



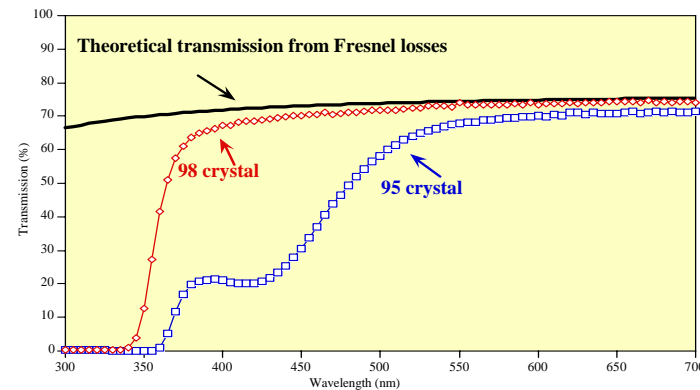
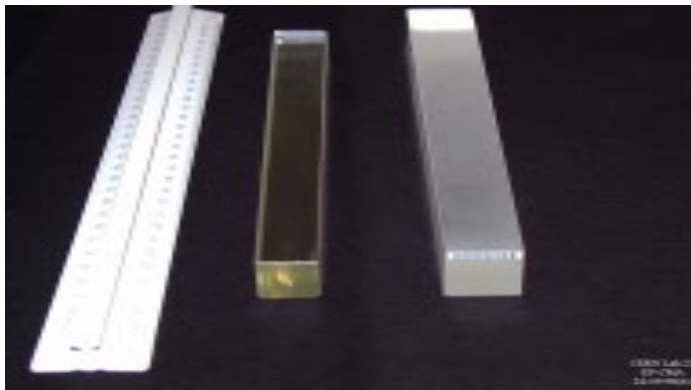
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# STATUS on PWO crystals from Bogoroditsk for CMS-ECAL

Etiennette Auffray

SCINT2001 Conference  
Chamonix, September 17 2001

- ◆ 1992 Crystal2000 : 1st interest on PWO
- ◆ 1994 : choice of PWO for CMS-ECAL
- ◆ 1994-1998 : R&D phase



- ◆ 1998-2000 : Preproduction of 6000 crystals
  - ⇒ Increase the rate of production
  - ⇒ Reach an uniformity in quality of crystals
- ◆ 2001 : Start of the Production



# Main Result on RD Phase



Radiation damage mainly due to Host structure defects :

Primary defects :

Lead vacancy  $V_k(\text{Pb})$

Oxygen vacancy  $V(\text{O})$

Secondary defects created for charge compensation

for  $V_k(\text{Pb})$  :  $\text{O}^{\cdot-} + \text{h}$ ,  $\text{Pb}^{2+} + \text{h}$

for  $V(\text{O})$  : F and  $\text{F}^+$  centres

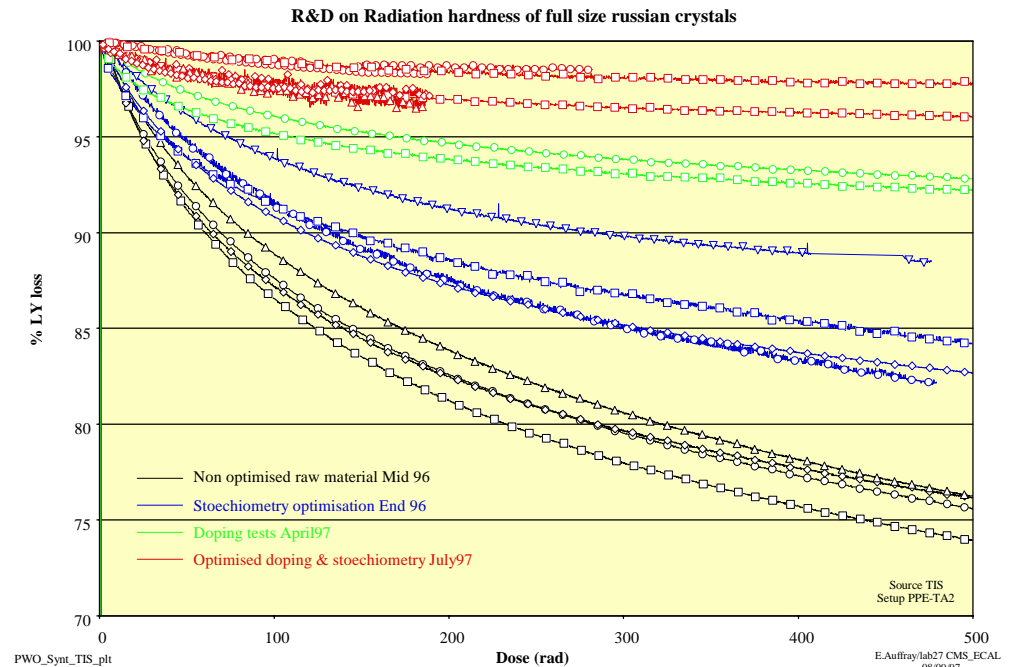
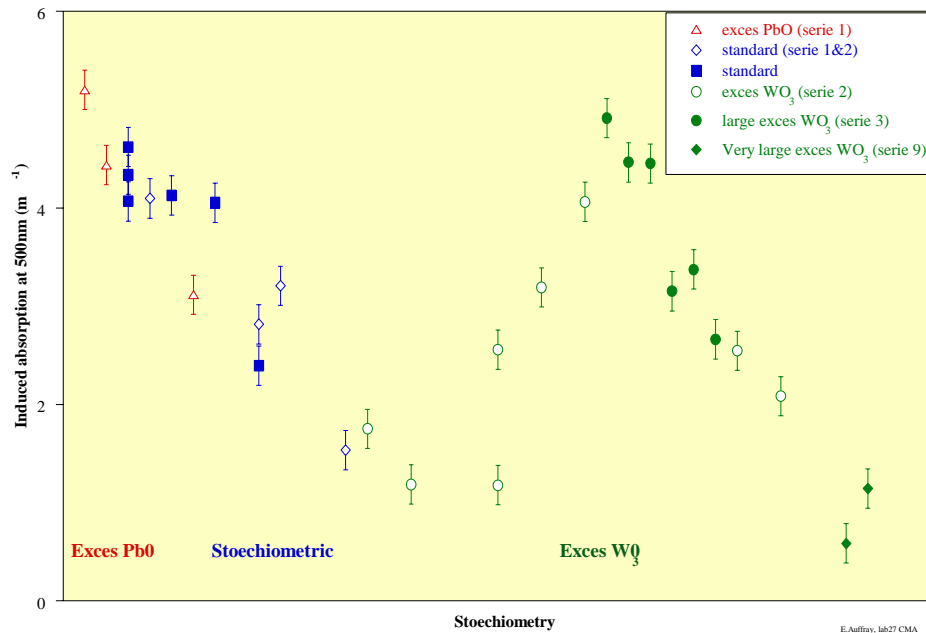
Optimisation of :

growth conditions

stoichiometry

Compensation by doping

Y, Nb





# Goal of Pre-Production Phase

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## For Producer :

Increase the rate of production

Improve the crystal quality and homogeneity of properties

## For CMS-ECAL community

Setting up the Regional centres

Installation of Automatic Crystal Control System (ACCOS)

