Forward Physics with the ATLAS Detector

Results, Prospects and Polish Contribution

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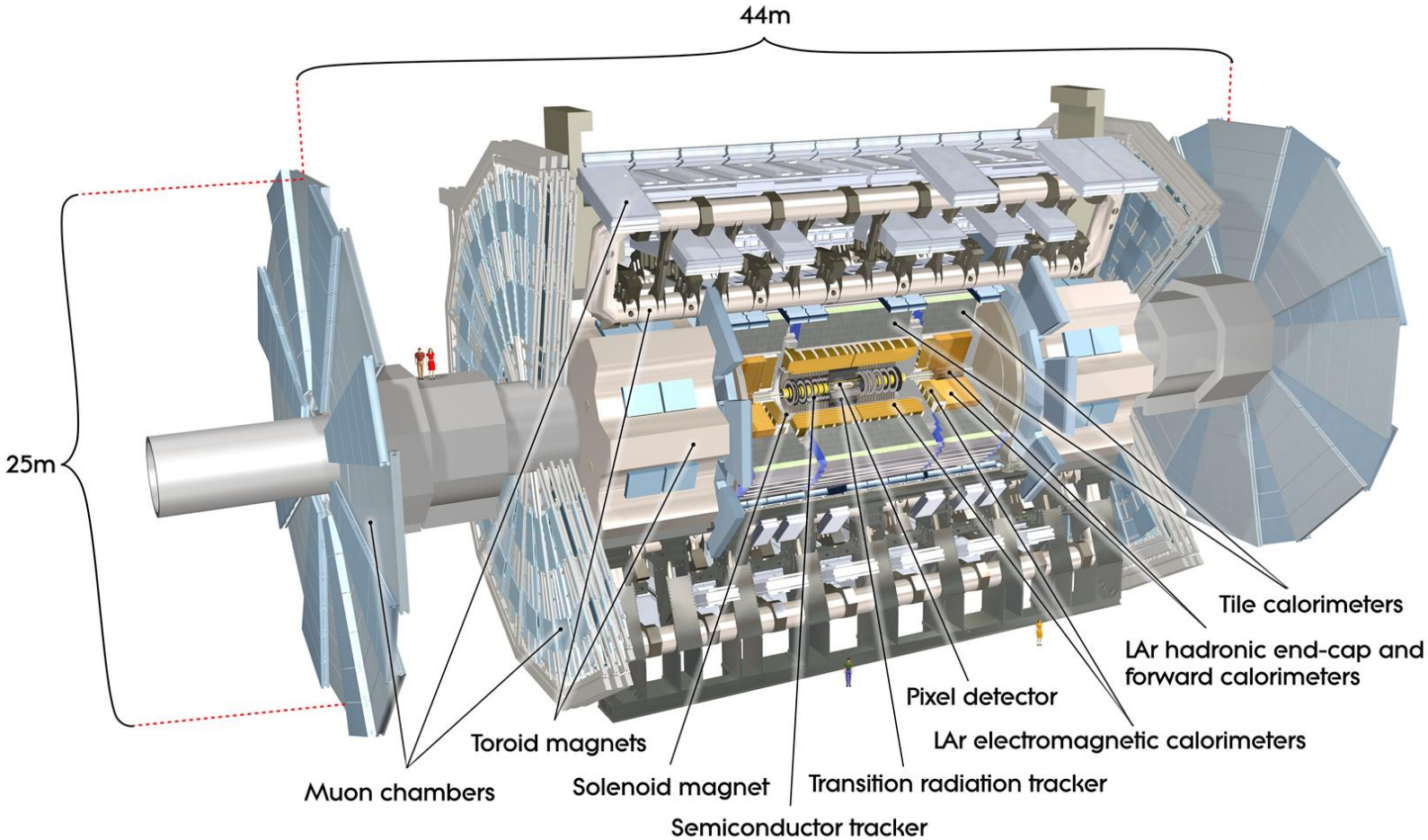
"Collider Physics" 2nd Symposium of the Division for Physics of Fundamental Interactions of the Polish Physical Society

13 – 15 May 2016, Katowice

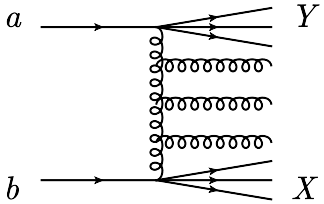
Introduction



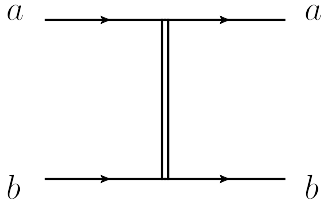
...but also forward detectors providing measurements of forward intact protons: **ALFA** and **AFP**

