PANDA electromagnetic calorimeter

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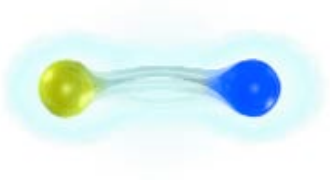
PANDA Issues

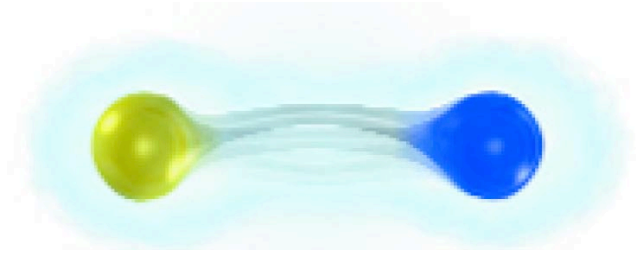


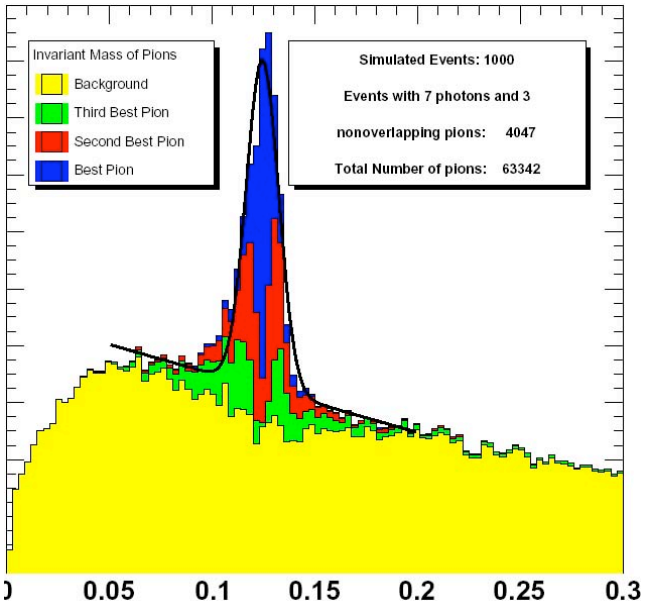
- charmonium spectroscopy
- gluonic excitations (hybrids, glueballs)
- in medium mass modifications
- γ-ray spectroscopy of hypernuclei

Example: charmonium hybrid

$$p\bar{p} \rightarrow H_c\,\eta$$
$$\hookrightarrow \gamma\gamma$$
$$\hookrightarrow \chi_c\,\pi^0\pi^0$$
$$\hookrightarrow \gamma\gamma\gamma\gamma$$
$$\hookrightarrow J/\psi\,\gamma$$
$$\hookrightarrow l^+\,l^-$$

