DWG input for the digitization model (More description below line 40; updated on top of the last discussion at https://indico.bnl.gov/event/18156/)
Please enter column C to R, In particular update to column F-P

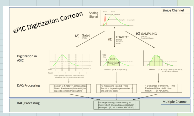
					Analog Features				Type (A) Digitizers Gated (eg. ITS 3)		Type (B) Digitizers TOA/TOT: (eg. EICROC, ALCOR, HGCROC64)			Type (C) Digitizers Sampled: (eg. SALSA, fADC)		Contact (name/email)	Comment e.g. assumptions, link to reference talk/document
Subsystem	Region	Channel Count	Threshold [keV, MeV or p. e.]	Intrinsic/dark noise rate at this threshold [Hz, noise hit per chan per second]	Shaping time (FWHM)	2 us (target value)	Total hit time resolution	Charge sharing	Gate on time (integration time)	Gate off time (deadtime)	Time resolution	Time bits	ADC/TOT bits	Sample Frequency	ADC bits		
MAPS	Barrel	17G	0.65 keV	10^-3 per pixel per second (limit)				1.2 at 90deg	2 us (target value)							Laura Gonella (laura.gonella@cern.ch)	Pixel pitch = 15 um, reticle size = 18.85 mm x 30 mm, detector layout shown here https://indico.bnl.gov/event/17713/ , number of channels from here https://indico.bnl.gov/event/17882/
MAPS	Disks	19G	0.65 keV	10^-3 per pixel per second (limit)				1.2 at 90deg	2 us (target value)								
MPGD	Barrel	30k–60k	~0.25keV	~1 [1]	~500 ns [2]	~20 ns [3]	~20 ns [4]	3-5						50 MHz [5]	>=10 ENOB [6	Francesco Bossù (francesco.bossu@cea.fr)	N channels per layer (1 layer quoted), Assume S/N=50, threshold=5*sigma_noise
LGAD	Barrel	2.4M	0.5 keV	30 Hz / channel	5 ns		30 ps	2			10 ps	10	8			Zhenyu Ye (yezhenyu@uic.edu)	Assume S/N = 25, threshold is set at 5*noise, 100 MHz clock
LGAD	Forward	8.9M	0.5 keV	30 Hz / channel	5 ns		25 ps	2*2 in x*y			10 ps	10	8			Zhenyu Ye (yezhenyu@uic.edu)	Assume S/N = 25, threshold is set at 5*noise, 100 MHz clock
pfRICH	Backward	~70k	<0.5 p.e.	~100Hz/channel												Alexander Kiselev (ayk@bnl.gov)	DCR number taken from Incom's test reports. Not sure what is meant by integration time for this type of detector / electronics. All single photon hits will be individually measured and time stamped to better than ~50ps. EICROC peaking time is <20ns (?). With a ~100Hz DCR per channel hit overlap probability seems to be very low.
mRICH	Backward	69632	0.5 p.e.	TBD depending on sensor choices (as dRICH)												Xiaochun He (xhe@gsu.edu), Rachel, Murad	Two parallel paths: 1. Follow the dRICH readout development; 2. Use HRPPD when it is available. The mRICH for ePIC consists of 68 modules. Each module has 1204 channels with 3mm x 3mm pixel size.
DIRC	Barrel	74k	0.2 p.e.	100 Hz/channel												Greg Kalicy (kalicy@cua.edu), Jochen Schwiening (j.schwiening@gsi.de)	
dRICH	Forward	320 k	0.5 p.e.	1-300 kHz / channel							50 ps	23	23			Roberto Preghenella (preghenella@bo.infn.it) Pietro Antonioli (pietro.antonioli@bo.infn.it)	detector is readout in continuous mode with hardware-level inhibit to only integrate approx. 1/4 of the clock where, which is what is indicated here as integration time. Intrinsic DCR increases with increasing integrated lumi and decreases after annealing and the numbers reported here assume that together with the use of the readout strobe.
