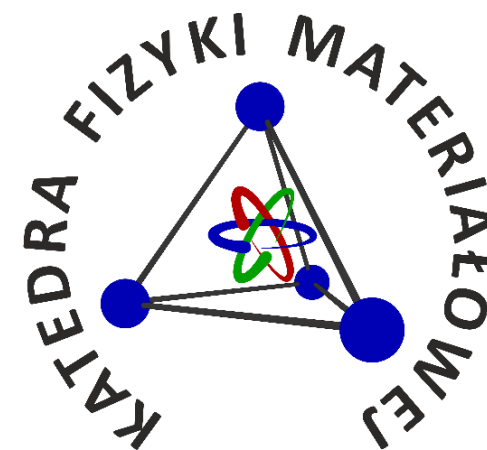
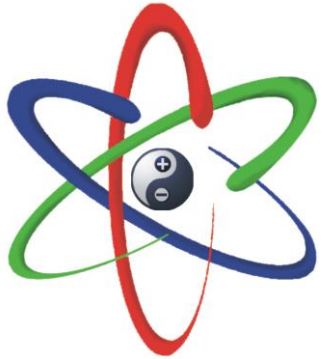


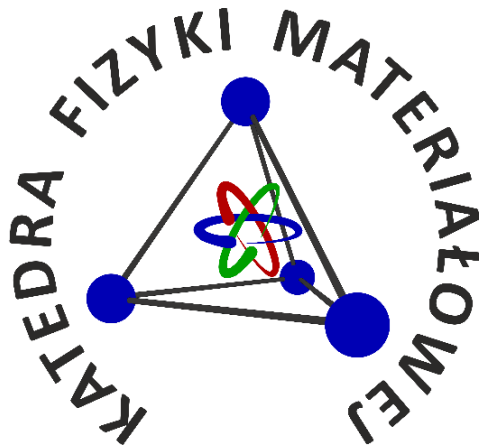
# Marek Gorgol



**UMCS**  
INSTYTUT FIZYKI



Zakład  
Metod  
Jądrowych



jednolite studia magisterskie (2005 – 2010)

praca magisterska: „Wpływ modyfikacji powierzchni na strukturę stopów żelaza, tytanu i glinu wykorzystywanych jako materiały konstrukcyjne”

Studia doktoranckie (2010 – 2016)

praca doktorska: „Badanie procesów fizykochemicznych w materiałach porowatych techniką spektroskopii czasów życia pozytonów”

Zatrudnienie w Instytucie Fizyki UMCS

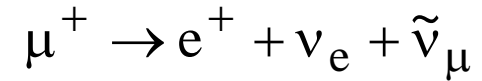
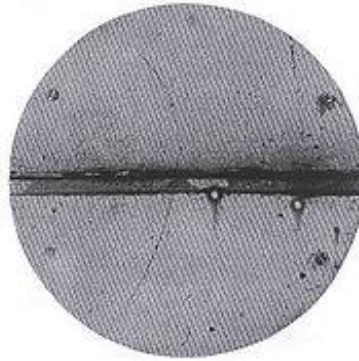
2017 – 2019      Stanowisko Asystenta

2019 –            Stanowisko Adiunkta

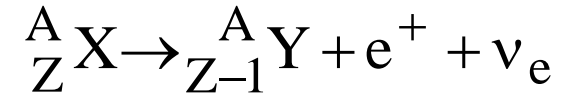
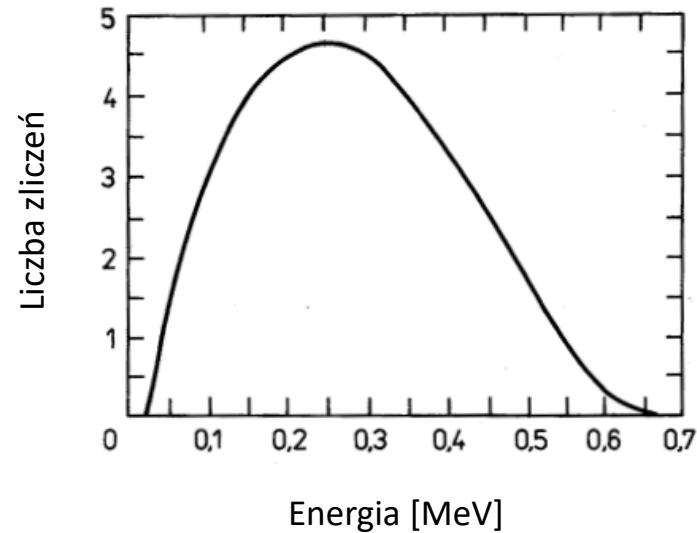
# Pozyton

## Powstawanie pozytonu

parametr	elektron	pozyton
masa [kg]	$9,109 \times 10^{-31}$	$9,109 \times 10^{-31}$
energia spoczynkowa [keV]	511	511
ładunek [C]	$-1,602 \times 10^{-19}$	$1,602 \times 10^{-19}$
liczba barionowa	0	0
liczba leptonowa	1	-1
spin	1/2	1/2
parzystość	-	+
moment magnetyczny	$\mu = \frac{1}{2} \cdot \hbar \cdot \frac{e}{m_e}$	$\mu = -\frac{1}{2} \cdot \hbar \cdot \frac{e}{m_e}$



$$E_{gr} = 2m_e c^2 \left( 1 + \frac{m_e}{M} \right)$$

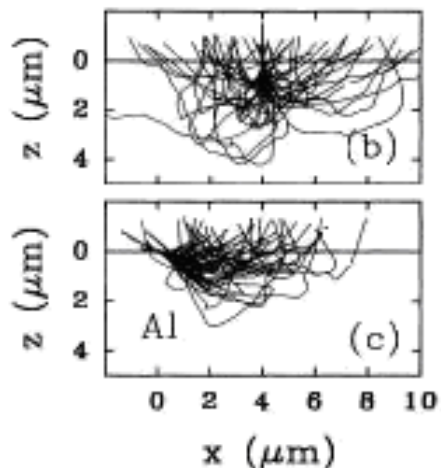
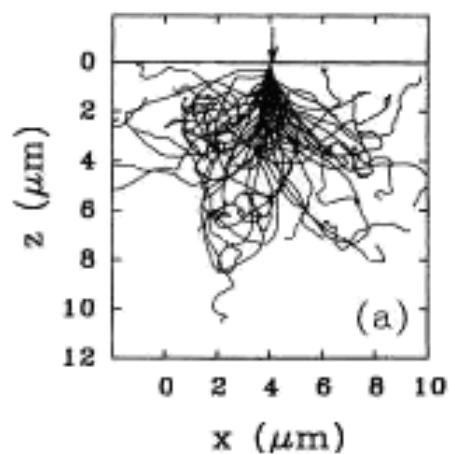


C. D. Anderson, Phys. Rev. 43, 491 (1933)

R. D. Evans, *The Atomic Nucleus*, McGraw-Hill, New York 1955, pozyskane z: E. Skrzypczak, Z. Szepliński, *Wstęp do Fizyki Jądra Atomowego i Cząstek Elementarnych* Wydawnictwo PWN, 2002

termalizacja

anihilacja



$$2m_e c^2 + E_{k_{e^+}} + E_{k_{e^-}} = \sum_i h\nu_i$$

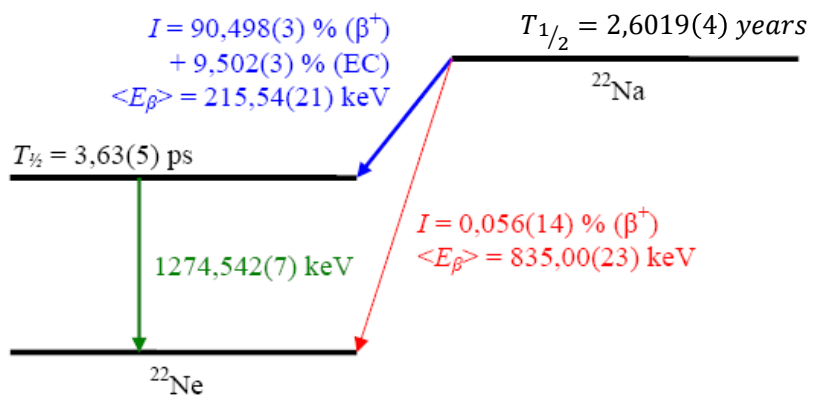
$$\sigma_{2\gamma} = \frac{\pi r_0^2}{\gamma + 1} \left( \frac{(1 + 4\gamma + \gamma^2)}{\gamma^2 - 1} \ln(\gamma + \sqrt{\gamma^2 - 1}) - \frac{3 + \gamma}{\sqrt{\gamma^2 - 1}} \right)$$

$$\sigma_{2\gamma} = \pi r_0^2 \frac{c}{v}$$

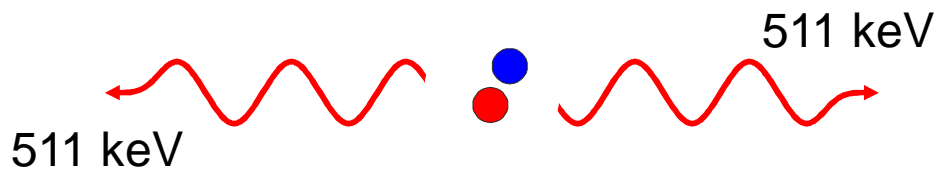
$$\lambda = \sigma_{2\gamma} v |\psi(0)|^2 = \pi r_0^2 c n_e$$

