

# Positron Source Activation

A. Ushakov, S. Riemann

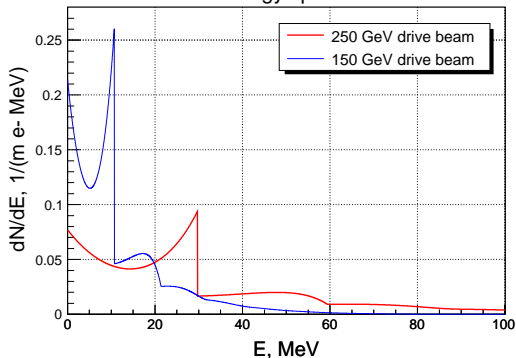
DESY Zeuthen

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Rutherford Appleton Laboratory

# Helical Undulator

Undulator type	U250	U150
Undulator period, cm	1	
Magnetic field, T	1.07	
K-value	1	
e <sup>-</sup> drive beam energy, GeV	250	150
Energy of 1 <sup>st</sup> harmonics cutoff, MeV	29.7	10.7
Mean photon energy, MeV	33.31	11.99
Number of photons, $\gamma/(e^- m)$	2.575	

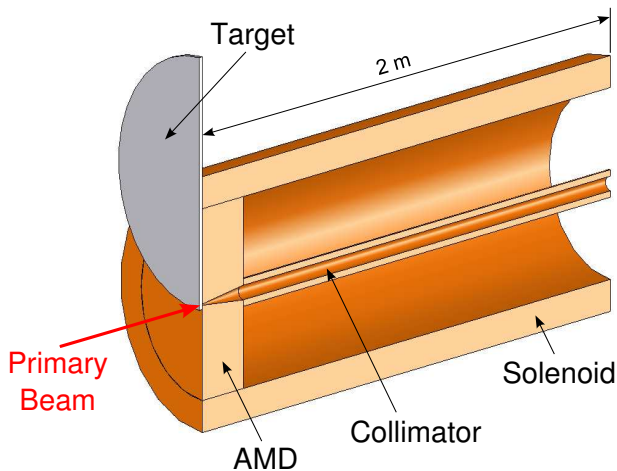
Photon energy spectrum



# Target

Target type	W	Ti	Graphite
Target thickness, $X_0$	0.4		
Target compound	75% W, 25% Re	90% Ti, 6% Al, 4% V	100% C (1.88 g/cm <sup>3</sup> )

# Source Model



# Activation of Source Parts (U150Ti)

	$A_{\text{sat}}$ GBq	$A_{5000\text{h}}$ GBq	$\dot{D}_{5000\text{h}}$ mSv/h	$\dot{D}_{+1\text{h}}$ mSv/h	$\dot{D}_{+1\text{d}}$ mSv/h	$\dot{D}_{+1\text{w}}$ mSv/h
Target	5288	3421	437	397	213	164
AMD	3689	3566	81	14.0	3.6	0.1
Collimator	1090	1077	21	2.0	0.4	0.1
Solenoid	943	932	2.7	2.2	0.6	<0.1
	11011	8996	542	415	218	164

# Comparison of Target Activation

$$N_{e^+}^{IP} = 2 \cdot 10^{10}, e^+/s$$

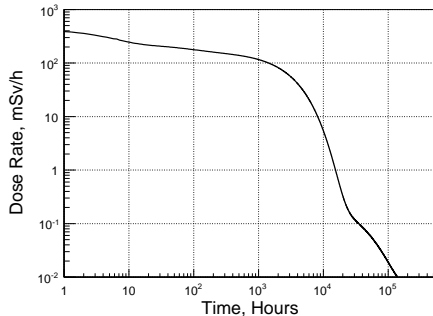
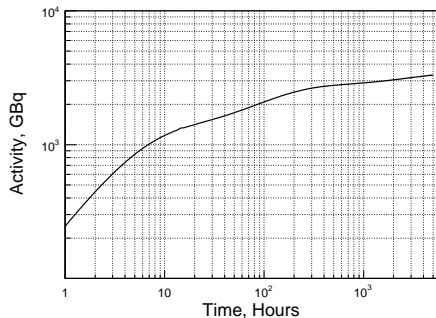
150 GeV drive beam energy

Source type	Ti-6Al-4V	W-25Re	C
$A_{5000h}$ , GBq	$3606 \pm 198$	$6772 \pm 173$	$15505 \pm 84$
$\dot{D}_{+1w}$ , mSv/h	$170 \pm 7$	$116 \pm 17$	$24 \pm 1$

