

# Forward Physics and Optics at the HL-LHC

Rafał Staszewski

Henryk Niewodniczański  
Institute of Nuclear Physics  
Polish Academy of Sciences  
(IFJ PAN Cracow)

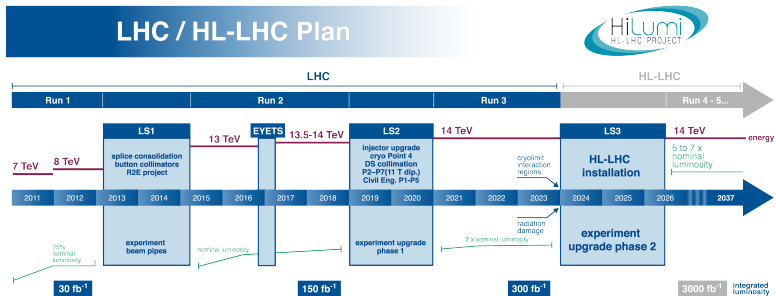


**LHC Working Group on Forward Physics and Diffraction**  
**21 – 22 March 2011, CERN**

# Introduction

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# Physics

# Possible physics programme

Normal running (high lumi, low  $\beta^*$ )

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- exclusive Higgs ( $b\bar{b}$  decay, spin, QCD mechanism)
  - + very convincing physics case
  - + interest beyond FWD community
  - feasibility very uncertain
  - may require detectors in cold region
  
- new physics in two-photon processes at high mass
  - + complementary to other searches
  - + interest beyond FWD community
  - unclear if competitive with other channels
  - additional pots should be considered
  
- exclusive jets (SM & BSM)
  - + complementary to other searches
  - + interest beyond FWD community
  - feasibility very uncertain
  - unclear if competitive with other channels

# Possible physics programme

## Dedicated runs

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- Dedicated runs with low  $\beta^*$ 
    - high mass diffraction  
*continuation of Run II programme, aim at better precision*
  - Dedicated runs with high  $\beta^*$ 
    - low mass diffraction  
*inclusive and exclusive, continuation of Run II programme*
    - elastic scattering at large  $t$   
*search for secondary dips, perturbative description*
    - total cross section  
*solve discrepancy between ALFA and TOTEM*
- 
- + low  $\beta^*$  runs with small luminosity should be feasible
  - + possibly the only way to continue diffractive physics @HL-LHC (in ATLAS & CMS)
  - not clear how large  $\beta^*$  will be possible
  - requires dedicated machine time
  - physics may not be interesting outside FWD community

# Possible physics programme

Heavy ion runs (if foreseen?)

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- Tagging nuclear fragments (spectators) in pA and AA runs
  - + feasible
  - + possible centrality determination
  - not yet clear that useful information can be extracted from such measurements
- Proton tagging in pA (photoproduction studies)
  - requires high  $\beta^*$  optics with HI

# Optics

based on results from Maciej Trzebiński (IFJ PAN Cracow)  
for HL-LHC V1.0 optics (present version: 1.2)

# Betatron Function

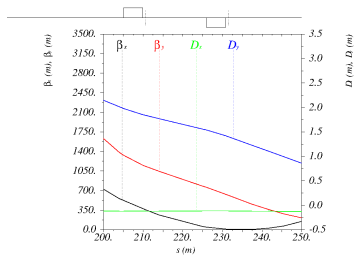
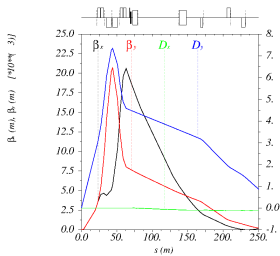
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Optics	$\beta_x^*$ [m]	$\beta_y^*$ [m]	$x$ [mm]	$y$ [mm]	$p_x$ [ $\mu$ rad]	$p_y$ [ $\mu$ rad]
collision Round	0.150	0.150	$\pm 0.750$	0	0	$\pm 295$
collision Flat	0.075	0.300	$\pm 0.750$	0	0	$\pm 275$
collision sRound	0.100	0.100	$\pm 0.750$	0	0	$\pm 360$
collision sFlat	0.050	0.200	$\pm 0.750$	0	0	$\pm 335$

- $x, y$  – transverse position at the IP,
- $p_x, p_y$  – crossing angle of Beam 1 at the IP.

