(An Introduction to) Characterization of Crystals for Dual Readout Calorimetry

Adam Para

July 15, 2011

Need of Crystals

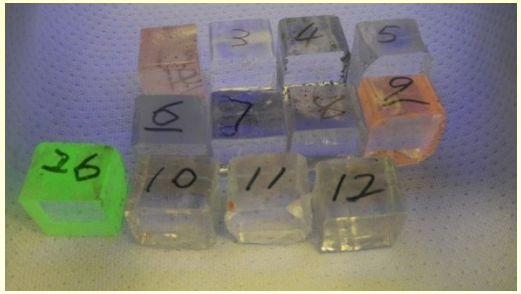
- We want to construct very large calorimeter from scintillating crystals.
- Cherenkov light is in UV/blue: need good transmission for short wavelength.
- We want to read out, and distinguish the scintillation and Cherenkov light. It is desirable that the scintillation light is ~green/yellow and slow
- We need large quantities of crystals: they need to be inexpensive

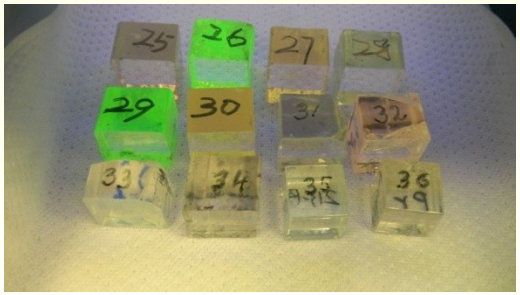
Candidate Crystal: PbF_2

- PbF_2 is an excellent Cherenkov radiator (good transparency down to λ=250nm)
- It is potentially an inexpensive crystal (melting temperature ~850C)
- It needs to be doped to make it scintillate. This is in principle an advantage:
  - Tailor the scintillating agent to match our requirements (emission spectrum, response time)
- Challenges:
  - Find the scintillating dopants which are compatible with PbF_2 crystals production
  - Find dopants which do not affect (in a major way) transparency to Cherenkov light

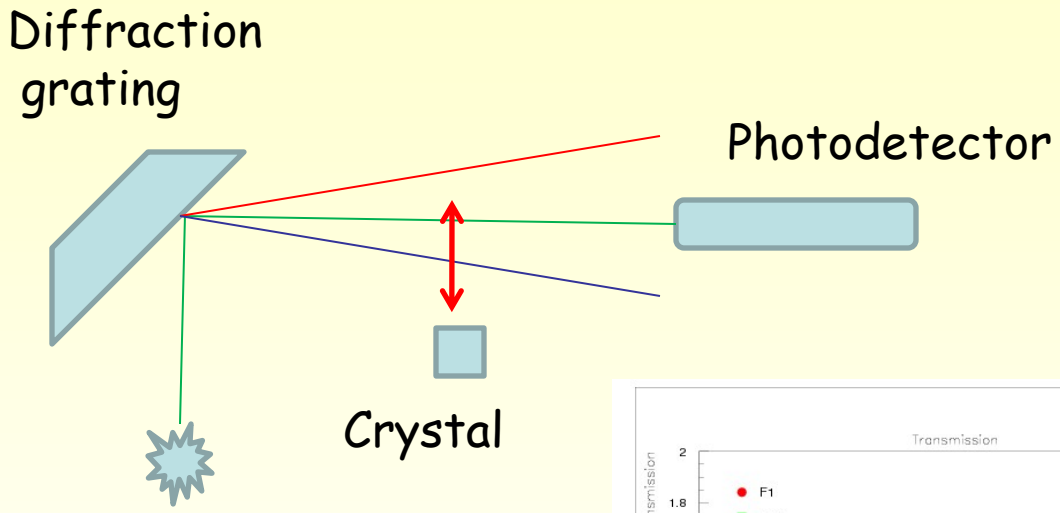
	Doping		Doping				Doping
1	none	11	0.5% BaF_2 +0.25%EuF_3	21	0.2% BiF_3	31	5% BaF_2 +0.25%EuF_3
2	0.05% CaF_2 +0.5%EuF_3	12	5% BaF_2	22	0.75% BiF_3 +0.35%EuF_3	32	0.5% CaF_2 +1%EuF_3
3	1% CaF_2 + 1%EuF_3	13	10% BaF_2 +0.25%EuF_3	23	0.75% BiF_3 +0.35%EuF_3 +0.07%NaF	33	1% CaF_2 +0.25%EuF_3
4	0.2% CaF_2 +0.25%EuF_3	14	1% BaF_2	24	1% BaF_2 +0.25%EuF_3	34	0.05% CaF_2 +0.25%EuF_3
5	1% CaF_2	15	0.25%ErF_3	25	1.5% BiF_3 +0.7%HoF_3 +0.15%NaF	35	(213-B) +0.1%Tb
6	0.2% CaF_2 +0.25%EuF_3 +0.025%YF_3	16	0.2% CaF_2	26	0.75% BiF_3 +0.35%ErF_3 +0.07%NaF	36	(93302-3) +0.1%Pr
7	0.2% SrF_2	17	0.25% SmF_3	27	0.75% BiF_3 +0.35%SmF_3 +0.07%NaF	37	(93302-4) +0.1%Nd
8	0.5% SrF_2 +0.25%EuF_3	18	0.25% HoF_3	28	0.35%HoF_3 +0.07%NaF	38	(93302-3) +0.1%Yb
9	0.5% SrF_2 +1%EuF_3	19	0.25% GdF_3	29	0.35%ErF_3 +0.07%NaF	39	(93307-6)) +0.1%Sm
10	0.2% BaF_2	20	0.25% PrF_3	30	0.35%SmF_3 +0.07%NaF	40	(P983309-4) +5000ppmTb +100ppmCe

