

Project to install roman pots at 220 m in ATLAS

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Contents:

- Roman pot location
- Si detectors
- Timing detectors
- Trigger

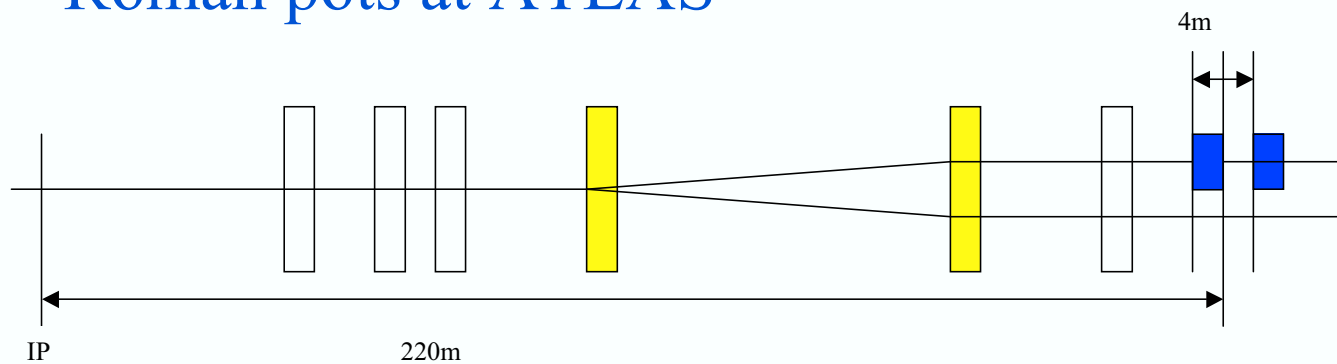
Collaboration between Cracow, Giessen, Paris 6, Prague, Saclay, Stony Brook, Michigan State University (Lansing), and in addition University of Chicago, Argonne National Lab and Photonis for timing detectors

Roman pot projects at LHC

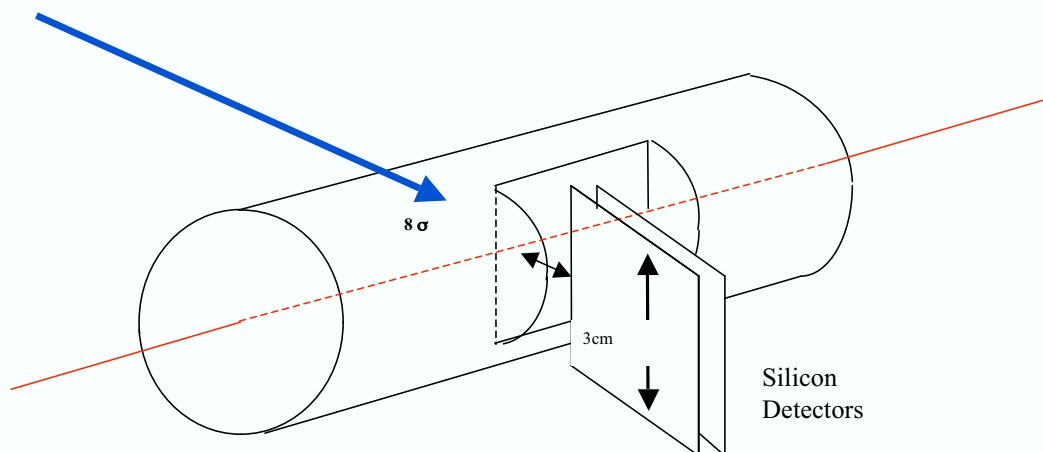
- TOTEM project accepted, close to CMS
- FP420: Project of installing roman pot detectors at 420 m both in ATLAS, CMS; collaboration being built
- Roman pot detectors at 220 m in ATLAS:
 - Natural follow-up of the ATLAS luminosity project at 240 m to measure total cross section
 - Complete nicely the FP420 m project
 - Collaboration between Saclay, Prague, Cracow, Giessen, Paris 6, University of Michigan and Stony Brook (so far) being pursued
 - Collaboration with the FP420 m project concerning detectors, triggers, simulation...
- For more information, see the web pages of FP420, CMS, TOTEM, ATLAS

