PANDA FEE Survey

Subsystem Contact Person: tbn

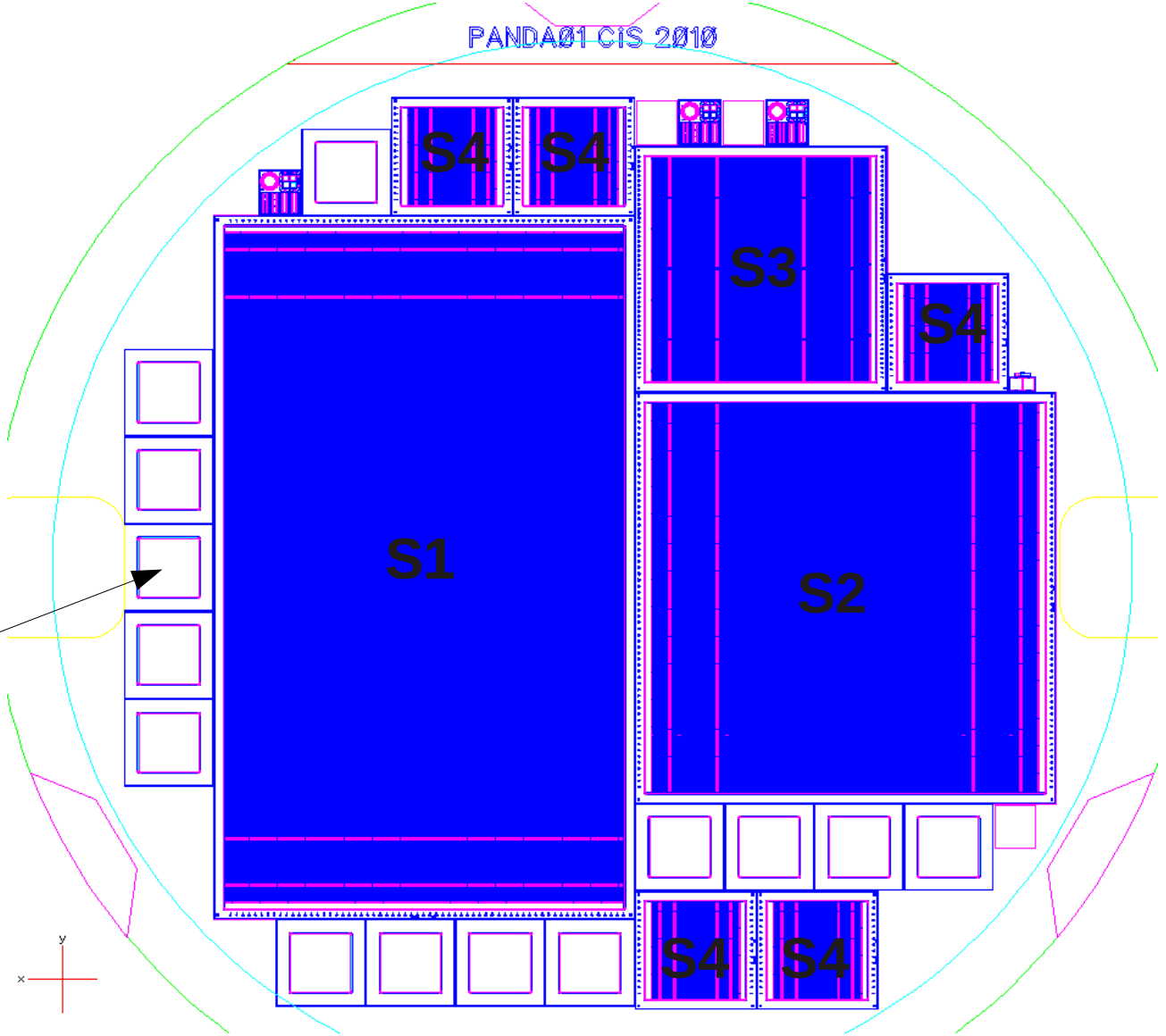
	Addressed and understood	**Under study**
Detector capacitance	10pF (p), 17pF(n)	
Detector signal shape and fluctuations	Noise calculations with simple CR-RC shaper	
Signal polarity	both	
Leakage current, if any	10nA/strip, ca. 5µA@1e14n-eq.	

	Addressed and understood	**Under study**
Event rate per channel.	10 ev./µs	
Time resolution.	1.86ns rms @ 155 MHz clock	
Time extraction method.	comparator	
Required precision for synchronization (SODA).		?
Available space on the front-end electronics for synchronization piggy-back card		?

