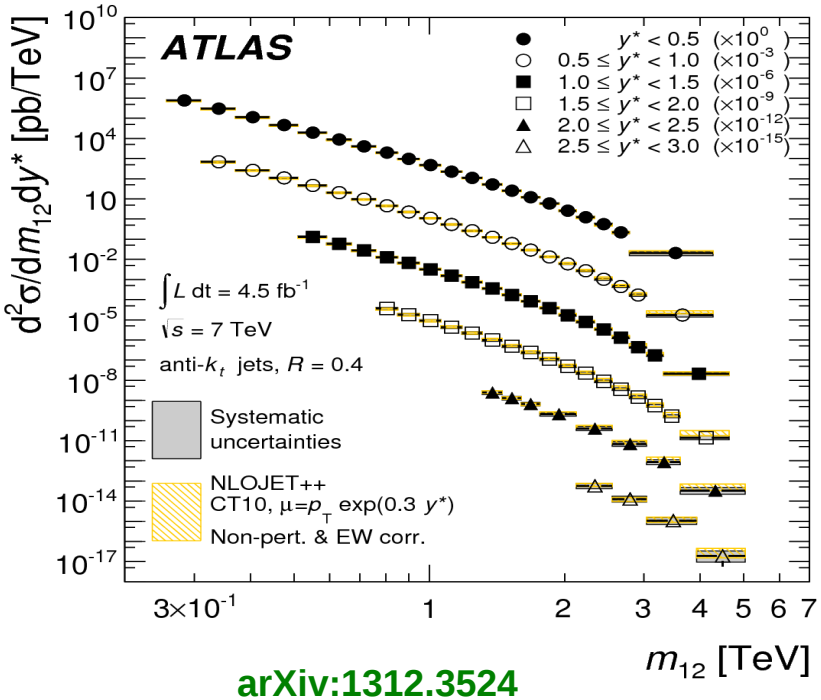
Low Mass Drell-Yan Production at 7 TeV

- low mass Z/γ*→ll production provides complementary constraints on PDFs
- measurement of fiducial, differential cross section as a function of dilepton mass
  - 1.6 fb^{-1} of Z→ee/μμ:
    26 GeV < m_{ll} < 66 GeV
  - 35 pb^{-1} of Z→μμ:
    12 GeV < m_{ll} < 66 GeV
- results unfolded to parton level:
  - no good description of low mass data from pure NLO calculation
  - good performance of fixed-order NNLO calculation as well as from NLO+PS
- choice of PDF studied using HERAFitter
  - including HERA I and this data in PDF fit not enough to improve NLO performance

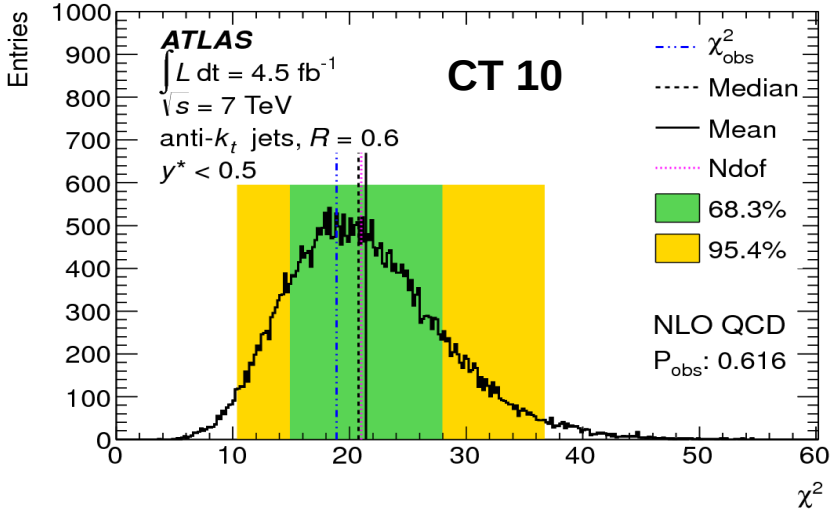
arXiv:1404.1212



Dijet Production Cross Section at 7 TeV



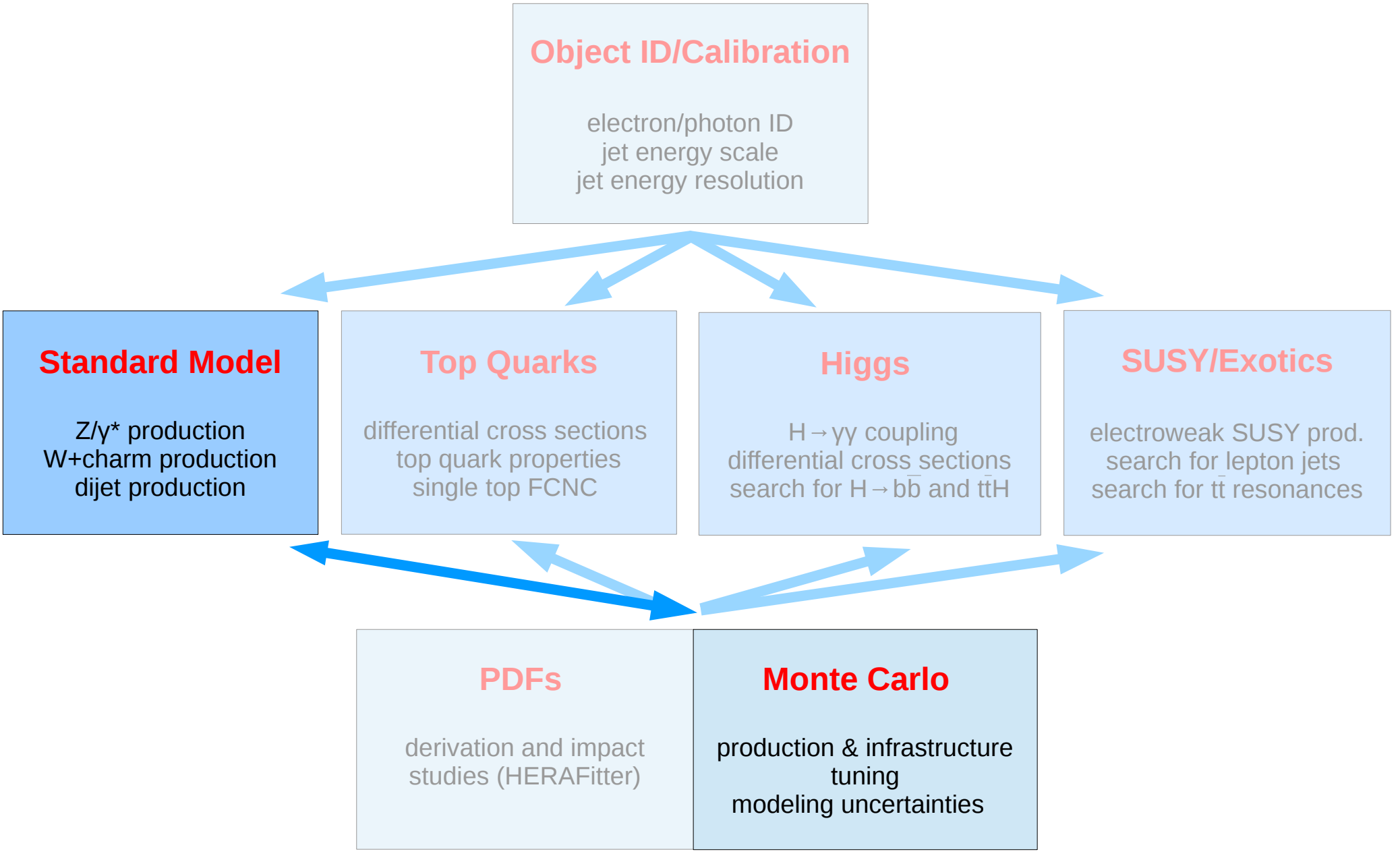
arXiv:1312.3524



- double-differential dijet cross section as a function of
  - dijet mass (300 GeV to 5 TeV)
  - rapidity gap bins (up to $y^* = (y_1 - y_2)/2$ 3.0)
- result unfolded to particle level:
  - comparison to NLO QCD predictions from NLOJet++ including electroweak and non-perturbative corrections
  - good description over 8 orders of magnitude
- quantitative comparison to various predictions with different PDFs
  - best compatibility with CT10

