

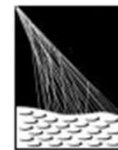
# Results of the validation of the first 45 units - Lecce

D.Martello on behalf of the INFN Groups

Grenoble 28th March 2018

SSD Meeting





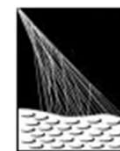
### **Status**

- In Lecce, we have fully assembled 68 detectors (see M.R. Coluccia Talk)
- Of them 66 are fully tested with the available validation facility (see G. Cataldi talk)

### **What will be present**

- In the present talk will be shown the results of the first 46 detectors (1<sup>st</sup> container +1)
- Not only results of the analysis but also quality checks.

## Quality checks after assembling



	SSD TEST PROCEDURE	EDMS REF. : XXXXXXXX Rev. : 2018-02-05
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<b>AUGERPRIME SSD TEST REPORT FORM</b>	
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SSD SERIAL NUMBER:			
Operator(s)		Date:	
		Location	
		Comments	

<b>Assembly visual inspection</b>		
<i>Item</i>	<i>OK ?</i>	<i>Comments</i>
Top cover	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Handling Bracket	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Roof supports	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Frame corners	<input type="checkbox"/> YES <input type="checkbox"/> NO	
PMT Flange	<input type="checkbox"/> YES <input type="checkbox"/> NO	
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO	
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO	
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO	

<b>Optical visual inspection</b>		
<i>Item</i>	<i>OK ?</i>	<i>Number and comments</i>
Bubbles presence	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Picture file name		Location
<b>Light Tightness Verification</b>		
Max and Min ev. Rate values		
TBW		
TBW		
<b>MIP Measurement Performances</b>		
<i>Item</i>	<i>Value</i>	<i>Comments</i>
FWHM of MIP (%)		
MIP (#P.E.)		
TBW		
Data file name		Location

After the assembling the units has been inspected by two independent groups of students.

Any not uniformity reported has been cross-checked by “expert” people and if confirmed, reported.

### Summary

4 detectors with a handling bracket not in the correct position

5 detectors with one of the roof support bars with anomalies

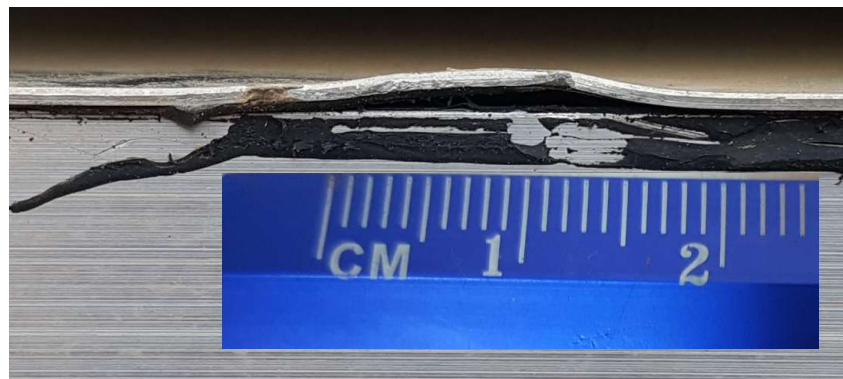
2 detectors with an anomaly of the top cover panel

## Quality checks after assembling

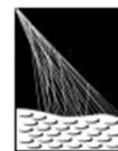
detectors with a handling bracket not in the correct position



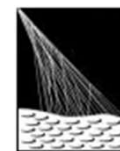
detectors with an anomaly of the top cover panel



detectors with one of the roof support bars with anomaly



## Quality checks after assembling



	SSD TEST PROCEDURE	EDMS REF. : XXXXXXXX Rev. : 2018-02-05
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### AUGERPRIME SSD TEST REPORT FORM

SSD SERIAL NUMBER:			
Operator(s)		Date:	
		Location	
		Comments	

#### Assembly visual inspection

Item	OK ?	Comments
Top cover	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Handling Bracket	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Roof supports	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Frame corners	<input type="checkbox"/> YES <input type="checkbox"/> NO	
PMT Flange	<input type="checkbox"/> YES <input type="checkbox"/> NO	
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO	
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO	
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO	

#### Optical visual inspection

Item	OK ?	Number and comments
Bubbles presence	<input type="checkbox"/> YES <input type="checkbox"/> NO	
Picture file name		Location

#### Light Tightness Verification

Max and Min ev. Rate values			
TBW			
TBW			

#### MIP Measurement Performances

Item	Value	Comments
FWHM of MIP (%)		
MIP (#P.E.)		
TBW		
Data file name		Location

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### Summary

4 detectors with a handling bracket not in the correct position

5 detectors with one of the roof support bars with anomalies

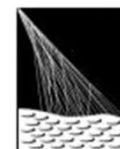
2 detectors with an anomaly of the top cover panel

**FIXED!**

**FIXED!**



# The Cookies



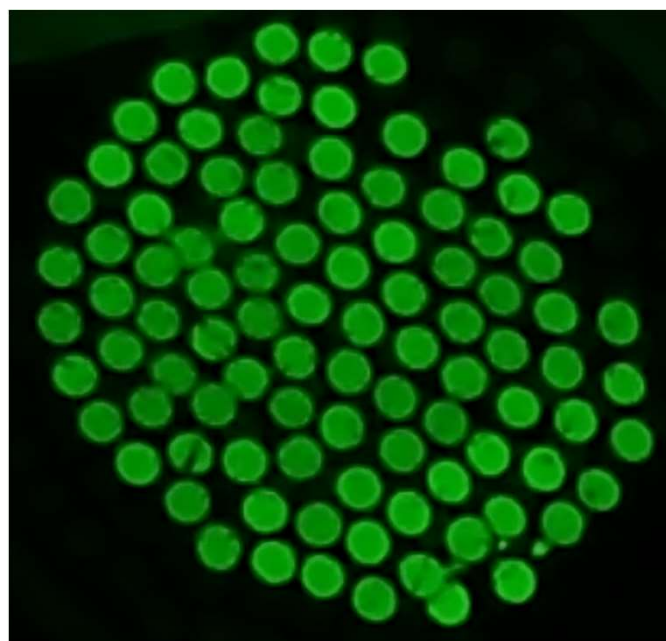
	SSD TEST PROCEDURE	EDMS REF. : XXXXXXXX Rev. : 2018-02-05
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## AUGERPRIME SSD TEST REPORT FORM

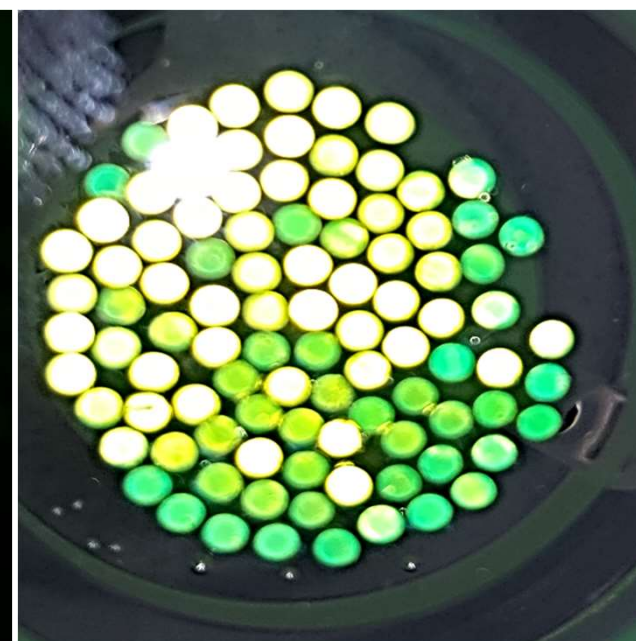
SSD SERIAL NUMBER:			
Operator(s)		Date:	
		Location	
		Comments	
<b>Assembly visual inspection</b>			
Item	OK ?	Comments	
Top cover	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Handling Bracket	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Roof supports	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Frame corners	<input type="checkbox"/> YES <input type="checkbox"/> NO		
PMT Flange	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
<b>Optical visual inspection</b>			
Item	OK ?	Number and comments	
Bubbles presence	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Picture file name		Location	
<b>Light tightness verification</b>			
Max and Min ev. Rate values			
TBW			
TBW			
<b>MIP Measurement Performances</b>			
Item	Value	Comments	
FWHM of MIP (%)			
MIP (#P.E.)			
TBW			
Data file name		Location	

Collected a photo of each cookie produced.  
We take photo with flash and external light.  
The flash and the light make the defects in the cookie well evident.