Measurements with rapidity gaps

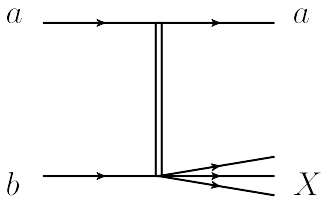
non-diffractive interaction



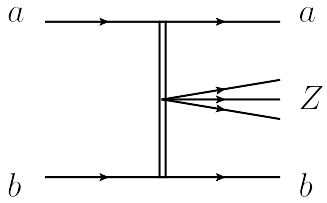
elastic scattering



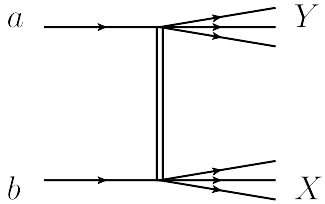
single diffraction

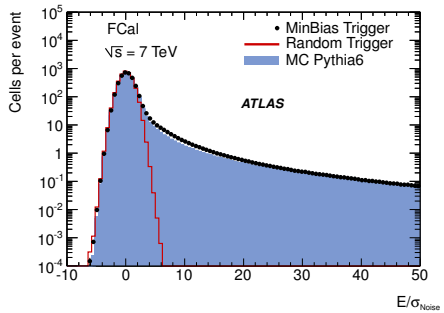


central diffraction

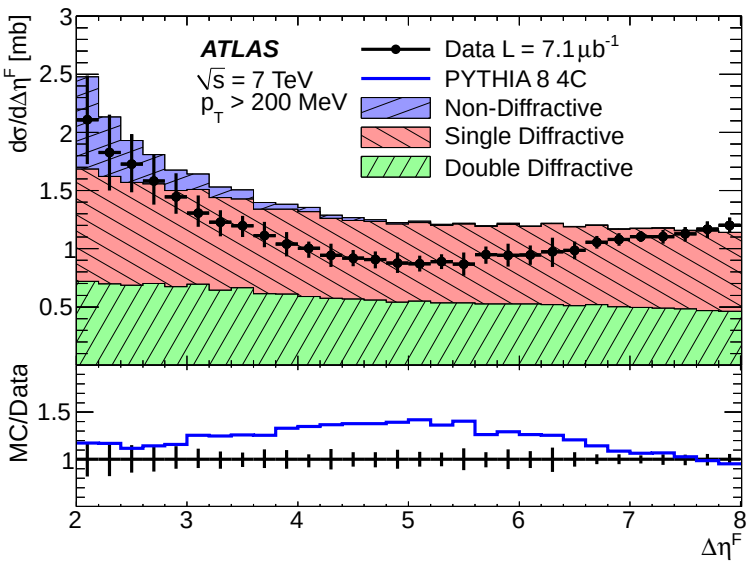


double diffraction



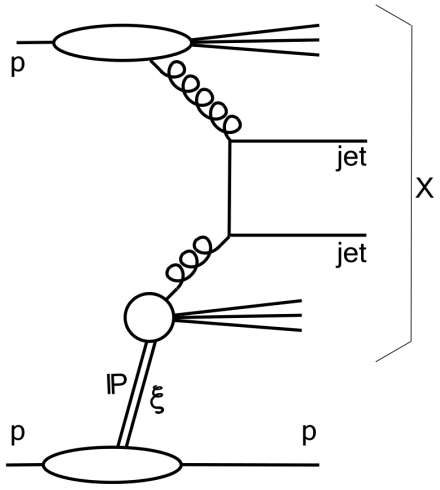


- Calorimeter used to measure rapidity gaps
- Eur. Phys. J. C72 (2012) 1926



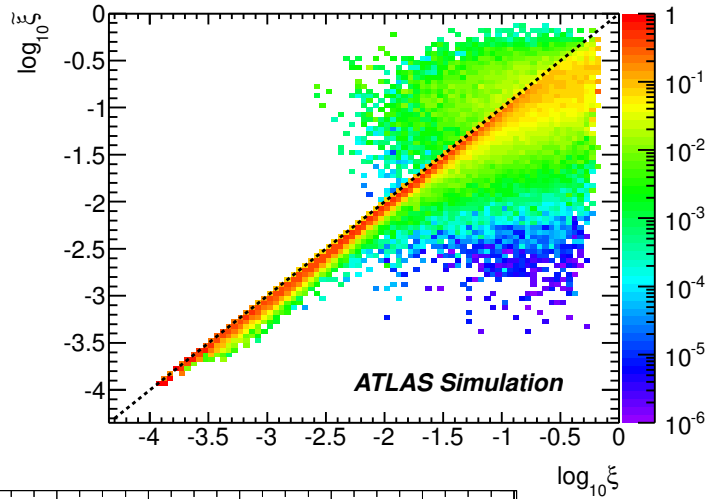
- Separation of diffractive processes from non-diffractive processes
- Full separation of single and double diffraction not possible

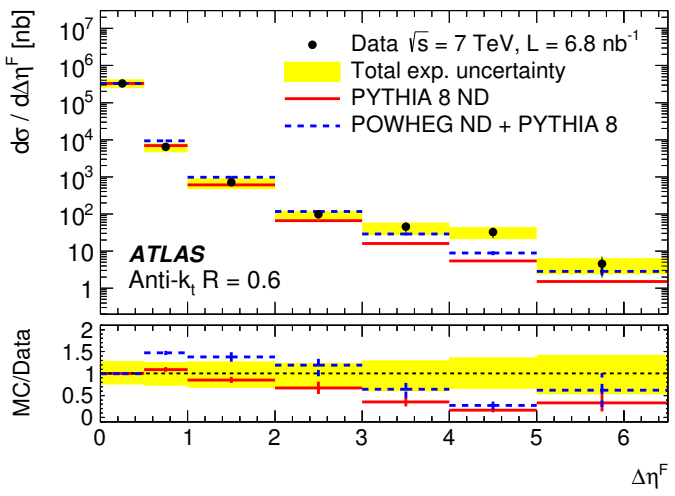
Measurements with rapidity gaps – diffractive jets

