

# Pyroelectric line detector

## for THz spectrometer

# requirements

- arc shaped line detector, coverage  $> 50$  deg
  - sufficient S/N for  $P = 100$  nJ/ $\mu$ m
  - single shot capable at 1  $\mu$ s spacing
  - reasonable number of channels
    - coverage  $\Delta\lambda/\lambda \sim 1$  per grating stage
    - 30 elements  $\rightarrow$  3 %  $\lambda$ -resolution
    - 4 x 30 = 120 elements in total, required ADC channels
  - affordable
- 

## detector element:

thin (25  $\mu$ m) pyroelectric crystal (LiTaO<sub>3</sub>) with front- and backside metallic coating (made by Infratec, Dresden)

## electronics:

charge sensitiv pre-amp + subsequent Gaussian shaping

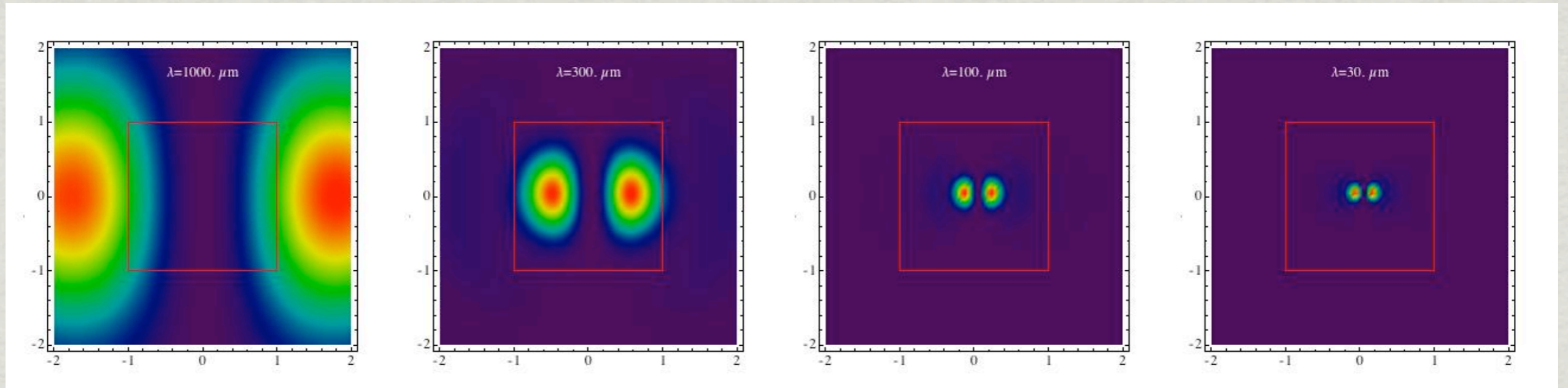
# The size of sensor elements

$\lambda = 1 \text{ mm}$

$\lambda = 300 \text{ }\mu\text{m}$

$\lambda = 100 \text{ }\mu\text{m}$

$\lambda = 300 \text{ }\mu\text{m}$

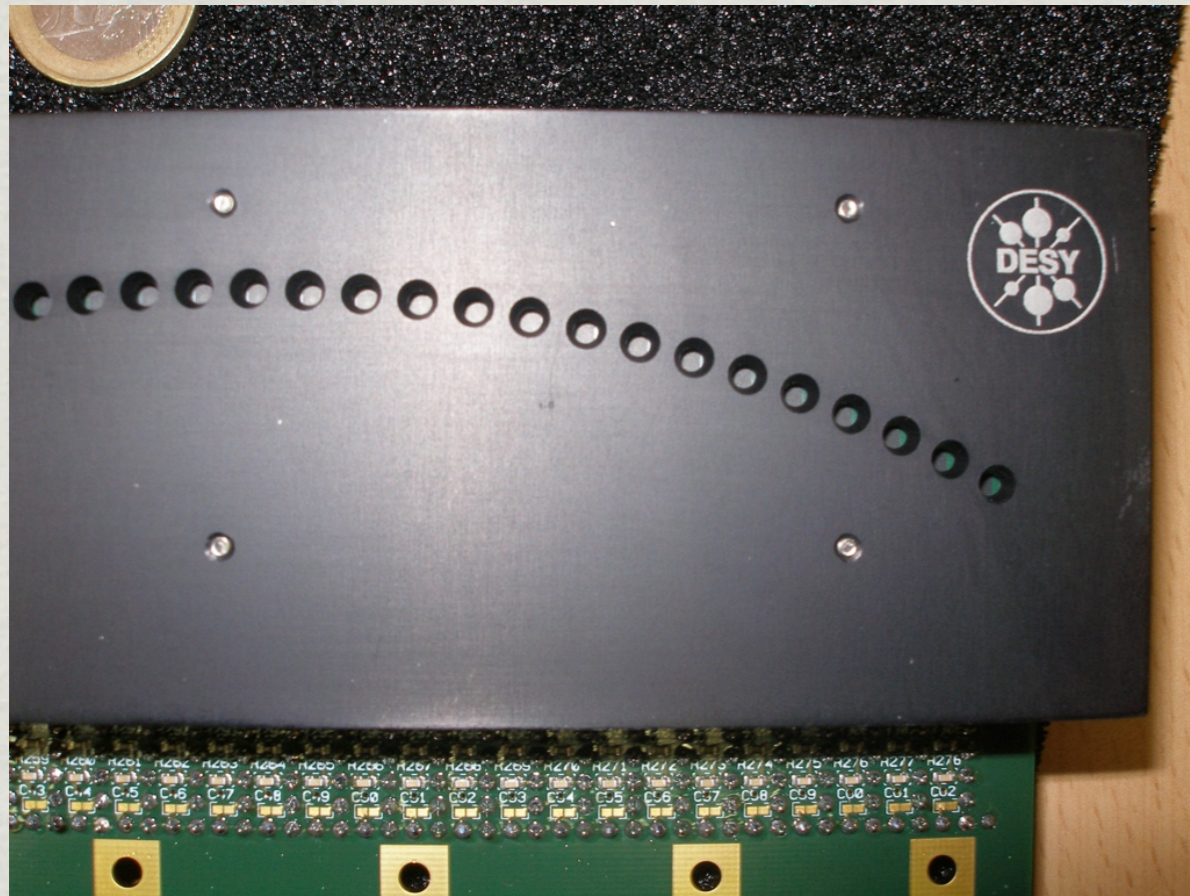


Transition radiation  $\gamma=1000$ , horizontal polarization,  
de-magnification 1:3,  $f = 150 \text{ mm}$

2x2 mm ok up to  $\sim 300 \text{ }\mu\text{m}$   
5mm pitch x 30 elements = 150 mm arc length  
 $57^\circ$  at 150 mm radius