G. R. Massoumi, W. N. Lennard, P. J. Schultz, Phys. Rev. B 47, 11007 (1993).

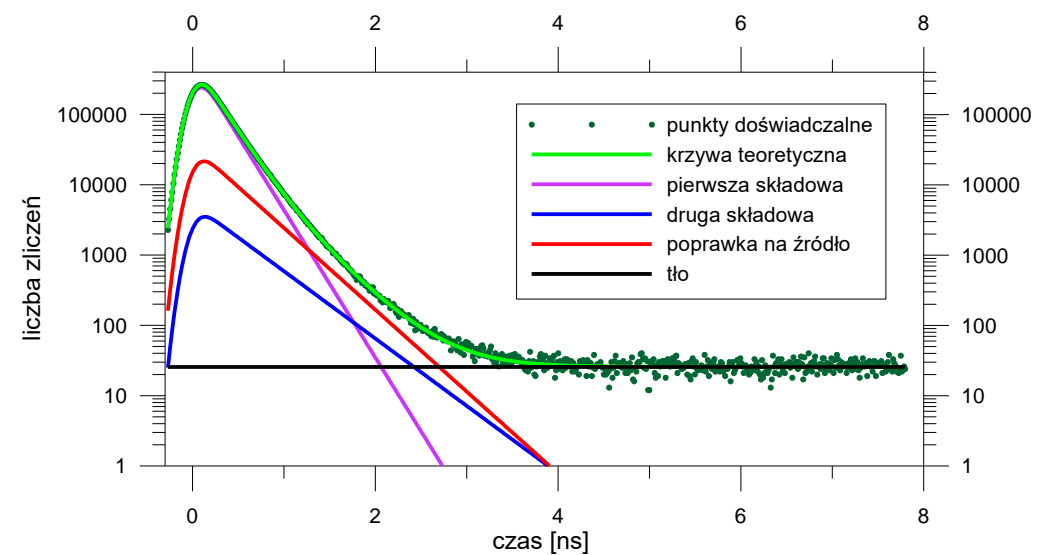
# Spektroskopia PALS



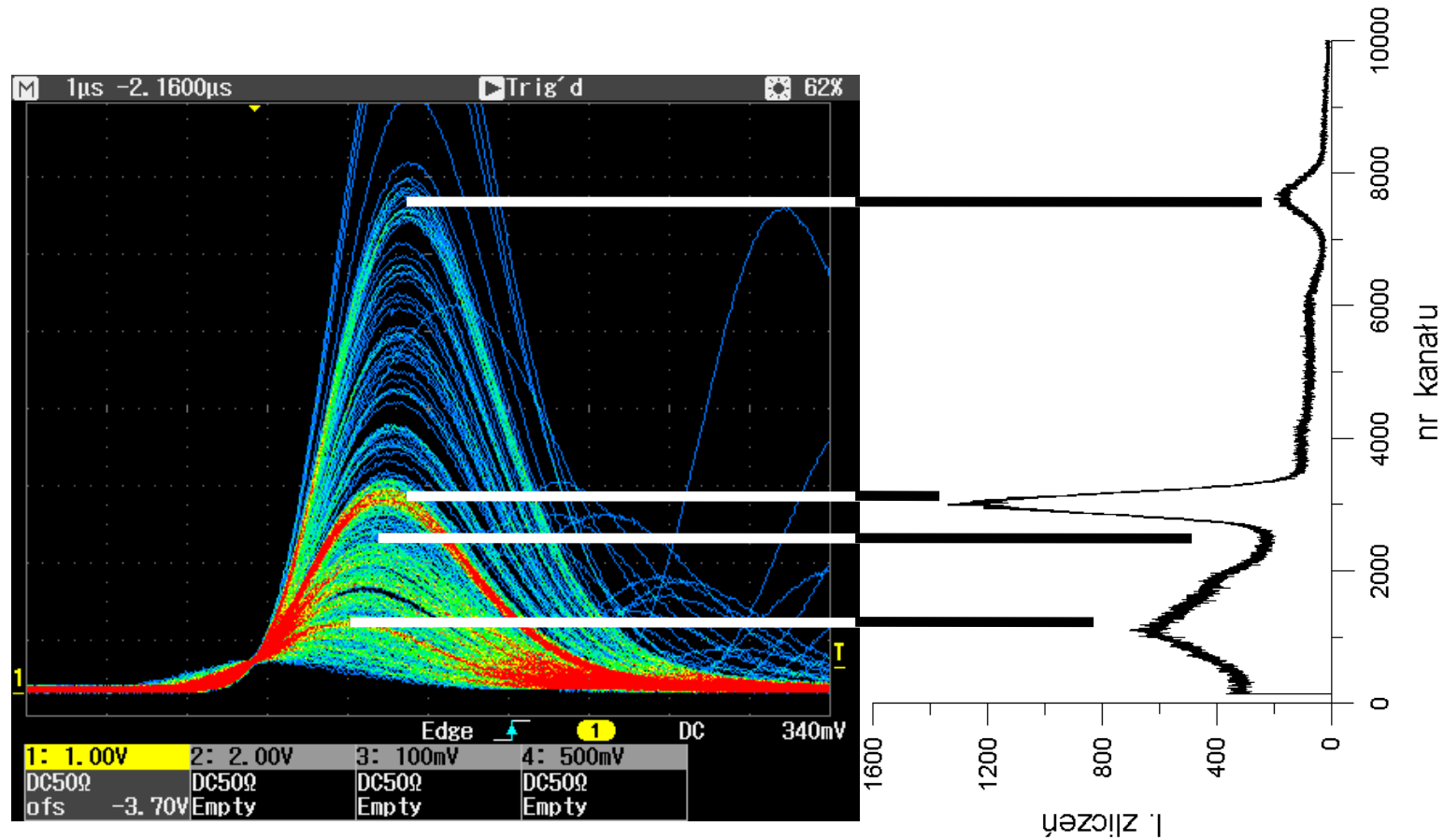
„START”



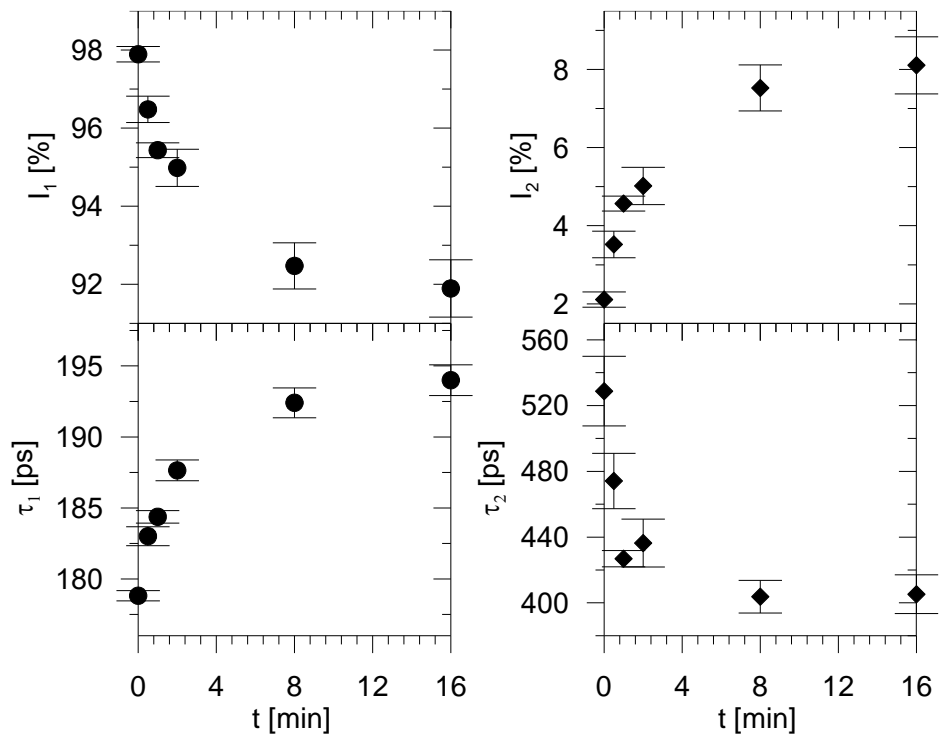
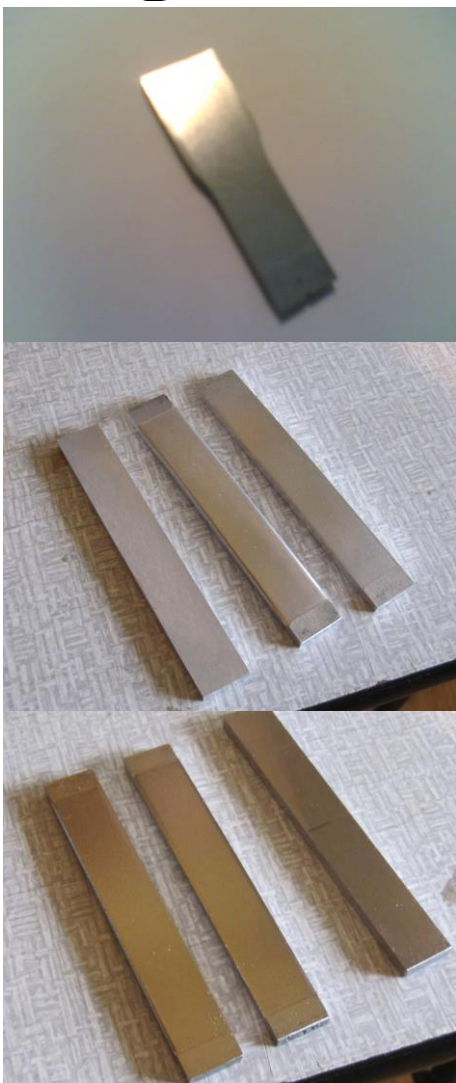
„STOP”



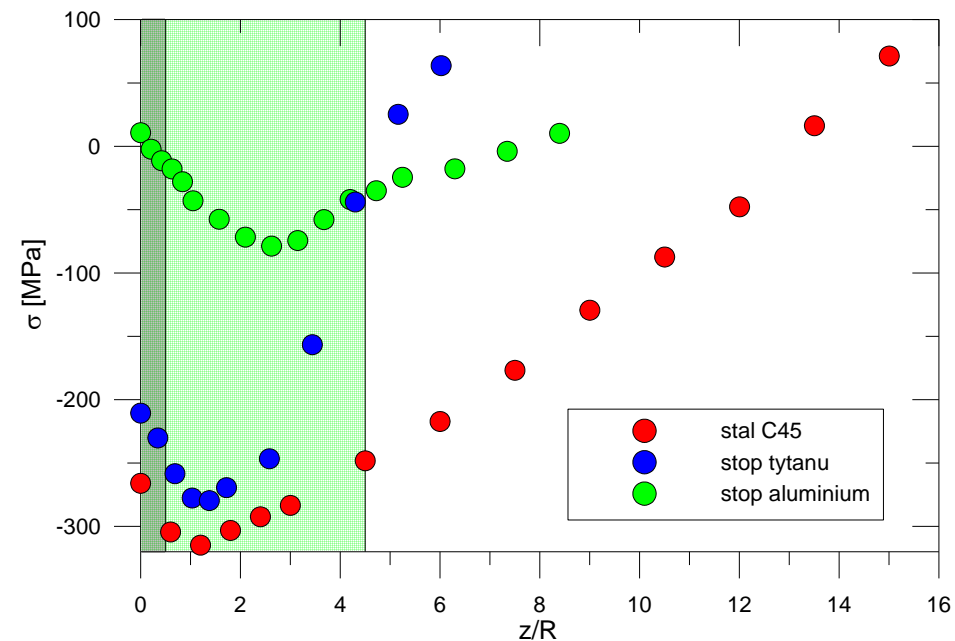
# Spektroskopia PALS



# Przykłady badań stopów metali

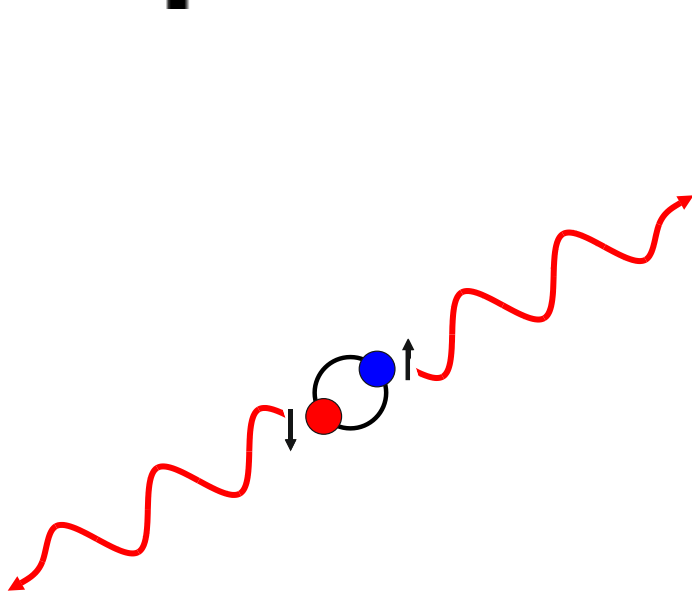


Zależność natężeń i średnich czasów życia pozytonów od czasu nagniatania dla stopu tytanu Ti6Al2Mo2Cr.



