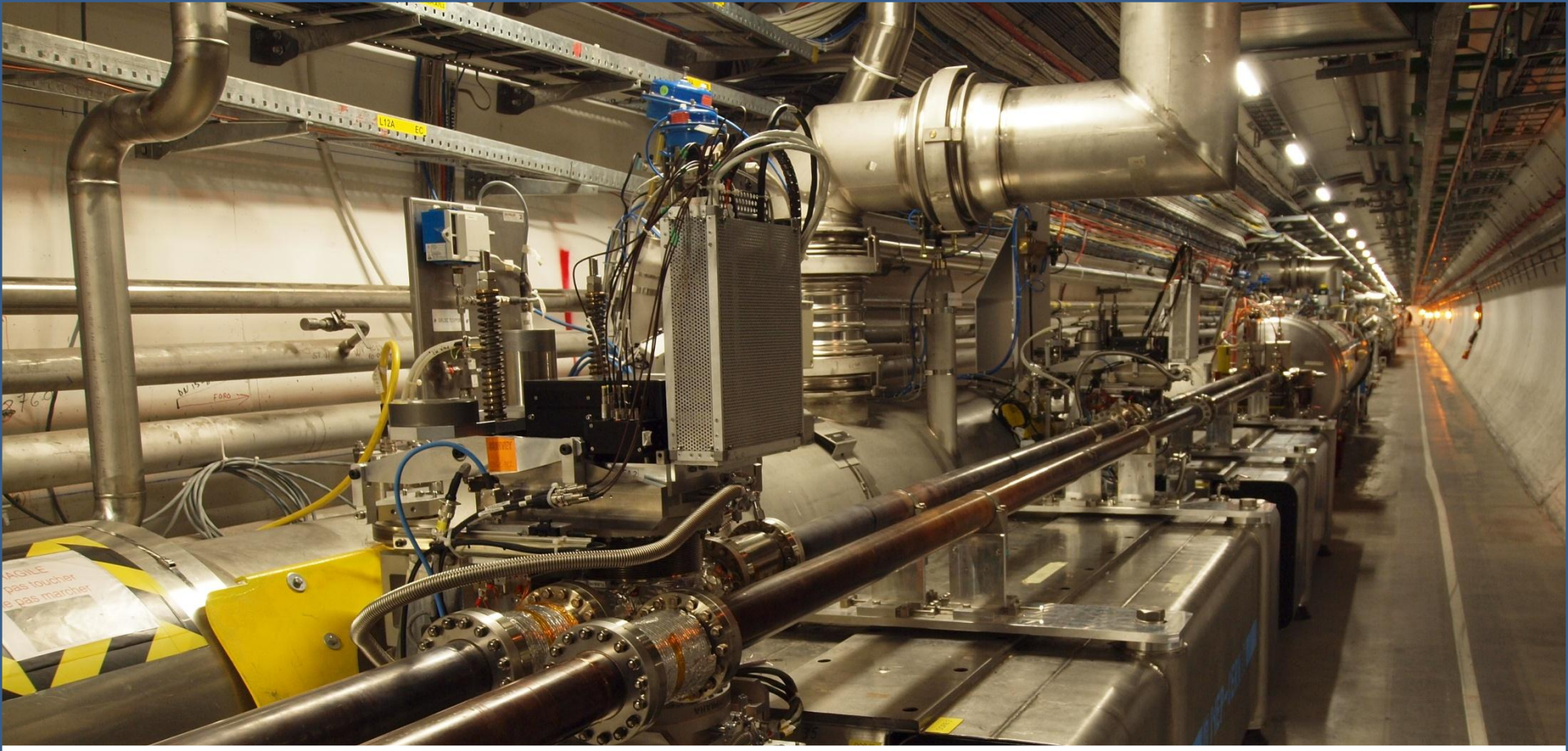


Measurement of elastic scattering with ALFA

– and the many steps before

Sune Jakobsen

On behalf of the ATLAS collaboration

Agenda

ALFA detector system

Installation of ALFA in 2011

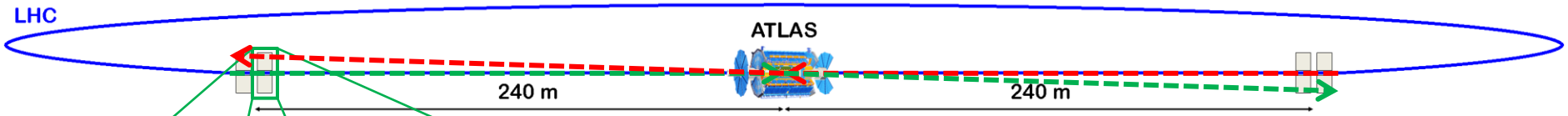
Triggering of ATLAS by ALFA

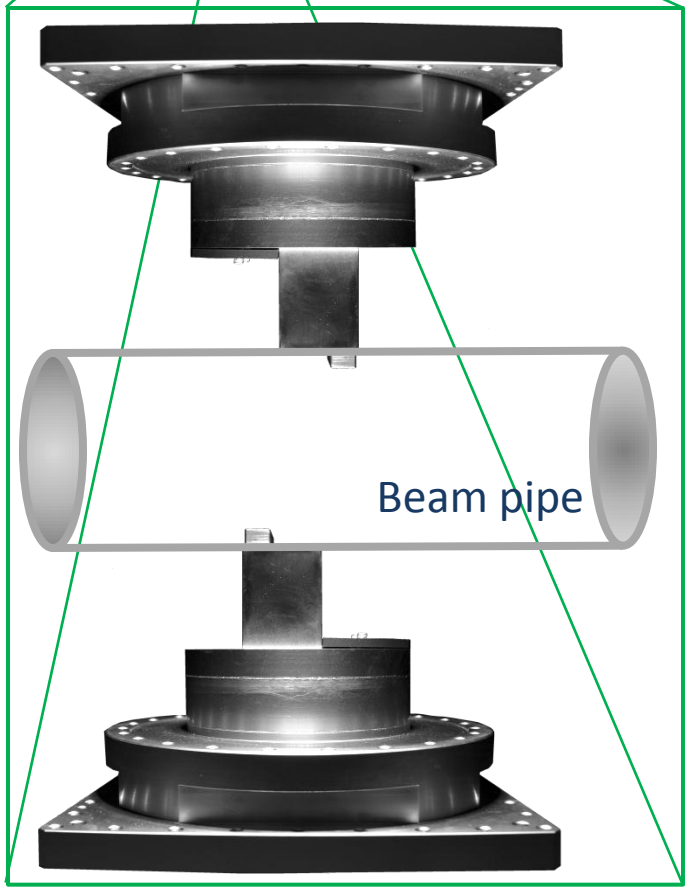
Beam based alignment (scraping)

