# ATLAS Forward Detector Trigger

ATLAS is presently planning to install forward detectors (Roman Pot system) in the LHC tunnel with prime goal to **measure the luminosity** at very low –t values i.e. in the **Coulomb region**

⇓

the trigger issue is basically simple …

**Outline**

- Detector Layout
- Trigger Implementation
- Trigger Rates

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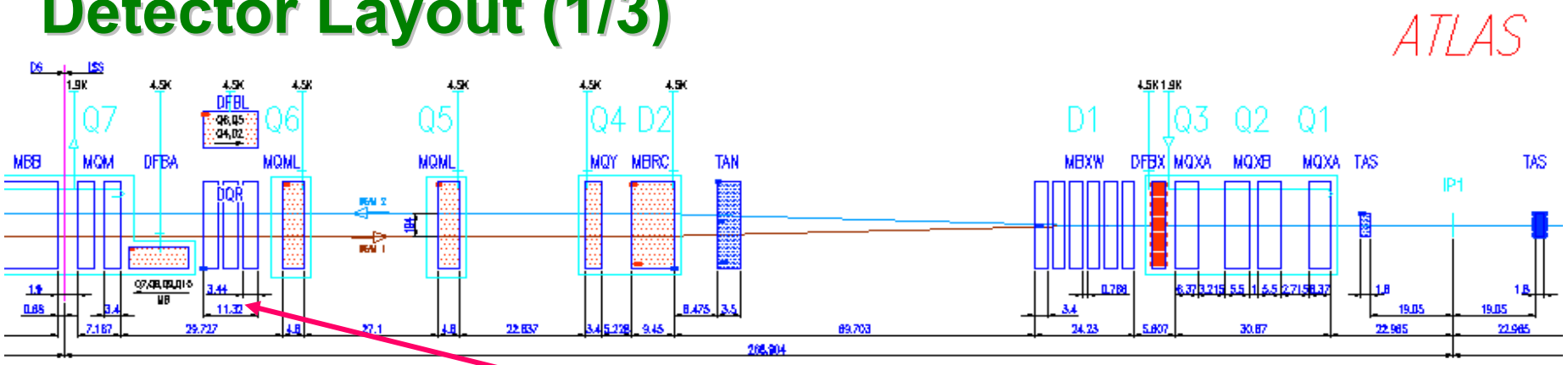
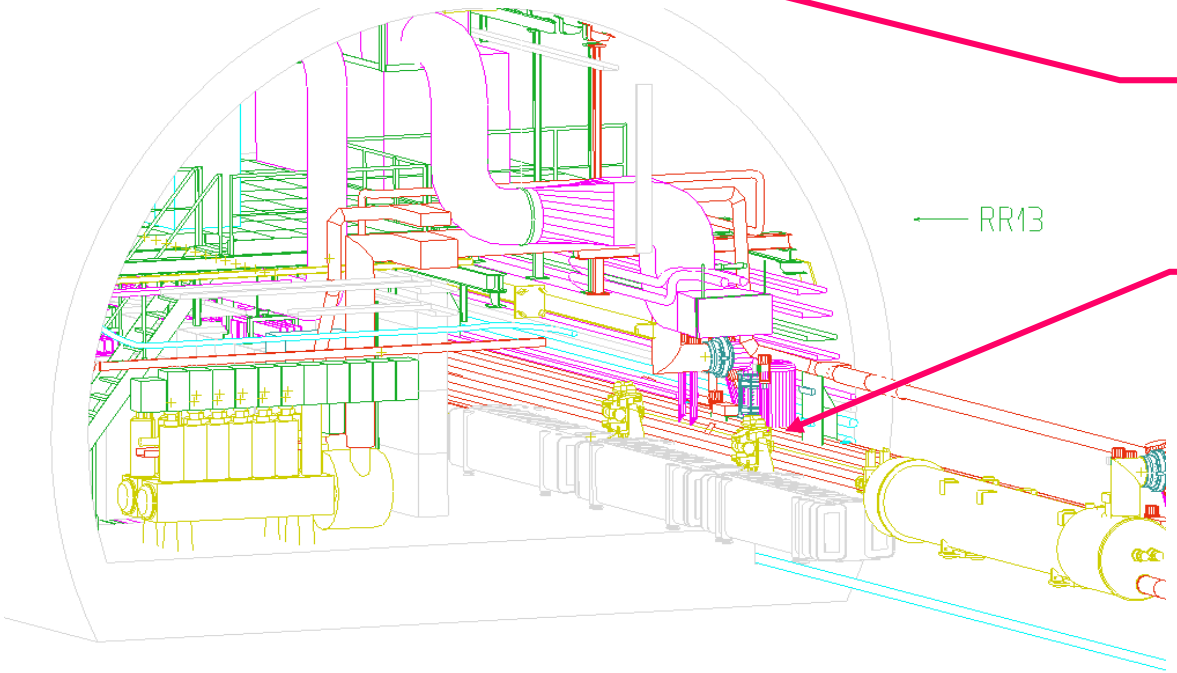
# Detector Layout (1/3)