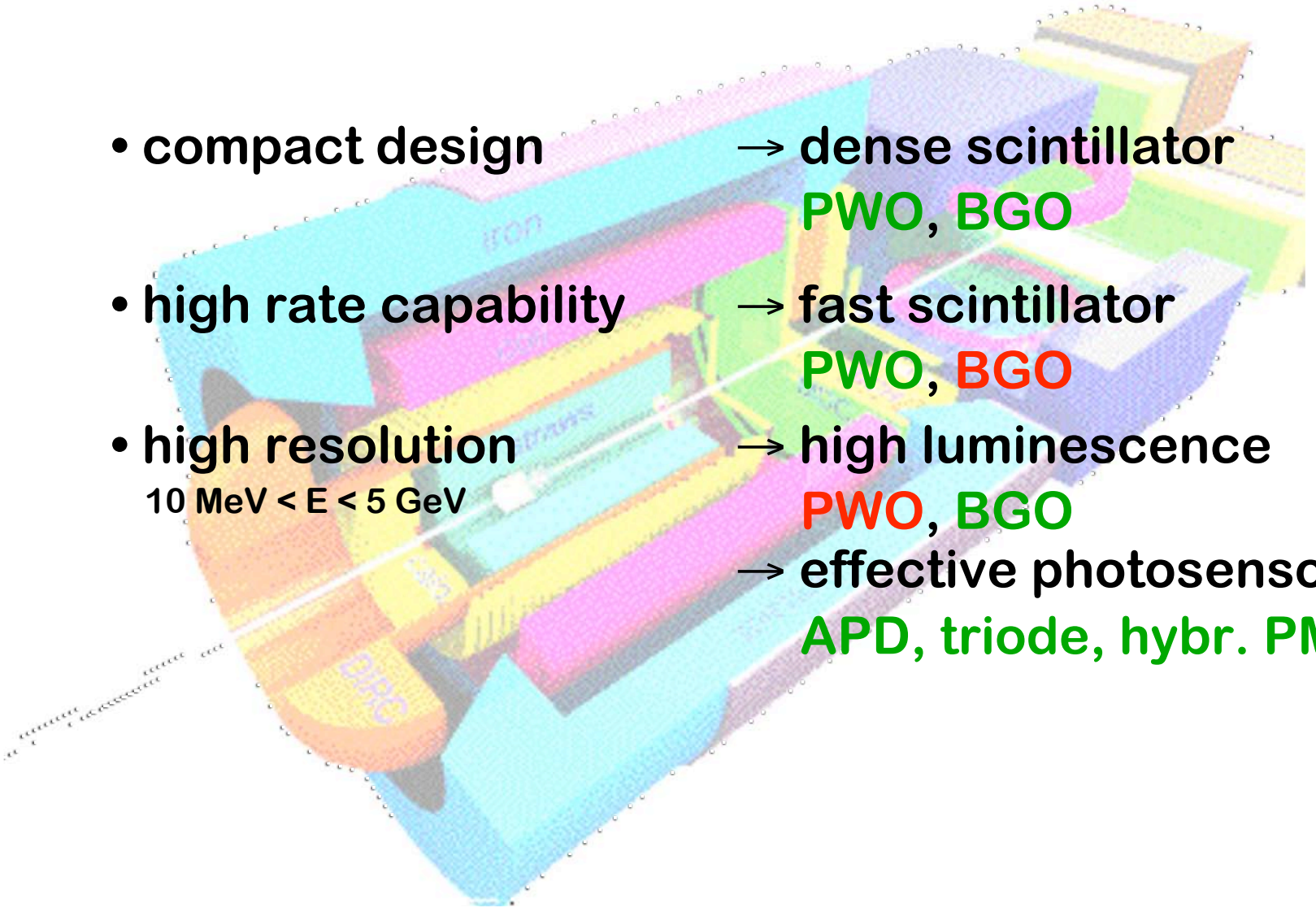
$$\Rightarrow p\bar{p} \rightarrow l^+\,l^-\,7\gamma$$





