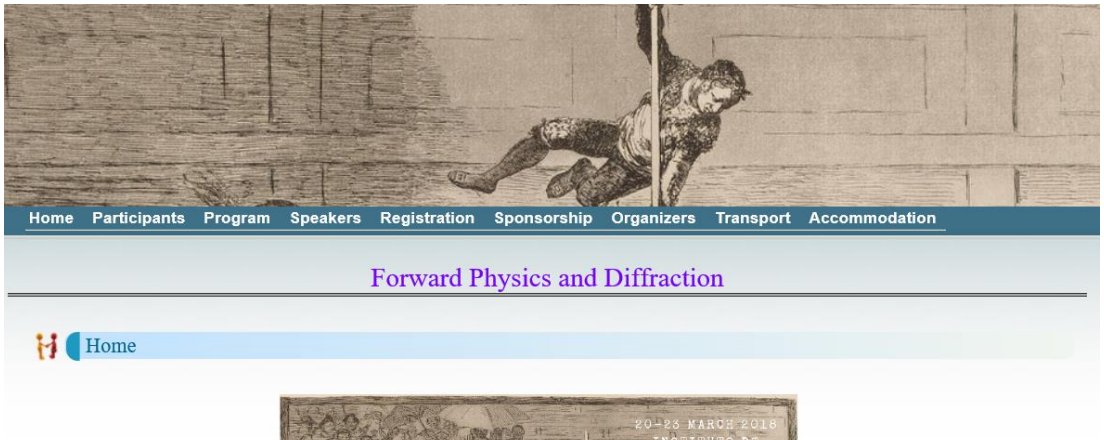
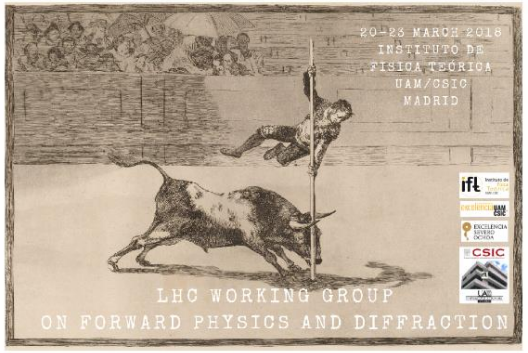
Madrid 20-23 March 2018
Forward Physics and Diffraction

Future prospects with the ALFA spectrometer





Per Grafstrom
University of Bologna.
On behalf of ATLAS

Future prospects with the ALFA spectrometer

- 2018
- Run 3 2021-2023
- Beyond Run3 HL-LHC

2018 Running with ALFA

Tentative schedule of LHC

2 weeks for special runs

Dates are not defined

- The low energy run
- The high beta* run at 13 TeV for diffractive studies and elastics

