Real-Time Detection of a Pure-Beta Emitter (P-32) utilizing the Nano-Fiber Optic Detector

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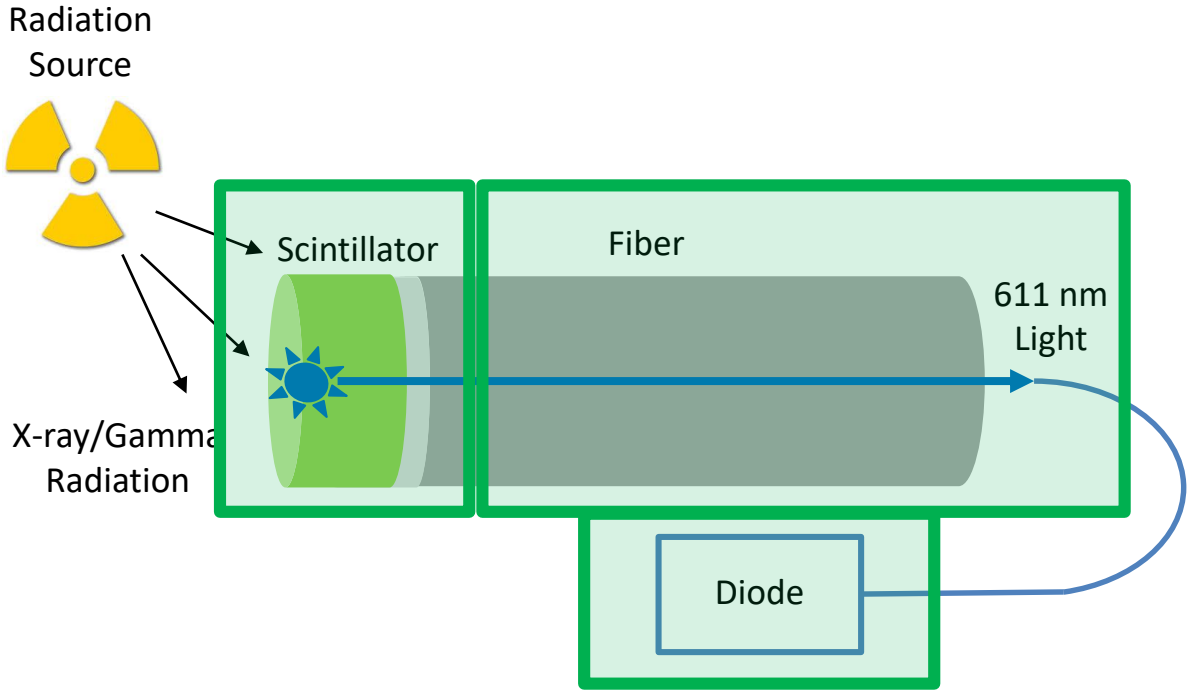
Background

- Real-time detection of beta particles is difficult because of the relatively short range in tissues and solid materials
- Limiting factors of conventional detectors is due to the size and the thickness of their entrance windows
- Liquid scintillation is commonly used but lacks real-time readout

Introduction: Nano-Fiber Optic Detector



Nano-FOD Major components

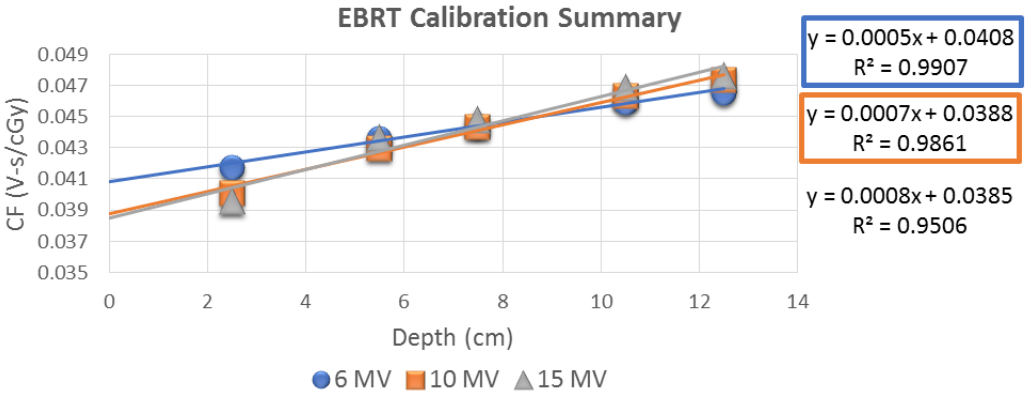
Scintillator is a pressed pellet consisting of inorganic scintillator material, [Y1.9O3; Eu0.1, Li0.16]. The light output is proportional to exposure