250 GeV drive beam energy

Source type	Ti-6Al-4V	W-25	C
$A_{5000h}$ , GBq	$2201 \pm 90$	$2302 \pm 56$	$10166 \pm 154$
$\dot{D}_{+1w}$ , mSv/h	$135 \pm 27$	$38 \pm 4$	$14 \pm 1$

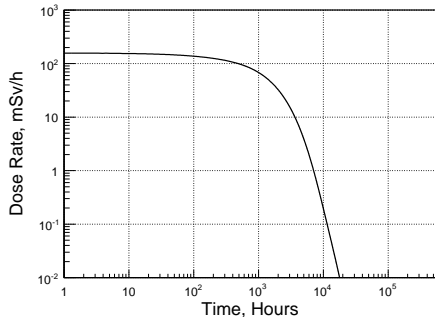
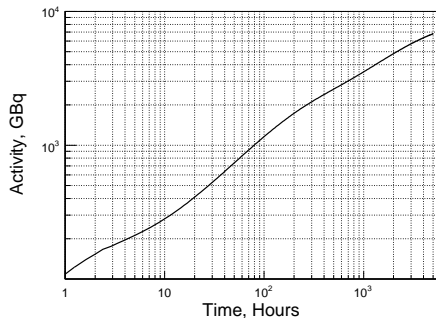
# Activity and Dose Rate (U150Ti)



Nuclei	A	$T_{1/2}$ , h	$A_{5000h}$ , GBq	$E_{\gamma}$ , keV (Intensity, %)
Sc	47	80.4	1416.4	159.4 (68.3)
Ti	45	3.1	961.2	719.6 (0.15)
Sc	46	2011.9	544.5	1120.5 (99.99)
Sc	44	3.9	198.3	1157.0 (99.9)

Nuclei	A	$T_{1/2}$ , h	$\dot{D}_{+1w}$ , mSv/h
Sc	46	2011.9	153.7
Sc	47	80.4	5.7
Sc	48	43.7	2.6
V	48	389.7	2.1

# Activity and Dose Rate (U150W)

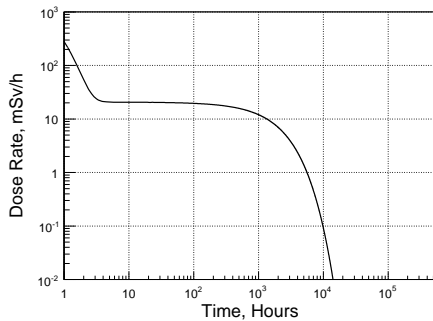
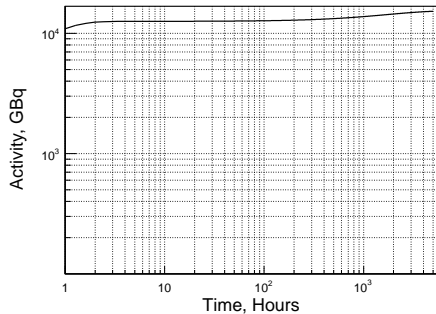


Nuclei	A	$T_{1/2}$ , h	$A_{5000h}$ , GBq	$E_{\gamma}$ , keV (Intensity, %)
W	181	2908.3	2344.0	136.3 (0.03)
W	185	1802.5	1513.7	125.4 (0.02)
Re	186	90.6	1349.2	137.2 (9.5)
Re	184	911.9	988.1	903.3 (37.9)
Re	183	1680.0	394.2	162.3 (23.3)

Nuclei	A	$T_{1/2}$ , h	$\dot{D}_{+1w}$ , mSv/h
Re	184	911.9	121.4
Re	183	1680.0	4.5
Re	182	64.0	1.4
Re	186	90.6	0.9
Ta	182	2746.3	0.5



# Activity and Dose Rate (U150C)



Nuclei	A	$T_{1/2}$ , h	$A_{5000h}$ , GBq	$E_{\gamma}$ , keV (Intensity, %)
C	11	0.3	12577.0	477.6 (10.4)
Be	7	1278.9	2681.2	
C	10	<0.1	19.3	

Nuclei	A	$T_{1/2}$ , h	$\dot{D}_{+1w}$ , mSv/h
Be	7	1278.9	23.0

- Reduction of dose rate by a factor of  $10^4$  to level of 0.03 mSv/h is required
- For Ti-alloy target:  $^{46}\text{Sc}$  with  $T_{1/2} = 84$  d makes 93% contribution in dose rate  $\dot{D}_{+1w}$ ,  $^{46}\text{Sc}$  during decay radiates 1.1 MeV photons
- For undulator based source: at least 15 cm of lead shielding is required