PANDA-EMC Meeting
Vienna, December 1, 2015

Status on developments @ GI

- development on $PbWO_4$ @ CRYTUR and SICCAS
- PROTO 120
    - details on de-polished crystals (S. Diehl)
- Resources @ GI
    - APD irradiation
    - quality control of crystals @GI and CERN
    - barrel mechanics and assembly

New lead tungstate crystal production for High-Energy Physics experiments based on the Czochralski technique

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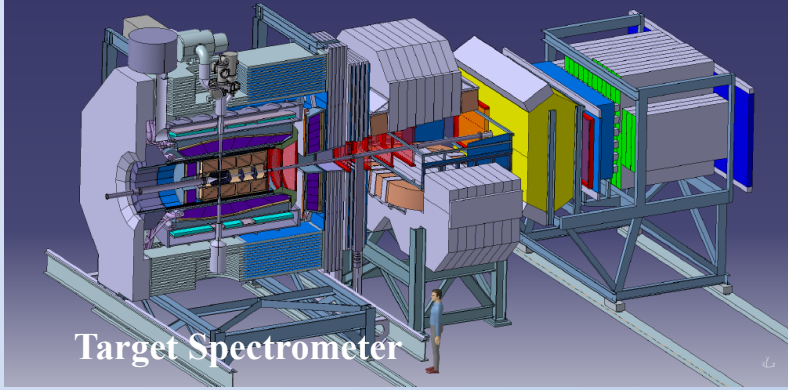
- **the $PbWO_4$ quality for PANDA@FAIR: PWO-II**
- **alternative producer: SICCAS**
- **startup @ CRYTUR**
- **the achievements up to now**
- **summary and outlook**

Target Spectrometer @ PANDA:

based on high-quality PWO-II

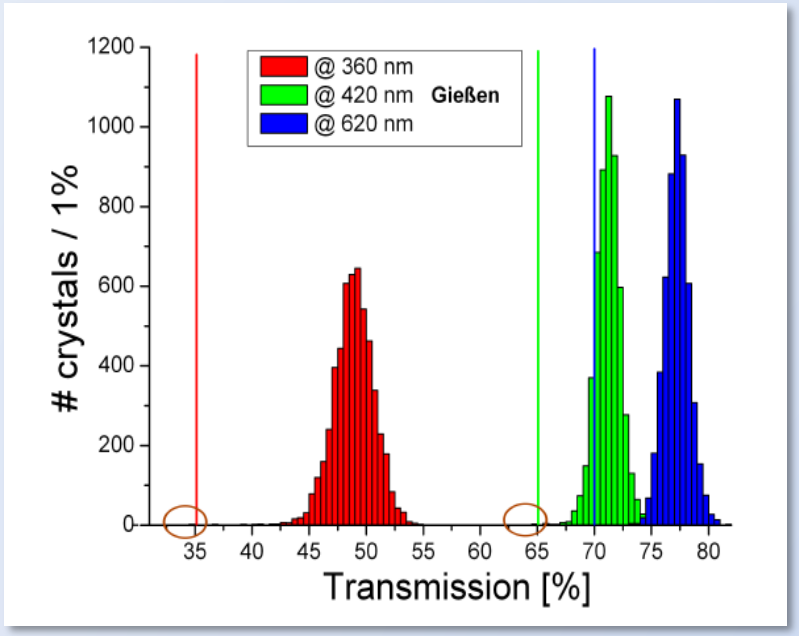


- physical goals of PANDA require further development

	PWO-I (CMS)	PWO-II (PANDA)
luminescence maximum, nm	420	420
La, Y concentration level, ppm	100	40
expected energy range of EMC	150MeV - 1TeV	10MeV - 10GeV
light yield, phe/MeV at room temperature	8-12	17-22
EMC operating temperature, °C	+18	-25
energy resolution of EMC at 1GeV, %	3,4	2,0