Machine designed to make the full characterisation of 30 crystals in 7 hours

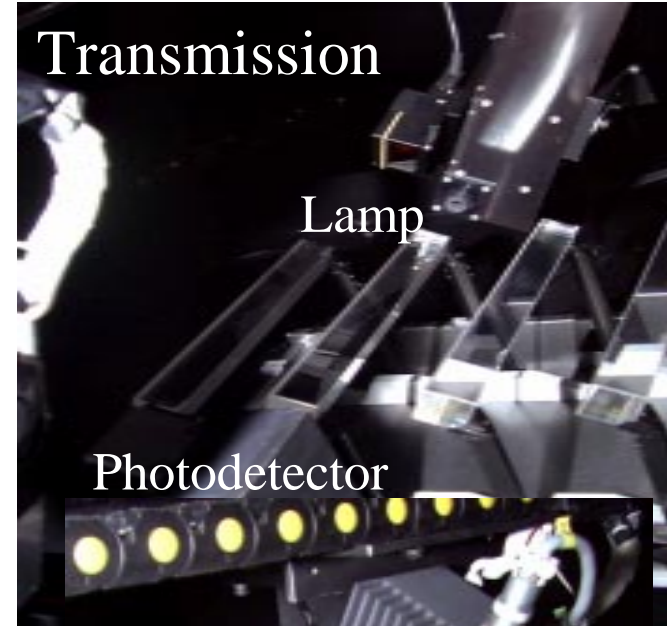
All the 6000 crystals have been measured on ACCOS at CERN



# Quality Control



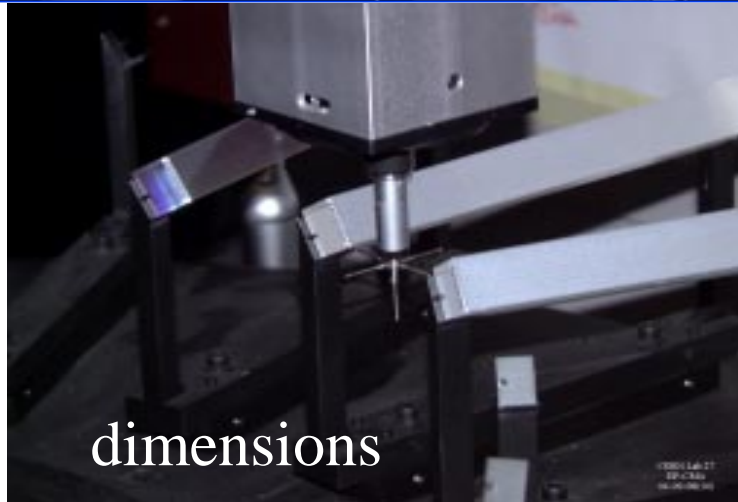
ACCOCCE



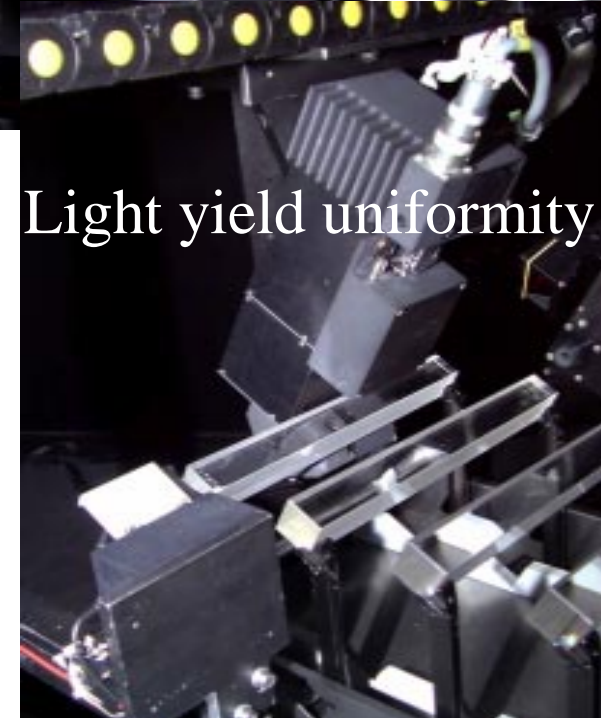
Transmission

Lamp

Photodetector



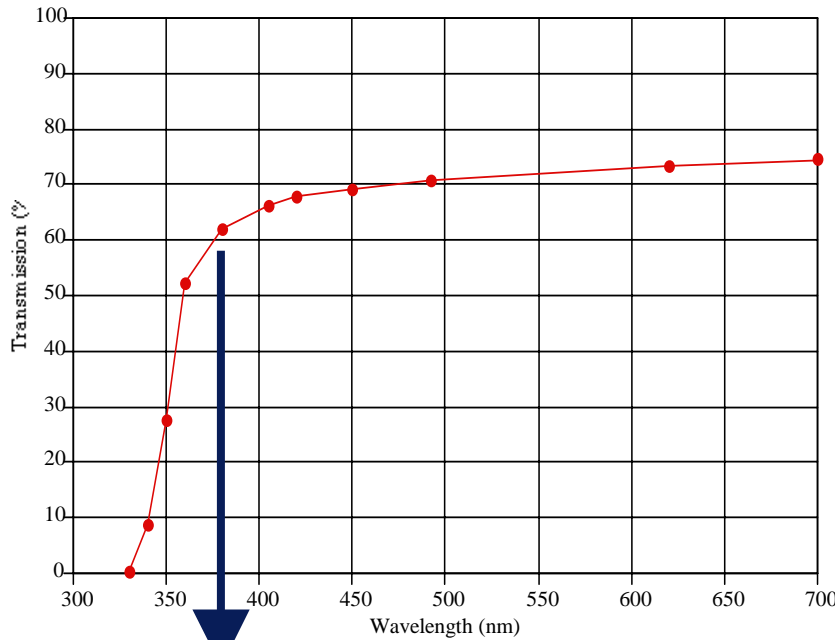
dimensions



Light yield uniformity



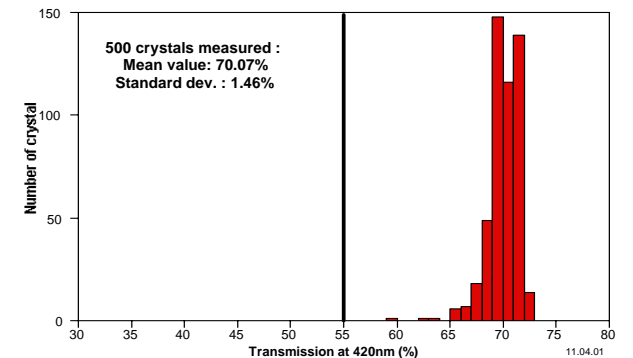
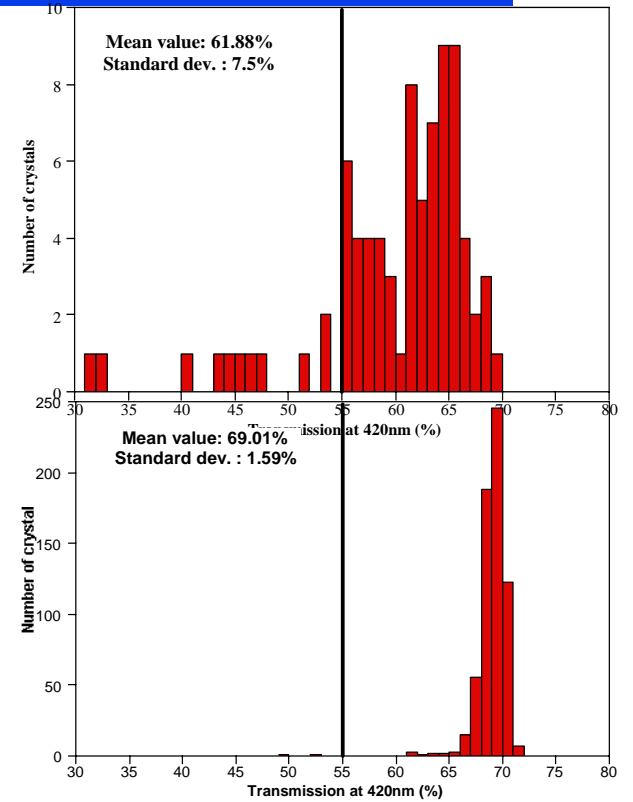
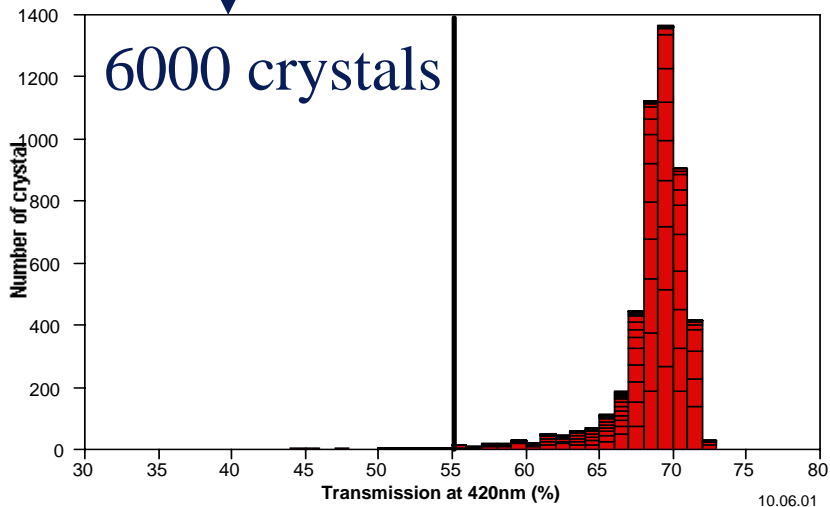
# 420nm Optical Transmission