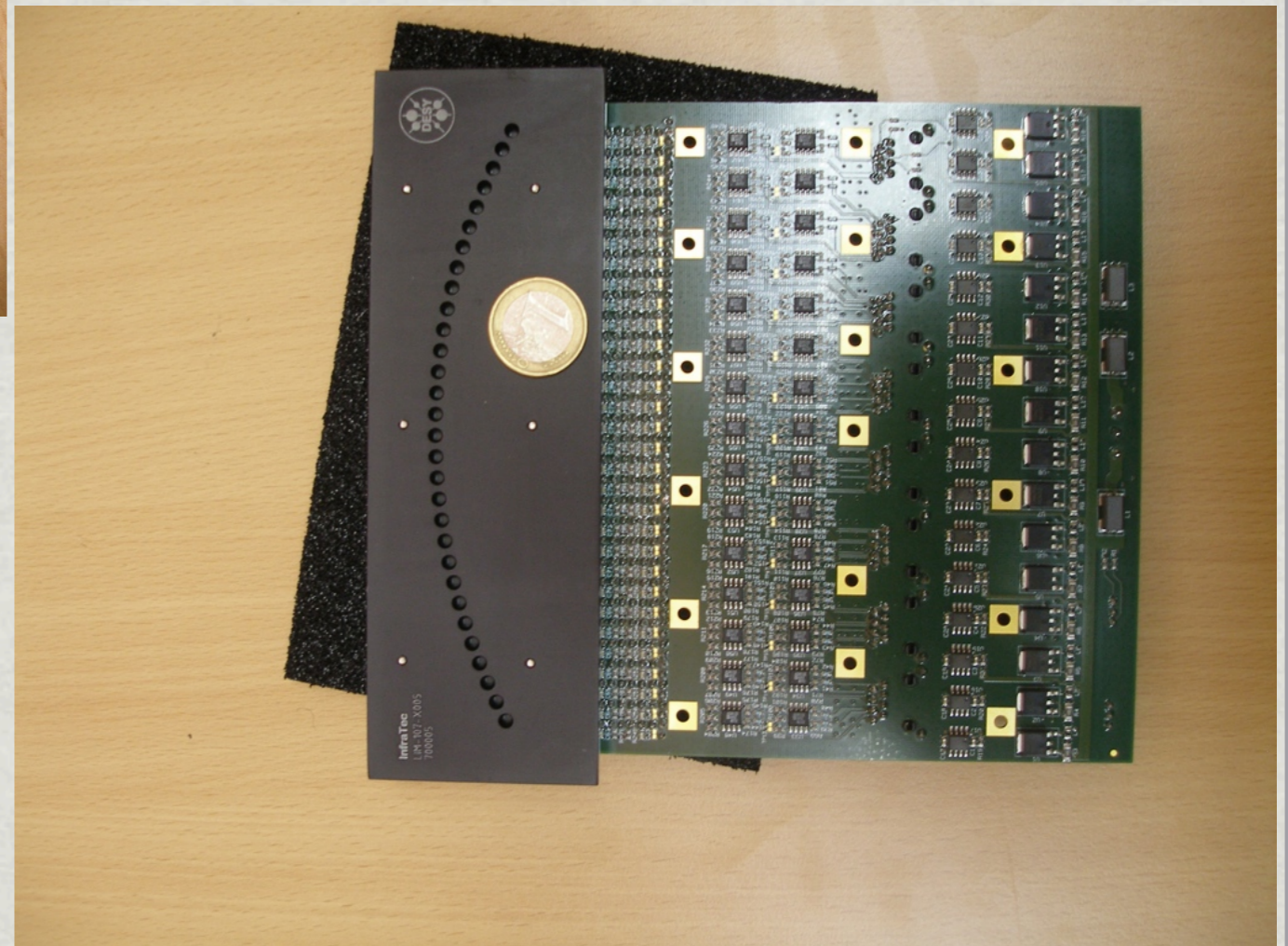
*you can not make „small device“ like for VIS  $\lambda$*

# 30 channel arc-line detector LIM-107



30 individual crystals bonded on PCB board

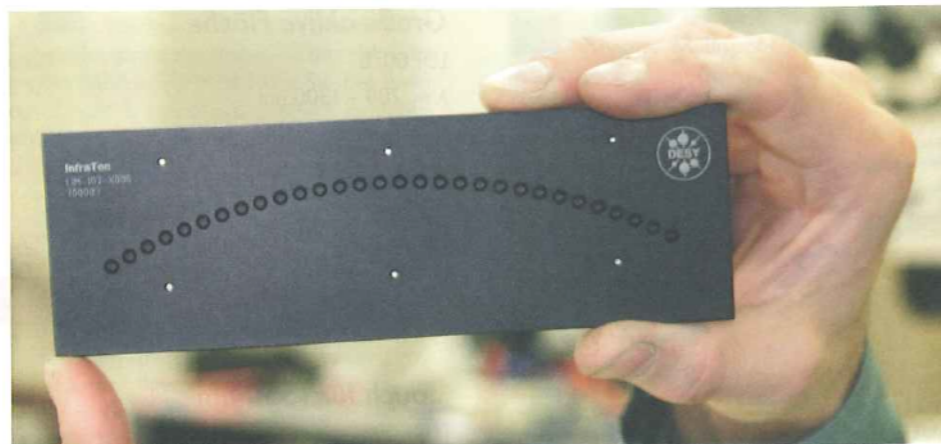
produced and sold by



# advertising the pro line

## Pyroelektrischer Detektor

### Sensorzeile zur THz- und mm-Wellenlängen-Detektion



In Zusammenarbeit mit dem Institut „Deutsches Elektronen-Synchrotron DESY“ hat InfraTec eine 30-elementige pyroelektrische Zeile (LIM-107) entwickelt, welche Synchrotron-Strahlung im Terahertz- und Millimeterwellenbereich in einem Spektrometer detektiert.

