

# *Particle detectors to study Cosmic Rays*

Stage at Tor Vergata  
Students~Researchers  
June 13~17 2016

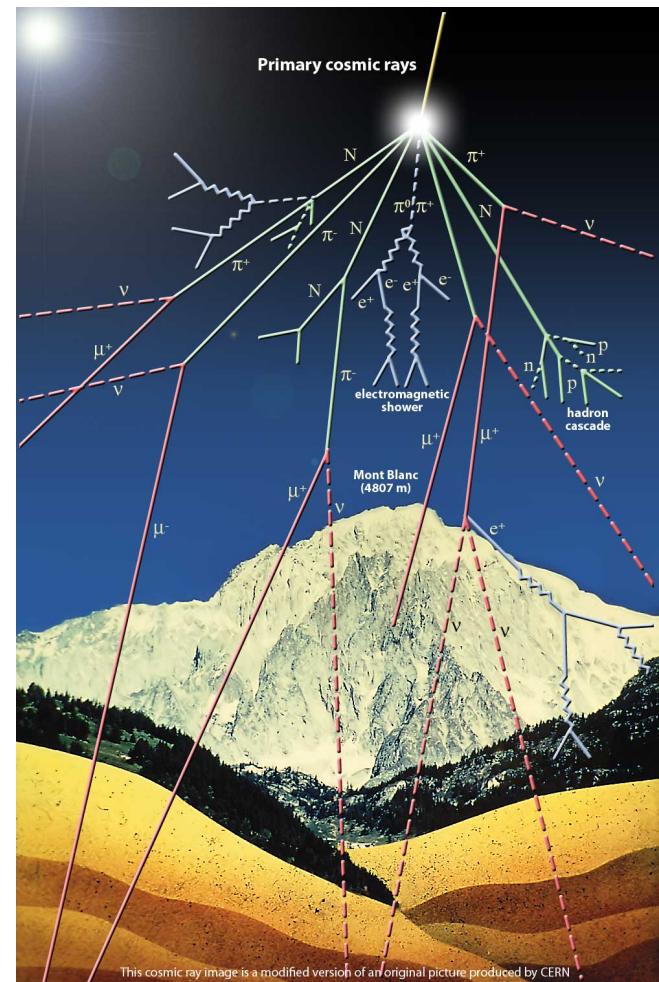
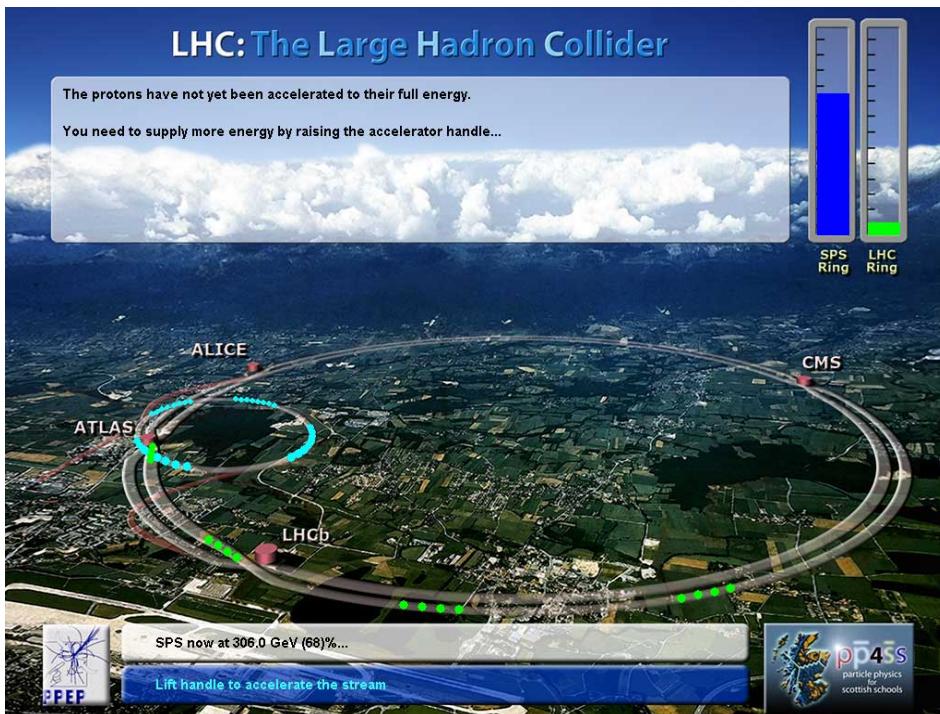
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Sara Maggio, L.S. Bruno Touschek (Grottaferrata)  
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# *Summary*

- A little bit of theory
- RPC as the muon trigger in Atlas detector
- RPC performances with cosmic ray
- Atlas data analysis.