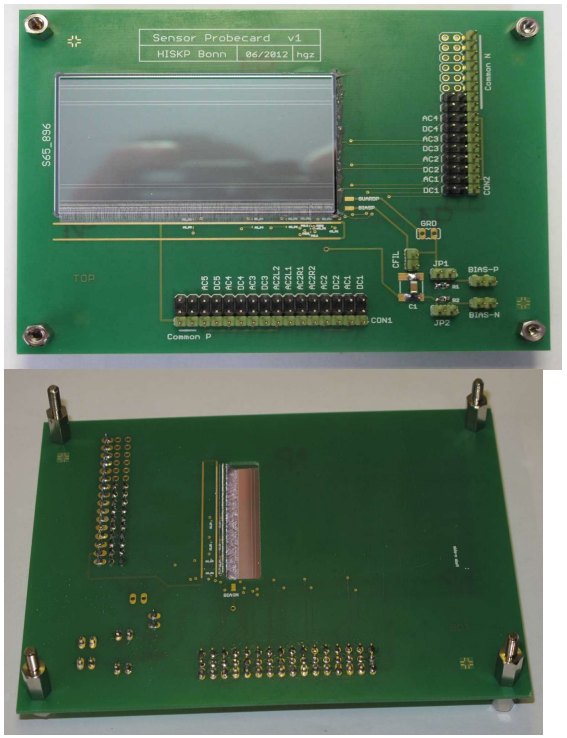
Amplitude/energy resolution if any	>=8Bit linear	
Energy extraction method (e.g. ToT, ADC, etc)	ToT	
FEE support/need for online calibration		tbd
FEE support for online event selections		
Data format and abstraction levels (Hits, Clusters,Energies, Pattern, Rings...)		Scope of MDC development
Limit on power consumption.	1W/FE, ca. 1W/MDC	

	Addressed and understood	Under study
System modularity/granularity.	TDR	
Power distribution/management (number of regulators, distance between the last regulators and the front end, number of power cables, grounding scheme...)		Work started
Data transmission scheme	GBT e-links → GBT	
Data concentrator cards (intended as the intermediate layer interfacing the front-end to DAQ)		
expected number of data concentrator cards (~# of SODA inputs)	50 barrel, 4 fw	
number of optical fibres to the burst-building network (compute nodes)	50+4	
amount of the configuration data required by the front-end:		?
should be distributed by SODA?		
Requirement for a low-latency watch-dogs in the system front-end - data concentrator		Implement extended status words in MDC-out frames
Level of radiation protection foreseen (total dose and SEU).	5-10MRad on FE level	

Current Sensor Prototypes

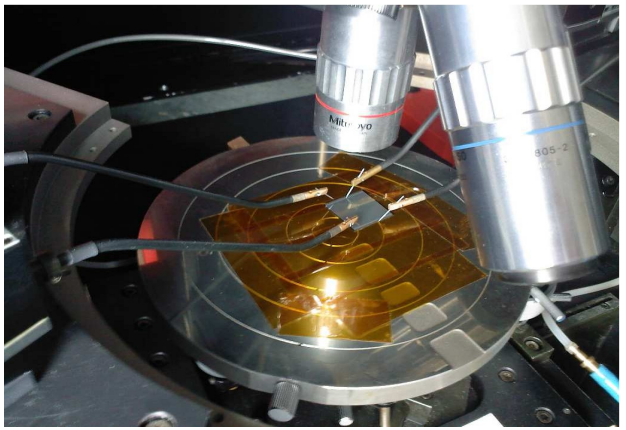


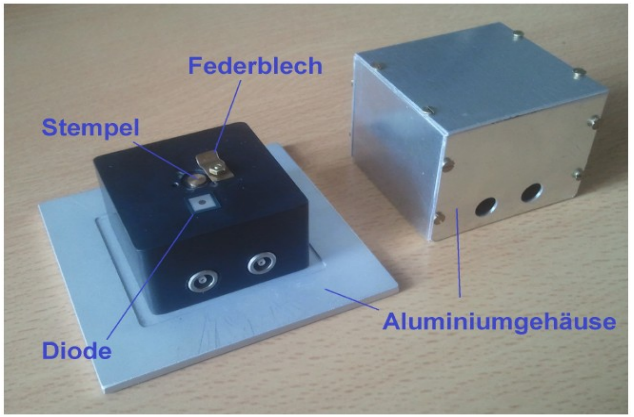
Sensor Characterization



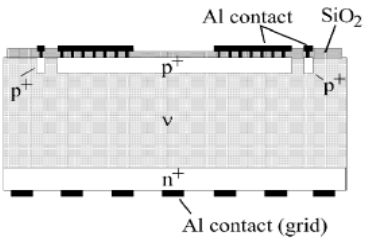
“Probecard”: fixed sensor assembly with all strips bonded to common lines (top and bottom)