Rozkład naprężeń własnych dla stali C45 oraz stopów tytanu i aluminium w zależności od wartości parametru  $z/R$ .

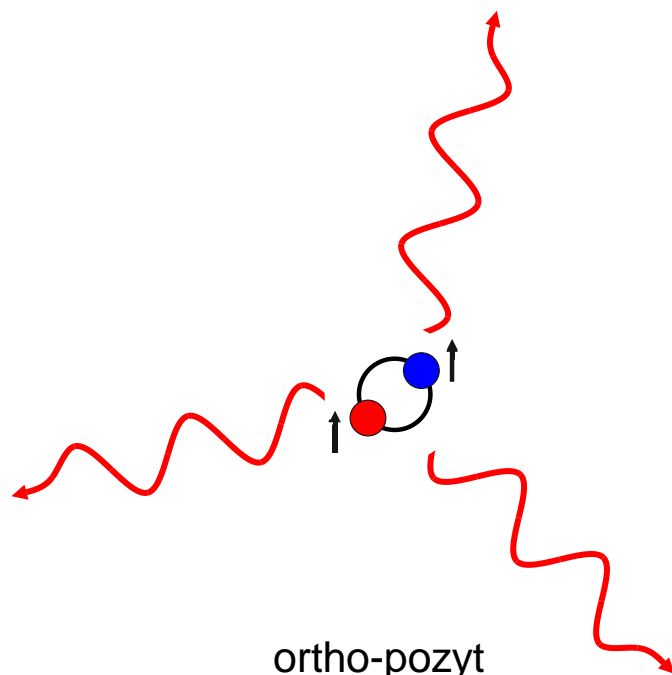
# Atom pozytu



para-pozyt  
(p-Ps)

$$I_{p\text{-Ps}} = (7,98950 \pm 0,00002) \text{ ns}^{-1}$$

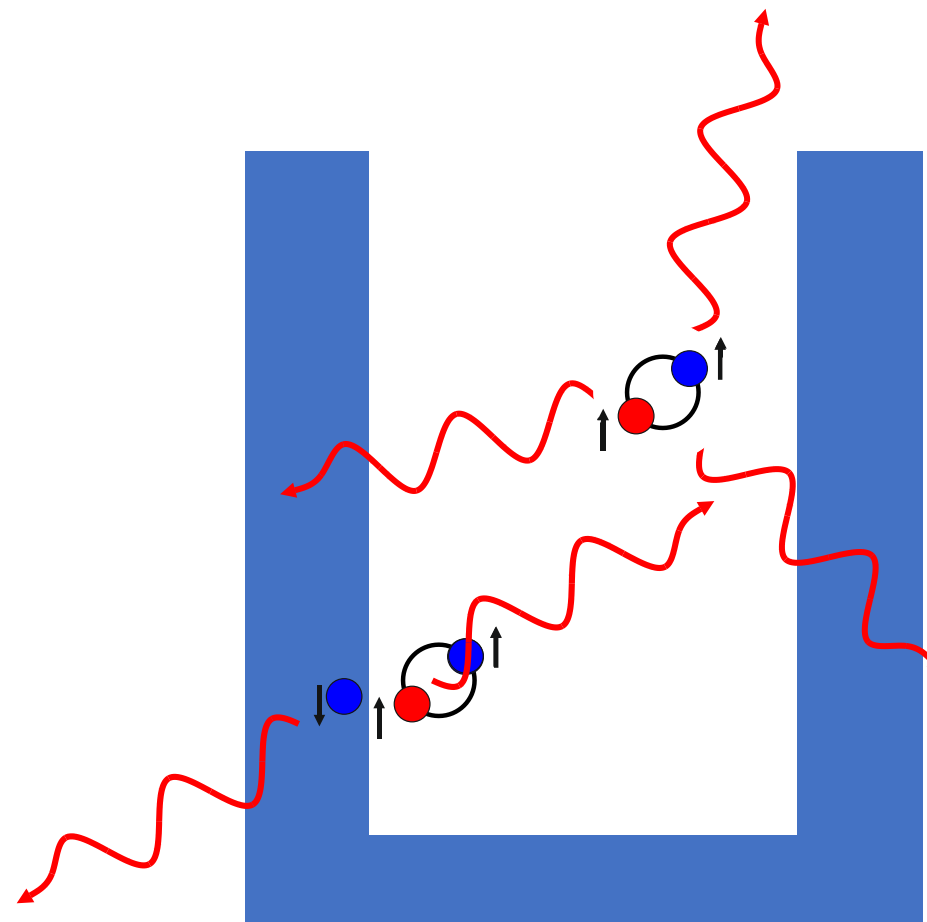
$$\tau_{p\text{-Ps (vac.)}} = 125,16 \text{ ps}$$



ortho-pozyt  
(o-Ps)

$$I_{o\text{-Ps}} = (7,03993 \pm 0,00001) \text{ ms}^{-1}$$

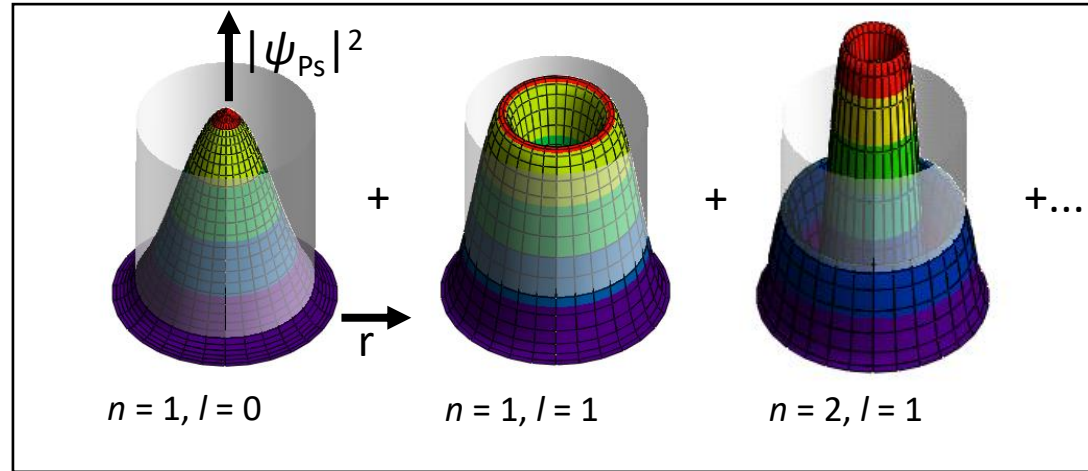
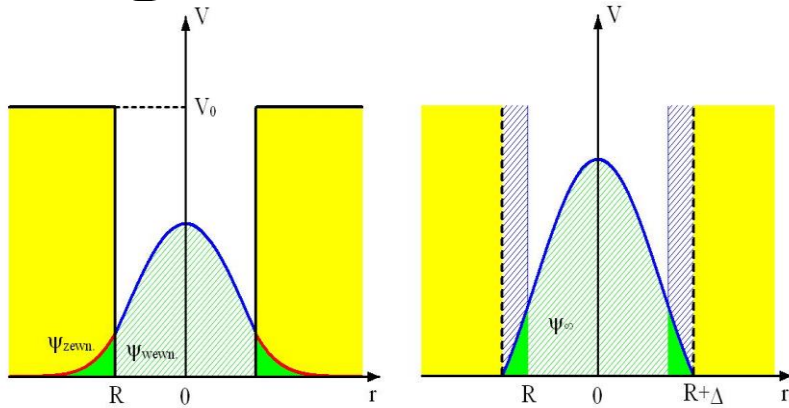
$$\tau_{o\text{-Ps (vac.)}} = 142,05 \text{ ns}$$



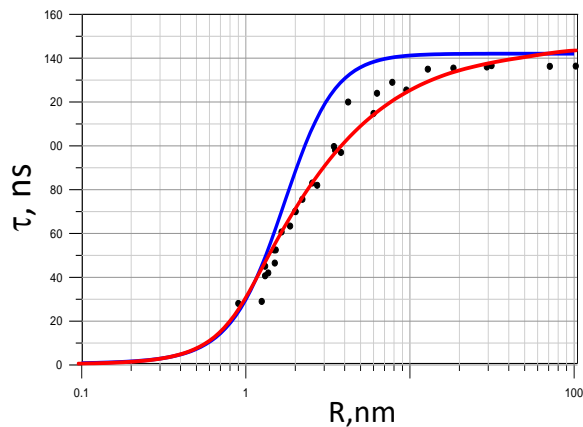
Proces „pick off”