β* = 90 m campaign 2011- determination of total cross section

Summary and plans for 2012

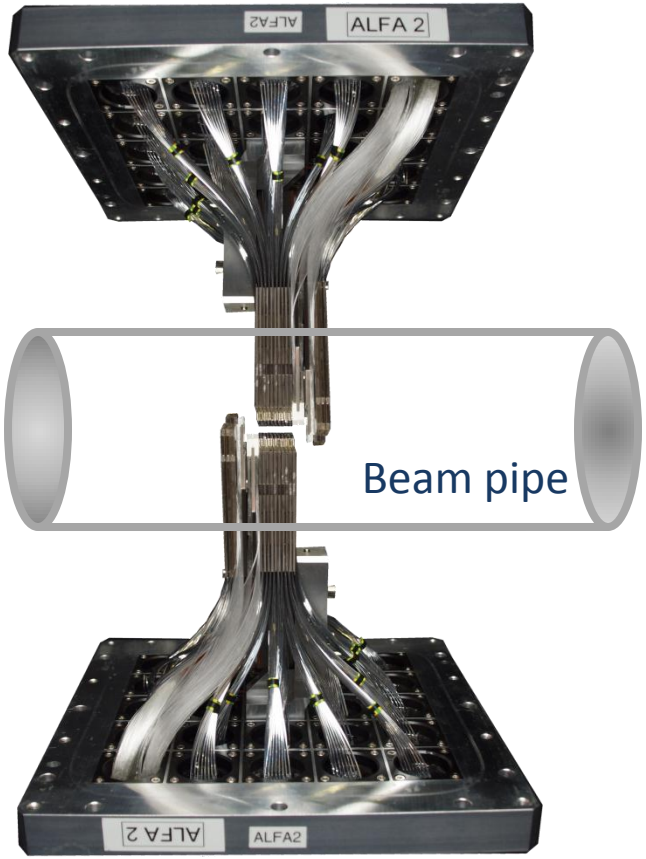
Absolute Luminosity For ATLAS - ALFA



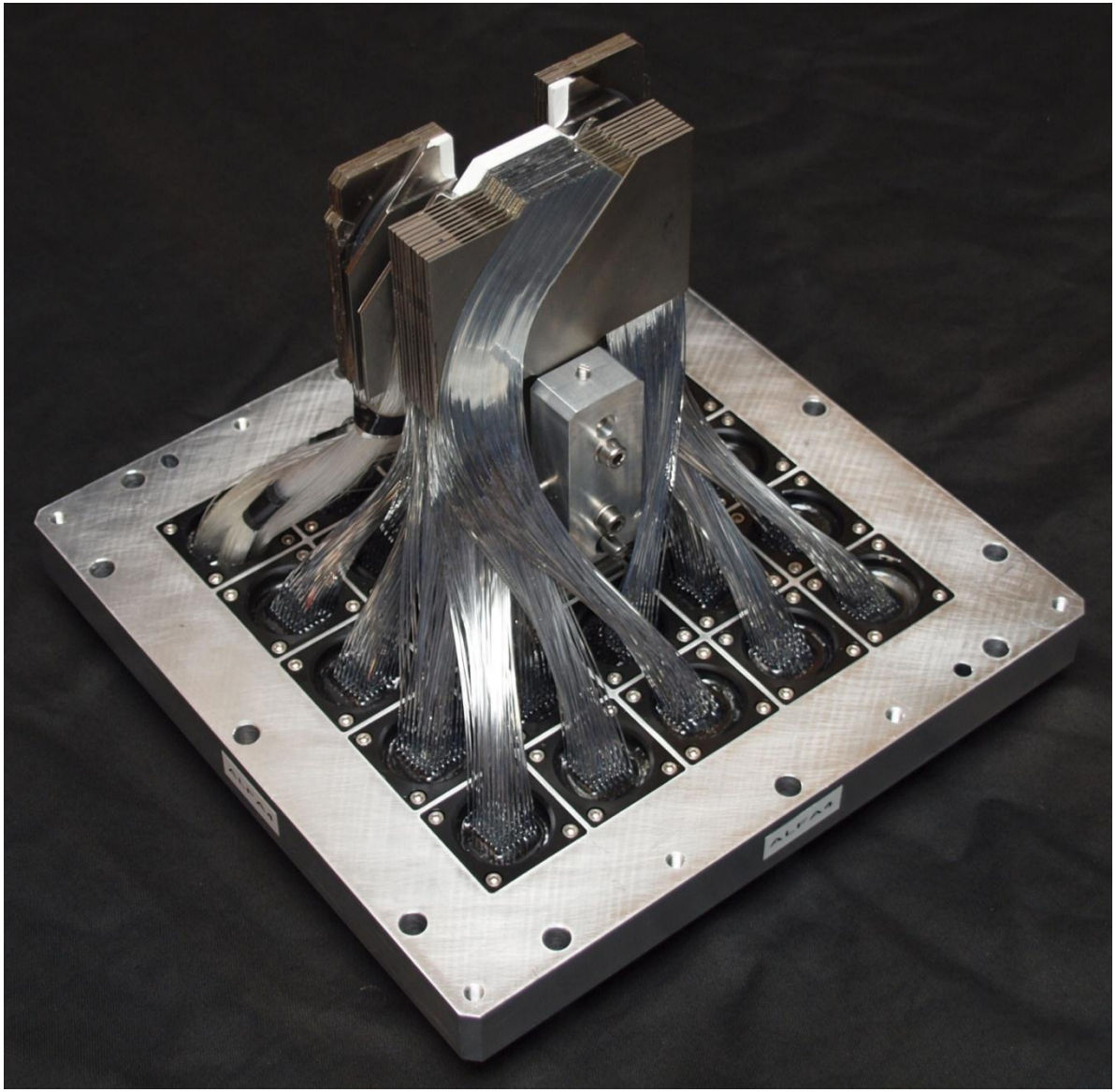


Approach the beam to few mm with Roman Pot

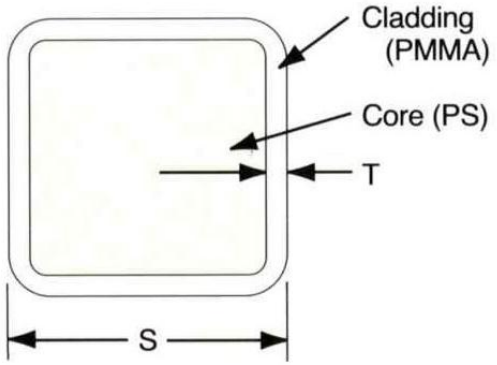
Only used in dedicated high β* runs



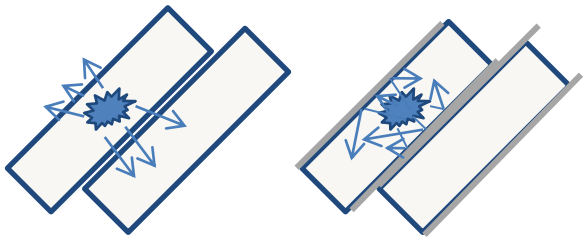
ALFA detector



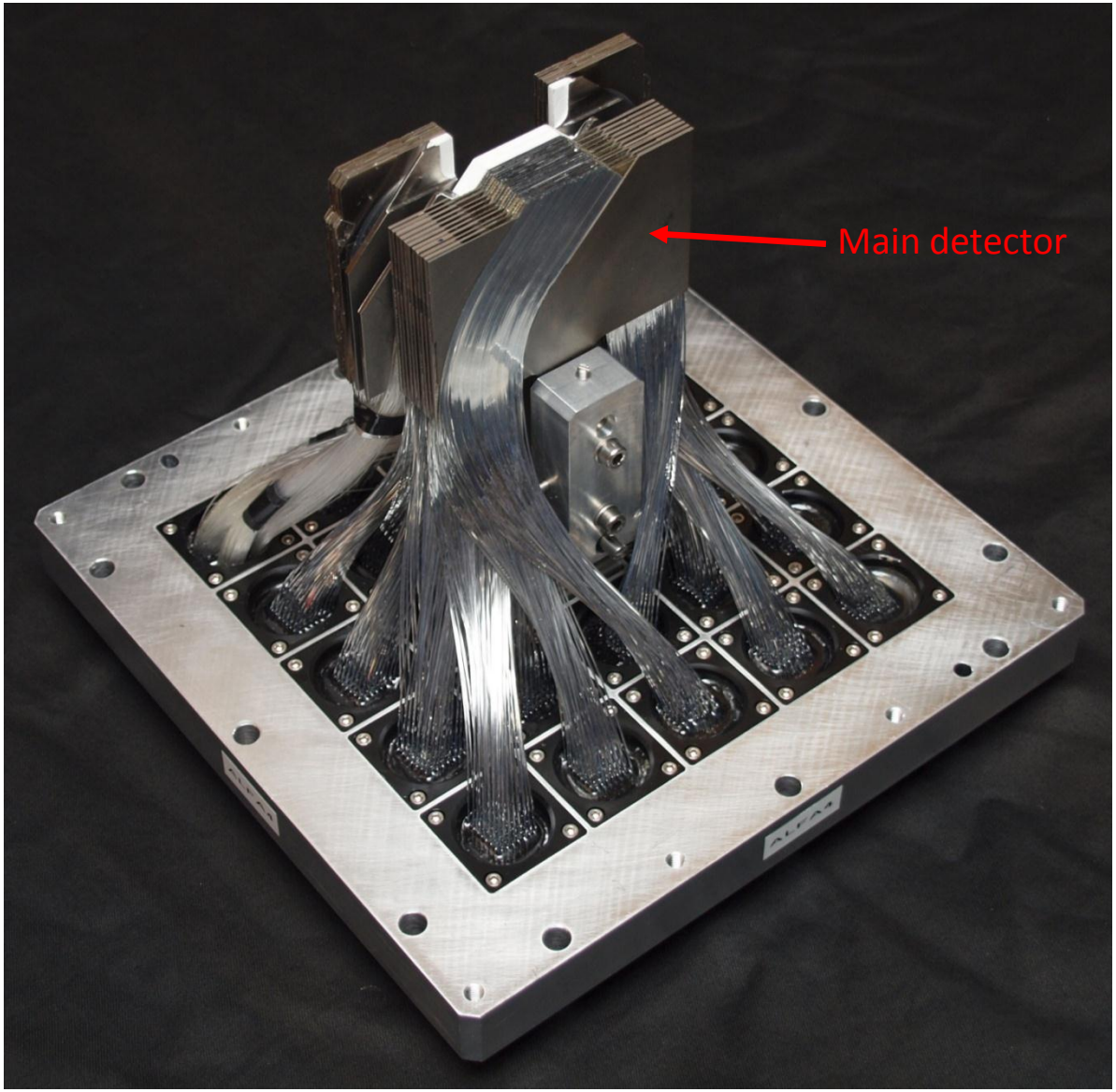
500 µm scintillating fibers



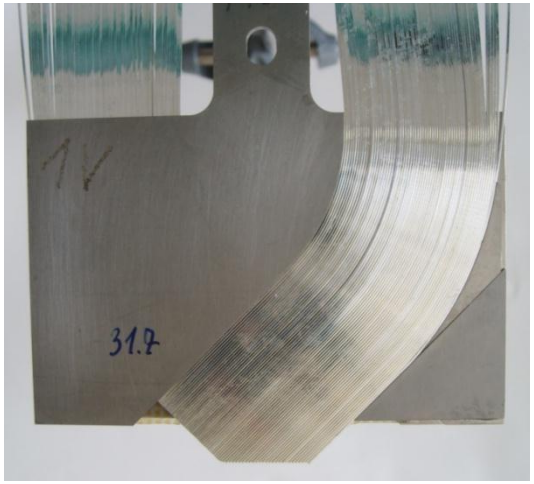