# *Active physics and passive physics: two sides of the same coin!*

- What happens with cosmic rays and with accelerators?
- What are the differences?



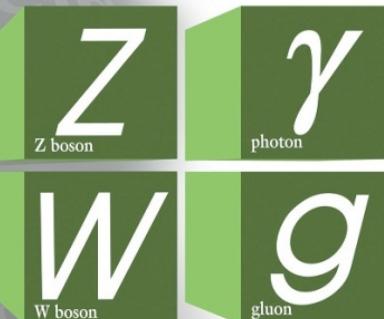
- What about the time?
- What can you see in the end?

*Which are these particles?*

## Quarks



## Forces

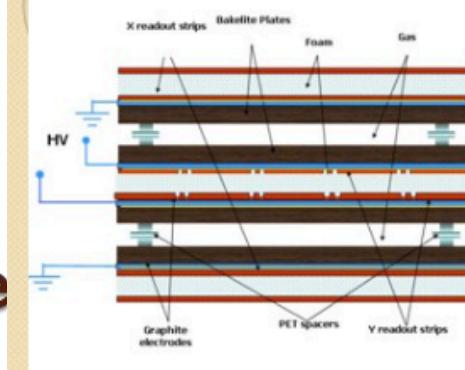


## Leptons

# How to detect these particles

## The ATLAS Resistive Plate Chambers

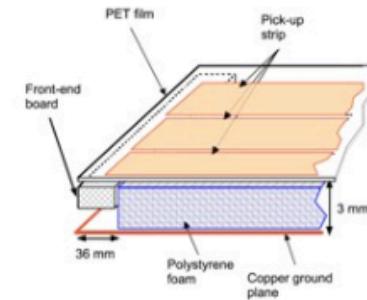
Gaseous detector, operated at atmospheric pressure ATLAS RPC works in saturated avalanche regime.



Each unit contains 2 layers of gas volume.

2mm gas gap, bakelite resistivity  $\sim 1\text{--}4 \times 10^{10} \Omega\text{cm}$

$\eta$  and  $\phi$  read-out copper strips panels, pitch ranging from 26.4 to 37 mm



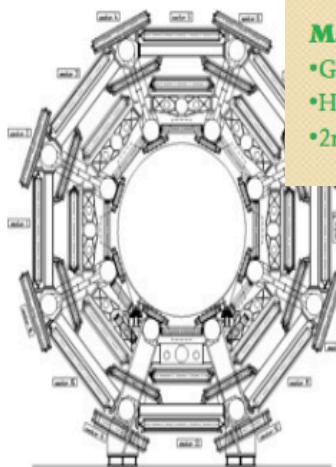
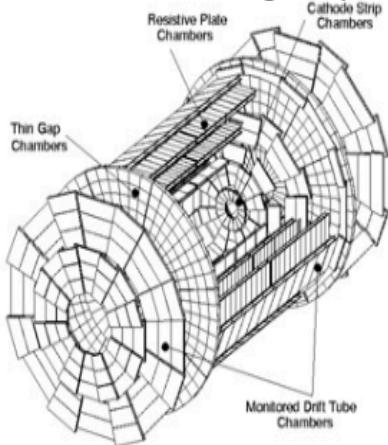
### Main ATLAS RPC tasks:

- Good time resolution for bunch-crossing identification ( $\sim 1$  ns).
- High rate capability to sustain the high background level.
- 2nd-coordinate measurement with a 5-10mm resolution

## The ATLAS Muon Spectrometer

Resistive Plate Chambers (RPC) are used as Muon Trigger

Detector in the barrel region ( $-1 < \eta < 1$ )