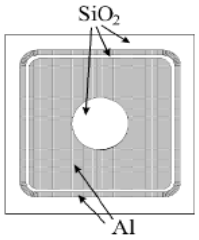
Probe Station





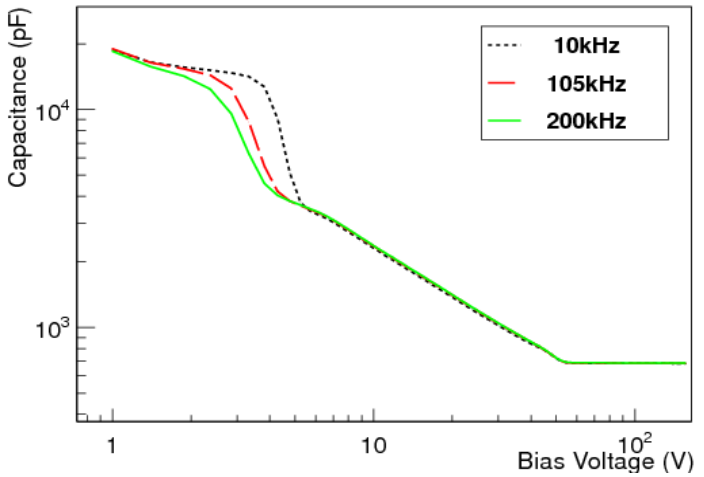
Wafer test diode fixture

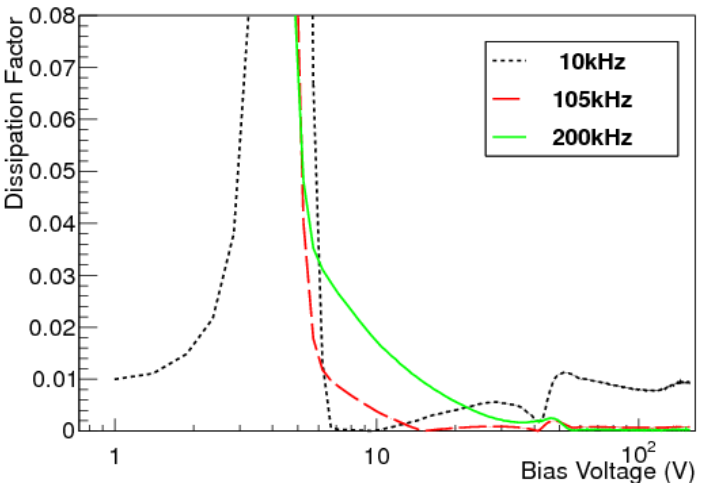




Sensor Characterization

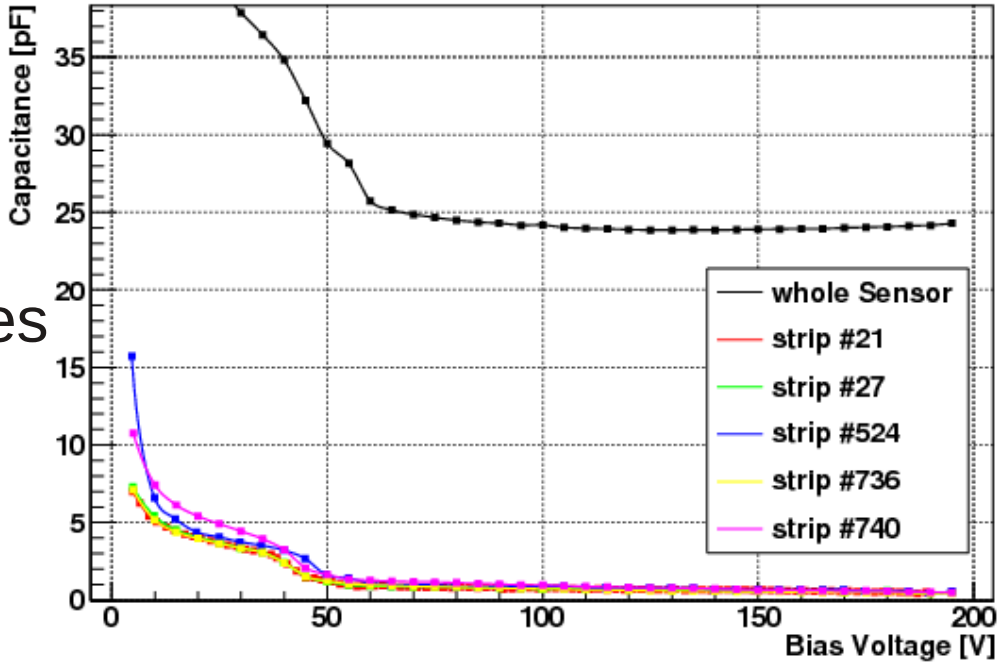
- **Probecard setup:**
  - sacrifice one sensor for complete characterization