Aluminum coating



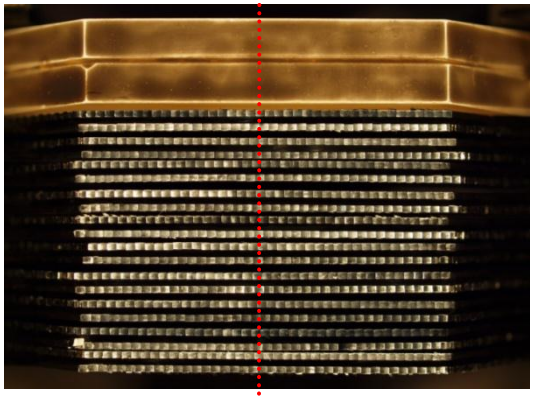
ALFA detector



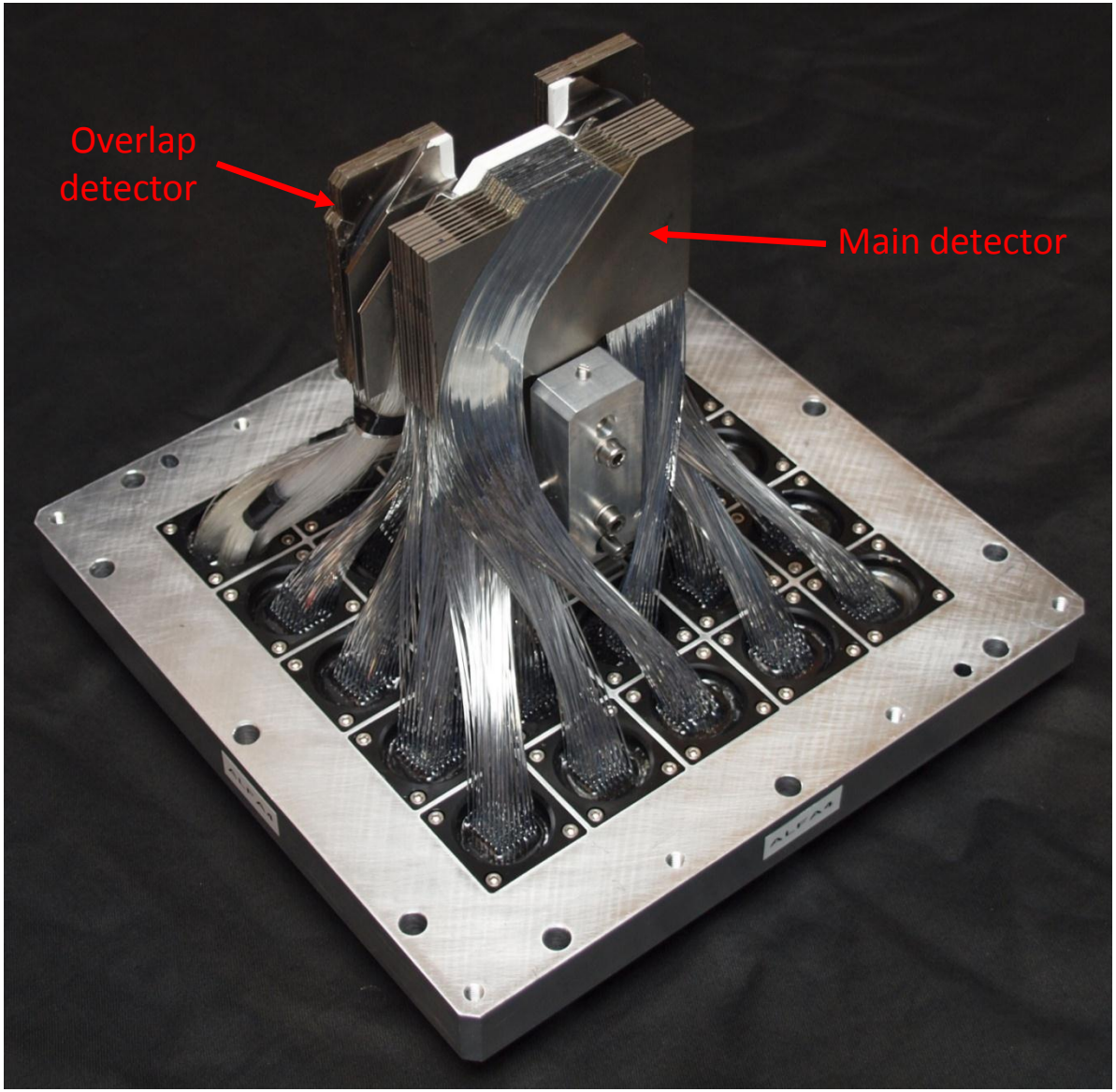
Main detector plan



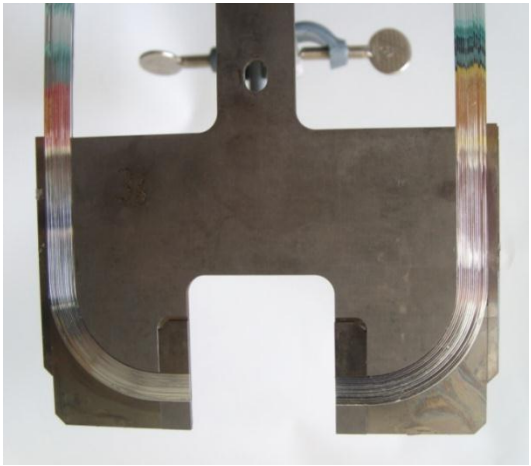
Staggering of plans



ALFA detector



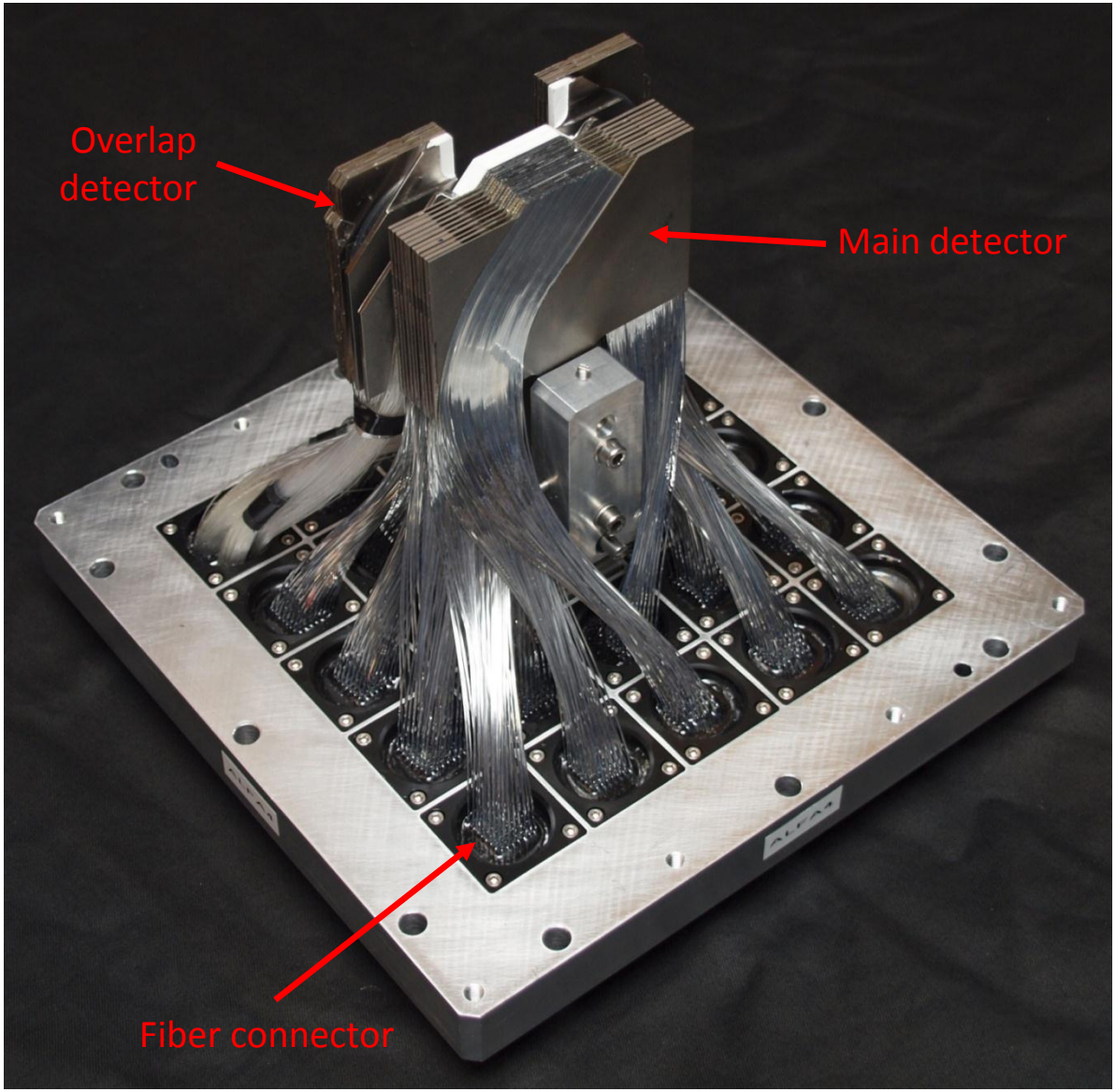
Overlap detector plan



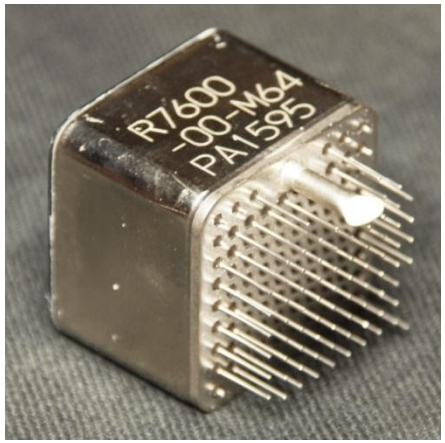
Overlap detector principle

on slide 15

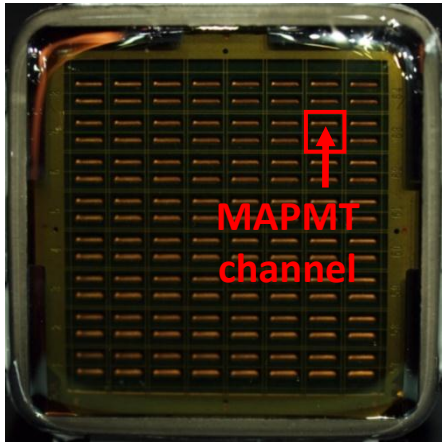
ALFA detector



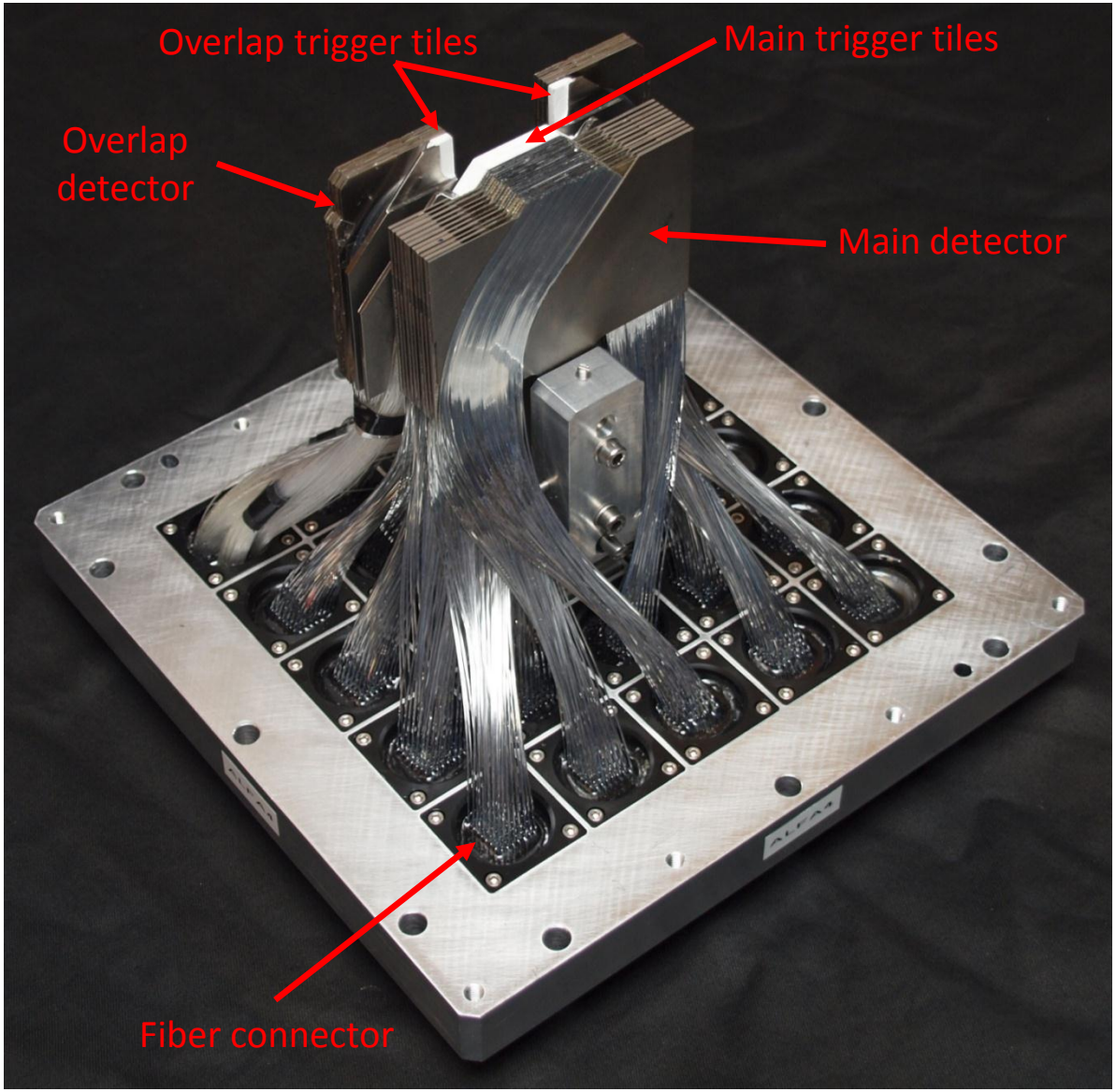
MultiAnode PhotoMultiplier Tube (MAPMT)