→ strong impacts on PDF and QCD predictions

DESY ATLAS - Physics and Performance



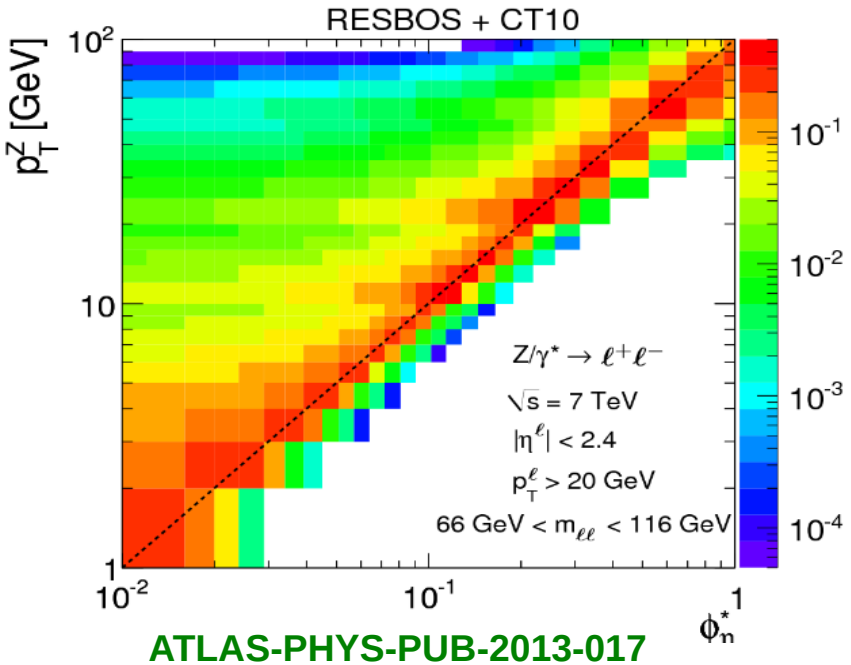
Tuning NLO+PS Generators

- predictions of NLO+PS generators fail in certain parts of phase-space
  - modeling of low p_T vector bosons crucial for precision W boson mass
- aim to describe dynamical effects of pQCD
- first tune of NLO+PS generators
  - Powheg+Pythia 8
  - based on $\phi_\eta^* \sim p_T^Z$

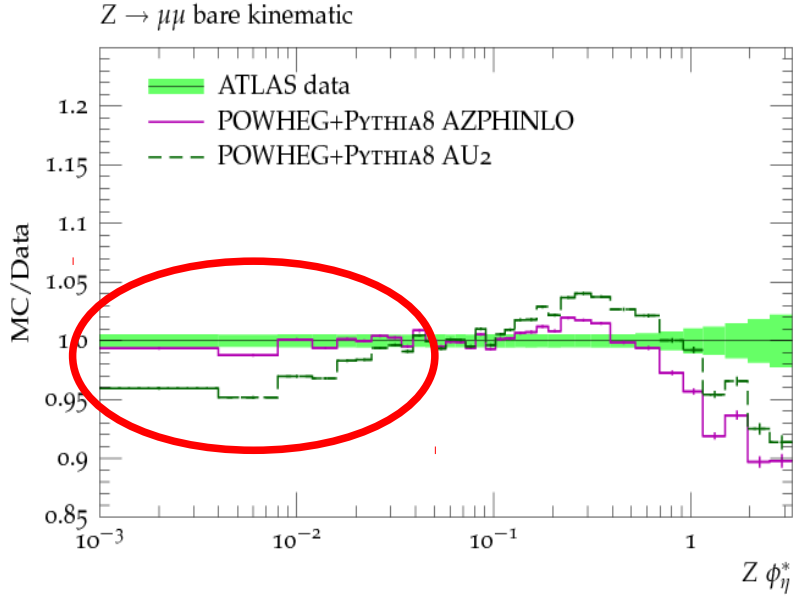
→ significant revision of matching algorithm

→ 5% improvement in low ϕ_η^* region

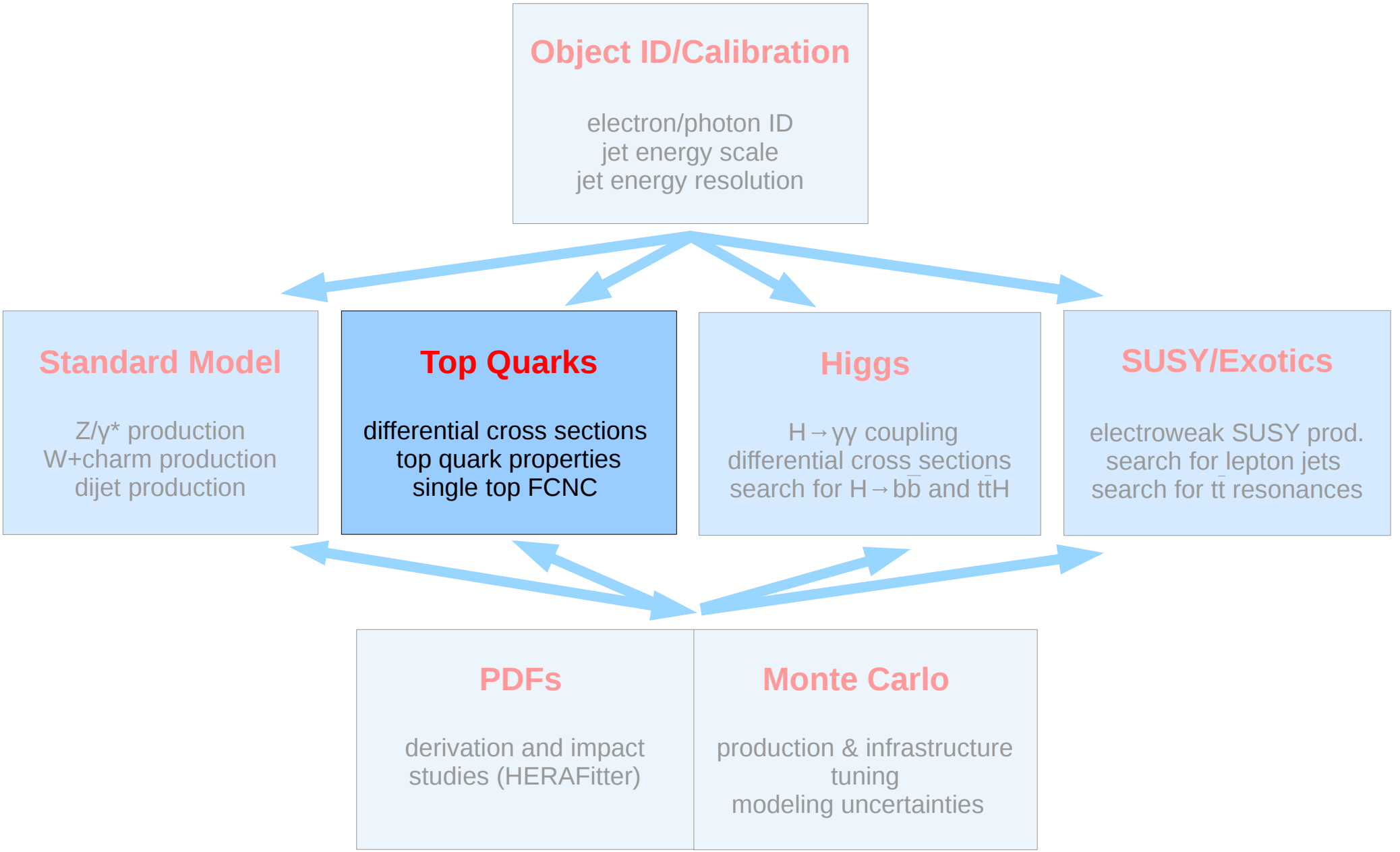
- good performance when validated against Tevatron data