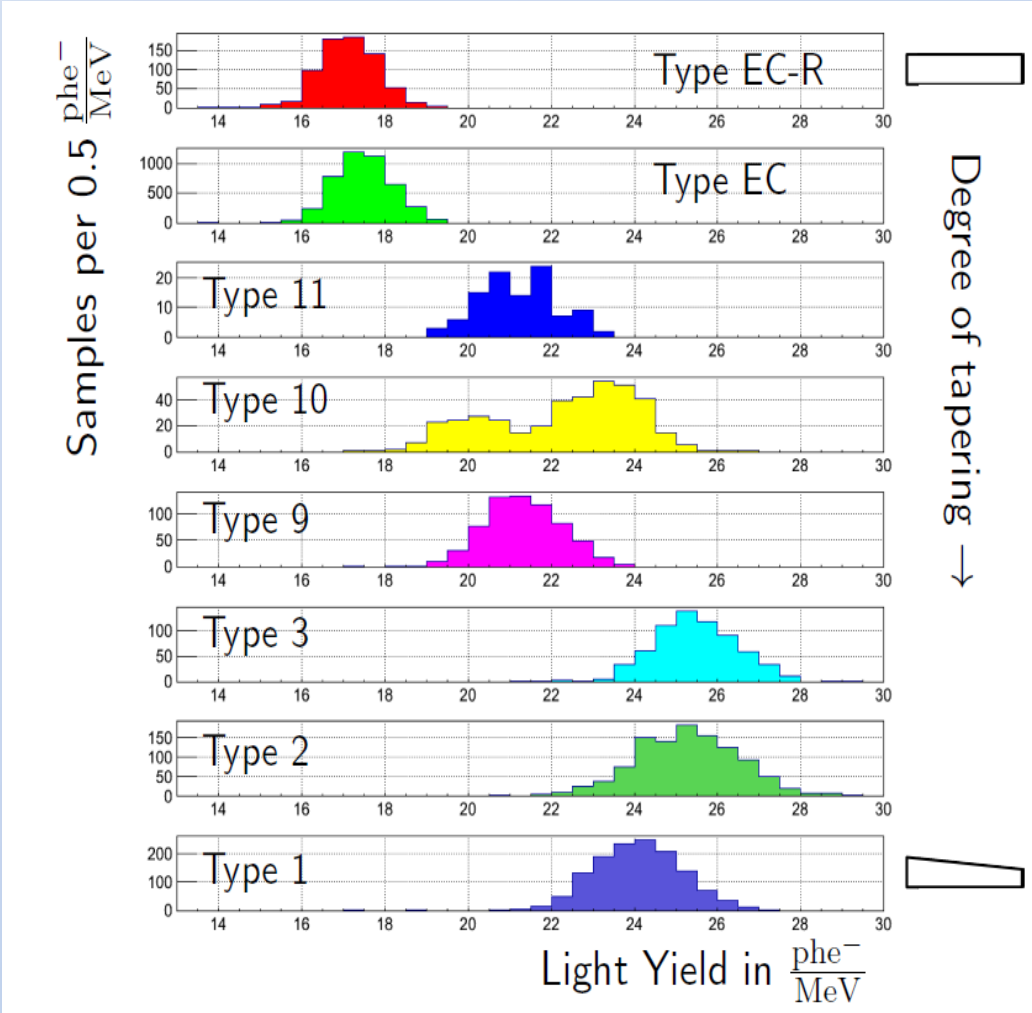
• optical longitudinal transmission

BTCP



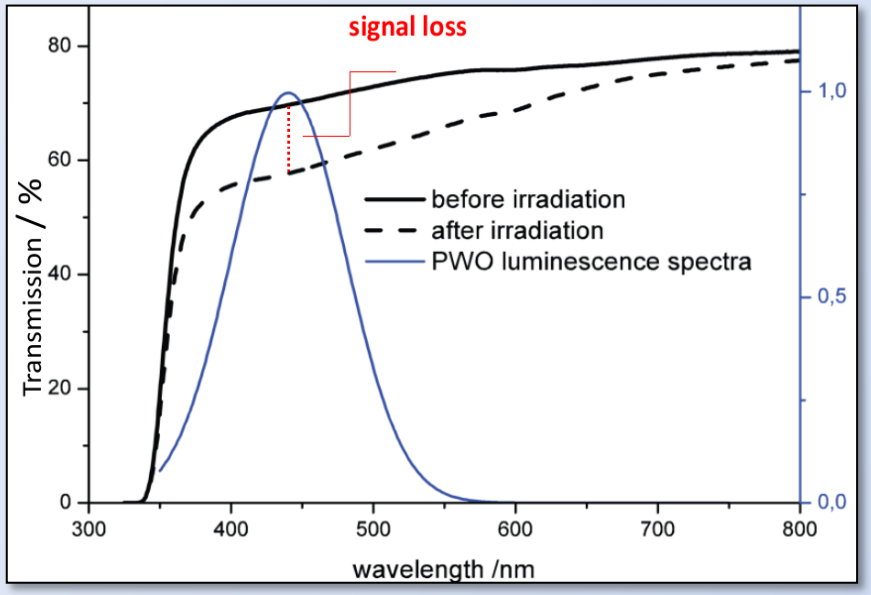
property	condition	specification
longitudinal transmission	at 360nm	$\geq 35\%$
	at 420nm	$\geq 60\%$
	at 620nm	$\geq 70\%$
uniformity of transv. transmission	wavelength at $T = 50\%$	$\Delta\lambda \leq 3$nm