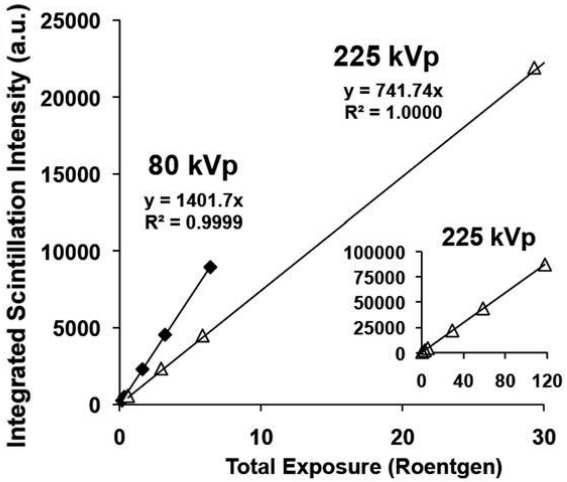
Fiber is a silica core optical fiber capable of transmitting emitted light to diode

Diode is a photodiode that converts light output to voltage

Introduction: Nano-FOD

- Findings thus far have demonstrated a linear response to x-rays ranging from diagnostic imaging (80 kVp) and radiation therapy (15 MV) energy levels
  - No evidence of scintillation intensity saturation at the highest energies tested to date

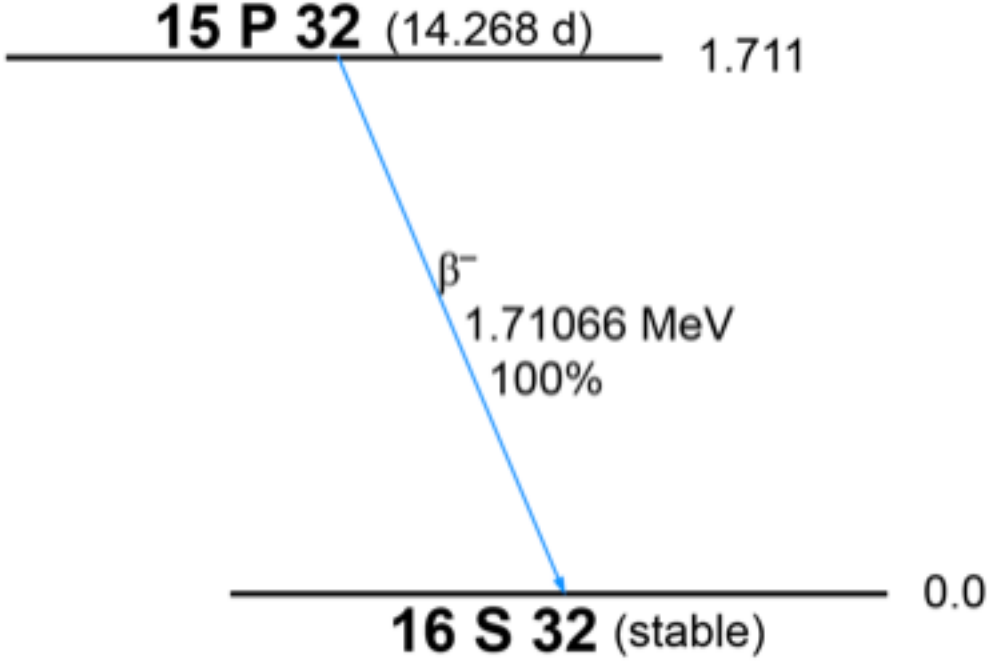




Introduction: Goal

- Applications of the nano-FOD to β detection have not previously been explored
- Determine if the nano-fiber optic detector is capable of detecting pure β emissions by placing it in contact with P-32 in liquid solution
  - Verify the net signal over time decays with the published half-life of P-32 (14.29 days)
  - Determine a calibration factor between the output of the device (millivolts) to dose rate (cGy/s)