ATLAS-PHYS-PUB-2013-017

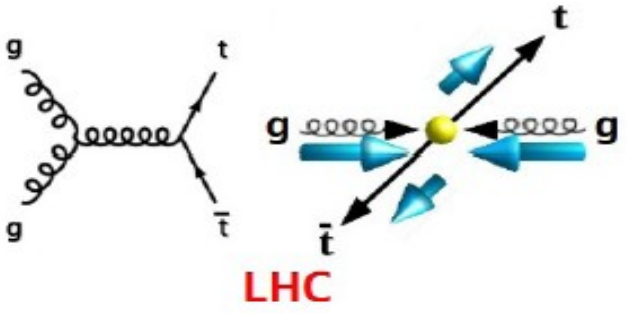


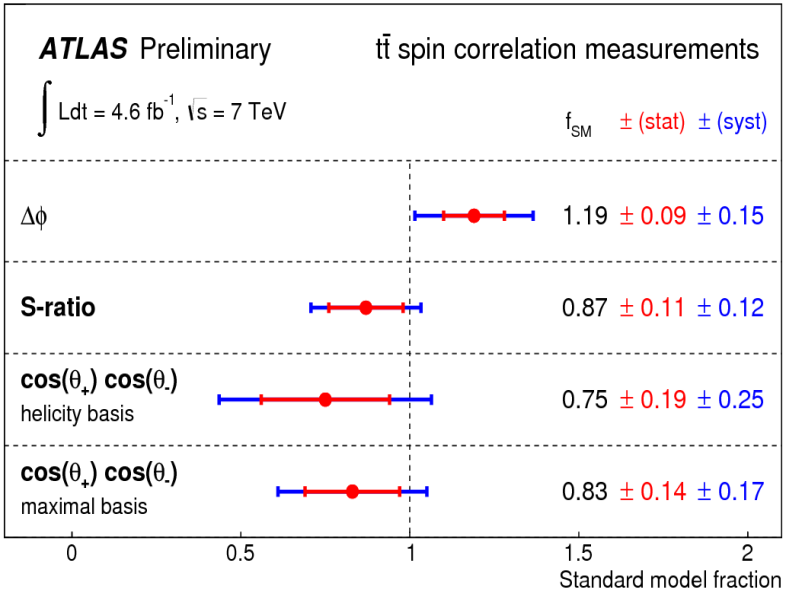
DESY ATLAS - Physics and Performance

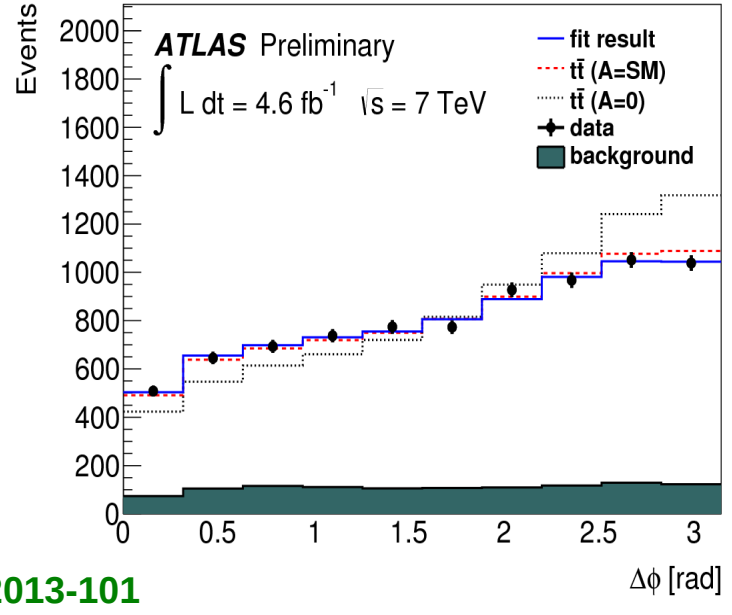


Top Quark Spin Correlations

- measurement probes full chain from production to decay
  - sensitive to new physics with different spin configurations e.g. stops around top mass
- correlation strength inferred from angles of $t\bar{t}$ decay products
- various methods used
  - all results well consistent with SM prediction
  - measurements limited by systematic uncertainties

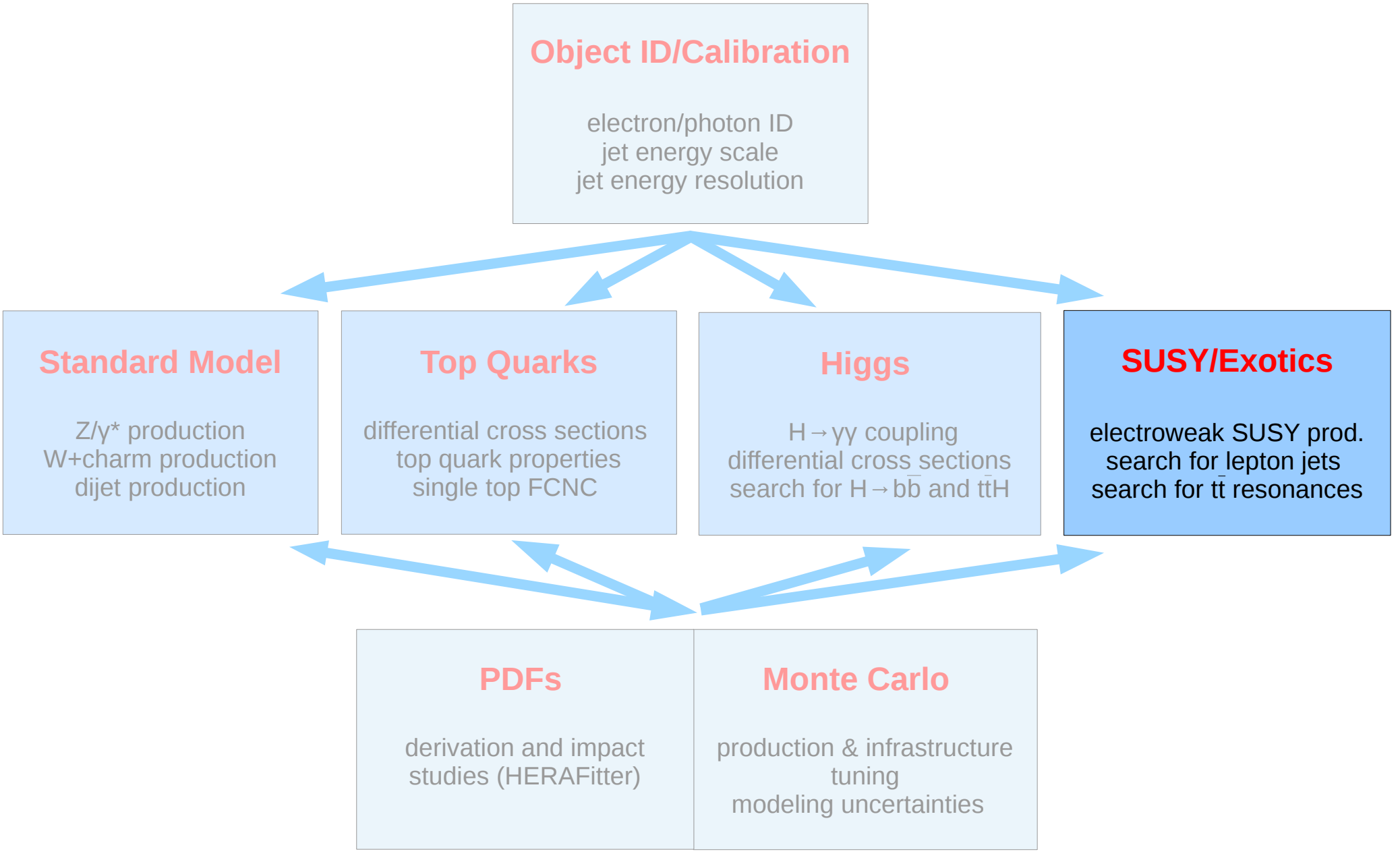






ATLAS-CONF-2013-101

DESY ATLAS - Physics and Performance



Electroweak SUSY Searches

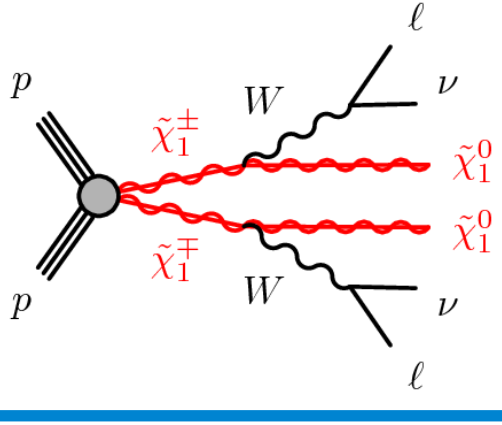
- electroweak production of SUSY particles
  - focus on dilepton final states
  - dominant at LHC for heavy gluinos/squarks:
    1st/2nd generation squarks and gluino limits ~ 1 TeV
- 8 TeV analysis significantly improved
  - better selection cuts
  - more final states added