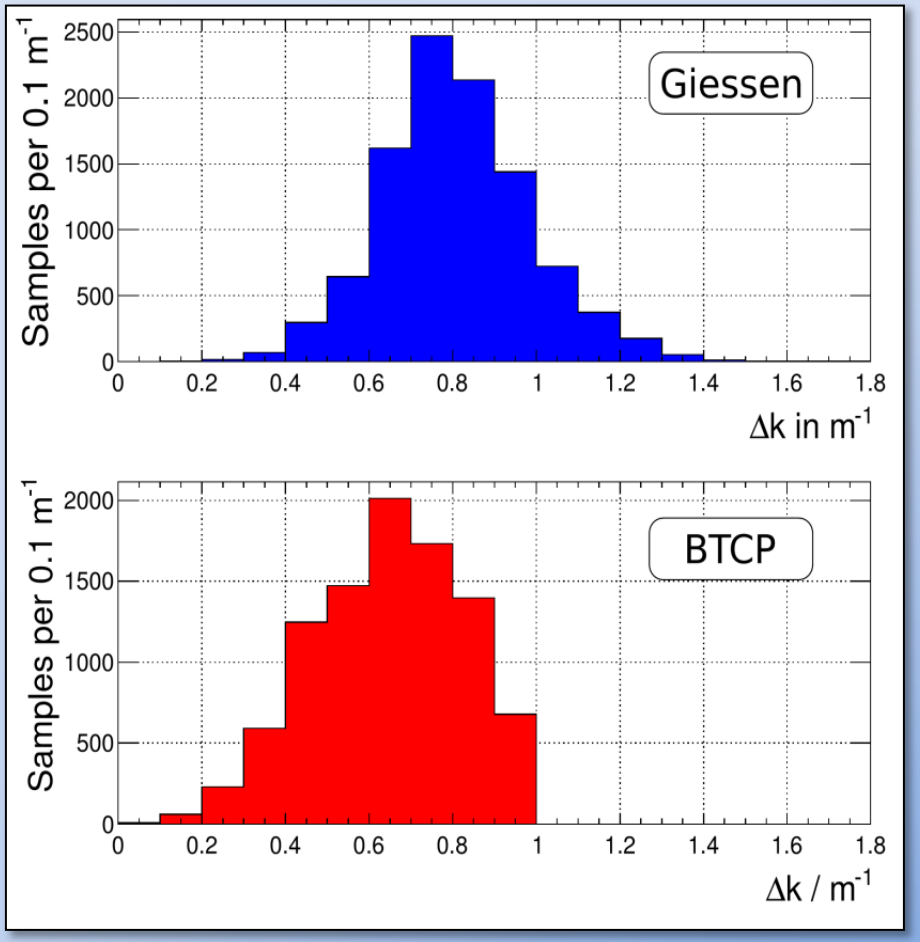
• light yield @ 18°C



- **radiation hardness**

BTCP





tested using γ-rays: ~ 1.2 MeV ^{60}Co

integral dose: 30Gy

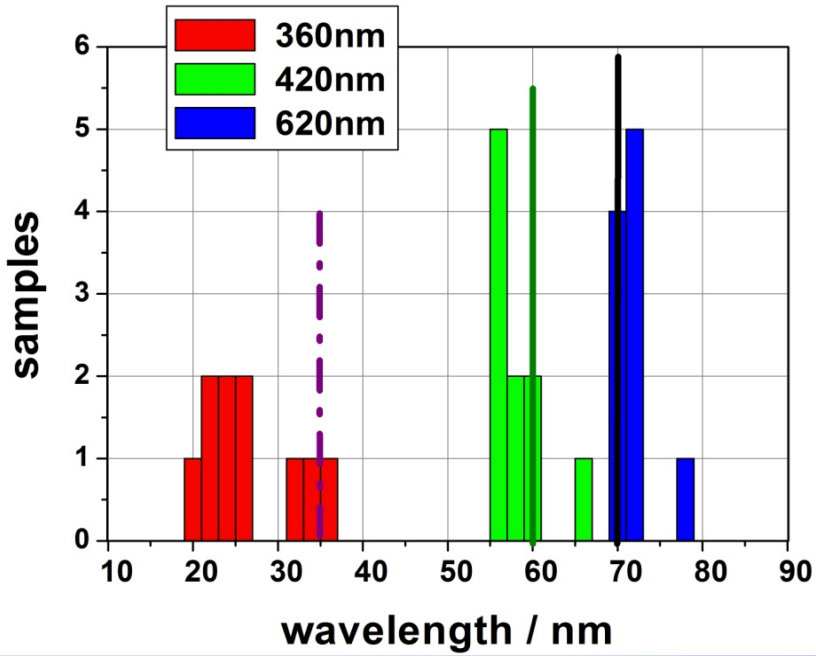
$$\Delta k = \ln\left(\frac{T_{bef}}{T_{after}}\right)\cdot\frac{1}{d}$$

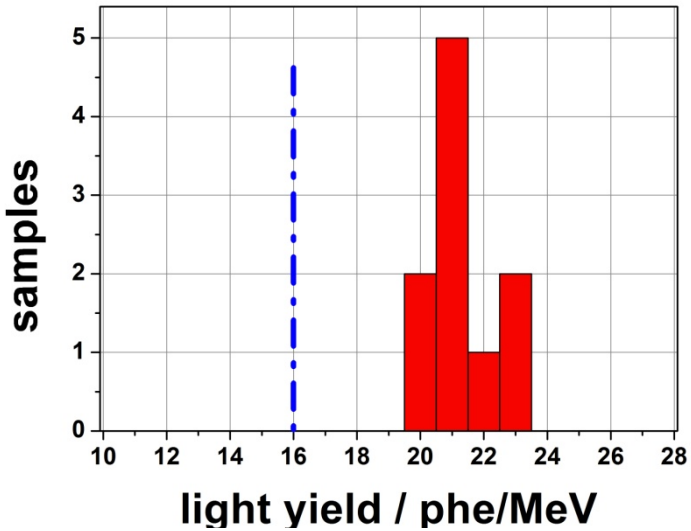
acceptance limit: Δk < 1.1 m^{-1}

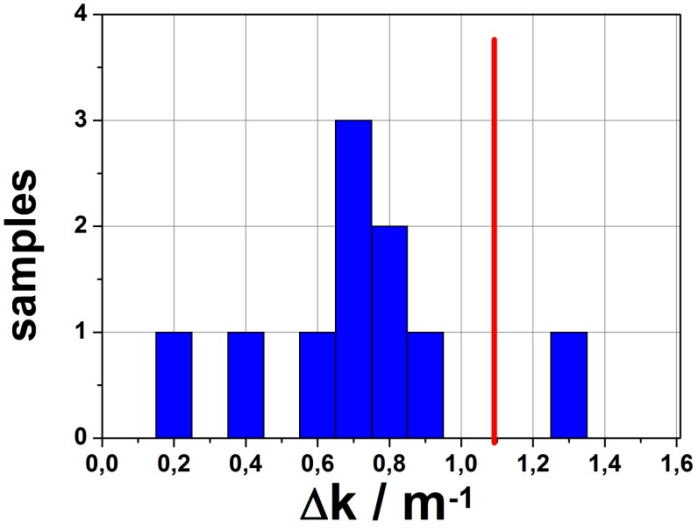
- **former production @ SICCAS,** Shanghai, China

