

# First PET prototype design meeting

introduce the group  
define the scope of the project  
first idea on how to build the prototype  
status of European activities

# The group

DESY:	Erika Garutti	(GL)
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Heidelberg:	Hans-Christian Schultz-Coulon	(GL)
	Alexander Tadday	(diploma student / finished)
Lebedev:	Valentin Koslov	(GL)
	Adel Terkulov	(senior physicist)
Shinshu:	Tohru Takeshita	(GL)
	Satoru Uozumi*	(Post-Doc)

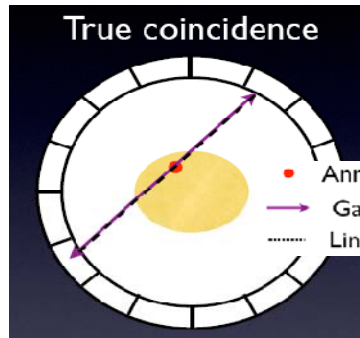
\*soon Kobe

# Spin-off application to PET detectors

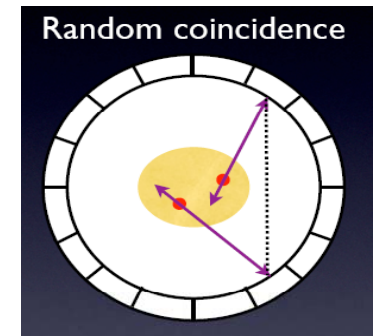
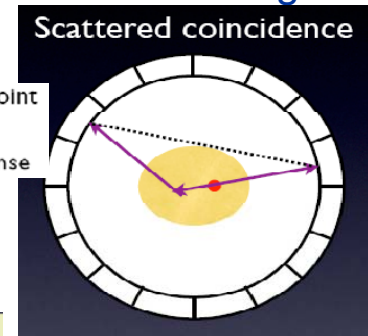


## Positron Emission tomography :

identify back-to-back scattered 511 keV  $\gamma$  from  $e^+e^-$  annihilation, suppress background and determine true line of response



## Background events



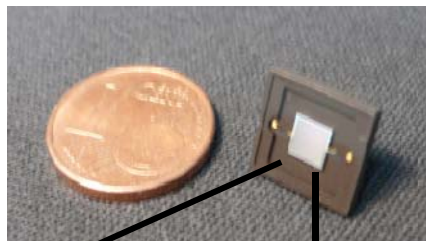
## requirements for photo-detector:

- compact → high granularity
- magnetic field independent (MR)
- direct r/o of crystals → blue
- high gain → easy electronics

similar to calorimeter R&D

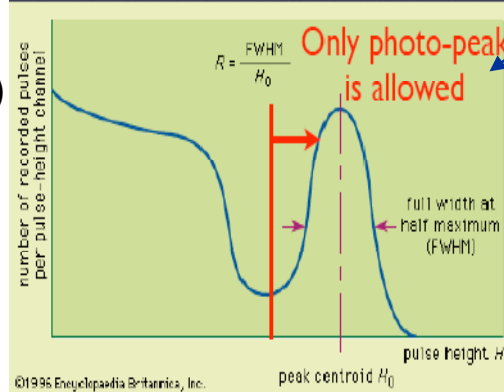
→ same solution:

## MPPC from Hamamatsu

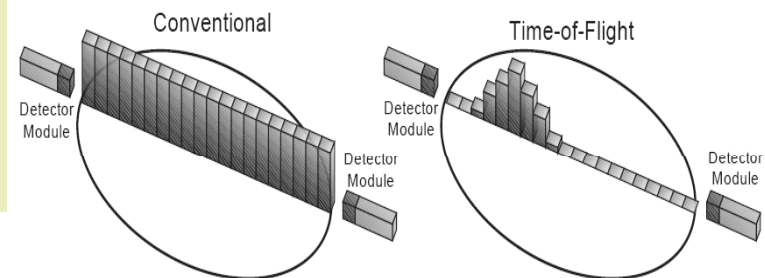


3x3 mm<sup>2</sup> active area

## remove Compton-scattered $\gamma$



remove combinatorial bg by ToF meas.  
 $\Delta t = 500 \text{ ps} \rightarrow \Delta x = c/2 \Delta t = 7.5 \text{ cm}$