# Czas życia o-Ps, a rozmiar wolnej objętości

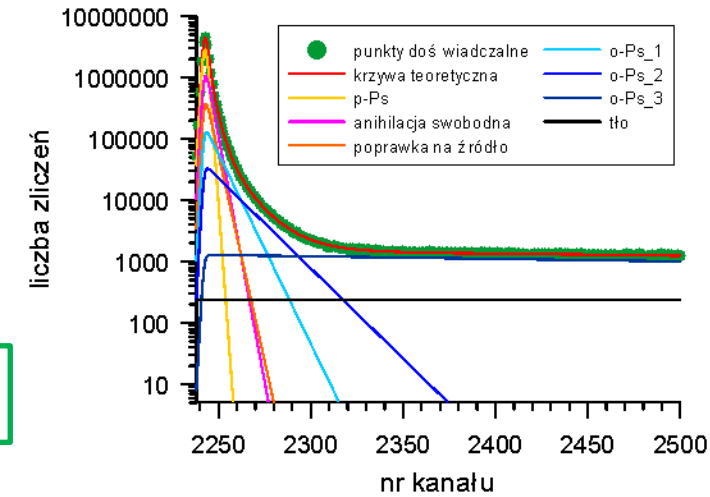
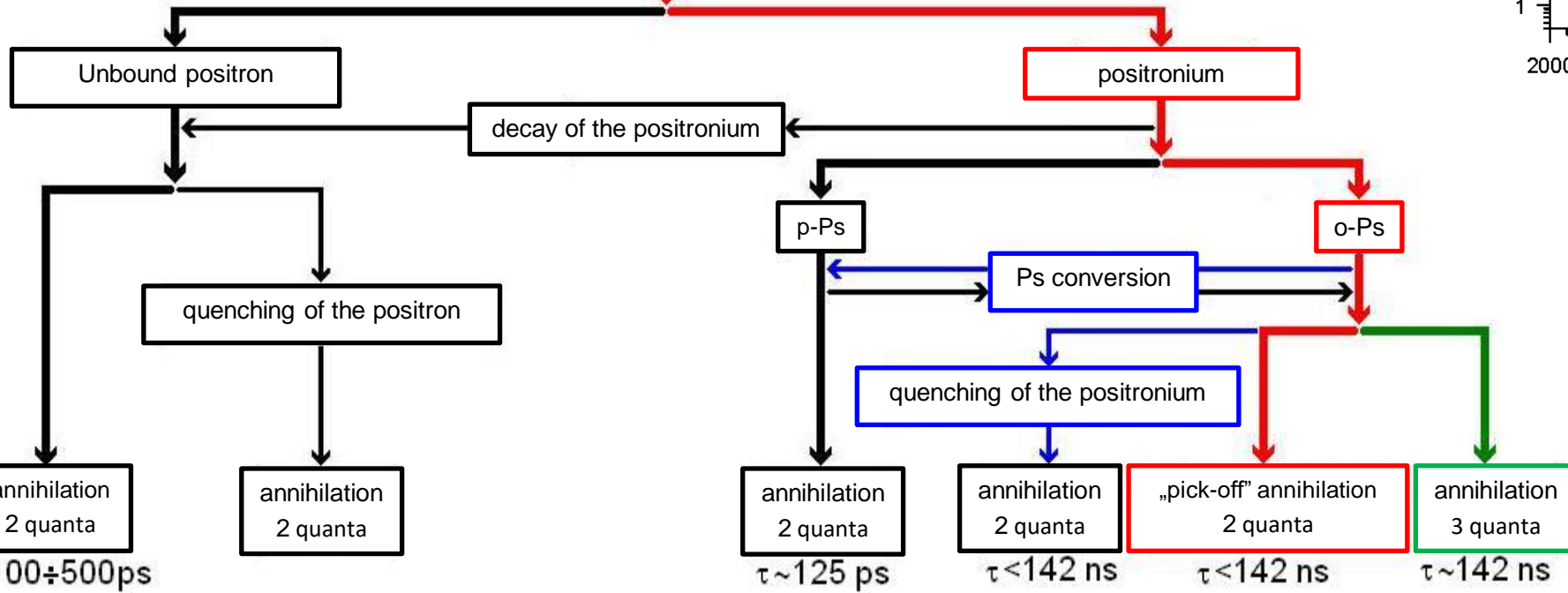
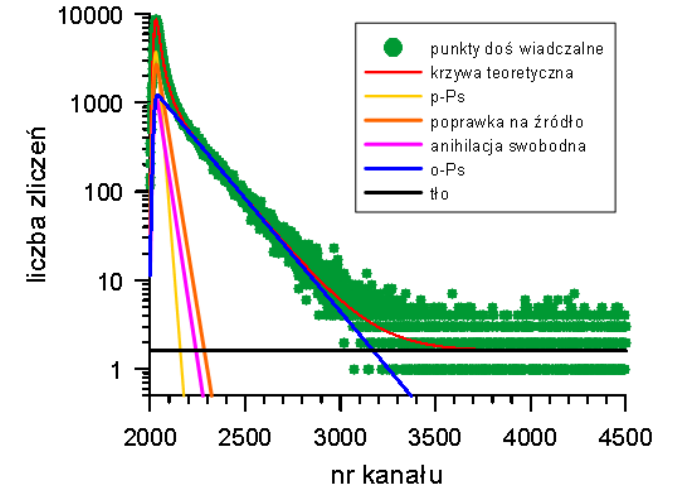
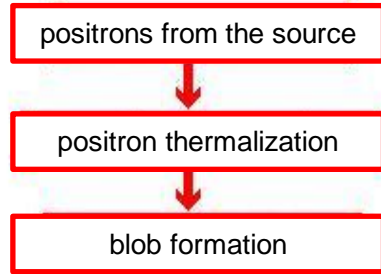


$$\tau_{o-Ps} = \frac{1}{2 \cdot \left( 1 - \frac{R}{R+\Delta} + \frac{1}{2\pi} \sin\left(\frac{2\pi R}{R+\Delta}\right) \right)} \text{ ns}$$

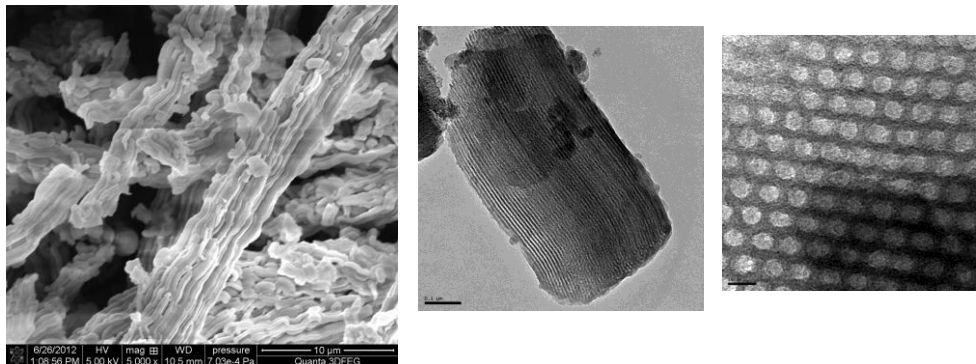


$$\tau_{o-Ps_{3D}} = \left( \frac{\sum_{n=1}^{n_{\max}(X_{nl})} \sum_{l=0}^{l_{\max}(X_{nl})} (2l+1) \lambda_{nl} \exp\left(\frac{-h^2 X_{nl}^2}{16\pi^2 m_e (R+\Delta)^2 kT}\right)}{\sum_{n=1}^{n_{\max}(X_{nl})} \sum_{l=0}^{l_{\max}(X_{nl})} (2l+1) \exp\left(\frac{-h^2 X_{nl}^2}{16\pi^2 m_e (R+\Delta)^2 kT}\right)} \right)^{-1}$$

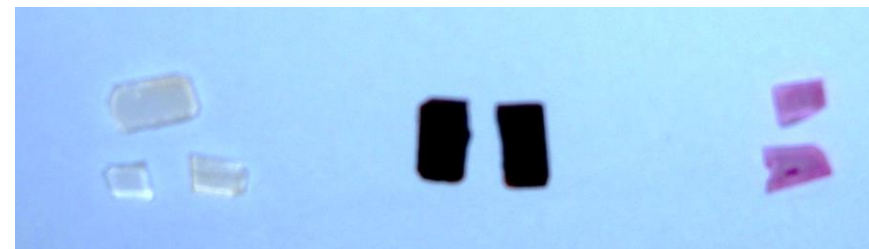
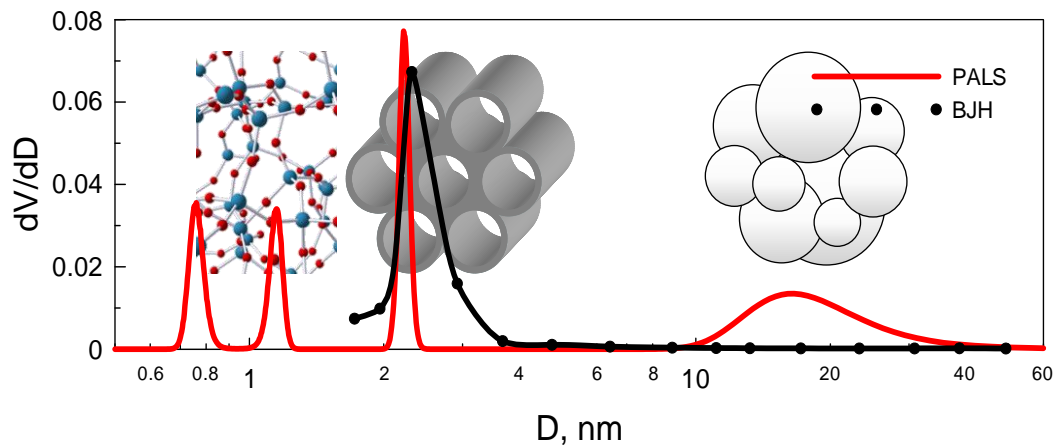
# Stopień komplikacji