Scheme of roman pot detectors

Roman pots at ATLAS



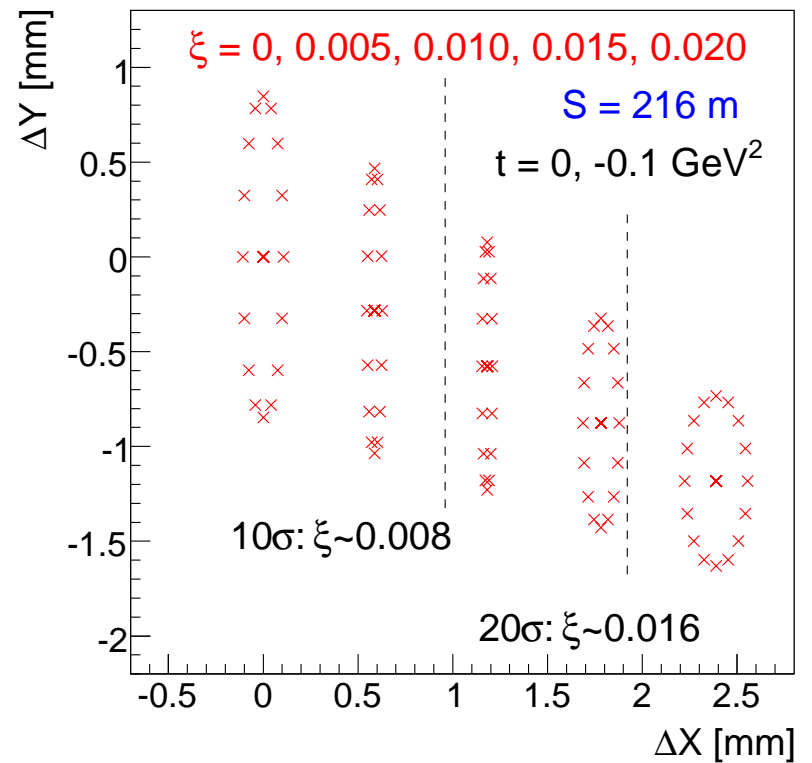
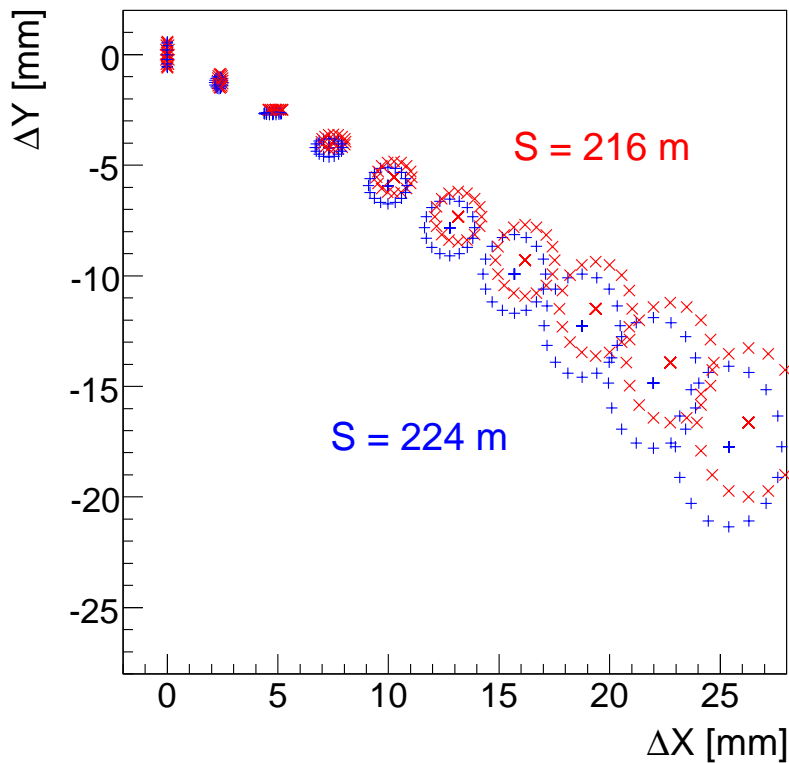
As close as possible
to the beam:
 $10\sigma = 1\text{mm}$



