

# Produkcija i detekcija neutrona

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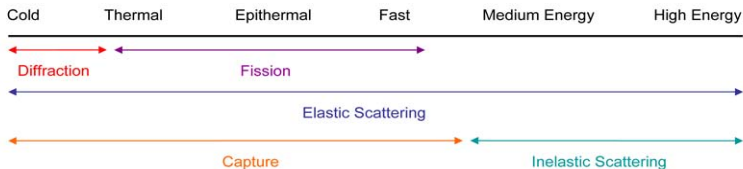
SSIF '16./'17.

## neutron

- ▶ u d d
- ▶  $q = T_3 + \frac{1}{2}(B + S)$
- ▶  $m = 939,56 \text{ MeV}/c^2$
- ▶  $\mu = -1,91 \mu_N$
- ▶  $s = 1/2$

## interakcija sa materijom

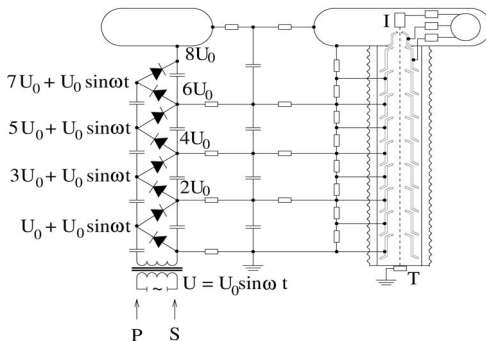
- ▶ raspršenje na jezgrama atoma: elastično ( $n, n$ )  
 neelastično ( $n, n'$ )
- ▶ apsorpcija u jezgri: elektromagnetska ( $n, \gamma$ )  
 nabijena ( $n, p$ ), ( $n, \alpha$ )...  
 neutralna ( $n, 2n$ ), ( $n, 3n$ )...  
 fizija ( $n, f$ )



# Cockcroft-Walton generator

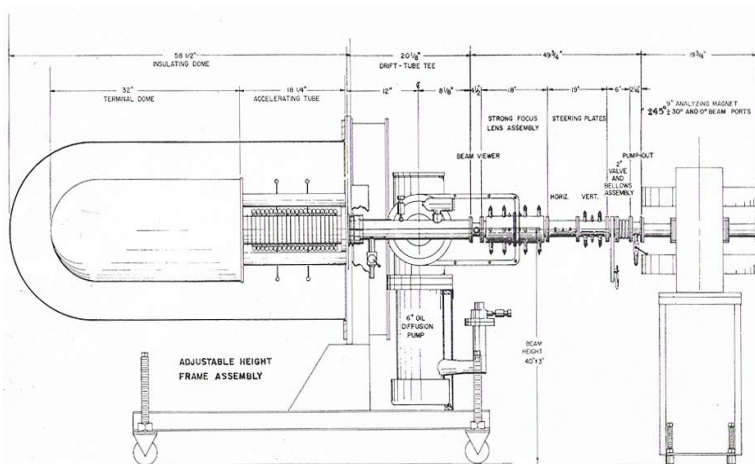
- ▶ kaskadni generator visokog DC napona sa niskog AC napajanja

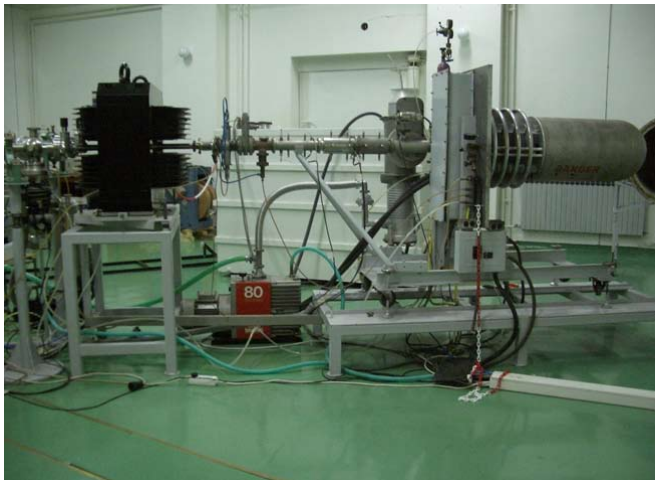
$$U = 2nU_0 - \frac{I}{fC} \left( \frac{2}{3}n^3 + \frac{3}{4}n^2 + \frac{1}{2}n \right) \pm \frac{I}{fC} \frac{n(n+1)}{2}$$