64 individual channels

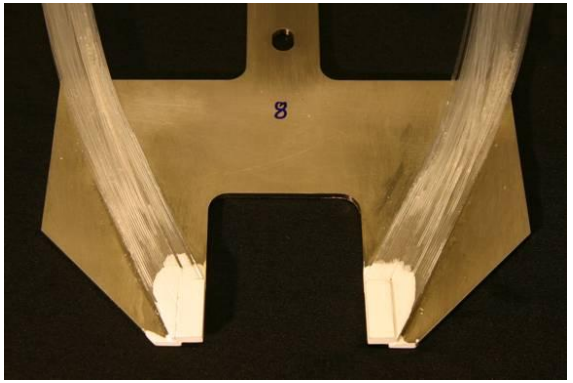


ALFA detector

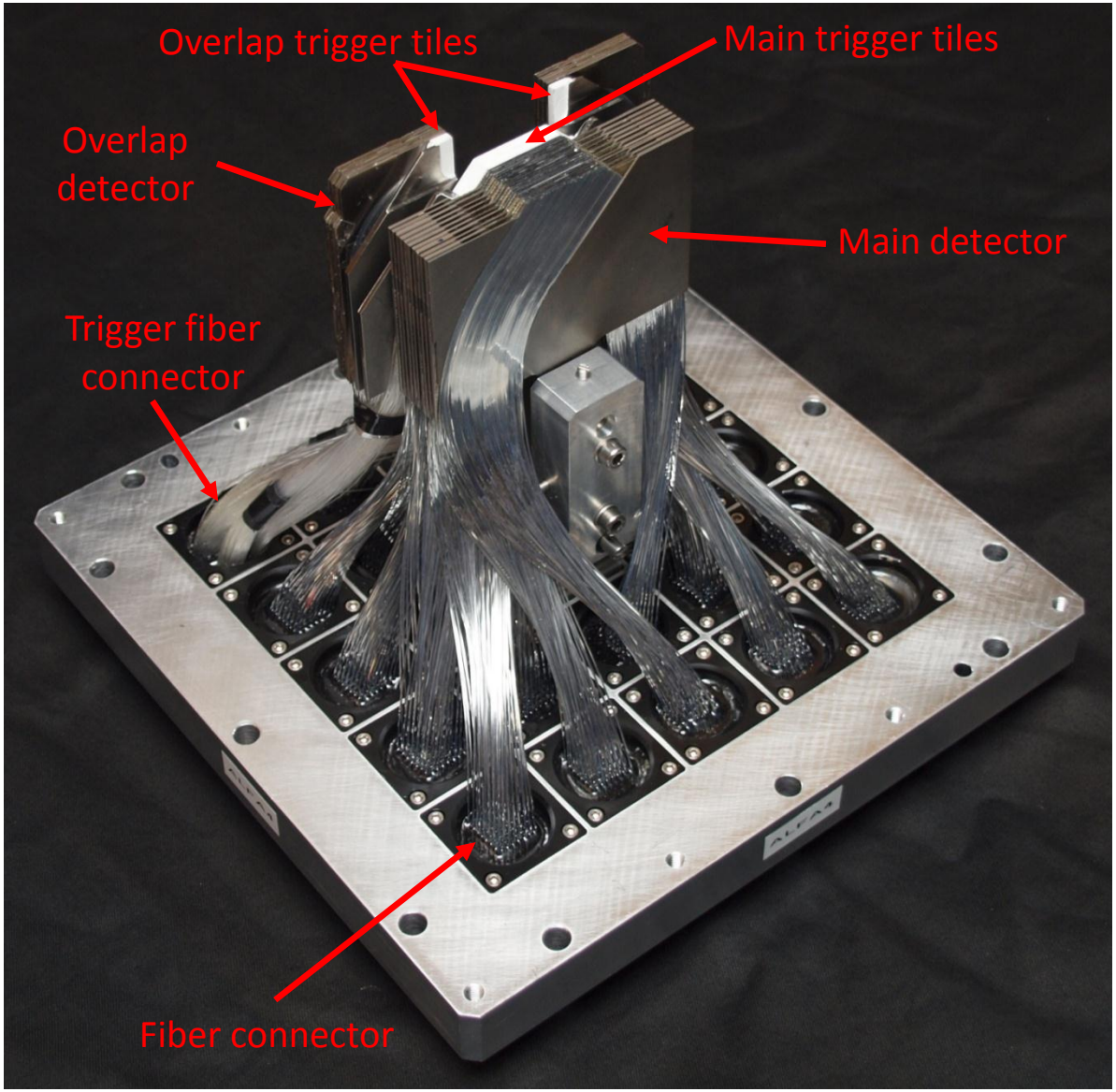


Main trigger scintillator tile

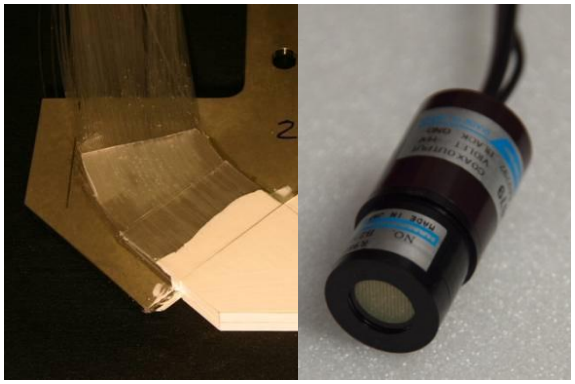
Overlap trigger scintillator tiles



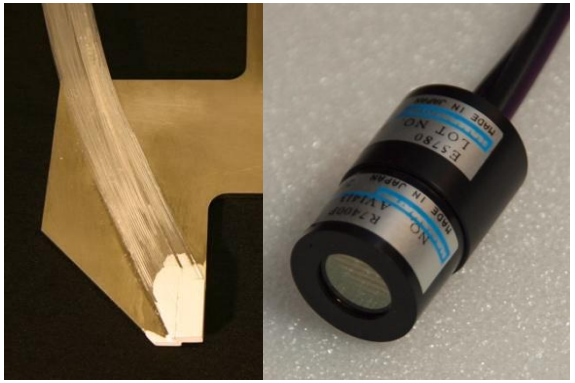
ALFA detector



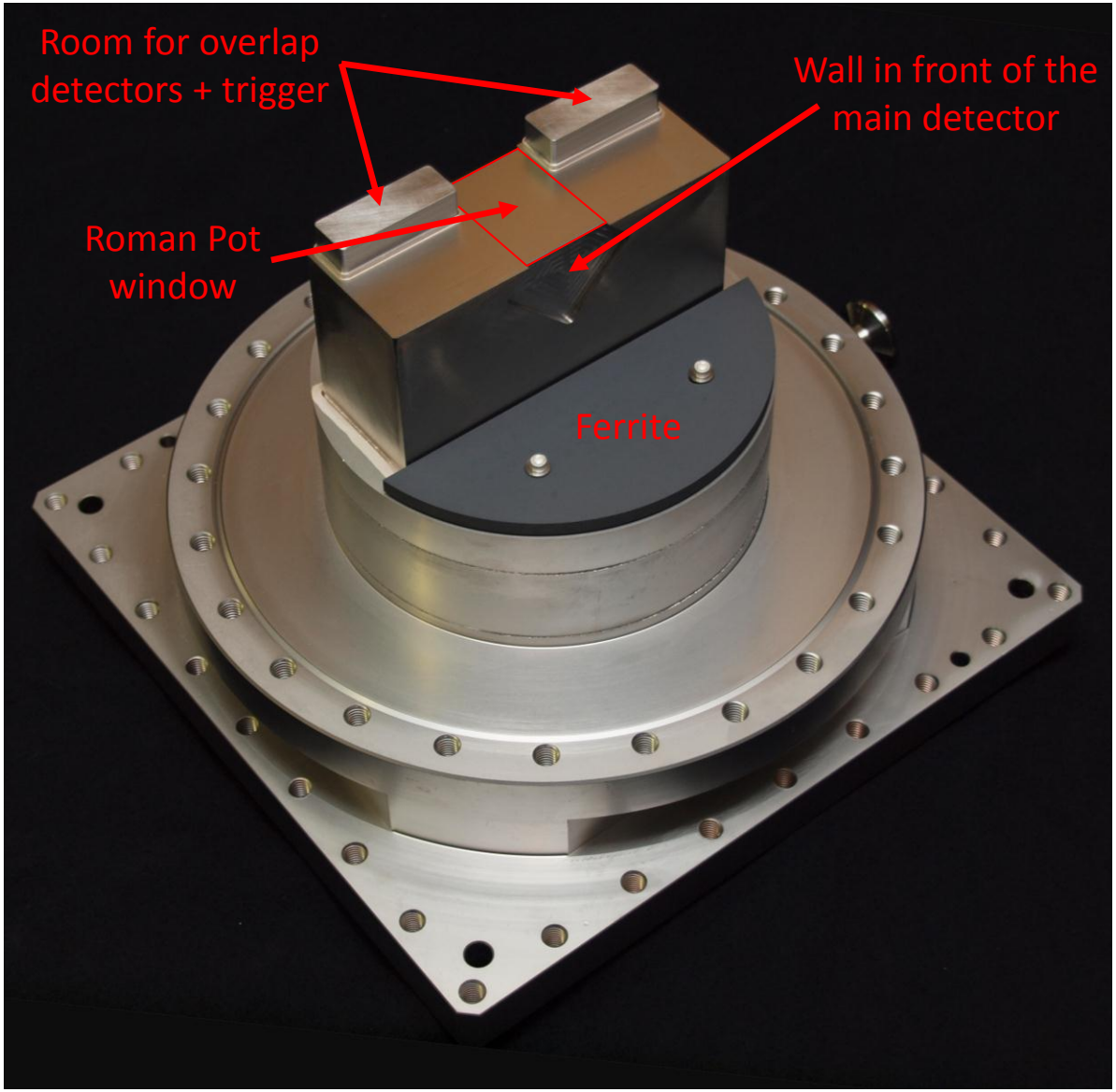
Main trigger scintillator tile



Overlap trigger scintillator tiles



ALFA Roman Pot



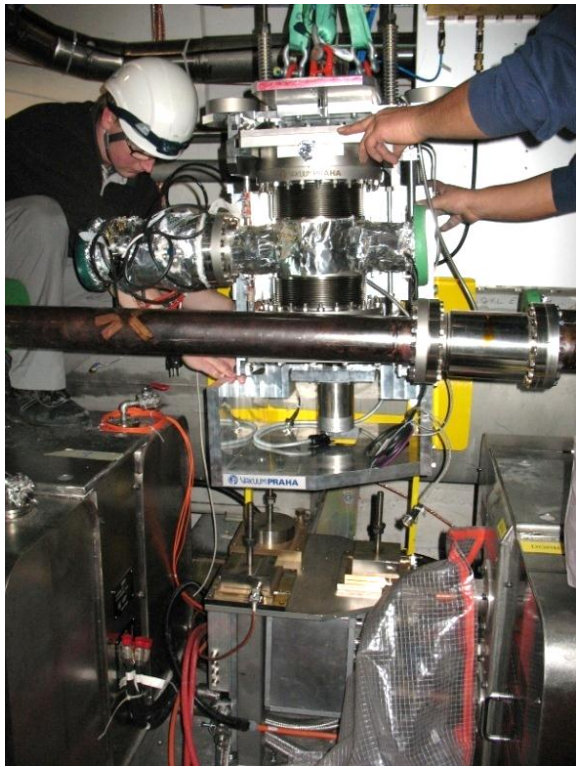
Separates the detector from the ultra high beam vacuum

Window thickness 200 µm

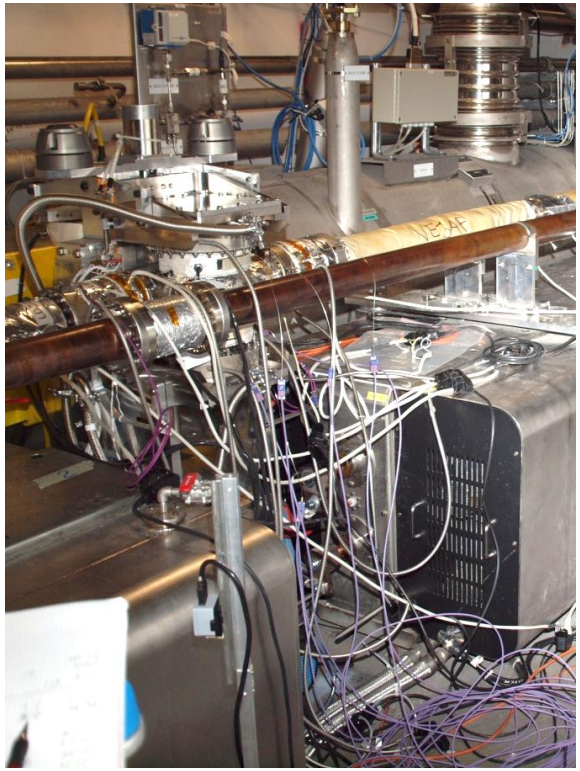
Secondary vacuum inside (detector side) to keep window flat

Station installation in LHC

Palfinger with ALFA station



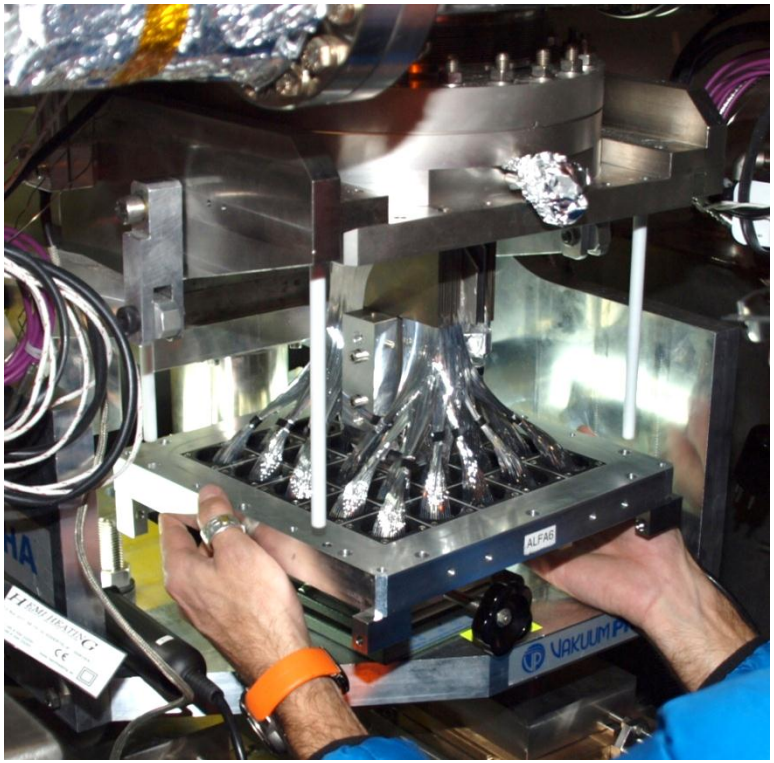
Positioning of the station on the foot



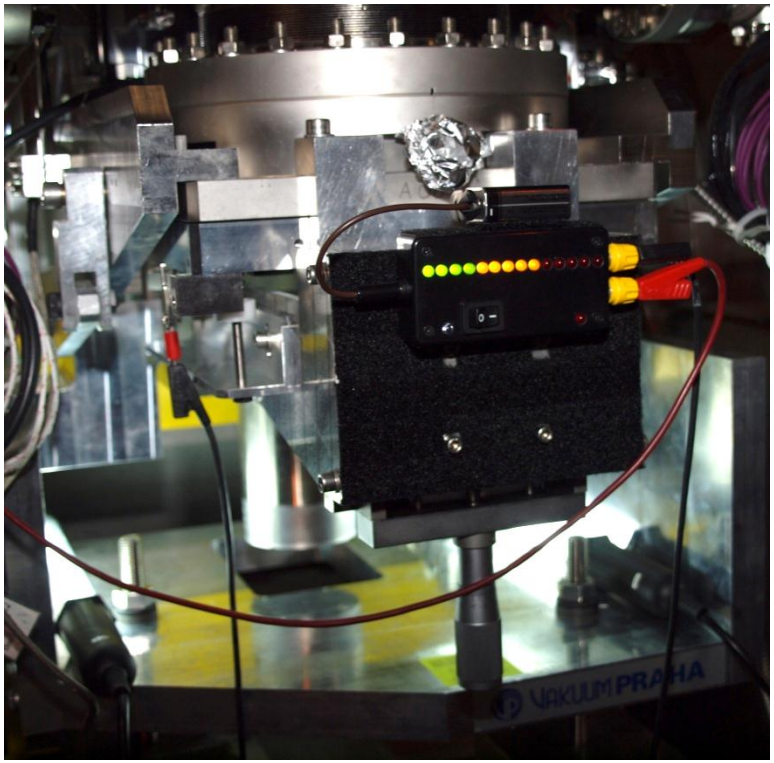
Bake out equipment installed on the ALFA stations and the beam pipe