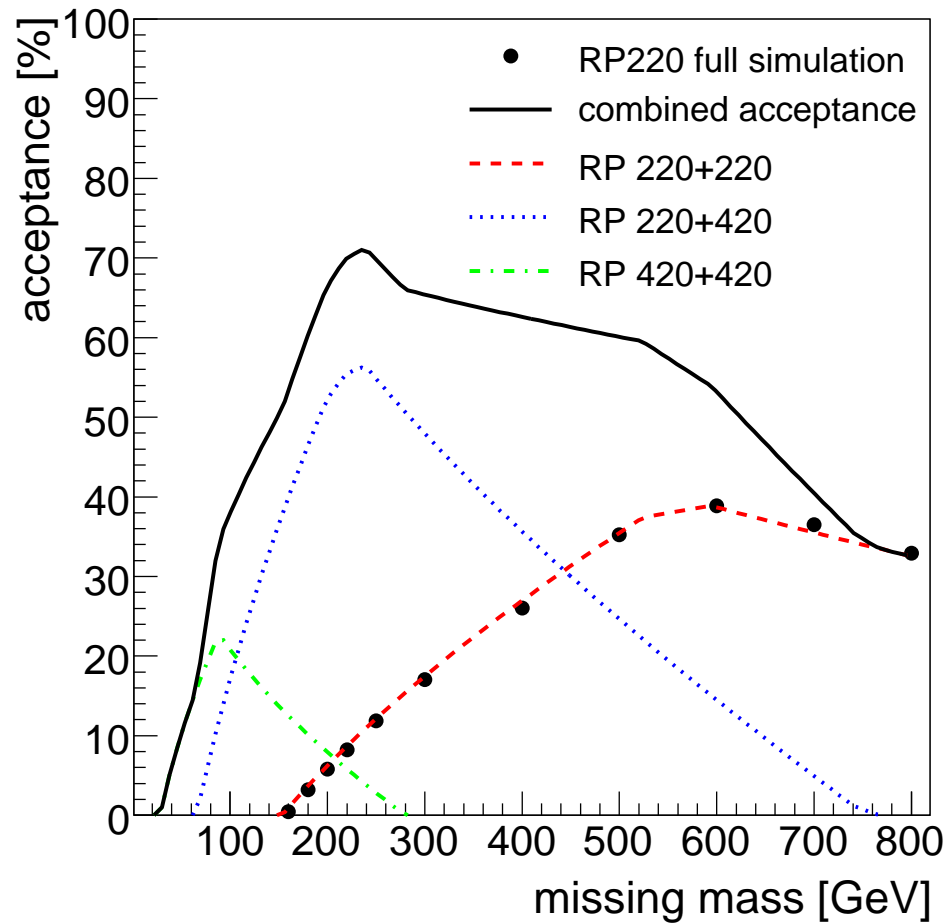
Assume roman pots located at 216 and 224 m

