Problems caused by backscattering of 1.27MeV photons for PALS
Abstract

1. Common PALS–Setup

2. Possible backscattering scenarios

3. Changes in the experimental setup
Common PALS–Setup

- Photomultiplier with BaF₂ scintillator as stop tube
- Photomultiplier with plastic scintillator as start tube
- 1.27MeV–photon @ e⁺ birth
- 2 * 0.511MeV–photon @ annihilation
- Positron lifetime as difference between detection of birth and annihilation photon
Possible backscattering scenarios

1st scenario

- 1.27MeV-photon triggers stop-signal and loses energy
- Backscattering of 1.27MeV-photon at BaF$_2$ scintillator
- Photon with enough energy left to trigger start-signal at tube with plastic scintillator
- Assumed effect: prompt curve
Possible backscattering scenarios

2nd scenario

- 1.27MeV-photon triggers start-signal with energy < 1.27MeV
- Backscattering of photon at plastic scintillator
- Enough energy left to trigger stop-signal at tube with BaF$_2$ scintillator
- Assumed effect: prompt curve
Possible backscattering scenarios

3rd scenario

- 1.27MeV-photon triggers stop-signal and loses energy
- Backscattering of photon at BaF2 scintillator
- Arrival of backscattered photon and annihilation photon in the rise time of start tube → start-signal
- Assumed effect: prompt curve
Changes in the experimental setup

- Problem: pure silicon, positron lifetime: $\tau = 210\text{ps}$ instead of $219\text{ps}$
- Experimental setup:
  - start and stop tubes face to face $180^\circ$

![Diagram of experimental setup]

- Energy window: $0.25$ to $0.6\text{MeV}$
- Energy window: $0.7$ to $1.3\text{MeV}$
Changes in the experimental setup

- Problem: pure silicon, positron lifetime: $\tau = 210\text{ps}$ instead of $219\text{ps}$
Changes in the experimental setup

- Problem: pure silicon, positron lifetime: $\tau = 210\text{ps}$ instead of $219\text{ps}$
Changes in the experimental setup

- First idea: Pb–shield with hole in middle in front of stop tube with BaF$_2$ scintillator
- Experimental setup:

  Pb–shield to reduce backscattering angle for 1.27MeV–photons from BaF$_2$ scintillator

![Diagram](attachment:image.png)

Energy window:
- 0.25 to 0.6MeV
- 0.7 to 1.3MeV
Changes in the experimental setup

- First idea: Pb−shield with hole in middle in front of stop tube:

\[ \tau = 203 \text{ps} \]
Changes in the experimental setup

- First idea: Pb–shield with hole in middle in front of stop tube:
Changes in the experimental setup

- Second idea: start and stop tubes offcentered + Pb–shield with hole in middle in front of stop tube with BaF₂ scintillator

- Experimental setup:

  Pb–shield in front of stop tube and both tubes offcentered to reduce backscattering angle for 1.27MeV–photons from BaF₂ scintillator

Energy window:
- 0.25 to 0.6MeV
- 0.7 to 1.3MeV
Changes in the experimental setup

- Second idea: start and stop tubes offcentered + Pb–shield with hole in middle in front of stop tube

\[ \tau = 220 \text{ps} \]
Changes in the experimental setup

- Second idea: start and stop tubes offcentered + Pb–shield with hole in middle in front of stop tube
Changes in the experimental setup

- Second idea: start and stop tubes offcentered + Pb–shield with hole in middle in front of stop tube: \( \tau = 220 \text{ps} \)

Complete spectrum with 3 lifetimes and 2 resolution functions

Offcenter geometry \( \rightarrow \) countrate drop of \( \sim 40\% \) (210 to 130 cts/s)
Changes in the experimental setup

- Standard PALS–setup with two plastic scintillators → no problems with the lifetime for silicon \( \tau = 220 \text{ ps} \)

- Experimental setup:

```
    stop tube
     ↓
  plastics
     ↑
    PM

  0.511\text{MeV} \gamma
```

```
    start tube
     ↓
  plastics
     ↑
    PM

  1.27\text{MeV} \gamma
```

Energy window:
0.25 to 0.6\text{MeV}

Energy window:
0.7 to 1.3\text{MeV}

- But much lower countrate of \( \sim 70 \text{ cts/s} \)
Thank you for your attention