Search for exclusive events at the Tevatron and project to install roman pots at 220 m in ATLAS

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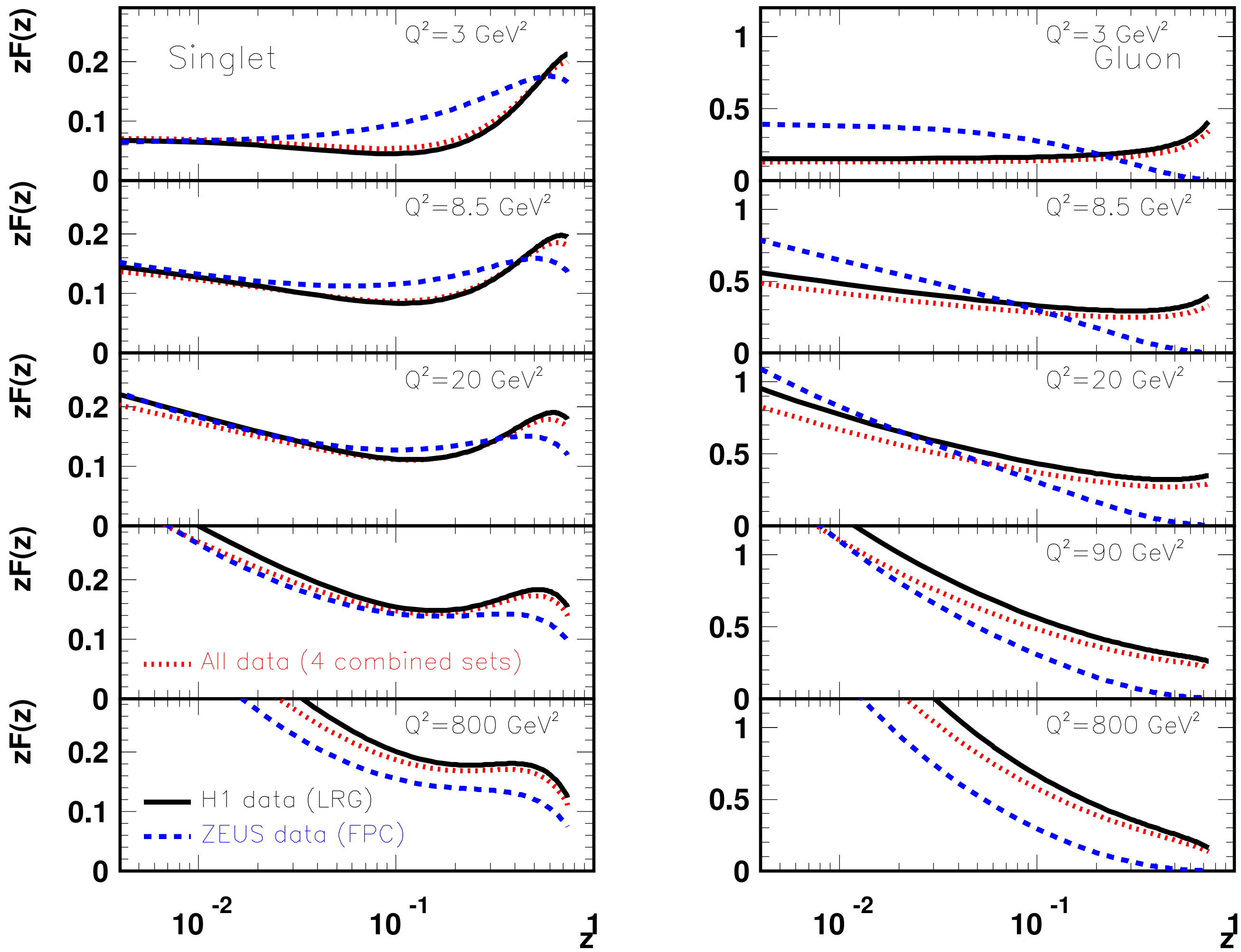
Contents:

- Exclusive events in the dijet channel
- Roman pot location
- Si detectors
- Timing detectors
- Trigger

NB: Other projects (FP420, TOTEM....) described in other talks

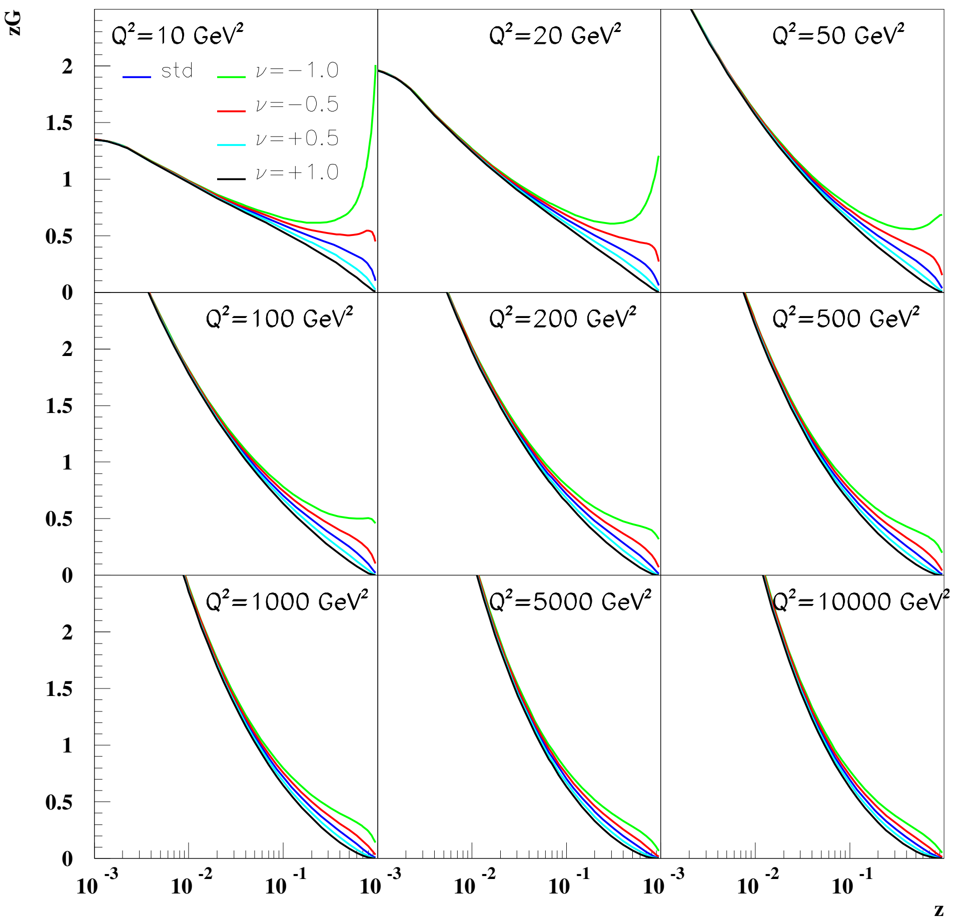
Parton densities in Pomeron

DGLAP fits to most recent H1 and ZEUS data (see: hep-ph/0609291, hep-ph/0602228)