$\Rightarrow$ **4π coverage for γ-detection essential!**

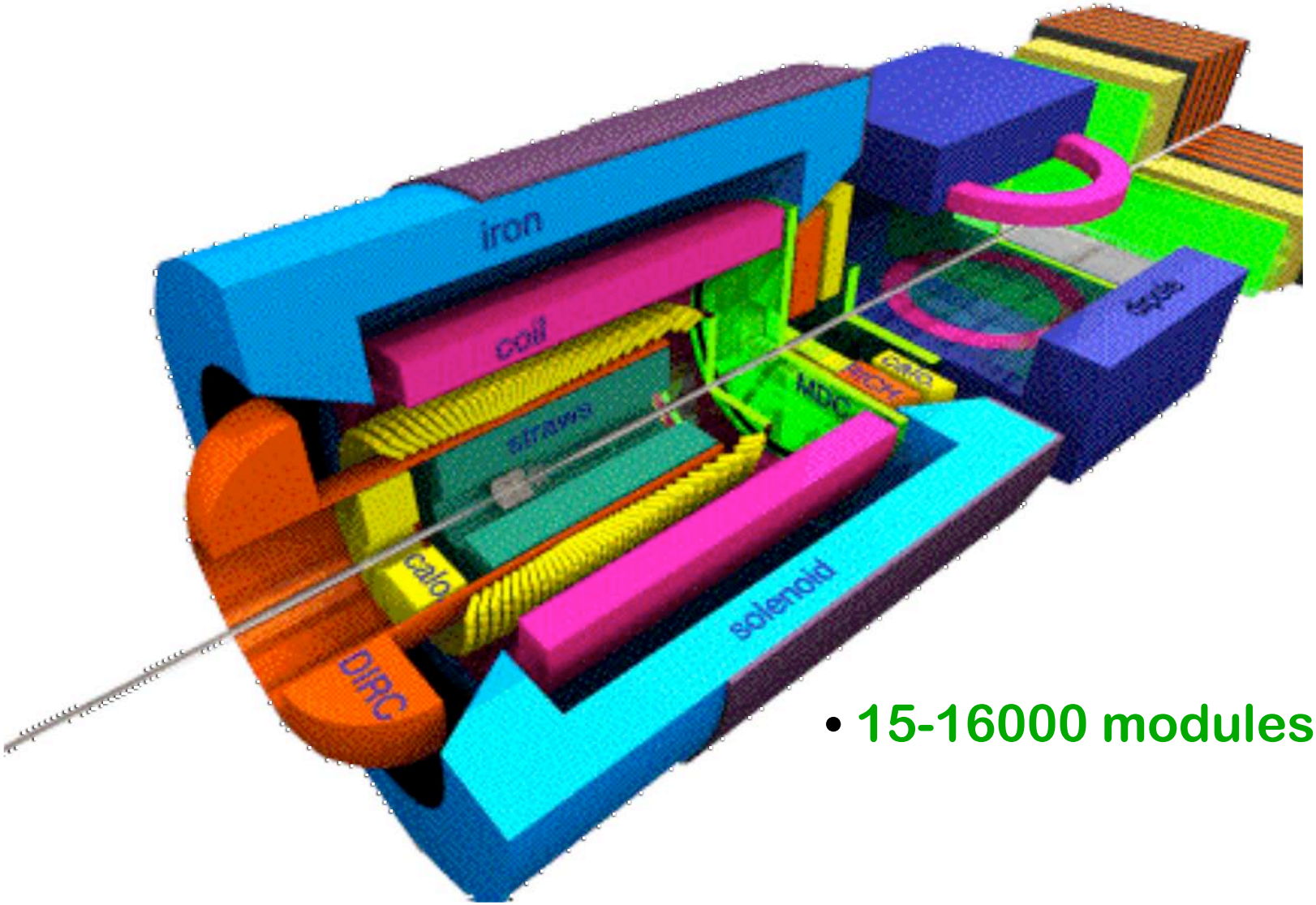
The Solution
PANDA EMC



- compact design → dense scintillator
  PWO, BGO
- high rate capability → fast scintillator
  PWO, BGO
- high resolution
  10 MeV < E < 5 GeV → high luminescence
  PWO, BGO
  → effective photosensor
  APD, triode, hybr. PM

The Solution

PANDA EMC



- 15-16000 modules

Under Evaluation

- **scintillator material**
  - **PWO (II, III)**

    SICCAS, Bogoroditsk

Under Evaluation

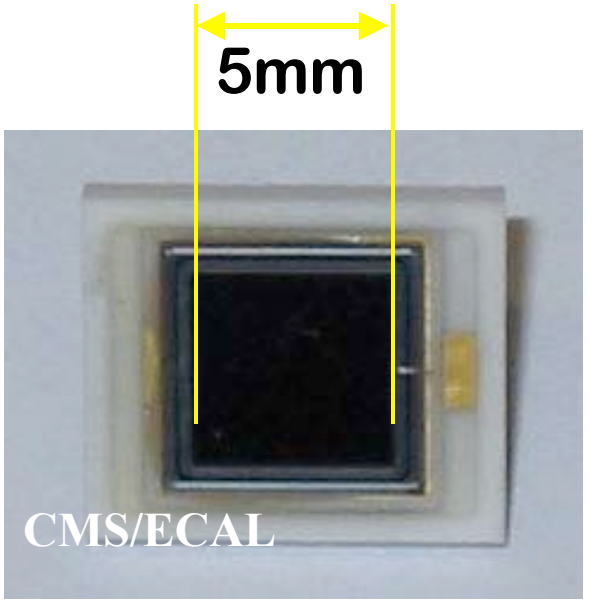
- **scintillator material**
  - **PWO (II, III)**