**Batch 1**  
**11/100 rejected**

**Batch 8**  
**0/500 rejected**

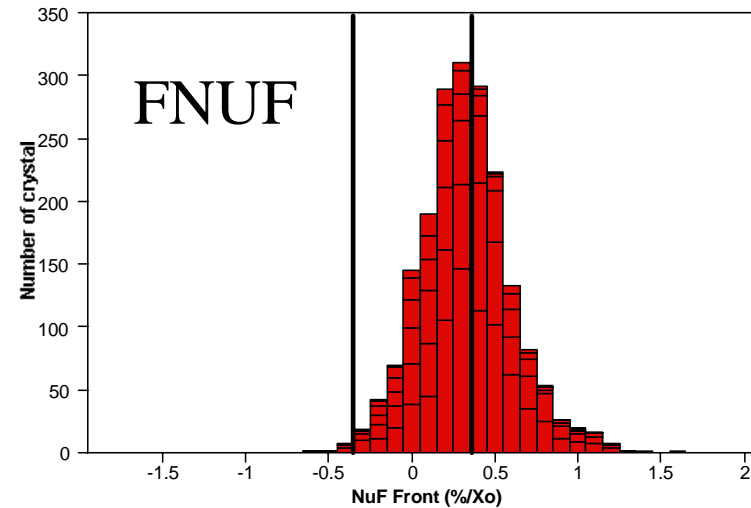
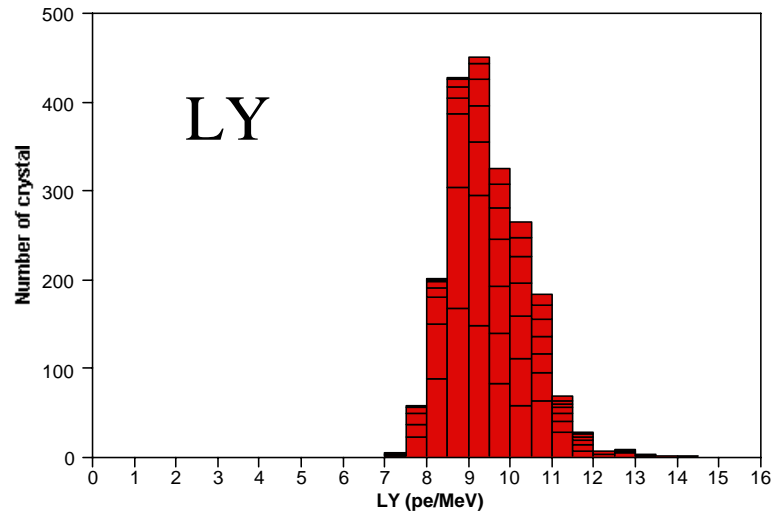
**Batch 14**  
**0/500 rejected**



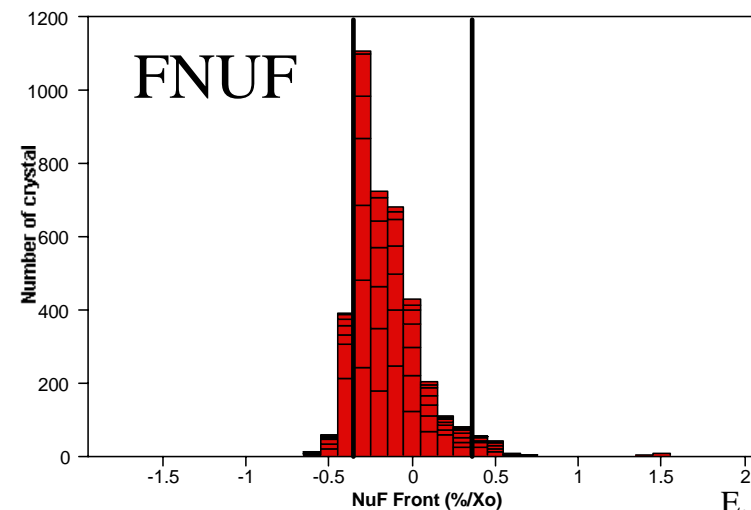
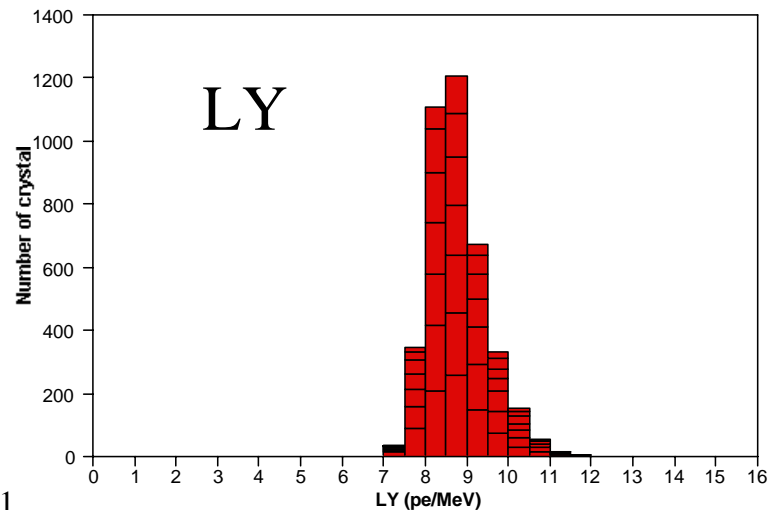