EEMC	Backward	3000	5000 keV	probably 0	100 ns	few ns	few ns	yes			100ps	TOA = 25ps TOT = 50ps	TOA = 10 TOT =12			Carlos Munoz (munoz@jlab.org)	
SciGlass	Barrel																
AstroPix	Barrel	359424000	15 keV	0	1 us			1 (maybe consider 1-2)	< 6 us		<50 ns		12 bit	Coarse TS: 2.5 Hz; Fine TS: 200 MHz	8 bit	Jadhav, Manoj (mjadhav@anl.gov), Maria Żurek (zurek@anl.gov)	end of this month we will have measured value for v3 chip of the noise rate (at the threshold), noise floor = 5 keV
SciFiPb	Barrel	5760	500 keV per readout unit (not fiber)		100 ns	few ns (4 ns for GlueX)	Few ns	By default			50-100 ps						Important: The Theshold is set on one readout unit, which is 4 SiPMs on one light guide. In our data model from EICrecon this are MergedHits (energy deposir rom fibers merged within one readout unit)
FEMC	Forward	19000	15 MeV	1.2kHz-64kHz per channel, see comments	100 ns	few ns	few ns	yeah (1 particle ==> N tower cluster)						32.8 MHz	12 (14 option TBD)	Oleg Tsai (tsai@physics.ucla.edu); Gerard Visser (gvisser@indiana.edu)	O.T.:Threshold is 5 MeV. Noise rate will vary approximately factor of 100 center/outher edges. Assumed room temperature, exposure 10^8 n/cm^2 outher, 10^10n/cm^2 inner, overvoltage ~1.5V. Noiser rate outher ~1.2 kHz, Inner ~64 kHz. Clustering requirements drops these rates to 0.
bHCAL (per layer)	Backward	10350	3 p.e./170 keV	10 Hz	25ns	25ns					100ps	TOA = 25ps TOT = 50ps	TOA = 10 TOT =12	40 MHz	10	Leszek Kosarzewski (kosarles@fjfi.cvut.cz), Oleg Tsai tsai@physics.ucla.edu	Threshold for each tower layer (towers=1035, layers=10) - Values adopted from fHCal.
Remove this line	Backward	1035	5000 MeV ???	???												Leszek Kosarzewski (kosarles@fjfi.cvut.cz)	Integrated threshold of the unit which is being readout
cHCAL (per layer)	Barrel	7680 (scint tiles)	5 MeV (deposited in scintillator)	few tens of Hz	25ns	25ns		-			100ps	TOA = 25ps TOT = 50ps	TOA = 10 TOT =12	40 MHz	10	John Lajoie (lajoie@iastate.edu) Derek Anderson (dmawxc@iastate.edu)	Threshold for each HCal tile - sPHENIX preamplifiers have a 30ns peaking time with return to baseline in 106ns. Energy threshold is set by desire to see muons, which lose about a GeV in traversing the calorimeter from inner to outer radius. The barrel HCAL will use the same readout electronics as the forward HCAL.
cHCAL (per unit), obsolete: to be removed	Barrel	1536 (towers)	125 MeV (tower energy, ~4 MeV deposited in scint)	layer rate x 5												John Lajoie (lajoie@iastate.edu) Derek Anderson (dmawxc@iastate.edu)	Integrated threshold of the tower unit which is being readout - this is historical, and for the second simulation campaign we will move to reading out each tile individually and there will be no "tower" structure, as recommended during the HCal review
fHCAL (per layer)	Forward	601160	500 keV		25ns	25ns		-			100ps	TOA = 25ps TOT = 50ps	TOA = 10 TOT =12	40 MHz	10	Norbert Novitzky (norbert.novitzky@cern.ch), Friederike Bock (fbock@cern.ch)	assuming we have SiPMs in every layer
