Optimization of a/b separation using Hidex counters and 2D graphical tool

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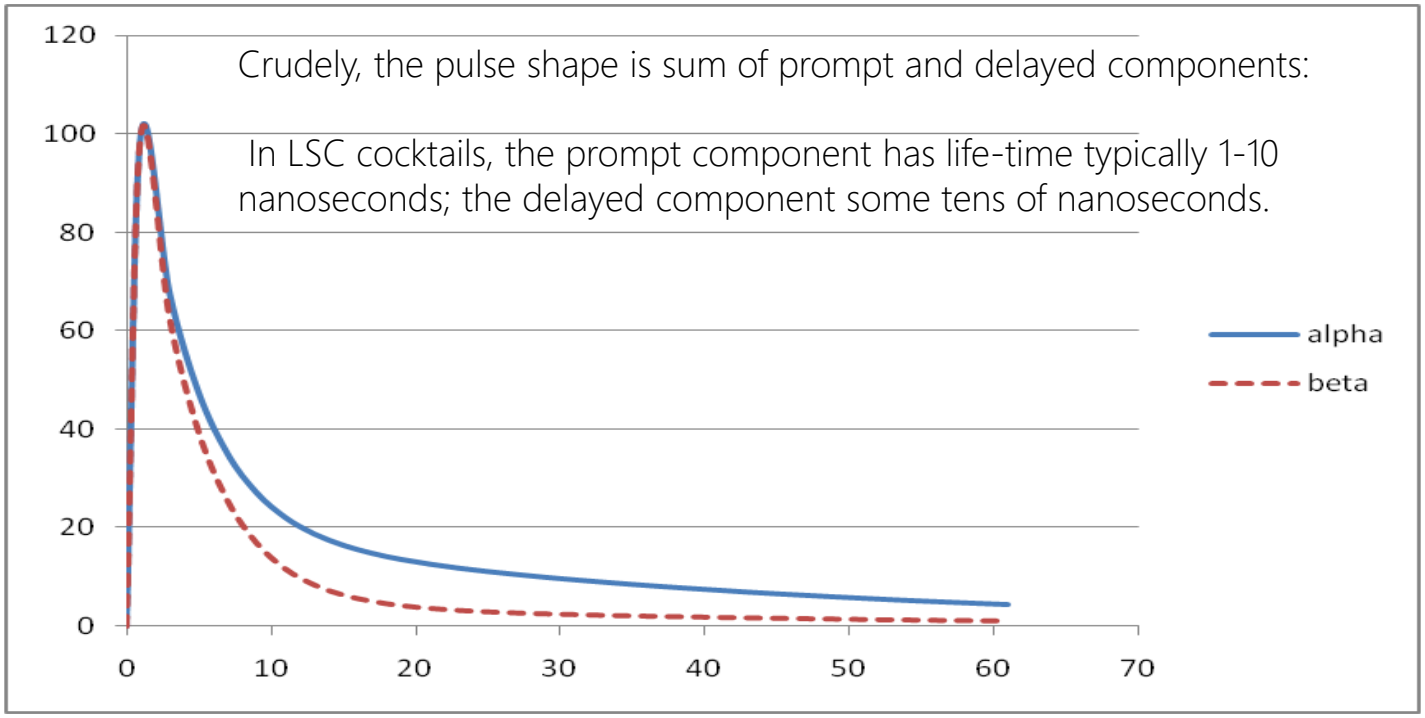
Alpha Beta separation

Pulse anatomy:

Ionizing particle excites several scintillator molecules to mixture of
Singlet states → fast decay or prompt component
Triplet states → long decay or delayed component
Alpha particles produce denser ionization which favors formation of triplet states, hence more delayed component.