Bridgeman technology

in 2014/15







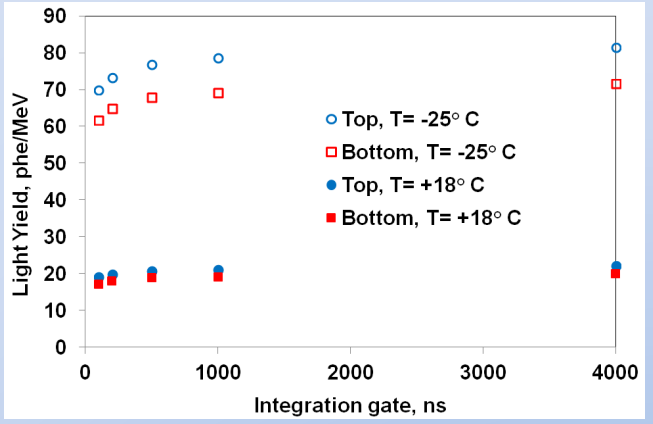
CRYTUR – Turnov, Czech Republic

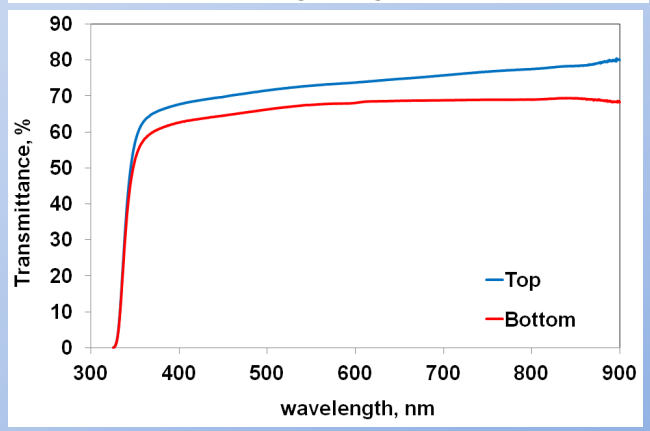
- **long tradition in the production of inorganic scintillators**
- **restart of PWO production in summer 2014**
  - production based on Czochralski technology
  - use of existing pre-mixture of raw material (*NeoChem*, Moscow)
  - network: close collaboration with *RINP* Minsk and *IPAS* Prague

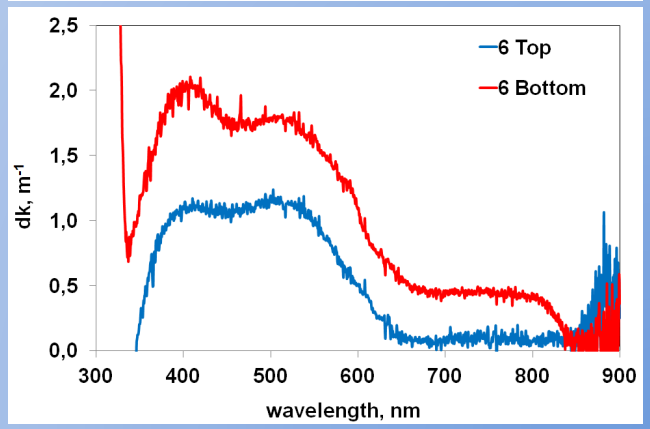
initial survey: production of small ingots under various conditions

Crystal sample	Growing conditions: atmosphere , dopants
1 Top	Air, undoped
2 Top	Air, Y 42 ppm
2 Bottom	Air, Y 48-62 ppm
3 Top	Air, Y 82-87 ppm
3 Bottom	Air, Y 96-123 ppm
5 Top	N_2 + 0.1% O_2, undoped
5 Bottom	N_2 + 0.01% O_2, undoped
6 Top	N_2 + 0.1% O_2, La+Y 207 ppm
6 Bottom	N_2 + 0.1% O_2, La+Y 131 ppm
7 Top	Air, La+Y 207 ppm
7 Bottom	Air, La+Y 140 ppm
PWO1 Top	Air
PWO2 Top	Air
PWO 2 Bottom	Air
PWO3 Top	Argon
PWO3 Bottom	Argon
PWO	Air+ dopants

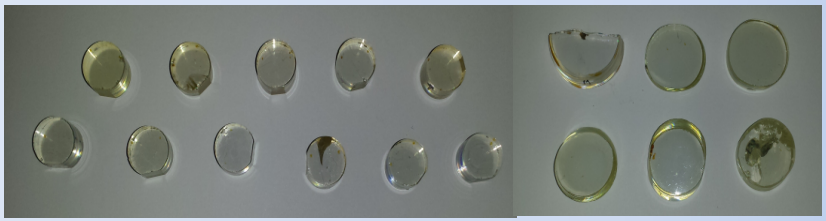
optimum sample





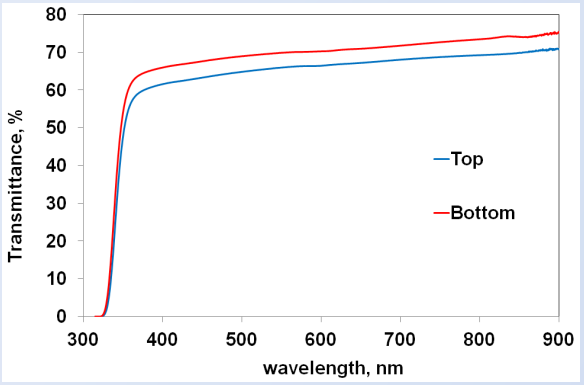


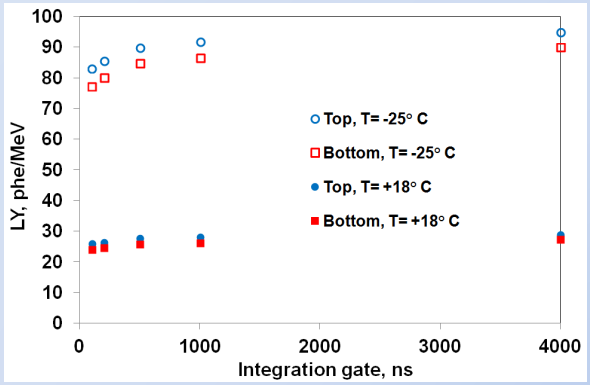
samples cut from **top** and **bottom** part of the ingot

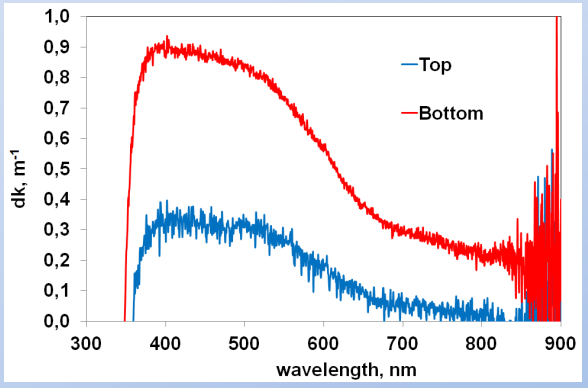


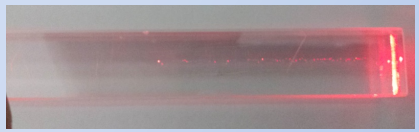
first full size ingots:

grown in Ar atmosphere and doped with La+Y

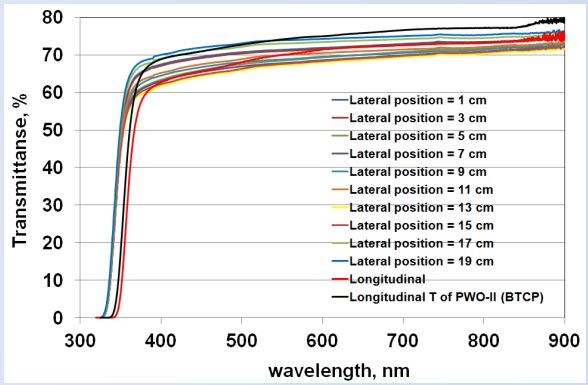


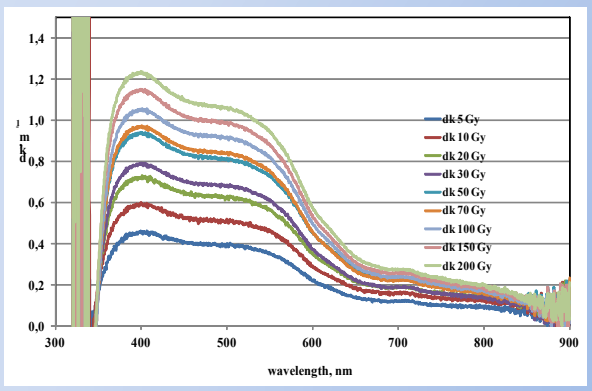


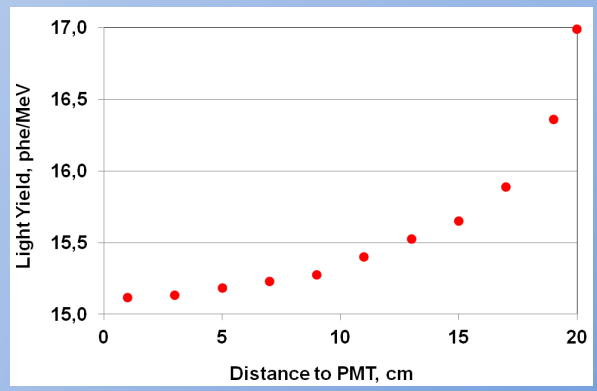




dimension: 20x20x200mm^3



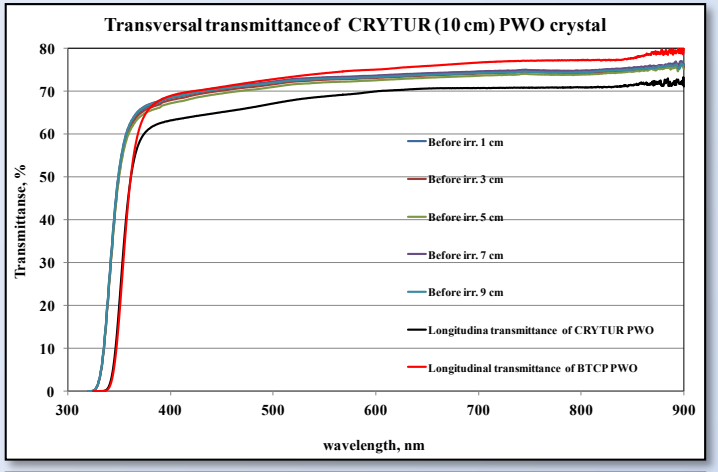


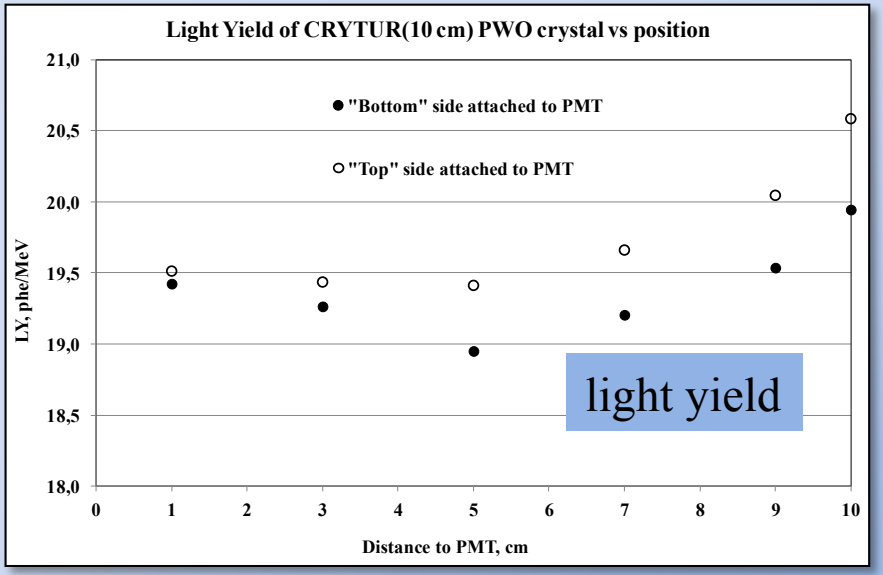


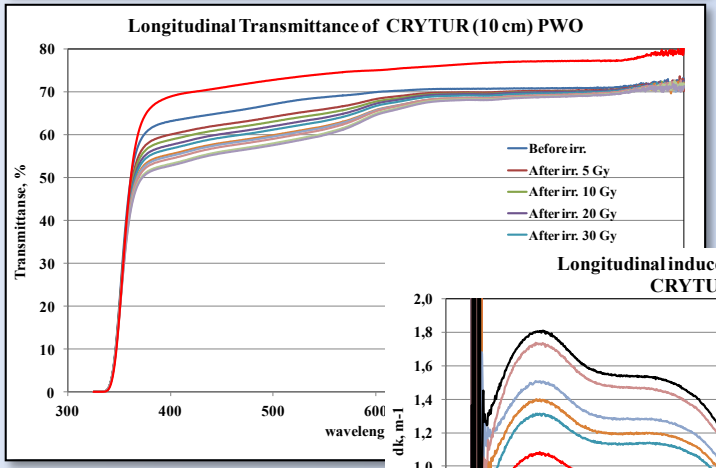
improved sample: no coloring or macro defects