fHCAL (per unit)	Forward	63280	5000 keV		25ns	25ns		-			100ps	TOA = 25ps TOT = 50ps	TOA = 10 TOT =12	40 MHz	10	Norbert Novitzky (norbert.novitzky@cern.ch), Friederike Bock (fbock@cern.ch)	assuming 5 layers of W combined + 6*10 Steel layers
fHCAL insert	Forward	9000	250 keV (0.5 MIP, with 1 MIP MPV=15 p.e at +2V and		125 ns	25 ns					100 ps	=50ps	TOT=12	40 MHz	10	Miguel Arratia (miguel.arratia@ucr.edu)	Assuming each tile readout independently. Assuming 1.3 mm SiPM at +2V and 3 mm thick scintillator. Threshold can be placed in reco (EICrecon) after digitization
low Q2 Tagger	Far Backward	33M	1 keV	0												Simon Gardner (simon.gardner@glasgow.ac.uk)	assuming 55um pixels covering a total area of about 0.1m2
low Q2 Tagger (CAL)	Far Backward	512	0	due to high channel occupancy - no zero-s.												krzysztof.piotrzkowski@cern.ch	
B0 MAPS	Far Forward	2.5B	1 keV													Alex Jentsch (ajentsch@bnl.gov)	Assuming 10um pixels, with 2500cm2 total active area - likely an overestimate at this point on channels
B0 LGAD	Far Forward	260k	1 keV		750ps	30ps	30-50ps	capability exists, not needed; may impact timing			15-20ps jitter					Alex Jentsch (ajentsch@bnl.gov)	Assuming 500um pixels, with 650cm2 active area - **assume 30um sensor for analog information (conservative estimate)** - rise time = 300ps; shaping time ~ 300ps * 2.5; useful information: https://arxiv.org/pdf/2211.09698.pdf
B0 PbWO4	Far Forward	105	1 MeV	100 kHz - assuming SiPMs with a large radiation load.												Alex Jentsch (ajentsch@bnl.gov)	Assuming 2.5cm square crystals, 650cm2 total area, threshold for photon tagging in e+Au
Roman (Pots)	Far Forward	550k	1 keV	low < 10 hz (average particle E > 100 GeV)	750ps	30ps	30-50ps	capability exists, not needed; may impact timing			15-20ps jitter					Alex Jentsch (ajentsch@bnl.gov)	500um pixels, 26cm x 13cm active area, 4 layers - thresholds can be rather high since we are measuring beam-energy momenta - assume 30um sensor for analog information - rise time = 300ps; shaping time ~ 300ps * 2.5
Off Momentum	Far Forward	320k	1 keV	low < 10 hz (average particle E > 100 GeV)	750ps	30ps	30-50ps	capability exists, not needed; may impact timing			15-20ps jitter					Alex Jentsch (ajentsch@bnl.gov)	500um pixels, 10cm x 20cm active area, 4 layers - assume 30um sensor for analog information - rise time = 300ps; shaping time ~ 300ps * 2.5
ZDC PbWO4	Far Forward	576	1 MeV	low < 10 hz (with high threshold for high energy particle hits)												Alex Jentsch (ajentsch@bnl.gov)	Assuming 2.5cm square crystals, 3600cm2 total area, threshold for photon tagging in e+Au
ZDC W/Si	Far Forward	72000	10 MeV	negligible												Yuji Goto (goto@bnl.gov)	Noise is considered negligible compared to the signal hit rate if the threshold is high enough
ZDC Pb/Si	Far Forward	43200	100 MeV	negligible												Yuji Goto (goto@bnl.gov)	
ZDC Pb/Scint	Far Forward	72	100 MeV	negligible												Yuji Goto (goto@bnl.gov)	

