Dual REAdout Method principle

The Dual REAdout Method allows to improve the performances of hadronic calorimeters by measuring event-by-event the electromagnetic fraction of the hadronic cascade, thus reducing its fluctuation and obtaining a better resolution and linearity.
The method is based on the separation of the Scintillation light due to ionization and Cherenkov light produced almost exclusively by relativistic particles, i.e. the electromagnetic component of the hadronic shower.

DREAM Method in Crystals

Separation of Cherenkov (C) and Scintillation (S) light in crystals can be achieved by exploiting:

- ***Time structure:*** C light is prompt, while S is characterized by one or several time constants
- **Spectral Proporties:** C emission exhibits a λ^{-2} spectrum, while for S the emission spectrum is caracteristic of the crystal type, usually it shows some peaks.
- **Directionality:** C light is emitted at a characteristic angle $\theta_C = \arccos(1/\beta n)$, while S is isotropic (not feasible in real detectors)

Characteristic of optimal crystal for DREAM

In order to have the best possible separation a crystal must have a scintillation emission:

- ★ in a wavelength region far from the Cherenkov one
- ★ with a decay time of order of hundreds of nanoseconds
- ★ not too bright to get a good C/S ratio (<50% BGO emission)

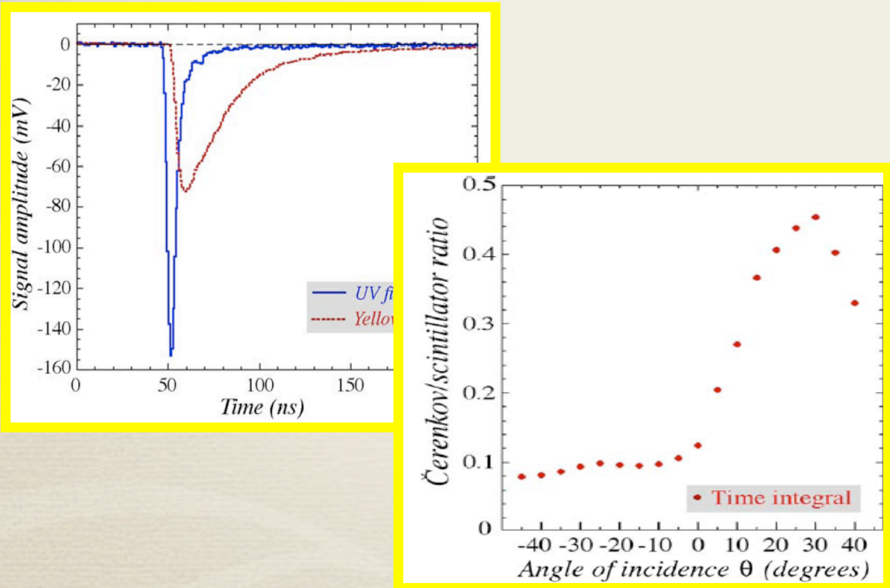
Results from 2008 Test Beam

Molybdenum doped $PbWO_4$

Molybdenum doping causes:

★ shift of the S spectra to higher λ wrt undoped crystal
★ longer S decay time (50 ns)
★ shift of the absorption cut-off to higher λ

This allows to obtain a ***very good C/S separation*** using filters.
Very narrow window where C light can be collected results in ***strong light attenuation*** **.**



Praseodymium doped $PbWO_4$

Praseodymium doping causes:

★ shift of the S spectra to higher λ (emission in the red region)
★ too long S decay time (~μs)
★ shift of the absorption cut-off to higher λ

The high wavelength shift allow for higher cut-off filters, resulting in ***no light attenuation*** effect.
The ***too long tail*** in scintillation emission is not suitable for fast calorimetry.