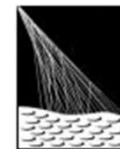
Without flash and light



With flash and light



## The Cookies



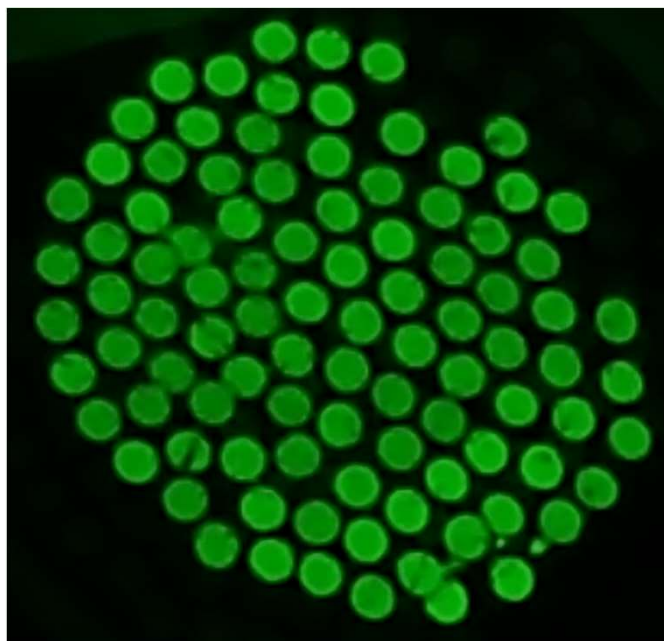
	SSD TEST PROCEDURE	EDMS REF. : XXXXXXXX Rev. : 2018-02-05
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### AUGERPRIME SSD TEST REPORT FORM

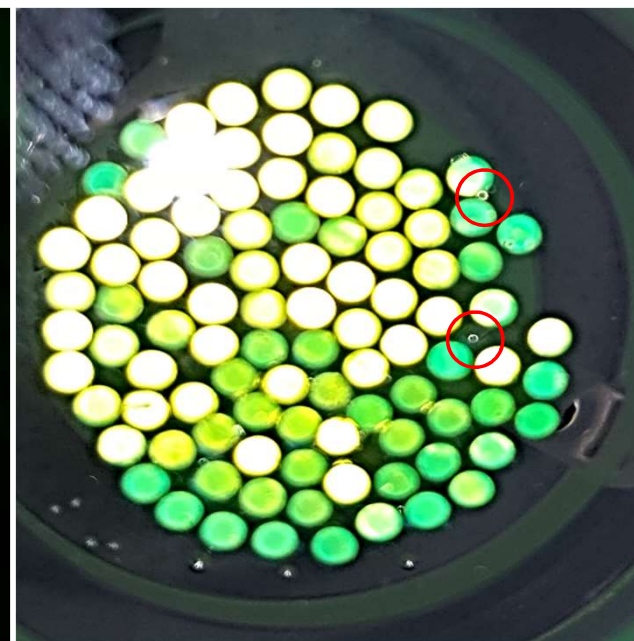
SSD SERIAL NUMBER:			
Operator(s)		Date:	
		Location	
		Comments	
<b>Assembly visual inspection</b>			
Item	OK ?	Comments	
Top cover	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Handling Bracket	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Roof supports	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Frame corners	<input type="checkbox"/> YES <input type="checkbox"/> NO		
PMT Flange	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
<b>Optical visual inspection</b>			
Item	OK ?	Number and comments	
Bubbles presence	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Picture file name		Location	
<b>Light tightness verification</b>			
Max and Min ev. Rate values			
TBW			
TBW			
<b>MIP Measurement Performances</b>			
Item	Value	Comments	
FWHM of MIP (%)			
MIP (#P.E.)			
TBW			
Data file name		Location	

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The flash and the light make the defects in the cookie well evident.

Without flash and light

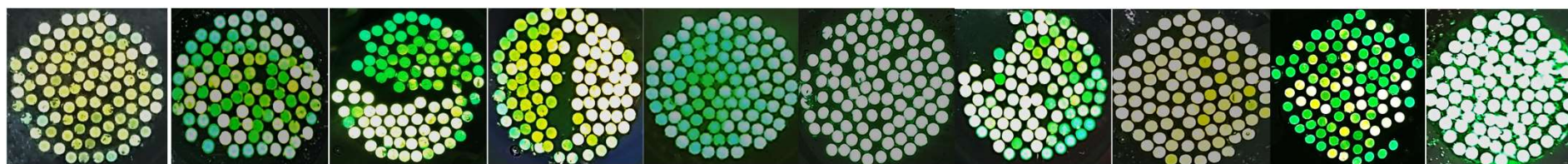
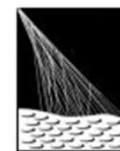


With flash and light



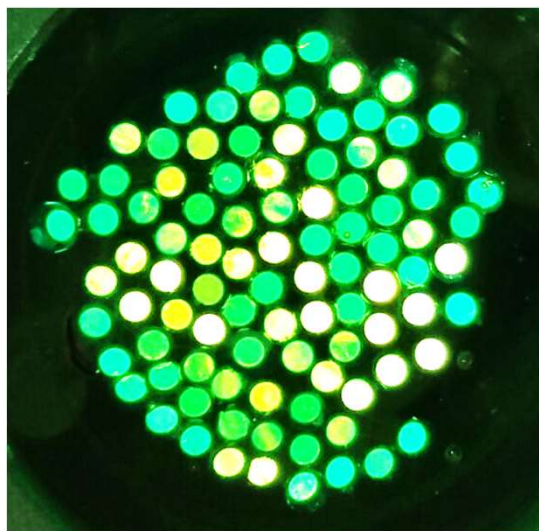


## The Cookies



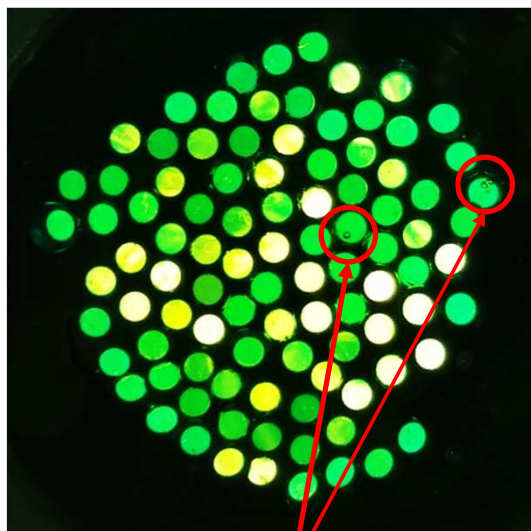
What is the goal of our photos?  
The goal was **NOT** to show that the cookie is nice.  
The goal was identify all the possible defects in the cookie.

Original



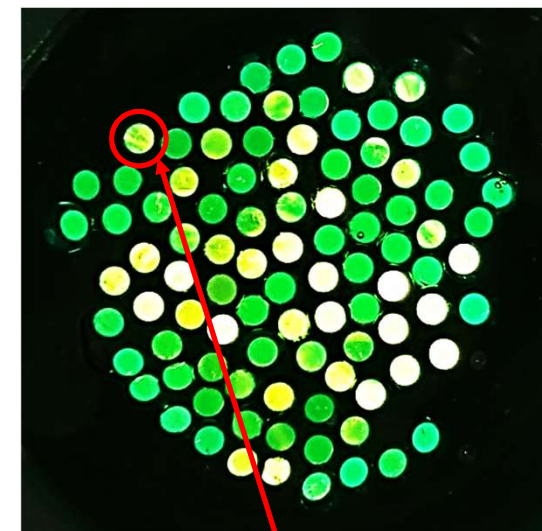
The color not uniformity depend by the flash and external light. Not relevant.