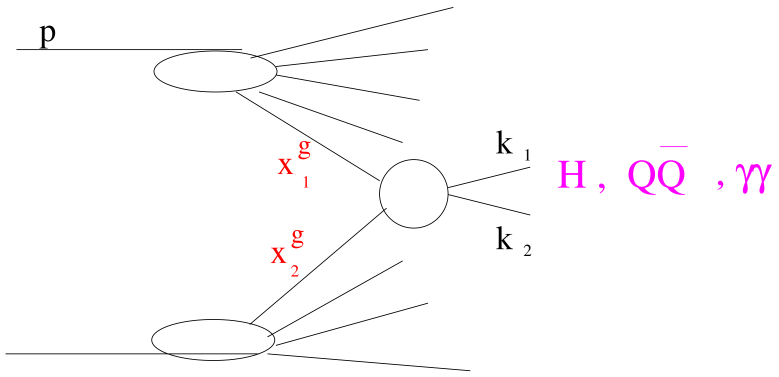
Uncertainty on high β gluon

- Important to know the high β gluon since it is a contamination to exclusive events
- Experimentally, quasi-exclusive events indistinguishable from purely exclusive ones
- Uncertainty on gluon density at high β: multiply the gluon density by $(1-\beta)^\nu$ (fit: $\nu = 0.0 \pm 0.6$)
- From HERA gluon density and survival probabilities, predict diffractive inclusive cross section at the Tevatron

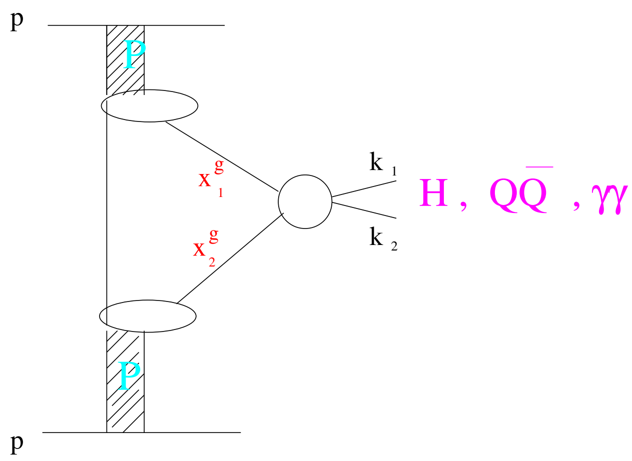


Look for exclusive events at the Tevatron

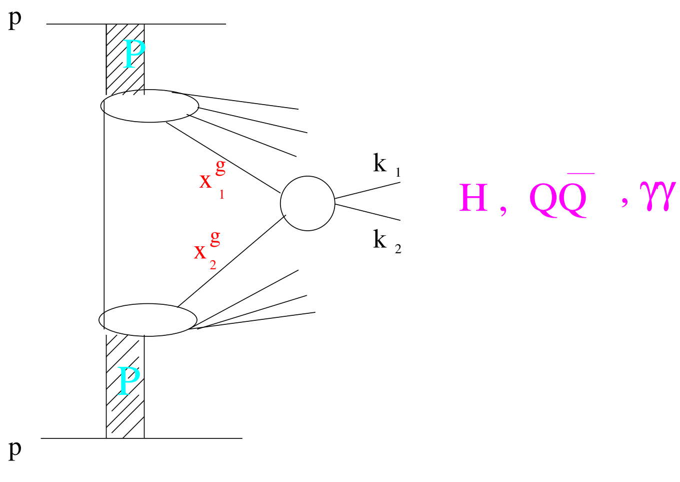
- "exclusive" events: events without pomeron remnant, search for exclusive events in dijet, diphoton, χ_C channels
- The full available energy is used in the hard interaction
- Interesting for LHC... (diffractive W, Higgs, photon anomalous coupling...)



"Standard"



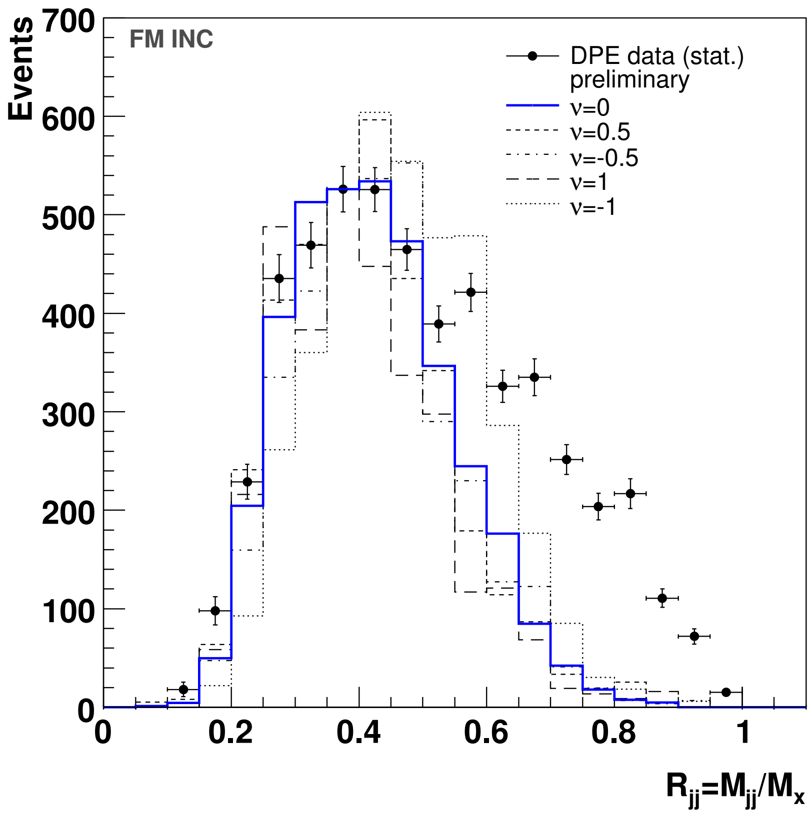
"Exclusive "



"Inclusive"