In all cases, DAQ will record processed data banks containing information leading to descriptions of 3 numbers: a time, ADC surrogate, and position (in detector coordinates) for each sensed particle.

Type (A) - gated: A hit is recorded if the signal is above threshold any time when the gate signal is high. There is no granularity of the recorded hit, in fact the data recorded is not an ADC value, rather it is the address of the pixel hit. The signals are read out during the period when the gate signal is low. There is no time information recorded, rather the time is implied by the start time of the gate.

Type (B)- TOA/TOT: The readouts are triggered by the signal crossing the threshold. Any variation of the digitization time is included in the time resolution of the chip

Type (C)- sampled: ADC values are registered each sampling cycle. If the ADC values are greater than the threshold the ADC value and corresponding time are written to DAQ. The time/ADC are calculated by averaging or fitting over hit timebins.



Suggested parameters needed to understand time response for each type

ALL	Shaping time (FWHM)
	Analog time resolution - (differences the shaped peak position due to slewing, noise, baseline shifts, etc...)
	Estimated total hit time resolution– (after digitization and DAQ processing)
	Charge sharing (average number of channels hit / particle)
Type (A)	Gated (eg. ITS-3)
	Gate on time (integration time)
	Gate off time (deadtime, at low level, expect shaping time to be greater than gate off time, so no actual hits lost)
Type (B)	TOA/TOT: (eg. EICROC, ALCOR, HGCROC64)
	Time resolution
	Time bits
	ADC/TOT bits
Type (C)	Sampled: (eg. SALSA, FLASH ADC)
	Sample Frequency
	ADC bits

DWG input for the digitization model (More description below line 40; updated on top of the last discussion at https://indico.bnl.gov/event/18156/)
Please enter column C to R, In particular update to column F-P

					Analog Features				Type (A) Digitizers Gated (eg. ITS 3)		Type (B) Digitizers TOA/TOT: (eg. EICROC, ALCOR, HGCROC64)			Type (C) Digitizers Sampled: (eg. SALSA, fADC)		Contact (name/email)	Comment e.g. assumptions, link to reference talk/document
Subsystem	Region	Channel Count	Threshold [keV, MeV or p. e.]	Intrinsic/dark noise rate at this threshold [Hz, noise hit per chan per second]	Shaping time (FWHM)	2 us (target value)	Total hit time resolution	Charge sharing	Gate on time (integration time)	Gate off time (deadtime)	Time resolution	Time bits	ADC/TOT bits	Sample Frequency	ADC bits		

DWG input for the digitization model (More description below line 40; updated on top of the last discussion at https://indico.bnl.gov/event/18156/)
Please enter column C to R, In particular update to column F-P

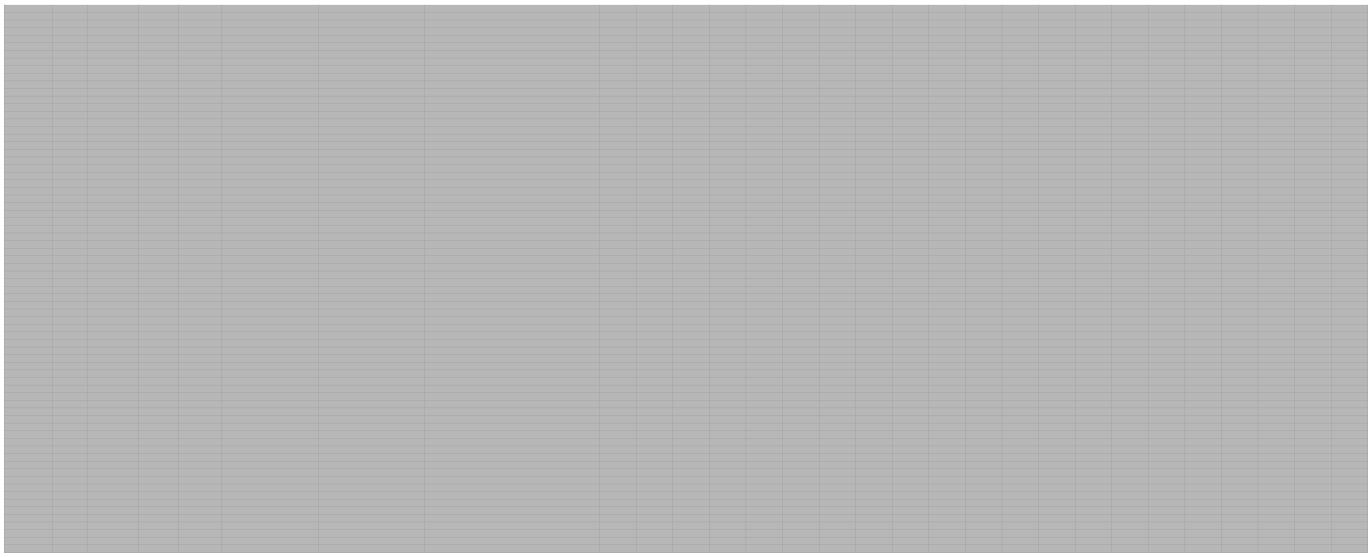
Subsystem	Region	Channel Count	Threshold [keV, MeV or p.e.]	Intrinsic/dark noise rate at this threshold [Hz, noise hit per chan per second]	Analog Features				Type (A) Digitizers Gated (eg. ITS 3)		Type (B) Digitizers TOA/TOT: (eg. EICROC, ALCOR, HGCROC64)			Type (C) Digitizers Sampled: (eg. SALSA, fADC)		Contact (name/email)	Comment e.g. assumptions, link to reference talk/document
					Shaping time (FWHM)	2 us (target value)	Total hit time resolution	Charge sharing	Gate on time (integration time)	Gate off time (deadtime)	Time resolution	Time bits	ADC/TOT bits	Sample Frequency	ADC bits		