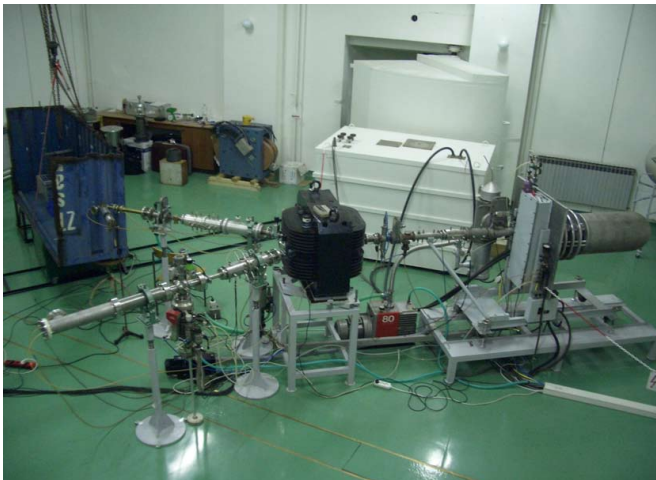


## Cockcroft-Walton akcelerator - neutronske generator, IRB

- ▶ tip: linearni elektrostatski akcelerator, 300 keV
- ▶ izvor visokog napona: visokonaponski uljni transformator 150 kV
- ▶ ionski izvor: R-F ionski izvor s kapacitivnom vezom (60 MHz, 120 W)
- ▶ vodjenje snopa: kvadrupolni dublet, elektrostatski deflektori, kvadratni kolimator i magnetski dipolni analizator
- ▶ vakuumski sustav: uljna difuzijska i turbomolekularna pumpa ( $\approx 1,5 \times 10^{-6} \text{ mbar}$ )







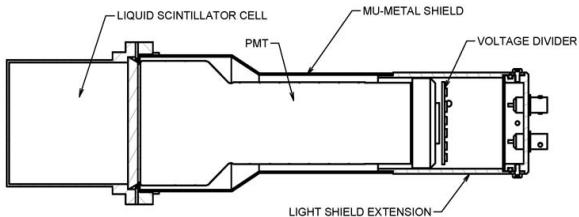


## reakcija produkcije

- ▶ tricijska meta:  $T_{1/2} \approx 12,33\text{god}$ ,  $A \approx 0,26\text{Ci}$
- ▶  ${}^3\text{H}(d, n){}^4\text{He}$ ,  $Q = 17,59\text{MeV}$
- ▶  ${}^3\text{He}(d, p){}^4\text{He}$ ,  $Q = 18,35\text{MeV}$

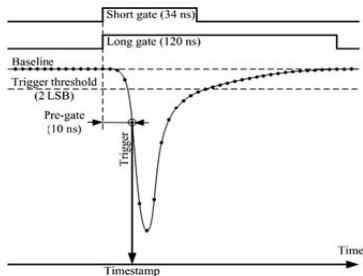
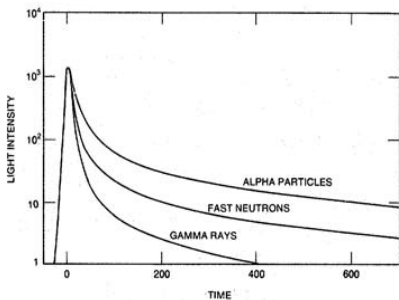
## EJ-309

- ▶ tekući scintilacijski detektor
- ▶ visoka osjetljivost na brze neutrone
- ▶ mogućnost detekcije u područjima viševrsnog zračenja
- ▶  $T_c = 144^\circ C$
- ▶ optimalni odziv pri 1500 – 1550 V



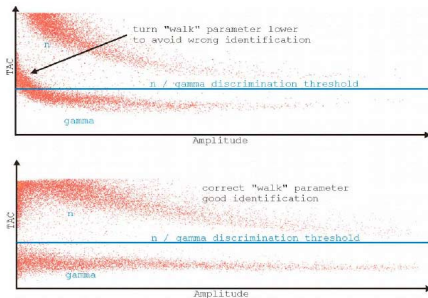
# PSD: pulse-shape discrimination

►  $P_S = 1 - \frac{Q_S}{Q_L}$



## MPD-8

- ▶ 8-kanalna jedinica za diskriminaciju
- ▶ široke namjene tj. primjenjiva za različite vrste i oblike kućišta tekućih scintilatora i za različite PMT
- ▶ Ndis, Walk, Qwin



## detekcija $\alpha$ čestice

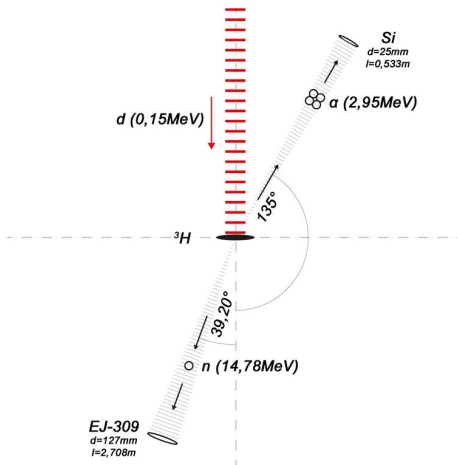
- ▶ Si poluvodički detektor sa površinskom barijerom
- ▶ problem razlučivosti detektora
- ▶  $E_{\alpha}(n) = 2,95 \pm 0,01 \text{ MeV}$
- ▶  $E_{\alpha}(p) = 3,09 \pm 0,01 \text{ MeV}$