Detector installation

Very delicate due to gaps between detector and Roman Pots of about 100-200 µm



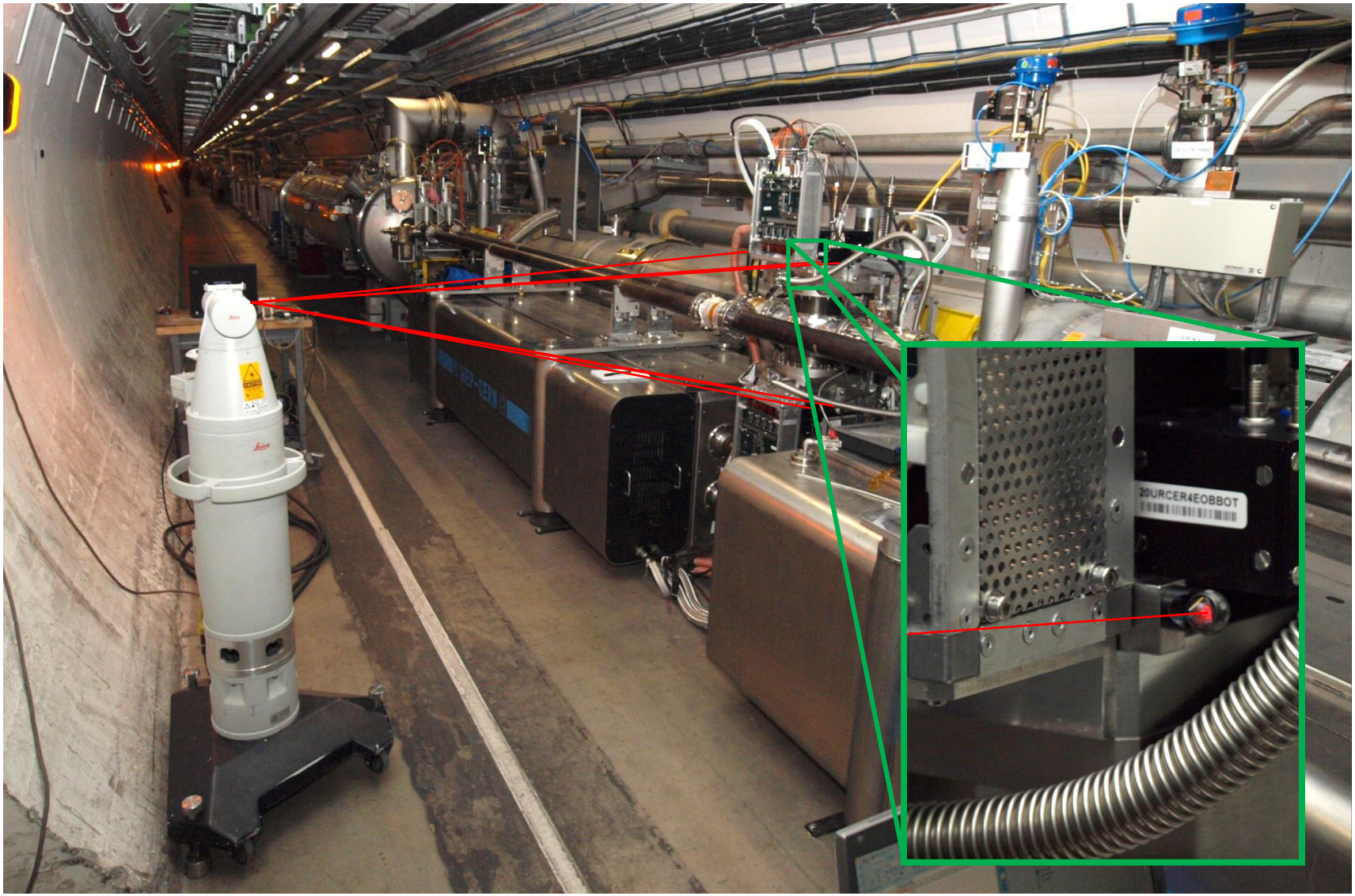
Detector on lifting table



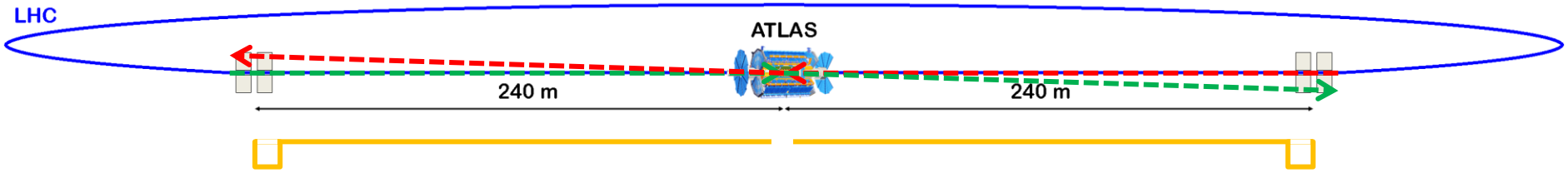
Custom made tools used

All detectors installed without problems

Survey in LHC to calibrate movement system



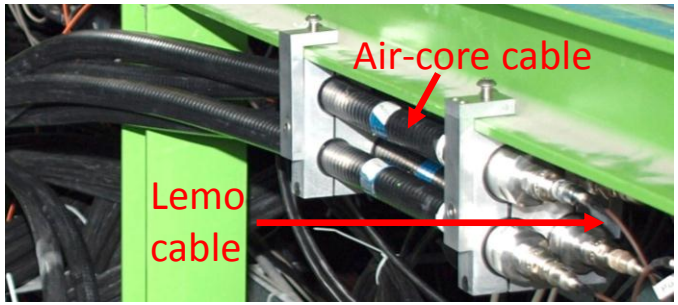
Delay of ALFA trigger signals



The particles have to travel 240 m (~800 ns) from the interaction point before reaching ALFA.

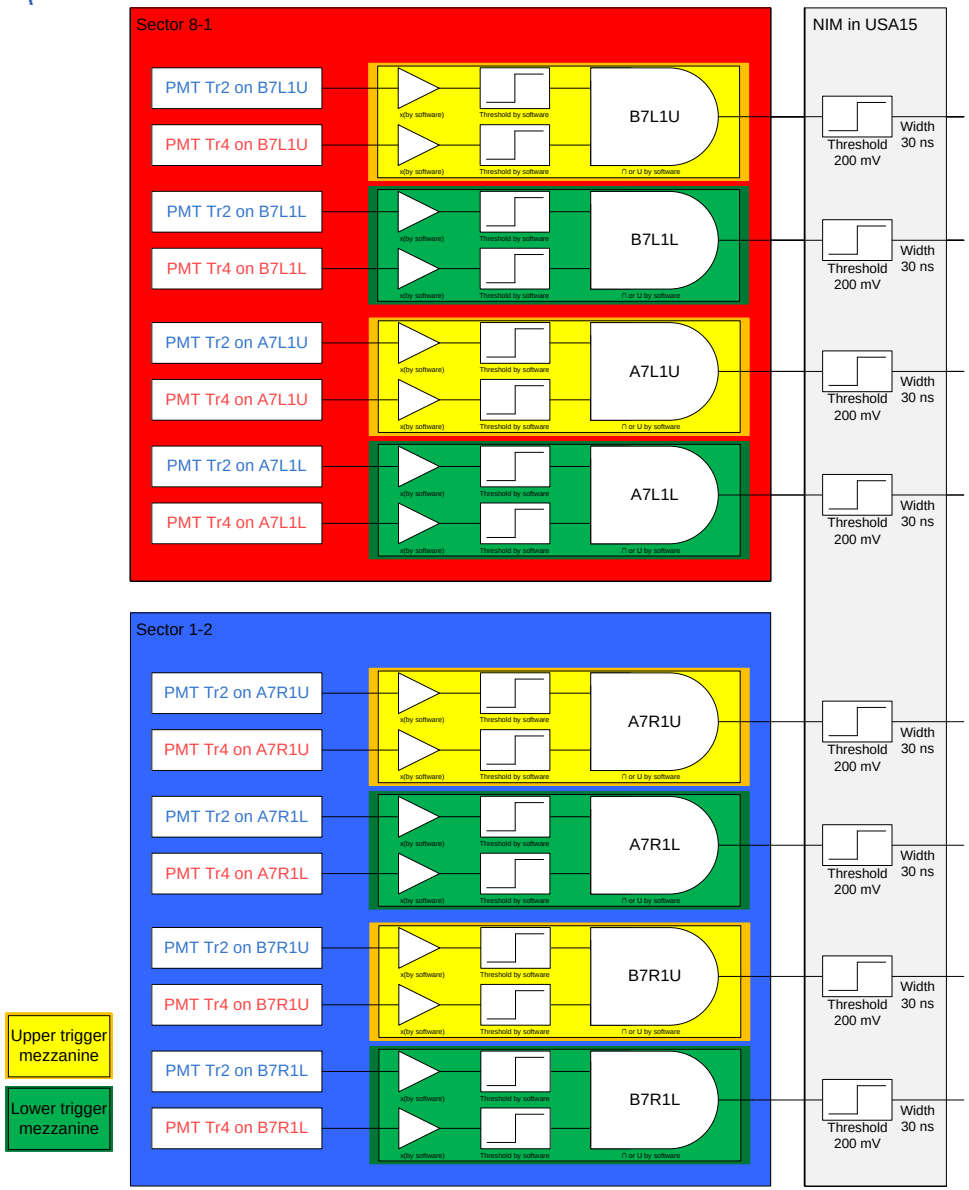
The trigger signals has to travel back to ATLAS.

Special air-core cables used with signal speed of 91 % c.

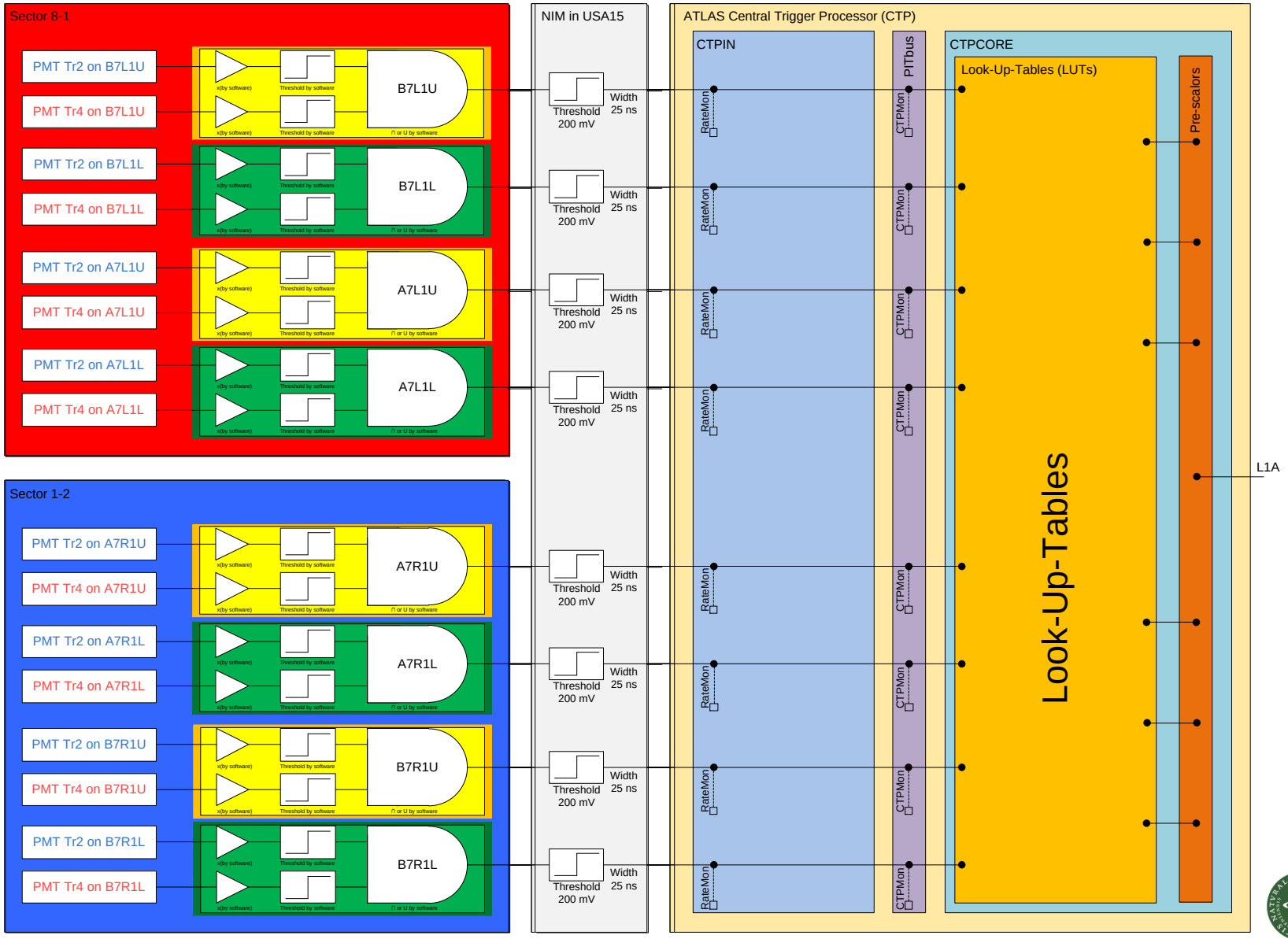


Signals arrives 500 ns later the normal ATLAS triggers, so a special latency/buffer setting has to be used when ALFA is included in the global ATLAS trigger.