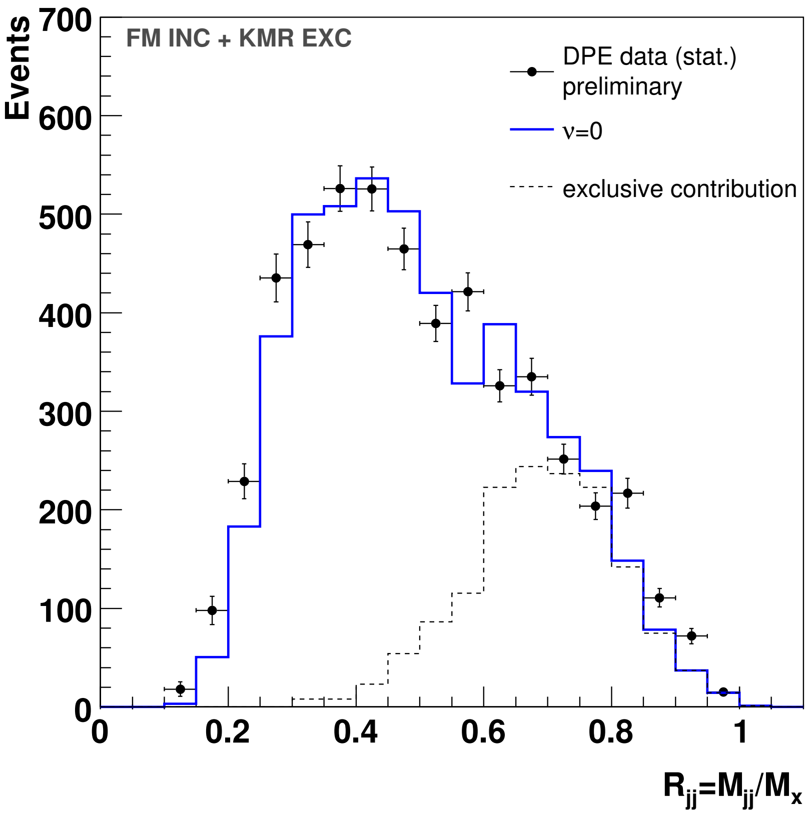
Dijet mass fraction measurement in CDF

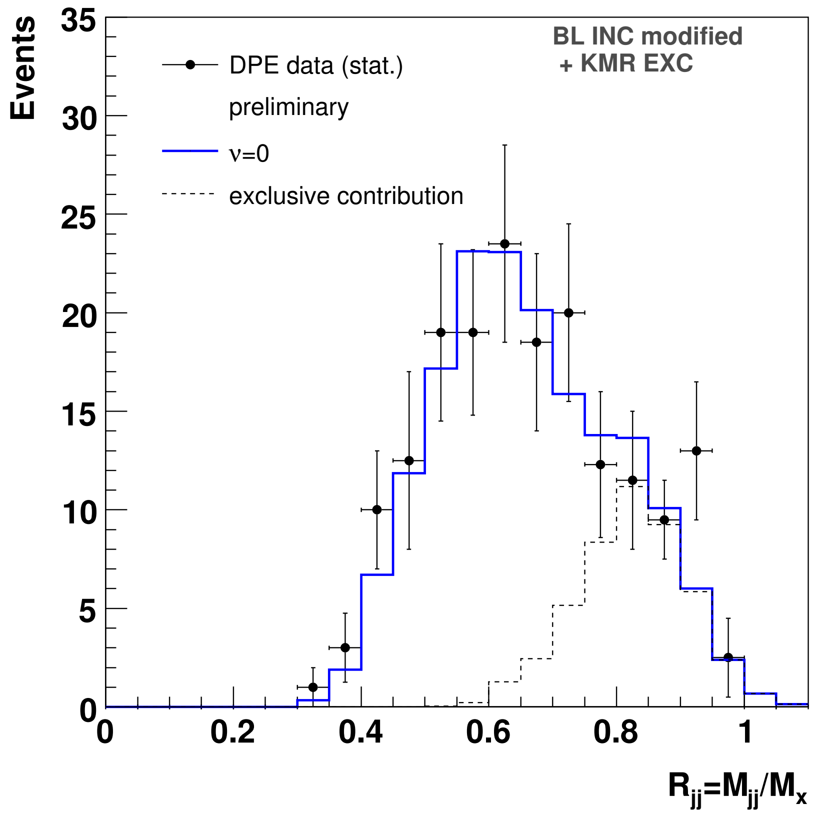
- Look for exclusive events (events where there is no pomeron remnants or when the full energy available is used to produce diffractively the high mass object)
- Select events with two jets only, one proton tagged in roman pot detector and a rapidity gap on the other side
- Predictions from inclusive diffraction models for Jet $p_T > 10$ GeV



Prediction from inclusive and exclusive diffraction

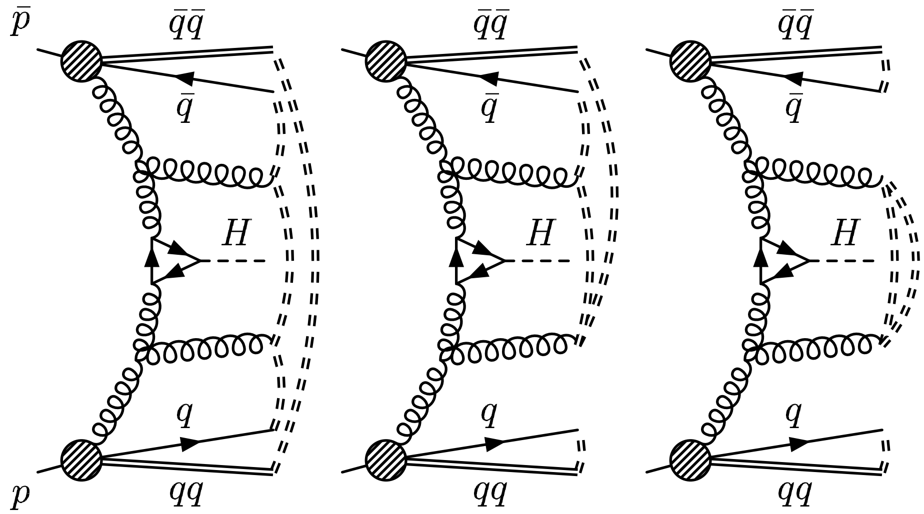
- Add the exclusive contribution (free relative normalisation between inclusive and exclusive contribution)
- Good agreement between measurement and predictions
- As an example: exclusive and inclusive models for $p_T > 10$ GeV and for $p_T > 25$ GeV
- See O. Kepka, C. Royon, arXiv:0704.19956 accepted by Phys. Rev. D, arXiv0706.1798