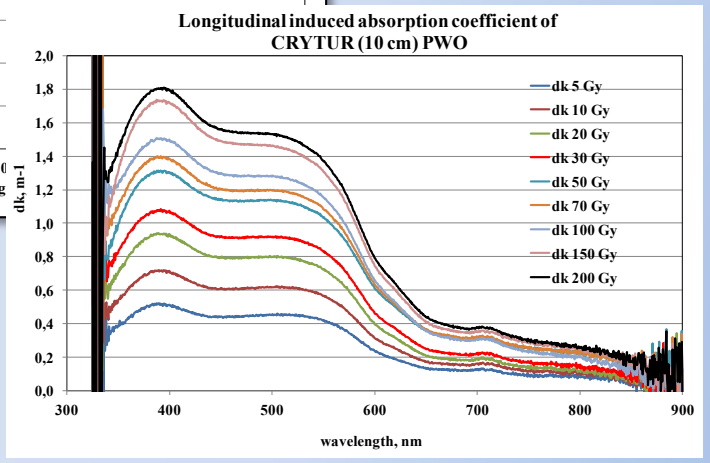
optical transmission and homogeneity

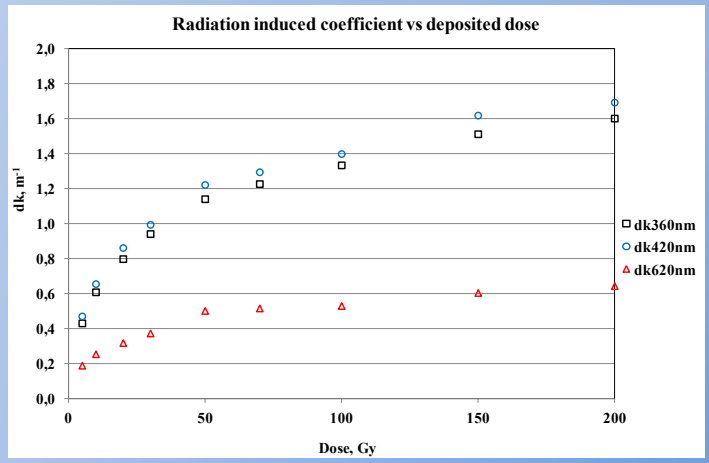
size: 20x20x100 mm³





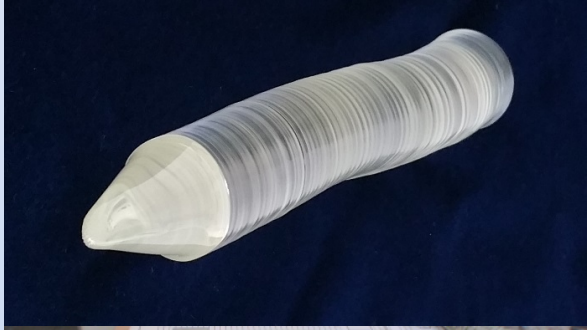


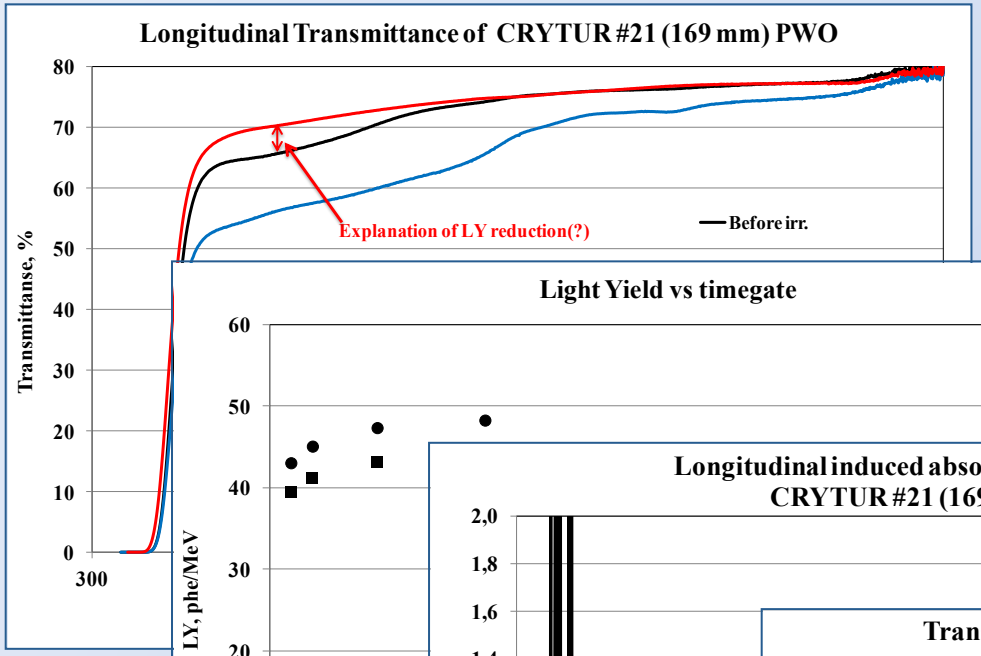


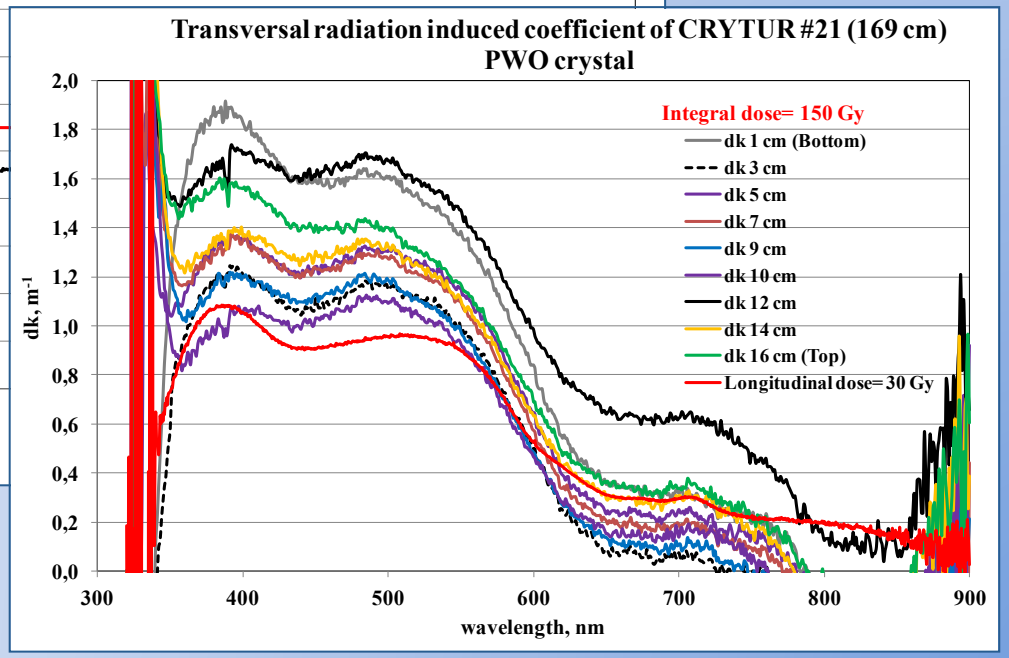


radiation hardness

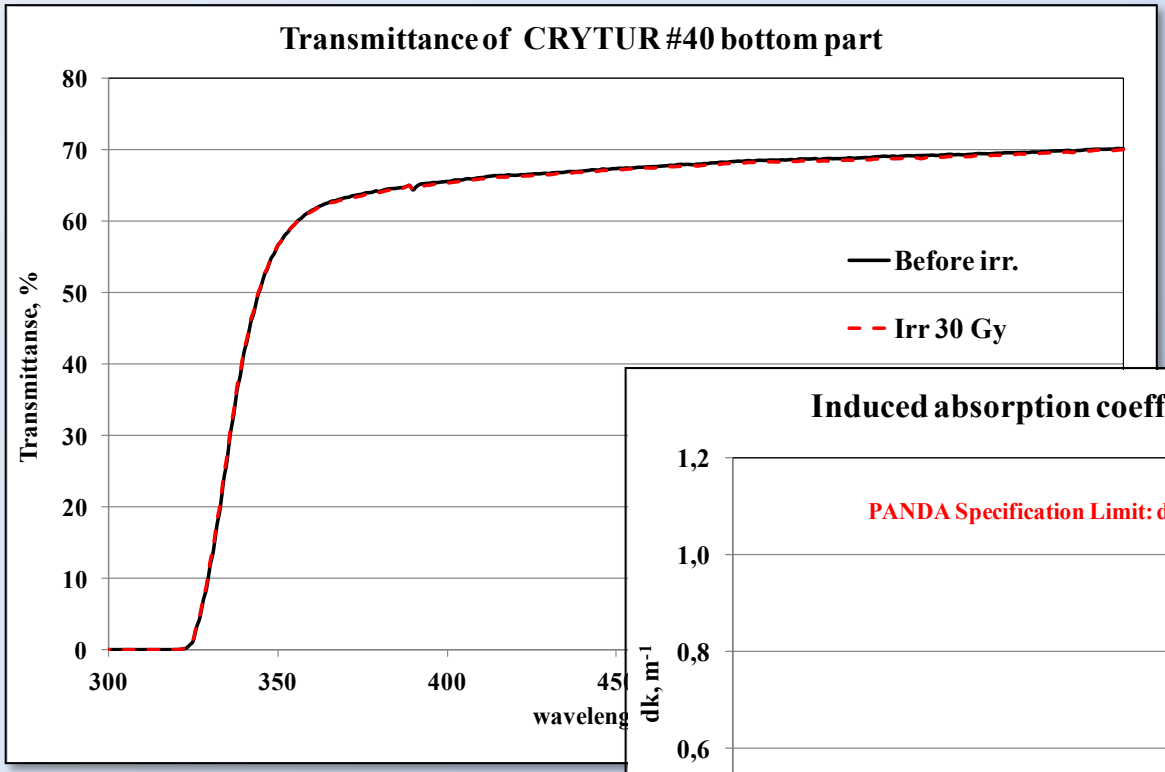
last sample: 20x20x169 mm^3

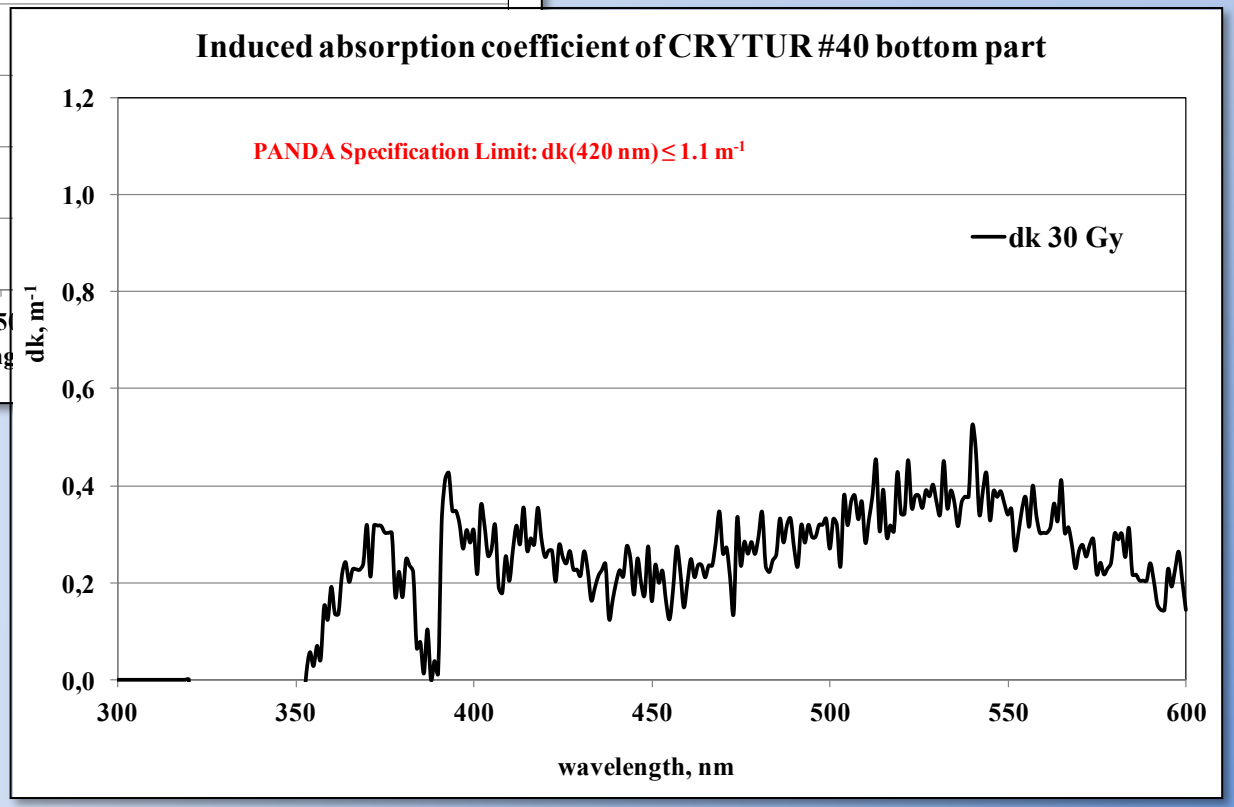






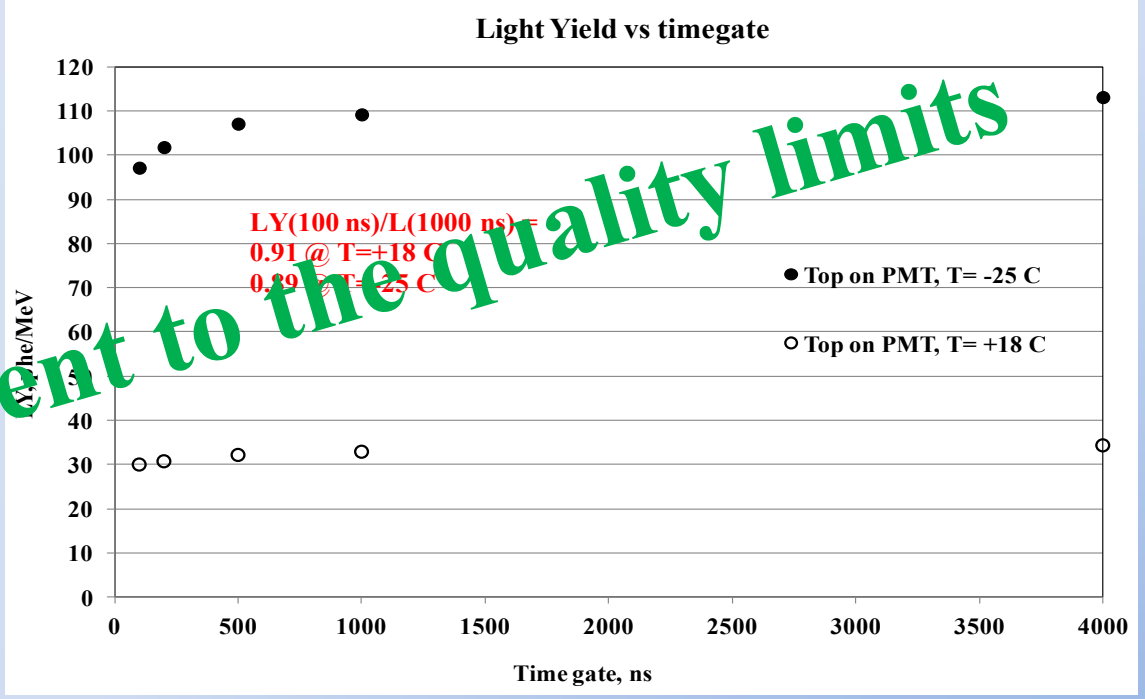
the most recent sample (#40): bottom part (1.2cm)





the most recent sample (#40): bottom part

LY (100ns)/ LY(1μs)
0.91 @ T= +18°C
0.89 @ T= - 25°C



in full agreement to the quality limits