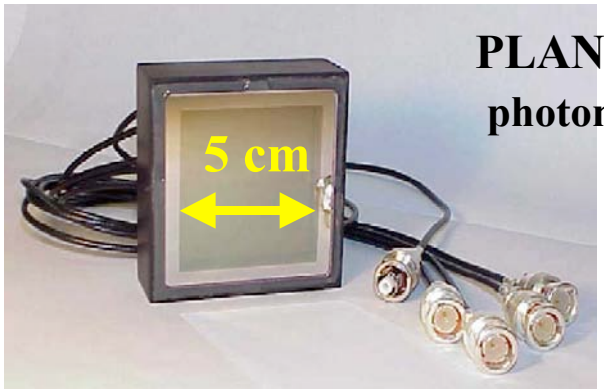
    SICCAS, Bogoroditsk
  - **BGO**

    SICCAS, (Saint Gobain)

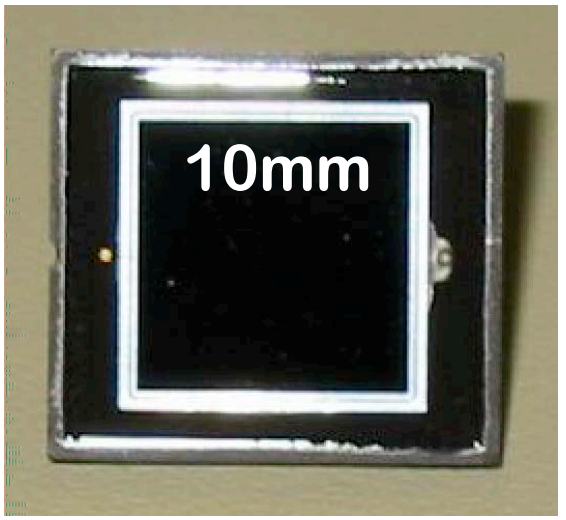
Under Evaluation

- scintillator material
  - PWO (II, III), BGO
- photo sensors
  - APD 5x5mm^2, 10x10mm^2
    (Hamamatsu,...)
  - hybrid PMT, vac. triode