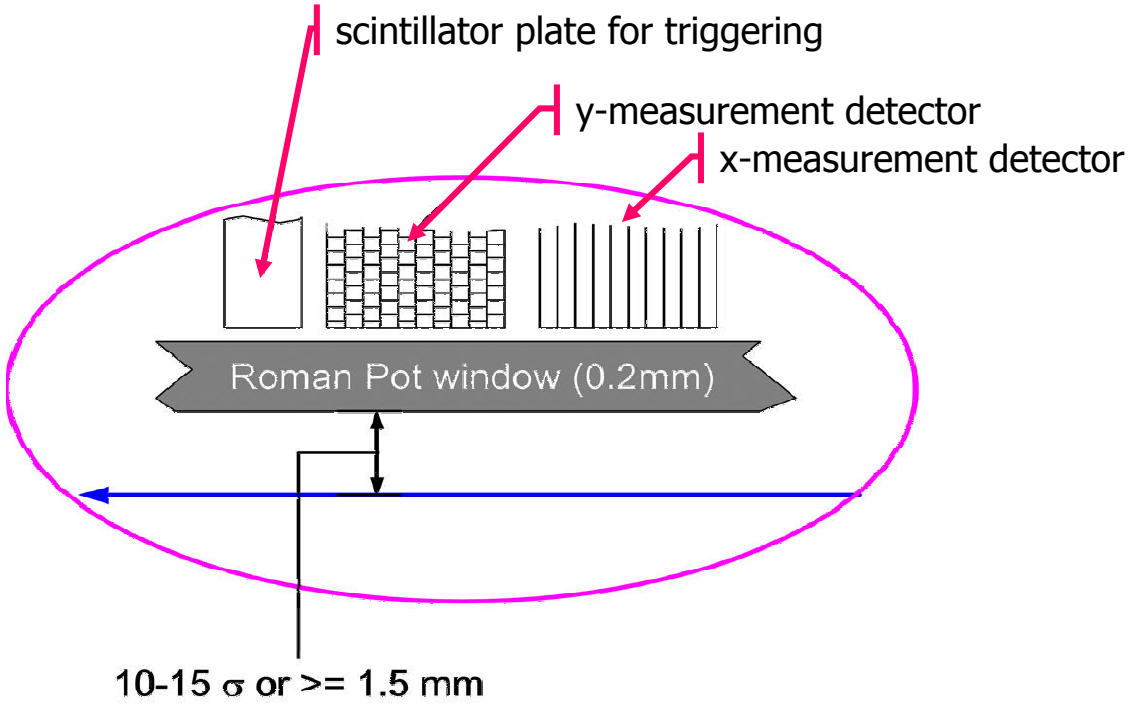

One **Roman Pot Station** per side: left and right from IP1

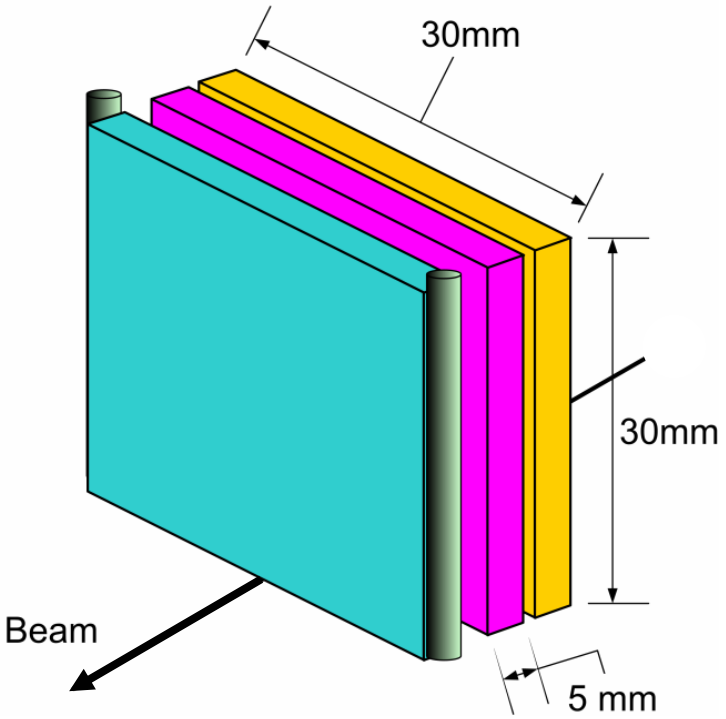
Each **RP station** consists of two **Roman Pot Units** separated by 3.4 m, centered at ~240.0 m from IP1