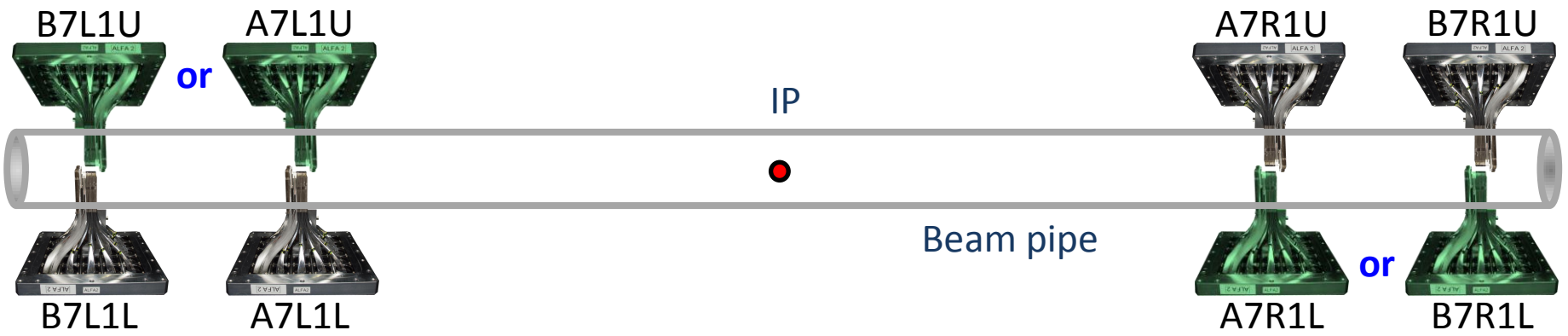
Current logic for main triggers



Current logic for main triggers

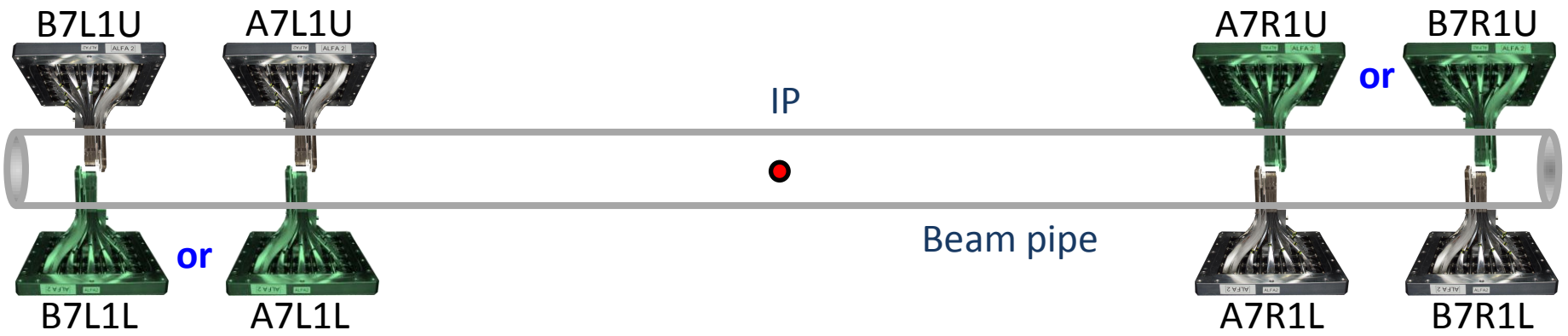


Examples of Look-Up-Tables



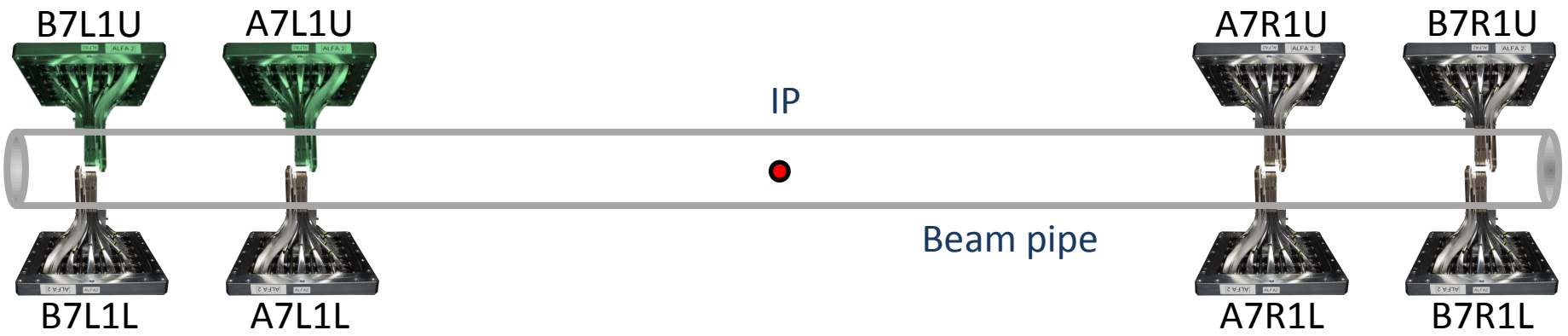
Elastics15	(B7L1U or A7L1U) and (A7R1L or B7R1L)
Elastics18	(B7L1L or A7L1L) and (A7R1U or B7R1U)
Single_Diffraction5	B7L1U and A7L1U
Single_Diffraction6	A7R1L and B7R1L
Single_Diffraction7	B7L1L and A7L1L
Single_Diffraction8	A7R1U and B7R1U

Examples of Look-Up-Tables



Elastics15	(B7L1U or A7L1U) and (A7R1L or B7R1L)
Elastics18	(B7L1L or A7L1L) and (A7R1U or B7R1U)
Single_Diffraction5	B7L1U and A7L1U
Single_Diffraction6	A7R1L and B7R1L
Single_Diffraction7	B7L1L and A7L1L
Single_Diffraction8	A7R1U and B7R1U

Examples of Look-Up-Tables



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Elastics18	(B7L1L or A7L1L) and (A7R1U or B7R1U)
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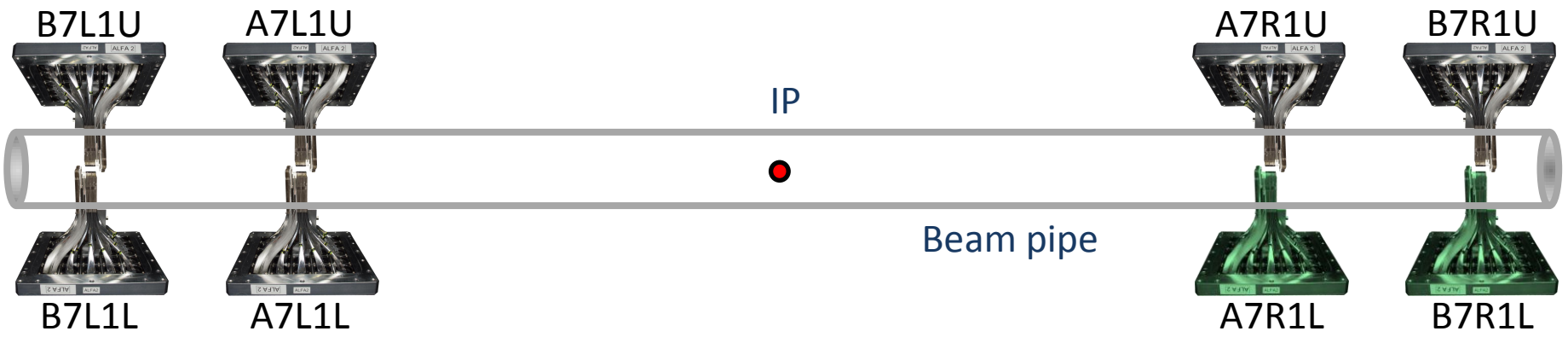
Single_Diffraction6	A7R1L and B7R1L
Single_Diffraction7	B7L1L and A7L1L
Single_Diffraction8	A7R1U and B7R1U

Examples of Look-Up-Tables



Elastics15	(B7L1U or A7L1U) and (A7R1L or B7R1L)
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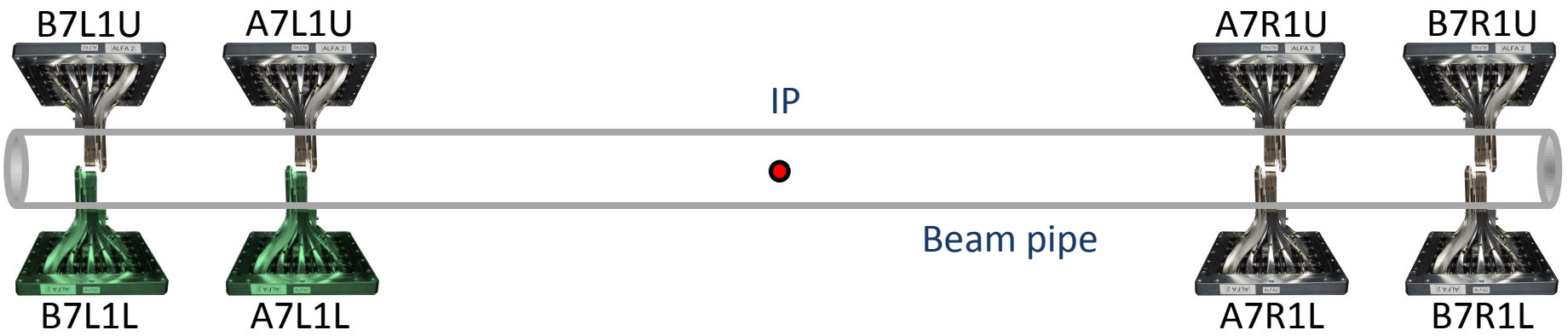
Single_Diffraction7	B7L1L and A7L1L
Single_Diffraction8	A7R1U and B7R1U

Examples of Look-Up-Tables



Elastics15	(B7L1U or A7L1U) and (A7R1L or B7R1L)
Elastics18	(B7L1L or A7L1L) and (A7R1U or B7R1U)
Single_Diffraction5	B7L1U and A7L1U
Single_Diffraction6	A7R1L and B7R1L
Single_Diffraction7	B7L1L and A7L1L
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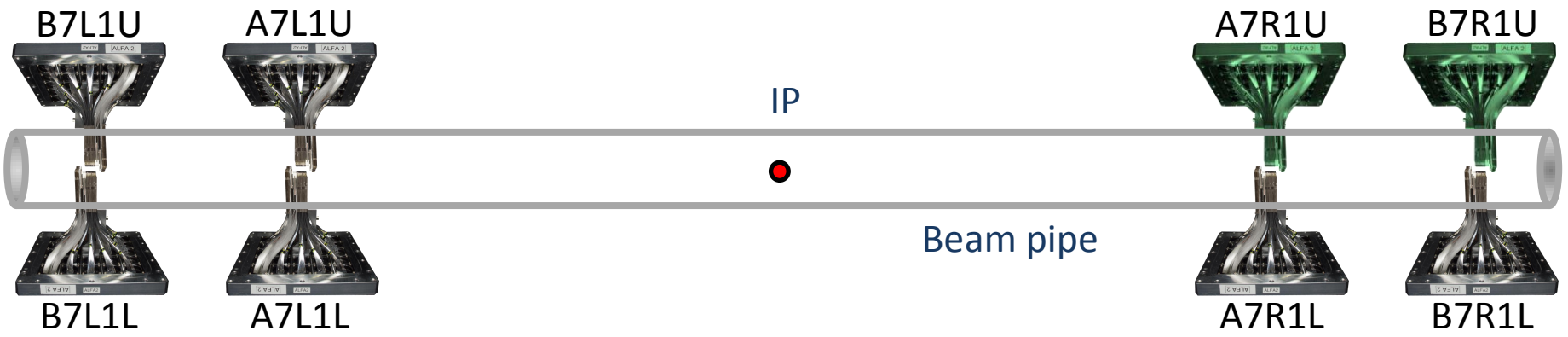
Examples of Look-Up-Tables