Light correction filter



Small bubbles in front the fibers

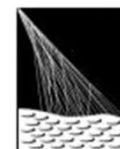
Sharpness filter



Not uniform surface of the fiber



# Light Tightness



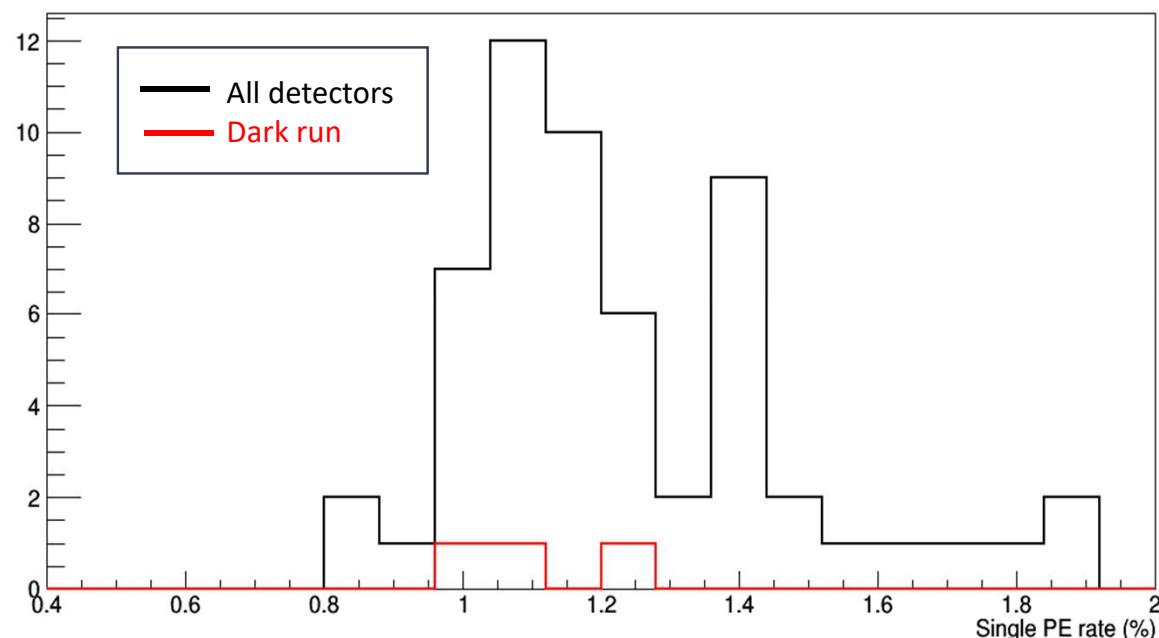
	SSD TEST PROCEDURE	EDMS REF. : XXXXXXXX Rev. : 2018-02-05
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## AUGERPRIME SSD TEST REPORT FORM

SSD SERIAL NUMBER:			
Operator(s)	Date:		
	Location		
	Comments		
<b>Assembly visual inspection</b>			
Item	OK ?	Comments	
Top cover	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Handling Bracket	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Roof supports	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Frame corners	<input type="checkbox"/> YES <input type="checkbox"/> NO		
PMT Flange	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
<b>Optical visual inspection</b>			
Item	OK ?	Number and comments	
Bubbles presence	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Picture file name		Location	
<b>Light Tightness Verification</b>			
Max and Min ev. Rate values			
TBW			
TBW			
<b>MIP Measurement Performances</b>			
Item	Value	Comments	
FWHM of MIP (%)			
MIP (#P.E.)			
TBW			
Data file name		Location	

Method presented by G. Cataldi in previous session

## Light Check



Distribution of the relative rate of single photons seen off-trigger after corrections (if any).

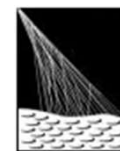
6 Chambers with light problems.

5 - light come inside in a point between the frame and the composite panel

1 – light from the hole below the bar!

**FIXED!**

## Mip Analysis



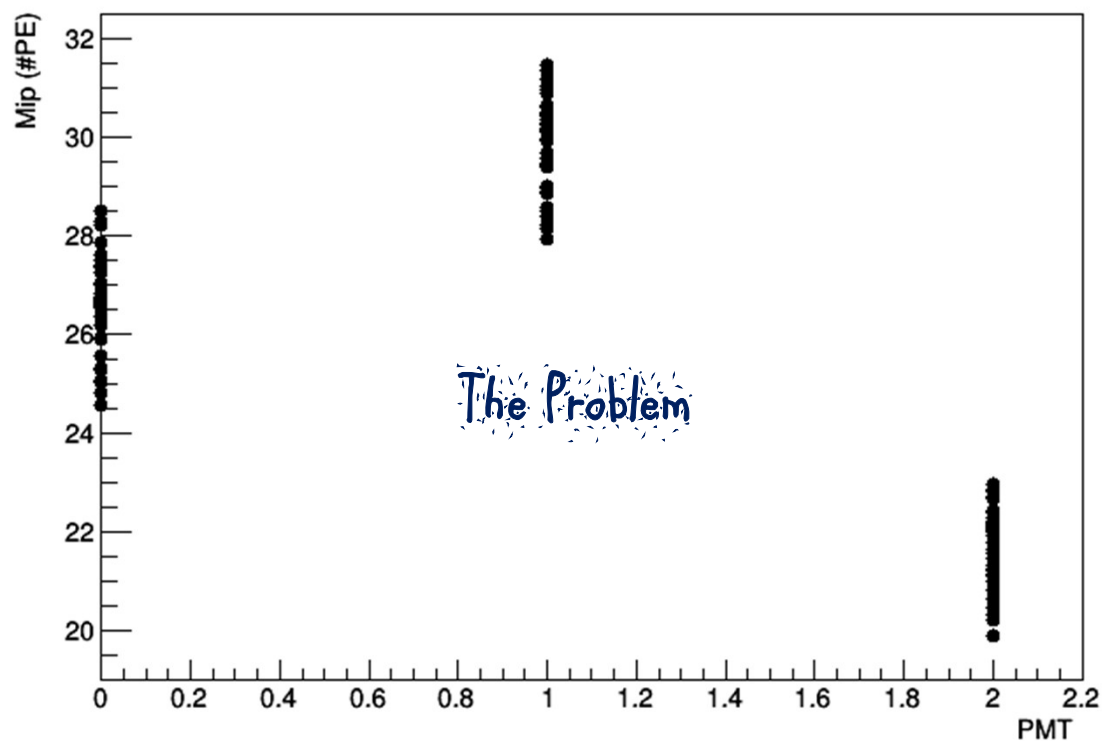
	SSD TEST PROCEDURE	EDMS REF. : XXXXXXXX Rev. : 2018-02-05
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Operator(s)		Date:	
		Location	
		Comments	
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Item	OK ?	Comments	
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PMT Flange	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
TBD	<input type="checkbox"/> YES <input type="checkbox"/> NO		
<b>Optical visual inspection</b>			
Item	OK ?	Number and comments	
Bubbles presence	<input type="checkbox"/> YES <input type="checkbox"/> NO		
Picture file name		Location	
<b>Light Tightness Verification</b>			
Max and Min ev. Rate values			
TBW			
TBW			
<b>MIP Measurement Performances</b>			
Item	Value	Comments	
FWHM of MIP (%)			
MIP (#P.E.)			
TBW			
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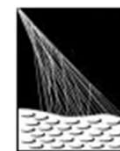
Method presented by G. Cataldi in previous session

### Mip Distribution

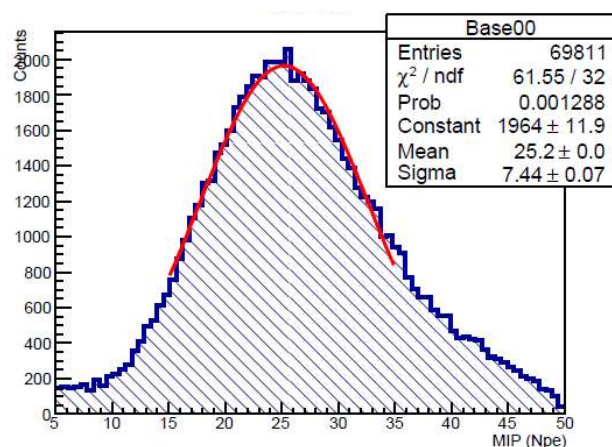


We have use three (identical) PMTs and take data in parallel. We see a evident dependence of the #PE on the PMT used.  
Some SSD units measured more times with different PMTs.