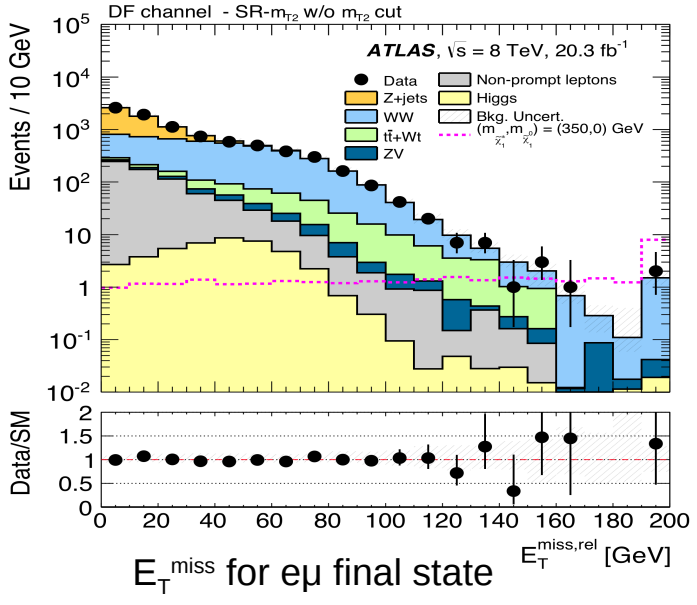
→ ~ 20% improved exclusion limits

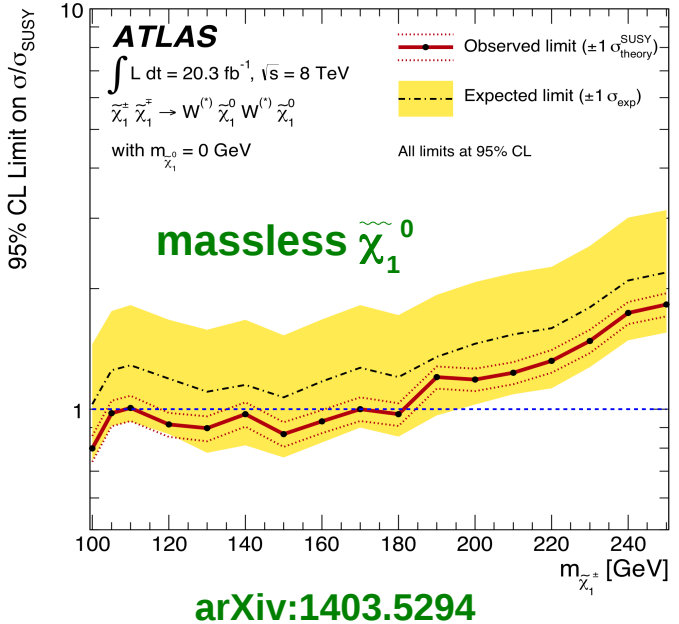
→ first exclusion of chargino pair production with W boson mediated decays

→ improved limits of trilepton analysis

- results also interpreted in pMSSM







arXiv:1403.5294

DESY ATLAS - Detector Operations and Upgrade

Current Detector

ALFA

commissioning
calibration
measurement

SCT

monitoring
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digitisation

Upgrade

Insertable B Layer
(Phase 0)

test beam for prototypes
fibre procurement & QA

Fast Track Trigger
(Phase 1)

simulation
optimisation

Tracker Endcap
(Phase 2)

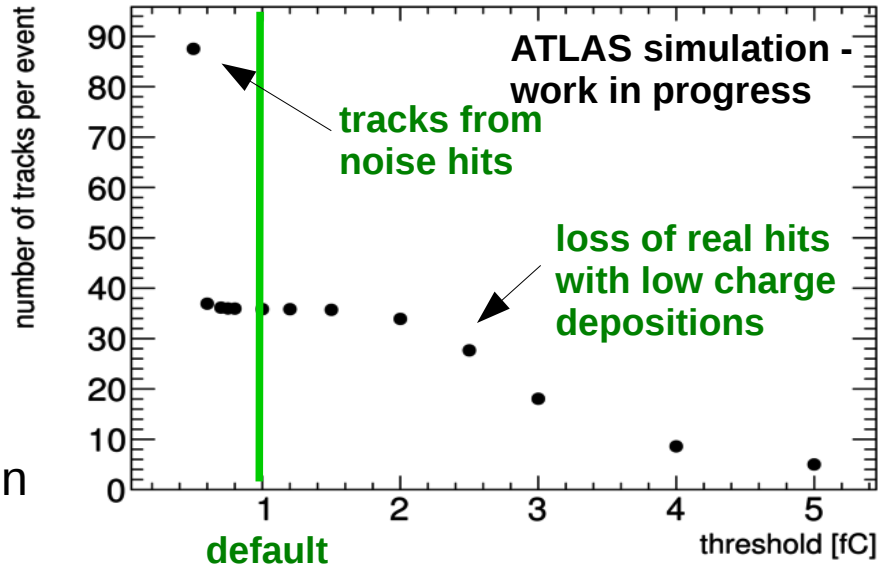
R&D “Petal 2014”
sensor studies
electronics
mechanics
upgrade simulation

DESY Test Beam

SCT Digitisation

- goal:
  - realistic simulation of detector and electronic response, e.g. charge collection, crosstalk
  - including increased radiation in Run 2
- recent achievements:
  - simplification of existing code
  - more physical effects, e.g. radiation damage, implemented in digitization for Run 2

    → time dependent conditions in simulation
  - study impact of various parameters on tracking performance in digitisation, e.g. noise, **threshold**, gain or crosstalk



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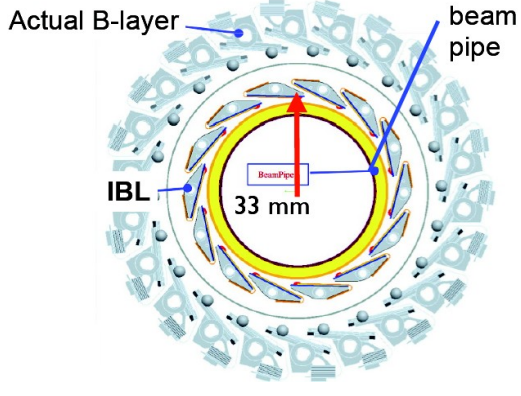
DESY Test Beam

Phase 0 Upgrade – Insertable B Layer

- facts:
  - new pixel layer around smaller, new beam pipe
  - radiation levels: ~5 x 10^{15} neq cm^{-2}
  - 75% planar sensors, 25% 3D sensors



- status:
  - IBL mounted on beampipe:

    all 14 staves assembled at CERN
  - being prepared for installation in May
- ATLAS DESY contributions:
  - detailed test beam study of IBL sensors and modules
  - procurement of the optical fibre for data transmission

picture from H. Pernegger, CERN

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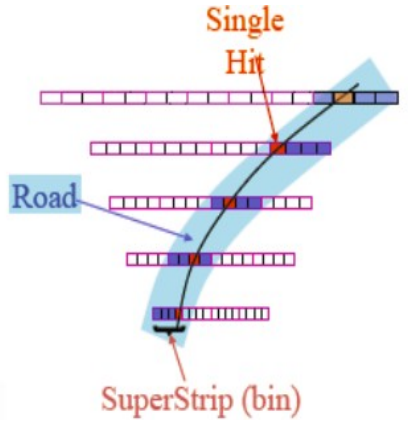
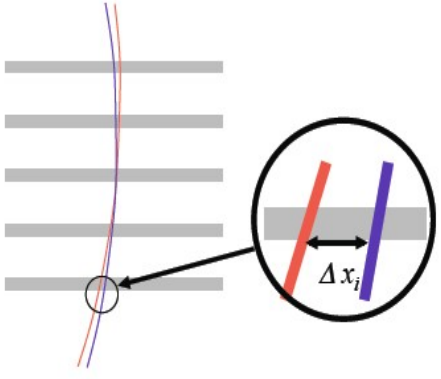
DESY Test Beam