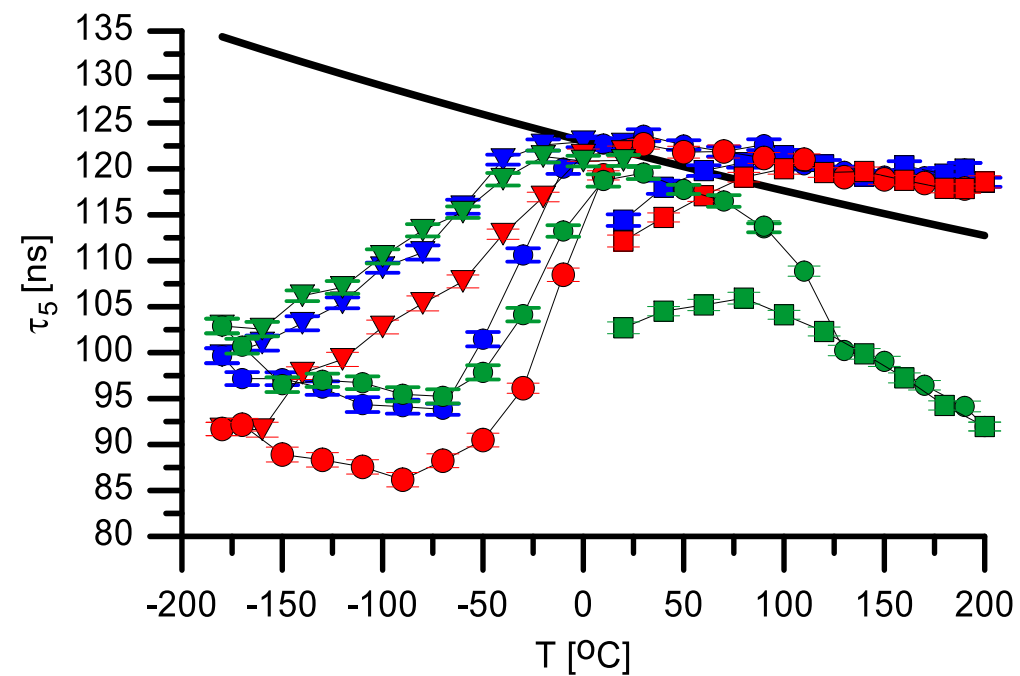
# Przykładowe badania porozymetryczne



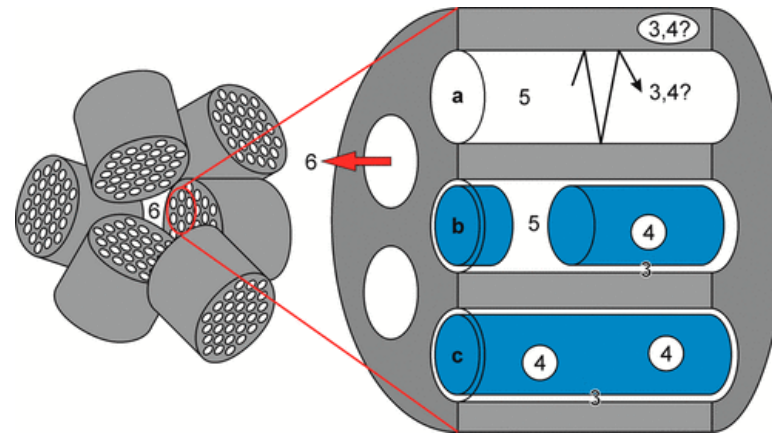
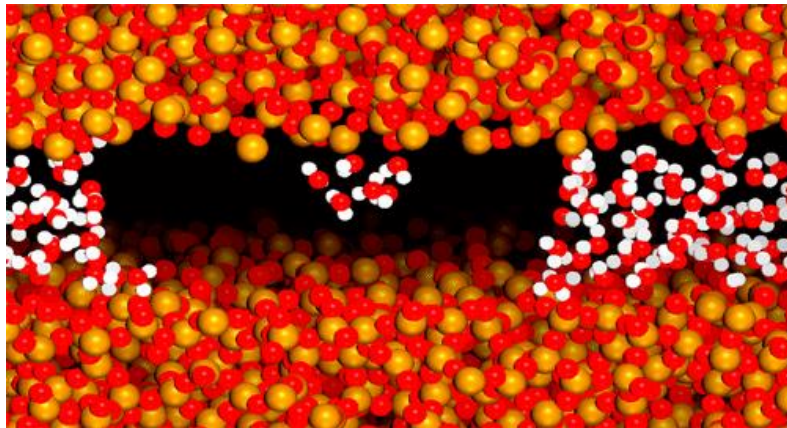
Krzemionka uporządkowana



Szklą porowate typu Vycor

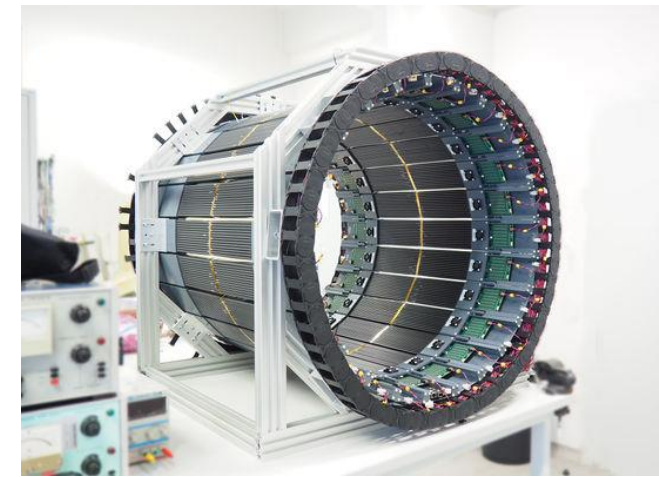
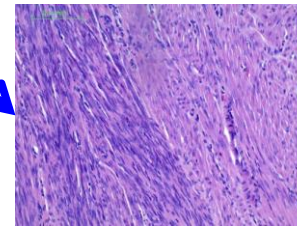
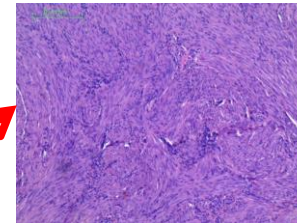
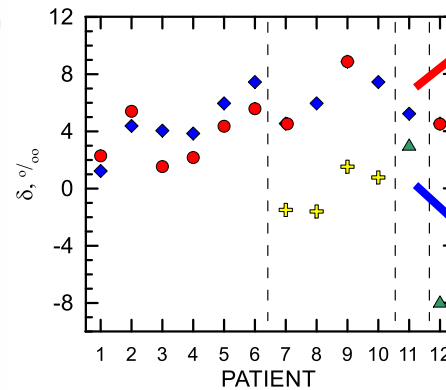
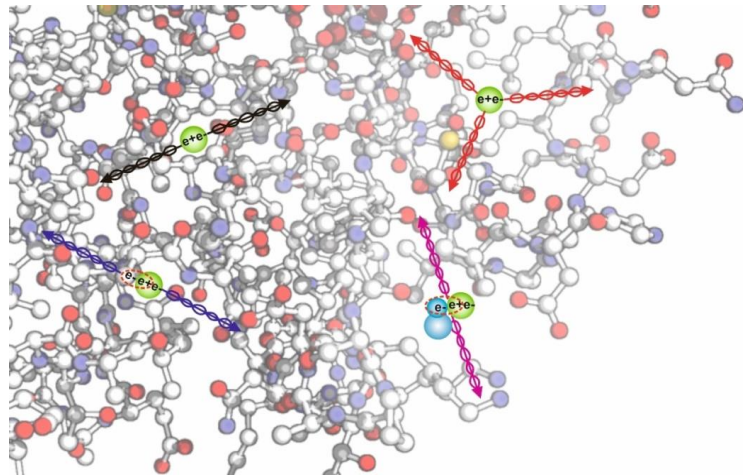


- Positron porosimetry (open/closed 0.2 ÷ 50 nm)
- Nano-confined substances (in situ ads/des etc.)

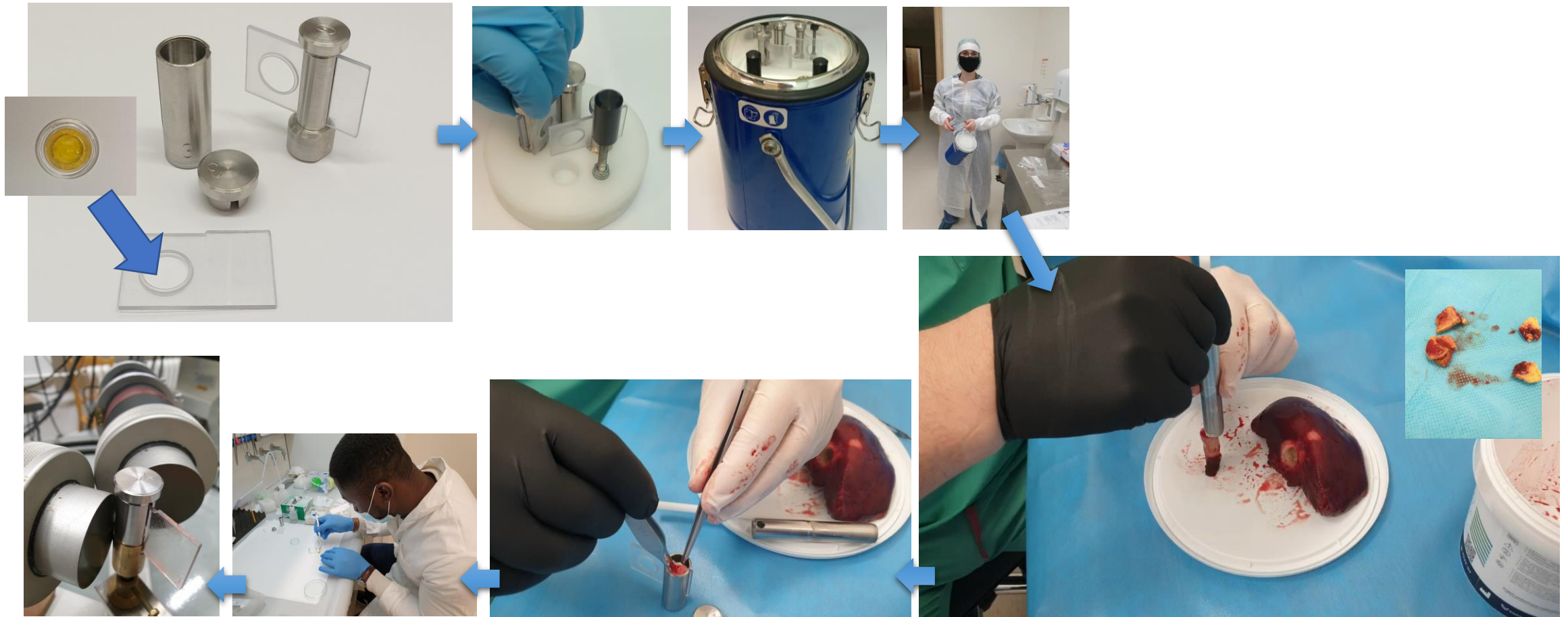


- Controlled drug delivery systems
- Modification of surface of construction alloys (nondestructive)

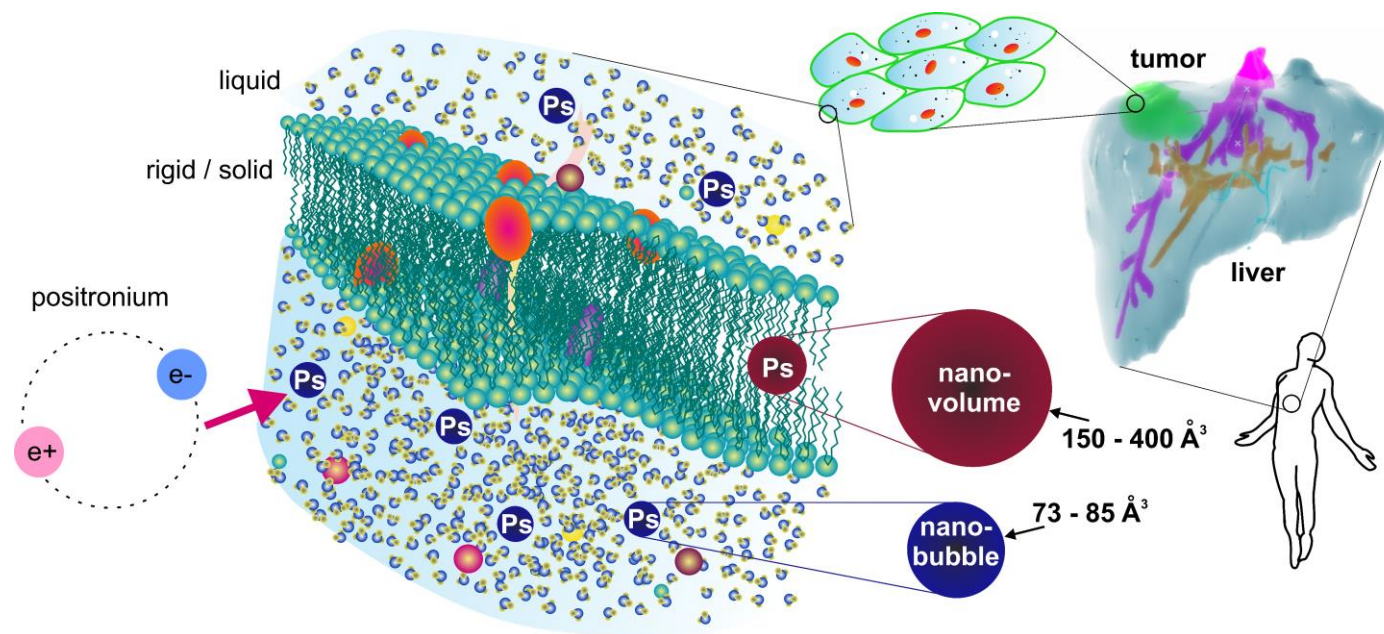
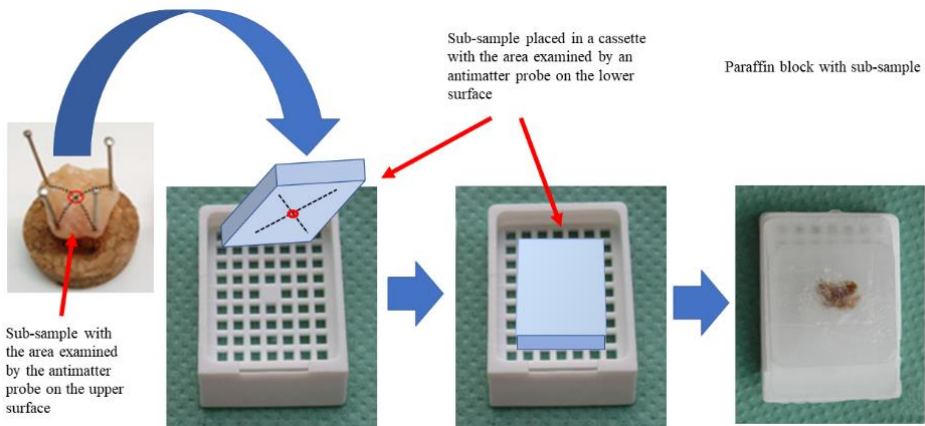
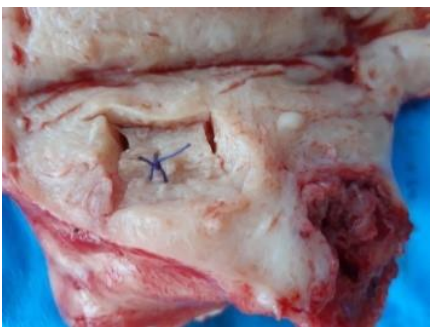
- **Biological material (human tissues)**
- **Pathogenic processes**
- **New body imaging method in PET based on positronium ( $e^+ - e^-$ )**