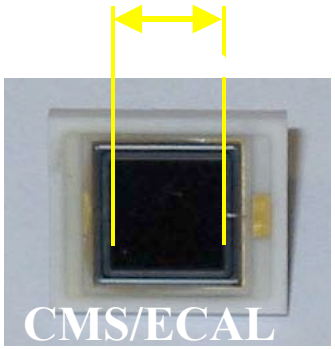




PLANACON™
photomultiplier BURLE



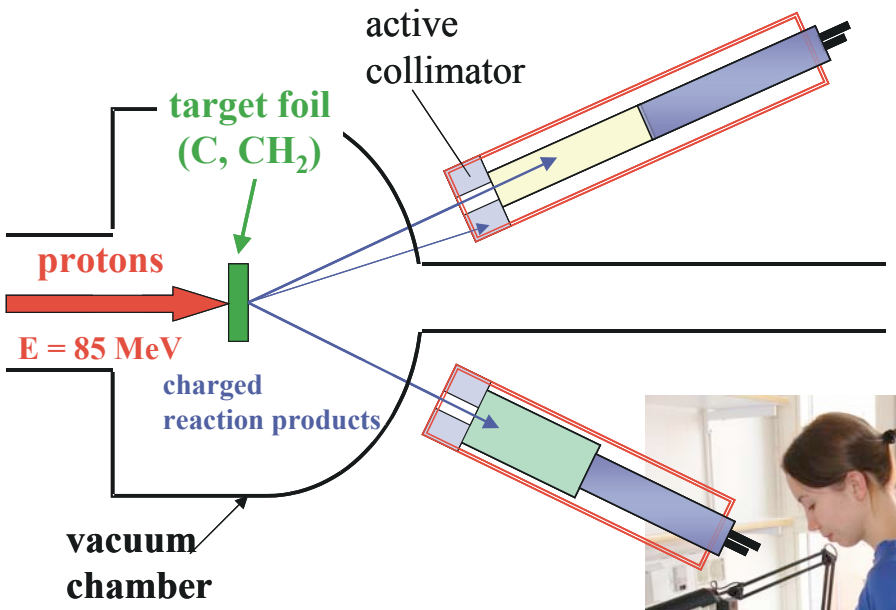
Under Evaluation



- scintillator material
  - PWO (II, III), BGO
- photo sensors
  - APDs, (hybrid PMT, vacuum triode)
- crystal shape and exact positioning
- radiation hardness