Materials and Methods: P-32

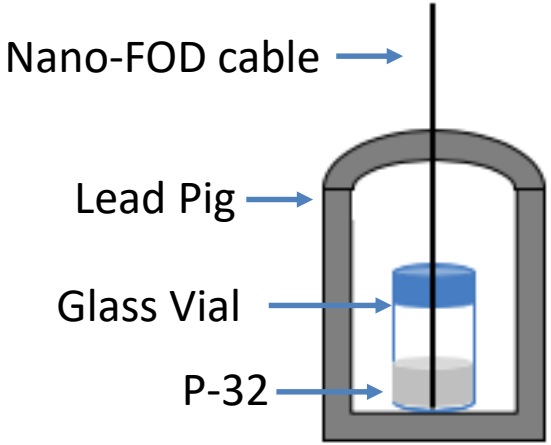


Materials and Methods: P-32

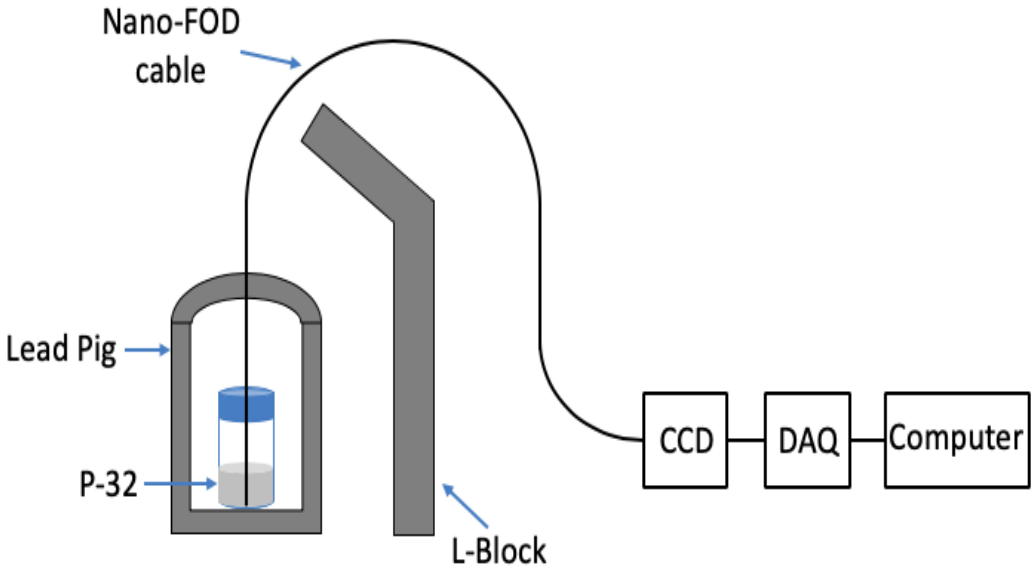
- Initial Activity Measurement
  - Activity 38.1 mCi/cc
  - 2 cc was used = 76.2 mCi
- Length of data collection was 55 days
- The time and date at the beginning of data acquisition was recorded for each set
- First Measurement
  - Activity: 38.09 mCi/cc
- Final Measurement
  - Activity: 4.24 mCi/cc

Materials and Methods: P-32 Setup

- To allow the nano-FOD tip to come in direct contact with the P-32, a 1 mm diameter hole was drilled through the tops of both the glass vial and lead pig