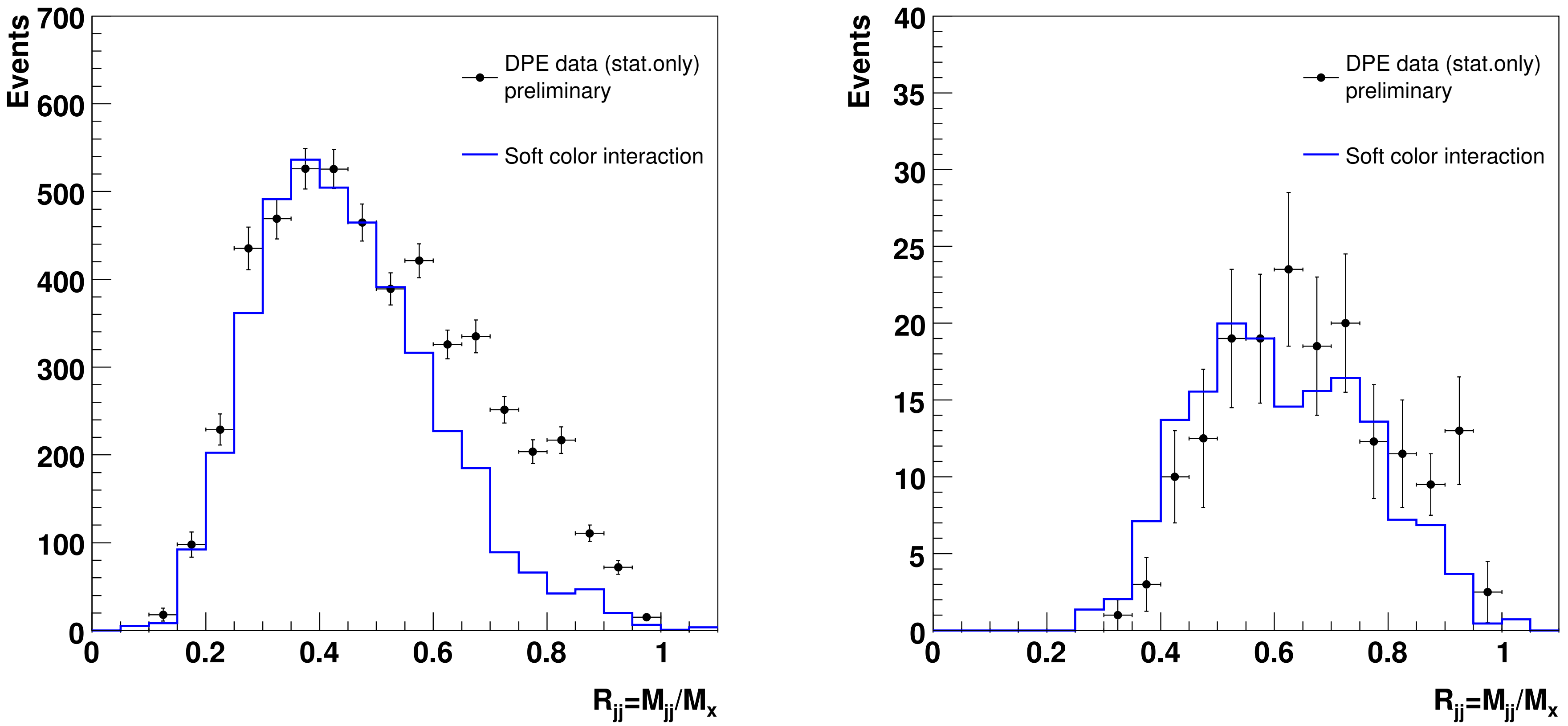
Soft Colour Interaction models

- A completely different model to explain diffractive events: Soft Colour Interaction (R.Enberg, G.Ingelman, N.Timneanu, hep-ph/0106246)
- Principle: Variation of colour string topologies, giving a unified description of final states for diffractive and non-diffractive events
- No survival probability for SCI models



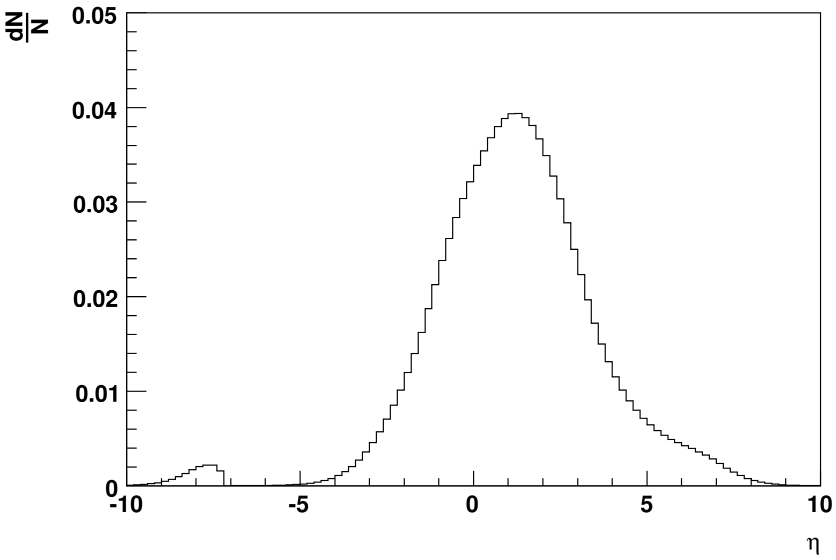
What about SCI?

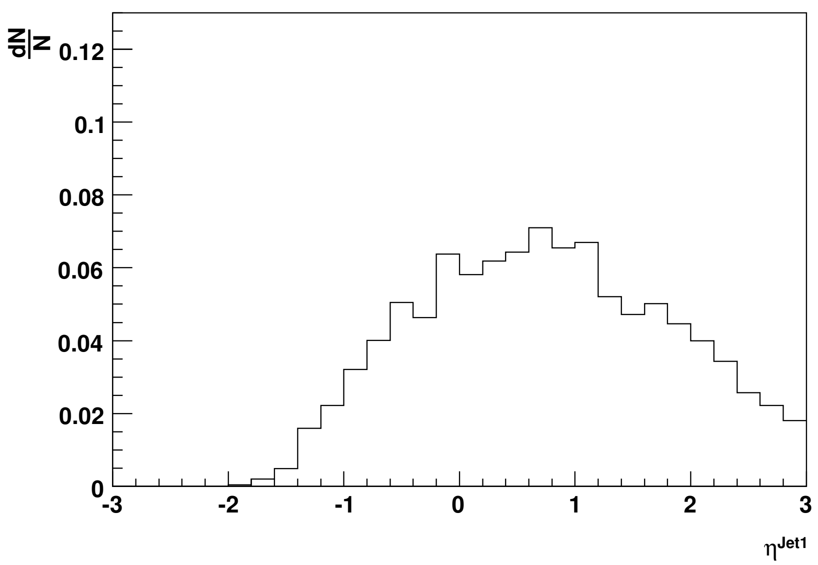
- SCI models give correct normalisation for single diffraction at Tevatron and diffraction at HERA without any additional parameter
- Exclusive events and SCI: Contribution of exclusive events needed much lower compared to Pomeron-like models, even vanishes for jet $p_T > 25$ GeV...



Comments about SCI

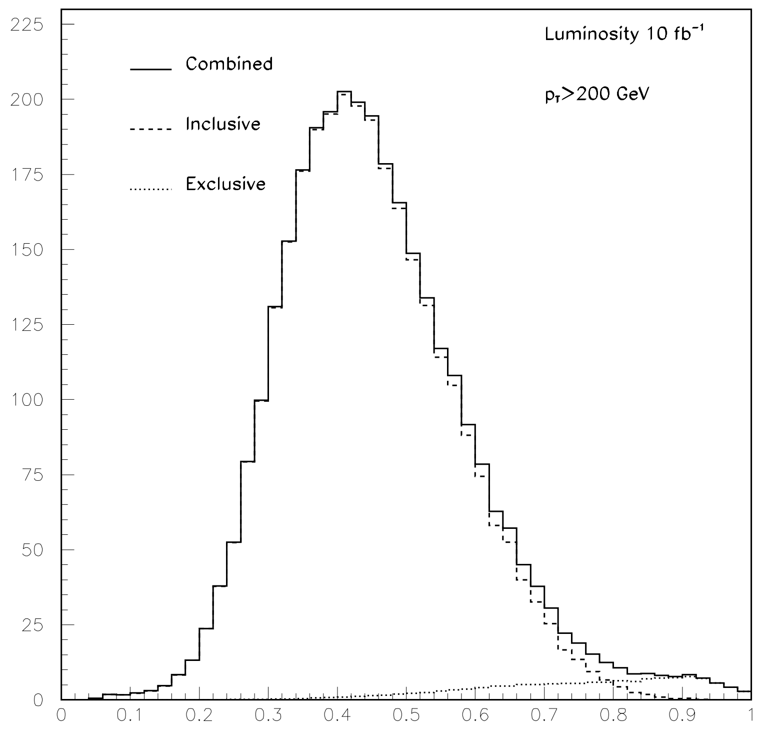
- Contribution of exclusive events much smaller for SCI
- "DPE" exchange in SCI models dominated by the following configuration for CDF events: 1 antiproton tagged in the final state, a bunch of particles going through the beam pipe on the other side (dominated by pions), no proton in the final state, due to the fact that only a rapidity gap is requested
- Jet rapidity boosted towards high rapidity: SCI model worth to be studied in more detail, but needs further improvement