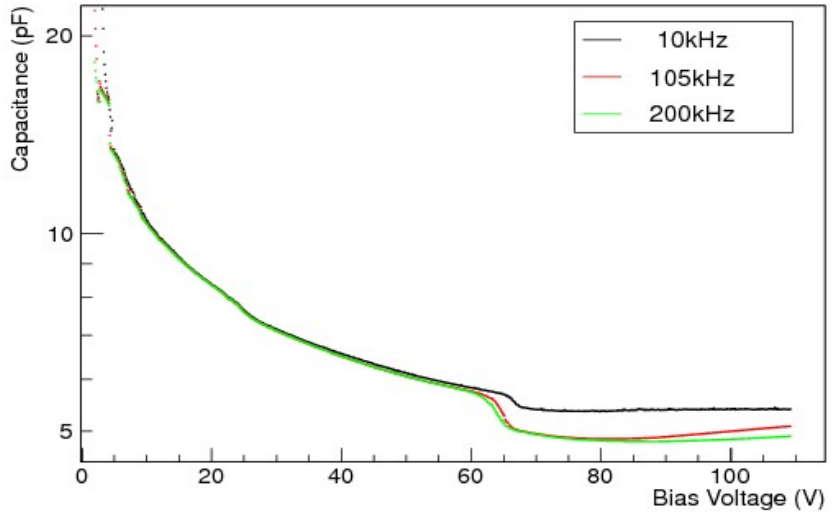
Sensor Characterization

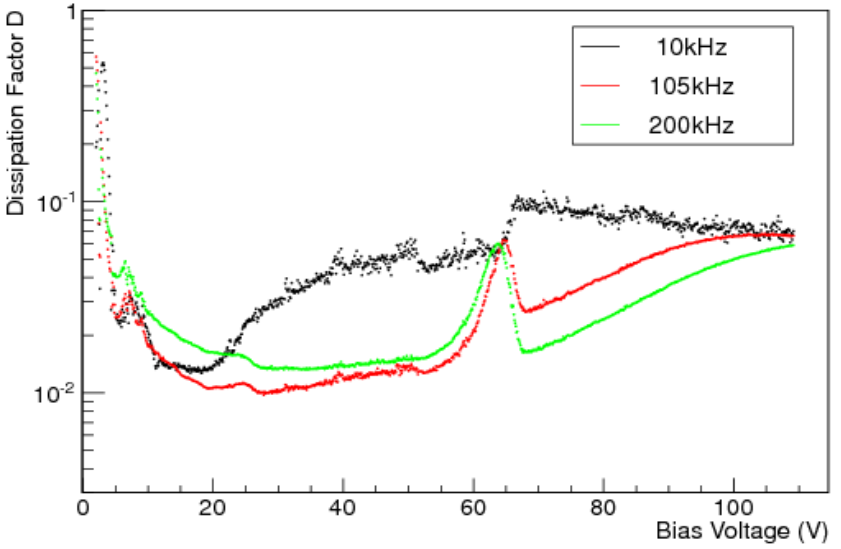
- **Probecard setup:**
  - sacrifice one sensor for complete characterization
- **Probestation setup:**
  - Measure I-V and C-V curves for individual monitoring of each sensor of the same batch



Sensor Characterization

- **Wafer Test Diodes**
  - Use diodes to deduce sensor parameters (V_{dep},C_b,I_l)
  - Discrepancies between measurements and expectations





S1 Capacitances

Property		Capacitance			
		predicted	ITC01	CIS01-S1	CIS01-S4
c_{is}	(pF/cm)	2.0	2.4(2)	2.88(15)	—
				2.70(6)†	
c_b	(pF/cm)	0.25	—	0.2290(4)†	—
c_c	(pF/cm)	>10	11(1)	p: 41.6(6)	p: 51.3(10)†
				p: 54.0(15)†	
				n: 46.3(9)†	
C_{stray}	(pF)	—	—	0.025(2)‡	—
				0.026(2)‡	—

Table 4.3.: Values for sensor capacitances predicted from geometrical capacitor model with edge fringing (c_b) or reported values for similar sensor configurations (c_{is}) [139,153,154] and measured values for three different sensor types. (†) indicates that the corresponding values were obtained with the probe card setup, the values marked with (‡) were reconstructed based on the measured stray capacitance C_{p-n} between the bias contacts.