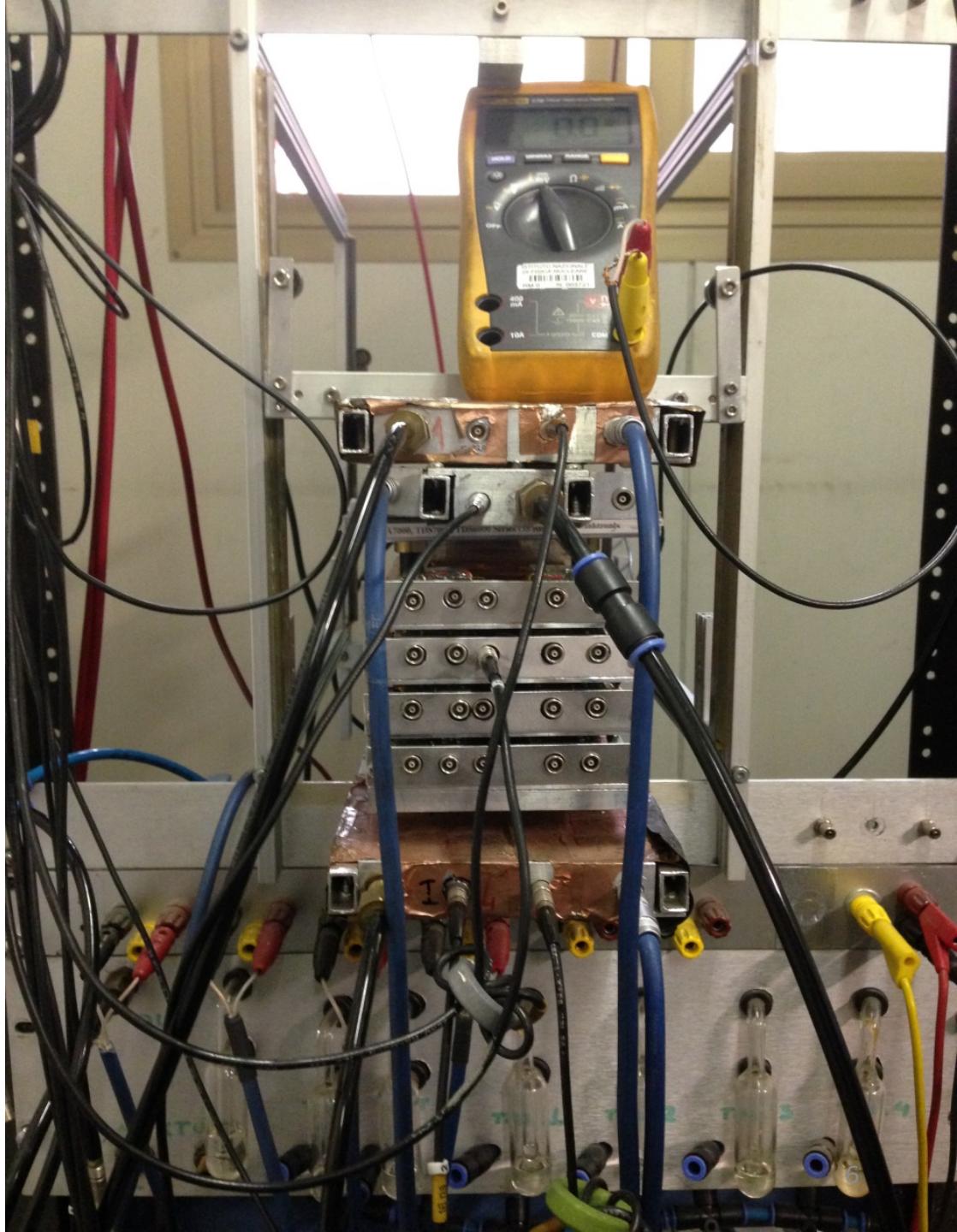
- ✓ More than 1100 RPC units
- ✓ 368.416 Read-out channels
- ✓ 26 different chambers type
- ✓ Total surface  $\sim 4000^2 \text{m}$