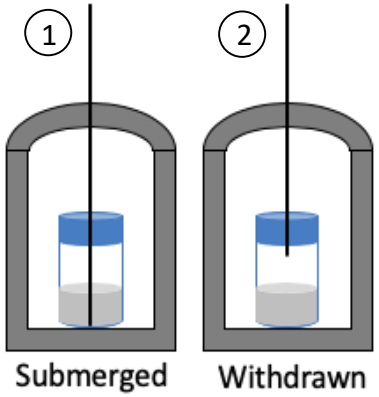


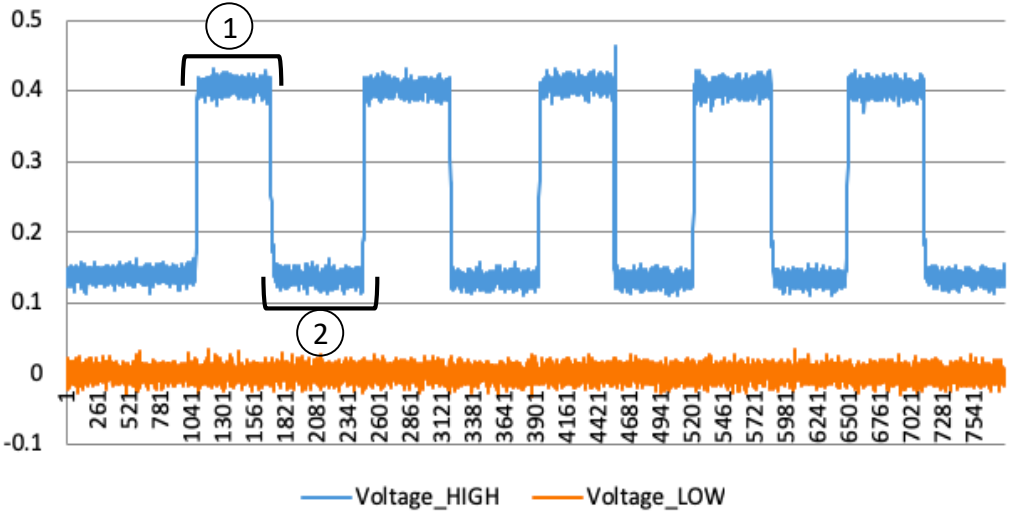
Materials and Methods: Setup



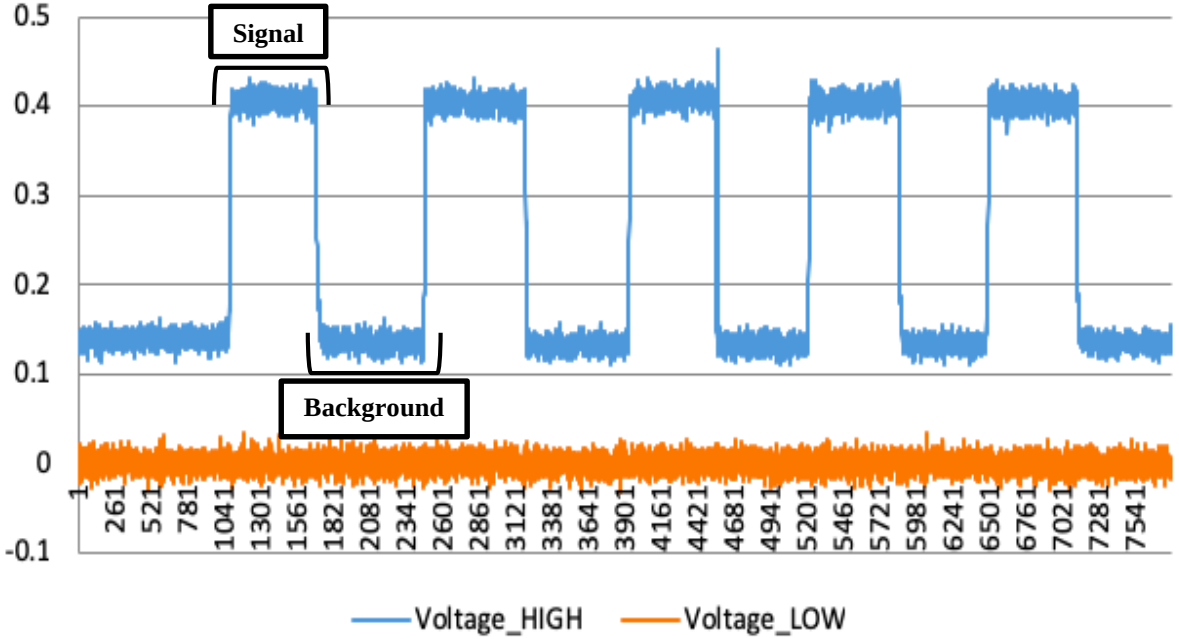
Materials and Methods: Measurement

- Process repeated to collect a set of 5 measurements