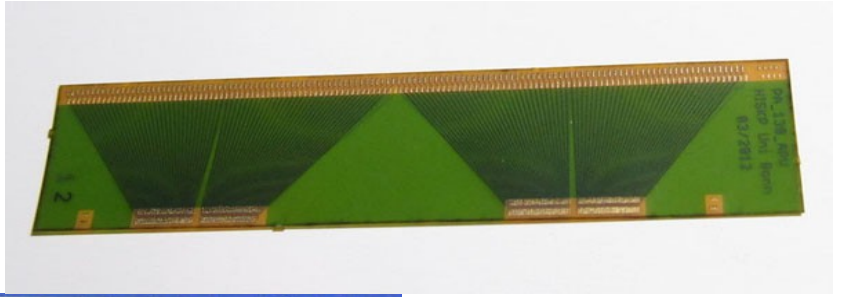
- For the PANDA full-size sensors we determine the total single strip capacitances (=FE-input load cap.):
  - p-side (l=58.275mm): 9.8±0.2 pF
  - n-side (l=33.315mm): 17.1±0.4 pF

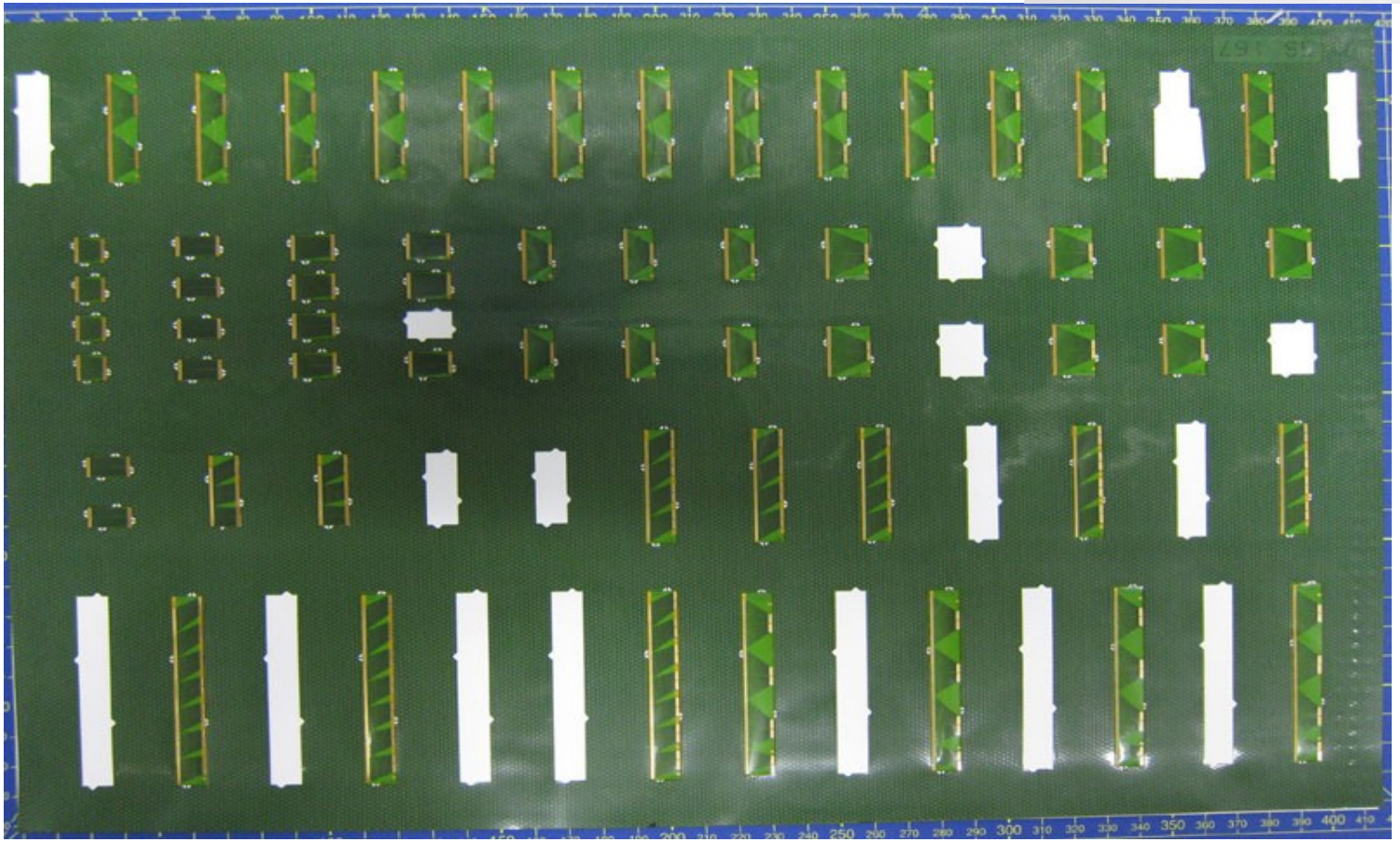
- New sensor run started (submitted still this year)
  - Same geometries, sizes, pitches as 2010 run
  - Poly-silicon instead of punch-through biasing
  - 10 masks can be reused, 2 modified, 2 new