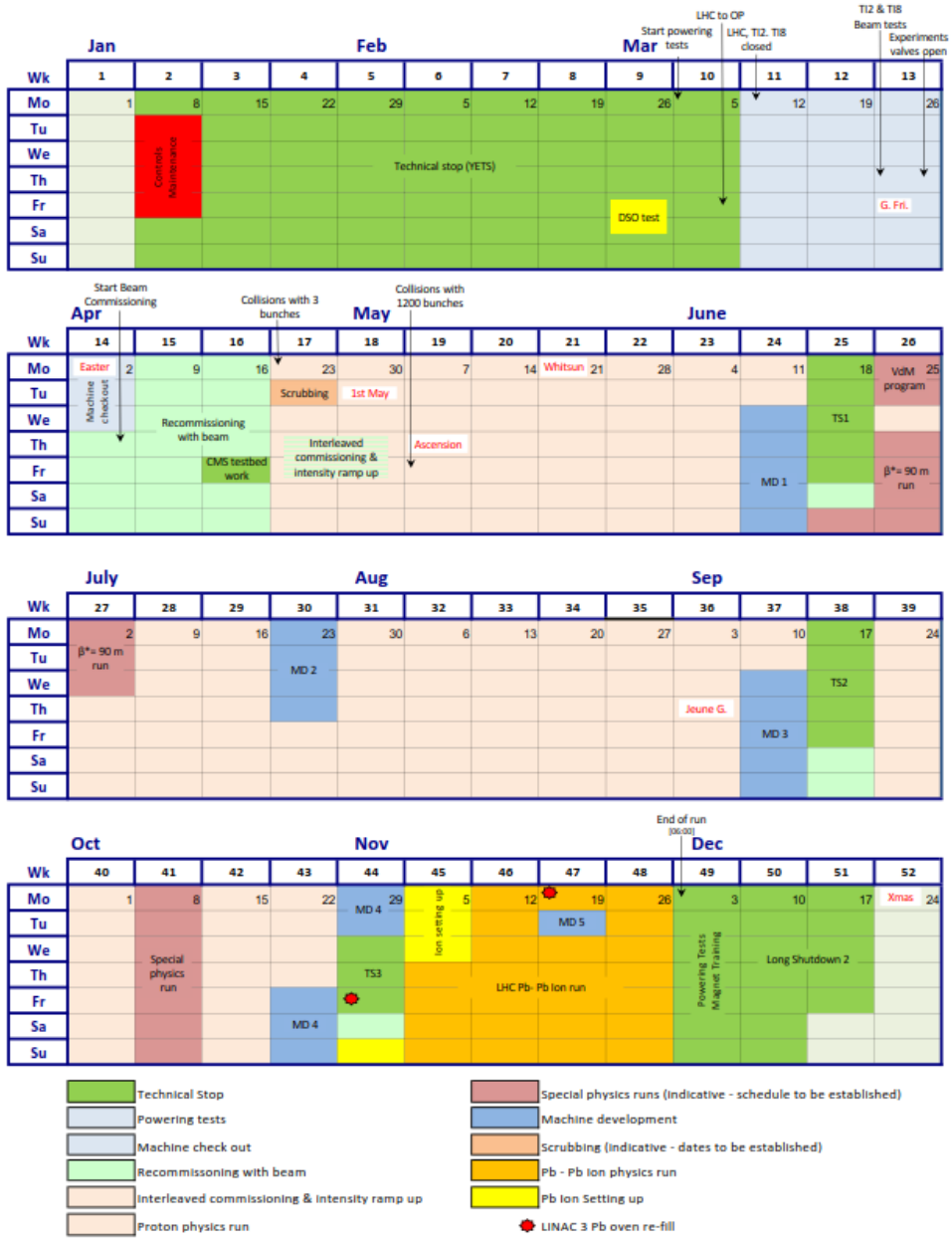
ALFA will participate in both

RS

LHC Schedule 2018

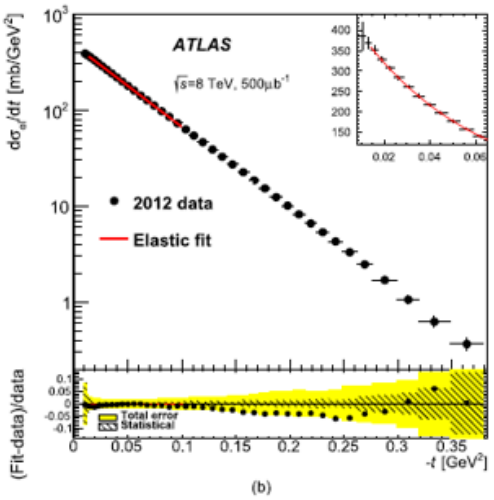
Approved by Research board on 06.12.2017

March 21, 2018
ver. 1.2



Short recap why ATLAS ask for a low energy run

ATLAS can measure the differential elastic cross section with the Roman Pot detectors.



Three basic parameters can be extracted

- σ_{tot} from extrapolation to t=0
- B i.e. the slope of the differential cross section
- ρ = the real to imaginary part of the elastic scattering amplitude in the forward direction.
  From interference between electromagnetic amplitude and strong amplitude at small t.