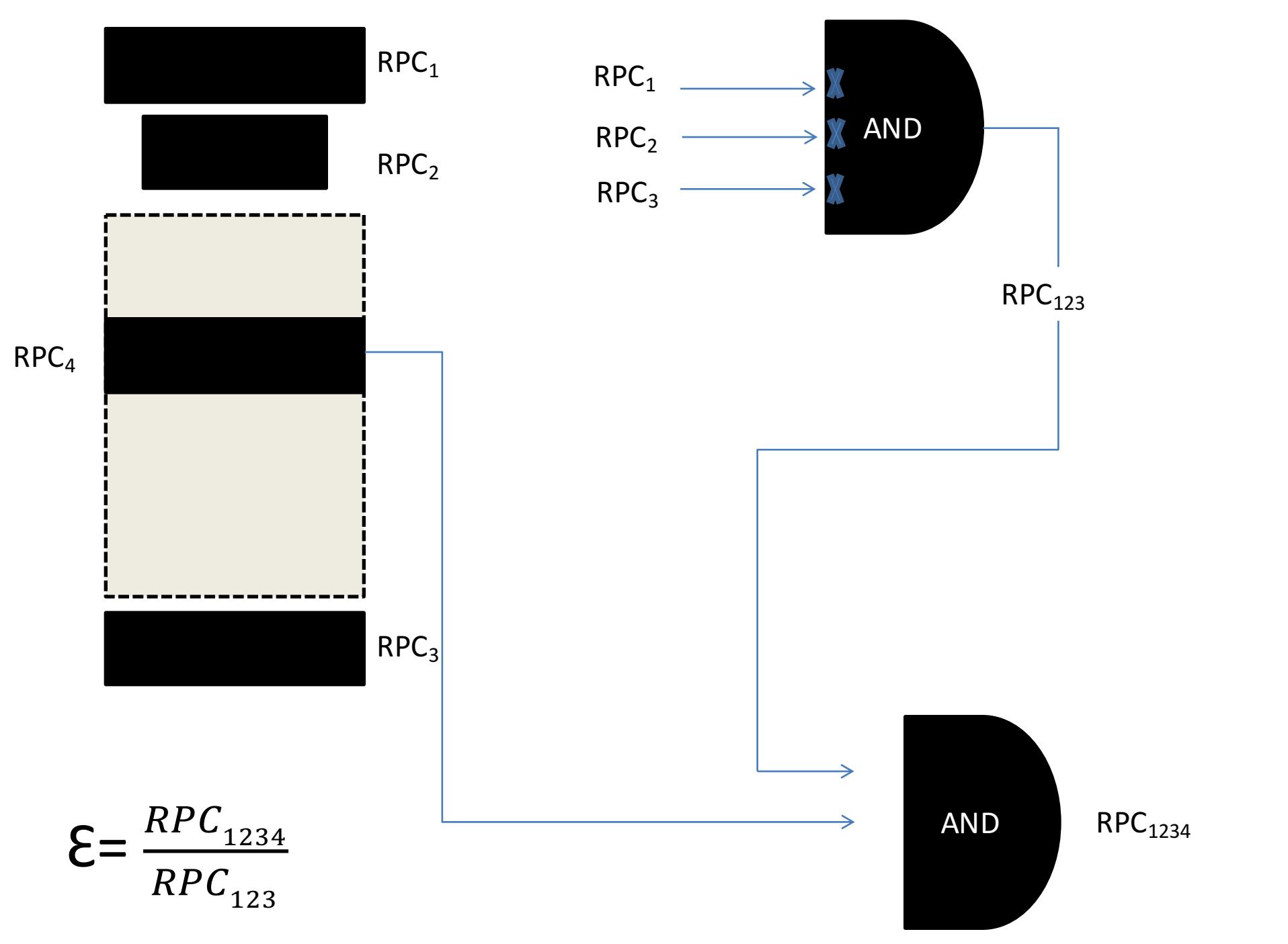
### Muon Trigger Segmentation in Barrel

- 16 Sector (Large and Small)
- 64 Sector Logic
- 396 trigger Towers

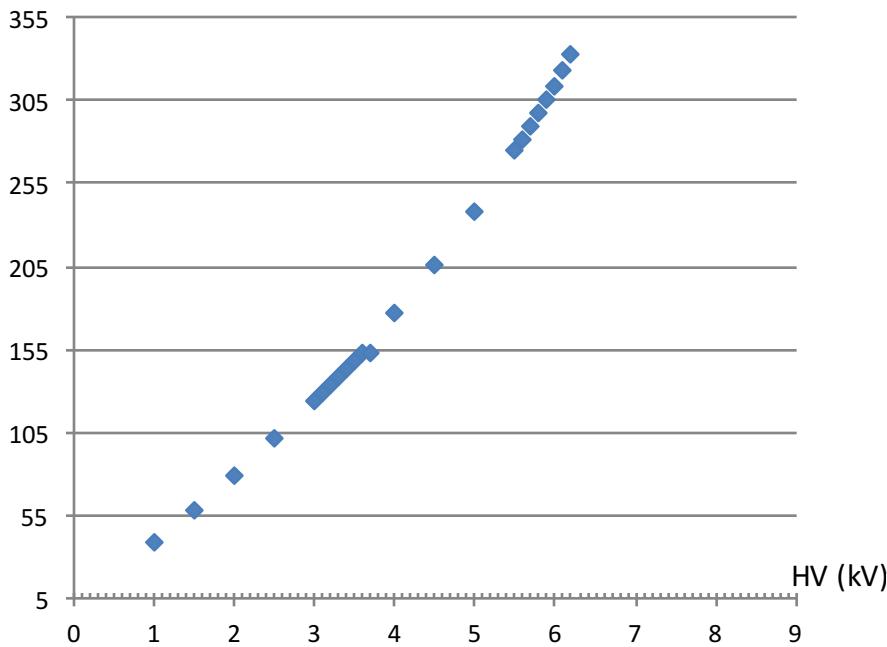
# *RPC telescope*

- Experimental setup
- Layout and process
- Measurements
- Analysis and plot





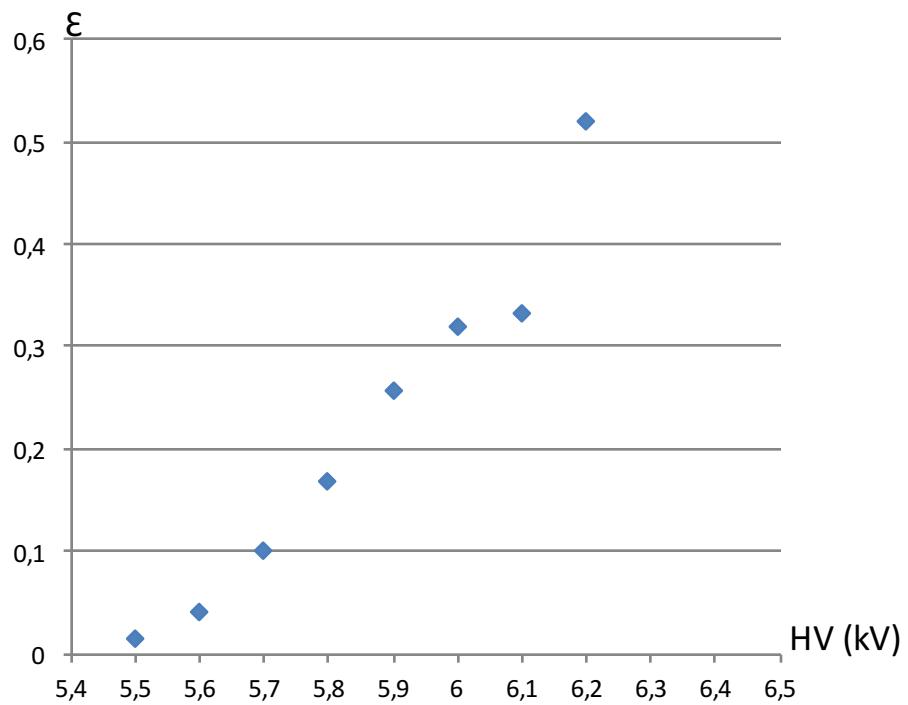
I nA\*10