Flex Prototypes

Pitch Adaptors

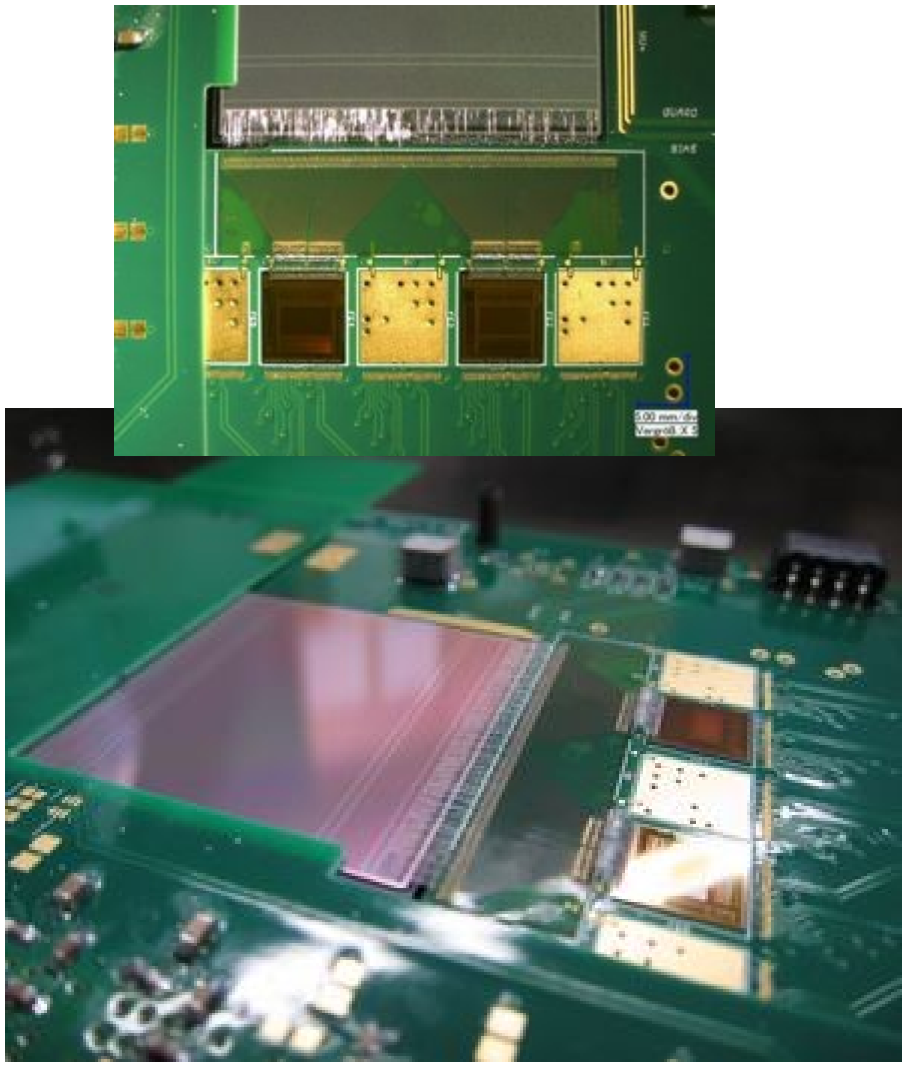
- For APV, n-XYTER, FSSR2
- For 50µ, 65µ and 130µ fanout
- 1,2,3,3.5,4 and 7 FE adaptors