further fine-tuning of the growing technology:

- pre-crystallization of the raw material
- temperature stabilization of the melt
- optimum concentration and homogeneity of the dopants

Outlook

- pre-production run: 100-150 crystals (Uppsala, GI)

- for calorimetry @ PANDA and future set-ups @ Jlab, …
  - NPS @ Jlab
  - upgrade @ BNL S-PHENIX
  - JRA @ HadronPhysics 3 (Carlos Munioz)
- SICCAS: limited quality

however, at least 2 manufacturers on the market
readiness for negotiations: summer 2016
remaining pre-mixed raw material has to be purchased
(14t @ NeoChem @ Moscow)
two most recent publications: TNS (*SCINT2015*)
Conf.Rec. *IEEE NSS 2015*

Ongoing activities: I

- limited resources 2015-16
- PROTO120
  - next test @ MAMI : Dec. 11-13, 2015
    - two 5x5 matrices
    - APFEL-ASIC, readout,
    - new mechanics, new cooling concept
    - monitoring from front side
    - implemented LEDs for recovery
  - readiness still open !

Ongoing activities: II

- **APD irradiation:** not yet started
- **quality control for pre-production**
  - ACCOS @ CERN again available
- **final concept for complete slice**
  - conclusions based on PROTO120
  - modifications and finalizing of design
  - assembly of first slice
  - readiness for mass production in fall 2016