*RPC current*

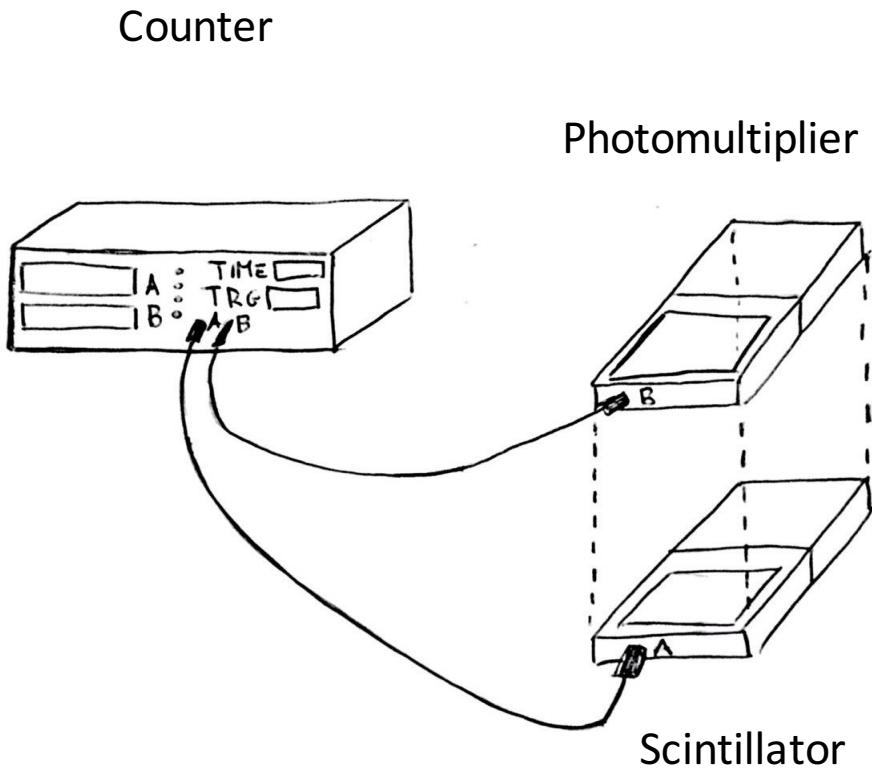
*RPC efficiency*

$$\epsilon = \frac{RPC_{1234}}{RPC_{123}}$$

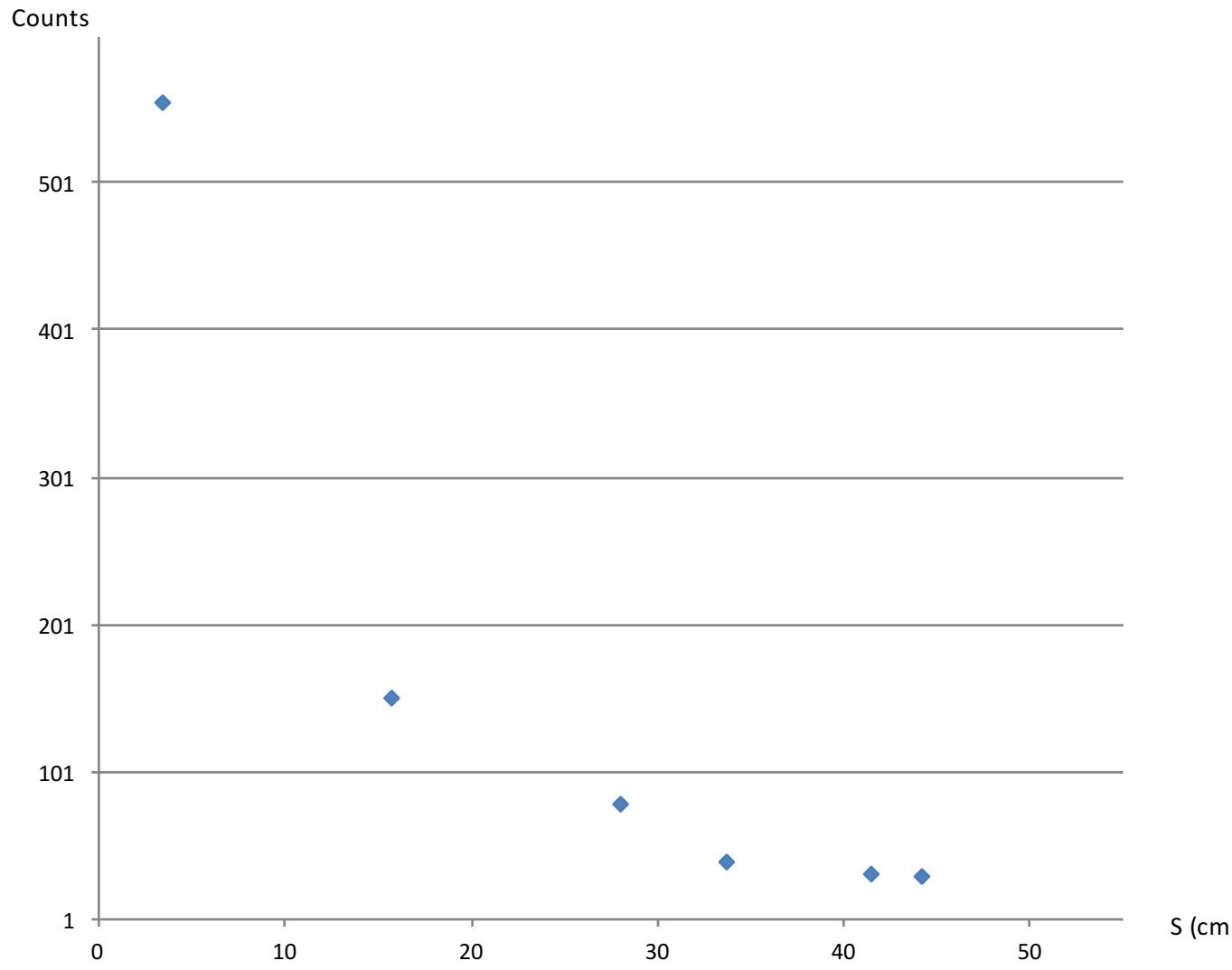


# *Counting rate as a function of detectors distance*

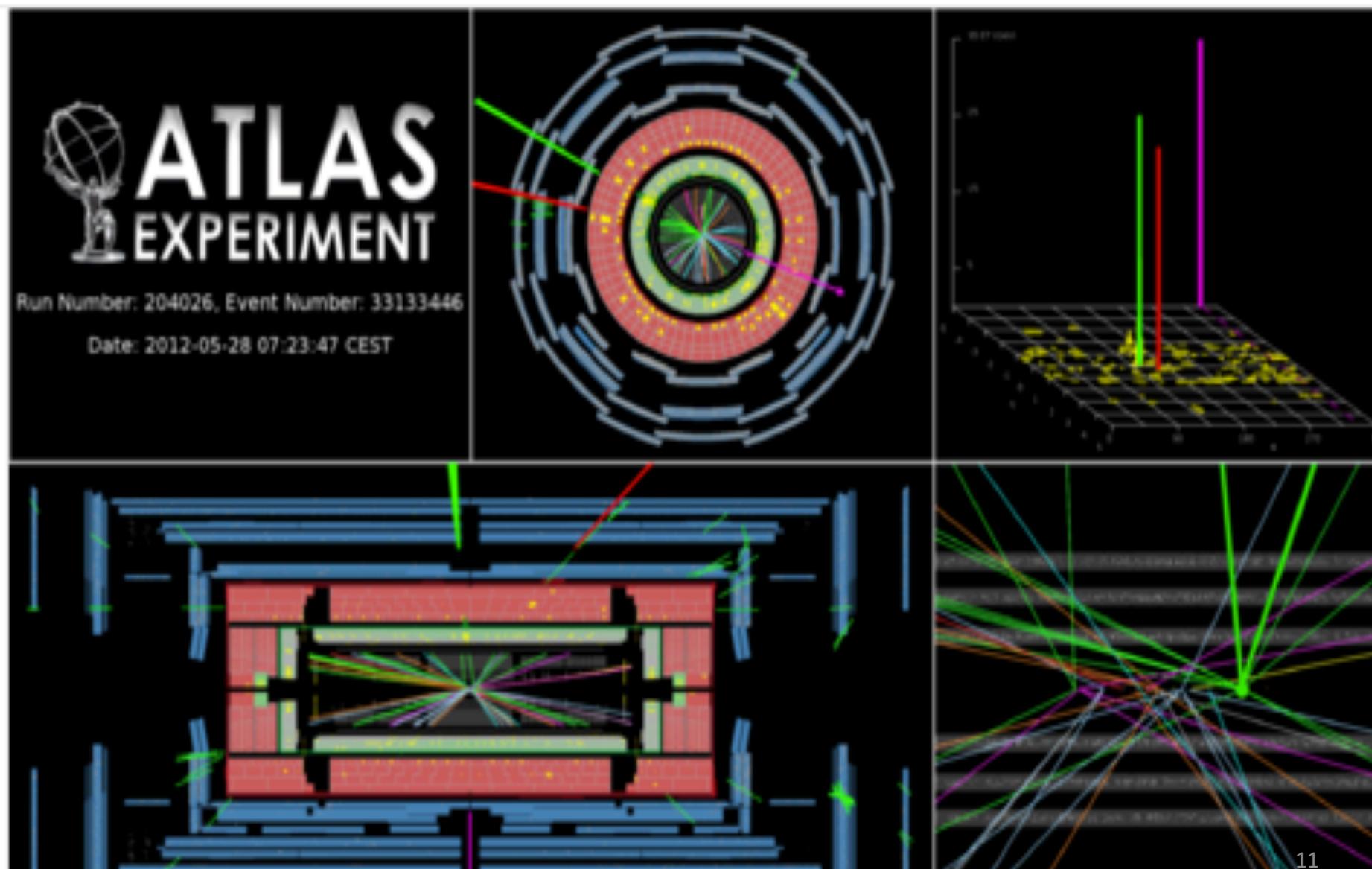
- Layout



# *Counting rate as a function of detectors distance*



# Atlas data Analysis



Total	37	28	34	20	54	26
$\Sigma W^+ , \Sigma W^- $	$ W^+ $	71	$ W^- $	48	$ W^+  +  W^- $	119
Ratio		$ W^+ / W^- $		<b>1.48</b>	$\pm$	<b>0.28</b>

## Comparison with results of the ATLAS collaboration (from 2011):

Measurement of the  $W \rightarrow l\nu$  and  $Z/\gamma\gamma^* \rightarrow ll$  production cross sections in proton-proton collisions at  $\sqrt{s} = 7$  TeV with the ATLAS detector\*) and Search for the Standard Model Higgs boson in the  $H \rightarrow WW^*(*) \rightarrow ll\nu\nu$  decay mode using 1.7  $\text{fb}^{-1}$  of data collected with the ATLAS detector at  $\sqrt{s} = 7$  TeV \*\*)

\*) Authors: The ATLAS Collaboration (Submitted on 5 Dec 2011): <http://arxiv.org/abs/1109.5141.pdf>