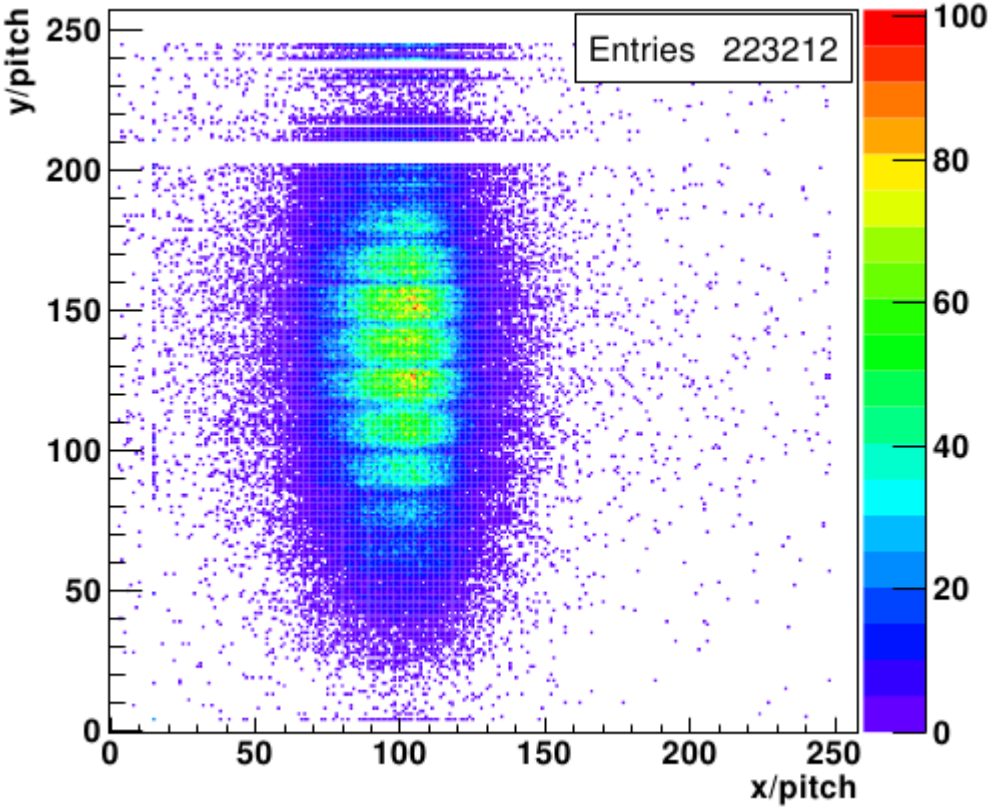




Flex Prototypes

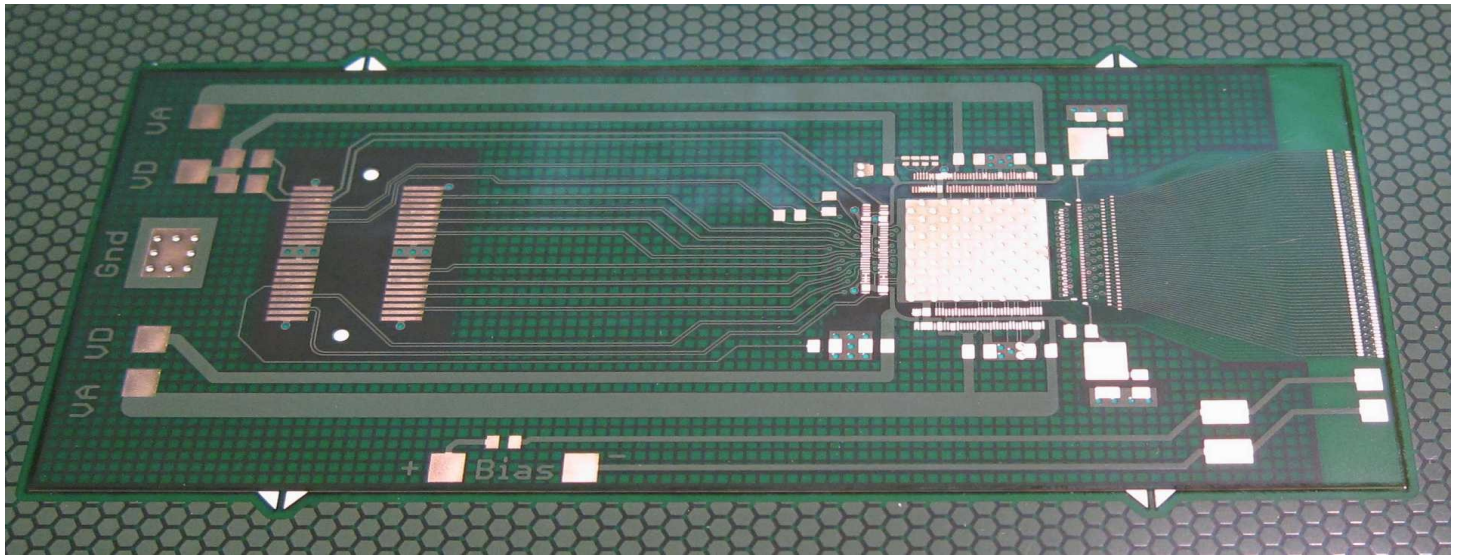
- For hybrid assemblies
- S2 sensor (3.3x3.3cm^2), 130µ pitch, 2 APVs
- Successful test SPS@CERN in autumn 2012