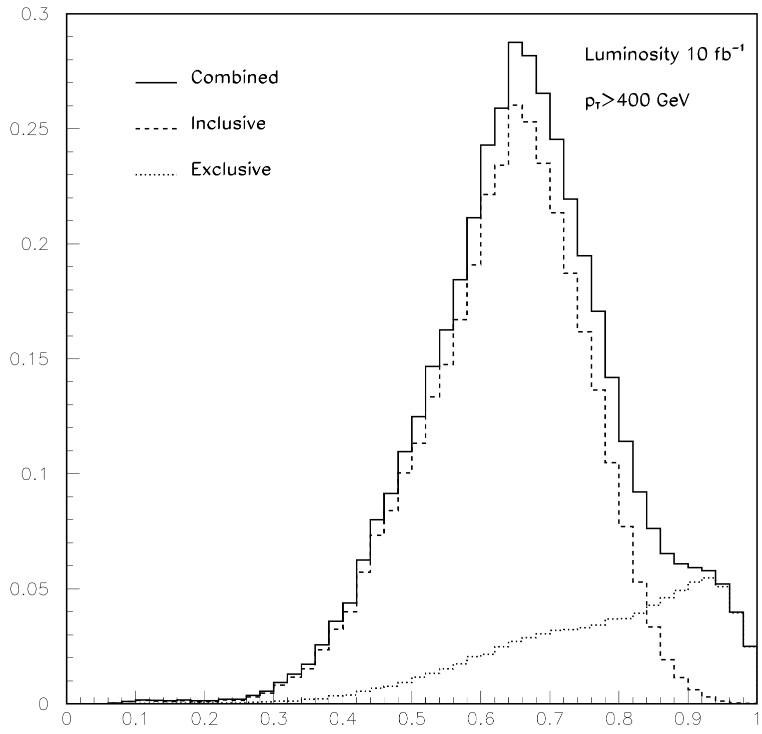




LHC: Exclusive and inclusive events

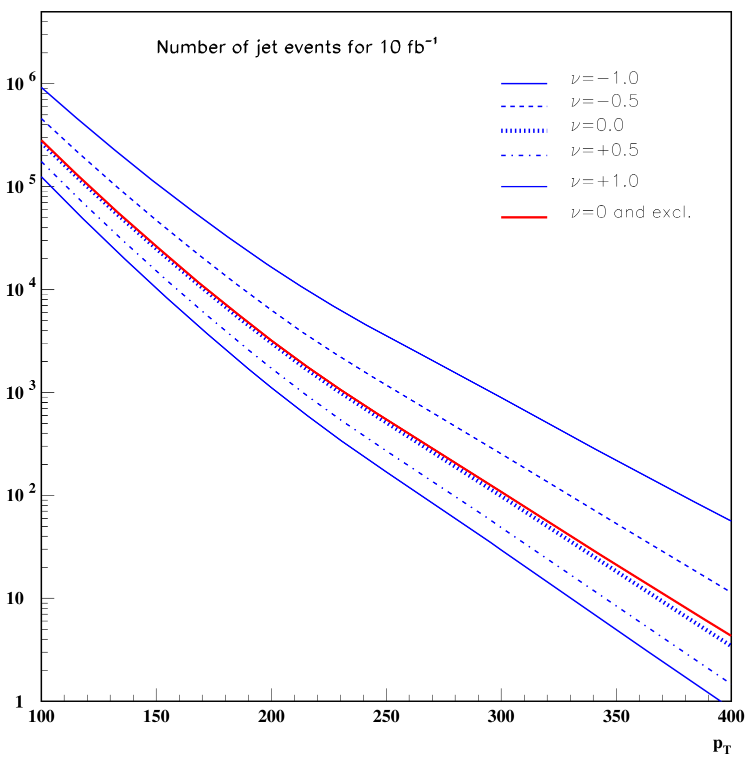
- Study of exclusive and inclusive production to be made at the LHC: study cross section of both components as a function of jet p_T and perform DGLAP QCD fits
- Important to understand background and signal for exclusive production of rare events: Higgs, SUSY...