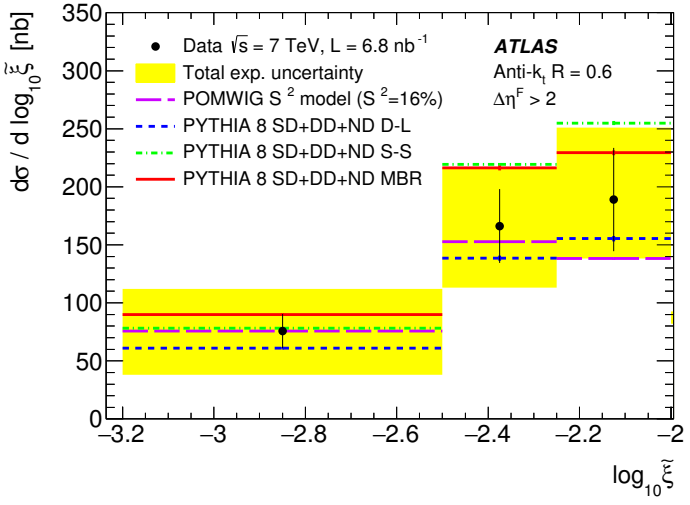


$$\xi = M_X^2/s$$

$$\tilde{\xi} = \frac{\sum p_T e^{\pm\eta}}{\sqrt{s}}$$

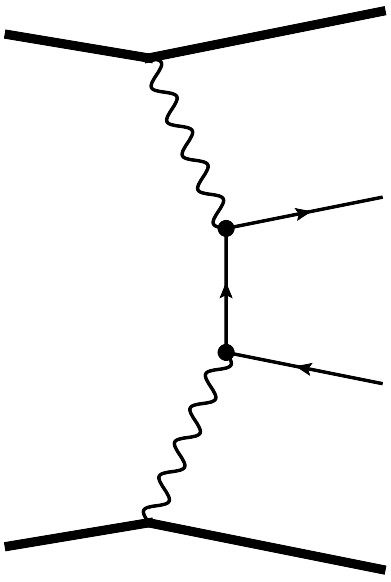


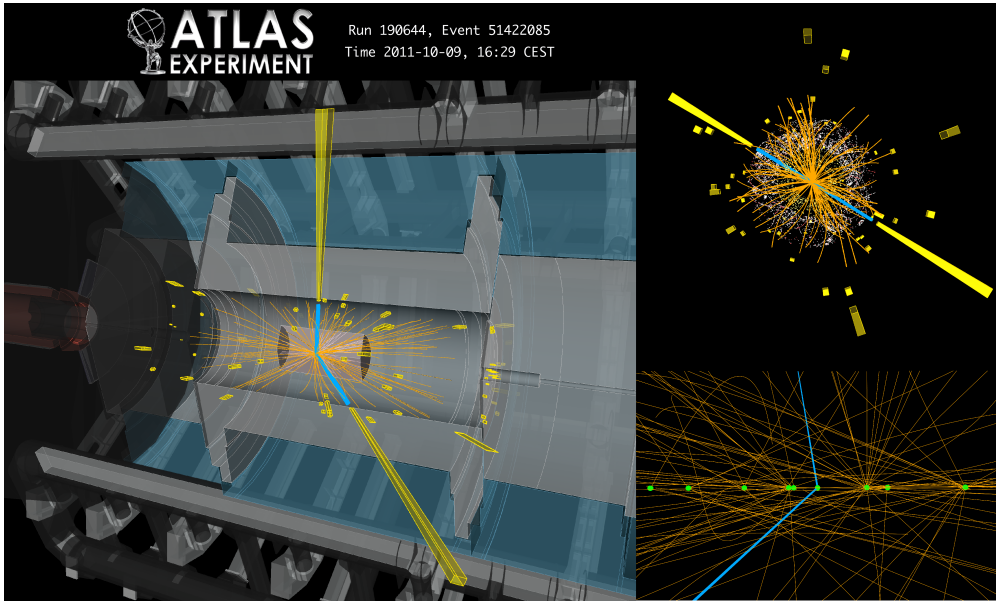


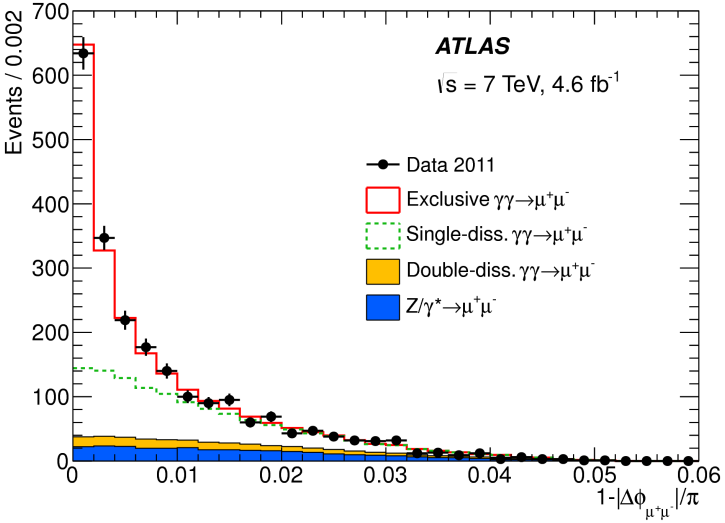


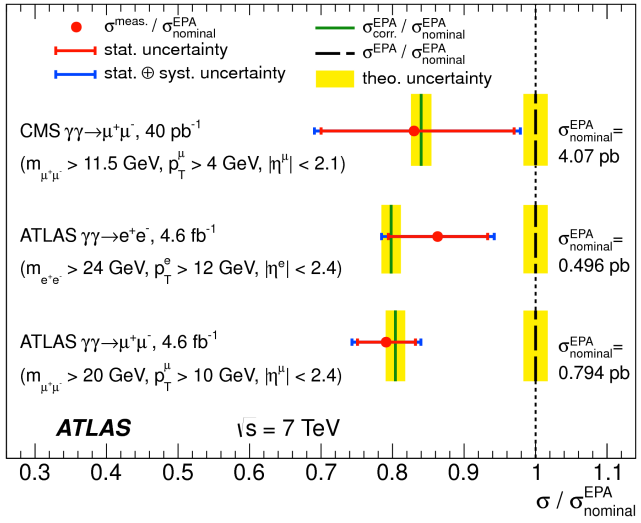
- Gap survival probability: 0.16 ± 0.04 (stat) ± 0.08 (exp. syst.)
- Phys.Lett. B754 (2016) 214-234