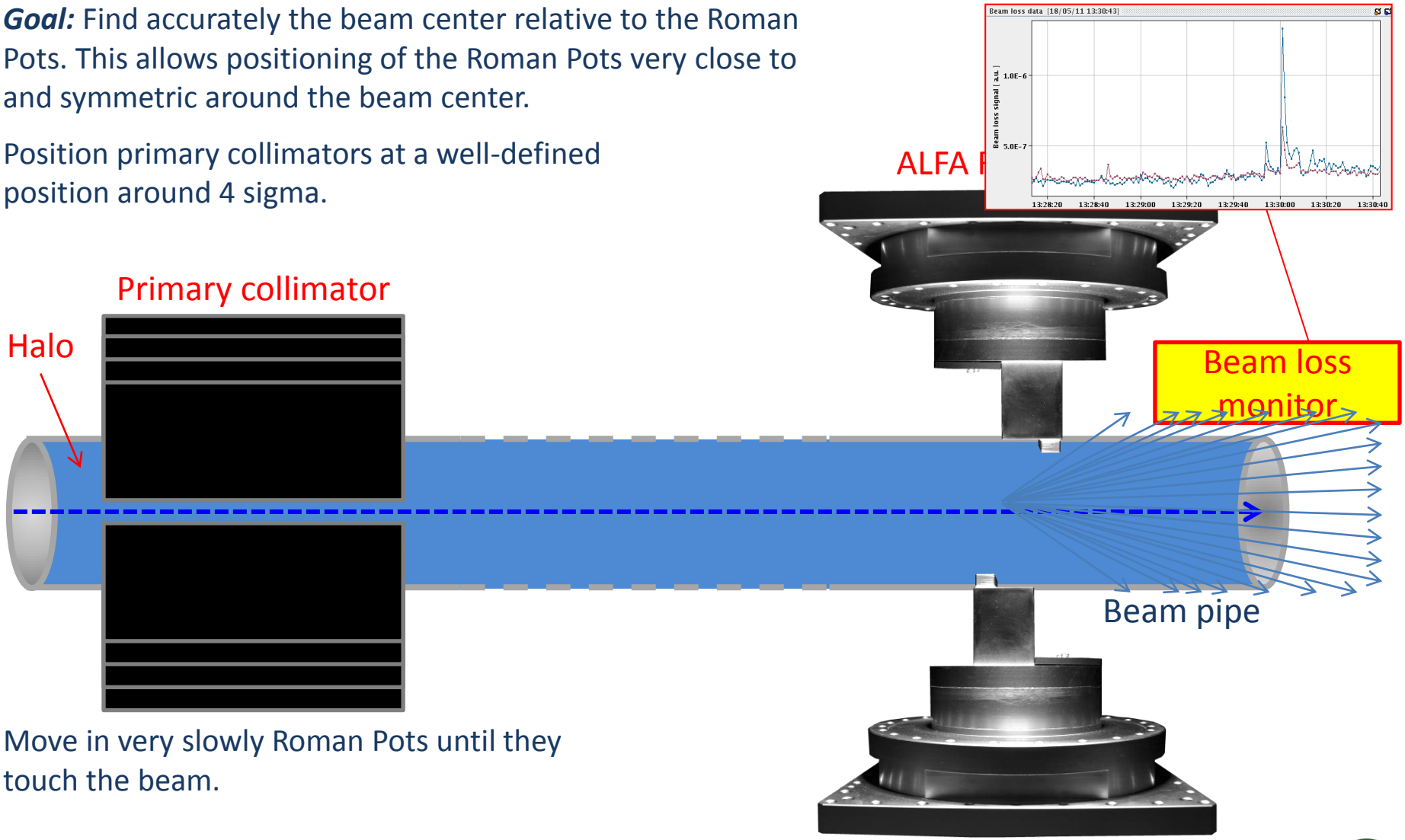


Elastics15	(B7L1U or A7L1U) and (A7R1L or B7R1L)
Elastics18	(B7L1L or A7L1L) and (A7R1U or B7R1U)
Single_Diffraction5	B7L1U and A7L1U
Single_Diffraction6	A7R1L and B7R1L
Single_Diffraction7	B7L1L and A7L1L
Single_Diffraction8	A7R1U and B7R1U

Beam based alignment (scraping)

Goal: Find accurately the beam center relative to the Roman Pots. This allows positioning of the Roman Pots very close to and symmetric around the beam center.

Position primary collimators at a well-defined position around 4 sigma.



Move in very slowly Roman Pots until they touch the beam.

Stop by BLM signal (or very high trigger rate).

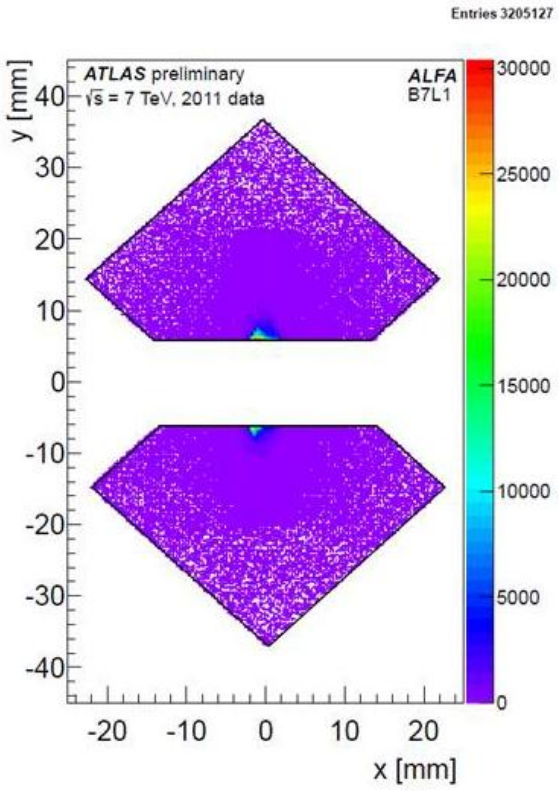
Data taking at 90 m beta* optics

Goal:
Physics data to determine total cross section.

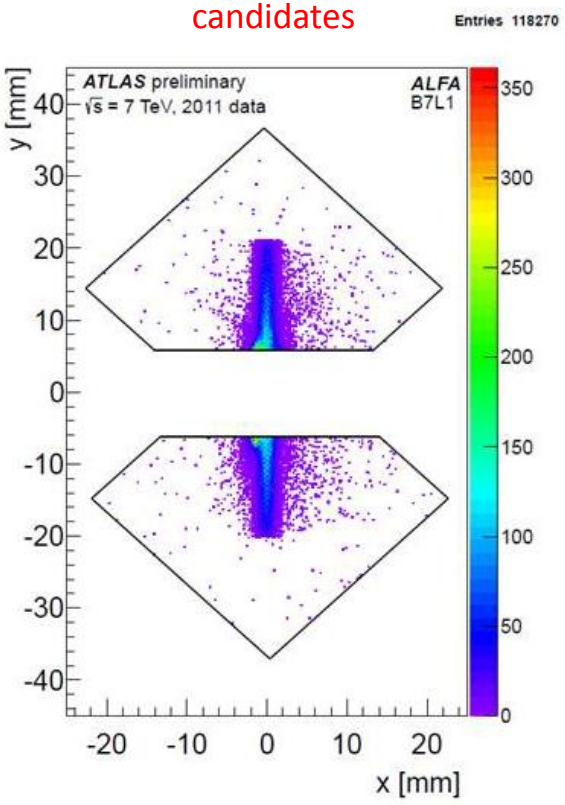
Roman Pot position:
6.5 nominal sigma (about 9 real sigma to detector edge).

Beam intensity:
1 bunch of 7E10 colliding.
13 bunches of 1E10 colliding.
1 bunch of 7E10 none-colliding.

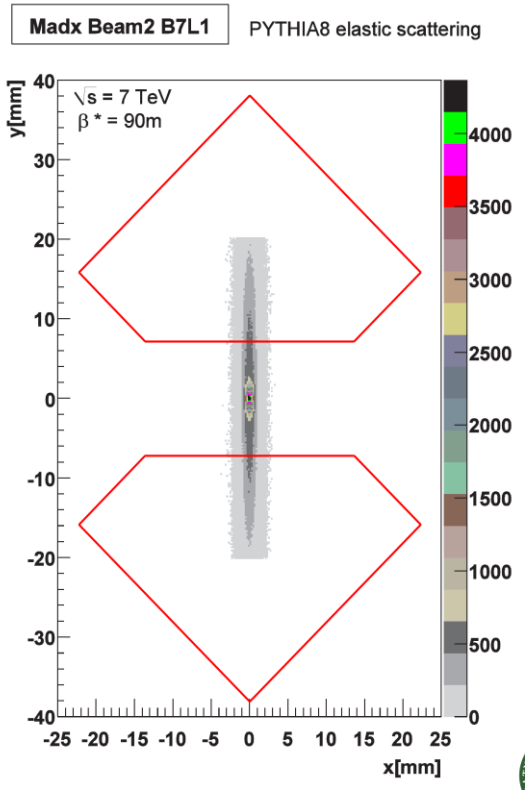
Track pattern before cuts



Track pattern for only elastic candidates



Simulated track pattern for elastic



Observations on beam quality from ALFA triggers

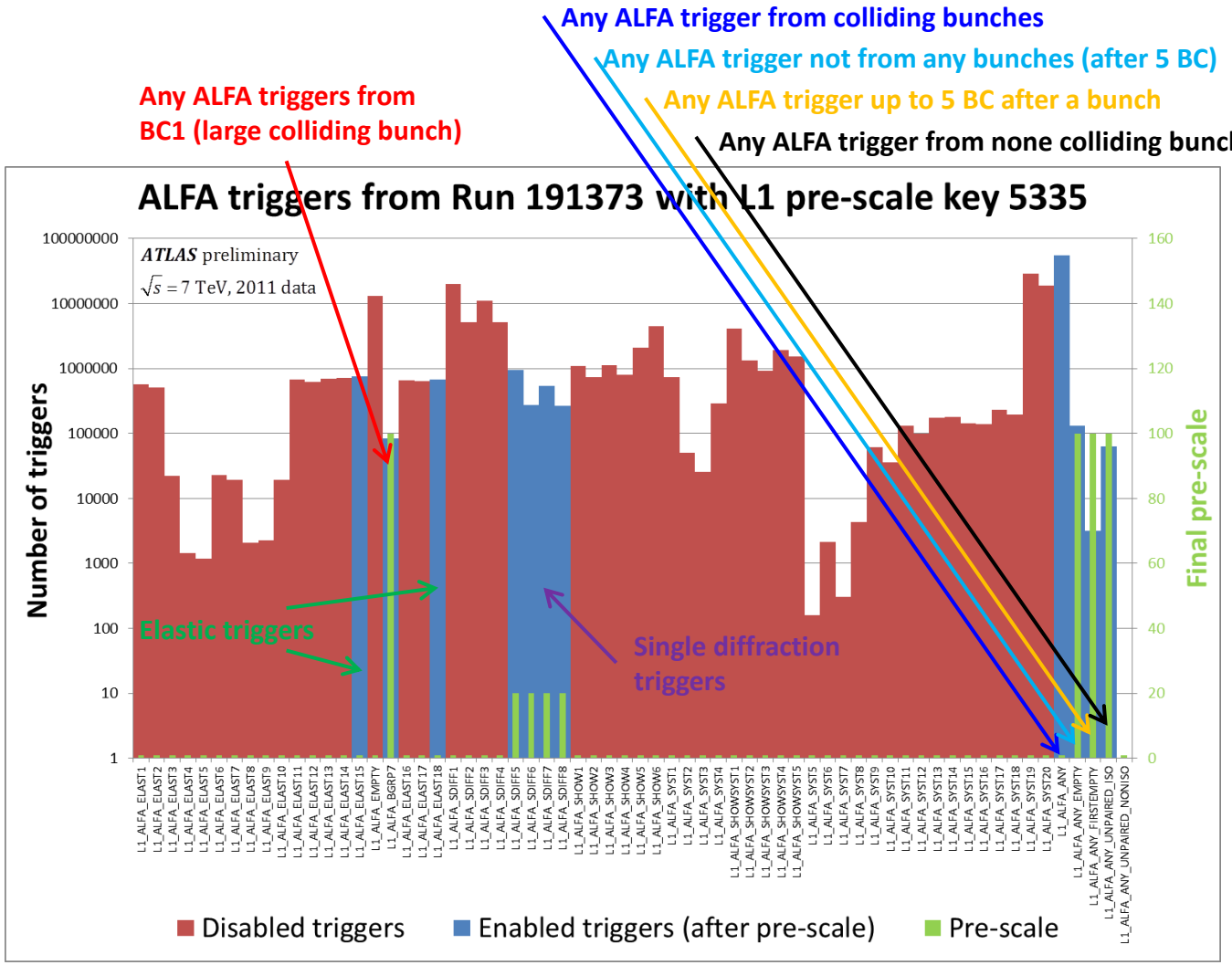
About 1.4 M elastic like triggers.