Example for 'collision Round':

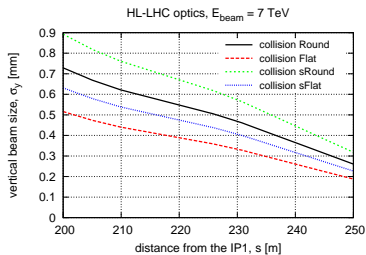
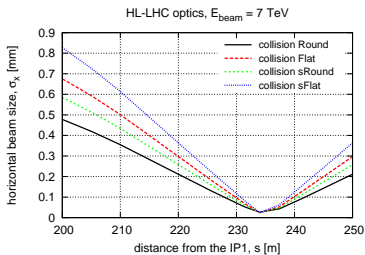




# Beam Size

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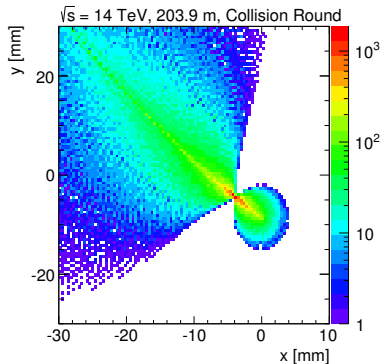
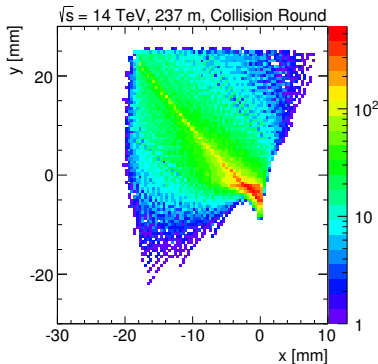
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- horizontal size: minimum around 235 m for all optics,
- vertical size decreasing with distance,

# Hit maps

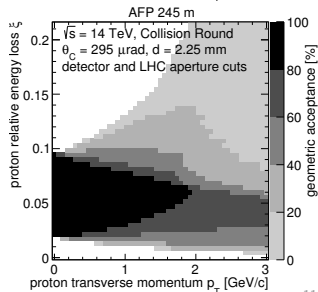
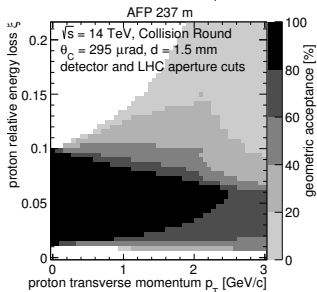
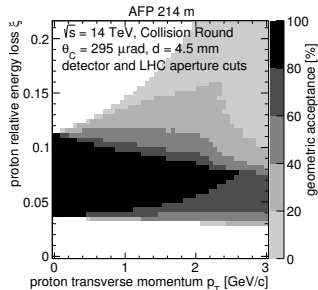
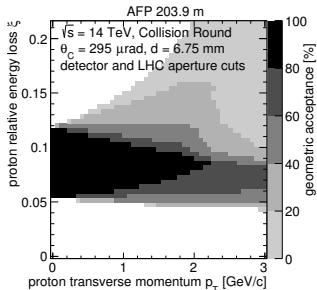
- Hit maps calculated for uniform grid in  $\xi$ ,  $p_T$  and  $\phi$  (unphysical distribution)
- Plots for Round optics, but all others are very similar
- Plots done for ATLAS IP



# Acceptance for at different location for horizontal detectors

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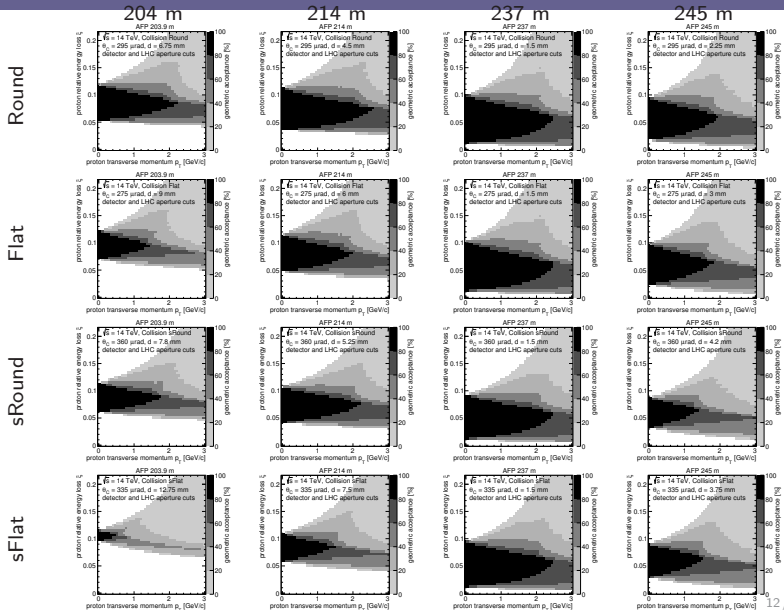
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# Acceptance for different optics scenarios

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# Summary and conclusions

- If there is interest to have forward proton detectors at HL-LHC, proposals should be prepared asap and more detailed studies performed
- Given (very likely) limited resources, it will probably not be possible to pursue all physics possibilities (at least in one experiment)
- Factors (related to each other) defining performance and feasibility of measurements:
  - 1 optics
  - 2 detectors (position, horizontal/vertical setup, resolution)
  - 3 machine time (for dedicated runs)
- Not clear if high  $\beta^*$  can be obtained
- Acceptance for horizontal detectors at low  $\beta^*$  look qualitatively similar to present situation at the LHC