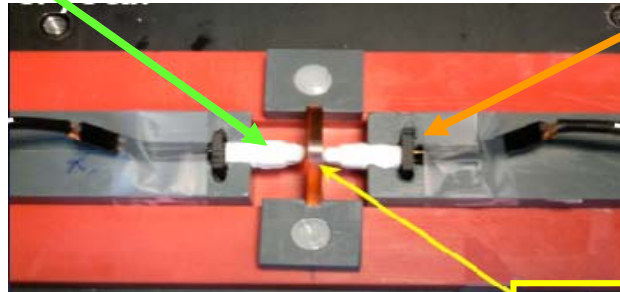


two channel setup with 3x3x15 mm LSO or LFS crystals + MPPC  
 → test performance for PET system: **E and t resolution**

# The project

test on single “PET-like” channel setup DONE !

2 x scintillator crystals  
LSO\*: 1x1x15 mm<sup>3</sup>  
3x3x15 mm<sup>3</sup>  
LFS\*\*: 3x3x15 mm<sup>3</sup>  
emission: ~420 nm  
decay time: ~40 ns  
Teflon wrapping



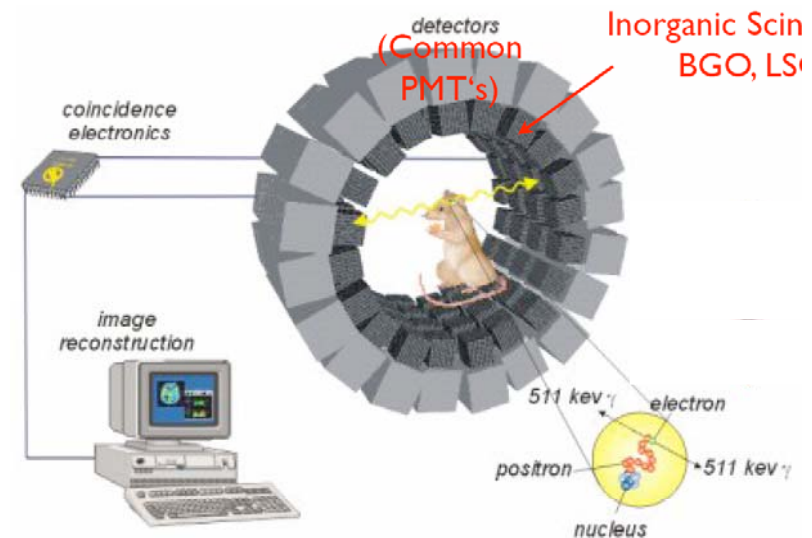
2 x MPPC  
1x1 mm<sup>2</sup>, 400 pixels  
3x3 mm<sup>2</sup>, 3600 pixels  
coupled with optical grease

Na<sup>22</sup> source

Now move toward a multi-channel (small animal) prototype

goals:

- test ch.-to-ch. homogeneity/reproducibility
- develop “scalable” multi-channel readout
- check calibration and monitoring
- stability of operation
- reconstruct non-point-like source using E and t resolution