About 2 M single diffractive like triggers (after pre-scale).

Only about 15 % of the "Any ALFA" triggers is from the large colliding bunch.

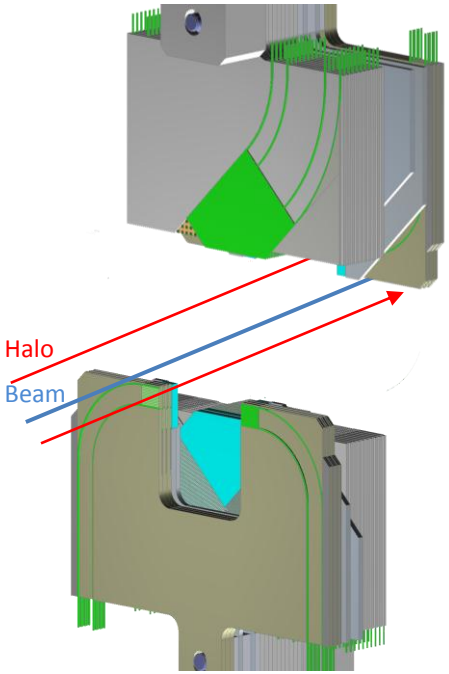
About 18 % of the "Any ALFA" triggers is not associated with any bunch.

About 12 % of "Any ALFA" triggers is from none colliding bunches.

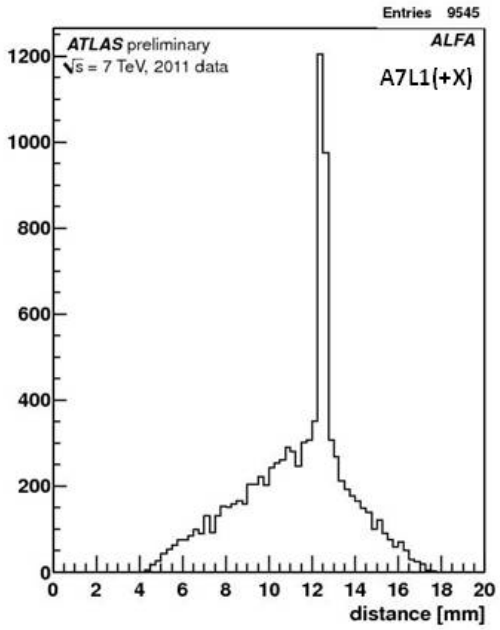


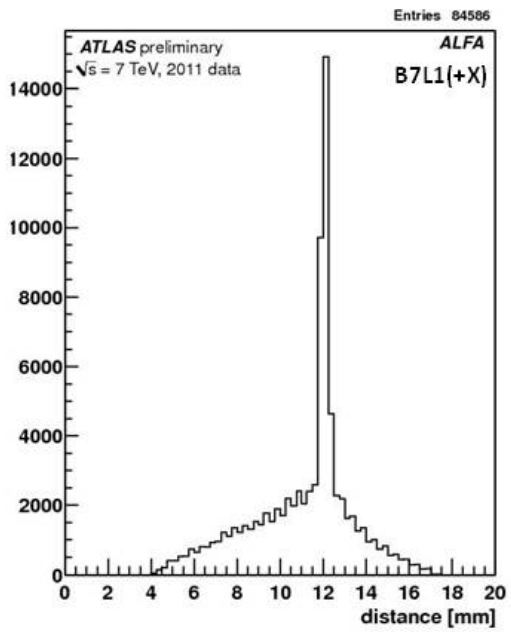
Detector alignment

Relative distance of the upper and lower Roman Pot is determined using particles passing both the upper an lower "overlap detector"



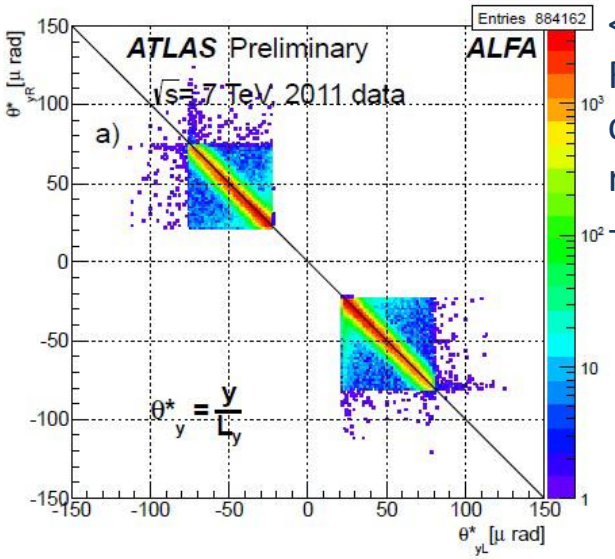
Reconstructed distance for (left) the first station from the IP and (right) the second station from the IP.





The global alignment of the all detectors is made using the distribution of elastic tracks in each detector.

90 m β* optics - correlations – evidence of elastic events



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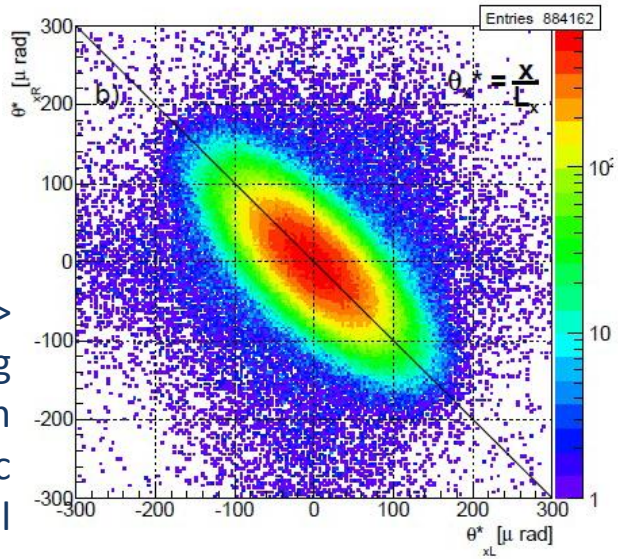
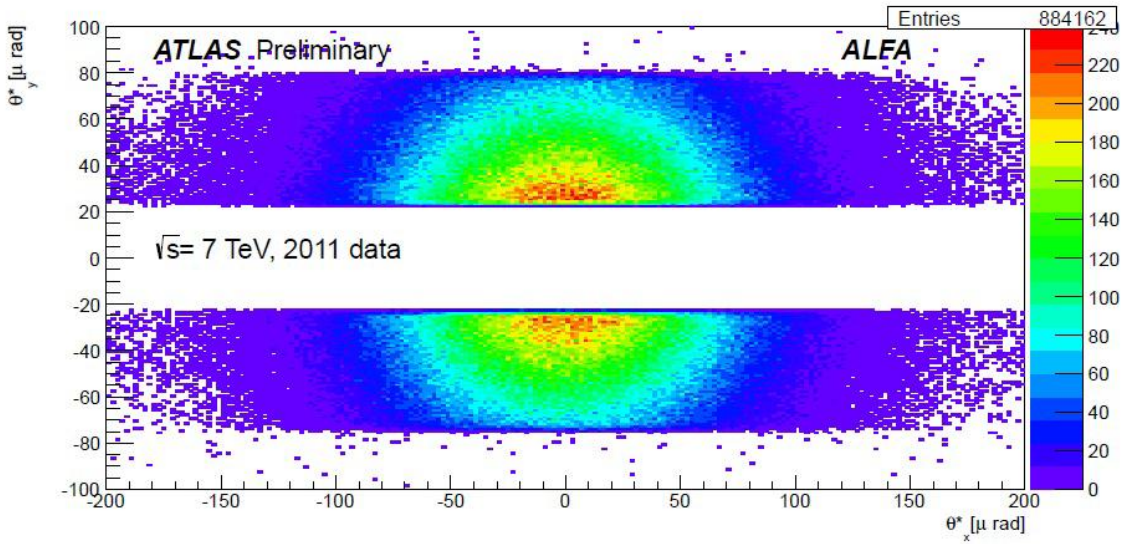
Reconstructed scattering angle correlation between left and right side for elastic candidates - Vertical

=>

Reconstructed scattering angle correlation between left and right side for elastic candidates - Horizontal





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Reconstructed scattering angle correlation between vertical and horizontal planes combining the left and right arm of ALFA

Analysis still ongoing to publish t-spectrum and total cross section.

Summary and plans for 2012

The ALFA detector system was installed in the winter shutdown 2010-2011 and is now fully integrated in ATLAS including common triggering (with special latency setting).

Elastic event data for determination of the total cross section was successfully taking with a special β* = 90 m optics .

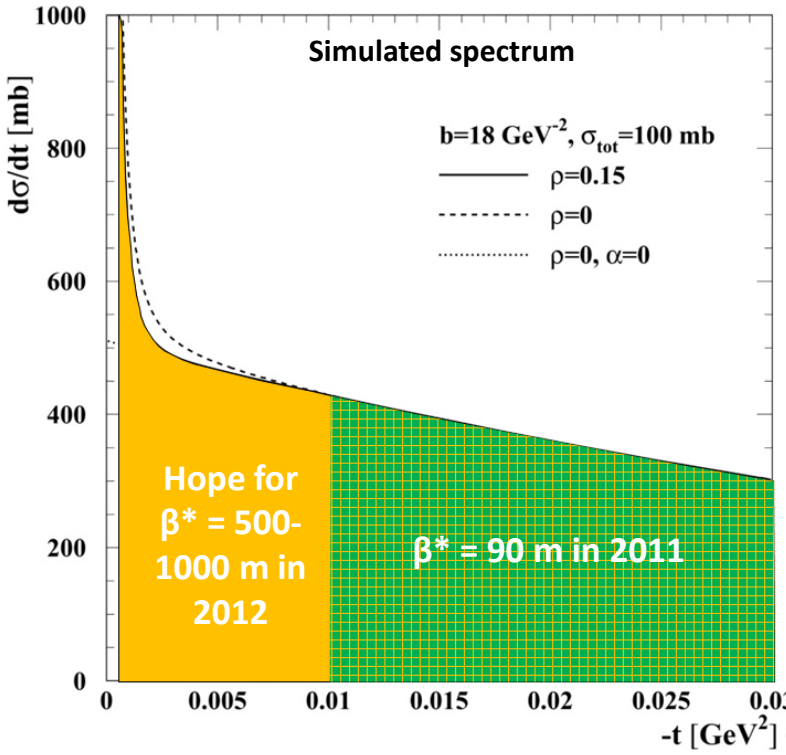
The Roman Pots has been aligned online with beam based alignment and offline using the distribution of elastic events and the measured relative distance of the detectors.

Correlations of scattering angles shown – Analysis to get t-spectrum and total cross section on-going.

2012: Repeat total cross section measurement with β* = 90 m optics at $\sqrt{s}$ = 8 TeV.

2012: Use the ALFA detectors for diffractive physics measurements at β* = 90 m.

2012 main goal: Using β* = 500-1000 m optics to try to probe the Coulomb-Nuclear interference region for luminosity and total cross section determination at $\sqrt{s}$ = 8 TeV.



Thanks for your attention