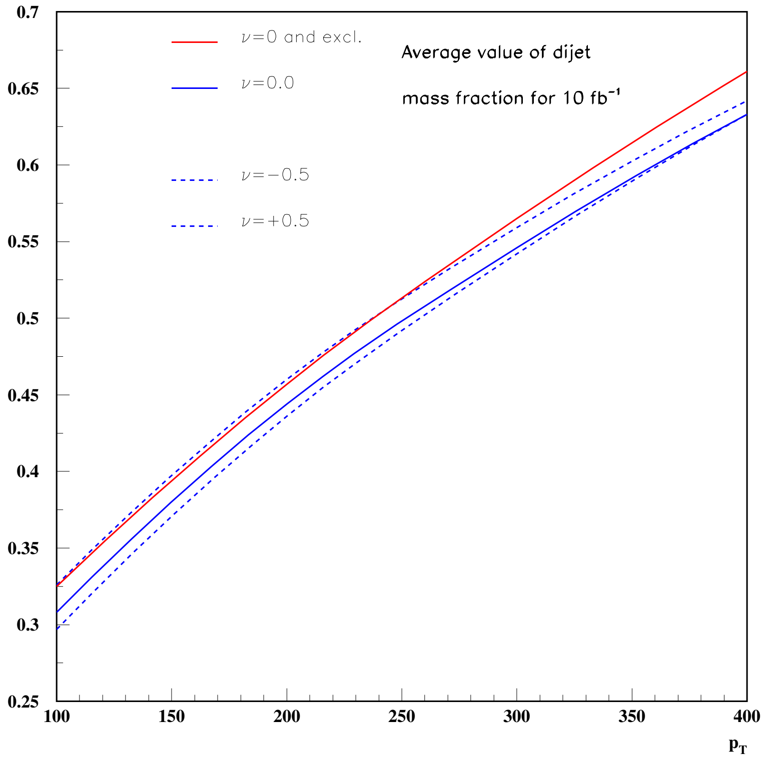




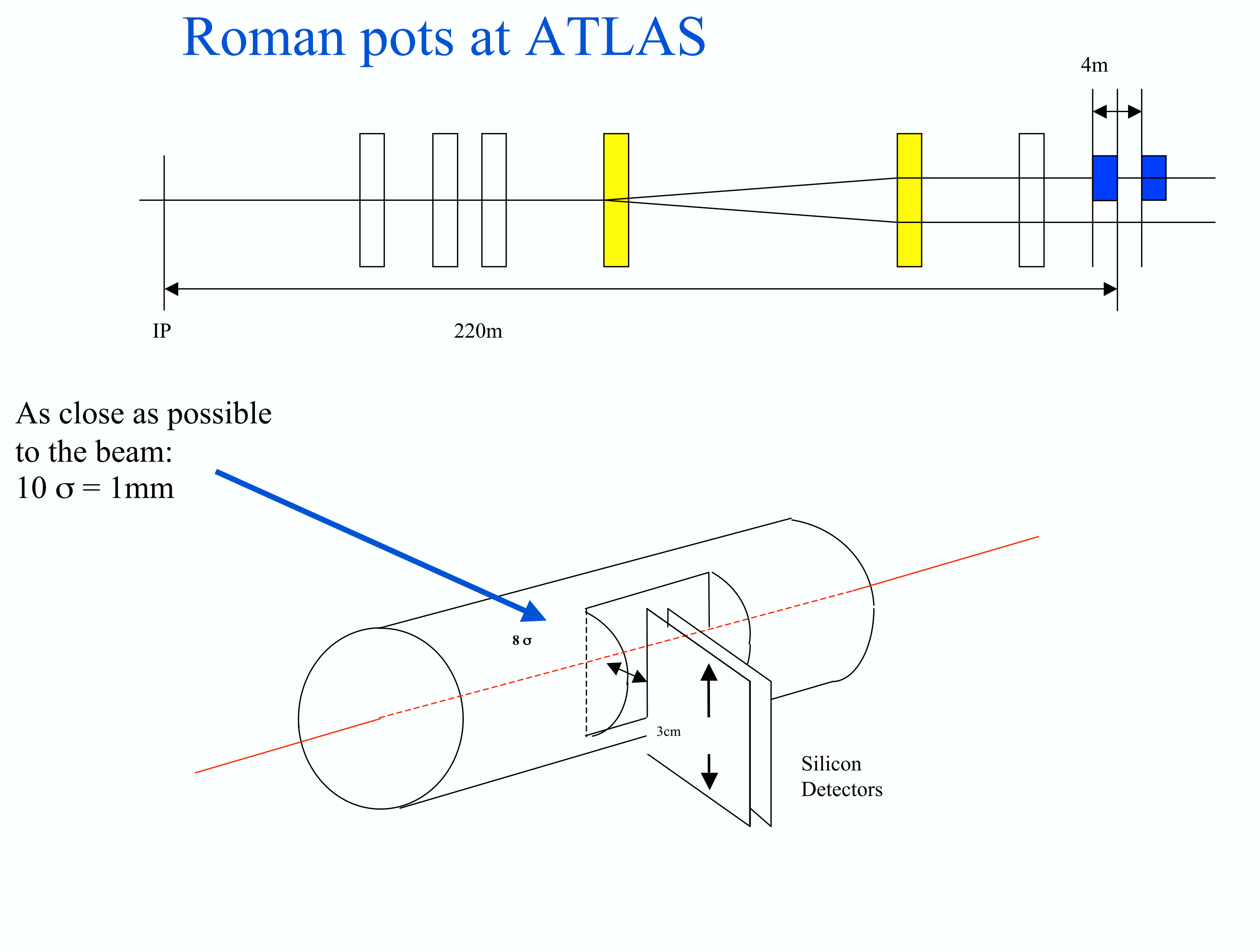
LHC: Exclusive and inclusive events

- Number of dijet events as a function of jet p_T:
  dominated by uncertainty on gluon density
- Dijet mass fraction (average value as an example):
  sensitive to exclusive production, quite easy to measure