Acceptance for 220 m pots

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



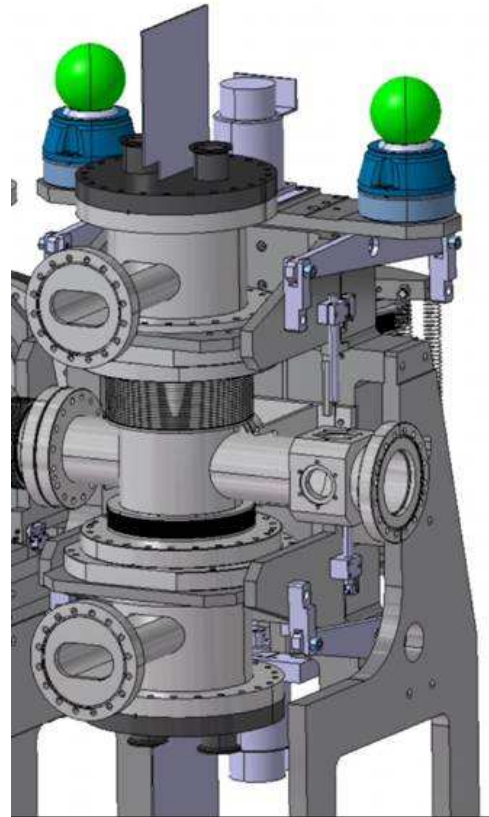
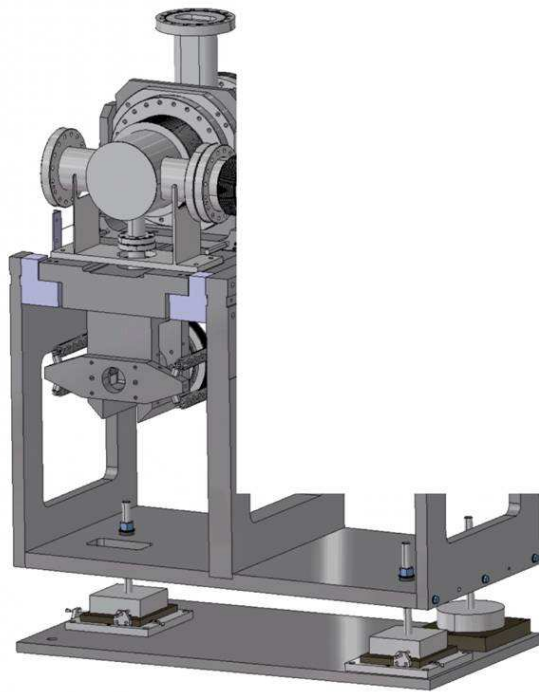
Roman pot projects



Both RP420 and RP220 needed to have a good coverage of acceptance (NB: acceptance slightly smaller in CMS than in ATLAS)

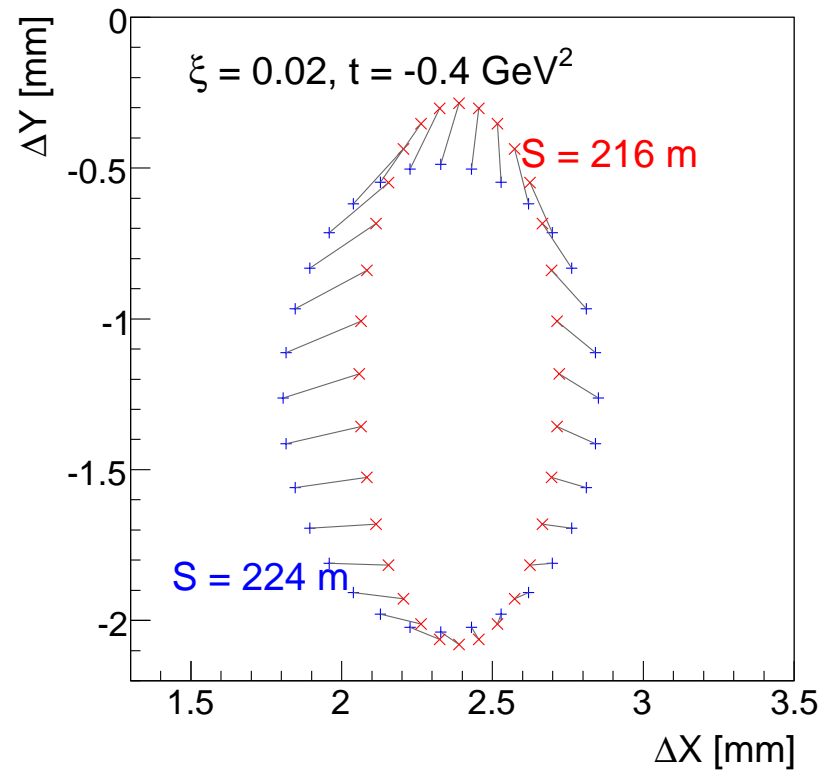
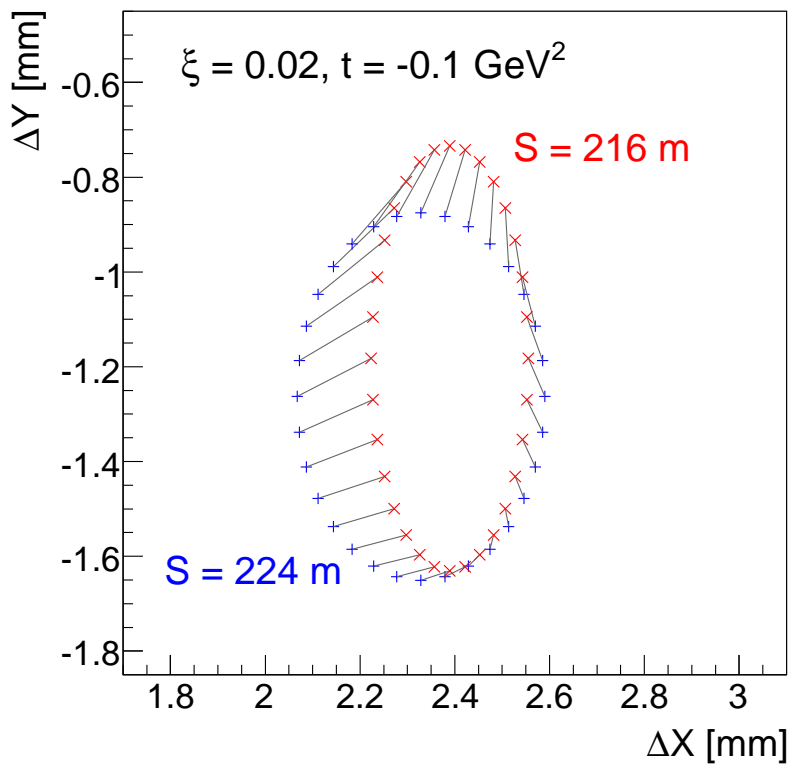
Roman pots at 220 m