Materials and Methods: Variable Definitions



$$Net\ Signal = Signal - Background$$

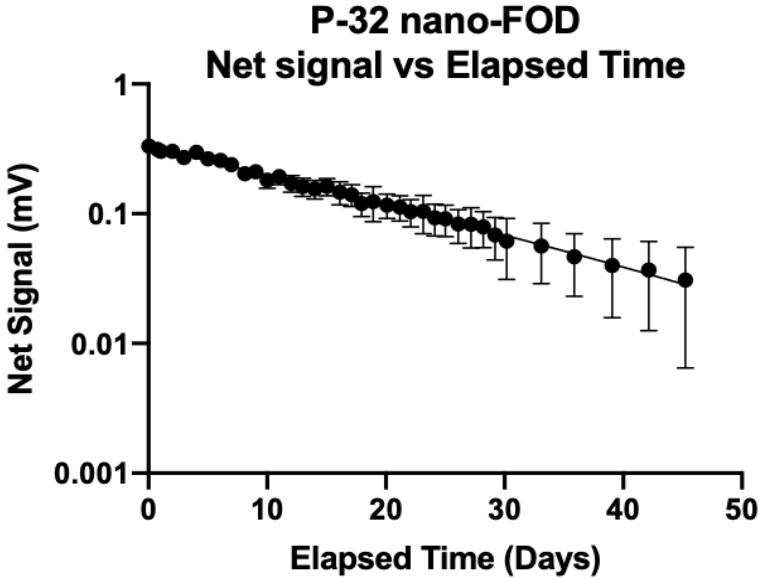
Materials and Methods: Calculations

P-32 half-life: 14.29 days

Experimental Half life:

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda_E}$$

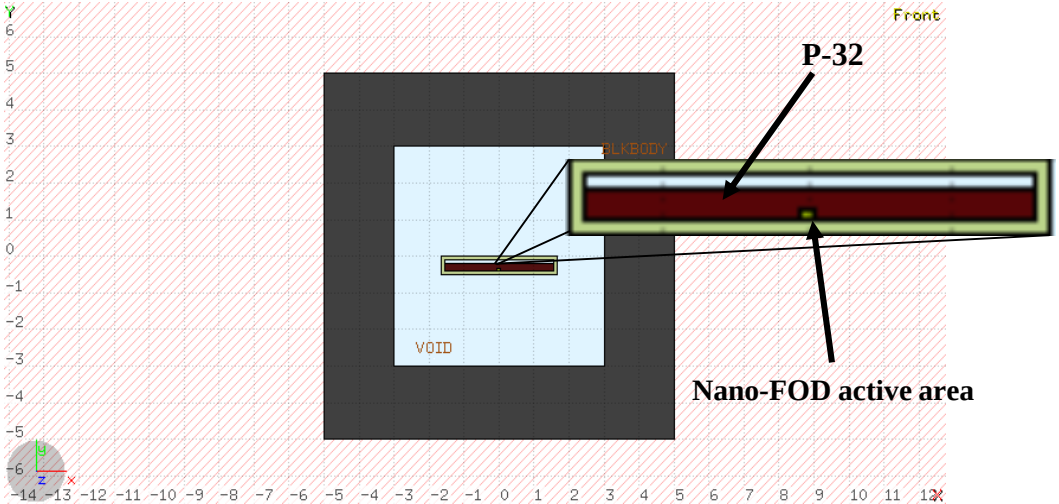
Results: Net Signal Decay



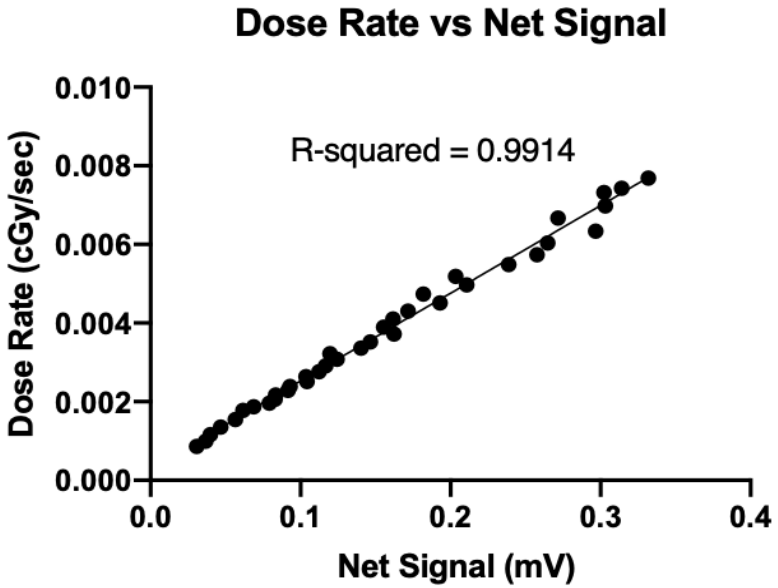
Non-linear exponential fit	$T_{1/2}$ (days)	Goodness of fit
One-phase model	13.46 ± 0.87	0.995

Monte Carlo

- Fluctuating Kascade (FLUKA) is a monte carlo program allowing for calculations of particle transport and interactions with matter
- Simulation based on experimental set up
  - Glass vial containing P-32 (36.1 mCi/cc) with a micron sized scintillator submerged in the liquid



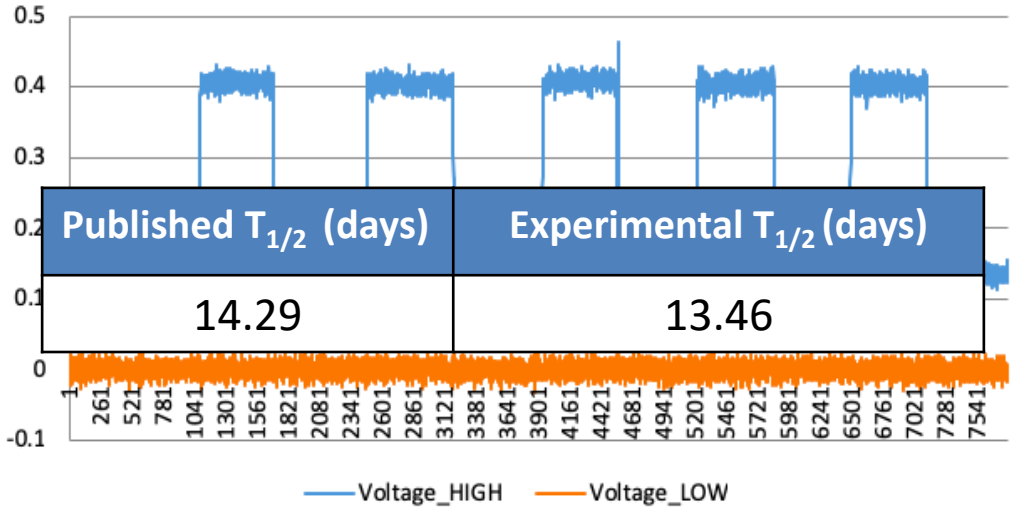
Results: Dose Rate



Equation	CF	Goodness of fit
y = **0.0223x** + 0.0003	0.0223	0.9914

Conclusions

- Nano-FOD is capable of detecting beta emissions from P-32
- The exp[illegible]nal is compar
- Calibra[illegible]nd Dose rate is a[illegible] ano-FOD ha[illegible] novel beta pa[illegible]



Published $T_{1/2}$ (days)	Experimental $T_{1/2}$ (days)
14.29	13.46

Questions?