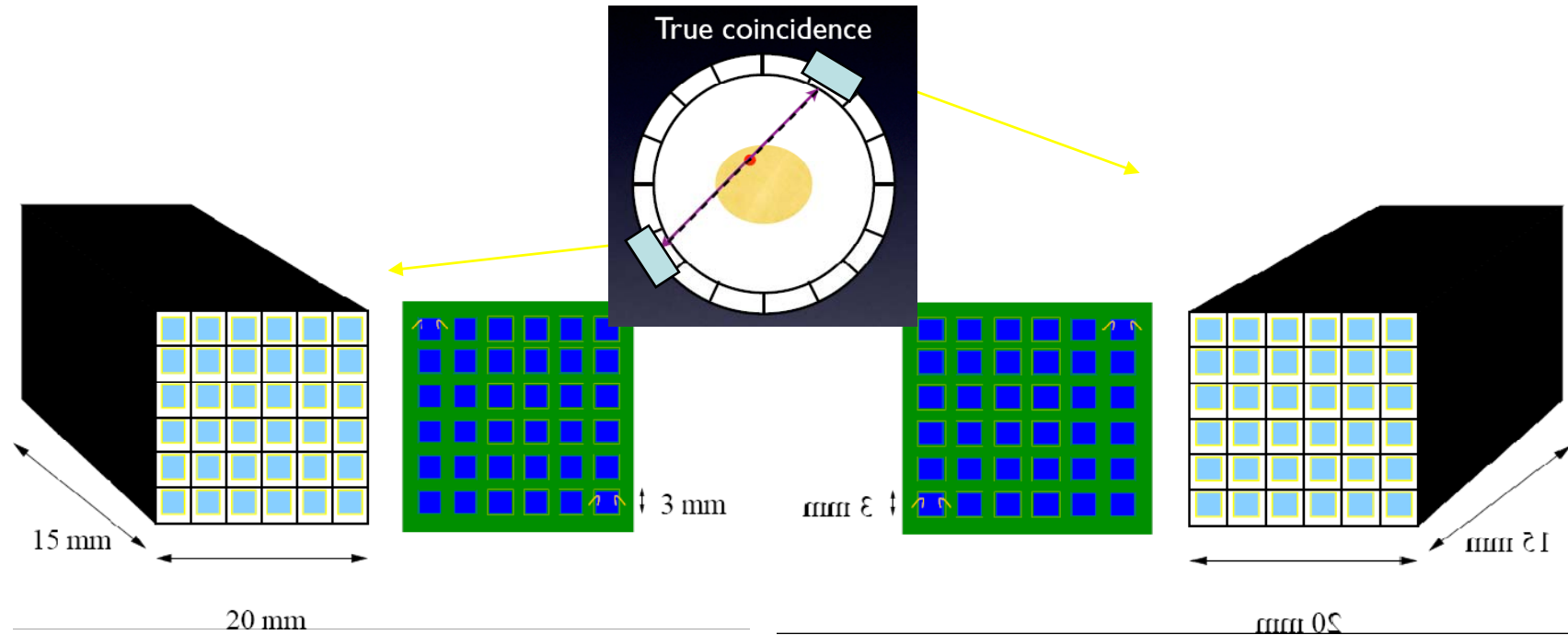


14/12/2007

Erika Garutti - PET prototype design

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## 2 – matrices design



### 1 Matrix design:

- 6x6 LSF crystals of 3x3 mm<sup>2</sup> area
- crystal length still to be optimized
- support structure still to be defined

→ see MC studies

idea: carbon fiber grid → introduce crystals without wrapping

- reflector paint from BICRON under investigation
- photo-detectors: 6x6 MPPM of 3x3 mm<sup>2</sup> active area

mounted on same PCB or separate 2x2 matrices → tolerances ?