# Light Yield

Batch 1 to 7  $\langle Ra \rangle$  depolished face +0.2%



Batch 8 to 14  $\langle Ra \rangle$  depolished face +0.39%

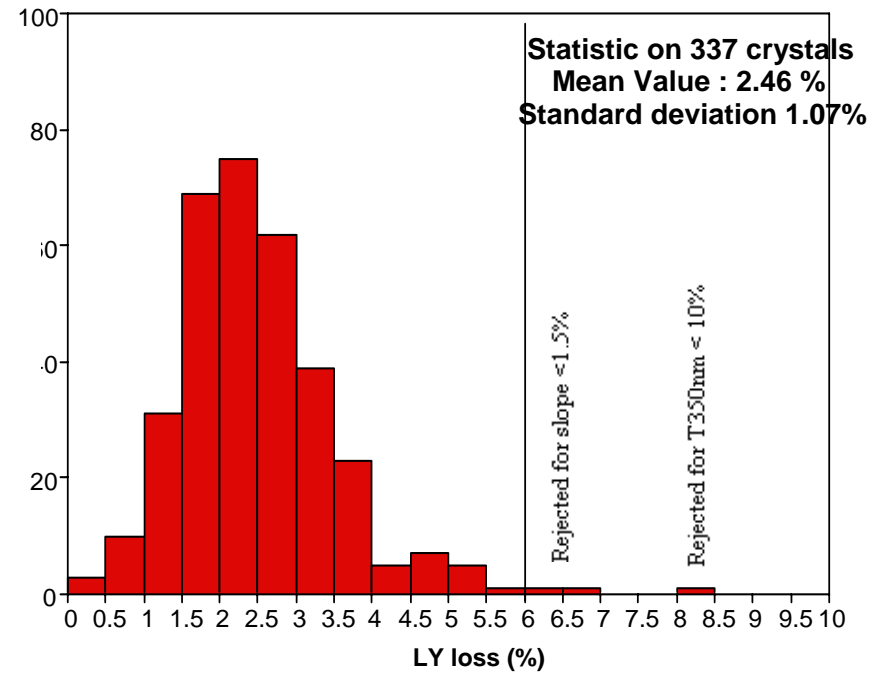
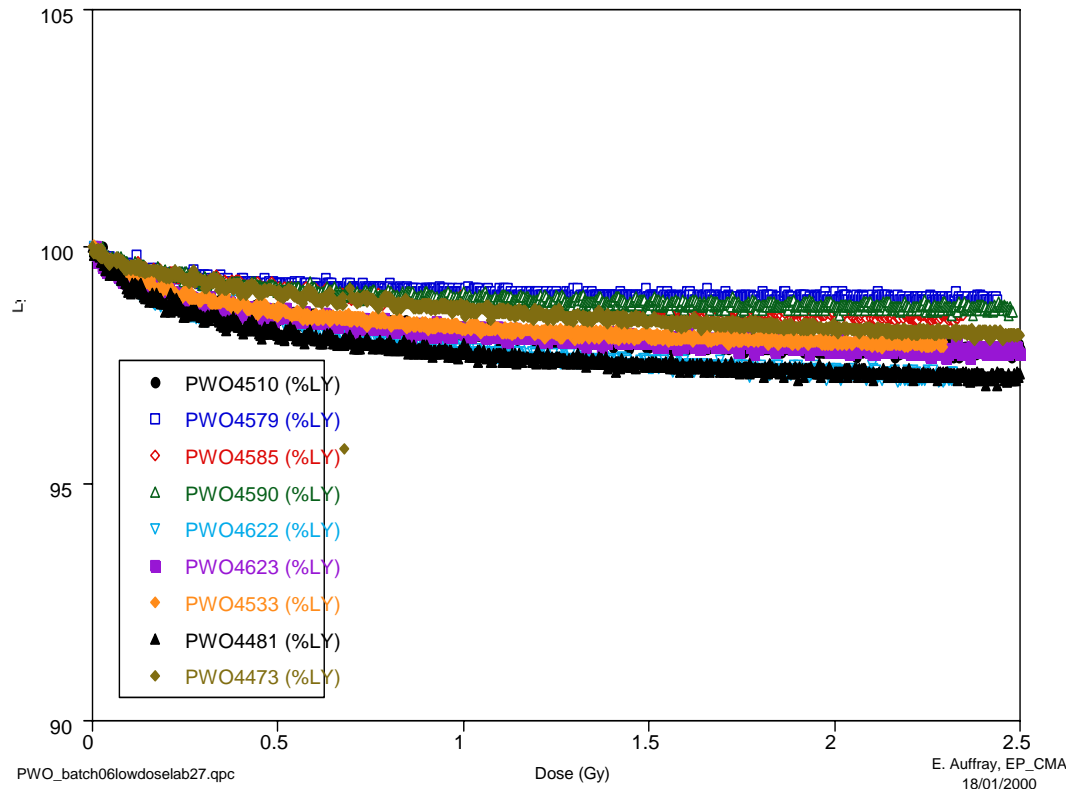