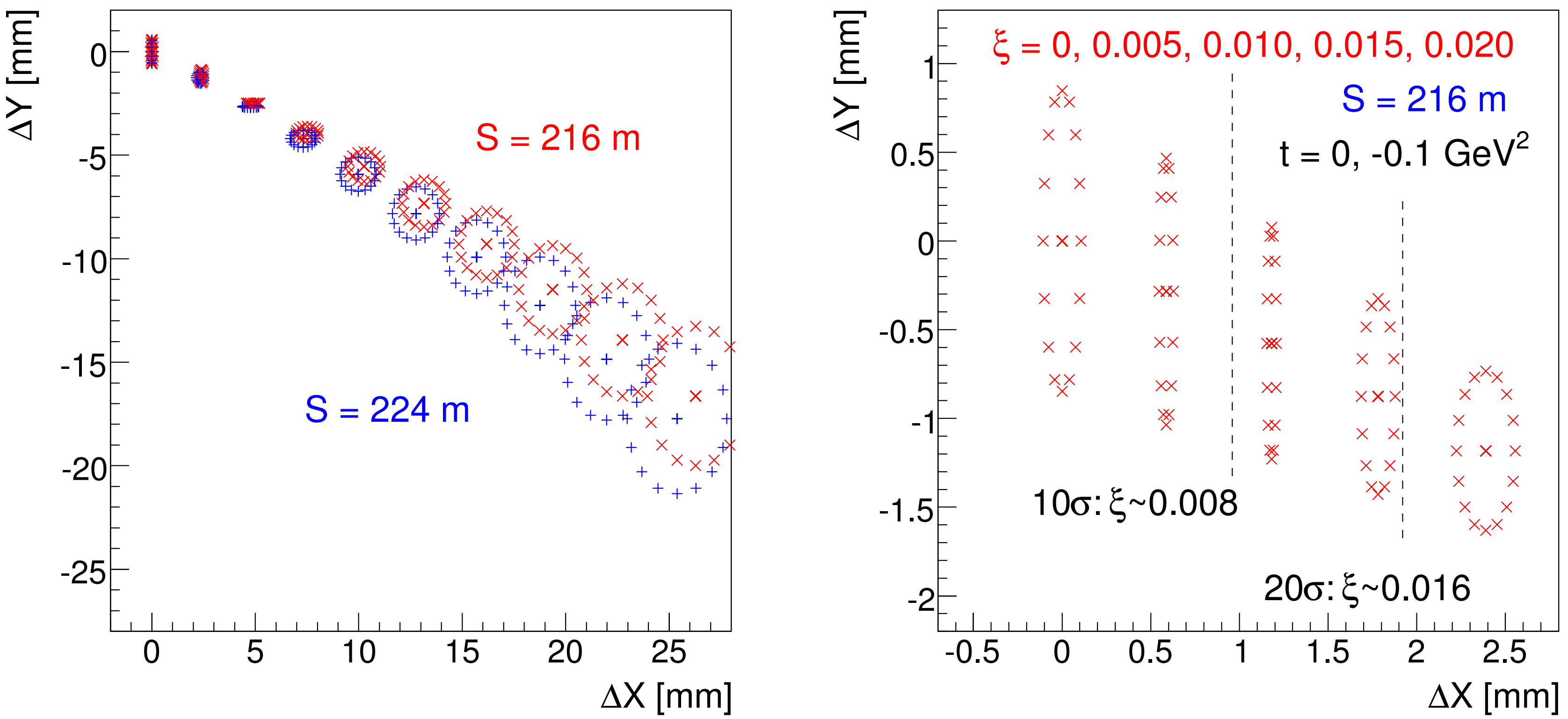
Scheme of roman pot detectors



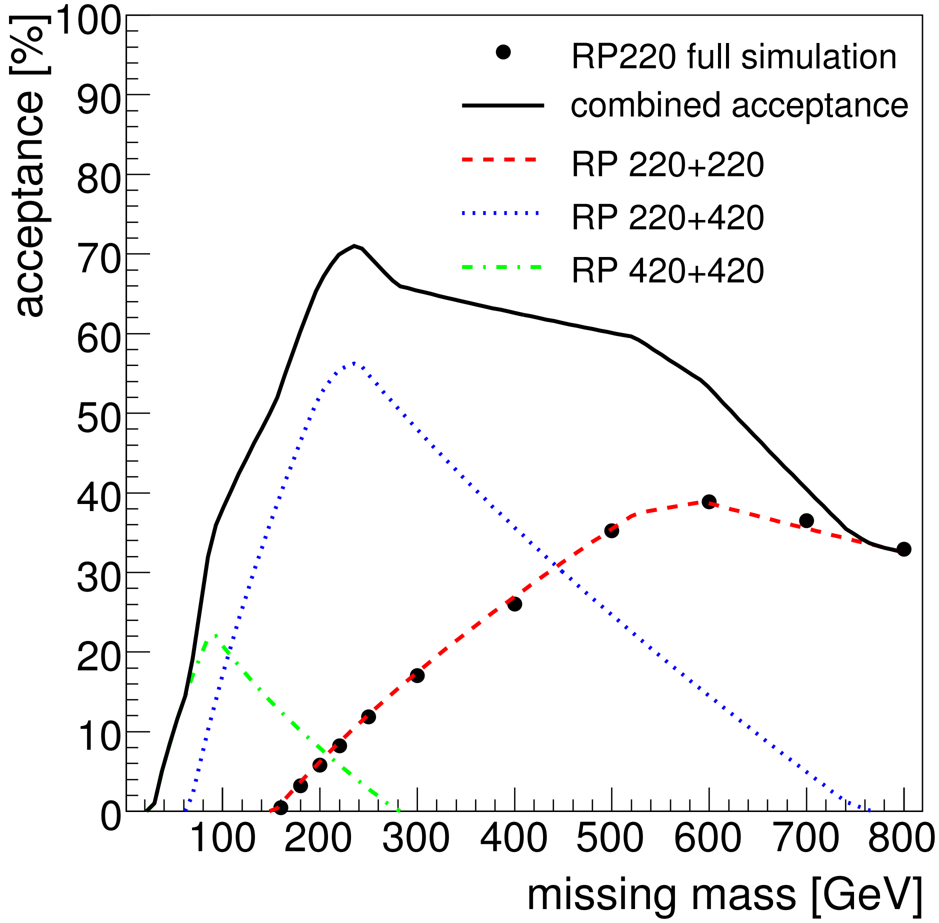
Assume roman pots located at 216 and 224 m

Acceptance for 220 m pots

- Steps in ξ: 0.02 (left), 0.005 (right), $|t|$=0 or 0.05 GeV^2
- Detector of 2 cm $\times$ 2 cm will have an acceptance up to $\xi \sim 0.16$, down to 0.008 at 10 σ, 0.016 at 20 σ
- As an example Higgs mass acceptance using 220 m pots down to 135 GeV and upper limit due to cross section and not kinematics



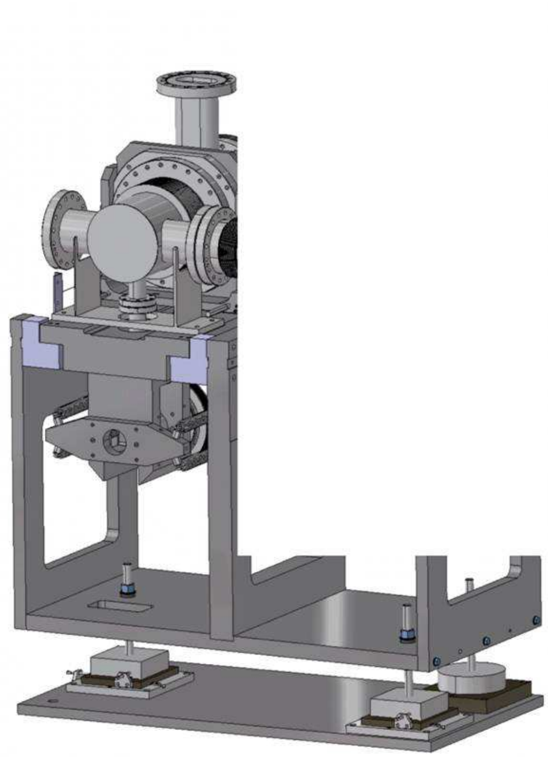
Roman pot projects

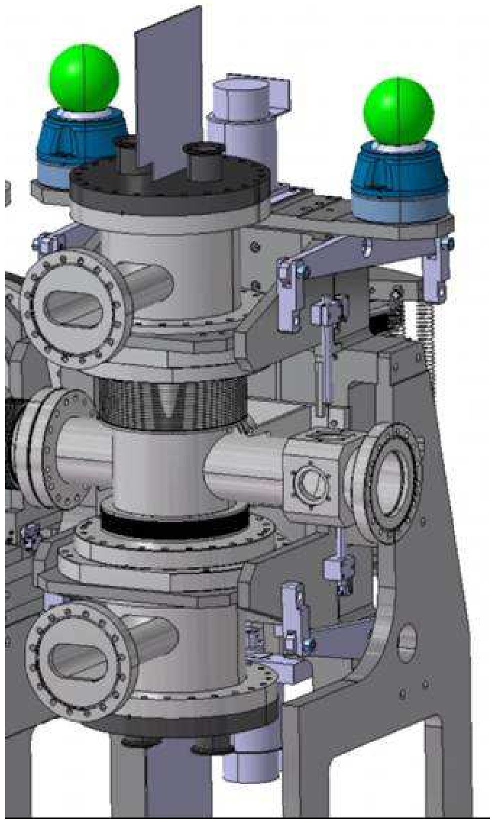


Both FP420 and RP220 needed to have a good coverage of acceptance (NB: acceptance slightly smaller in CMS than in ATLAS)