Exclusive dilepton production



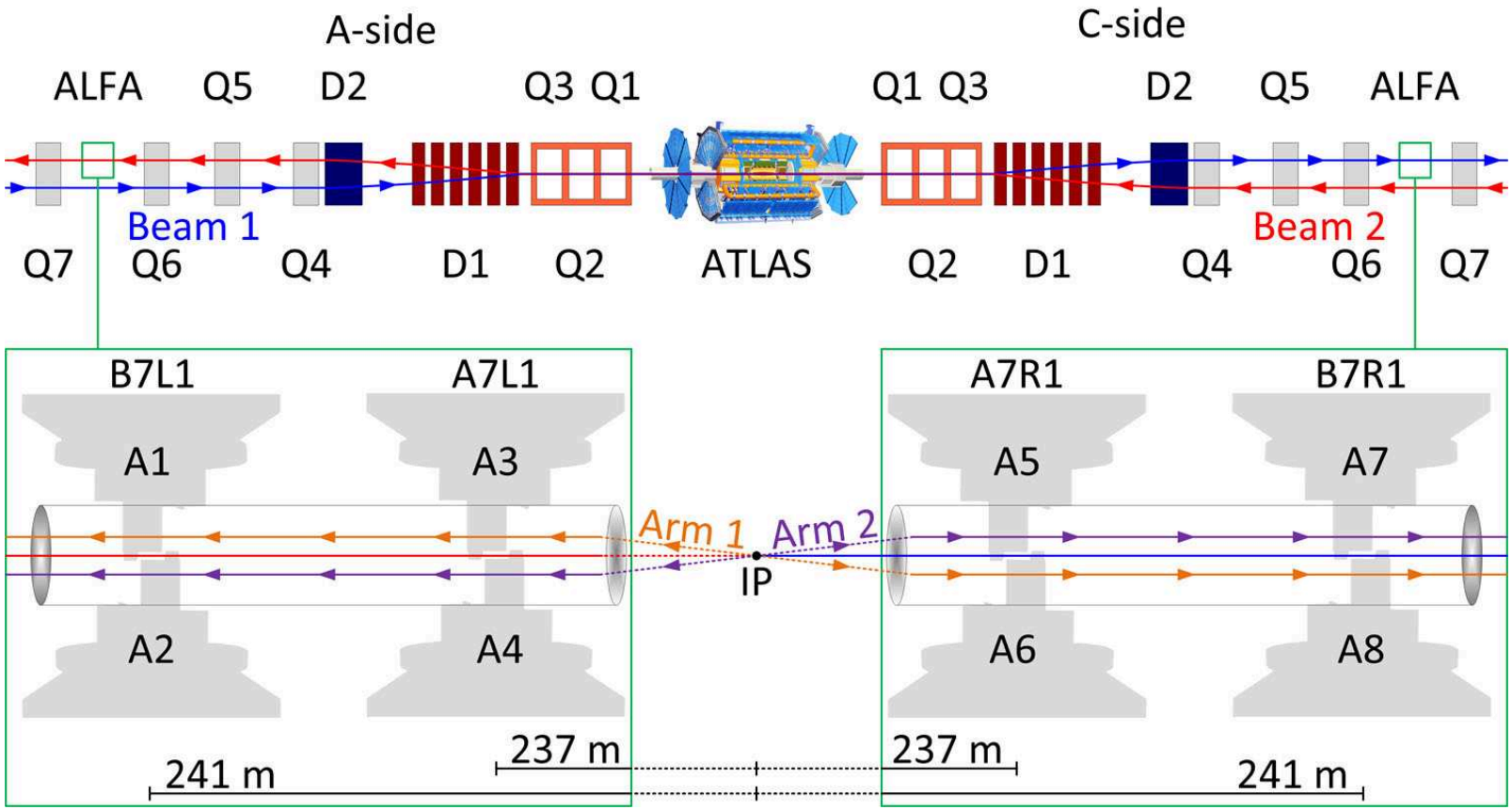






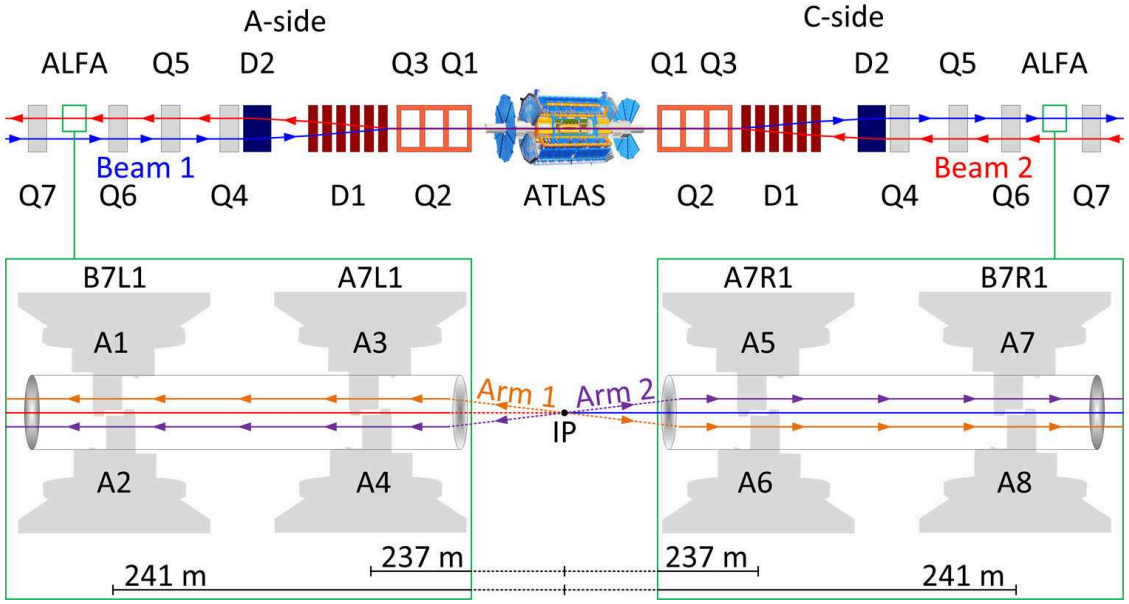
Phys.Lett. B749 (2015) 242-261; M. Dyndał, M. Przybycień (AGH)

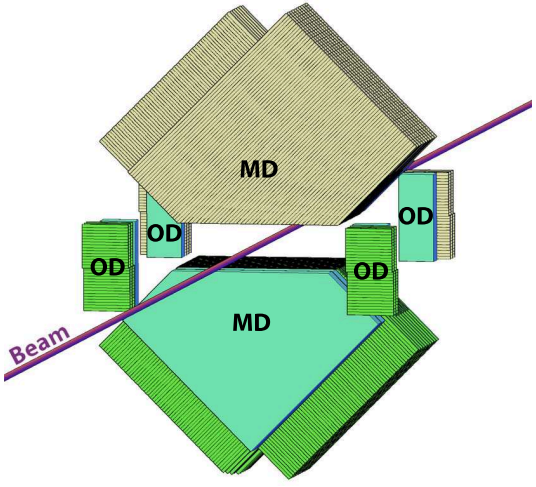
ALFA (Absolute Luminosity For ATLAS) detectors

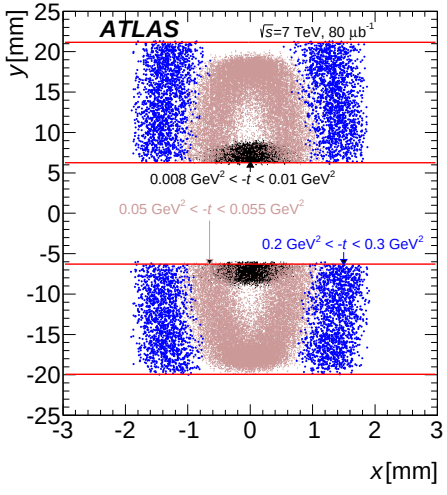


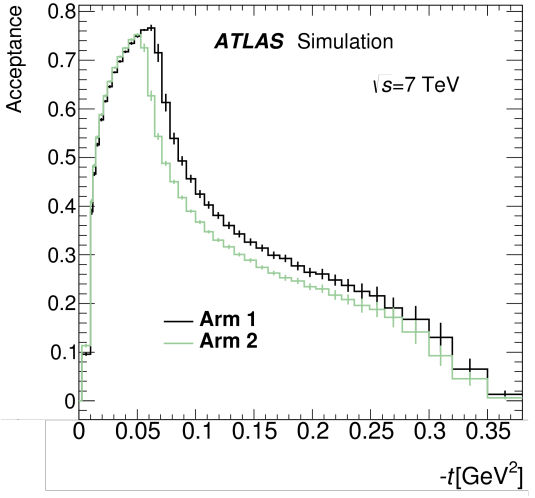
K. Korcyl (IFJ): trigger and data acquisition
B. Żabiński (IFJ): detector control system
G. Gach (AGH): data preparation
M. Trzebiński, R.S. (IFJ): LHC optics, alignment