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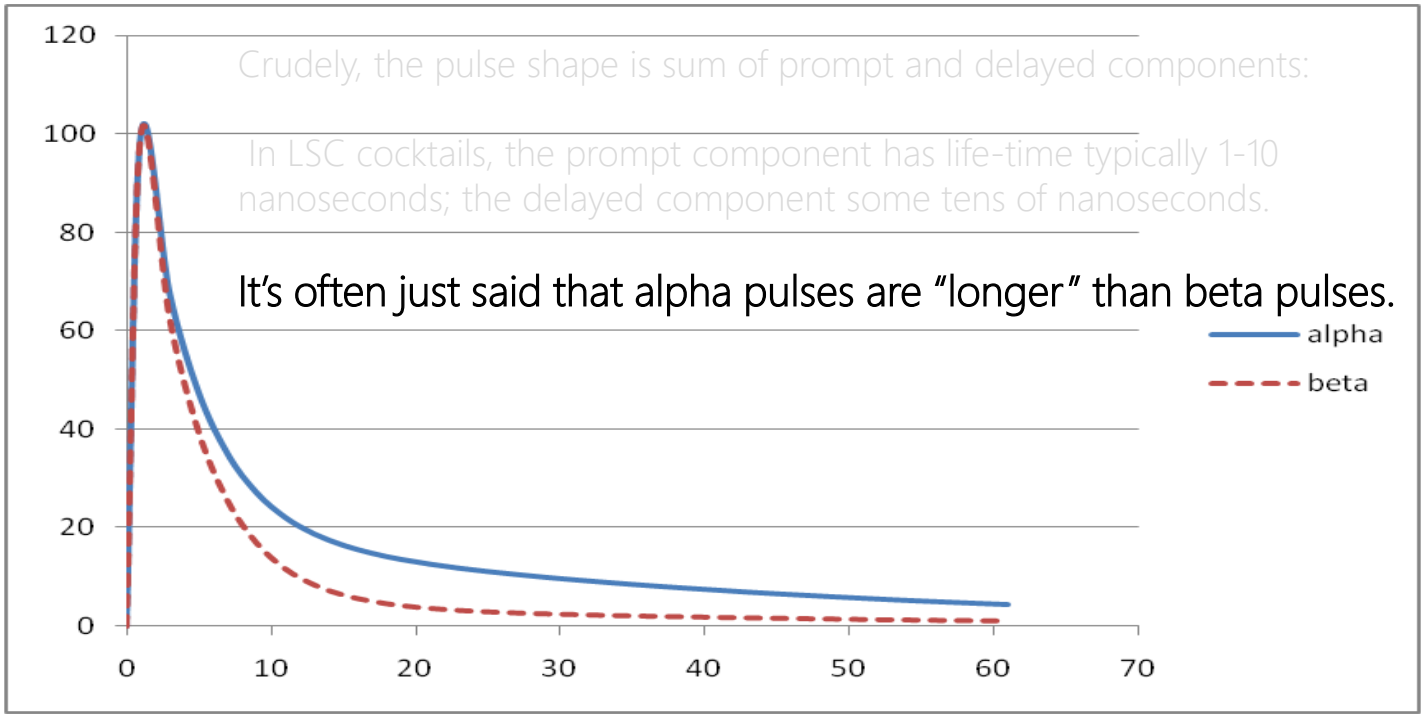


Crudely, the pulse shape is sum of prompt and delayed components:

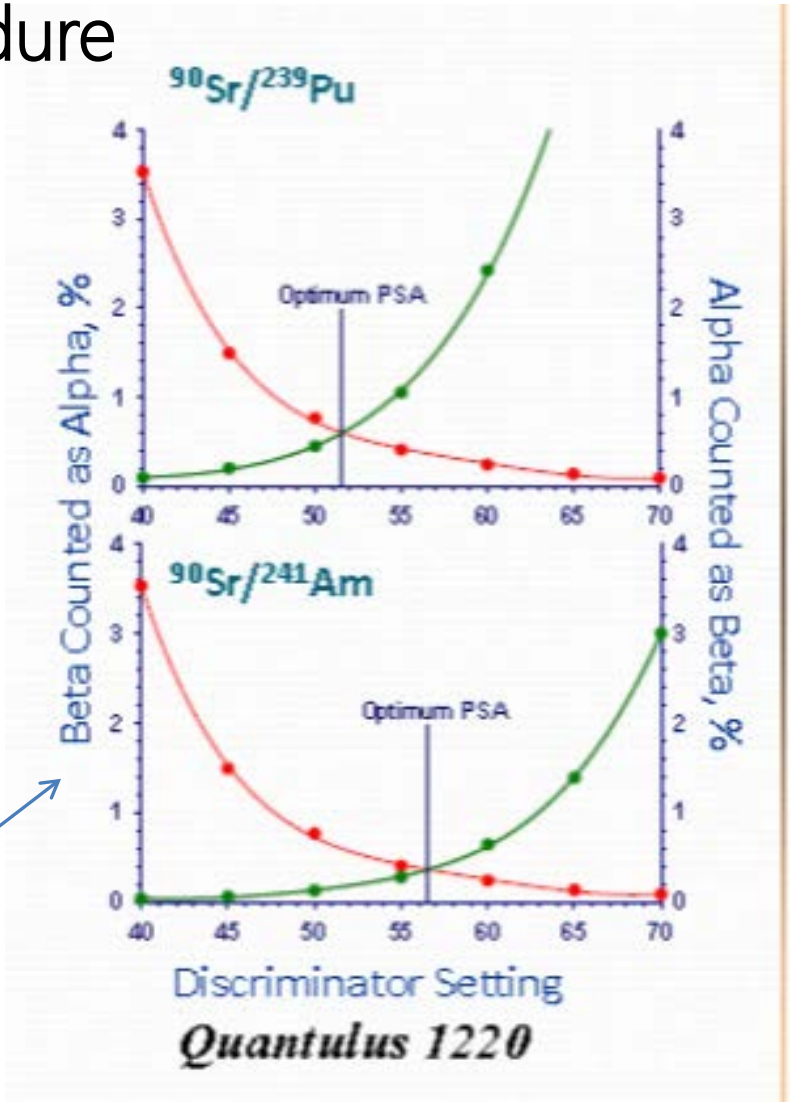
In LSC cocktails, the prompt component has life-time typically 1-10 nanoseconds; the delayed component some tens of nanoseconds.

It's often just said that alpha pulses are "longer" than beta pulses.

Conventional calibration procedure

- Optimization of the pulse decay discriminator (PDD, PSA,..) using a pure alpha and a pure beta emitter (typically Am-231, Pu-239/Sr-90, Cl-36)
- Optimum PDD varies based on the isotope energies and degree of quenching

$^{90}Sr/^{241}Am$, $^{90}Sr/239Pu$
3 mL of 0.5M HCl in 17 mL of Ultima Gold AB and Low ^{40}K glass vial.
(Ref: RRMC 2015)



Conventional calibration procedure

-> PSA is different for different isotopes

-> uncertainty of the results if the isotopes are not the same as in the unknown samples

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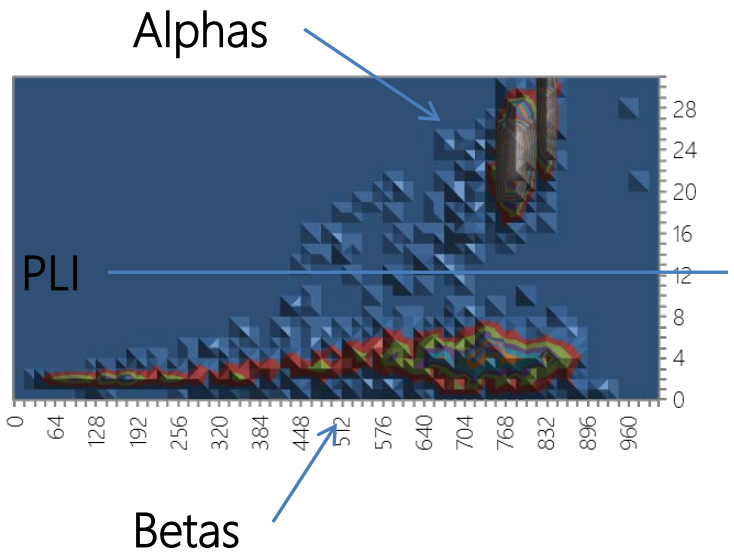
Calibration procedure with 2D graph