Die Eckdaten des Detektors LIM-107 sind wie folgt:

- 30 Elemente  $2 \times 2 \text{ mm}^2$  angeordnet auf einem Kreisbogen  $R = 150 \text{ mm}$  im Abstand  $5 \text{ mm}$

- 3 alternative Elektrodenbeschichtungen möglich für die Wellenlängenbereiche um  $100 \mu\text{m}$  (3 THz),  $300 \mu\text{m}$  (1 THz) und  $1 \text{ mm}$  (0,33 THz)

- Kein Fenster

- Betrieb im Vakuum möglich

- Außenabmessung ca.  $170 \times 55 \times 5 \text{ mm}^3$

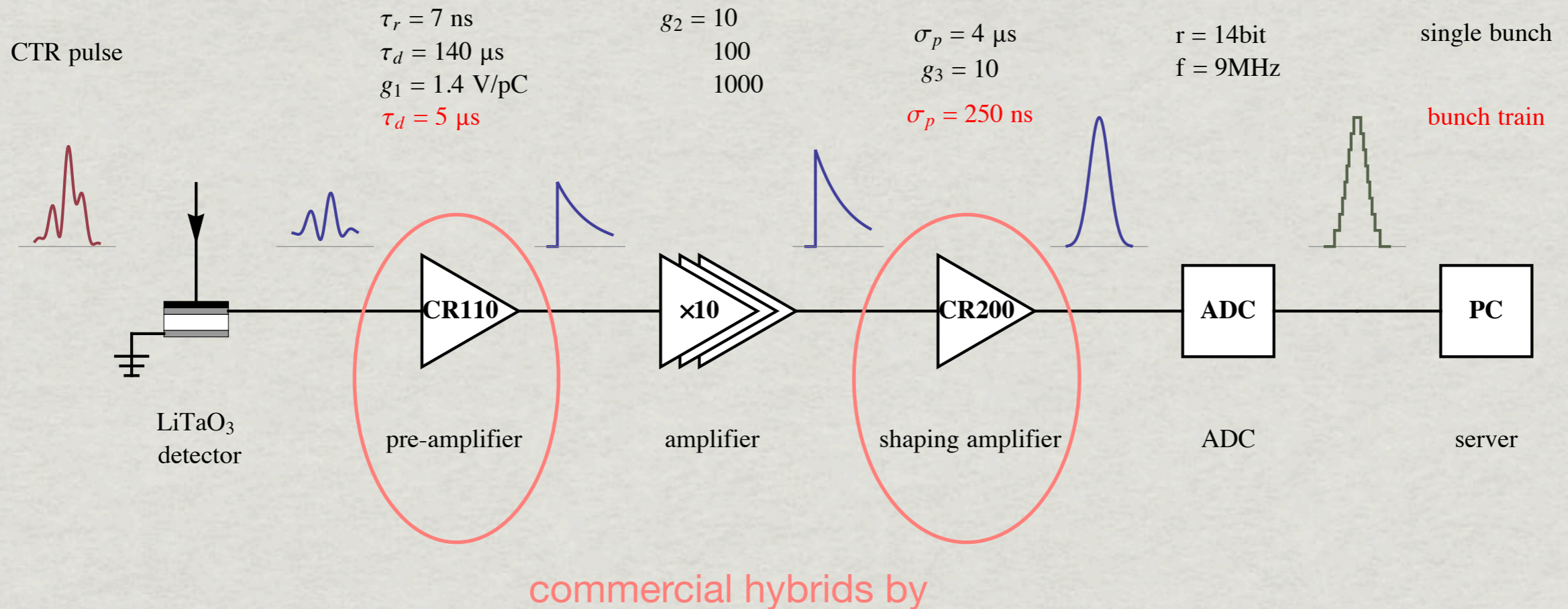
Eine angepasste schnelle Vorverstärkerelektronik ist bei Bedarf verfügbar.

**Joe Kunsch: 08142 2864-28**

**Datenblattservice - Webcode 033**

a few sold to MPQ munich..