Elastic events in ALFA

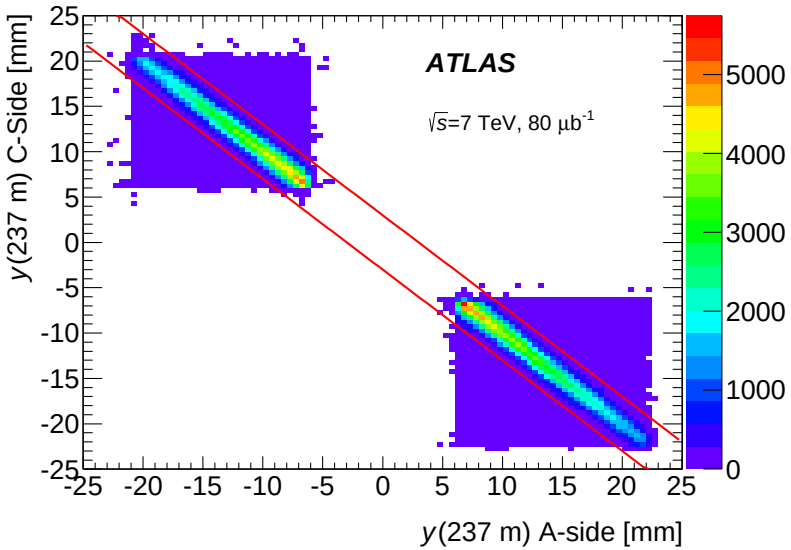


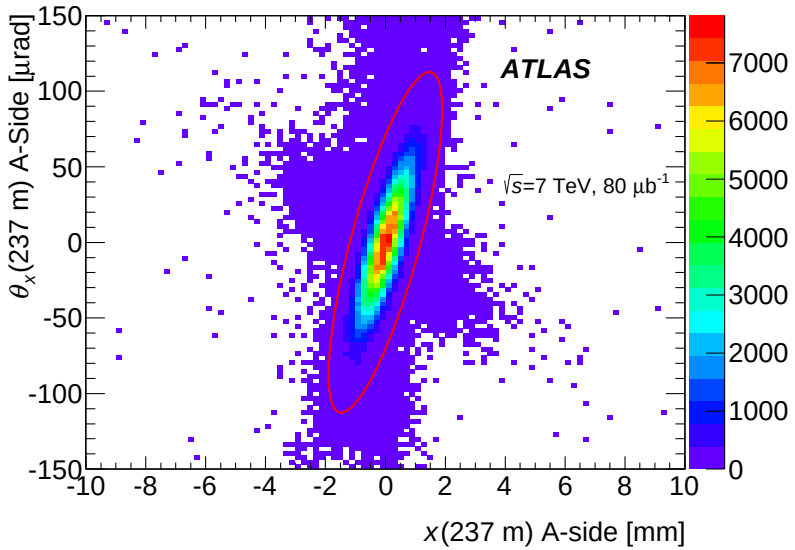


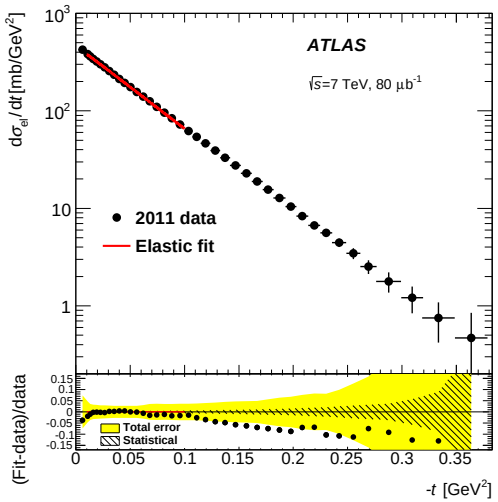


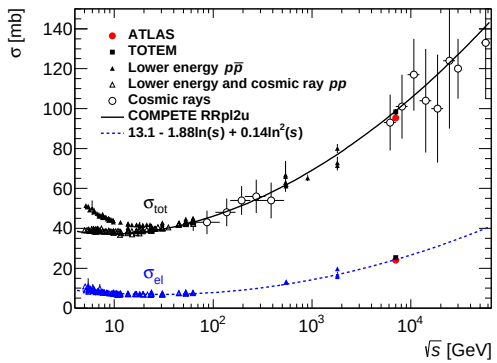


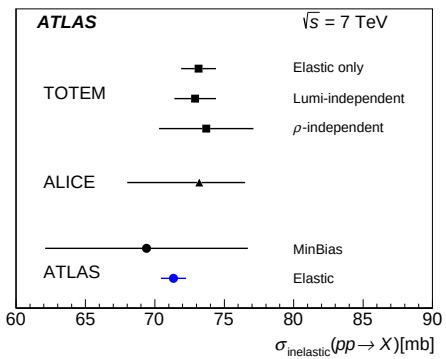
Total cross section measurements





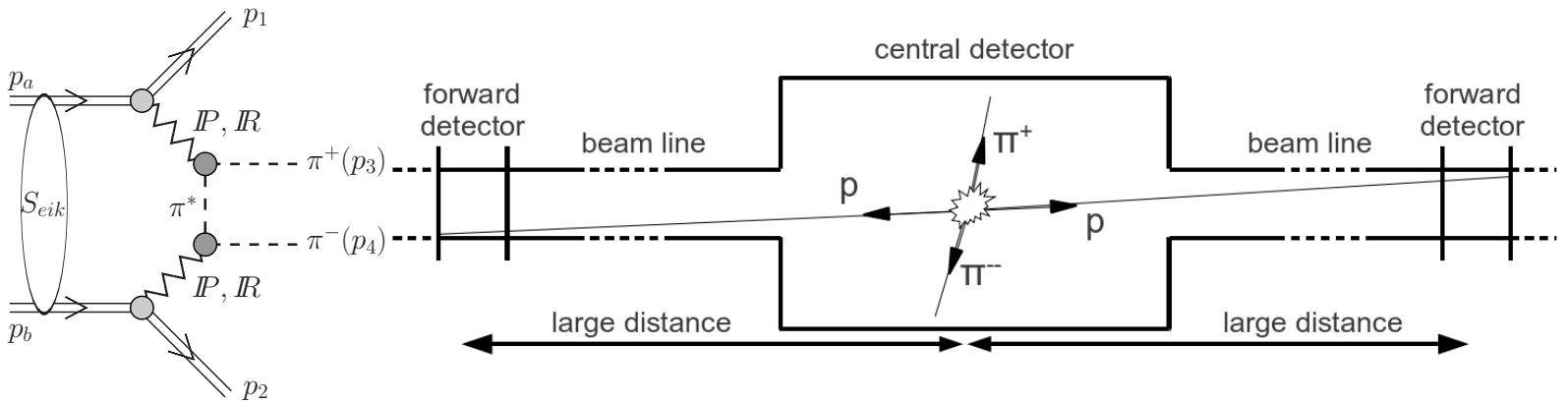


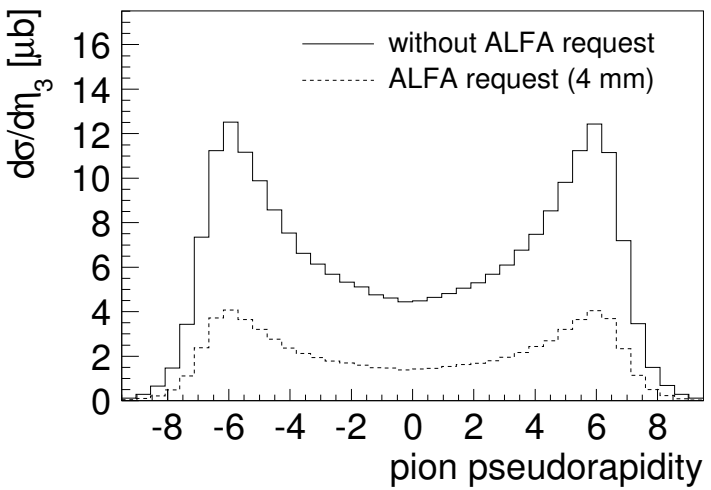