## akvizicija

- ▶ WaveRunner 8000 osciloskop
- ▶ 4 analogna i 16 digitalnih kanala
- ▶ raspon frekvencija 500MHz - 4GHz
- ▶ minimalno detektabilno trajanje signala od 2ns



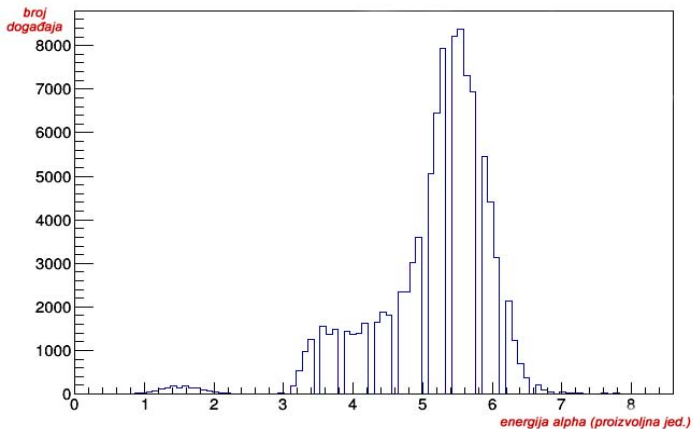
# eksperimentalni postav





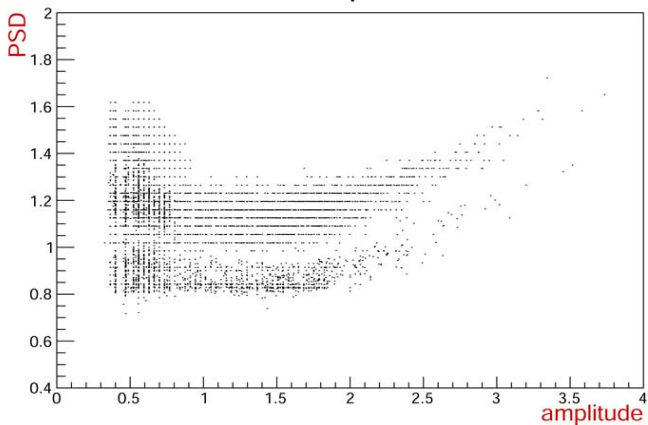
# Si detektor

alpha

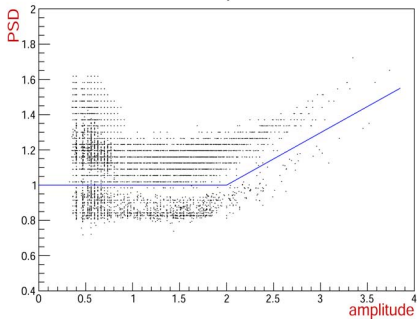


# detektor neutrona

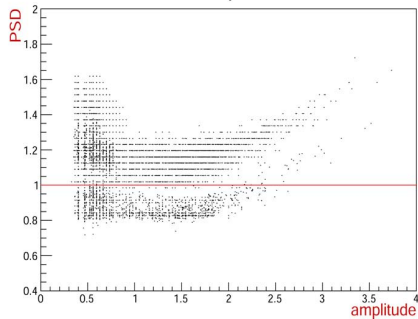
PSD:amp #run31



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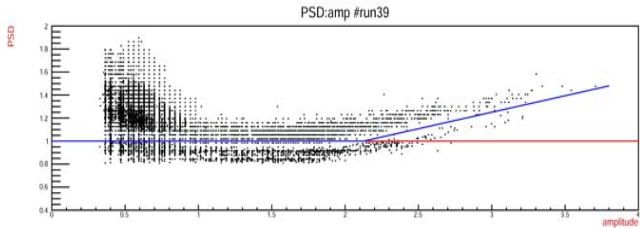
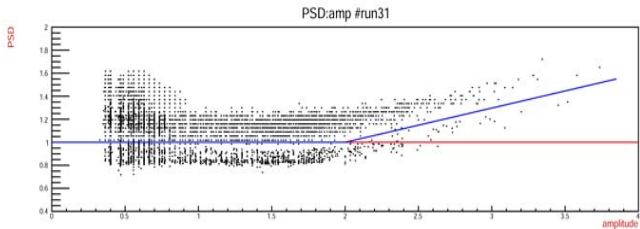
PSD:amp #run31



## run31 vs. run39

run 31  
walk=85  
ndis=140  
qwin=100

run 39  
walk=88  
ndis=144  
qwin=105



## zaključak

- ▶ uspješno postignuta eliminacija  $\gamma$  zračenja korištenjem MPD-8 diskriminatora pri detekciji neutrona EJ-309 scintilatorom
- ▶  $\approx 3\%$  krivoidentificiranog podrijetla signala
- ▶ potrebno mjerenje koincidencije događaja istovremenim detektiranjem neutrona i  $\alpha$  čestica kako bi se odredila točna efikasnost detektora neutrona