DWG input for the digitization model (More description below line 40; updated on top of the last discussion at https://indico.bnl.gov/event/18156/)
Please enter column C to R, In particular update to column F-P

					Analog Features				Type (A) Digitizers Gated (eg. ITS 3)		Type (B) Digitizers TOA/TOT: (eg. EICROC, ALCOR, HGCROC64)			Type (C) Digitizers Sampled: (eg. SALSA, fADC)		Contact (name/email)	Comment e.g. assumptions, link to reference talk/document
Subsystem	Region	Channel Count	Threshold [keV, MeV or p. e.]	Intrinsic/dark noise rate at this threshold [Hz, noise hit per chan per second]	Shaping time (FWHM)	2 us (target value)	Total hit time resolution	Charge sharing	Gate on time (integration time)	Gate off time (deadtime)	Time resolution	Time bits	ADC/TOT bits	Sample Frequency	ADC bits		

This is an older page, which was discussed in https://indico.bnl.gov/event/18156/
Leading order approximation of the digitization model, parameterized in the zero-suppression threshold, integration time, and noise rate

Subsystem	Region	Channel Count	Integration Time [ns]	Threshold [keV, MeV or p.e.]	Intrinsic/dark noise rate at this threshold [Hz, noise hit per chan per second]	Contact (name/email)	Comment e.g. assumptions, link to reference talk/document
MAPS	**Barrel**	**17G**					
MAPS	**Disks**	**19G**				Laura Gonella (laura.gonella@cern.ch)	
MPGD	**Barrel**	**30k--60k**	50--1000	~0.25keV	0	Francesco Bossù (francesco.bossu@cea.fr)	N channels per layer (1 layer quoted), Assume S/N=20, threshold=5*noise
LGAD	**Barrel**	**2.4M**	5	0.5 keV	30	Zhenyu Ye (yezhenyu@uic.edu)	Assume S/N = 25, threshold is set at 5*noise, 100 MHz clock
LGAD	**Forward**	**8.9M**	5	0.5 keV	30	Zhenyu Ye (yezhenyu@uic.edu)	Assume S/N = 25, threshold is set at 5*noise, 100 MHz clock
pfRICH	**Backward**	**~70k**	TBD	<0.5 p.e.	~100Hz/channel	Alexander Kiselev (ayk@bnl.gov)	DCR number taken from Incom's test reports. Not sure what is meant by integration time for this type of detector / electronics. All single photon hits will be individually measured and time stamped to better than ~50ps. EICROC peaking time is <20ns (?). With a ~100Hz DCR per channel hit overlap probability seems to be very low.
mRICH	**Backward**	**69632**		0.5 p.e.	TBD depending on sensor choices (as dRICH)	Xiaochun He (xhe@gsu.edu), Rachel, Murad	Two parallel paths: 1. Follow the dRICH readout development; 2. Use HRPPD when it is available. The mRICH for ePIC consists of 68 modules. Each module has 1204 channels with 3mm x 3mm pixel size.
DIRC	**Barrel**	**74k**	100 ns	0.2 p.e.	100 Hz/channel	Greg Kalicy (kalicy@cua.edu), Jochen Schwiening (j.schwiening@gsi.de)	
dRICH	**Forward**	**320 k**	2.5 ns	0.5 p.e.	1-100 kHz / channel	Roberto Preghenella (preghenella@bo.infn.it) Pietro Antonioli (pietro.antonioli@bo.infn.it)	detector is readout in continuous mode with hardware-level inhibit to only integrate approx. 1/4 of the clock where, which is what is indicated here as integration time. Intrinsic DCR increases with increasing integrated lumi and decreases after annealing and the numbers reported here assume that together with the use of the readout strobe.