## Mip Analysis



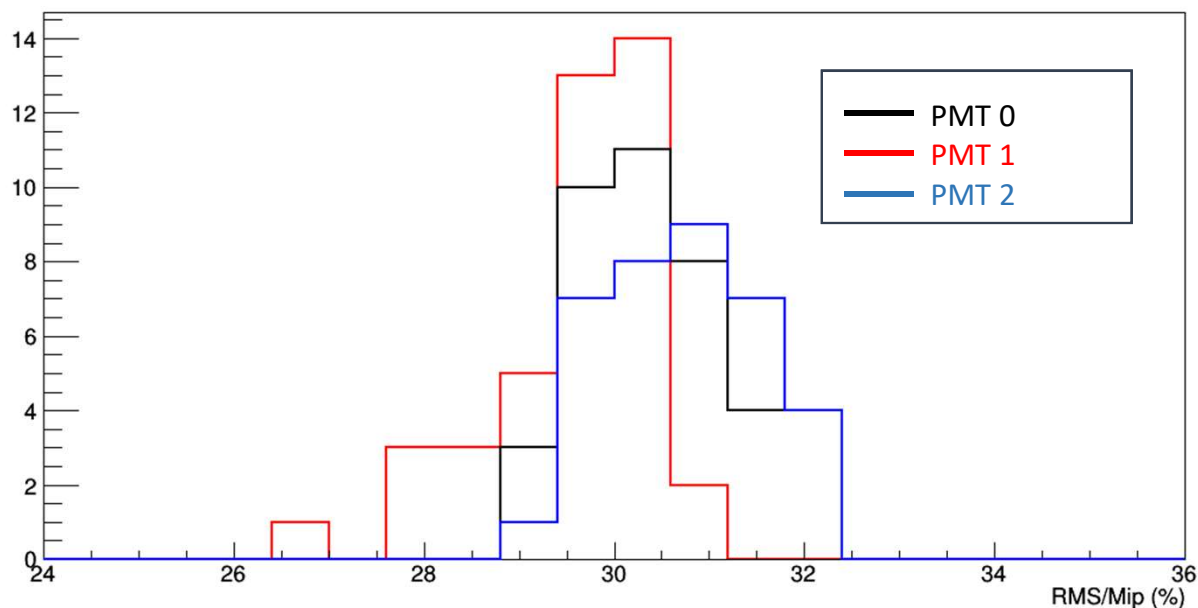
Mip distribution for one detector in # P.E.



For each detector the MIP distribution is fitted with a Gaussian. The **mean** and the **sigma** of the Gaussian has been used for the analysis.

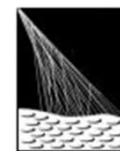
NOTE: is not the same of the mean and RMS of the full distribution

Spread of the MIP distribution for each detectors.

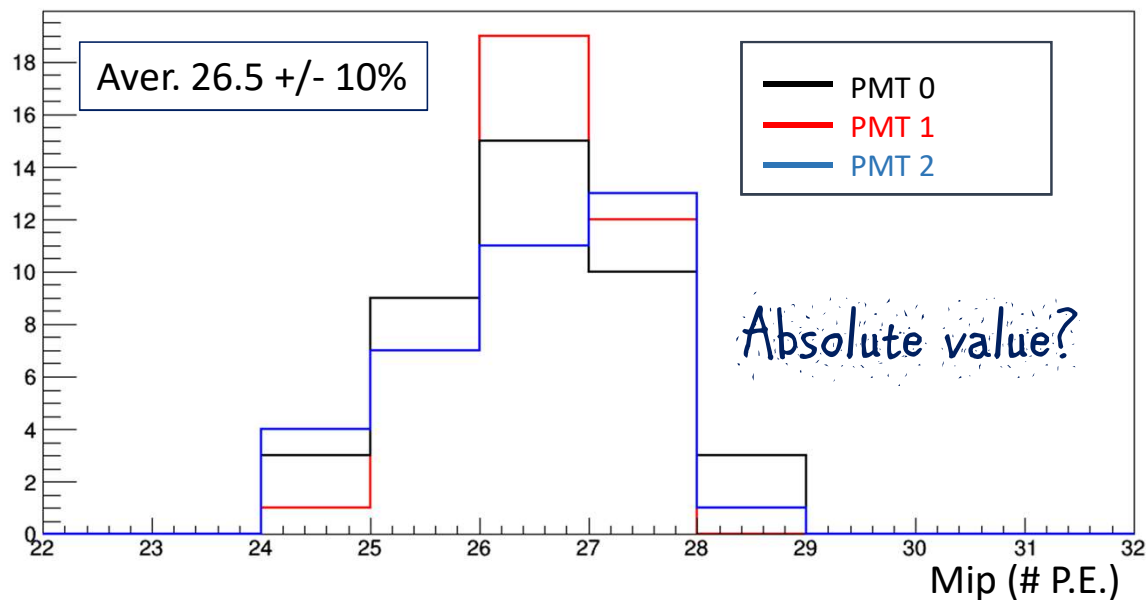


- Normalization with the PMTs is not necessary!
- The three distributions are compatibles.
- For each detector the spread is below the 36%

# Mip Analysis



Normalized

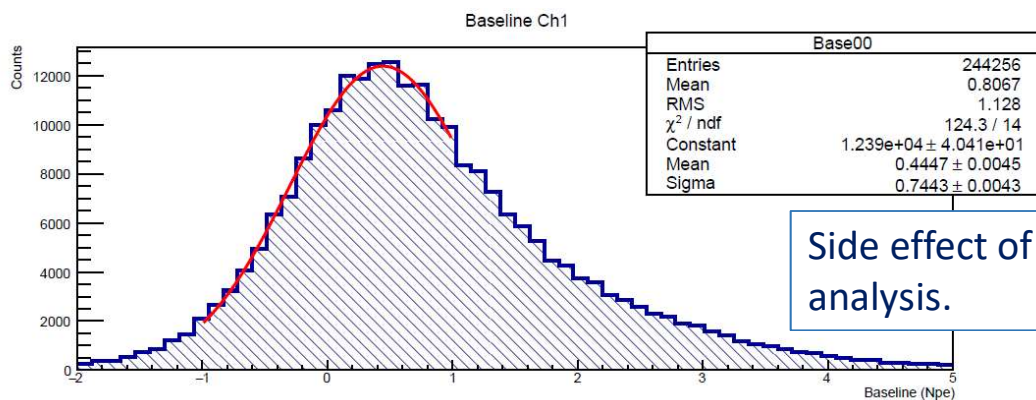


Assuming a constant factor of normalization between the different PMTs, the three distributions are in good agreement

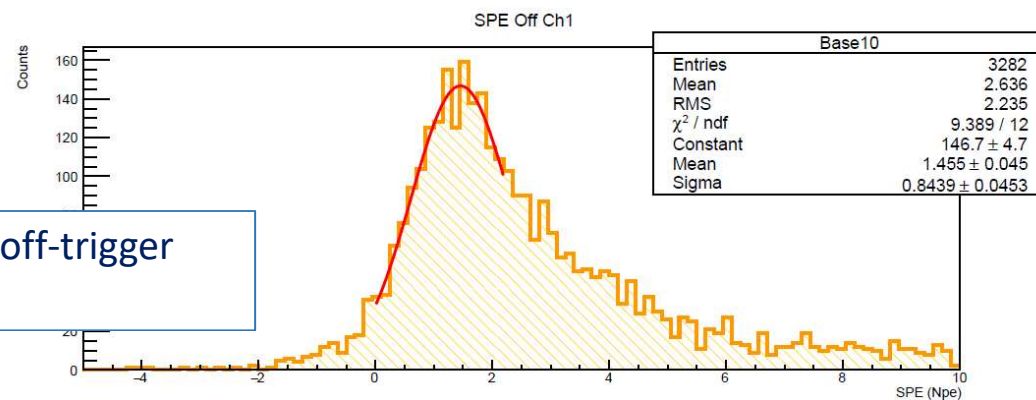
Normalization factors:

PMT0	1.0
PMT1	0.89
PMT2	1.22

Spread 33%

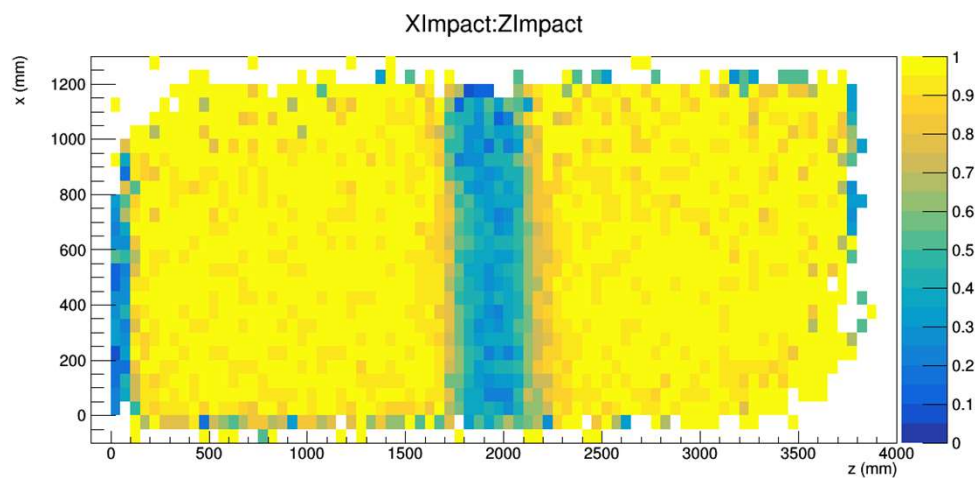
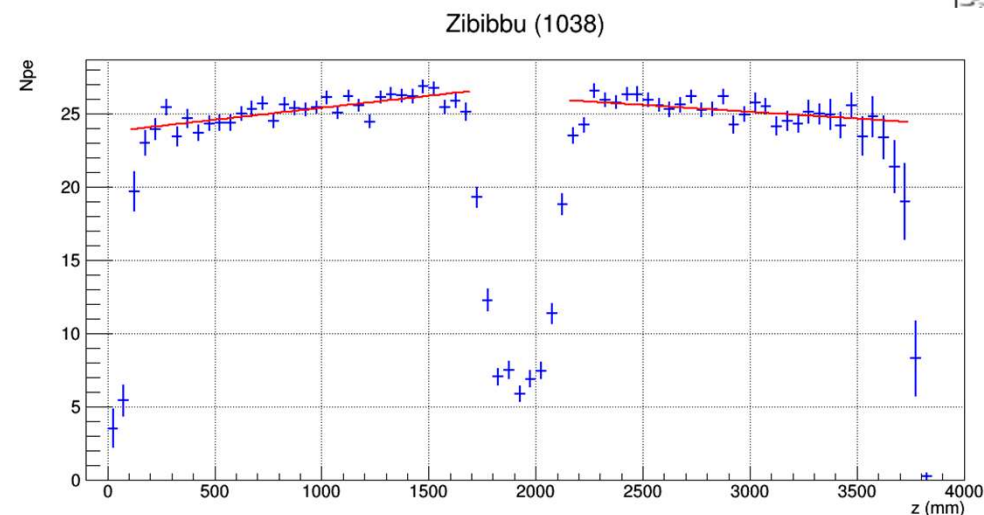
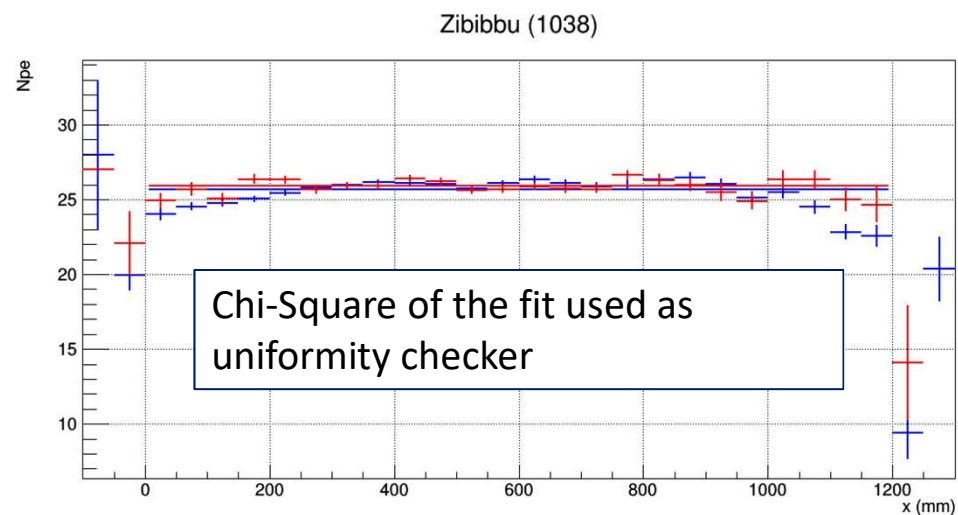
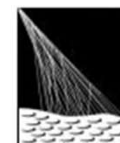


Side effect of the off-trigger analysis.



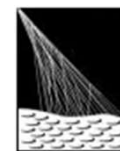


# Uniformity Analysis



The resolution of our tracking tower is not enough to identify small unevenness of the detectors. Anyway, we have roughly check the uniformity. The parameter used to characterize the uniformity is the chi-square of the fits with a constant in x view.

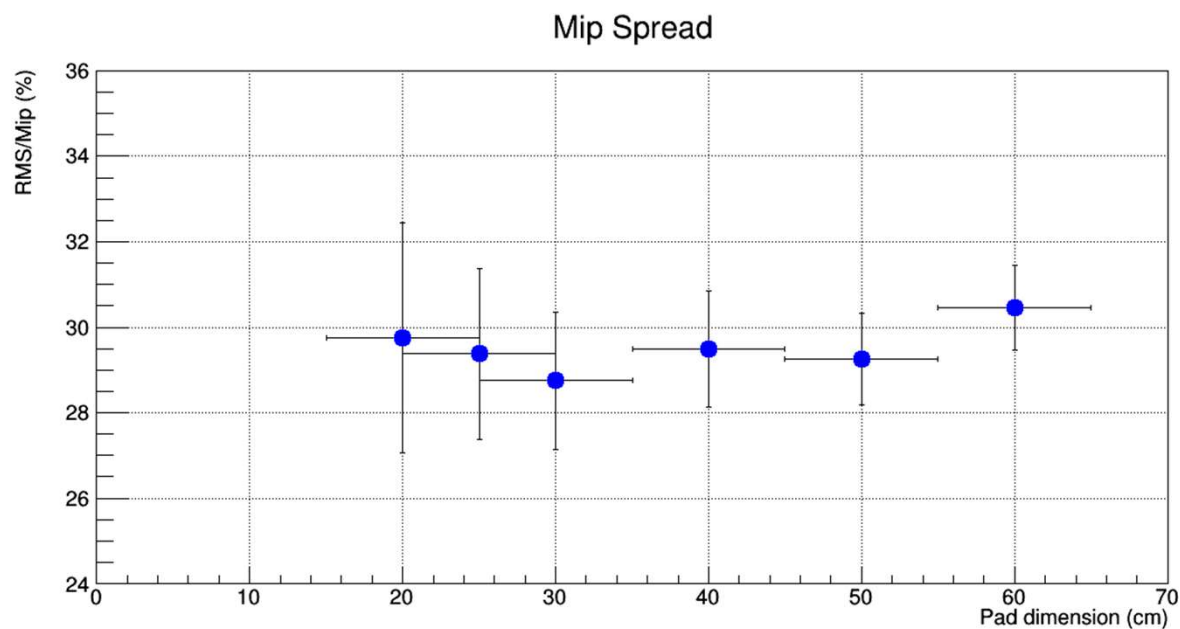
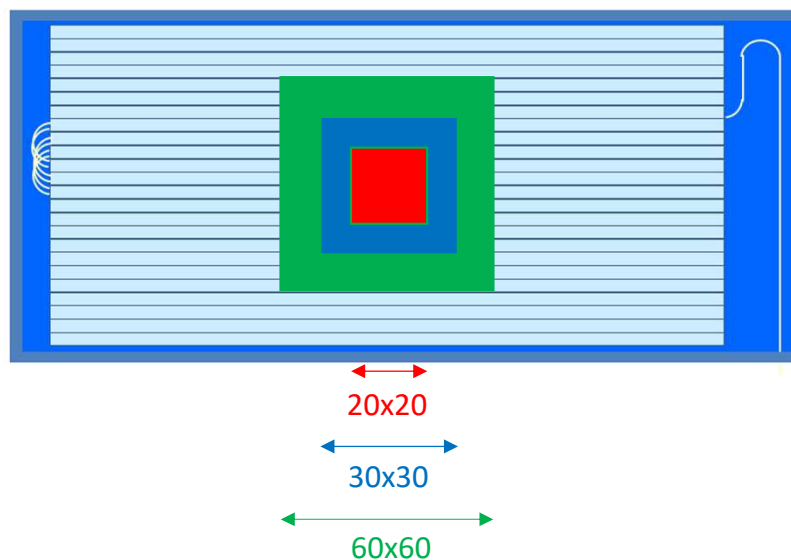
## Spread vs Uniformity



Is the spread of the MIP sensible to the uniformity?

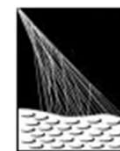
We know the impact point of the particle on the detector, therefore we can select regions of impact and compare performance of the different regions.

If the RMS of the Mip is sensitive to the uniformity of the detector therefore the spread has to increase with the dimension of the exploring region.