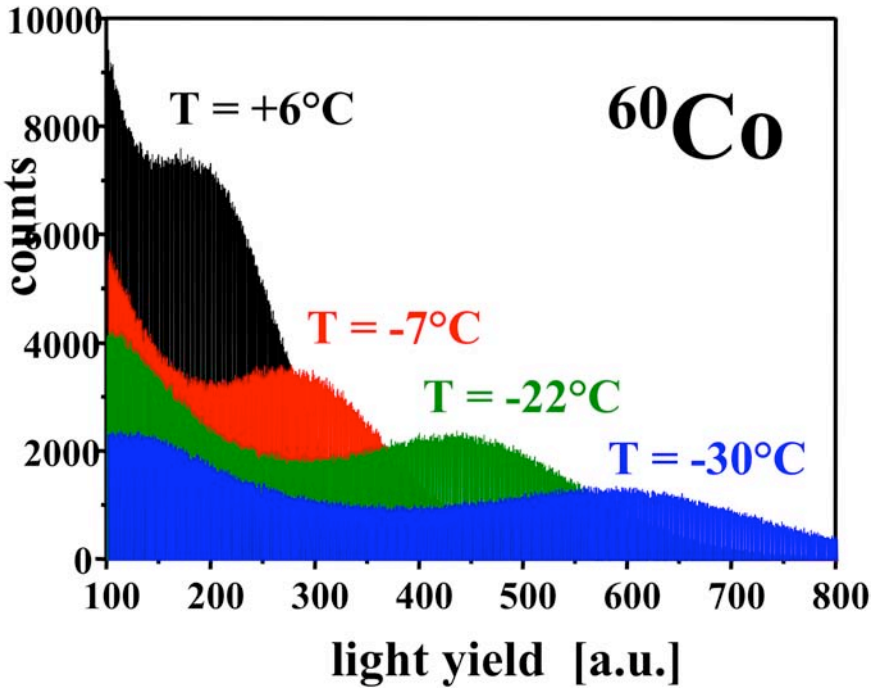
Experiments at KVI

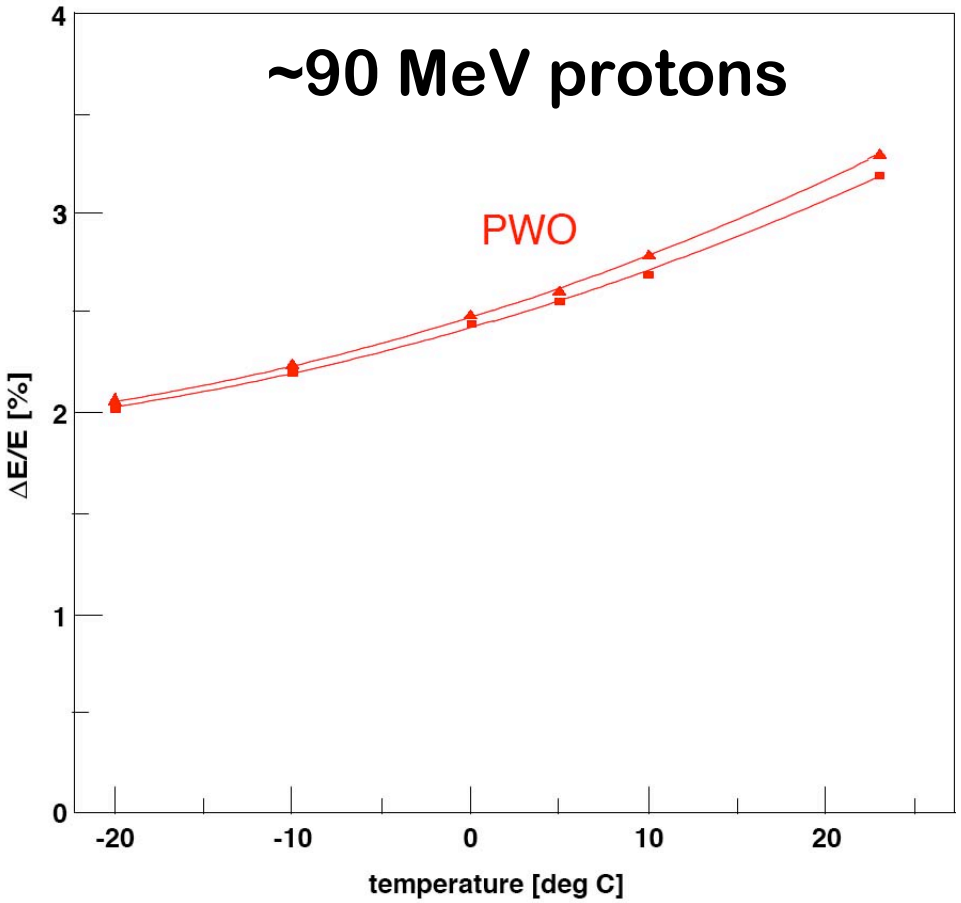
protons on PWO, BGO, CEF crystals and PMT, APD read-out



Energy Resolution vs Temperature

- PWO is fast and inexpensive, but the light yield is strongly temperature dependent.



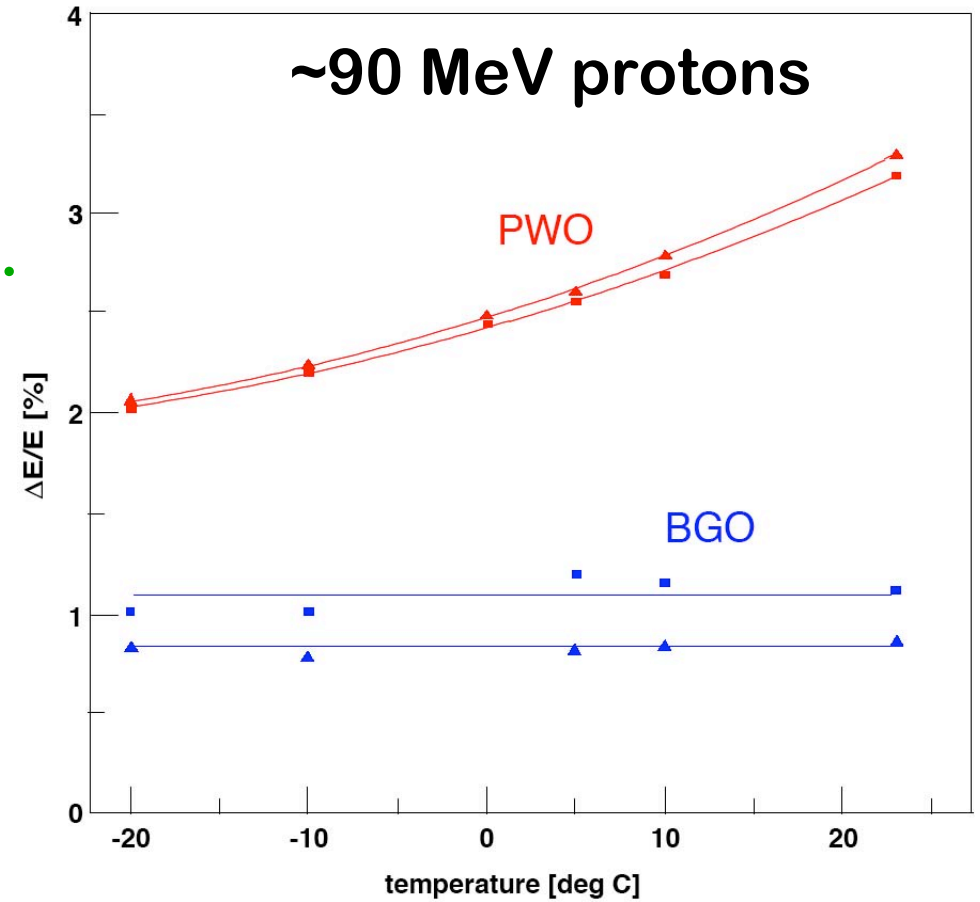


Energy Resolution vs Temperature

- PWO is fast and inexpensive, but the light yield is strongly temperature dependent.