- Applicable for Hidex Triathler and 300 SL & 600 SL counters

1. Measure a sample with alphas & betas
   (can be the same isotopes as you use in the misclassification run or just a typical unknown sample with some alphas)
2. Print out 2D spectra
3. Optimize the conditions if separation is not good
4. Select discriminator (PLI)
   (visually or by performing conventional misclassification run)
5. Measure the unknowns using selected PLI



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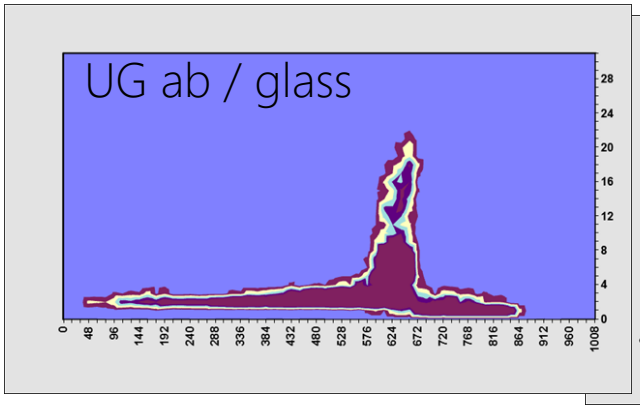
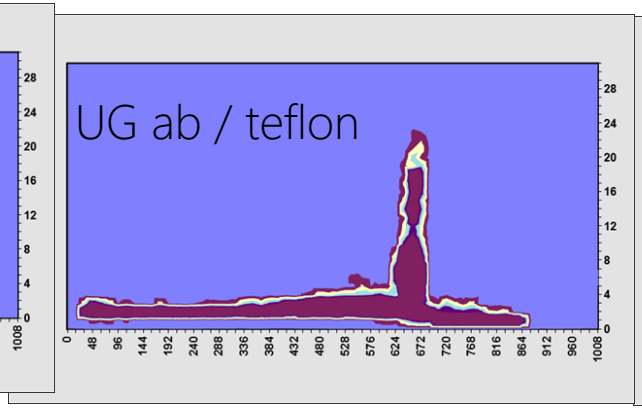
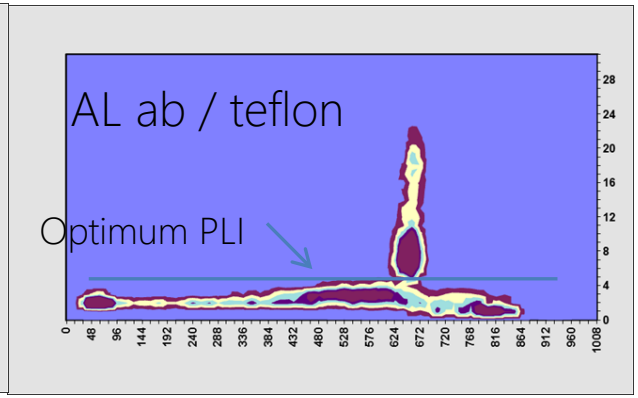
Example: $^{90}Sr/^{241}Am$ sample measured using Hidex 300 SL

(3 mL of 0.5M HCl in 17 mL of cocktail)







1. Alpha and beta regions merged together

-> misclassification of alphas as betas and vice versa

-> high uncertainty

2. Separation improved by selecting better vial type

3. Separation improved even more by selecting cocktail with higher separation efficiency

-> almost zero misclassification

-> low uncertainty

! 2D graph can be used also as a results verification tool for the unknowns

Summary

- 2D graph can be used as a tool:
  - for optimizing measurement conditions
  - for quality control of the results

- How to optimize the conditions:
  - selecting optimum vial materials
  - optimising sample e.g. remove oxygen
  - selecting cocktail with best possible separation efficiency
  - reducing quenching using different sample to cocktail ratio
  - optimizing instrument alpha/beta parameters

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Thank You!

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