Phase 1 Upgrade – Fast Track Trigger

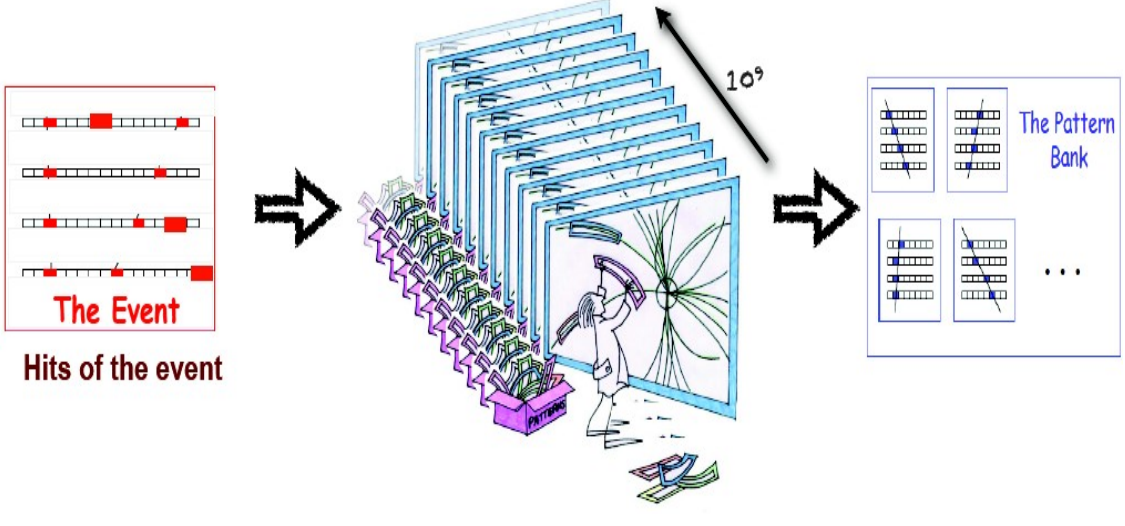
- dedicated hardware-based track finder
  - runs after L-1 trigger on duplicated Si-detector readout links
  - tracking input for full event for L-2 trigger
- finds and fits tracks (25 μs) in ID silicon layers at an "offline" precision



hit pattern matching to pre-stored patterns (coarse)



subsequent linear fitting in FPGAs (precise)



picture from B. Penning, WIT 2012

- recently started activities at DESY now taking shape
  - proper representation of FTK objects in event data model
  - hit pattern generation algorithm for associated memory chip

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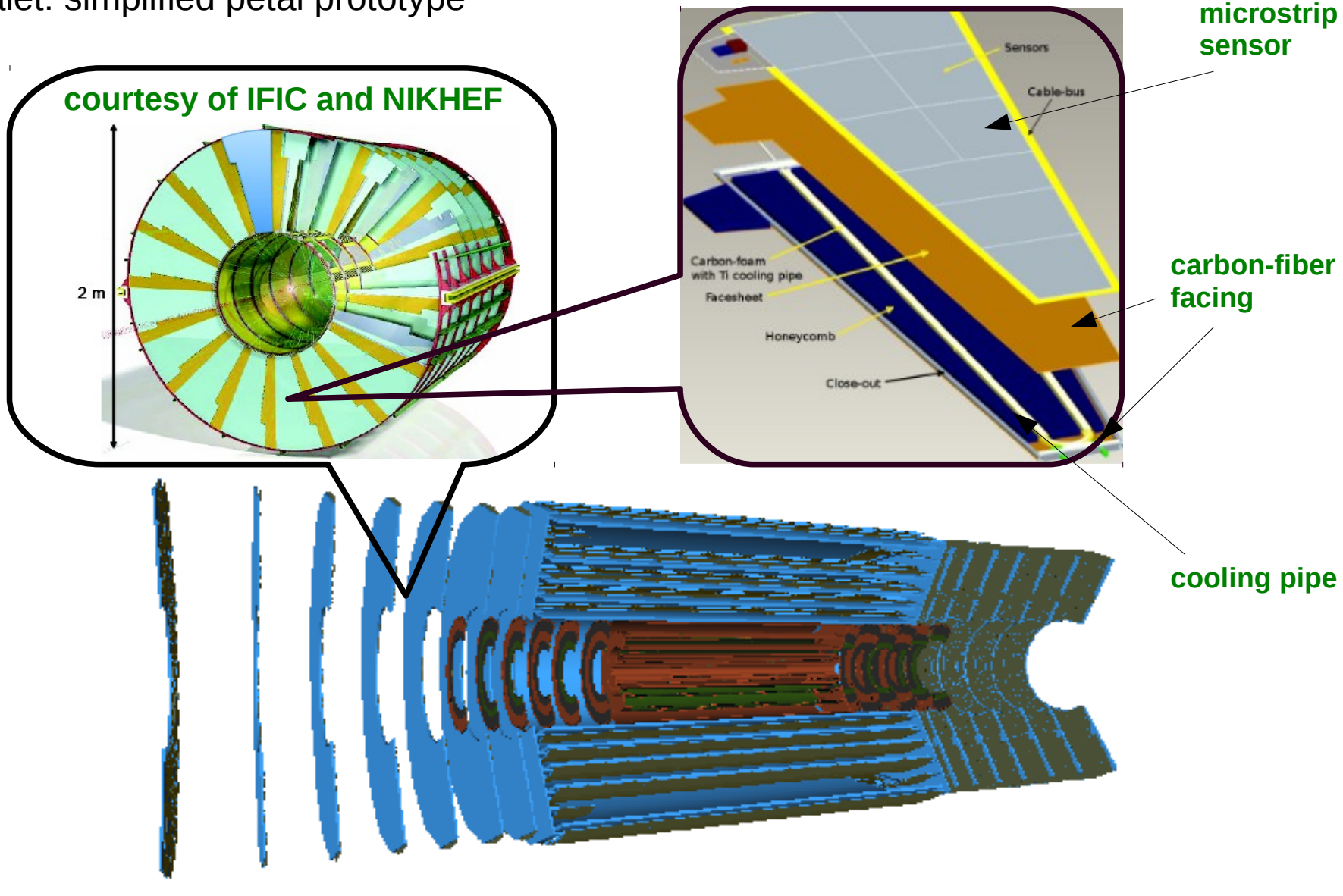
DESY Test Beam

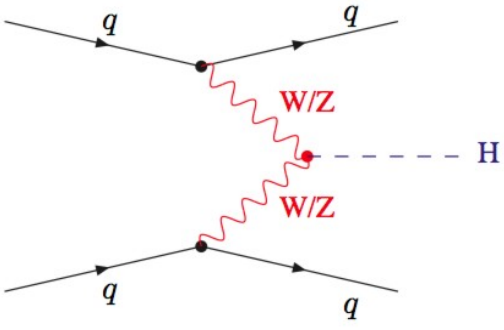
Petals

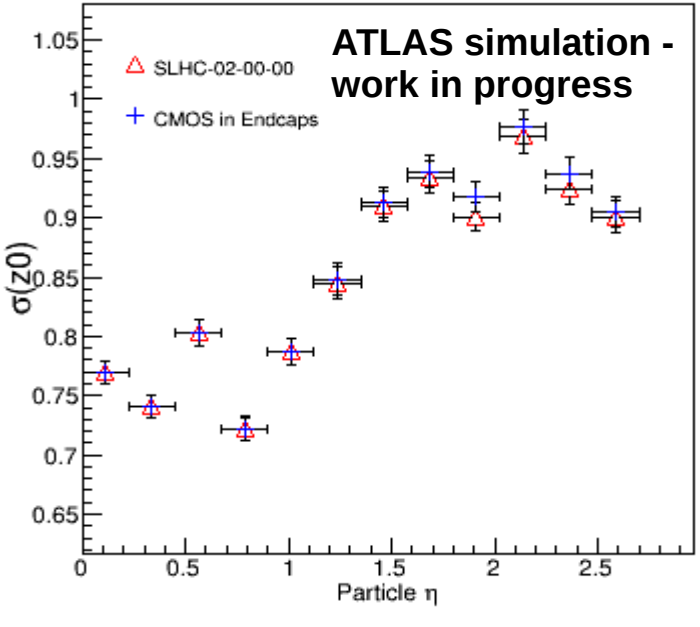
- basic building block of the end-cap discs
- petalet: simplified petal prototype

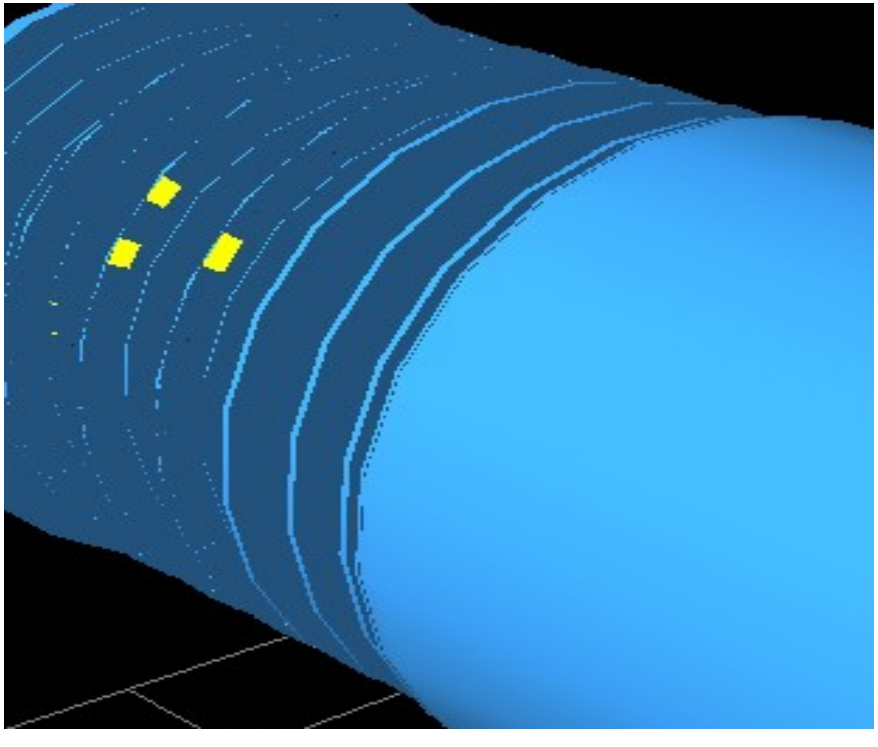


Upgrade Simulation

- continuation of strong efforts in upgrade simulation
  - high η studies up to 4.0
  - implementation of correct geometry of end-cap (petals)
  - alternative geometry with parallel strips
- parallel strips
  - first implementation
  - effect of tracking investigated
  - more studies needed, preliminary results promising