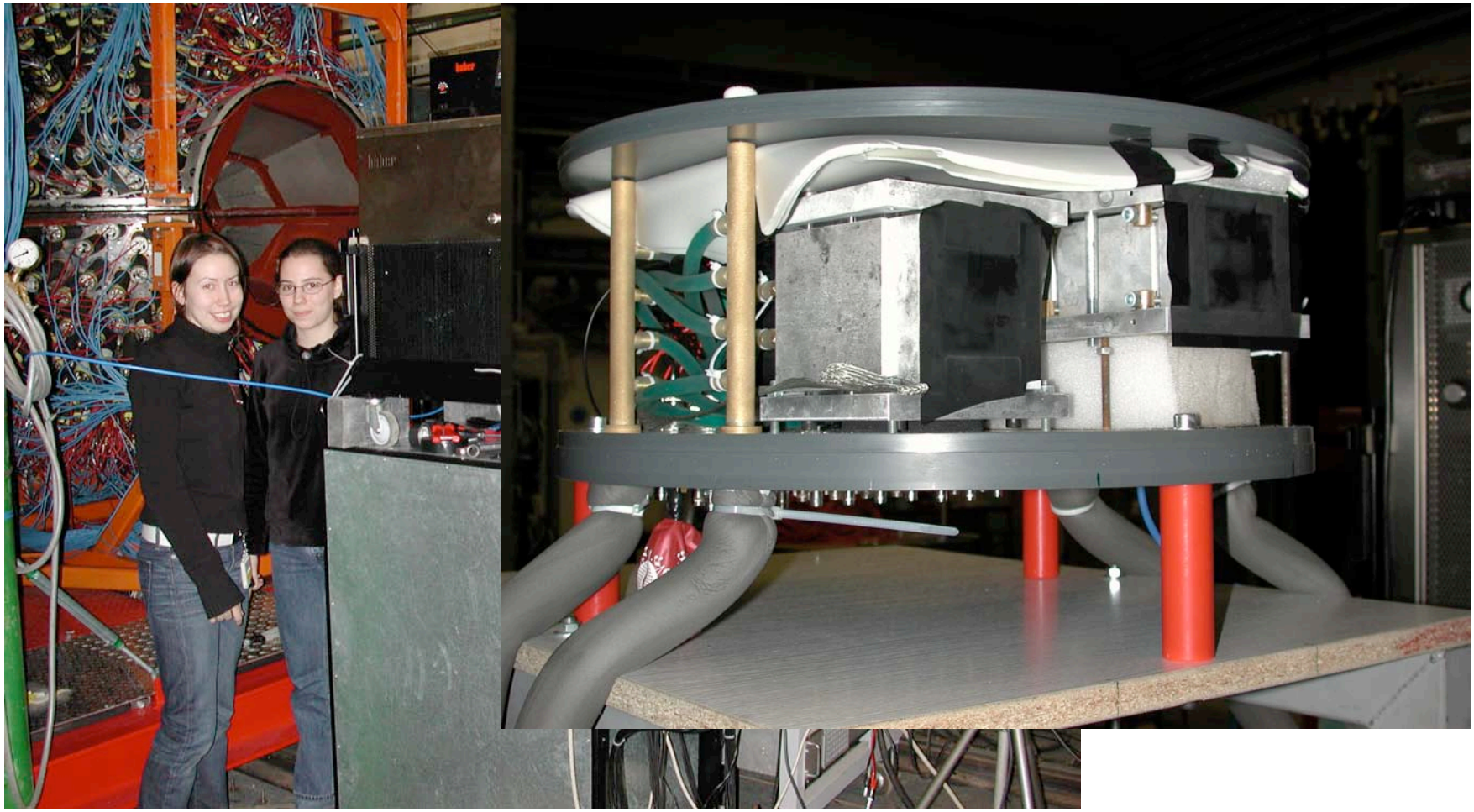
- BGO shows a constant and high light yield, but the timing is rather poor.