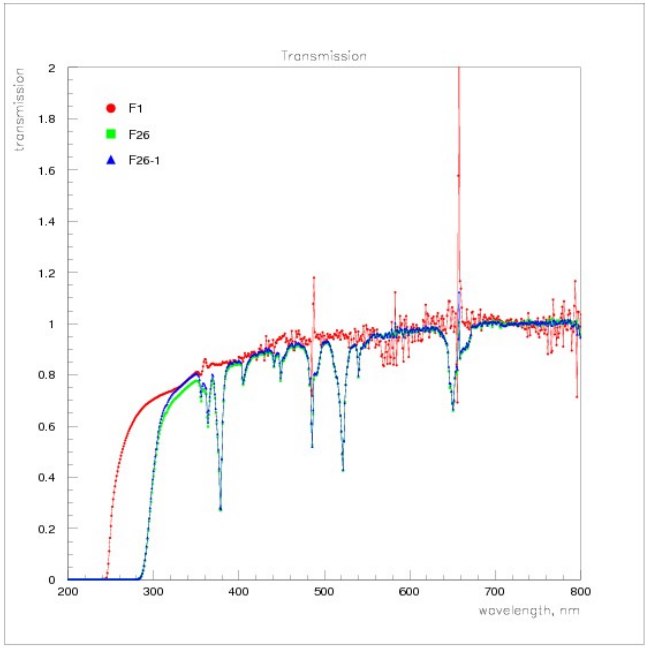
Sample Crystals Under UV excitation



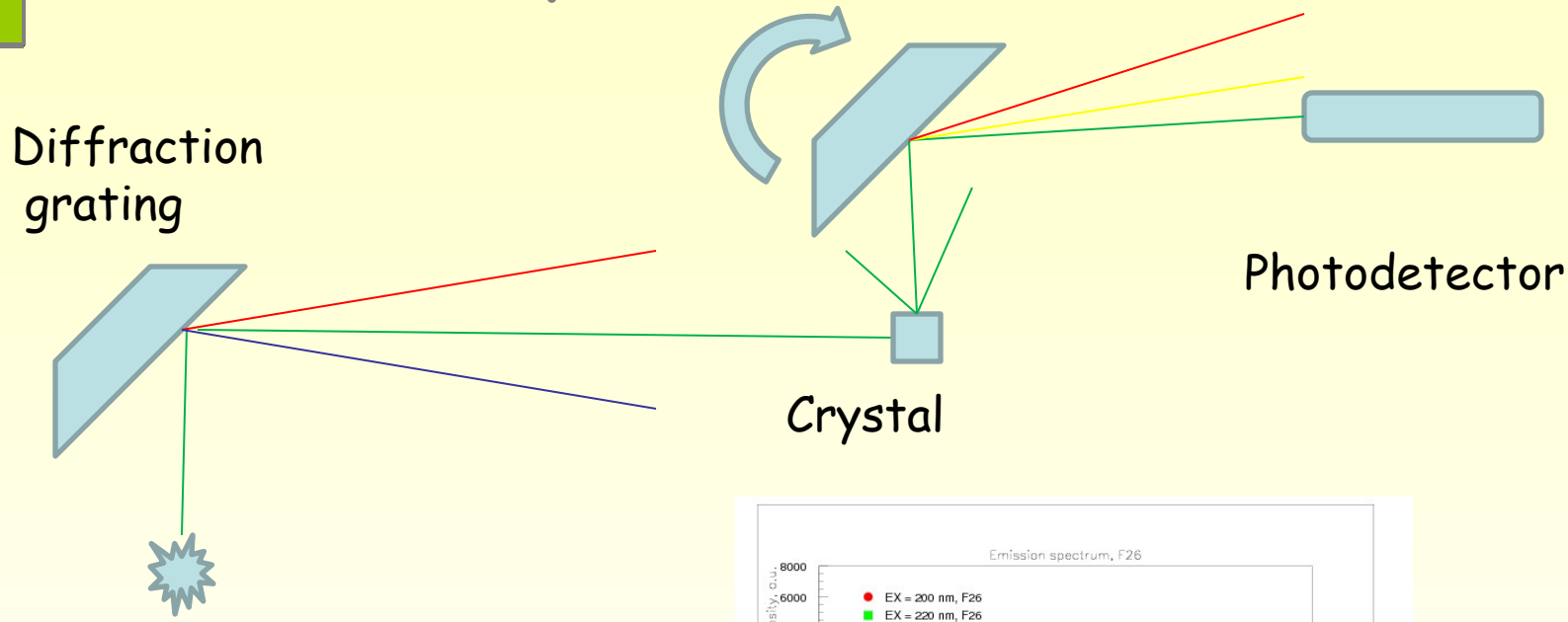


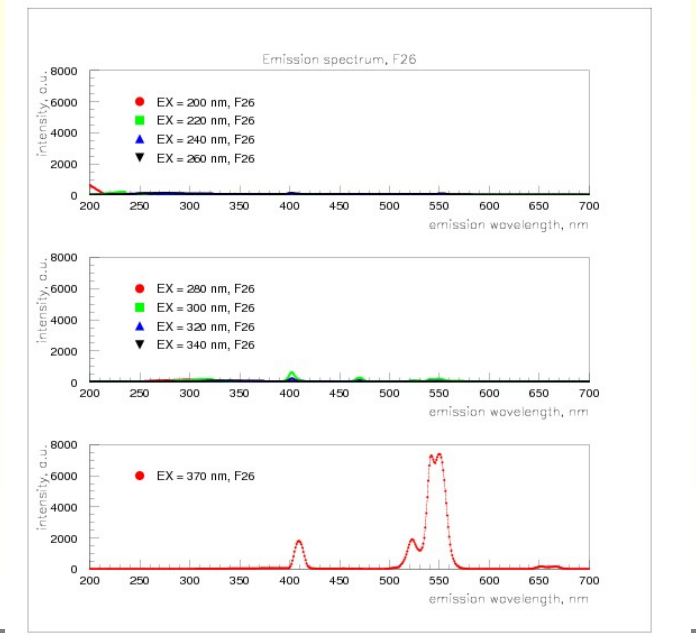
Transmission Measurement



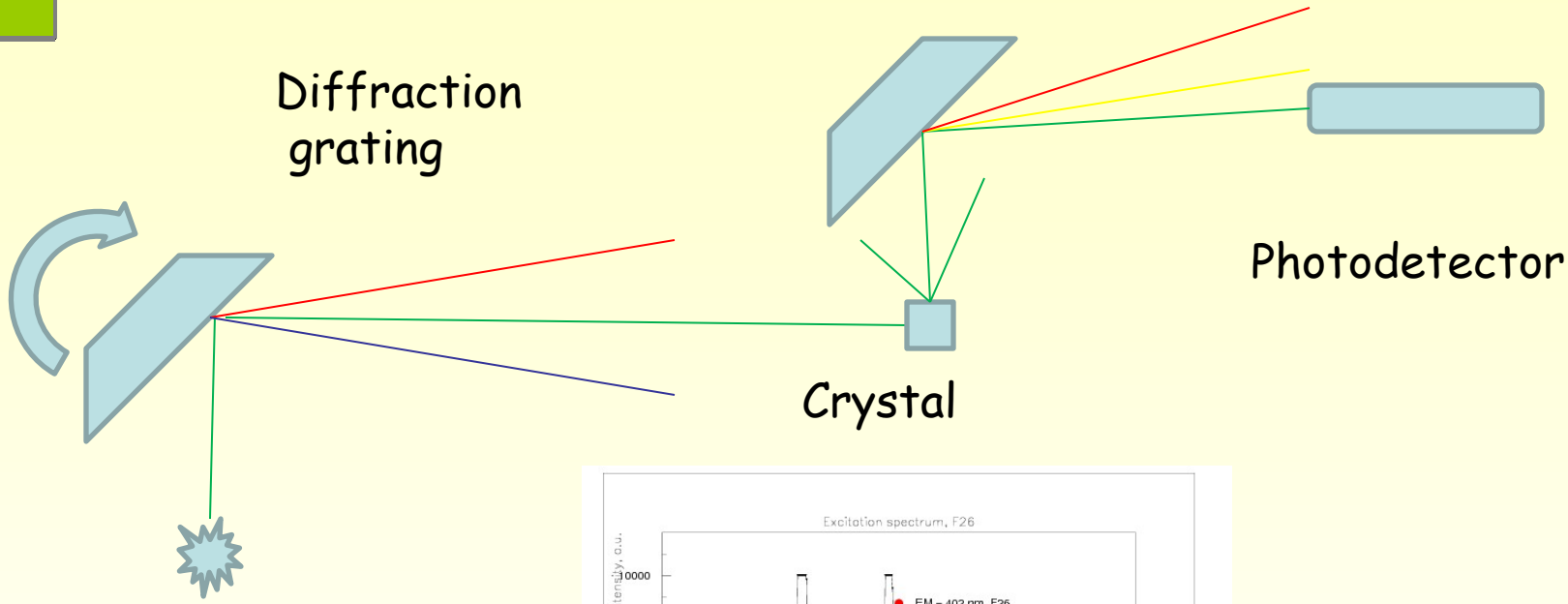