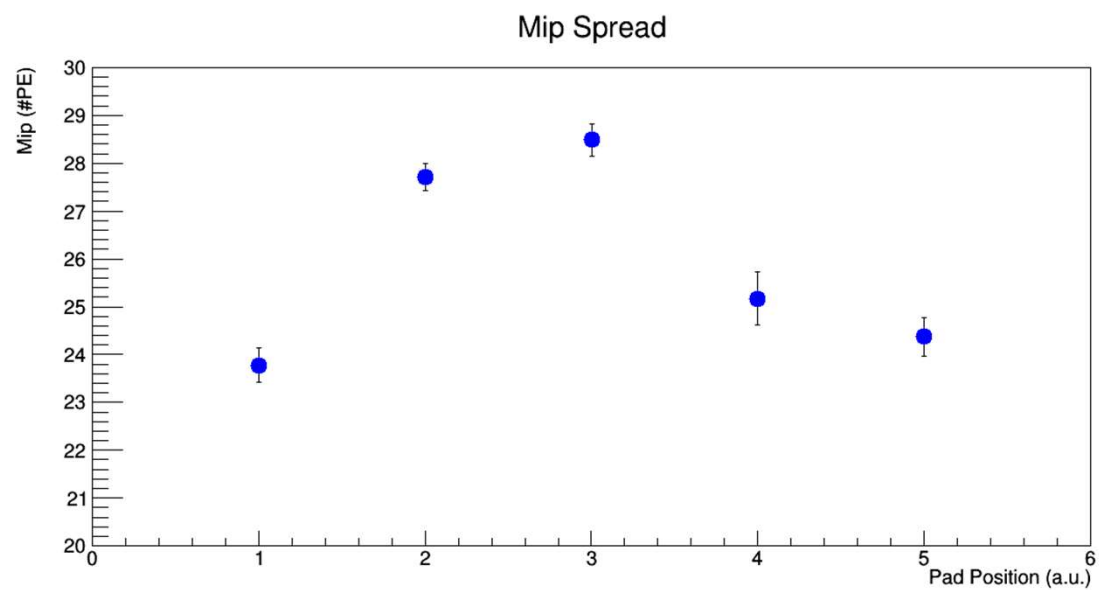
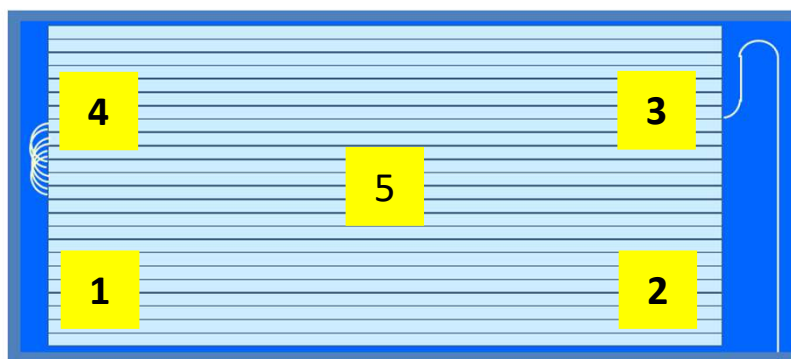
No correlation between the spread of the MIP and the dimension of the region under test.

## Spread vs Uniformity



Is the detector uniform?

Used regions of 25x25 cm<sup>2</sup>



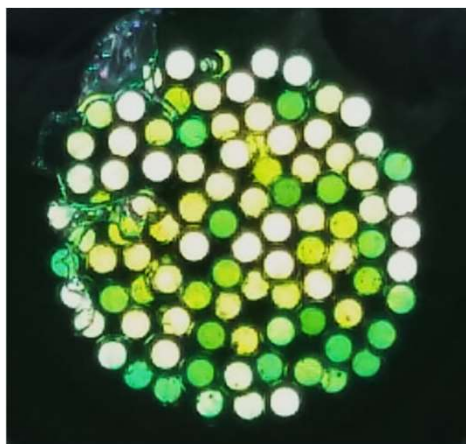
No correlation between the MIP and the position of the region under test.

## The Cookies

Lulentu (1004)  
Alignment vote 3



Mangiacani (1009)  
Bubble vote 2.5

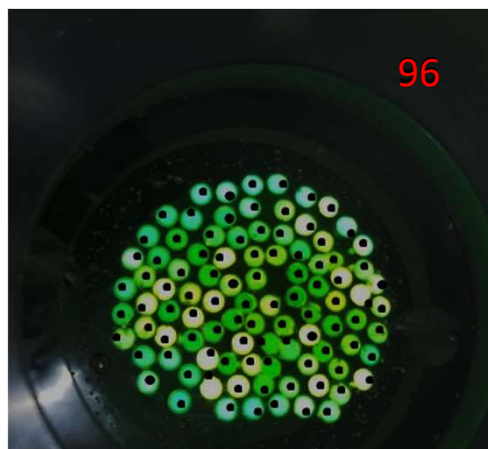


Evaluation of the quality of the cookie with a vote.

Two independent groups of students (two students per group) have evaluated the quality of the cookie with two votes.

- 1) Presence of bubbles (0 a lot, 10 no bubble)
- 2) Alignment of the fibers (0 very bad , 10 excellent)

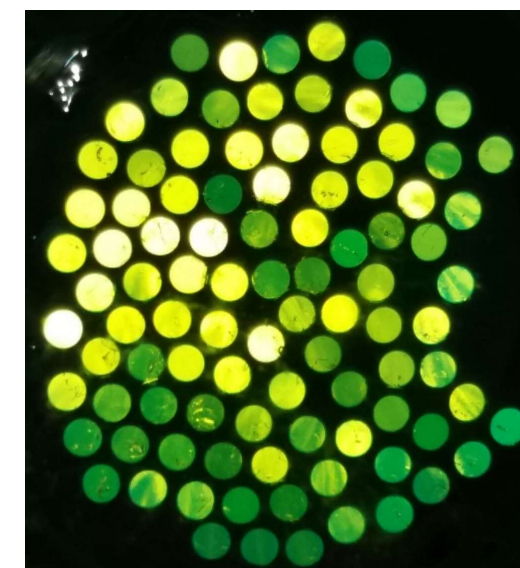
For each cookie the students have counted the number of visible fibers.



Rapicauli (1040)  
Vote alignment 9.5

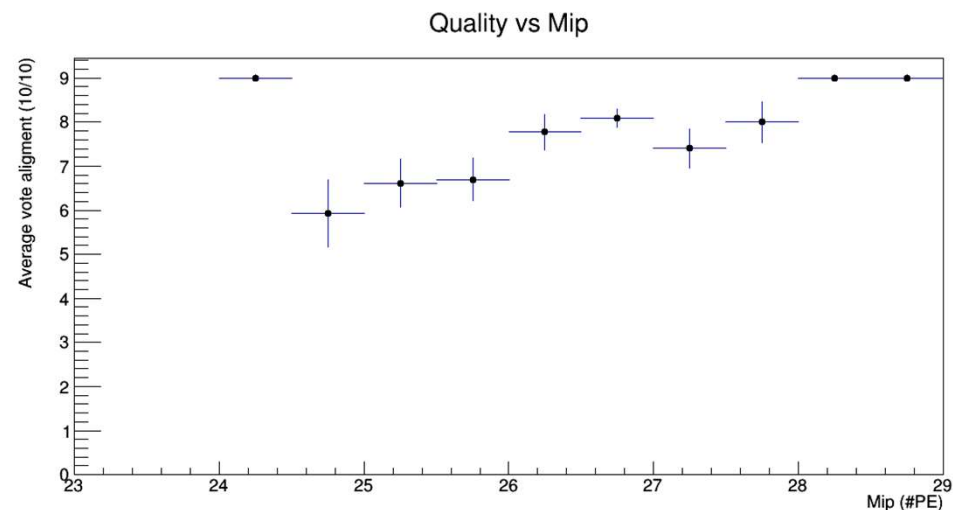
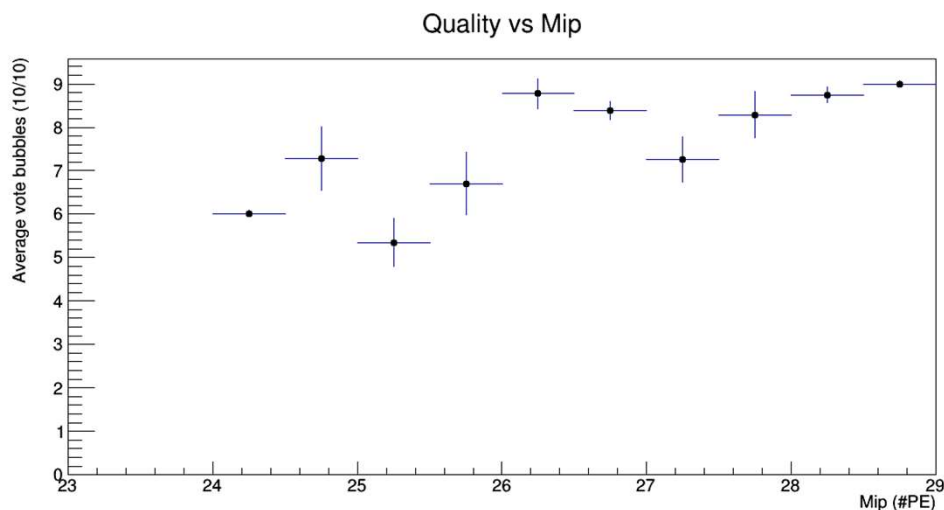
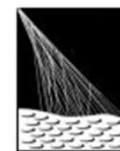