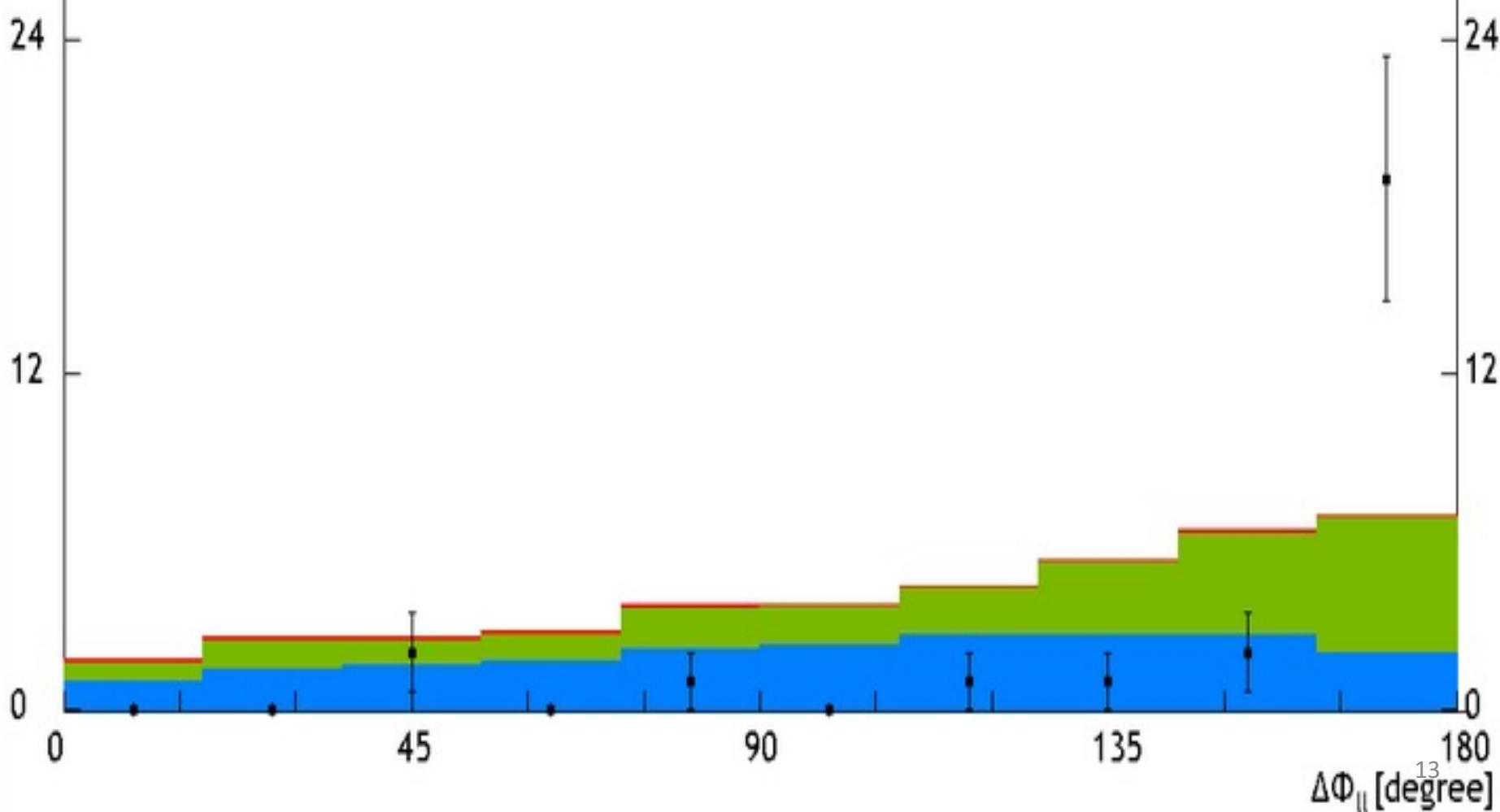
\*\*) Authors: The ATLAS Collaboration (24 Aug 2011): ATLAS-CONF-2011-134

	$W \rightarrow ... + \nu$				Background	WW cand.
	$e^+$	$e^-$	$\mu^+$	$\mu^-$		
Total	77885	52856	84514	55234	21930	469
$\Sigma W^+ , \Sigma W^- $	$ W^+ $	162399	$ W^- $	108090	$ W^+  +  W^- $	270489
Ratio		$ W^+ / W^- $		<b>1.50</b>	$\pm$	<b>0.12</b>

Masterclasses 2015 Search for  $H \rightarrow WW \rightarrow ll\nu\nu$ 

For Educational Use Only

- WW without Higgs
- Expectation for  $mH=125\text{GeV}/c^2$
- Background, e.g. from  $t\bar{t}$  or  $Z$
- Measurement: Template  
15.06.16



*Conclusion  
or  
beginning?*