Roman pots at 220 m

Schematic view of 220 m pots: keep horizontal pots only from the TOTEM pots





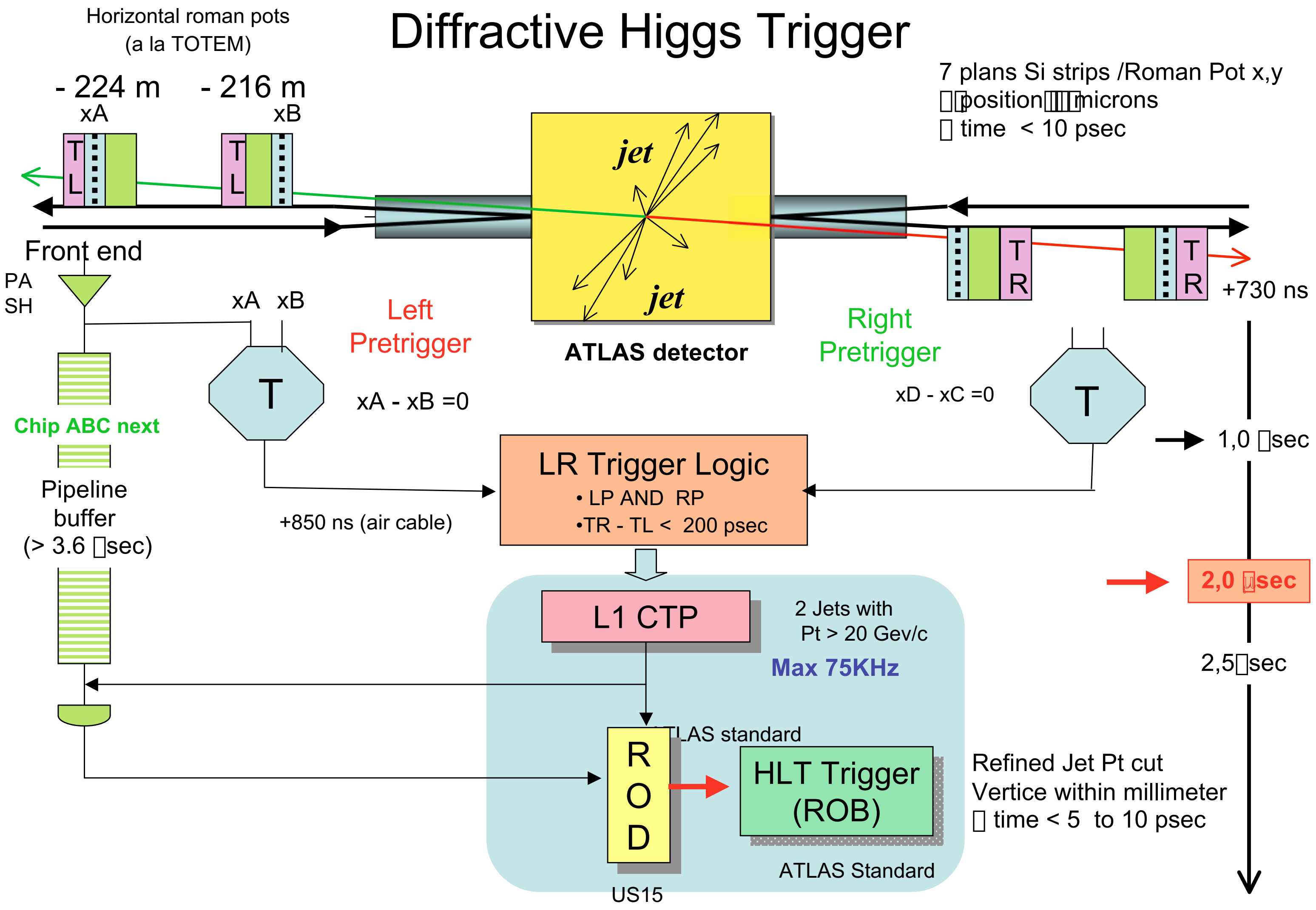
Which kind of detectors?

- Requirement: good resolution in position (good measurement of mass, kinematical propwerties), and in timing
- Position detectors:
  - Size of Si detectors: 2cm $\times$ 2cm
  - Spatial resolution of the order of 10-15 μm: Si strip detectors of 50 μm: 5 layers, 2 vertical, 1 horizontal, 1 U, 1 V (45 degrees)
  - Edgeless detectors: Between 30 to 60 μm
  - First prototype of detector being made by CANBERRA: test-stand (laser and radioactive source) being installed in Saclay
  - 2 additional layers used for the trigger: Strip detectors of 100-200 μm (to be optimised given the fact that we have 1 μs to send the trigger to ATLAS)
  - Readout and trigger chip ABCNext: standard Si readout for ATLAS
  - Other option in collaboration with FP420: 3D Silicon

Which kind of detectors?

- Timing detectors
  - Why do we need timing detectors? At the LHC, up to 30 interactions by bunch crossing, and we need to identify from which vertex the protons are coming, same problem for FP420
  - Timing detector resolution needed: of the order of 5 picoseconds (space resolution slightly more than 1 mm)
  - Radiation hardness
  - Detector space resolution: few mm, the total width of the detectors being 2.5 cm (4.5 cm available in roman pot)
  - Reference clock: either the LHC clock (resolution of 7-8 ps), or atomic clock (they need to be calibrated on each side)
  - Trigger information: at L1 (rough compatibility between both sides of ATLAS) and specially at L2 (compatibility with vertex position)
  - Development: new timing detectors in collaboration with the Universities of Chicago, Stony Brook, and Argonne, and with Photonis

Trigger: principle



Trigger: strategy

- L1 trigger when two protons tagged at 220 m
- L1 trigger when only one proton is tagged at 220 m: in that case, cut on acceptance at 220 m corresponding to the possibility of a tag at 420 m
- Cuts used:
  - 2 jets in central detector with $p_T > 40$ GeV
  - Exclusiveness of the process (2 jets carrying 90% of the energy) $(E_{T_1} + E_{T_2})/H_T > 0.9$
  - Kinematics requirement $(\eta_1 + \eta_2) \times \eta_{220} > 0$
  - At least one proton tagged at 220 m with $\xi < 0.05$ (compatible with the eventual presence of a proton at 420 m on the other side) **or** one proton tagged at 220 m on each side
- With those cuts, possibility to get a L1 rate less than 1 kHz for a luminosity less than 3.10^{33}cm^{-2} s^{-1}

Conclusion

- Dijet mass fraction data at the Tevatron: Needs additional component with respect to inclusive diffraction to explain dijet mass fraction data; exclusive contribution
- Roman pot project at 220 m in ATLAS: well advanced and complementary to the FP420 and RP240 projects
- Technology: standard roman pots from Totem (only horizontal pots)
- Position detectors: either Si strips or 3D edgeless Si detectors (being developped by FP420), both solutions to be tested
- Timing detectors: Resolution of the order of 5 ps needed, developped between Saclay, University of Chicago, Argonne National Lab (also for medical applications)
- Trigger: allows to trigger on 220 m double tagged events, and also “hybrid events” (220 and 420 m)
- Deadlines: 2009-2010: installation of roman pots, Si position detector, preliminary timing detector (resolution $\sim$ 50 ps), 2012: final timing detector (resolution $\sim$ 5-10 ps)
- Collaboration being built: Prague, Cracow, Saclay, Stony Brook, Giessen, Michigan State University, Paris 6, Heidelberg... Other groups very much welcome!