Santantoni (1020)  
Vote bubble 9.5





## Mip Analysis



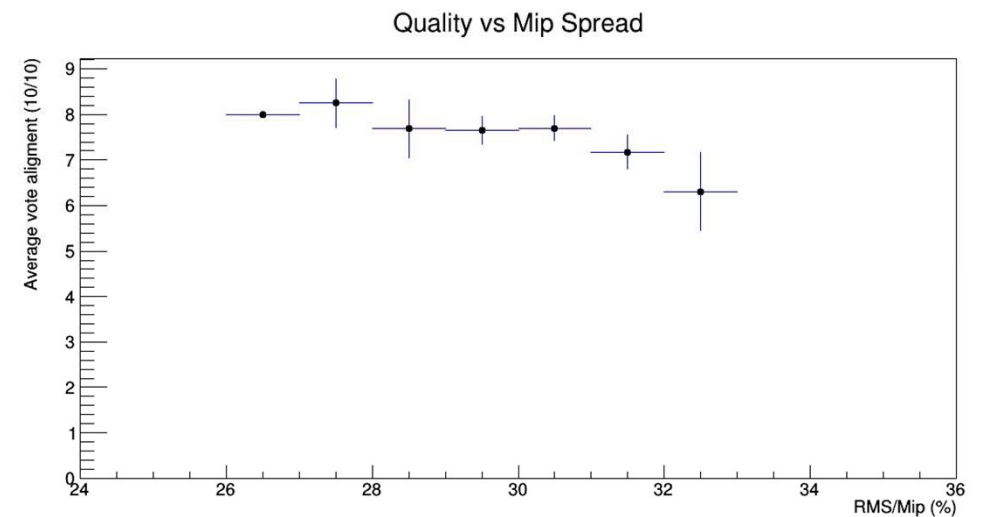
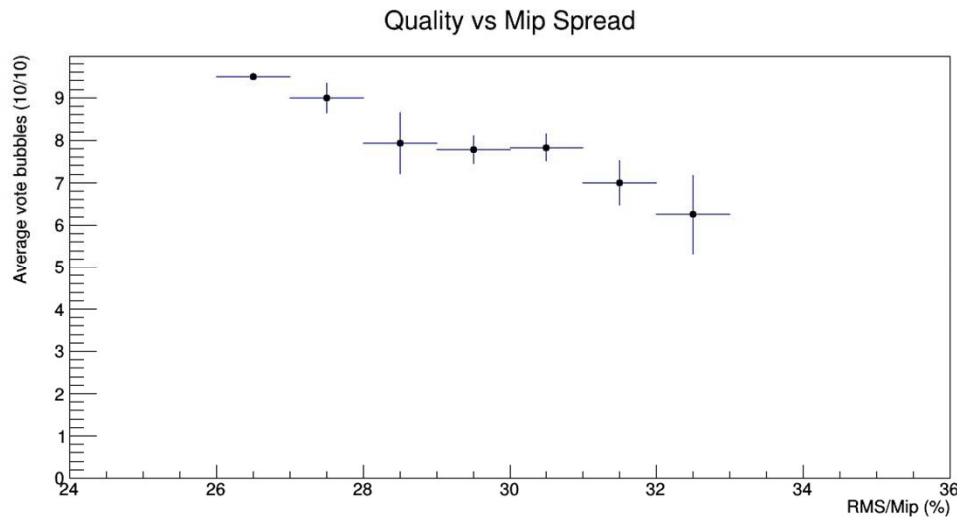
Comparison of the evaluation of quality of the cookies with the # P.E.

The average vote obtained by each cookie has been compared with the normalized number of photo-electrons. Both votes show a weak correlation with the # P.E.

Lower vote -> less photo-electrons

The presence of bubbles and the not perfect alignment seem influence the total number of photo-electrons of the MIP

## Mip Analysis



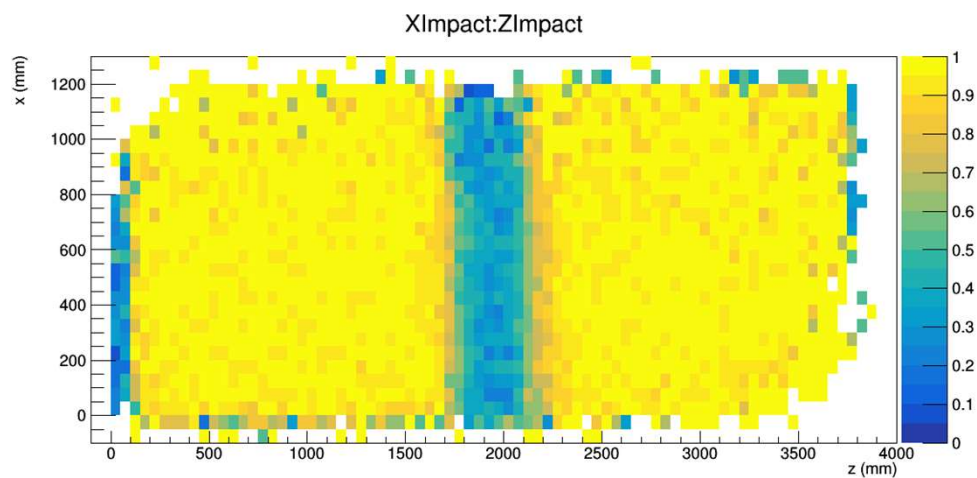
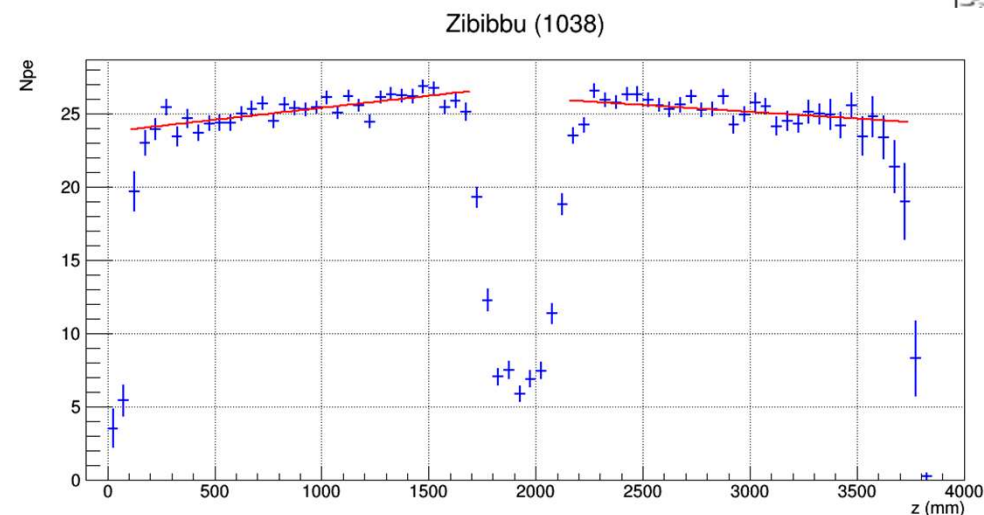
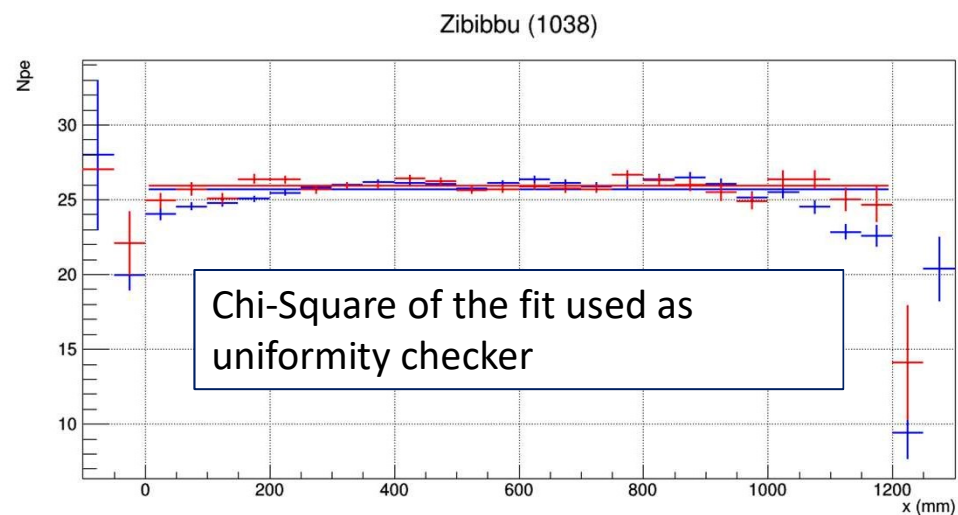
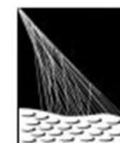
Comparison of the evaluation of quality of the cookies with the spread of the MIP

The average vote obtained by each cookie has been compared with the spread of the MIP distribution. Both votes show a correlation.