# Pomiary biologiczne

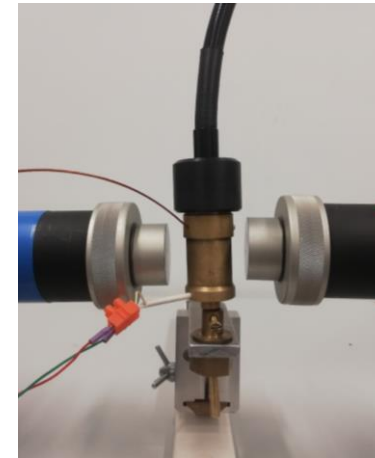
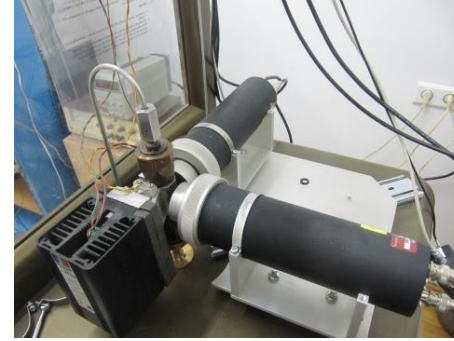
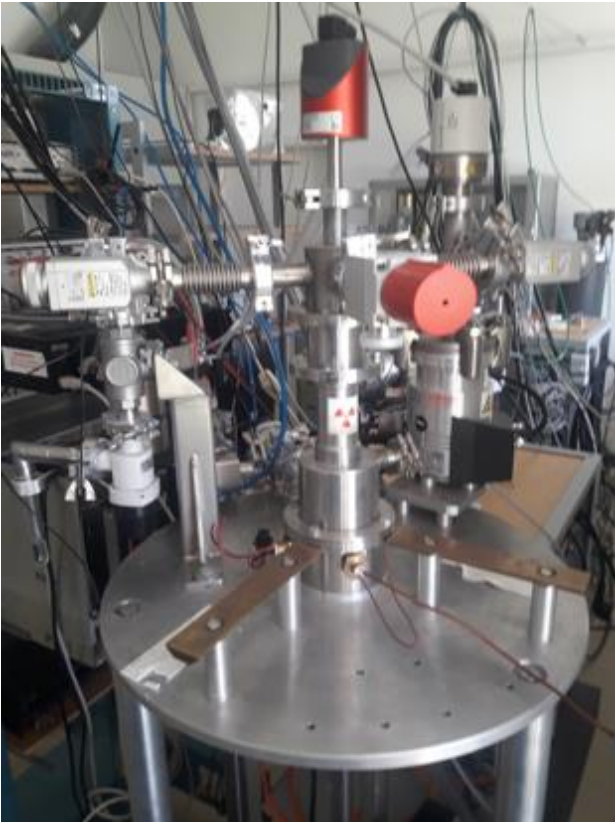


# Pomiary biologiczne



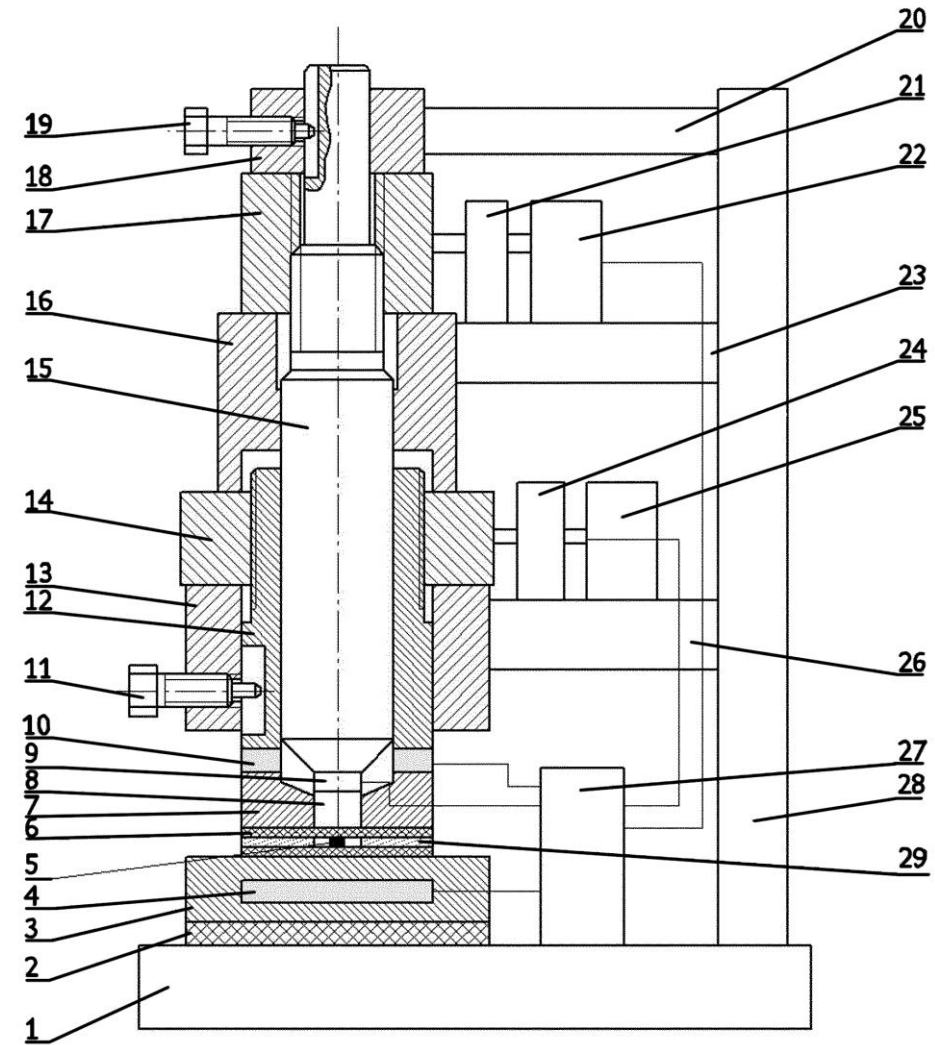
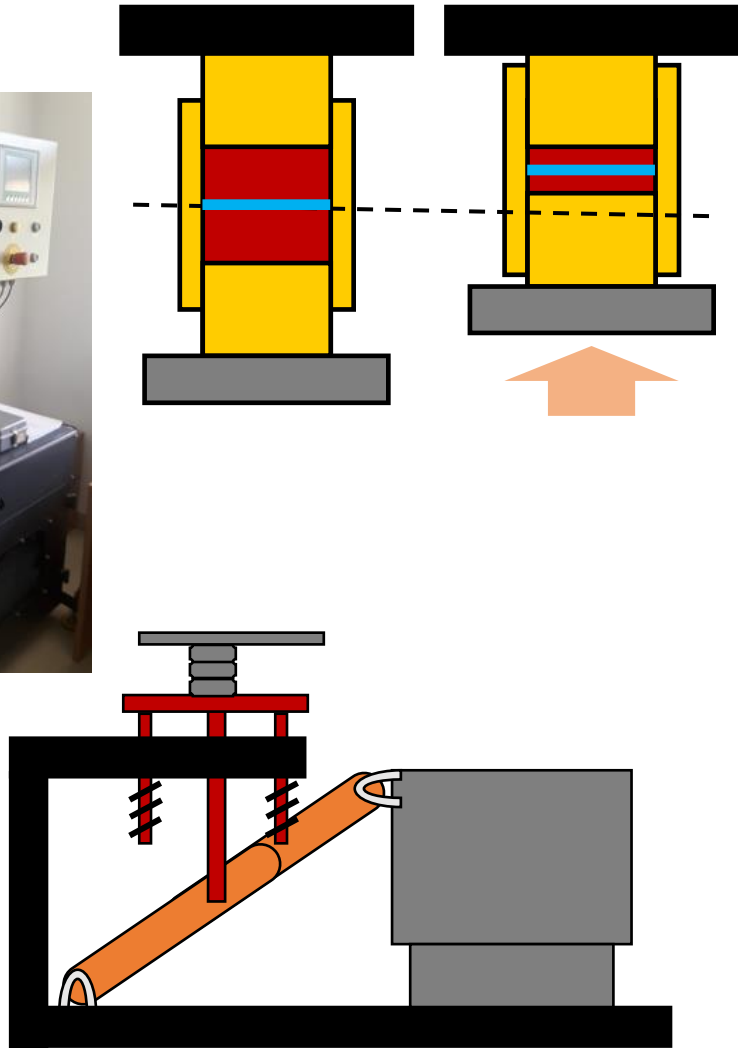
Zgardzińska, B., Chotubek, G., Jarosz, B. *et al. Sci Rep* **10**, 11890 (2020). <https://doi.org/10.1038/s41598-020-68727-3>