# electronic chain



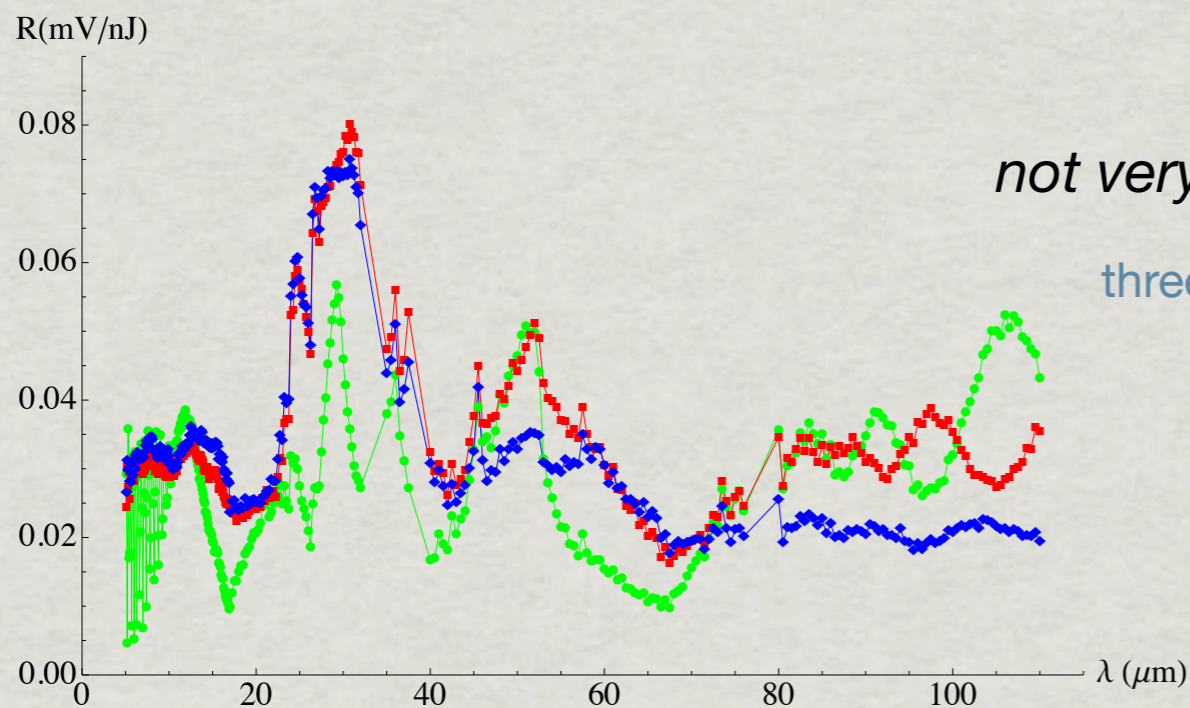
motherboards, signal transmitters- receivers (twisted pair), housing by



<b>Cremat, Inc.</b>	<b>Detection Electronics by Cremat, Inc.</b>
Products	Cremat's radiation detection electronics can be used with a wide range of detectors, including semiconductor radiation detectors, scintillator-photodiode detectors, avalanche photodiodes, photomultiplier tubes (PMTs), microchannel plate detectors, and gas-based detectors (e.g. proportional counters).
Application notes, etc..	
Ordering from the USA	