EEMC	**Backward**	**3000**	40	5000 keV	probably 0	Carlos Munoz (munoz@jlab.org)	
SciGlass	**Barrel**						
AstroPix	**Barrel**	**500M pixels (3.54 E+05 chips)**	Peaking time ~1 μs, latency < 6 μs (for v3a)	15 keV	0	Jadhav, Manoj (mjadhav@anl.gov), Maria Żurek (zurek@anl.gov)	end of this month we will have measured value for v3 chip of the noise rate (at the threshold), noise floor = 5 keV
ScifiPb	**Barrel**	**3360**	100 ns	1000 keV per readout unit (not fiber)			Important: The Theshold is set on one readout unit, which is 4 SiPMs on one light guide. In our data model from EICrecon this are MergedHits (energy deposir rom fibers merged within one readout unit)
FEMC	**Forward**	**19000**	100	3000 keV	1.2kHz-64kHz per channel, see comments	Gerard Visser (gvisser@indiana.edu) Oleg Tsai tsai@physics.ucla.edu	My guess may be wrong; Integration time is here interpreted as "peaking time"; sampling at 32 MSPS. O.T.:Threshold is 5 MeV. Noise rate will vary approximately factor of 100 center/outher edges. Assumed room temperature, exposure 10^8 n/cm^2 outher, 10^10n/cm^2 inner, overvoltage ~1.5V. Noiser rate outher ~1.2 kHz, Inner ~64 kHz. Clustering requirements drops these rates to 0.
bHCAL (per layer)	**Backward**	**10350**	100	3 p.e./170 keV	10 Hz	Leszek Kosarzewski (kosarles@fjfi.cvut.cz), Oleg Tsai tsai@physics.ucla.edu	Threshold for each tower layer (towers=1035, layers=10)
Remove this line	**Backward**	**1035**	100	5000 MeV ???	???	Leszek Kosarzewski (kosarles@fjfi.cvut.cz)	Integrated threshold of the unit which is being readout
cHCAL (per layer)	**Barrel**	**7680 (scint tiles)**	100ns integration / few ns resolution	25 MeV (~75 keV deposited in scint)	few tens of Hz	John Lajoie (lajoie@iastate.edu) Derek Anderson (dmawxc@iastate.edu)	Threshold for each HCal tile - sPHENIX preamplifiers have a 30ns peaking time with return to baseline in 106ns. Energy threshold is set by desire to see muons, which lose about a GeV in traversing the calorimeter from inner to outer radius.
cHCAL (per unit), obsolete: to be removed	**Barrel**	**1536 (towers)**	100ns integration/ few ns resolution	125 MeV (tower energy, ~4 MeV deposited in scint)	layer rate x 5	John Lajoie (lajoie@iastate.edu) Derek Anderson (dmawxc@iastate.edu)	Integrated threshold of the tower unit which is being readout - this is historical, and for the second simulation campaign we will move to reading out each tile individually and there will be no "tower" structure, as recommended during the HCal review
fHCAL (per layer)	**Forward**	**601160**	75-100	500 keV		Norbert Novitzky (norbert.novitzky@cern.ch), Friederike Bock (fbock@cern.ch)	assuming we have SiPMs in every layer