# Detector Layout (2/3)

## The Roman Pot Detectors

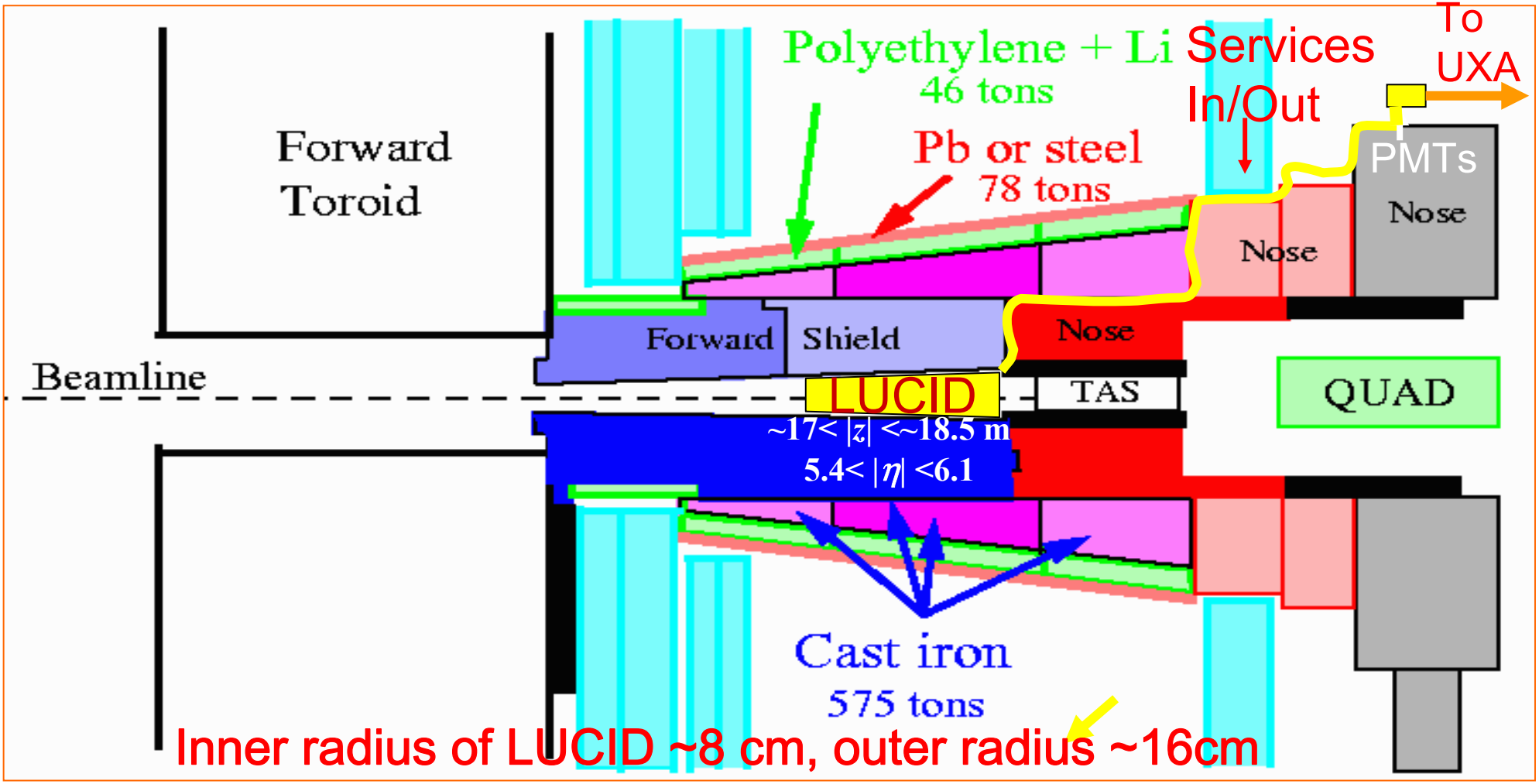
- Scintillating fiber tracker
  - Kuraray 0.5 mm × 0.5 mm fibers
  - 10 layers per coordinate
  - 50 μm offset between layers
- Large scintillator plane for trigger
  - 2-3 mm thick
  - double fiber readout from the edges