# 2 – matrices design... cont

1 Matrix design:

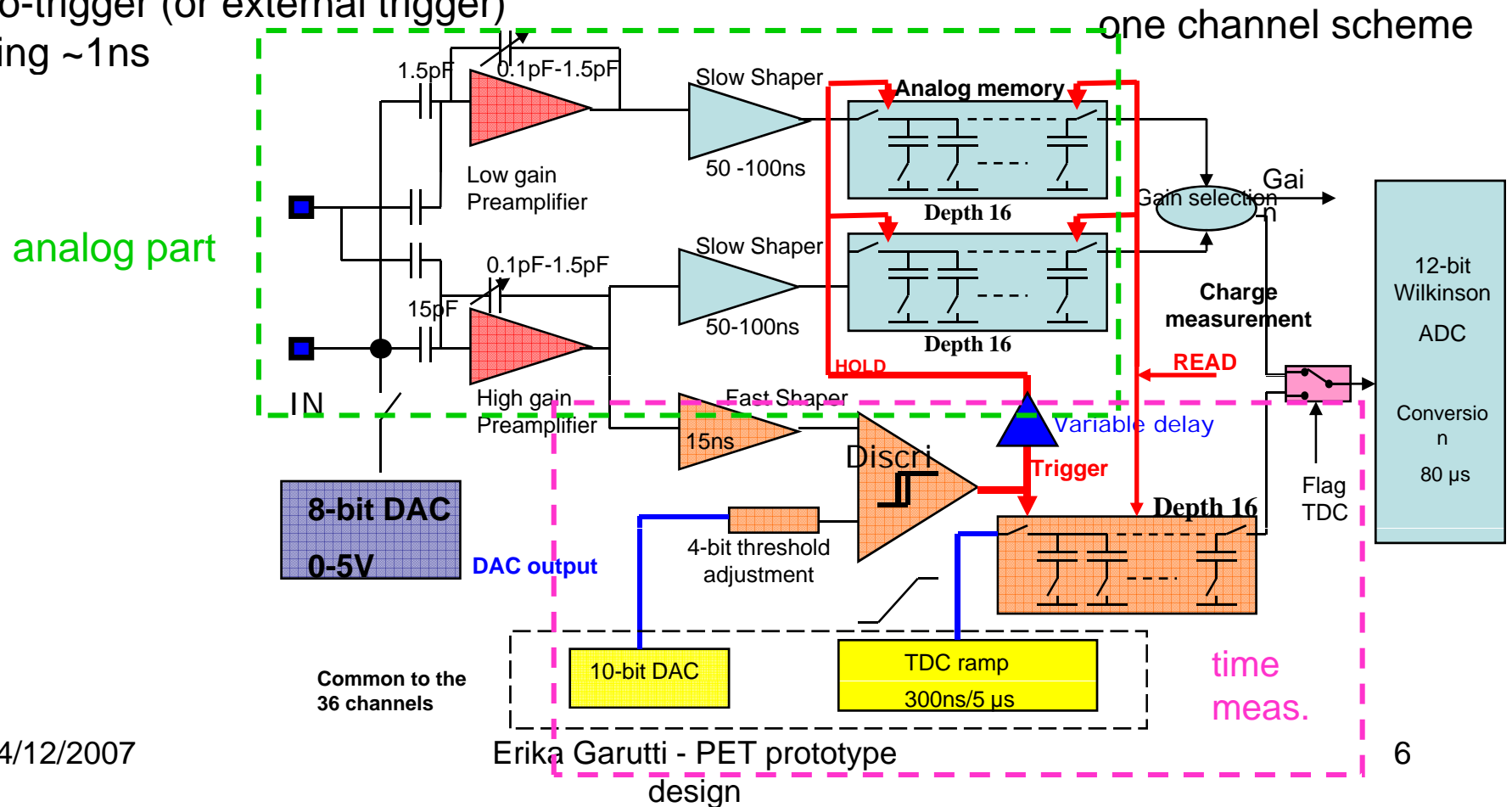
-6x6 LSF crystals of 3x3 mm<sup>2</sup> area = 36 ch. (x 2)

-readout of each MPPC with SPIROC chip (36 ch.)