Lower vote -> larger spread

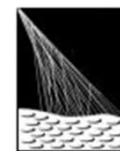
The presence of bubbles seem to influence more the spread of the MIP distribution

# Uniformity Analysis

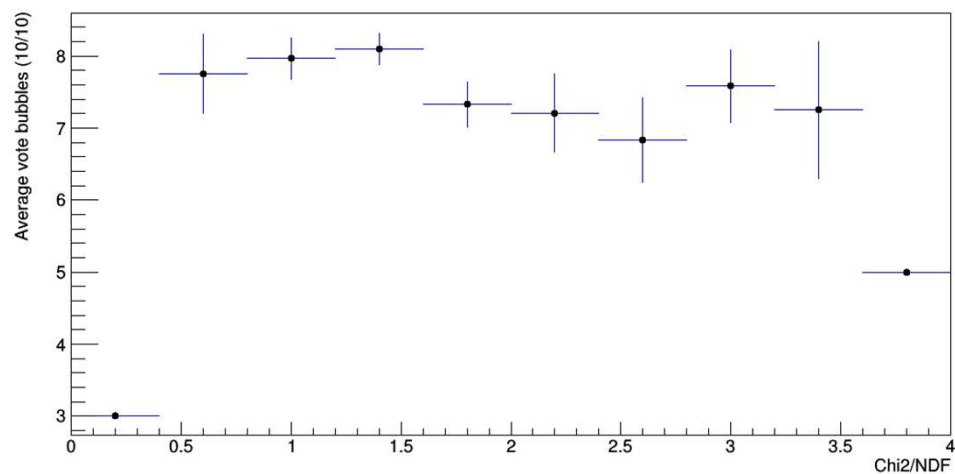


The resolution of our tracking tower is not enough to identify small unevenness of the detectors. Anyway, we have roughly check the uniformity. The parameter used to characterize the uniformity is the chi-square of the fits with a constant in x view.

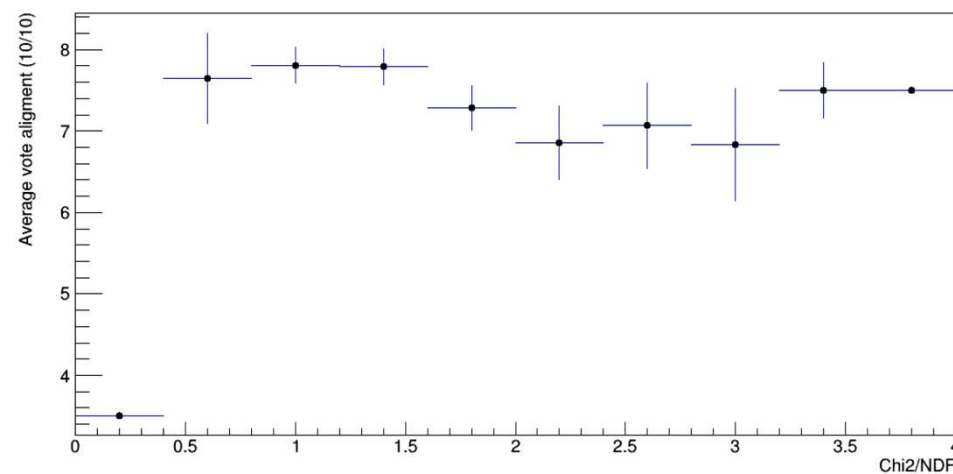
# Uniformity Analysis



Quality vs Uniformity



Quality vs Uniformity

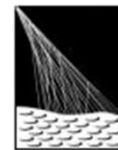


Not found an evident correlation between the chi-square and the “vote” of the cookies

The uniformity is not correlated with the quality of the cookie?  
Our tracking tower do not have enough resolution?



# Conclusions



Up to 66 detectors tested with the validation facility at Lecce

In this presentation are included the results of the first 46 detectors produced

Not serious problems found during the assembling process. The anomalies has been identified and (if necessary) corrected

The performance of the detectors (Mip spread) are inside the specifications but **we have a problem** to evaluate the **absolute number of photo-electrons** that generate a MIP.

While the distributions of the relevant parameters seems Gaussian, it is possible to identify a correlation between the quality of the cookie and the number of photo-electrons of the MIP and its spread

With our validation facility we do not see not uniformity effects

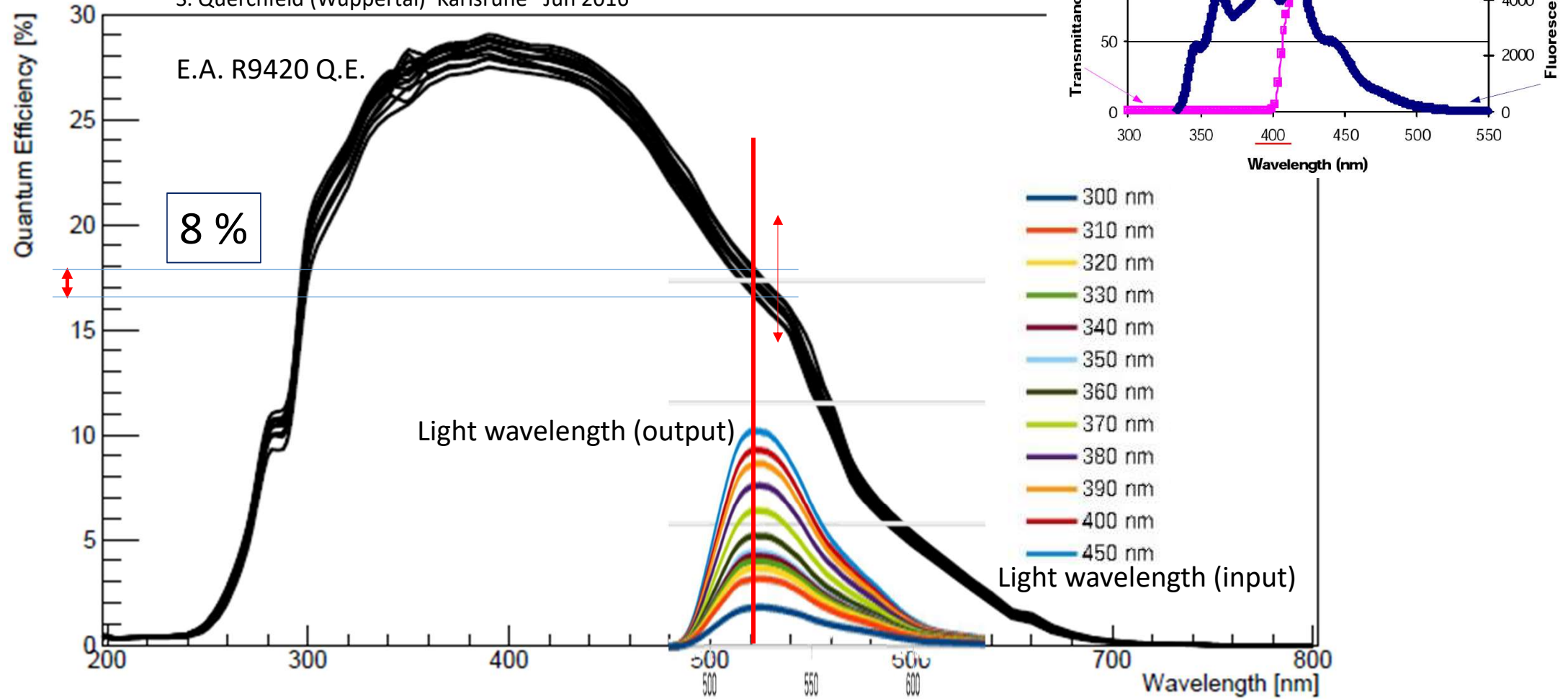
Backup

R. Smida (KIT) Orsay 3-6 Feb 2015

## FNAL Scintillators

S. Querschfeld (Wuppertal) Karlsruhe Jun 2016

E.A. R9420 Q.E.



D. Mandat (CAS) Torino 22-24 Apr 2015