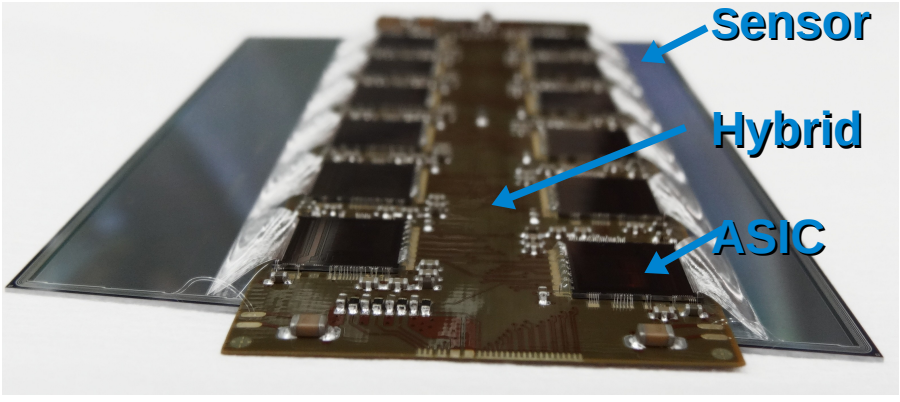




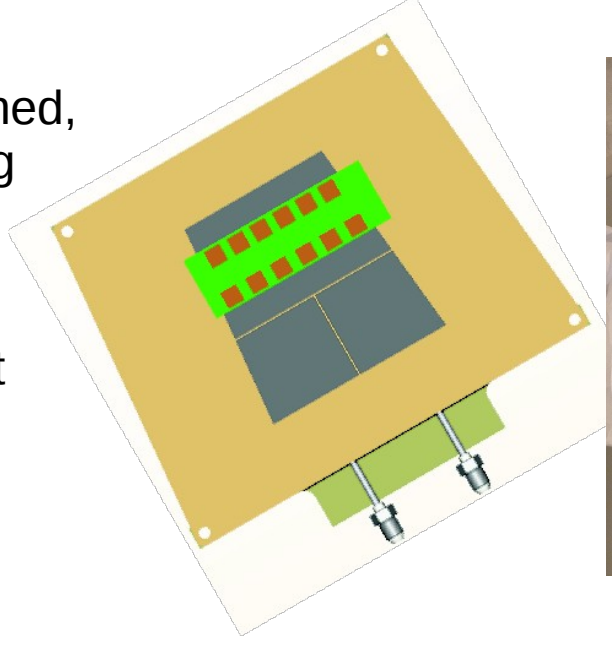


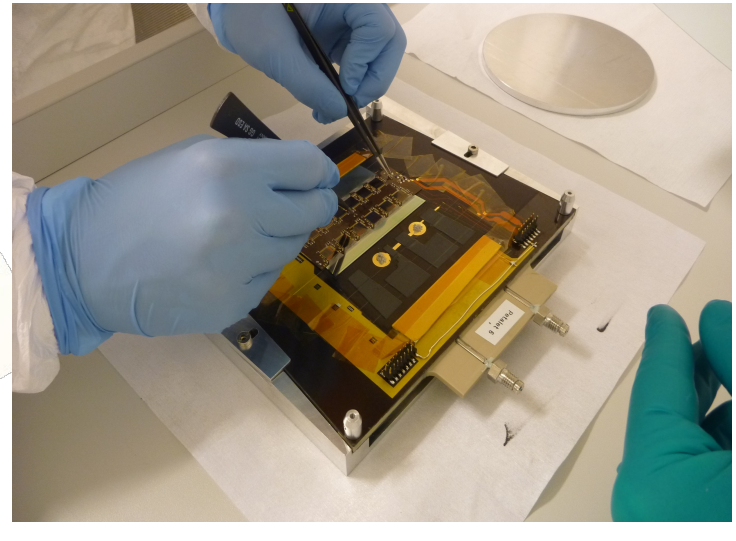
R&D for Tracker Endcap - Petalet

- several petalet modules produced
  - test results show expected performance in threshold and noise
- first petalets assembled at DESY
  - being tested now
- good understanding of assembly process
- electrical routing on petal rather complex because of double-module structure
  - petalet as test bed
  - first modifications planned, e.g. different HV routing
- next step:
  - production of full petal
  - will start with innermost module with 4 hybrids



petalet module (1500 channels)

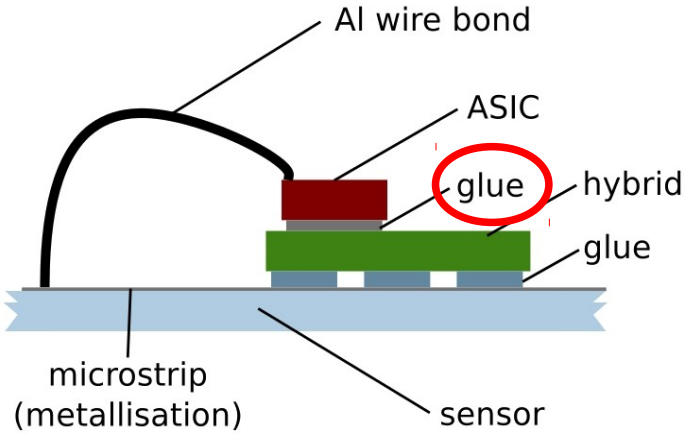


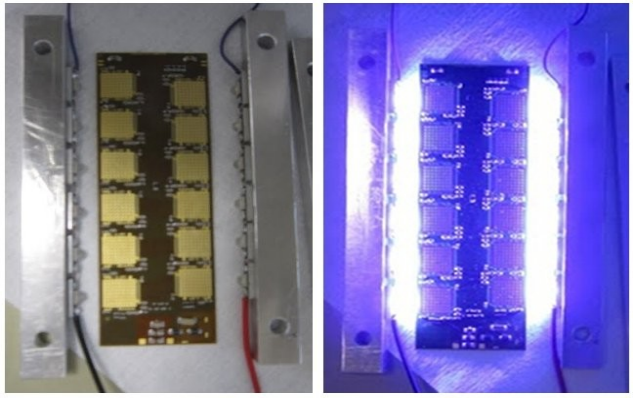


petalet assembly

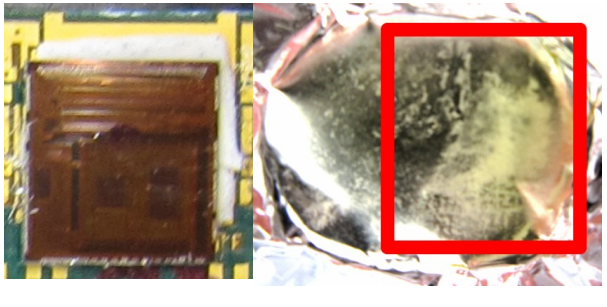
R&D for Tracker Endcap – Adhesive Evaluation

- many connections in tracker glued
- R&D strategy:
  - test currently employed adhesives, e.g. for irradiation, aging
  - explore alternatives
- asic to hybrid alternative: UV curing glues
  - faster curing
  - better radiation length
  - less activation
  - longer shelf-life
- 3 of 7 adhesive candidates fully HL-LHC compliant
- future work:
  - extend studies to petal core adhesives