individual DAC for Bias adjustment

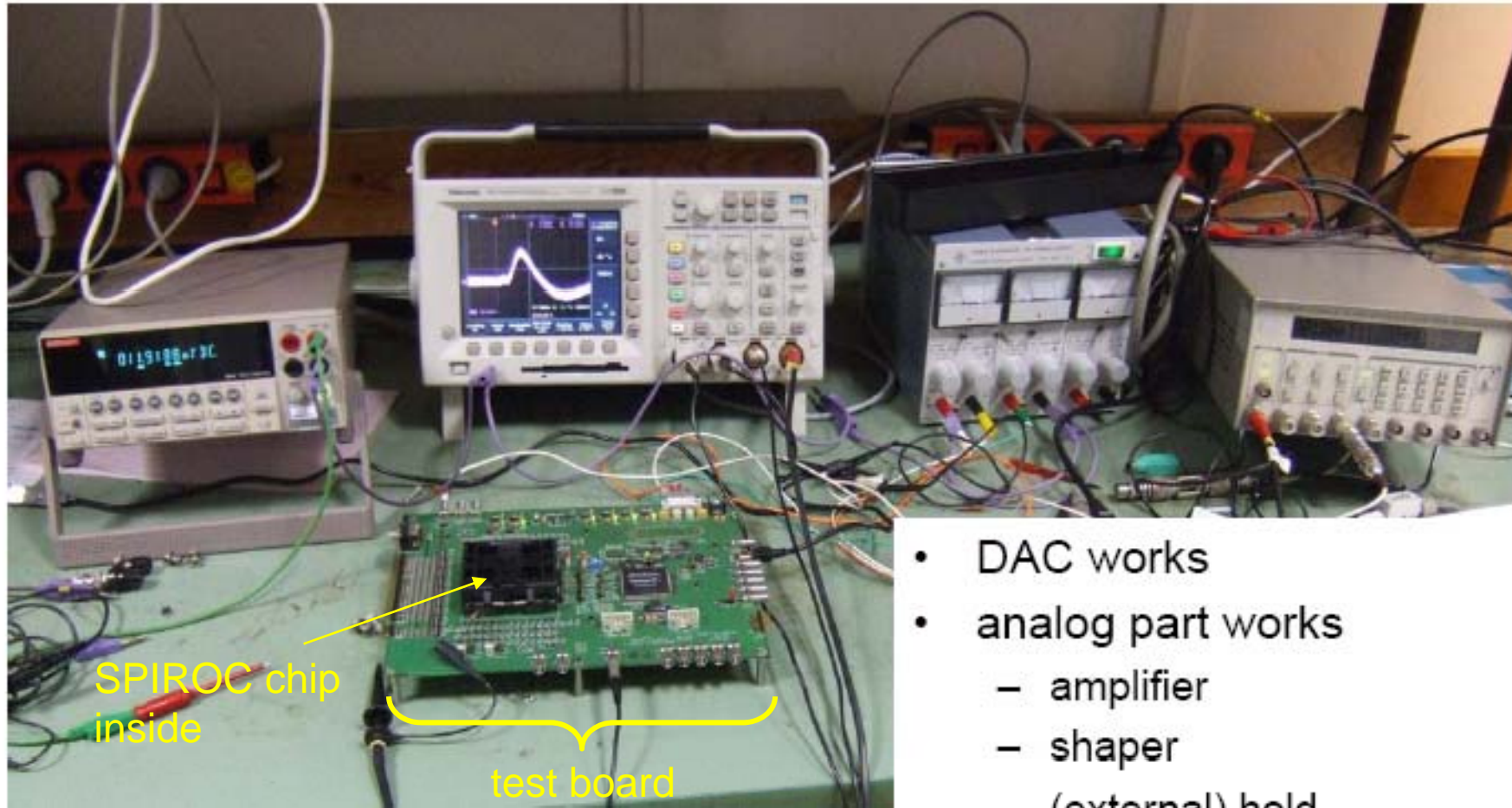
auto-trigger (or external trigger)