# Radiation Hardness

## Front irradi., 1.5Gy, 0.15Gy/h

Low dose rate irradiation of some BTCP crystals of Batch06 in lab27



10.06.01

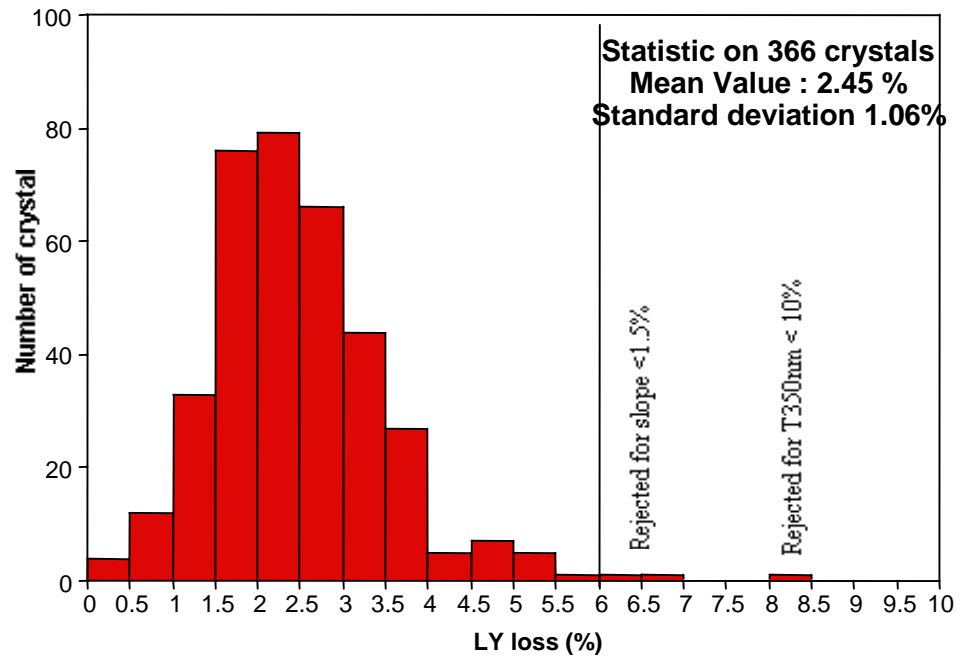




# Radiation Hardness



Front irradi., 1.5Gy, 0.15Gy/h

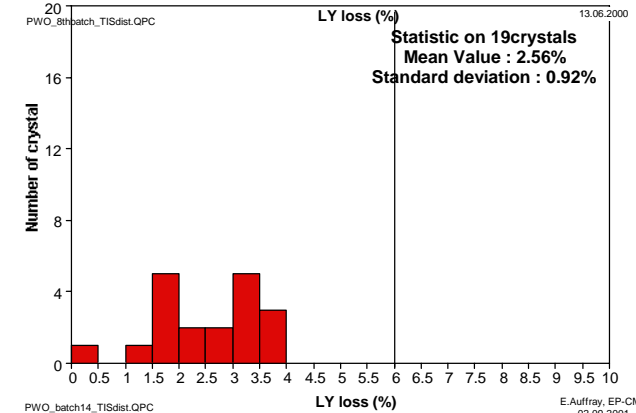
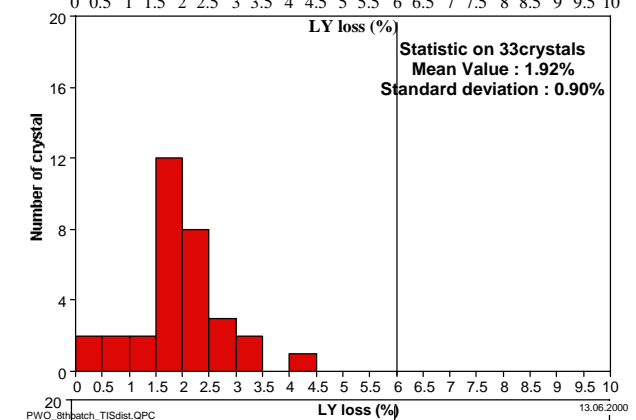
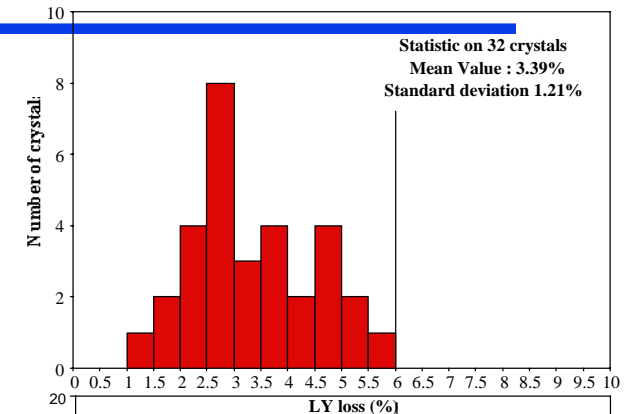


02.09.01

Batch1

Batch8

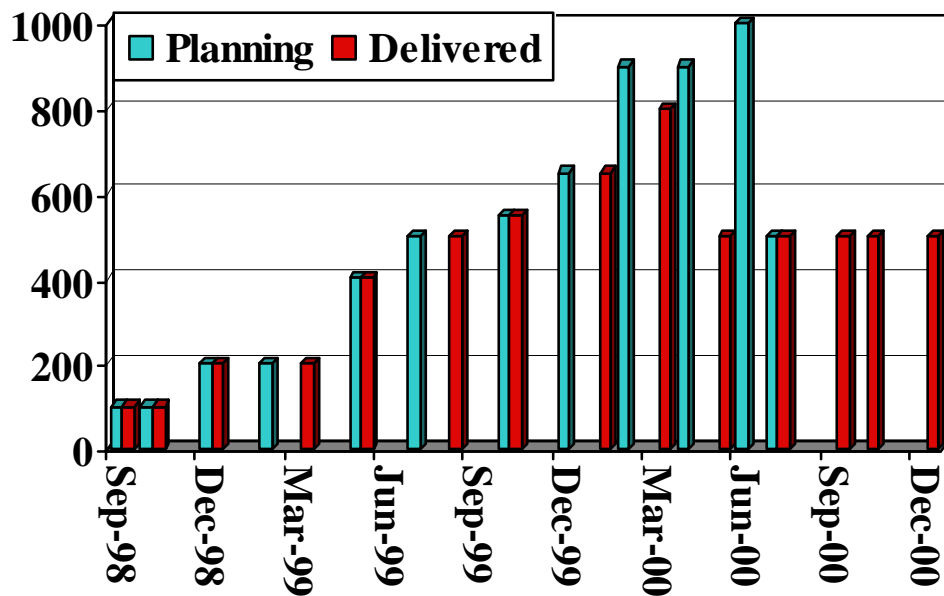
Batch14



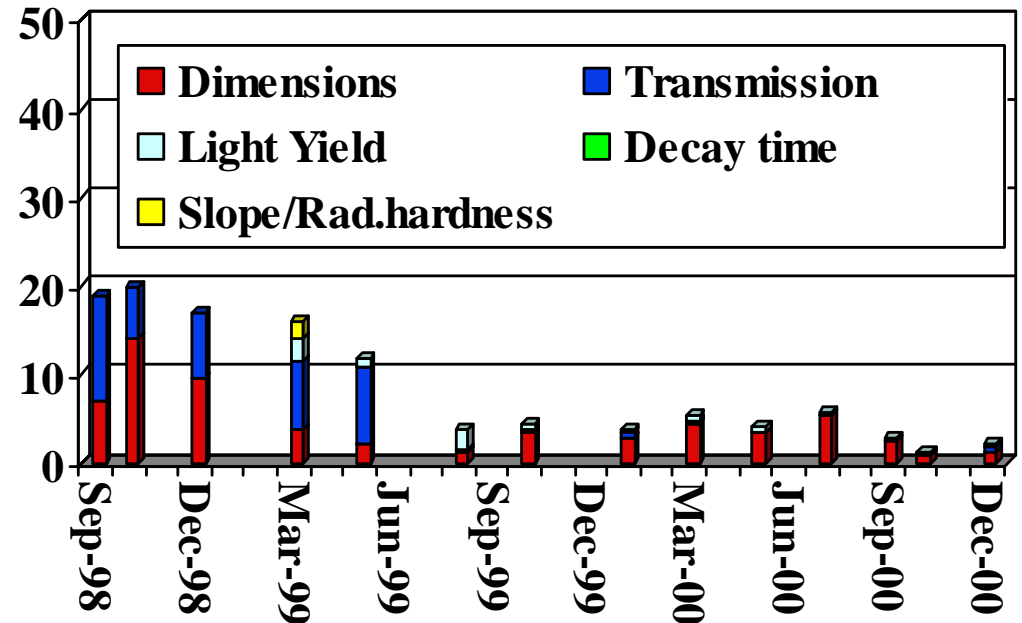


# Pre-Production Phase

**From Sept 98 to Dec 2000 6000 Crystals produced by BTCP**



Success to increase :  
The yield  
The production rate



Improvement and Homegenisation  
of crystal quality



# Since beginning 2001 : Production phase

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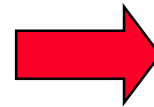


It remains to be produced before end 2004 :

- 56000 crystals for Barrel
- 16000 crystals for Endcaps

Today we have :