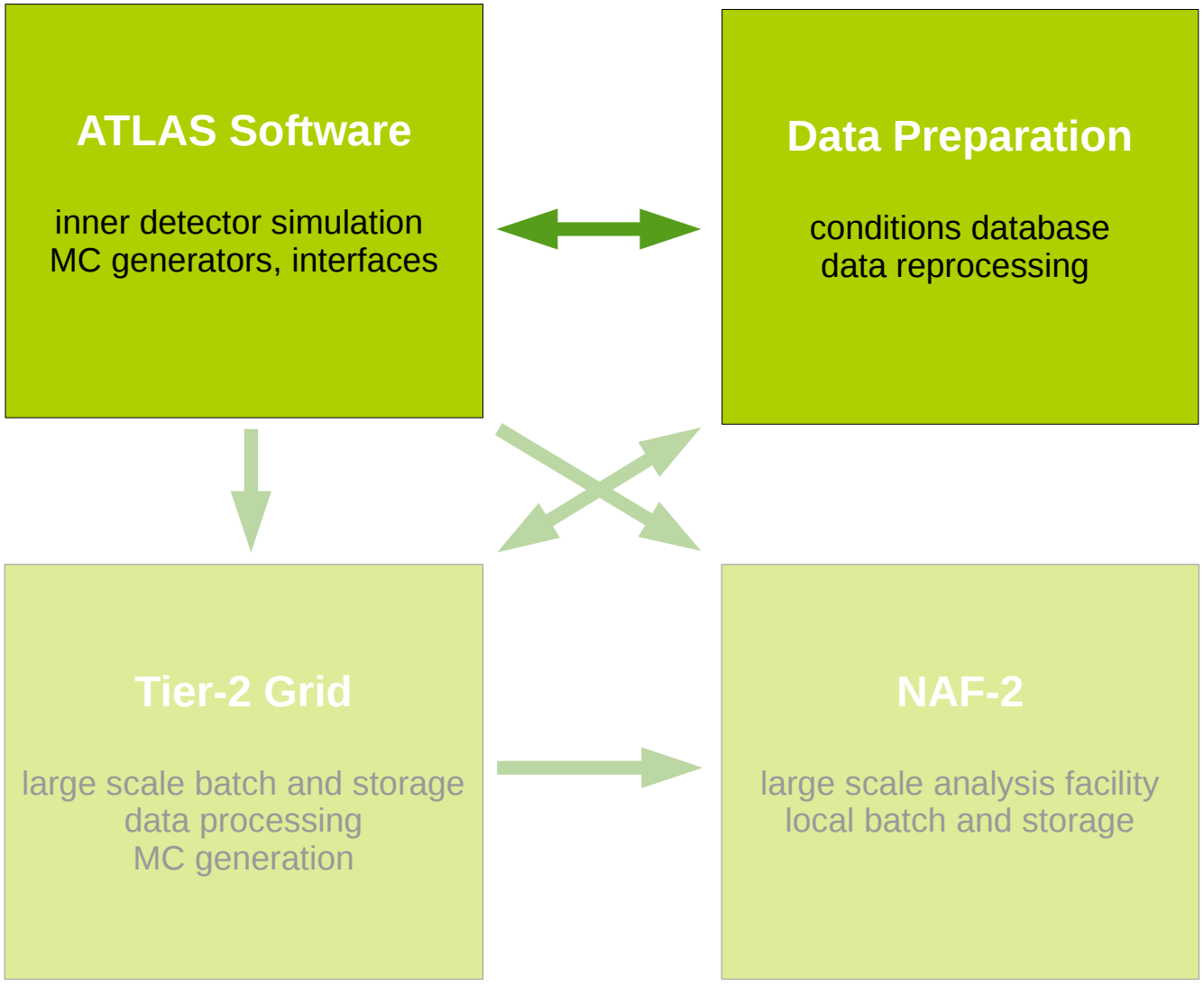


examples of glue test failures:
slid off **alu. corrosion**



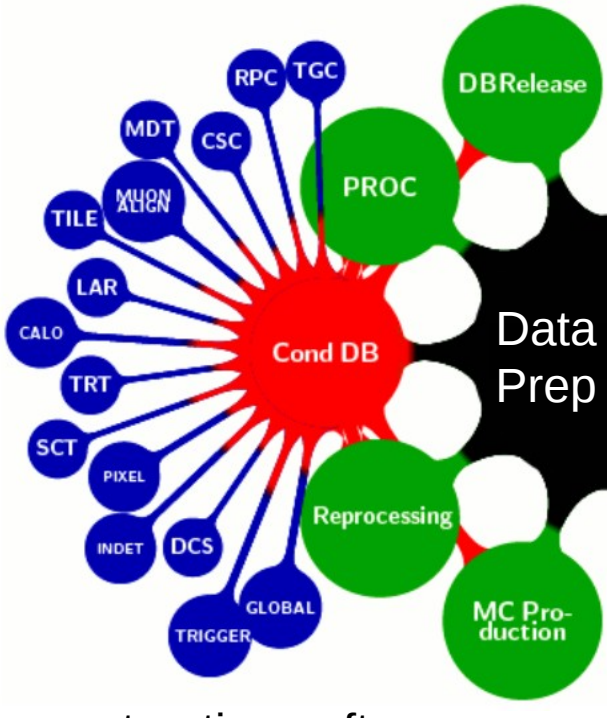
unchanged after irradiation

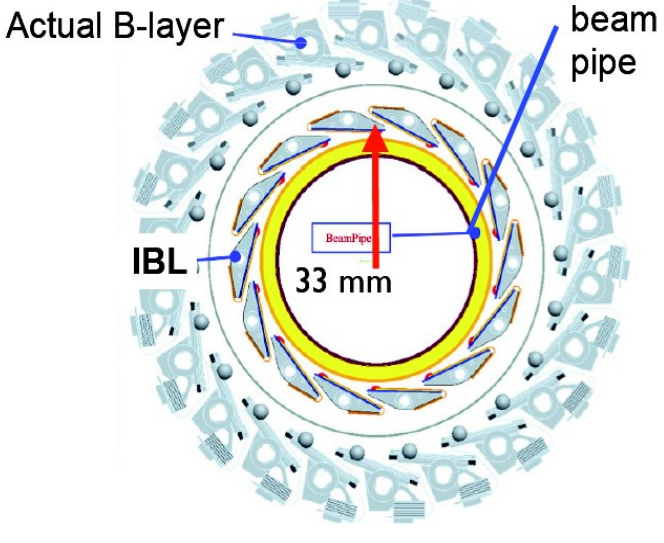
DESY ATLAS – Computing



ATLAS Computing and Software

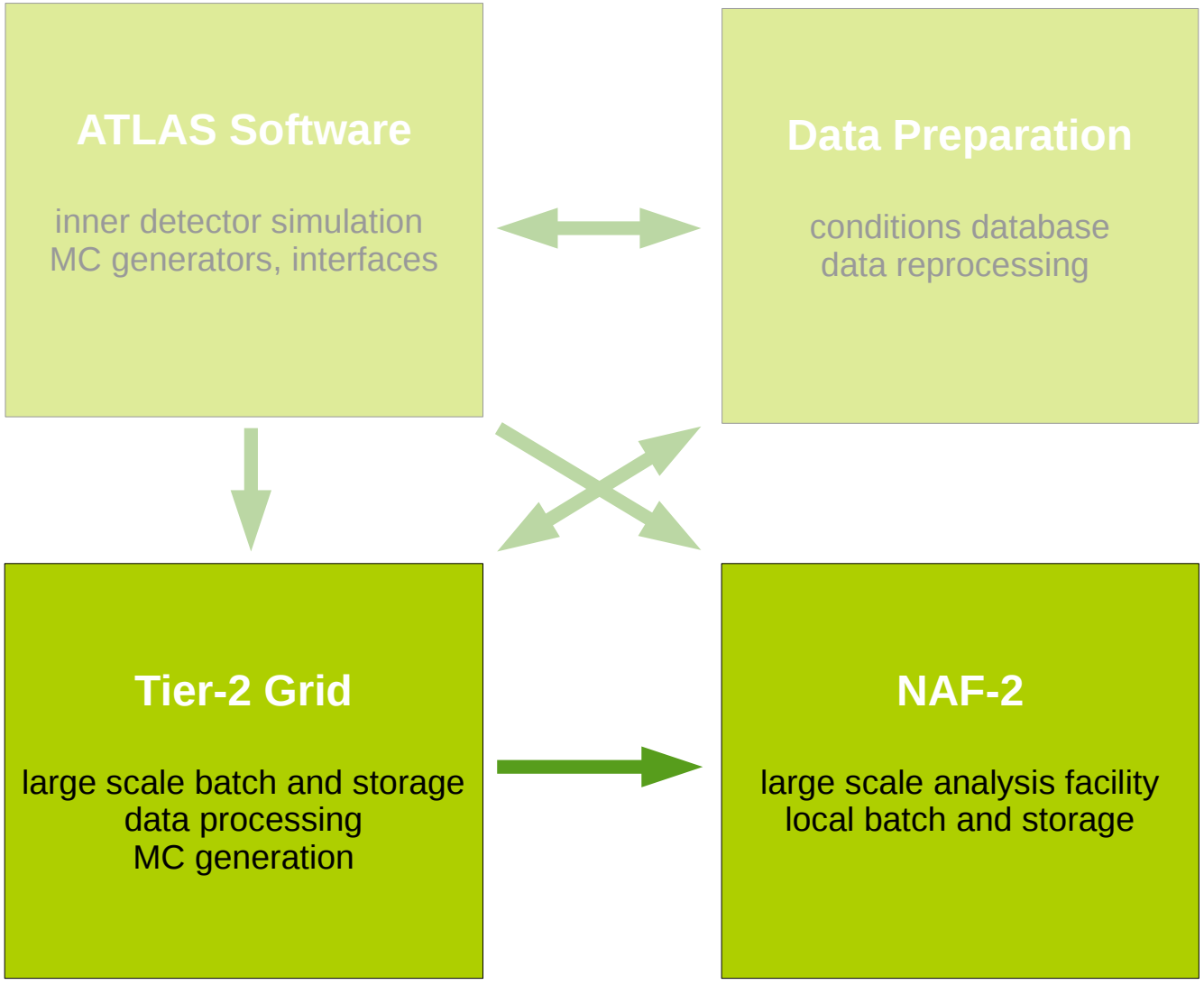
- key contributions in data preparation
  - coordination of reprocessing and conditions database
    - testing of new data production interfaces for reprocessing
    - preparing new conditions DB for Run 2 data taking
  - crucial period for Data Challenge 2014 and Run 2