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



Hit maps at 216 and 224 m

- Study difference between hit maps at 216 and 224 m:
test the idea of using displacement at the trigger level to distinguish with halo
- No unique shift direction between 216 and 224 m



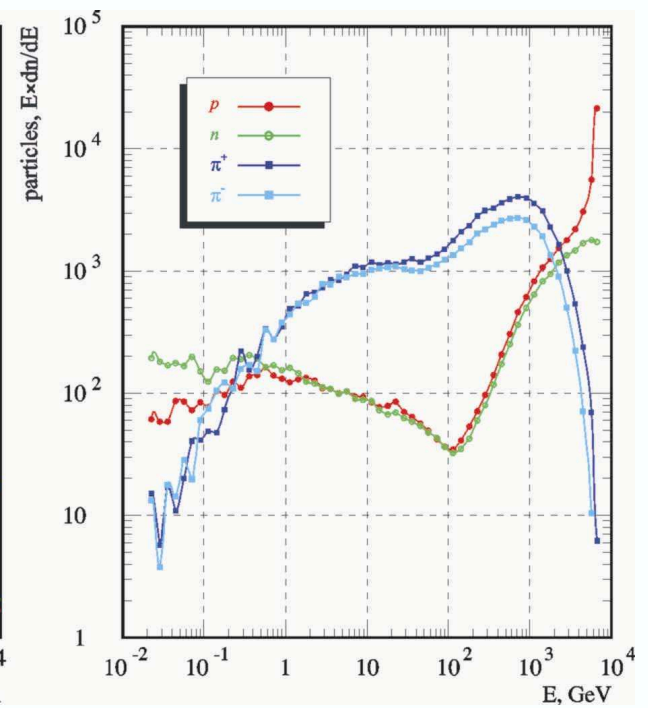
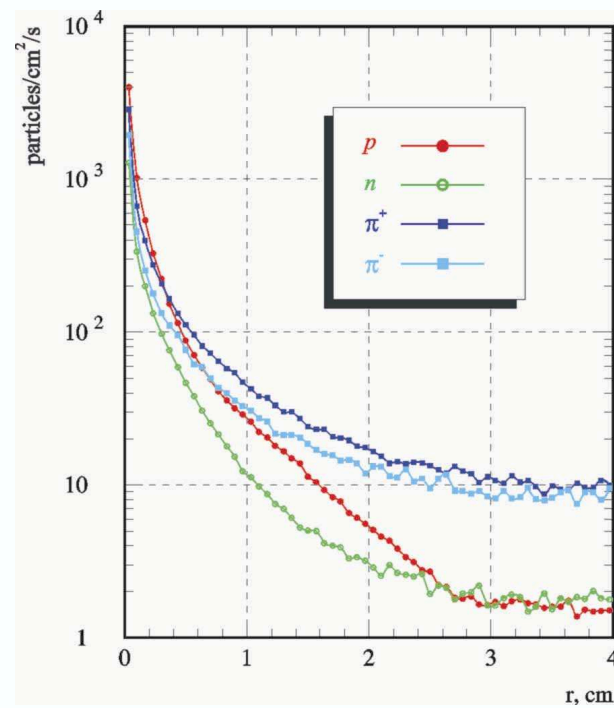
Fluxes in roman pot detectors (from LHC BD)