# Główne zainteresowania

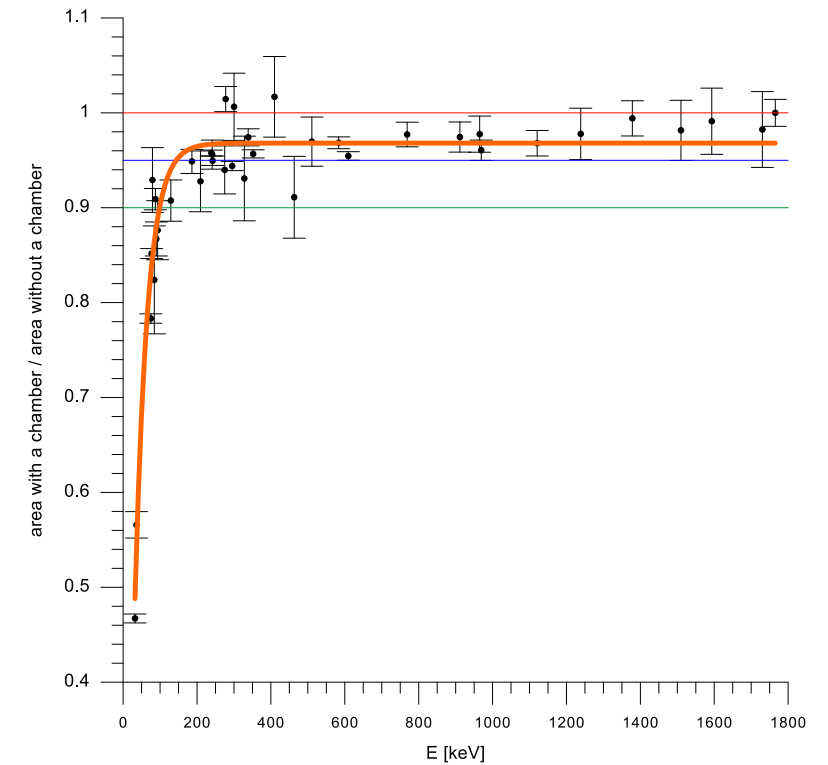
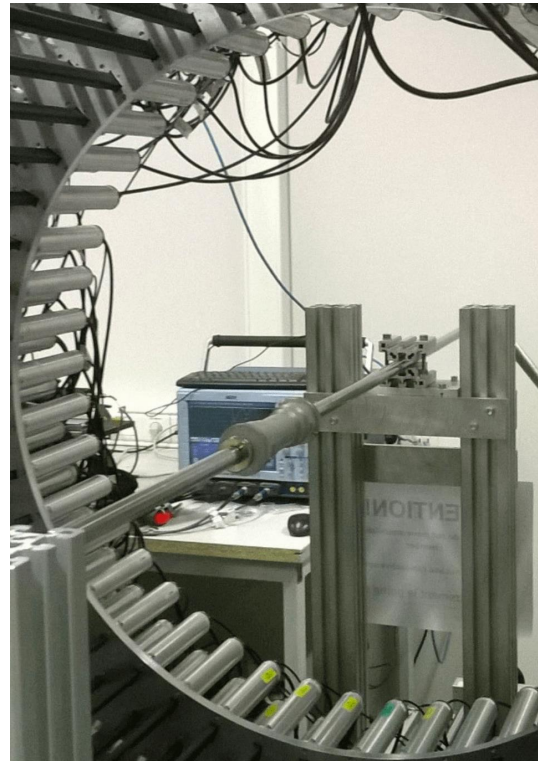
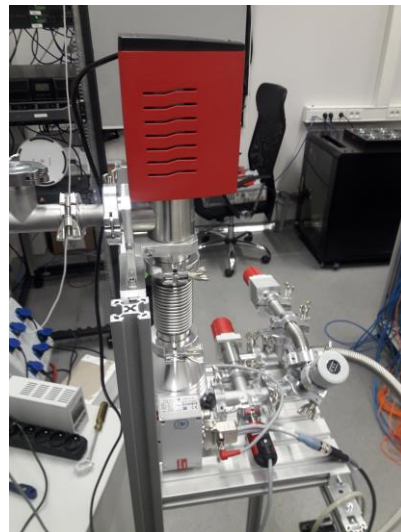
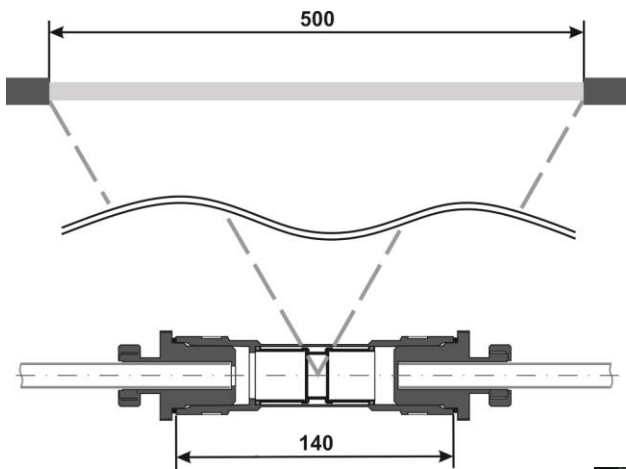


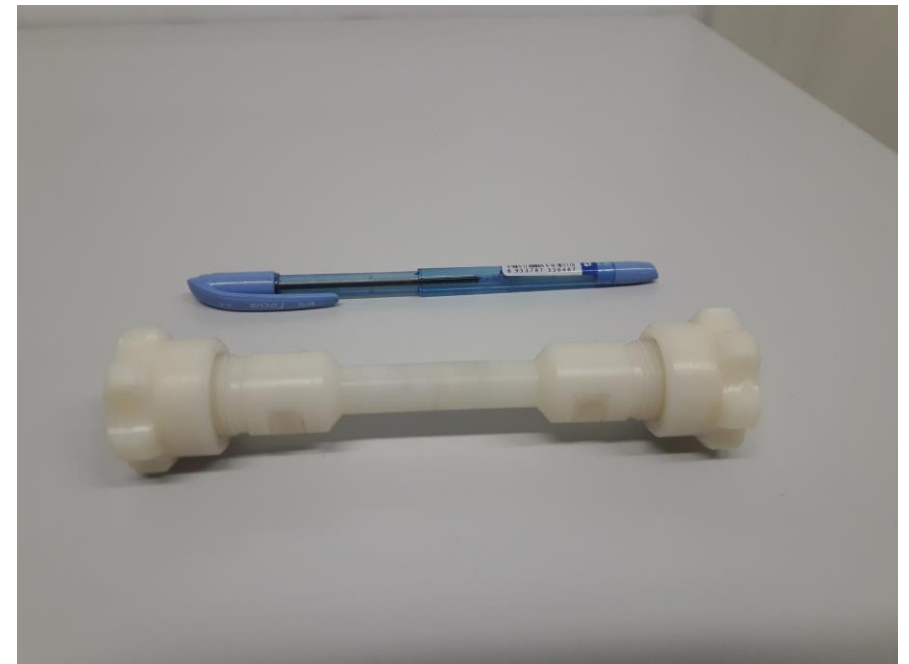
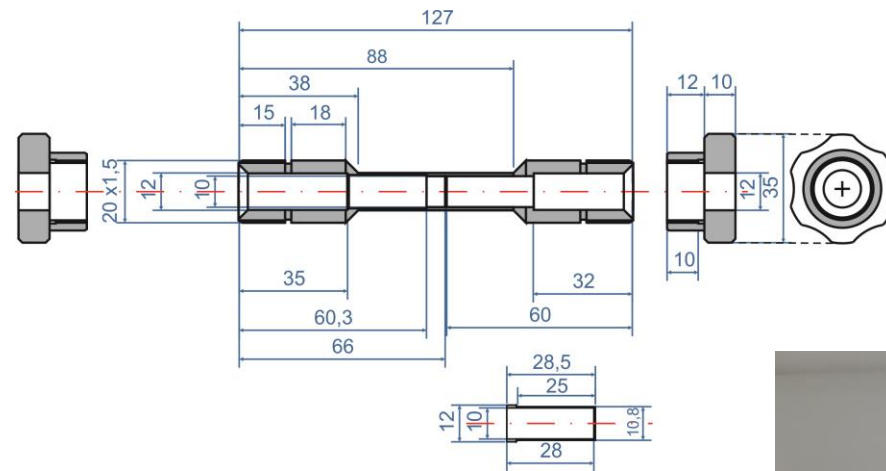
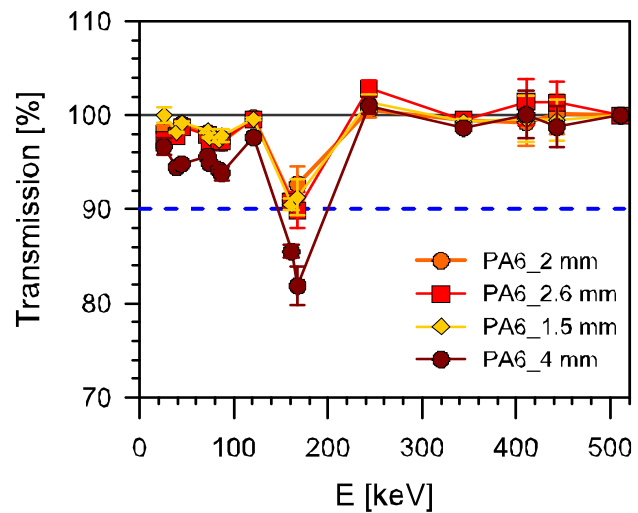
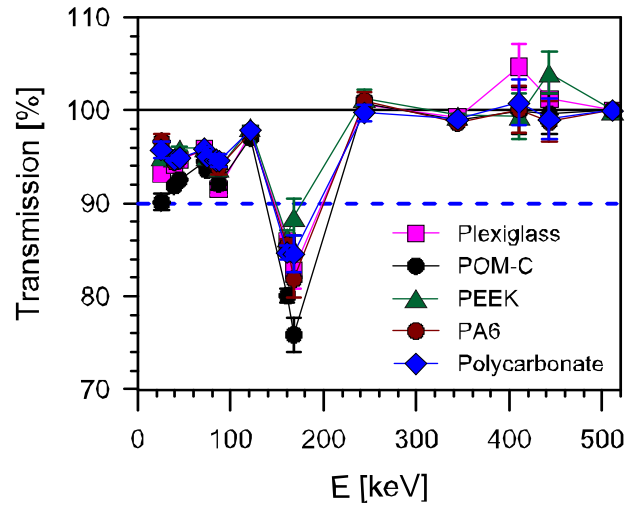