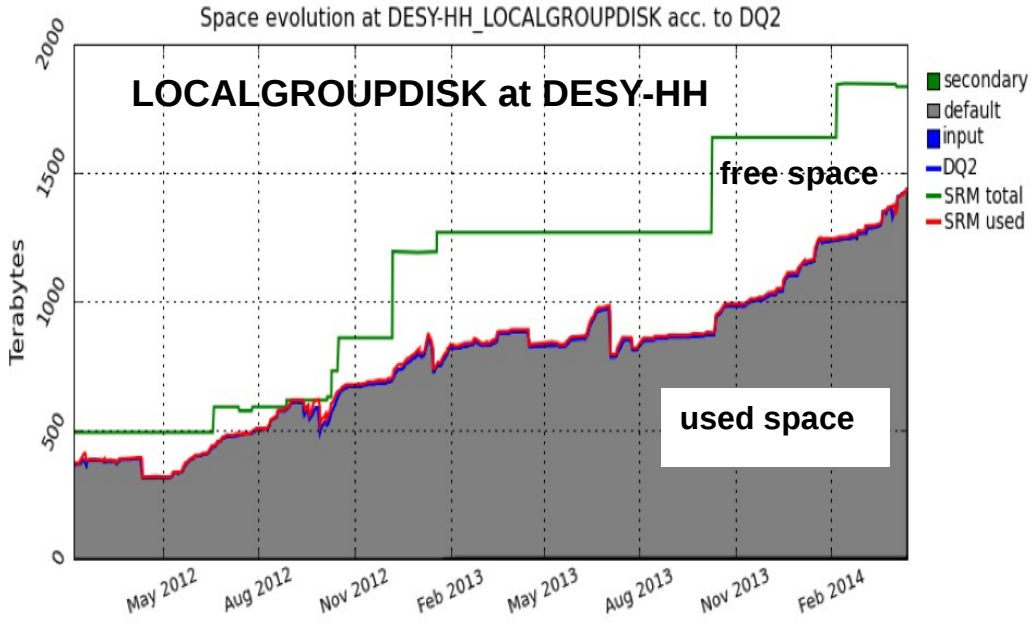
- substantial changes to reconstruction software
  - full support of IBL
  - improved CPU performance to combat increased combinatorics from higher multiplicities
  - new functionality for improved tracking performance under high pile-up
  - reduced event size on disk

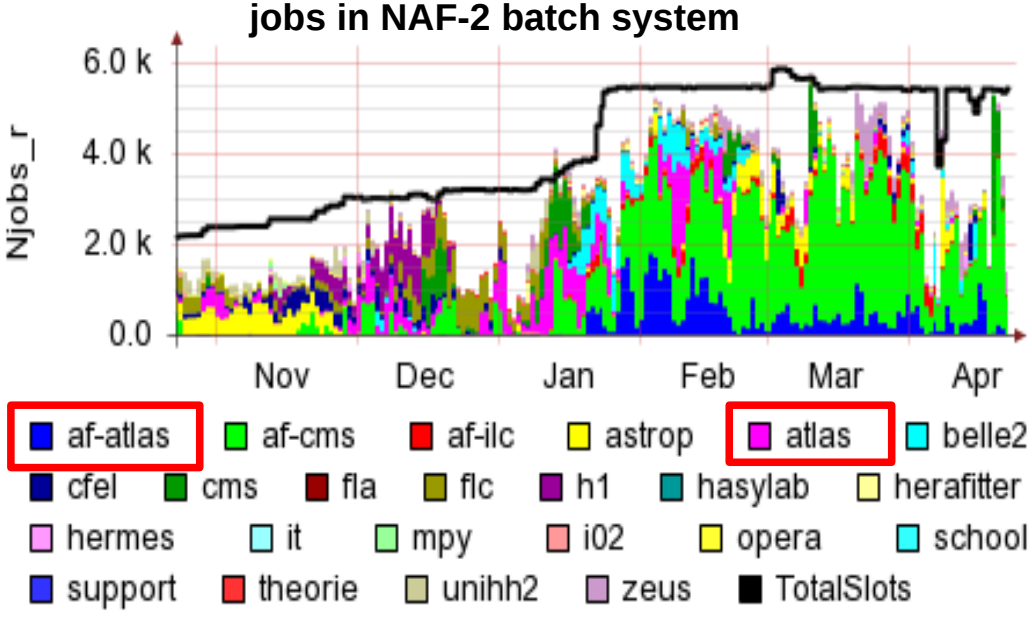
DESY ATLAS – Computing



ATLAS Resources and Storage at DESY

- DESY Tier-2 crucial grid resource to ATLAS collaboration
  - pledges delivered well in advance
  - LOCALGROUPDISK storage in HH approaching 2PB
  - DESY-HH, DESY-ZN two of the most reliable sites in the German cloud





- users migration to NAF-2 recently completed
  - NAF-2 for ATLAS at DESY-HH only
  - increases in batch system resources and Sonas storage in NAF-2 namespace
  - final shutdown of NAF-1 in June

Recent Publications - Papers

peer reviewed journal publications:

- Measurement of dijet cross sections in pp collisions at 7 TeV centre-of-mass energy using the ATLAS detector, sub. to JHEP
- Measurement of the low-mass Drell-Yan differential cross section at √s = 7 TeV using the ATLAS detector, sub. to JHEP
- Measurement of the production of a W boson in association with a charm quark in pp collisions at √s = 7 TeV with the ATLAS detector, sub. to JHEP
- Search for Higgs boson decays to a photon and a Z boson in pp collisions at √s = 7 and 8 TeV with the ATLAS detector, Phys. Lett. B 732C (2014)
- Search for direct production of charginos, neutralinos and sleptons in final states with two leptons and missing transverse momentum in pp collisions at √s = 8 TeV with the ATLAS detector, acc. by JHEP
- A double-sided, shield-less stave prototype for the ATLAS Upgrade strip tracker for the High Luminosity LHC, JINST 9 (2014) P03012

⇒ 6 new papers with significant DESY contributions since last PRC !

Recent Publications - Notes

conference and public notes:

- Example ATLAS tunes of Pythia8, Pythia6 and Powheg to an observable sensitive to Z boson transverse momentum, ATL-PHYS-PUB-2013-017
- A study of the sensitivity to the proton parton distributions of the inclusive photon production cross section in pp collisions at 7 TeV measured by the ATLAS experiment at the LHC, ATL-PHYS-PUB-2013-018
- Comparison of the response of the ATLAS detector to electromagnetic processes in data at 8 TeV and simulation using different G4 setups, ATL-PHYS-PUB-2014-003

⇒ 3 new public notes with significant DESY contributions since last PRC !

Summary

- DESY plays a key role within the ATLAS experiment
- strong contributions to all analysis fields from SM measurements to searches for new physics
  - supported by large expertise in object IDs and MC modeling
- important contributions to the ATLAS detector and computing
  - SCT operation and digitisation
  - database and software management
- involved into all phases of upgrade
  - special focus on HL-LHC upgrade