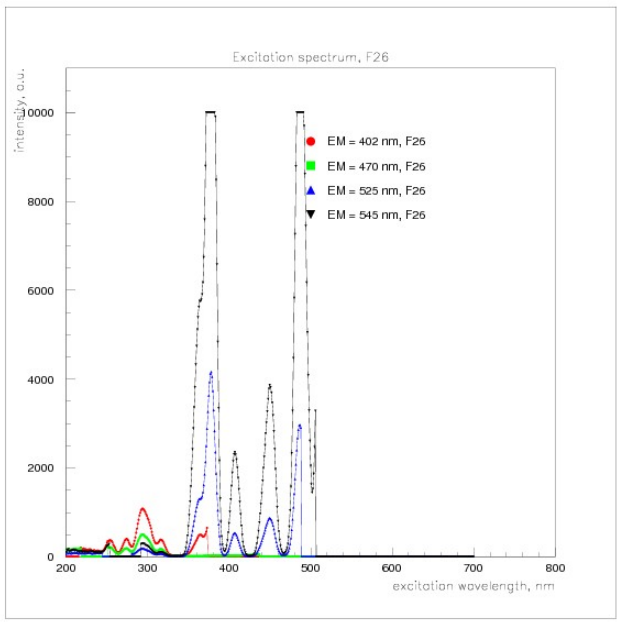
Emission Spectrum Measurement



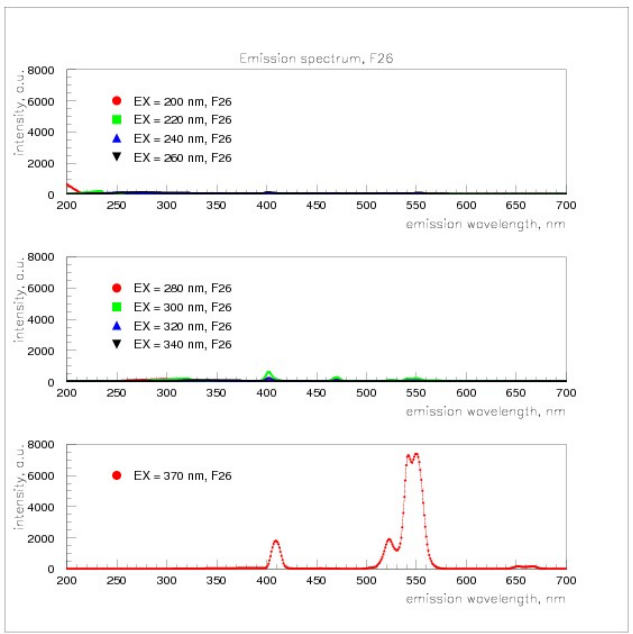


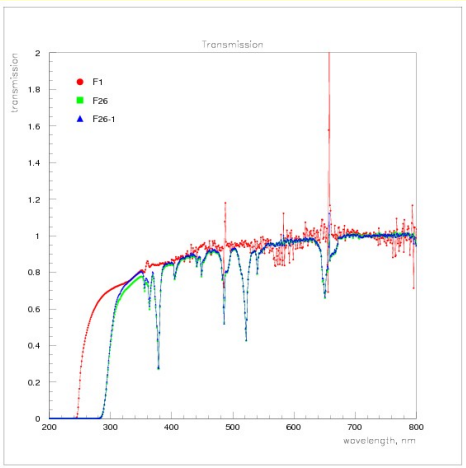
Excitation Spectrum Measurement

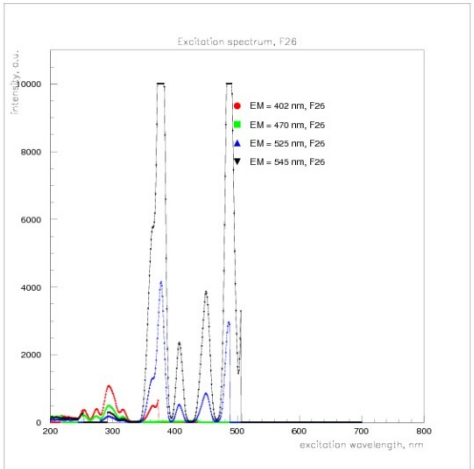