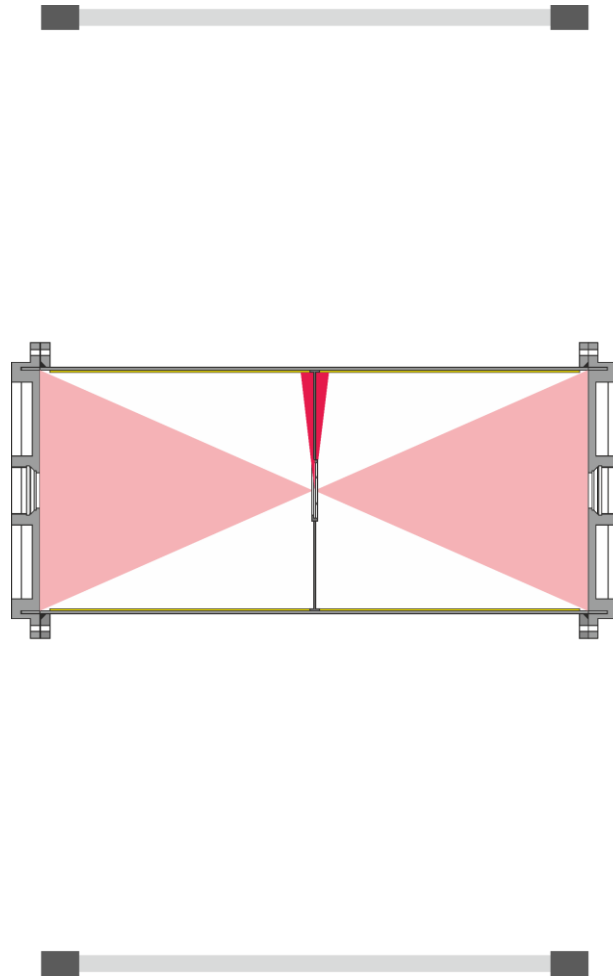
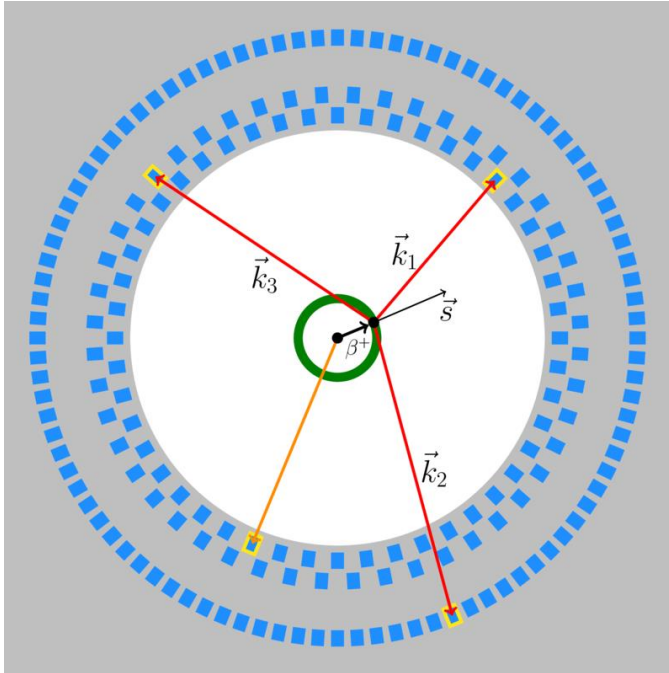
# Przykładowe problemy do rozwiązania



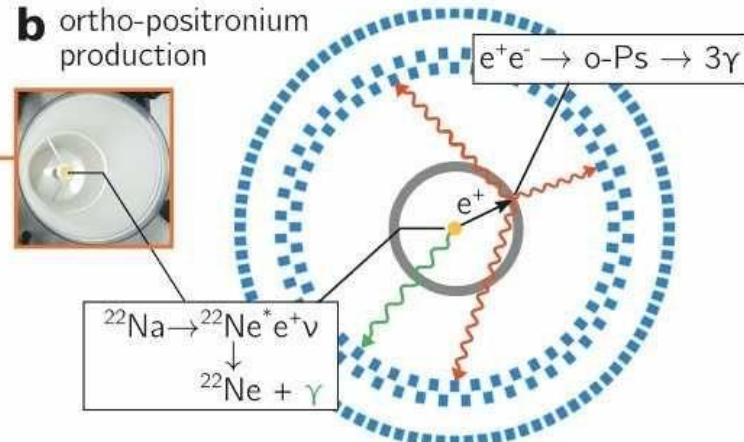
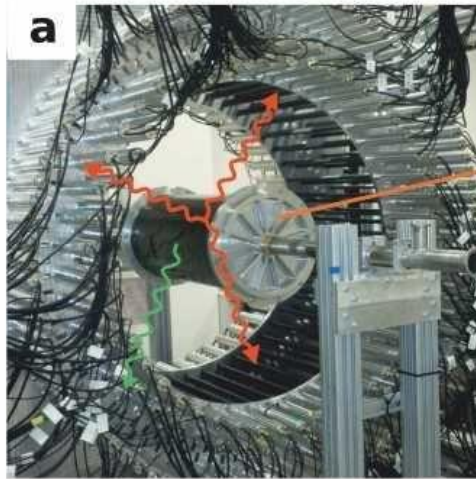
# Współpraca z grupą J-PET



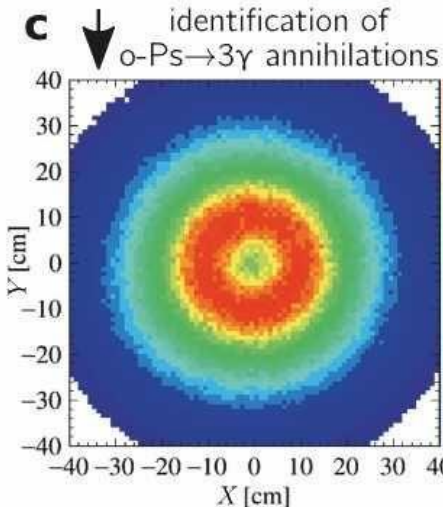




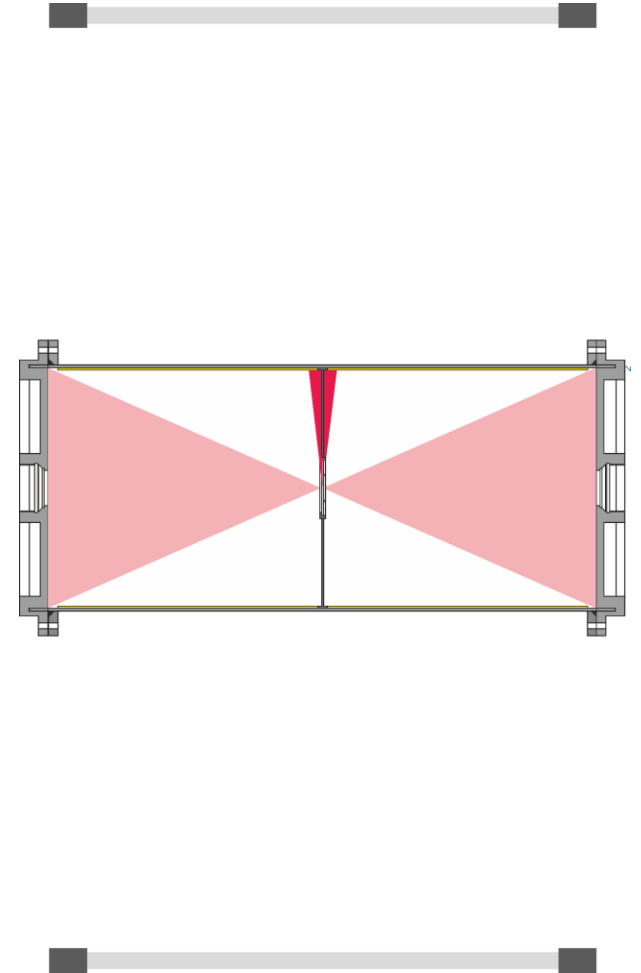
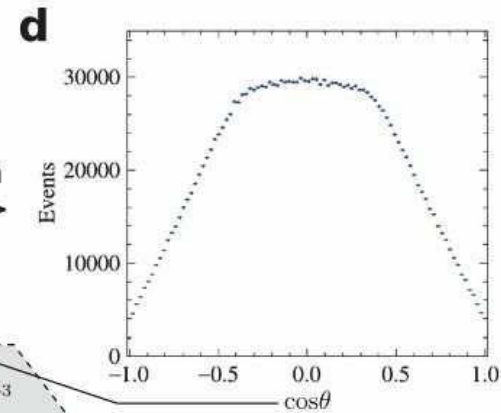
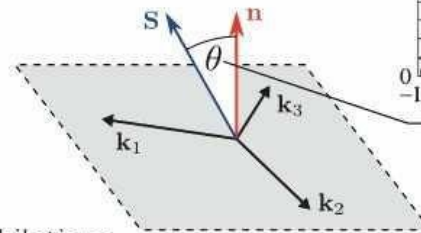
# Współpraca z grupą J-PET



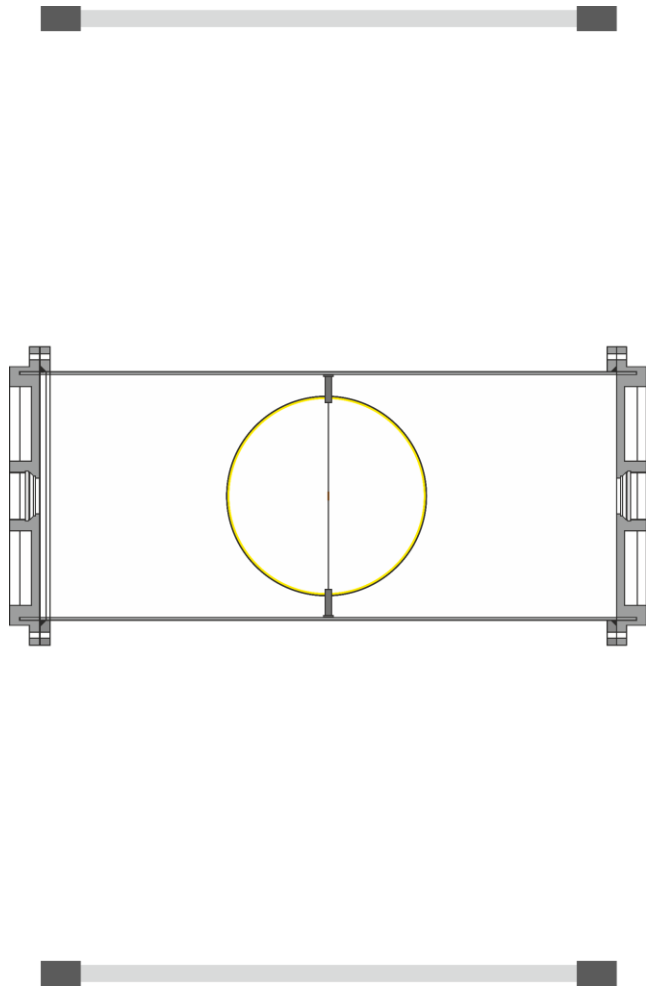
Schematic cross section of the J-PET detector



extraction of CPT-asymmetric angular correlation




# Współpraca z grupą J-PET



# Pierwotna motywacja



II Otwarte Zebranie Sekcji Fizyki Jądrowej Polskiego Towarzystwa Fizycznego



Dziękuję za uwagę