

SPDC mean rate

Q: What is the typical coincidence rate of spontaneous parametric down-conversion (SPDC) of a PPLN waveguide?

A:

$$f_s = f_i = (2\pi)^{-1} \int \sinh^2[s(\omega_s)] d\omega_s \quad (\text{rate in photons/sec}) \quad \text{with}$$

$$s(\omega_s) = -\sqrt{\frac{\hbar\omega_p\omega_s(\omega_p-\omega_s)F_p}{8\varepsilon_0c^3An(\omega_p)n(\omega_s)n(\omega_p-\omega_s)}} \times \chi^{(2)}(\omega_p - \omega_s; -\omega_s, \omega_p) \times L$$

$\omega_{\text{idler}} \leq \omega_{\text{signal}}$ $\omega_{\text{pump}} = \omega_{\text{signal}} + \omega_{\text{idler}}$ $L =$ interaction length inside the NL crystal

F_{pump} : mean pump rate (ph/s) n : indices of refraction

Following is an example of a degenerate type-II SPDC in PPLN waveguide, assuming 1cm long crystal length, beam cross-section: $25\mu\text{m}^2$, $d_{31}/\varepsilon_0 = 4.6\text{pm/V}$:

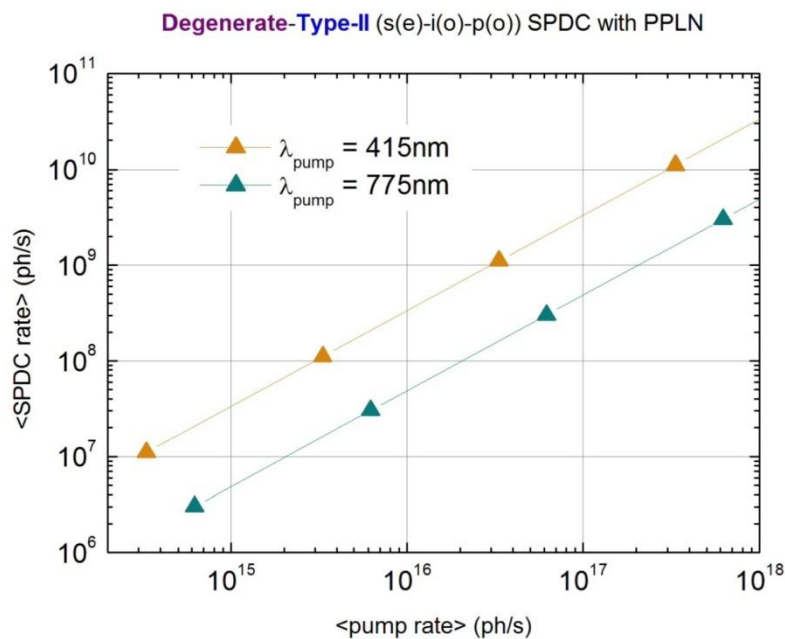


Fig.1 Mean SPDC emission rate versus mean pump rate for two “degenerate” conversions in PPLN waveguide crystal

	$\lambda_s = 830\text{nm}$	$\lambda_s = 1550\text{nm}$
-3dB bandwidth	0.8nm	2.8nm

Type	Reference	Crystal	Heralding efficiency	Heralding rate c/s	Wavelength (Bandwidth)	Special remarks
Bulk	Mosley 2008 [43]	KDP	44%	150	t=830 (20), s=830 (3.5)	spectral purity 0.95
Periodically-poled	Ljunggren 2005 [63]	ppKTP	48%	7,200	t=810 (2) s=1550	cw-pumped, SMF-coupling, $g^{(2)}(0)=0.024$
	Castelletto 2006 [64]	ppLN	48%	-	t=810 (2) s=1550	cw-pumped, SMF-coupling, different focusing conditions
	Fedrizzi 2007 [65]	ppKTP	22%	53,000	t=810 s=810	cw-pumped, study of different focusing conditions
	Scholz 2009 [75]	ppKTP	55%	5,000	t= (3MHz) s= (3MHz)	in cavity, $g^{(2)}(0)=0.01$
	Bocquillon 2009 [72]	ppKTP	30%	80,000	t=810 s=810	pulsed pump, $g^{(2)}(0)=0.08$
	Evans 2010 [79]	ppKTP	19.0%	1000	t=1552 (1) s=1552 (1)	SMF-coupling, spectral Schmidt number 1.07
	Smith 2012 [69]	ppKTP	80%	~10,000	t=820 (3) s=820	cw-pumped, SMF-coupling, TES detectors
	Brida 2012 [77]	ppKTP	-	~ 5	t=810 (10) s=1550 (30)	$g^{(2)}(0)=0.005$, optical shutter to supress background
	Pereira 2013 [68]	ppKTP	84%	11,000	t=810 (0.2) s=810 (0.2)	cw-pumped, SMF-coupling, symmetric heralding efficiency
	Ramelow 2013 [70]	ppKTP	87%	5,500	t=810 (0.5) s=810 (0.5)	TES detectors
Waveguide	Tanzilli 2001 [93]	ppLN	-	1,500	s=1314 (30)	first experiment in waveguides
	U'Ren 2004 [95]	ppKTP	85%	1,270	s=800	-
	Zhong 2010 [98]	ppKTP	-	3,000	s=1316 (1.2)	-
	Eckstein 2011[100]	ppKTP	60%	-	~1550 (5)	$g^{(2)}(0)=0.05$, Spectral purity=0.8/0.95 (Raw / background correction), mean photon number: 2.5
	Krapick 2013 [97]	ppLN	60%	105	t=803 (0.7) s=1575	$g^{(2)}(0) = 0.004$
	Harder 2013 [102]	ppKTP	80%	-	t=1535 (4) s=1535 (4)	mean photon number: up to 80, spectral purity = 0.86 (raw)

References:

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[202] Dickoff W.H. and Van Neck D.-Many Body Theory Exposed-WorldScientific-2005