- 6000 preproduction crystals
- 2000 production crystals



Need to Increase productivity



New crystal development :  
Ingot diameter increase

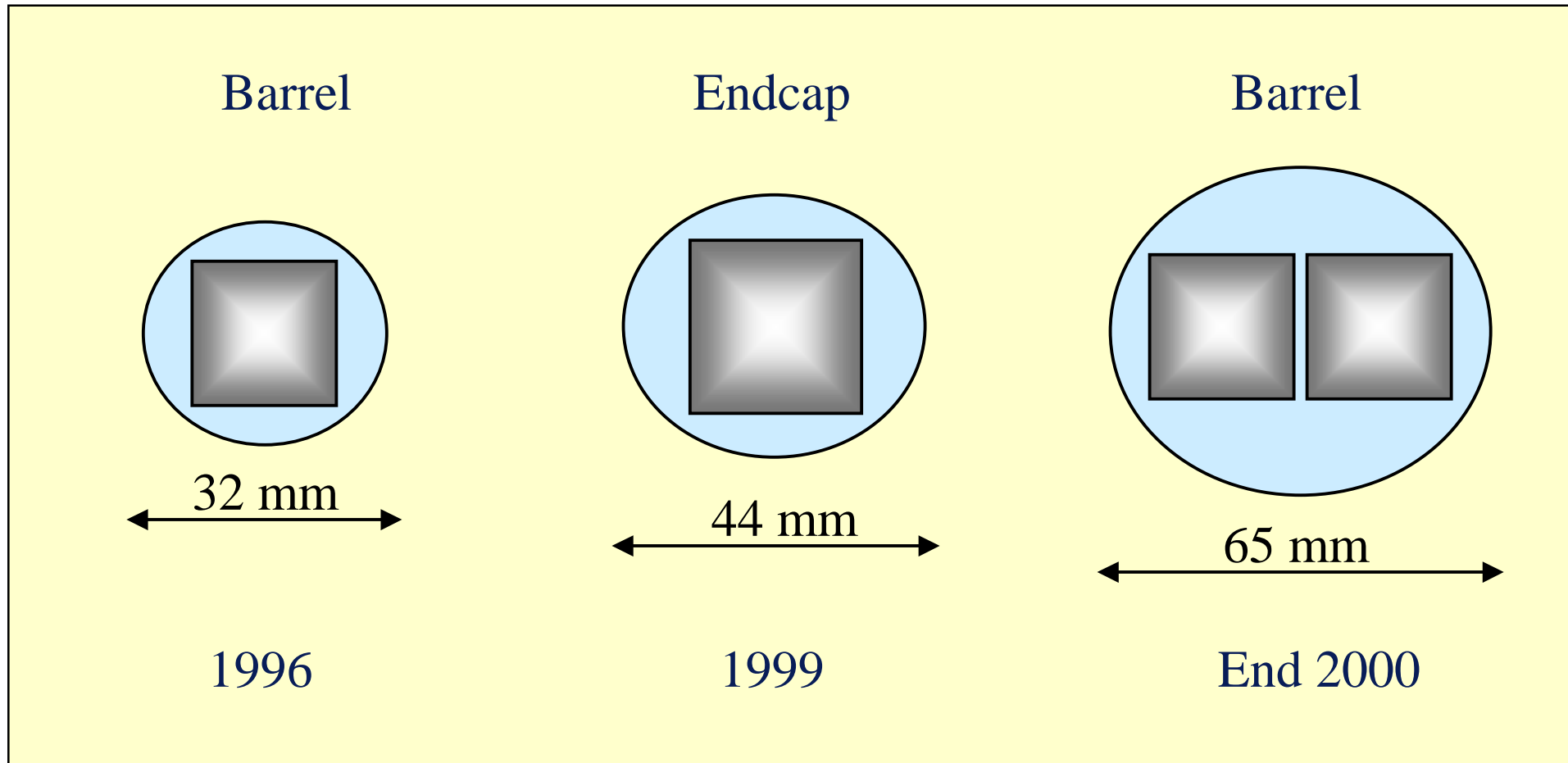


# 65mm diameter PWO ingots from Bogoroditsk





# Technology steps



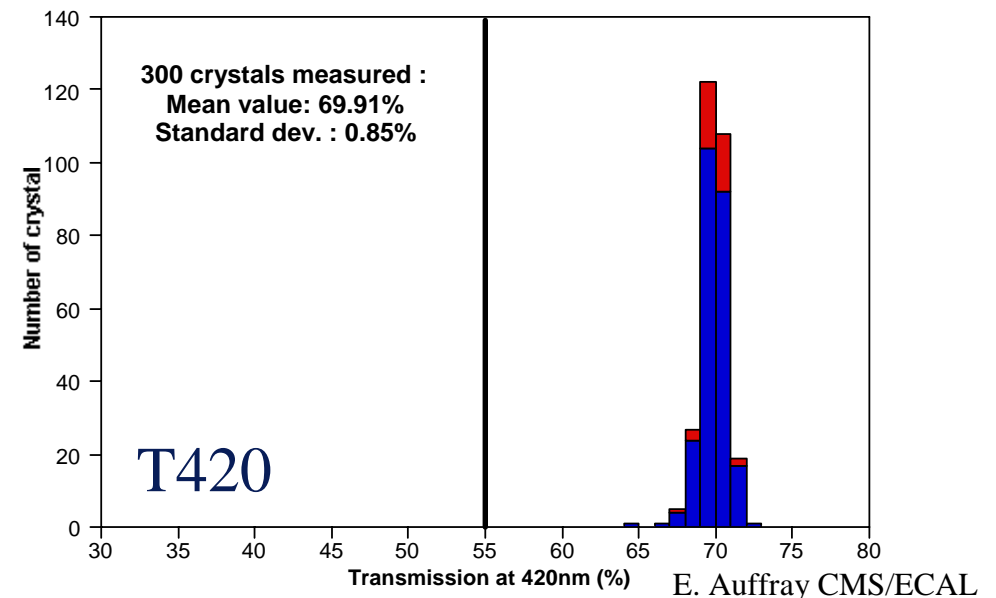
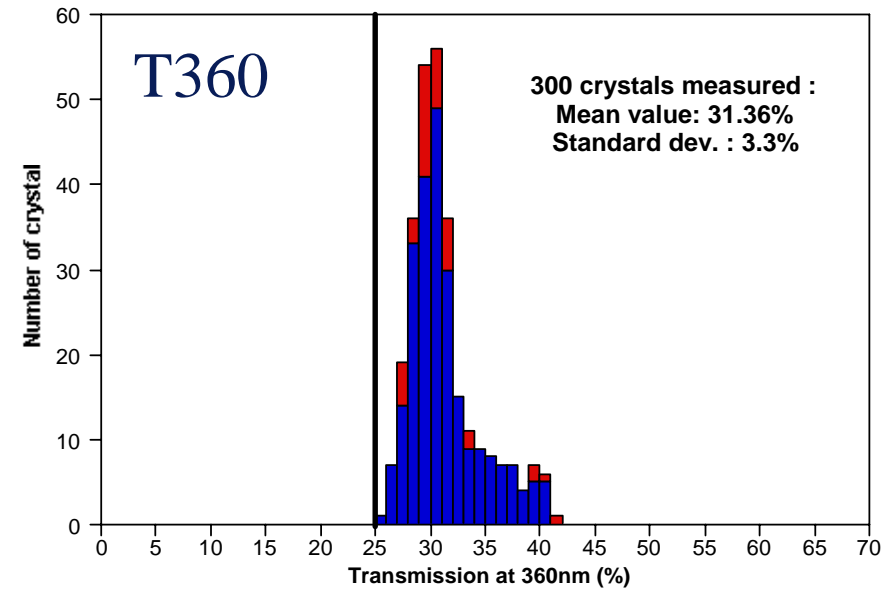


# New/Old technology statistical comparison



Batch P2 from CERN/ISTC production contract #1718 was used to compare:

- 260 barrel crystals produced with the standart technology
- 40 barrel crystals produced with the new technology