fHCAL (per unit)	**Forward**	**63280**	75-100	5000 keV		Norbert Novitzky (norbert.novitzky@cern.ch), Friederike Bock (fbock@cern.ch)	assuming 5 layers of W combined + 6*10 Steel layers
low Q2 Tagger	**Far Backward**	**33M**	100	1 keV	0	Simon Gardner (simon.gardner@glasgow.ac.uk)	assuming 55um pixels covering a total area of about 0.1m2
low Q2 Tagger (CAL)	**Far Backward**	**512**	5 ns	0	due to high channel occupancy - no zero-s.	krzysztof.piotrzkowski@cern.ch	
B0 MAPS	**Far Forward**	**2.5B**				Alex Jentsch (ajentsch@bnl.gov)	Assuming 10um pixels, with 2500cm2 total active area - likely an overestimate at this point on channels
B0 LGAD	**Far Forward**	**260k**	5ns			Alex Jentsch (ajentsch@bnl.gov)	Assuming 500um pixels, with 650cm2 active area
B0 PbWO4	**Far Forward**	**105**	40ns	1 MeV	100 kHz - assuming SiPMs with a large radiation load.	Alex Jentsch (ajentsch@bnl.gov)	Assuming 2.5cm square crystals, 650cm2 total area, threshold for photon tagging in e+Au
Roman (Pots)	**Far Forward**	**550k**	5ns	1 MeV	low < 10 hz (with high threshold for high energy particle hits)	Alex Jentsch (ajentsch@bnl.gov)	500um pixels, 26cm x 13cm active area, 4 layers - thresholds can be rather high since we are measuring beam-energy momenta
Off Momentum	**Far Forward**	**320k**	5ns	1 MeV	low < 10 hz (with high threshold for high energy particle hits)	Alex Jentsch (ajentsch@bnl.gov)	500um pixels, 10cm x 20cm active area, 4 layers
ZDC PbWO4	**Far Forward**	**576**	40ns	1 MeV	low < 10 hz (with high threshold for high energy particle hits)	Alex Jentsch (ajentsch@bnl.gov)	Assuming 2.5cm square crystals, 3600cm2 total area, threshold for photon tagging in e+Au
ZDC W/Si	**Far Forward**	**72000**	100ns	10 MeV	negligible	Yuji Goto (goto@bnl.gov)	Noise is considered negligible compared to the signal hit rate if the threshold is high enough
ZDC Pb/Si	**Far Forward**	**43200**	100ns	100 MeV	negligible	Yuji Goto (goto@bnl.gov)	
ZDC Pb/Scint	**Far Forward**	**72**	100ns	100 MeV	negligible	Yuji Goto (goto@bnl.gov)	



[1] This is understood to be the noise in absence of beam. In principle, increasing detector gain, per channel threshold can be set sufficiently high to discriminate efficiently signal from noise. Further noise rate reduction will depend on complexity of ZS algorithms incorporated in the readout electronics chain (e.g. TOT discrimination, clustering).

[2] Typical; Depends on programmable peaking time (~3x). Targeted peaking time range 50-500 ns; Also, in the case of MPGD the shaping time is more TOT rather then FWHM

[3] Determined by detector performance

[4] Determined by detector performance

[5] Typical; Programmable in (sub-)multiples of system clock

[6] 12-bit ADC with targeted ENOB at least 10. Allows finding the operational parameters ensuring acceptable S/N ratio and high dynamic range (ideally, MIP to threshold ratio of 10, threshold to noise ratio of 6 and max signal to MIP ratio of 16)