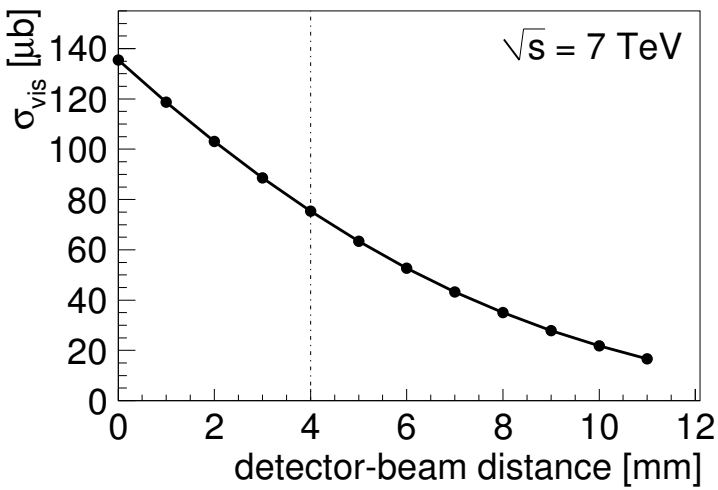


- Nucl.Phys. B889 (2014) 486-548

Diffraction with ALFA

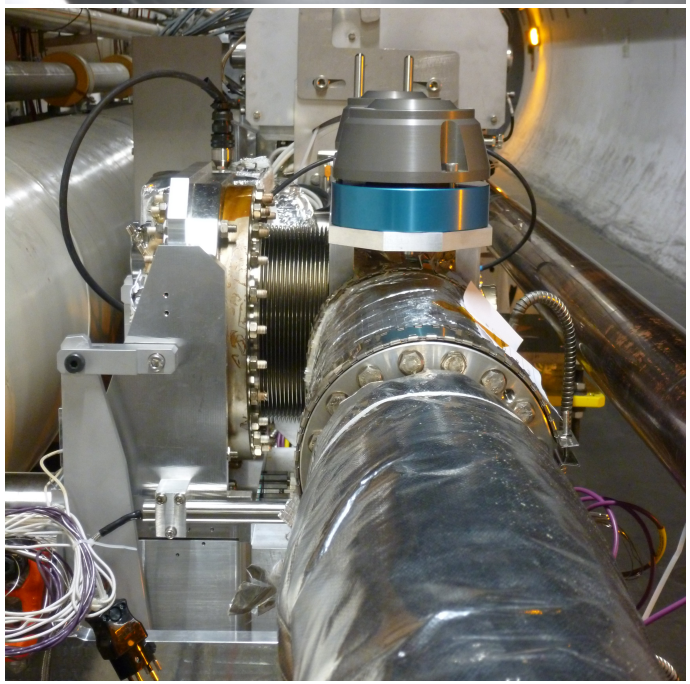


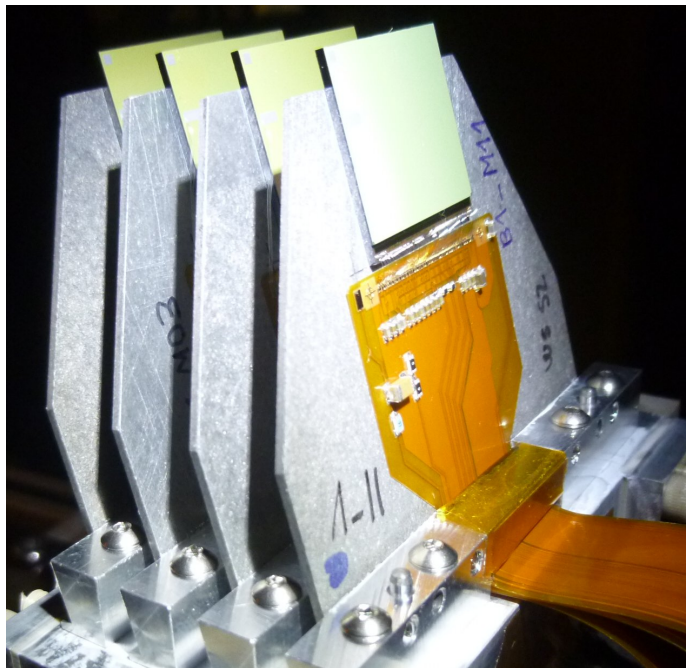




Proposal by P. Lebiedowicz, M. Trzebiński, J. Chwastowski, A. Szczurek, R.S. (IFJ PAN)
(Acta Phys.Polon. B42 (2011) 1861-1870)
Measurement efforts lead by L. Adamczyk (AGH)