# Detector Layout (3/3)

## Luminosity Monitoring Detector - LUCID



# Trigger implementation (1/2)

## Trigger

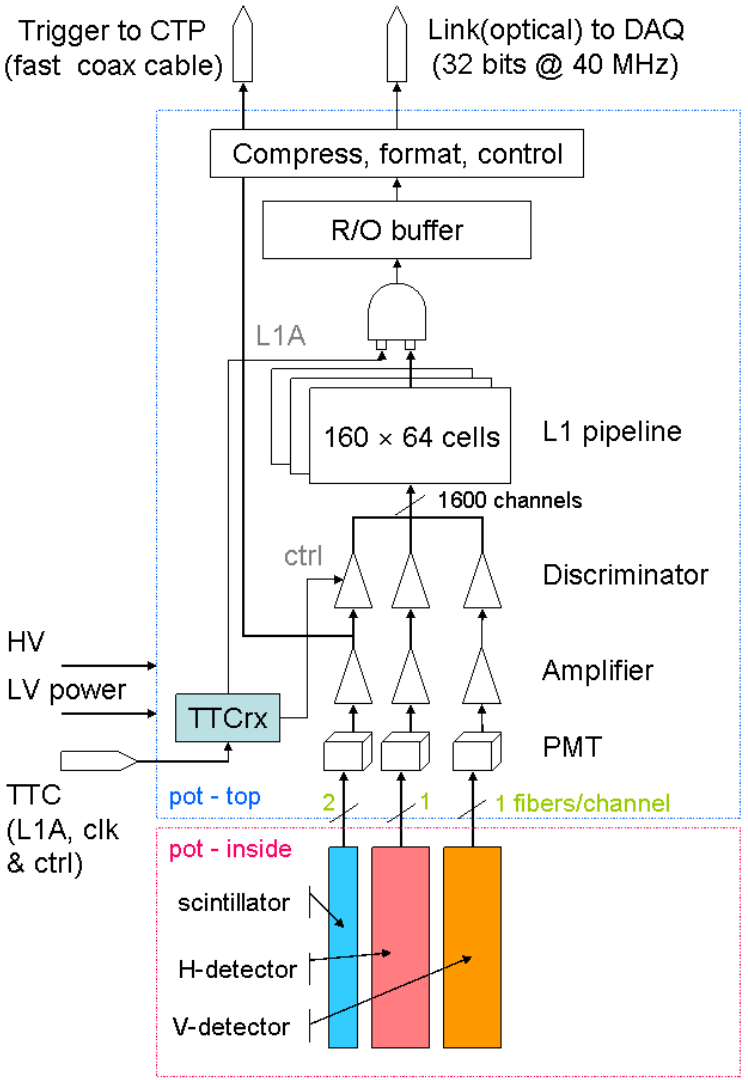
- Basic trigger menu for **elastic events**
  left-side (right-side) up (down) detector ⊕
  right-side (left-side) down (up) detector
- Trigger cables from each detector arrive to USA15
  - Air-core cables - shortest path
  - Final logic within ATLAS central trigger processor-CTP

## Read out modes

- **Stand-alone mode:** RP detectors and LUCID
  - The RP detector and LUCID pipelines will be made sufficiently deep to avoid any latency problems
- **Integrated mode:**
  - Can the RP trigger signals arrive within the defined L1 latency of 1.8us (including 0.4us for contingency) to the ATLAS central trigger processor?