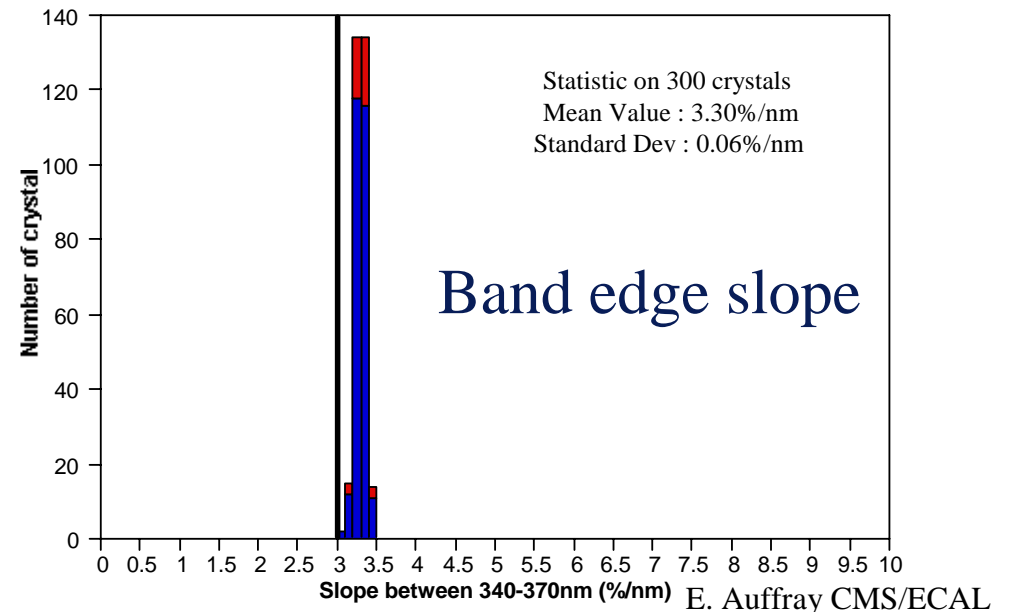
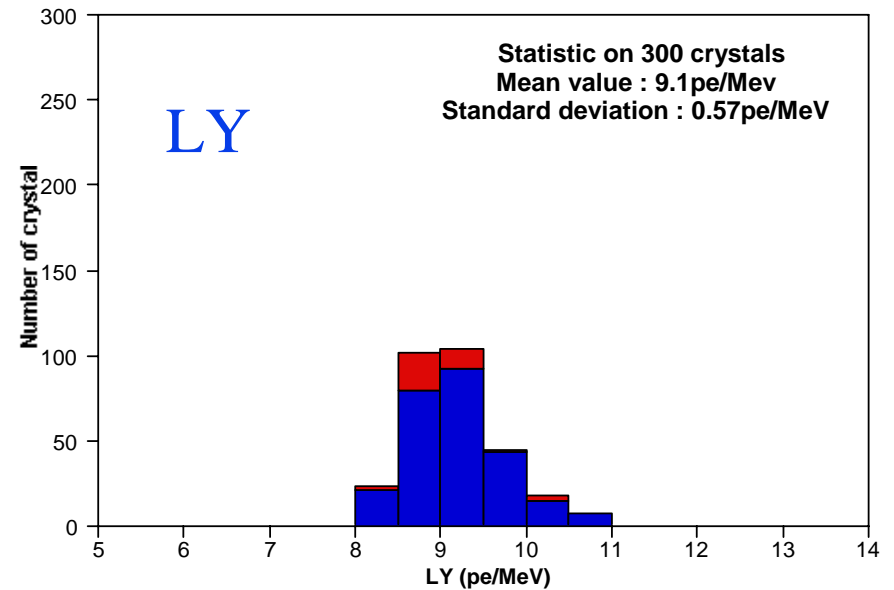


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Batch P2 from CERN/ISTC production contract #1718 was used to compare:

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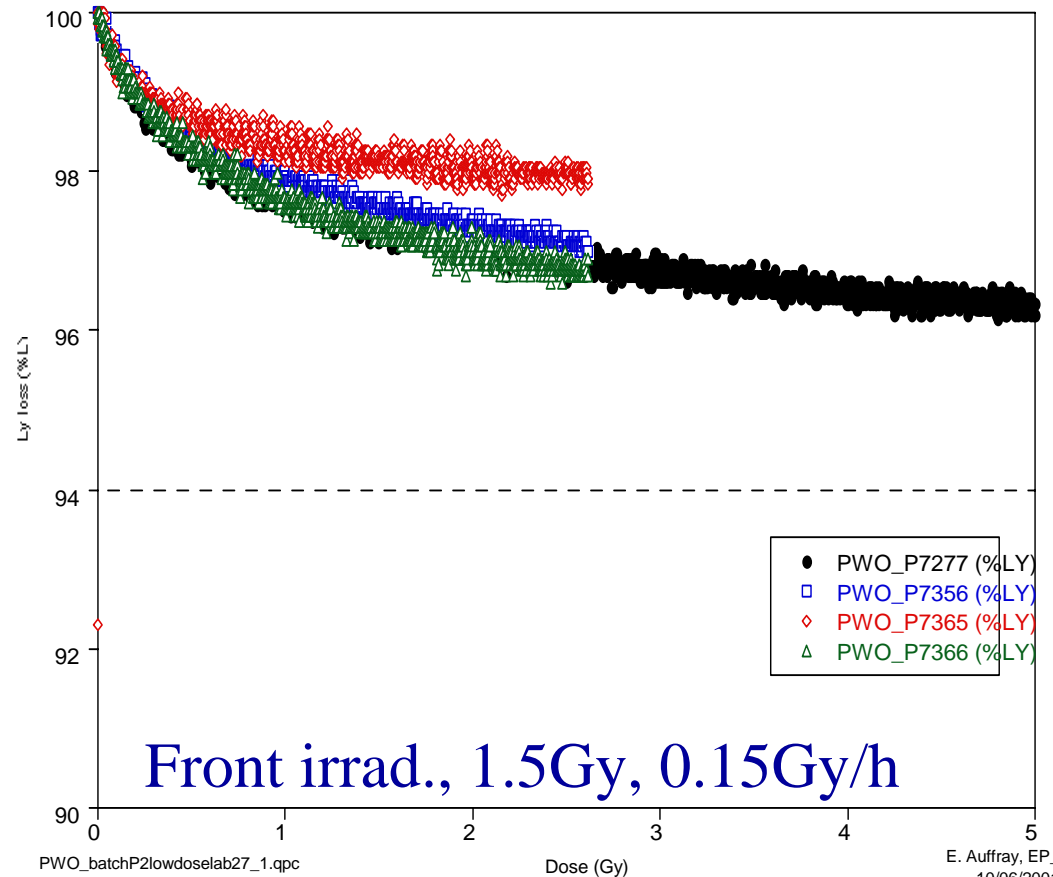
# New/Old technology statistical comparison