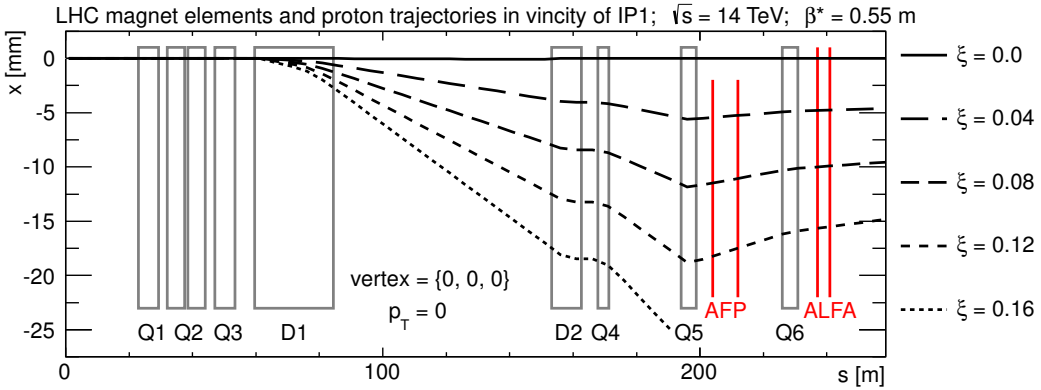
ATLAS Forward Proton (AFP) Detectors

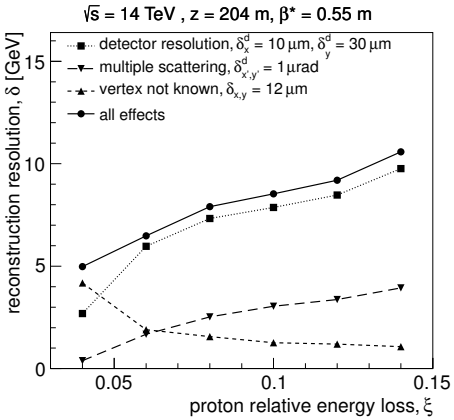


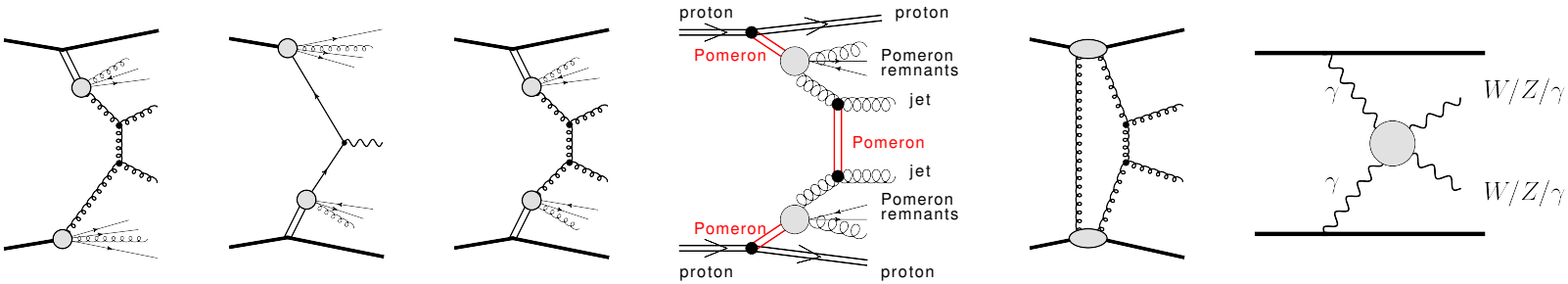


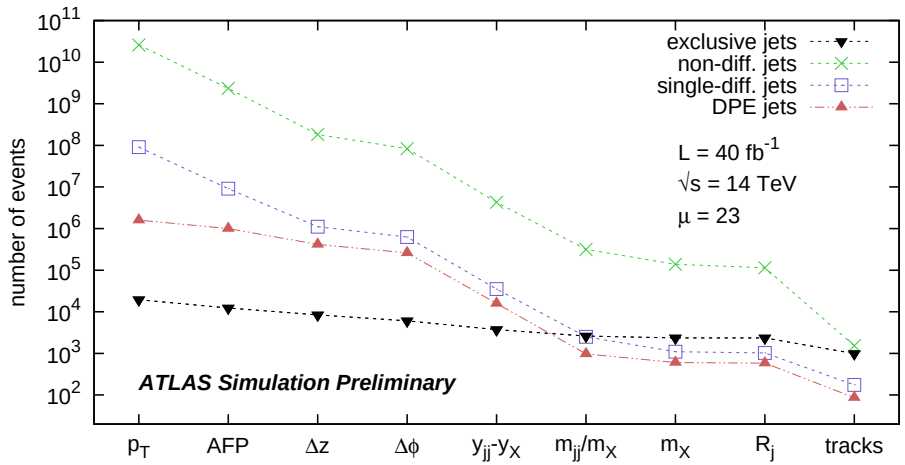
- Complementary to ALFA
- Horizontal approach
- Radiation hard
- Tracker + ToF
- Standard LHC optics
- Can measure rare processes

Design: feasibility studies, detector performance





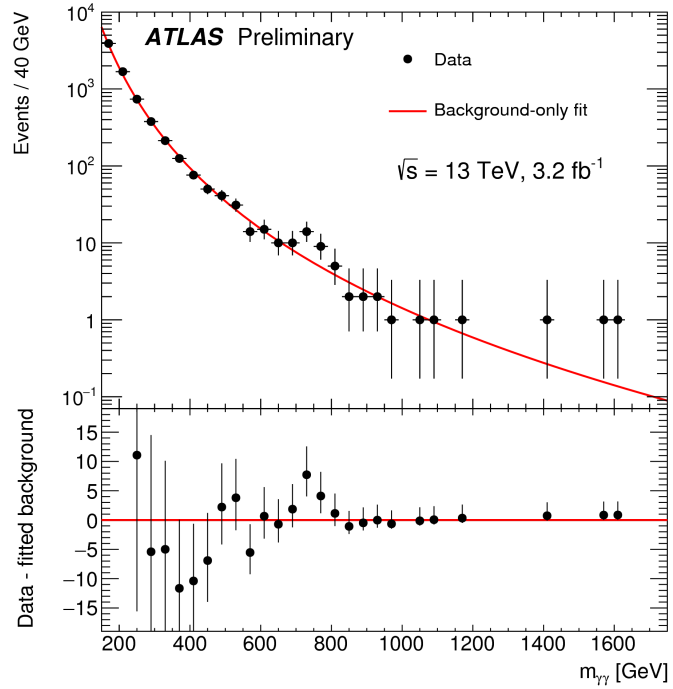


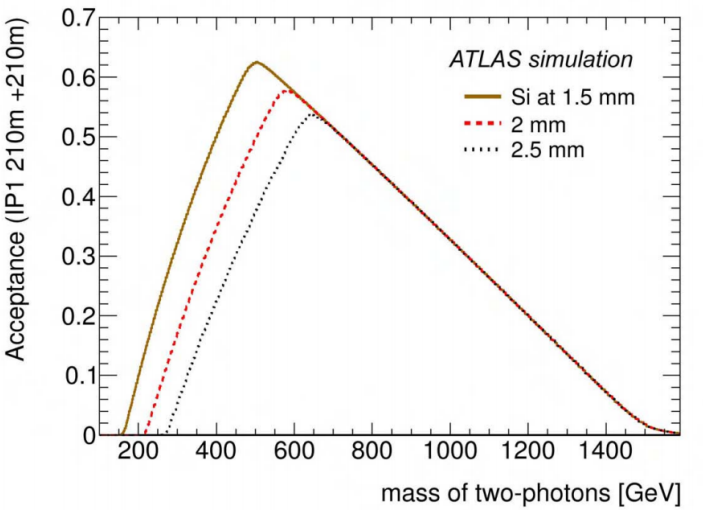


LHC optics, detector simulation, event reconstruction, alignment, physics programme

L. Adamczyk, J. Chwastowski, M. Dyndał, M. Trzebiński, R.S.

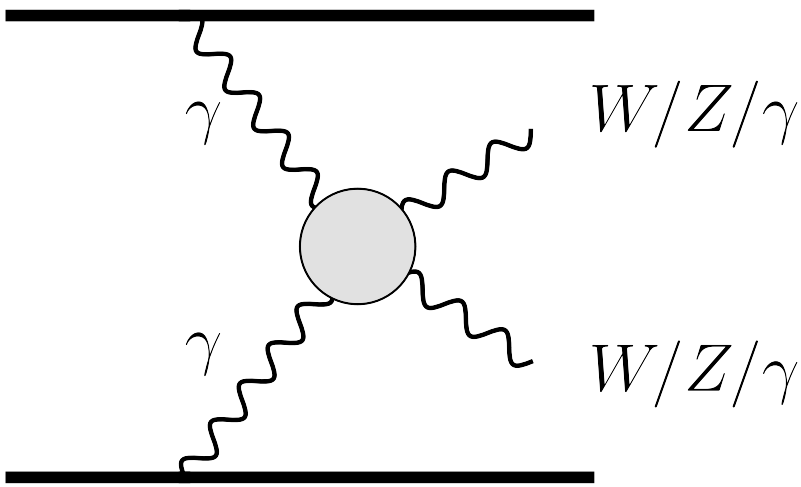
AFP and di-photon resonance at 750 GeV





- ATLAS and CMS observed an excess around 750 GeV in $\gamma\gamma$ events
- Decay to $\gamma\gamma$ means that exclusive two-photon production mechanism is possible:

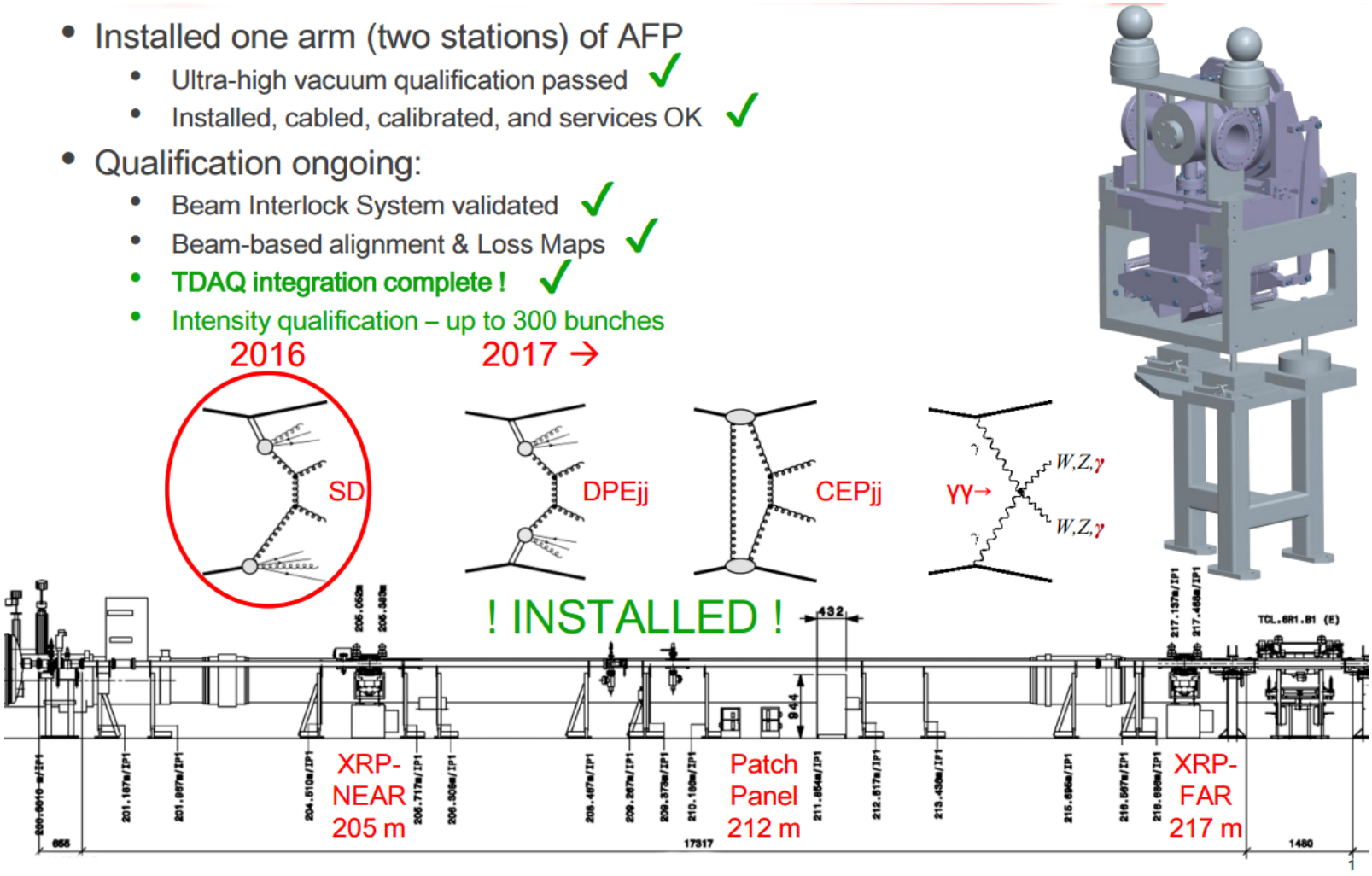
$$pp \to p + \gamma\gamma + p \to p + R + p \to p + \gamma\gamma + p$$



- Within AFP2+2 acceptance!

AFP commissioning

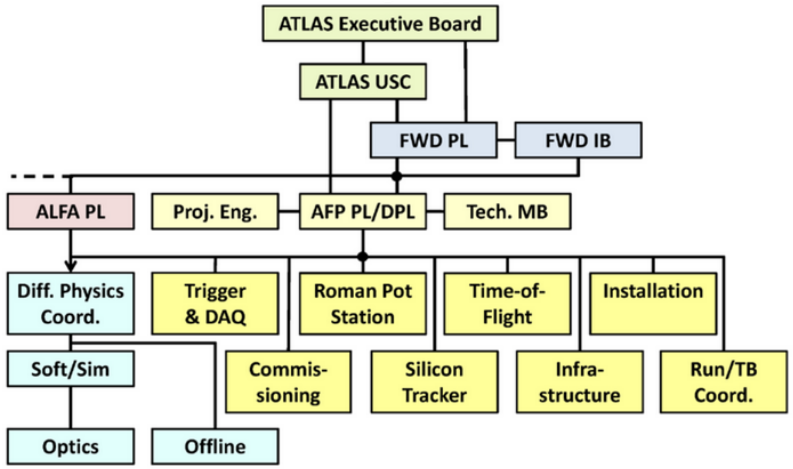
- Installed one arm (two stations) of AFP
  - Ultra-high vacuum qualification passed ✓
  - Installed, cabled, calibrated, and services OK ✓
- Qualification ongoing:
  - Beam Interlock System validated ✓
  - Beam-based alignment & Loss Maps ✓
  - **TDAQ integration complete !** ✓
  - Intensity qualification – up to 300 bunches



All this would not be possible without the support of NCN (2012/05/B/ST2/02480) and MNiSW (1285/MOB/IV/2015/0)

Involvement of Cracow groups in AFP

DCS
E. Banaś, S. Czekierda, Z. Hajduk, J. Olszowska
TDAQ
K. Korcyl, B. Żabiński
Commissioning, calibration
M. Trzebiński
Alignment
P. Buglewicz, J. Chwastowski, R.S.
Optics
M. Trzebiński, K. Cieśla
Beam tests
L. Adamczyk, S. Czekierda, M. Dyndał, M. Trzebiński, P. Buglewicz, K. Cieśla, P. Świerska, K. Janas, R.S.
Simulation
L. Adamczyk, M. Dyndał
Trigger
G. Gach, M. Trzebiński
Data preparation
G. Gach



The sub-projects are indicated by the boxes below the AFP Project Leader (PL).

AFP Tasks	Responsible	Deputy
Project Leader	M. Rijssenbeek	J. Pinfold
Project Engineer	C. Ng	
Physics	R. Staszewski	
Simulations	M. Dyndal, L. Adamczyk (alternating 6 mos.)	
Optics	M. Trzebinski	
Offline software	T. Sykora	
Roman Pot	C. Ng	M. Rijssenbeek
Roman Pot Station	M. Rijssenbeek	C. Ng
Infrastructure	P. Sicho	
Silicon Tracker	S. Grinstein	
Time of Flight Detector	T. Sykora	L. Nozka
Trigger & Data Acquisition	K. Korcyl	
DCS	E. Banas	
Run Coordination & Test Beams	J. Lange	
Installation	P. Sicho	M. Rijssenbeek
Commissioning	M. Trzebinski	M. Rijssenbeek

Summary

- Diverse activities related to forward physics in ATLAS
- Completed measurements:
  - without proton tagging – soft diffraction, hard diffraction, exclusive production
  - with ALFA detectors – measurements of elastic scattering and total cross section
- Ongoing measurements:
  - total cross section at 8 TeV
  - diffraction with proton tagging (ALFA)
- Succesfull installation and commissioning of first AFP arm
- Plans for future:
  - ALFA runs with ultra-high β^* LHC optics ($\rightarrow$ Coulomb-nuclear interference region)
  - AFP physics runs – high mass diffraction (soft and hard)
  - Installation of second AFP arm (2016/2017)
- Crucial contribution of Polish groups at AGH and IFJ PAN