Two main arguments for the low energy run

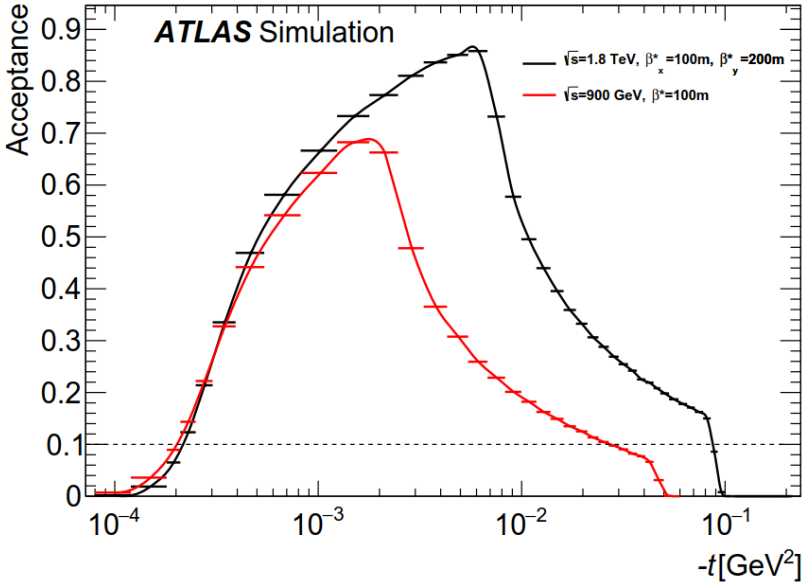
- ATLAS has taken data at 7, 8 and 13 TeV.
  (rho at 8 TeV and 13 TeV analysis ongoing)
  We want to complement the picture of the evolution of those parameters as a function of √s with a low energy point.
- There is a special interest in an accurate measurement of ρ in the whole energy range of LHC including a low energy point.
  I will concentrate on this.

The energy of the low energy run

The energy will be 900 GeV or 1.8 TeV

Background tests at 900 GeV in 2017 have shown too high background for meaningful running with ALFA .
Probably related to the fact that this is the injection energy and thus there is no ramping.
New attempts to reduce the background at 900 will be done in 2018.
If not successful 1.8 TeV will be tried

1.8 TeV is actually the preferred energy of ATLAS due to better acceptance!



Low energy run
Summary of Operational conditions

Beam conditions:

- Roman Pots at 3.0 $\sigma_{nominal}$
- Bunch intensity at injection: 0.7 E11 ppb
- Emittance: ~1.0.-2.0 um
- Pileup at IP1: ~0.01
- Colliding bunches: ~4
- No crossing angle.
- Integrated luminosity 300-500 μb^{-1}

(slide from Sune Jacobsen)

The high beta* run at 13 TeV

Physics motivation

- Diffractive processes in transition soft and hard QCD
- Elastic scattering in the dip region

In October 2015 ALFA took 0.6 pb-1 at 13 TeV with beta* = 90 meter optics for diffractive studies. This sample gave enough statistics for CEP analysis of low mass states below 1.2 GeV.

Analyses which would benefit from more integrated luminosity:

1. Central Exclusive Production of moderate and large masses
   - $\pi^+\pi^-$ ($m \gtrsim 1.2$ GeV), $\pi^+\pi^-\pi^+\pi^-$, K^+K^-, $p\bar{p}$
   - charmonium: χ_{c0}, χ_{c1}, χ_{c2} $\rightarrow$ $J/\psi(\rightarrow \mu^+\mu^-)\gamma$
2. Exclusive Production of jj
3. Exclusive Production of $\gamma\gamma$

Elastic scattering in the dip region
New interest - Odderon?