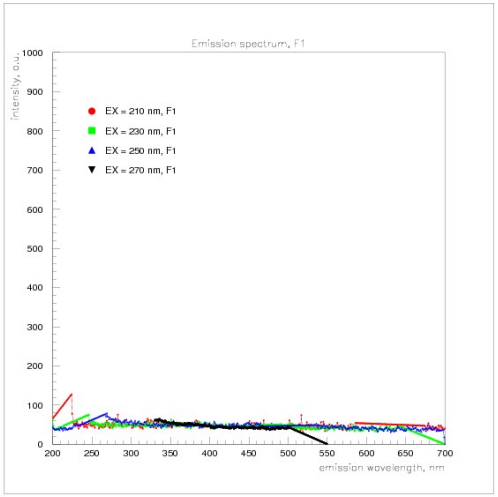
A Complete Picture

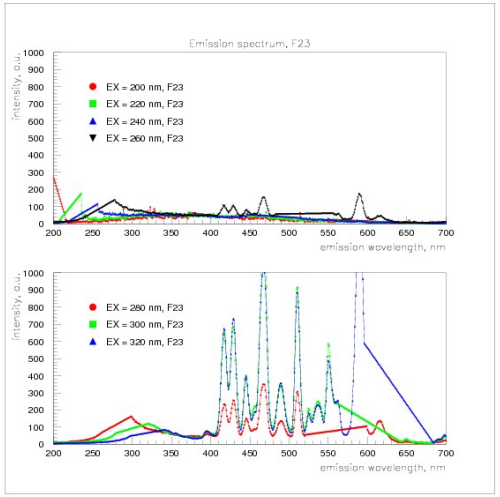


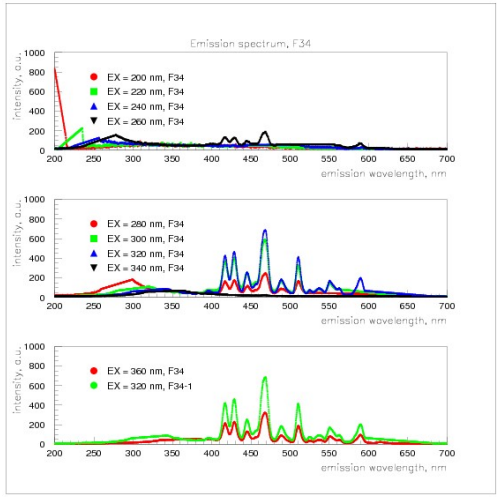


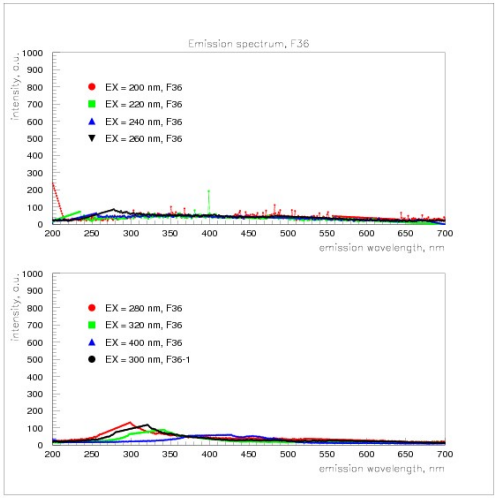


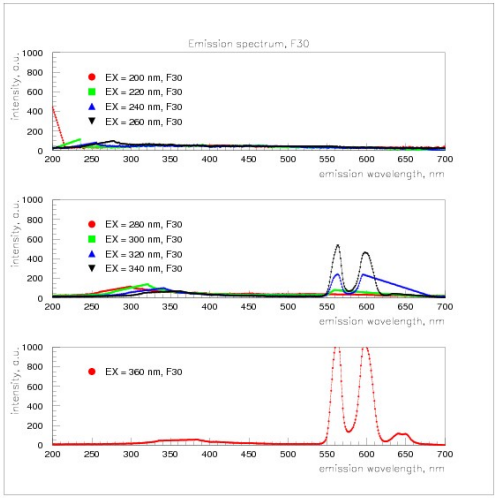
(Examples of) Emission Spectra

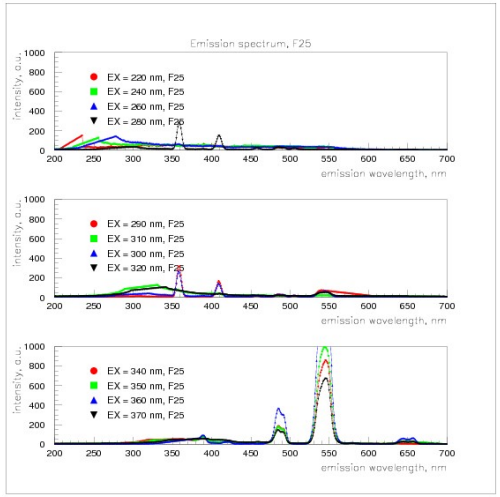












- Analysis requires comparisons and finding correlations between large number of plots. Image browser utility of great help.
- Browsing the image data base extremely helpful to find various defects and errors in labeling and presentation. They can (and are) fixed. But we need some cleanup utility to remove (or mark to be invisible) unwanted versions of the plots.