timing ~1ns





# SPIROC @ DESY



- DAC works
- analog part works
  - amplifier
  - shaper
  - (external) hold

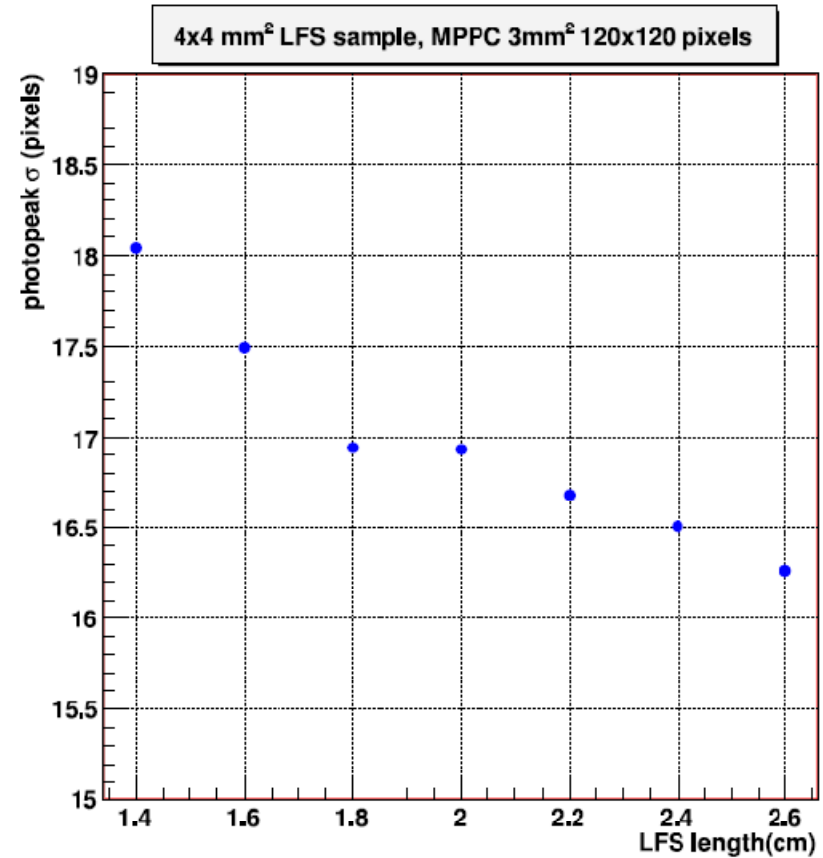
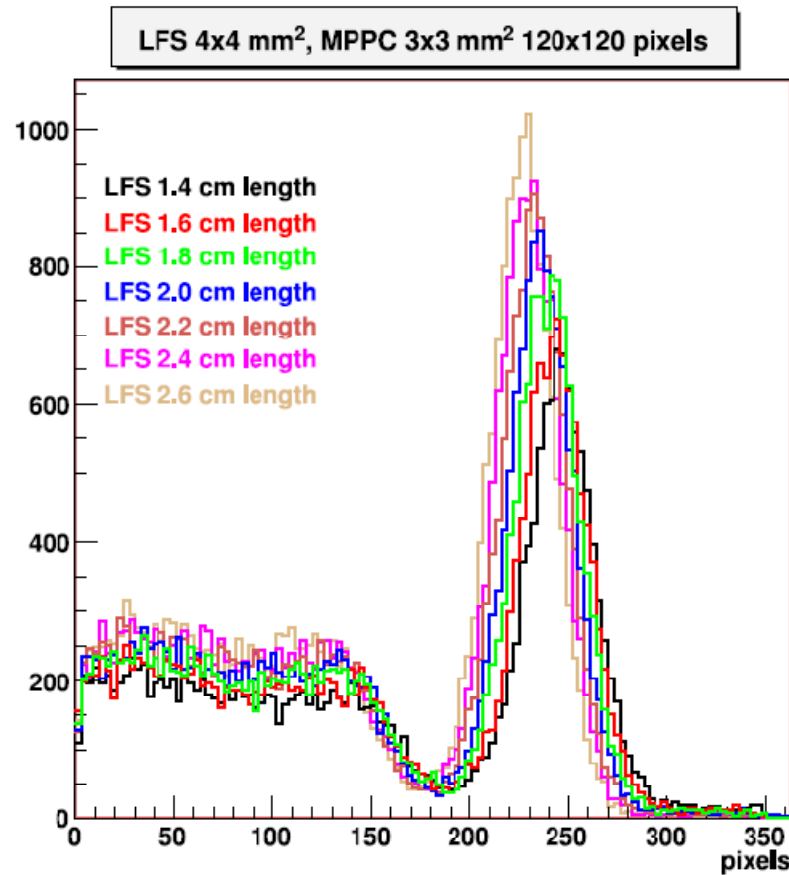
# Status of components

- crystal production & tolerances:
  - after specification ~ 3 weeks production
  - “10um accuracy on crystal dimensions is not a problem”
  - ➔ order 100 pieces by end of Jan. 2008
  - ➔ deliver 100 pieces from one ingot + 20 pieces (test) from a different one
- characterization of all crystals planned at DESY for Mar. 2008
  
- mechanical support structure to be designed / can be build at DESY
  
- readout:
  - chip is being tested / possible problems on timing part ...
  - 2 test board can be ordered and produced in LAL
  - synchronization between two boards to be investigated
  - readout of two boards to be defined
- ➔ backup plan: to start we can use the CALICE DAQ for amplitude r/o, no time