Khoze, Martin and Ryskin

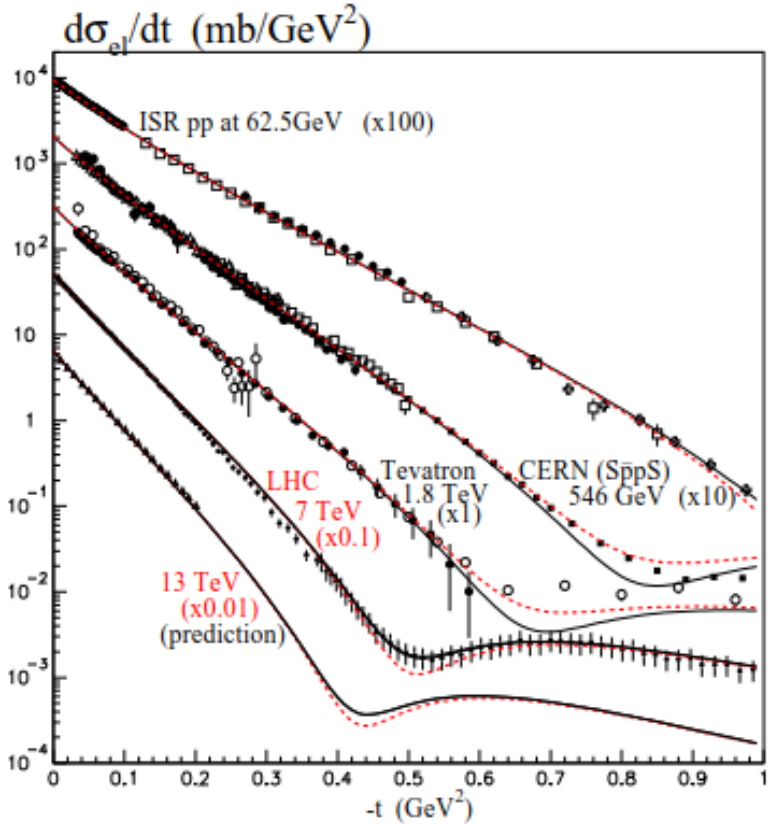
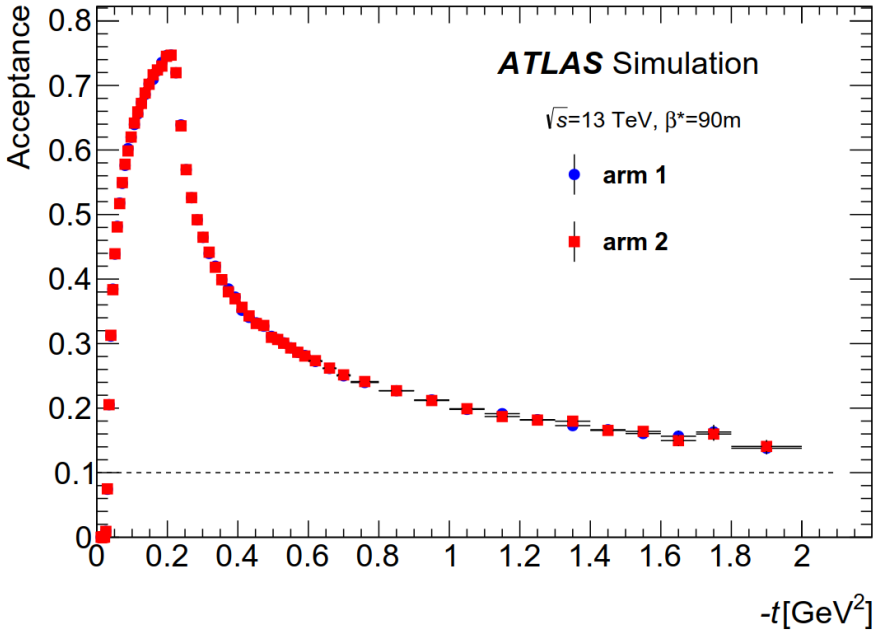


Figure 1: The dependence of the pp (or $p\bar{p}$) elastic cross section on the momentum transferred square t compared with the present data (see [5] for the references), and the prediction for $\sqrt{s} = 13$ TeV. The continuous curves correspond to the original model [4, 5], whereas the dashed curves show the effect of including an Odderon contribution as described in the text. The 13 TeV data are from [2].