# spectral sensitivity

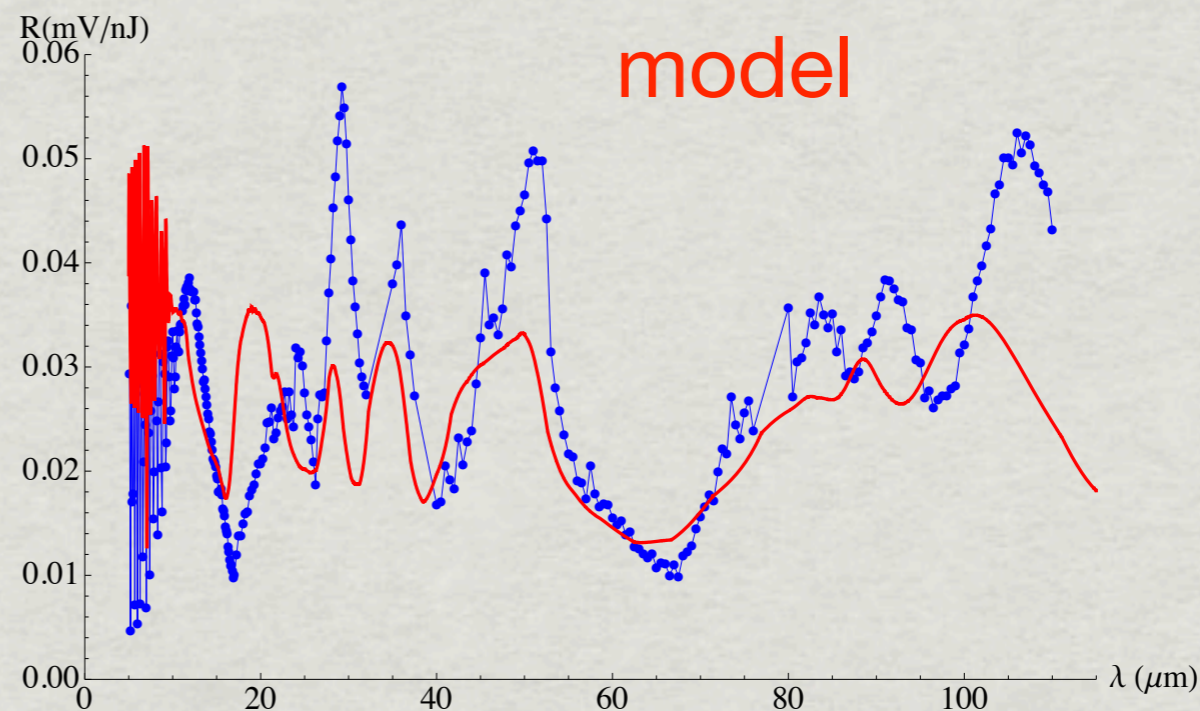
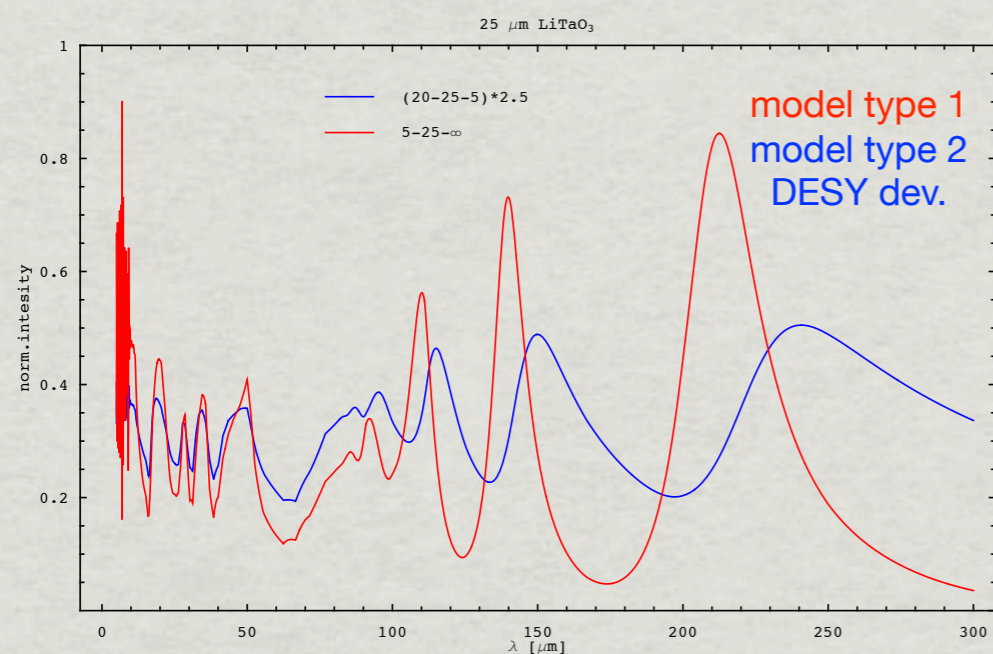
calibration at FELIX (C.Behrens & S.Wesch)