A. YES:
  - The RPs provide the trigger as, other ATLAS sub-detectors
  - Readout RPs, LUCID and any other sub-detector

B. NO:
  - We can program a software trigger in CTP for each BC
  - Running with 43 bunches in the machine (493KHz) and for the maximum L1 rate of 75KHz implies reading one out of 6(7) bunches
  - Loss in statistics



# Trigger implementation (2/2)

## Latency

| | | Time (ns) |
|---|---|---|
| Particle path from IP to RPs | 240(m) × 3.3357 (ns/m) | 800 |
| Signal treatment in local RP electronics | | 50 |
| Signal x-mission from RP to CTP in USA15 | 280 (m) × 3.586 (93%) (ns/m) | 1004 |
| Final coincidence – trigger menu | | 100(0) |
| | **Total** | **1954(1854)** |

- Almost meets the ATLAS L1 latency requirement of **1.8 us**
  - The final estimate can only be done after the cable path from the RPs to USA15 is defined
- If finally required, going beyond the 1.8us may be possible
  - The L1 latency is determined by the length of the pipelines for the LArgon Calorimeter
  - It has a length of 144 cells (3.6 us) part of which is used as derandomizer buffer to avoid dead time at the maximum rate of 75(100)KHz
  - Given the low rate for our case, the FE chips could be re-programmed to reduce the buffer space in favour of the pipeline part
    - For example going from **1.8us to 2.1us** seems quite feasible, however would require re-timing of ATLAS

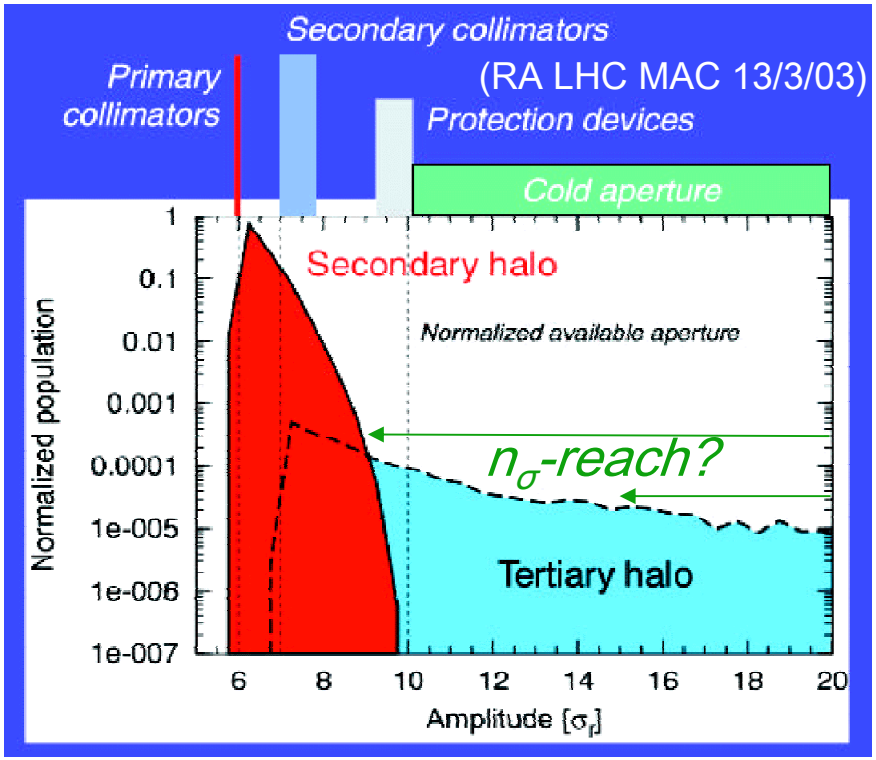
# Trigger Rates (1/1)

## Trigger rates

- Expected trigger rate for elastic events : **~ 30 Hz**
  - **1M events / 12 hours at $10^{27}$ cm$^{-2}$ s$^{-1}$**

## Backgrounds

- **Halo rate**
  - Depends on the collimation efficiency and detector position
  - 43 bunches in the machine, $10^{10}$ ppb, $\varepsilon_N$ = 1.0 um rad, $n_\sigma$=10 → 6-10 KHz
  - Is drastically reduced once a left-right coincidence is applied




- **Beam gas**
  - Also reduced by back-to-back signature
  - Even further using time of flight from IP and vertex reconstruction extrapolating the "local track" found in the two RP units

# Summary

At this (early) stage for our project:

- Triggering for the luminosity measurement with the Roman Pot detectors not our major worry
- Trigger detector, mode of operation, Rates and backgrounds for the running scenarios we envisage seem under control
- Main issue that of latency
  - We could say more once the cable path for the RP detectors (along with final ATLAS cabling) is defined
  - However possible solutions exist – will be evaluated if necessary

Still quite some way to go…..