ALFA acceptance 13 TeV 90 m

The high beta* run at 13 TeV
Summary of Operational conditions

Beam conditions:

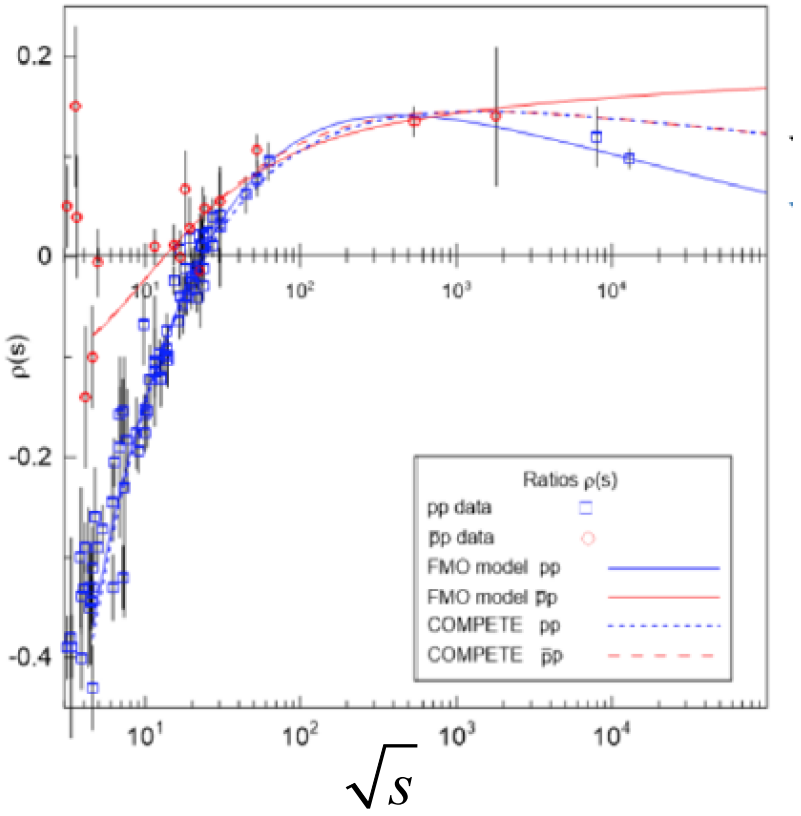
- Roman Pot position: ~10 $\sigma_{nominal}$
- Bunch intensity at injection: 1.0 E11 ppb
- Emittance: 1.0-2.0 um
- Half crossing angle: 50 µrad
- Bunch separation 50 or 100 ns.
- Bunches: up to 671 or 1342 colliding and minimum 2 (more likely 4) non-colliding.

(Slide Sune Jacobsen)

RUN 3 2021-2023

Physics motivation related to ALFA

- Measurement of total cross section at 14 TeV
- Measurement of rho at 1 more energy: a lot of interest on this after TOTEM recent results at 13 TeV
- Measuring in the "dip" region of the differential elastic scattering
- Diffractive physics at beta*=90m (search for exotics, Glueball, Odderon)
- AFP alignment (to be better investigated/quantified)



Beyond LS3 : HL-LHC

Will high beta * be possible??

- Collimations?
- Crab cavities?
- Limiting aperture close to IP

If there is an interest it must be declared soon
Soon lay-out around the IP's will be frozen

Back-up

Van der Meer scan for low energy campaign

A vdM is requested by ATLAS only (TOTEM does NOT foresee to make one).

This is strongly needed to provide a reliable luminosity measurement.

Beam conditions (still being discussed)**:**

Same energy as the physics run
β* = 11 m (optics already exists)
No Roman Pots (to minimize setup time)
Bunch intensity at injection: 1.0-1.2 E11 ppb
Emittance: ~2.0 um
Pileup at IP1: ~0.3
Colliding bunches: ~150
No crossing angle
Stable beam

Setup of beams:

Some loss maps and validations will be needed (~1-2 shifts).

Program:

Similar to normal vdM (~1 shift).

Trigger setup:

Similar to normal vdM.