Fluxes at 220 m at high lumi (10^{34}) (plots for $2 \cdot 10^{29}$)

RATE EVOLUTION WITH CUTS [MD2005]

Particle flux in [Hz]

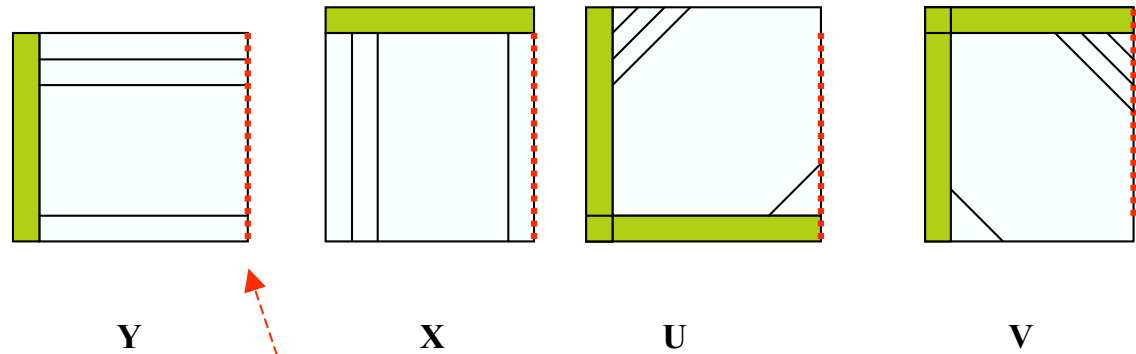
	p	n	π^+	π^-	e^+	e^-	γ
Pot at 220m	344	174	616	406	4630	3361	9.4×10^4



Which kind of detectors?

- Requirement: good resolution in position (good measurement of mass, kinematical properties), and in timing
- Position detectors:
 - Size of Si detectors: $2\text{cm} \times 2\text{cm}$
 - Spatial resolution of the order of $10\text{-}15\ \mu\text{m}$: Si strip detectors of $50\ \mu\text{m}$, as a first proposal: 5 layers, 2 vertical, 1 horizontal, 1 U, 1 V (45 degrees)
 - Edgeless detectors: Between 30 to $60\ \mu\text{m}$
 - First prototype of detector being made by CANBERRA: test-stand (laser and radioactive source) to be installed in Saclay following the Paris 6 experience
 - 2 additional layers used for the trigger: Strip detectors of $100\text{-}200\ \mu\text{m}$ (to be optimised given the fact that we have $1\ \mu\text{s}$ to send the trigger to ATLAS)
 - Readout and trigger chip ABCNext: standard Si readout for ATLAS
 - Other option in collaboration with FP420: 3D Silicon