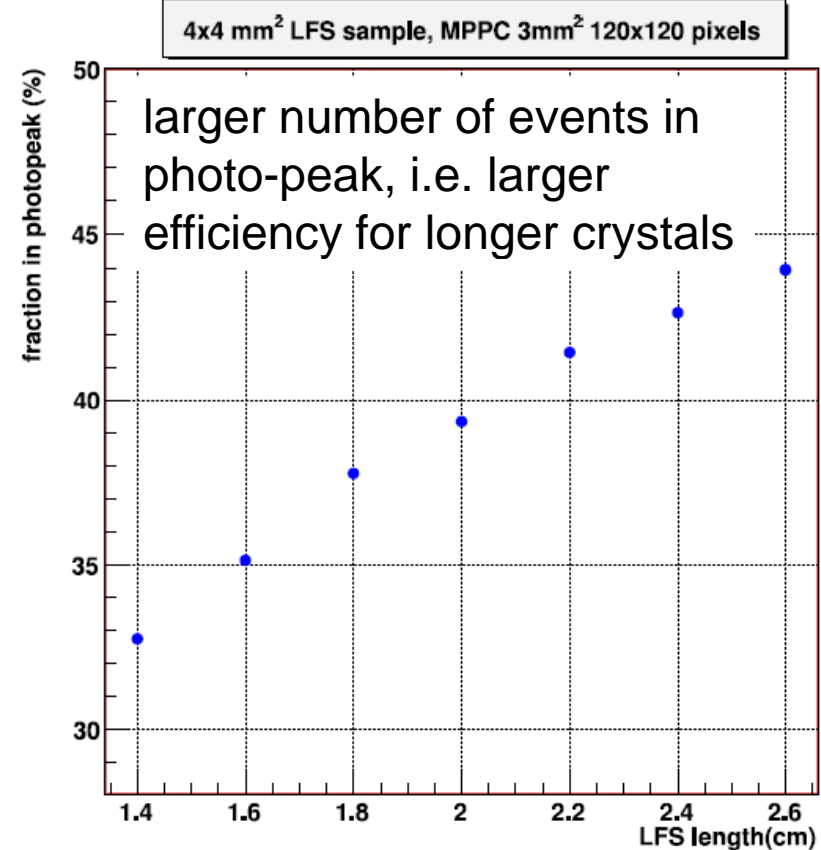
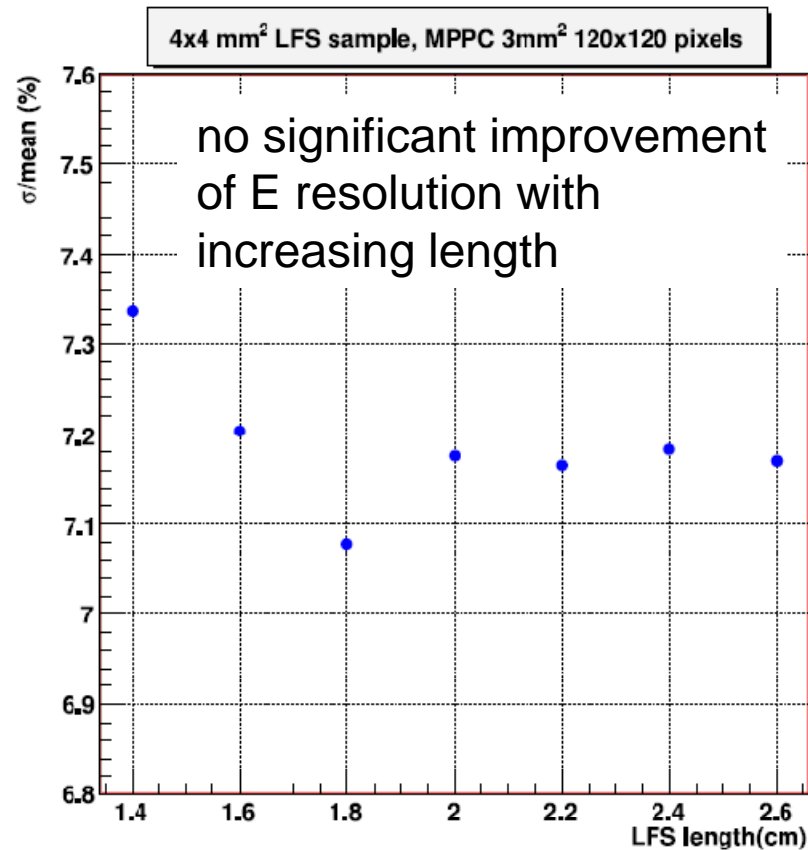
# Open issues for the design

# crystal length studies



plots from Adel Terkulov

# crystal length studies



preliminary! need to be confirmed/checked