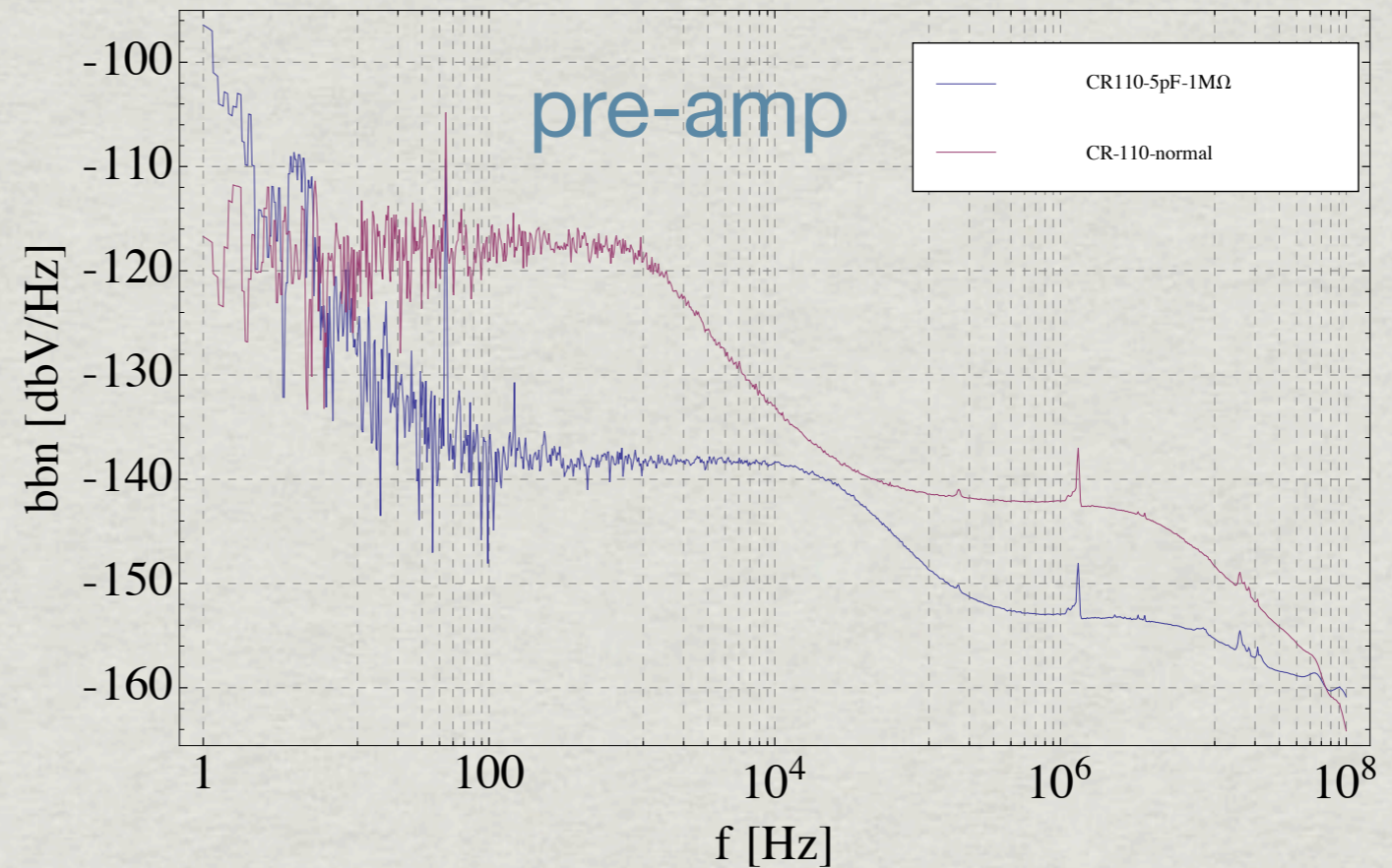
*not very uniform ..*

three different types (surface coating), different time constants

basic features understood by crystal properties



# sensitivity, signal / noise



## single bunches

normal CR-110 & 4  $\mu$ s Gaussian shaper  
sensitivity :  $R \sim 40 \mu\text{V/nJ}$   
integrated noise : 180  $\mu\text{V}$  single sample  
typical oversampling : 50  
noise level :  $\sim 0.6 \text{ nJ}$

## multiple bunches

fast CR-110 & 250 ns Gaussian shaper  
rel. signal :  $\sim 10 \mu\text{V/nJ}$   
integrated noise : 140  $\mu\text{V}$   
typical oversampling : 5  
noise level :  $\sim 6 \text{ nJ}$



# conclusions

- line detector well suited for  $> 0.5$  nC, especially single bunches ( $\ll 1$  MHz) rep. rate
- now commercially available, moderate price (  $\sim 2500$  €)
- spectral sensitivity not flat, understanding still to be improved
- sensitivity becomes borderline for multiple bunch operation at 1 MHz
- low charge operation (20 nC) basically out of range

## IRUVX - consortium

- find better detector !
  - improved pyro technology ? other material ?
  - $\mu$  bolometer array ?
  - cryogenic ?
  - ...