Different kinds of detectors



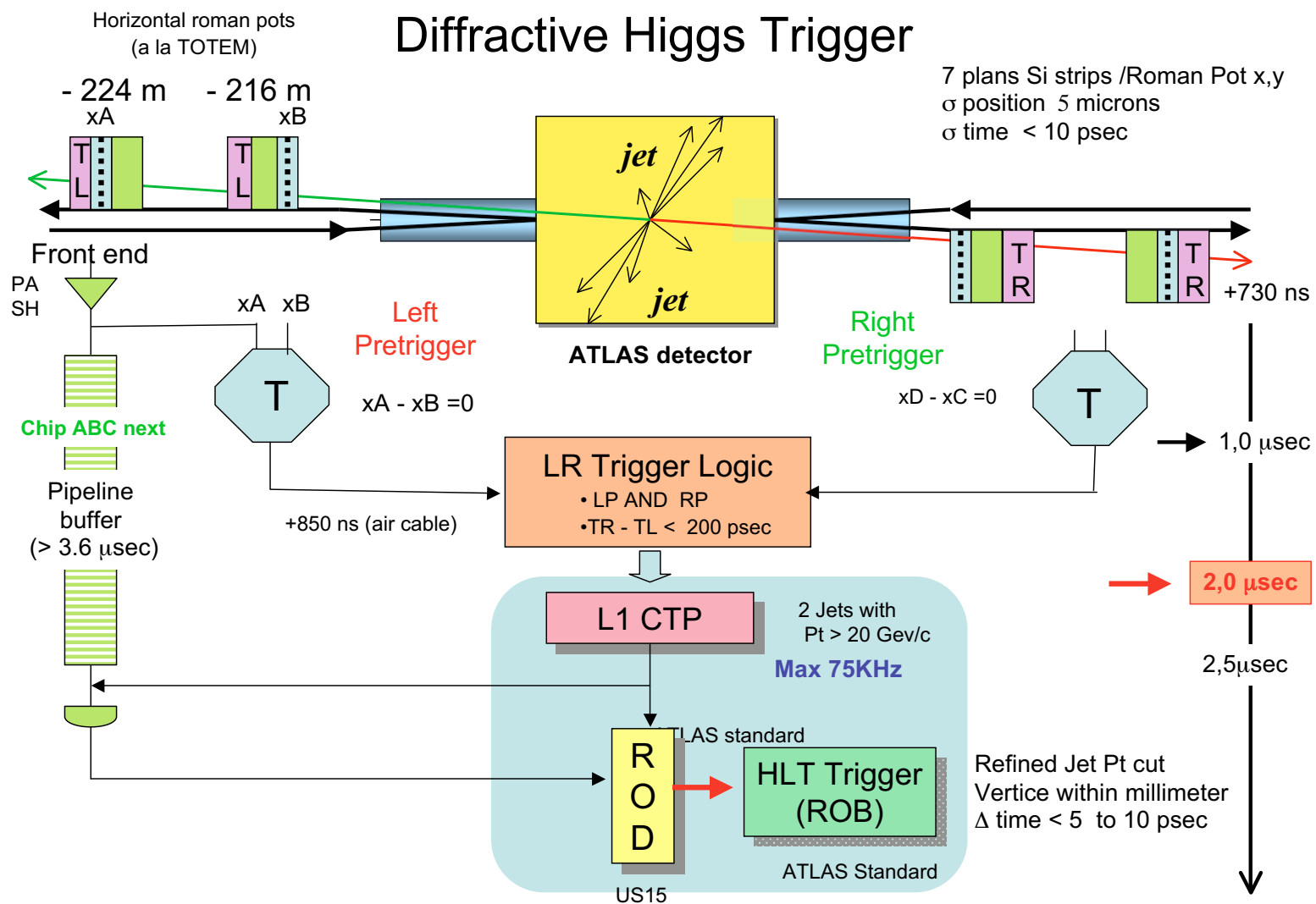
Edgeless cut

- 5 detectors to be used in readout per pot
- 2 additional detectors to be used for triggering (larger strips)

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
 - For more information, see:
<http://www-d0.fnal.gov/royon/timing/>, Saclay workshop on timing detectors on March 8 and 9

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 $3.10^{33} \text{cm}^{-2} \text{s}^{-1}$

Conclusion

- **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 developed by FP420), both solutions to be tested
 - **Timing detectors:** Resolution of the order of 5 ps needed, developed 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 ~ 50 ps), 2012: final timing detector (resolution ~ 5 -10 ps)
 - **Collaboration being built:** Prague, Cracow, Saclay, Stony Brook, Giessen, Michigan State University, Paris 6...
- Other groups very much welcome!