

Main design parameters for SuperFGD electronics

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Draft

02-May-18

Level 1	Level 2	Level 3	Unit	Nominal	Minimum	Maximum	
System	Basic parameters	Number of channels	[]	60000		100000	
		Cost(total)/channel	[JPY/channel]	1000			
		Power requirements	[W]	1000		2000	
Beam	Bunches per spill			8			
	Bunch width		[ns]	80			
	Bunch-to-Bunch separation		[ns]	600			
	Spill duration		[μ s]	5			
	Spill rate 2018 (run 9)		[Hz]	0.4			
	Spill rate for design		[Hz]	0.8			
	Beam power 2018 (run 9)		[kW]	500			
	Beam power for design		[kW]	1500			
Scintillator	Typical light yield		[pe/MIP/cm]	40	10	100	
	Crosstalk per side for 1 cube		[%/side]	3.7			
	Crosstalk for 1 cube		[%/cube]	22			
MPPC (S13360-1325PE)	Number of pixels		[]	2668			
	Operating voltage		[V]	58	53	63	
	Gain		[$\times 10^5$]	7			
	PDE		[%]	25			
	Dark count	at 0.5 pe threshold		[Hz]	70000		
		1.5 pe threshold		[Hz]			
		2.5 pe threshold		[Hz]			
ROC	Acquisition window per spill		[μ s]	20	10		
	Deadtime during acquisition window		[s]	0			
	Repetition rate		[Hz]	0.8		2	
	Hit amplitude	Dynamic range		[pe]	1000	500	
		Dynamic range (MPPC Gain=7e5)		[pC]	112		
		Detection threshold		[pe]	0.5		
		Detection threshold (MPPC Gain=7e5)		[fC]	56		
		Noise		[pe/noise ratio]	5		
	Hit time	Hits time sampling rate		[GHz]	1	0.4	5
		Trigger capability		[pe]	0.5		
	Synchronisation	Jitter (self-SuperFGD FEE only)		[ns]	10		
		Jitter (w.r.t other ND280 electronics)		[ns]	10		
		Jitter (w.r.t T2K beam)		[ns]	10		
Event rate (threshold at 0.5 p.e.)	Hits per channel per spill		[/ch/spill]	0.01			
	Hits per channel per spill (noise)		[/ch/spill]	2			
	Hits per ROC per spill		[/ROC/spill]	100			
Material budget	ROC board + FEE	ROC fractional radiation length	[x/X0]	10			
	Conectivity (board/flex/cables)	Cabling fractional radiation length	[x/X0]	10			
Environmental condition:Altitude				0			
Temperature	Operating		[$^{\circ}$ C]		5	35	
		Safe	[$^{\circ}$ C]		0	40	
		Transport and storage	[$^{\circ}$ C]		0	40	
Pressure	Operating			Atmospheric			
		Safe					
		Transport and storage					
Humidity	Operating		[%HR]		10	30	
		Safe	[%HR]		10	40	
		Transport and storage	[%HR]		10	40	
Shocks and vibrations	Operating						
		Transport					
Radiation, magnetic and electric	Radiation			0			
	Magnetic field (UA1)		[T]	0.2	0	0.5	
	SiPM Vop		[V]	50	0	100	
Life term	Test/qualification phase		[months]	2	0	6	
	Experiment phase		[years]	20			
	Expected operation fraction		[h/year]	4000			
Power consumption	Per channel ROC		[mW]	10			
	Per channel total		[mW]	15			