⇒ Simulations and studies of second and third generation PWO needed!



Experiments at MAMI

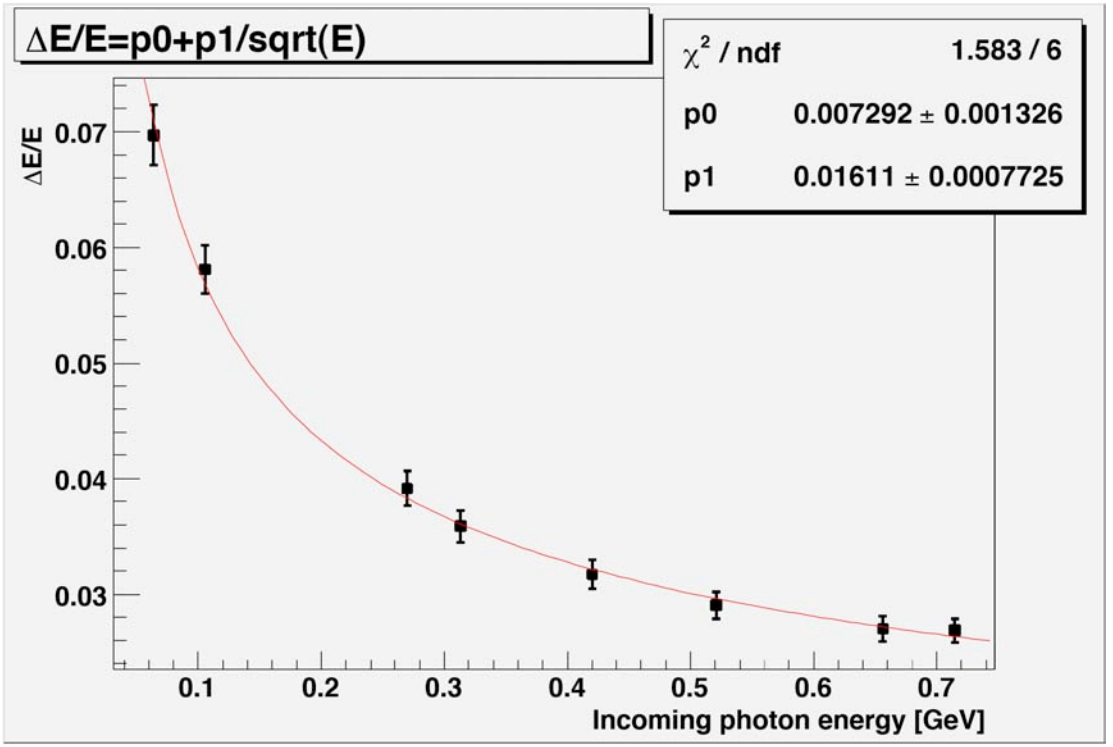
tagged photons on 3x3 PWO I,II arrays



Energy Resolution vs γ Energy

3x3 array PWO II at -24°C and PMT read-out:

$\Delta E/E = (0.7 \pm 0.1)\% + (1.61 \pm 0.07)\% / \sqrt{E[GeV]}$



PANDA CDR: $\Delta E/E = 0.3\% + 1.54\% / \sqrt{E[GeV]}$

⇒ Results with APD read-out and estimates on radiation damage still required!

- PANDA electromagnetic calorimeter
  - essential and challenging device!

Outlook

- Tests at MAMI and KVI (Oct - Nov 2004)
  - first studies with PWO III and APDs
- Monte-Carlo Simulations for benchmark channels and background in progress
  - required position and energy resolution
- Joint efforts at Uppsala and Stockholm to evaluate experimental:
  - energy and timing resolutions
  - radiation hardness to neutron flux