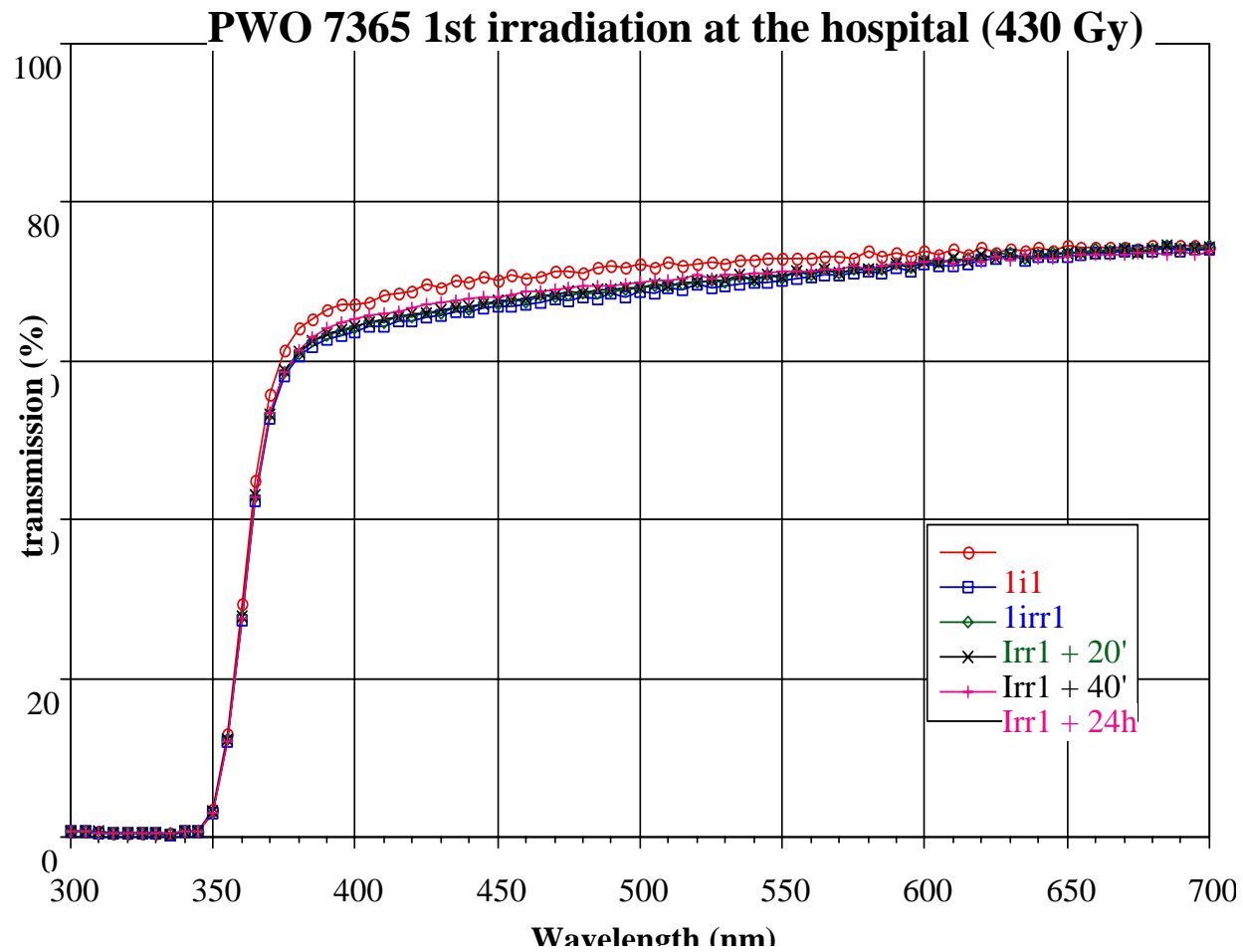
Batch P2 from CERN/ISTC production contract #1718 was used to compare:

- 260 barrel crystals produced with the standart technology
- 40 barrel crystals produced with the new technology

Low dose rate irradiation of some crystals from BatchP2-1







- ◆ Success of the R&D phase
  - Increase of the production rate
  - good quality crystals
  - uniform optical properties
  
- ◆ Technology for ingots up to 65mm diameter is now well under control
  
- ◆ The possibility to further increase the diameter and to apply this approach to endcap crystals is demonstrated

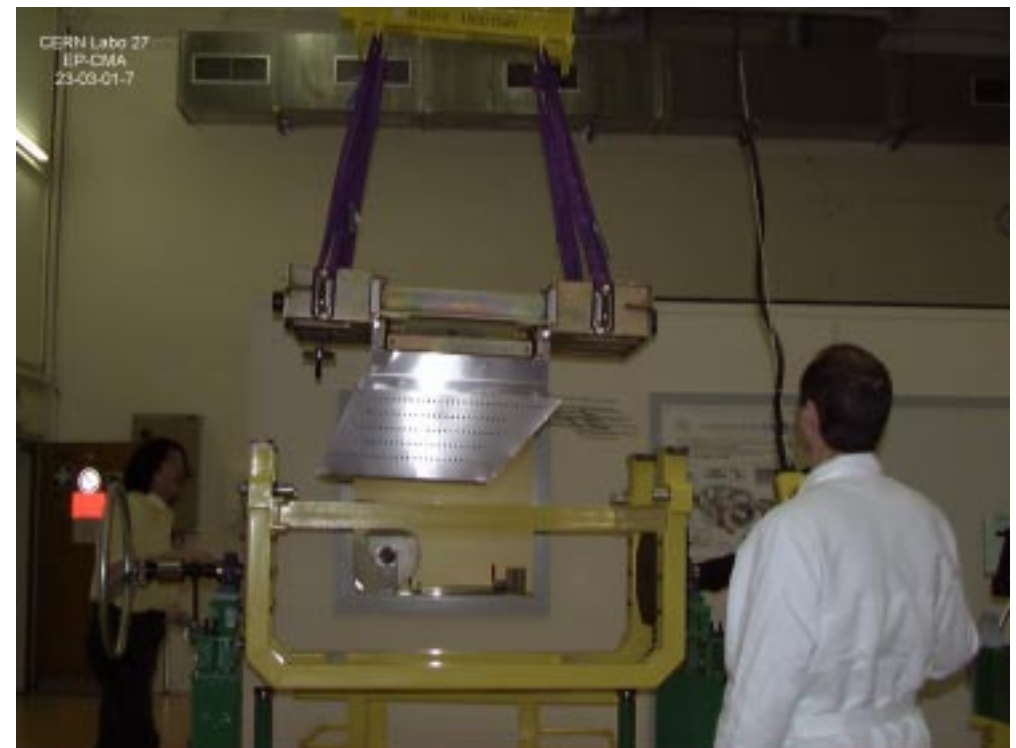
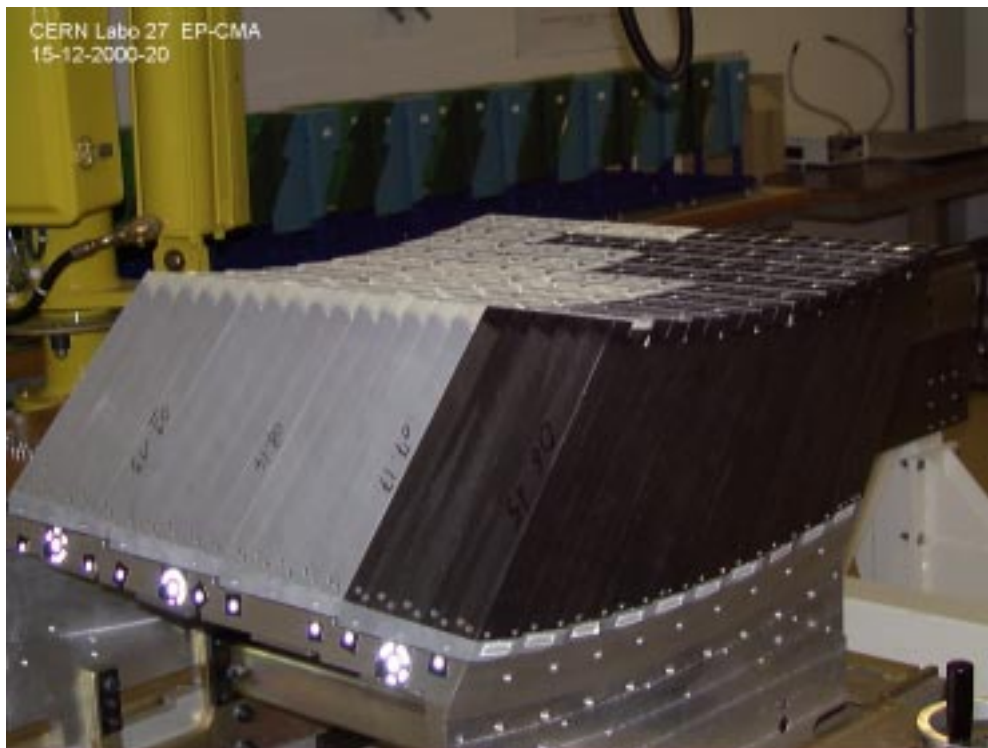




# Conclusions



Ready to construct the CMS-ECAL



**1st module of 400 crystals build in 2001 for ECAL**