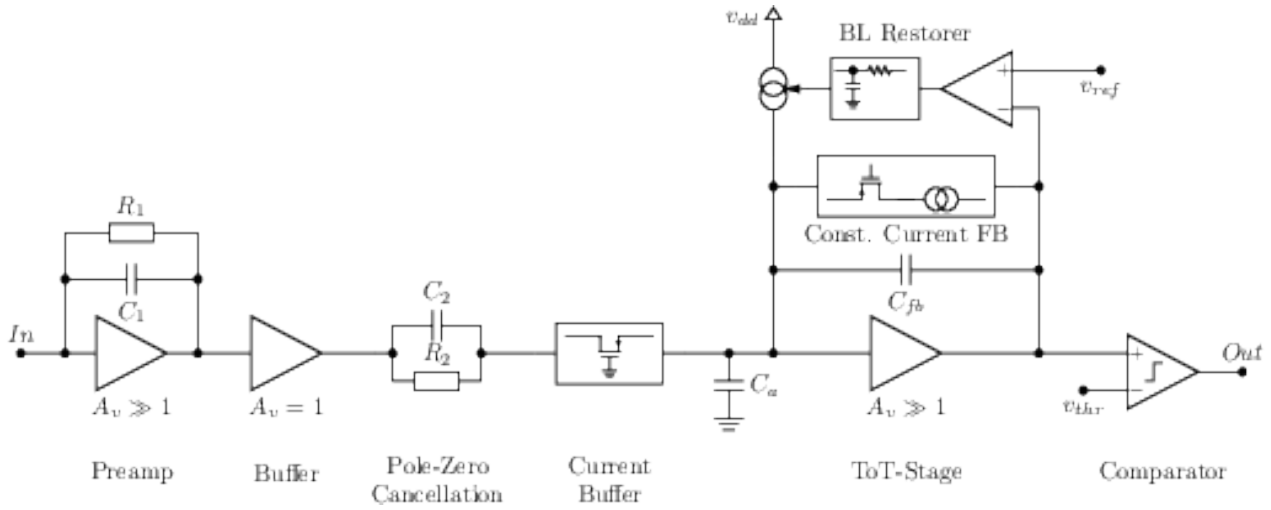
Flex Prototypes

Single FE flex
delivered, yet to be mounted

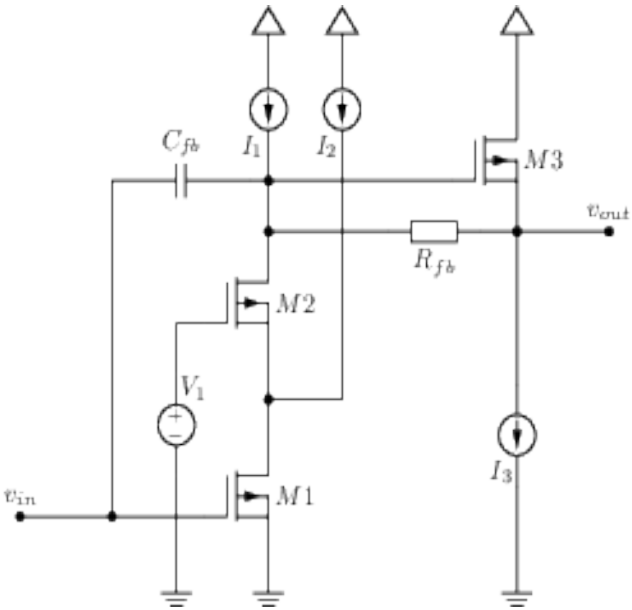


FE Noise Calculations

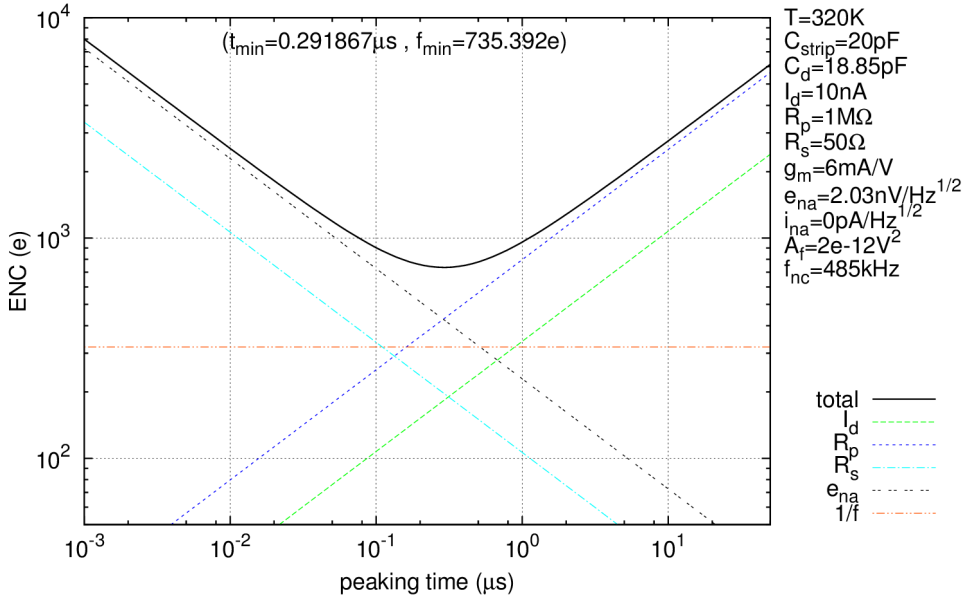
FE single channel topology



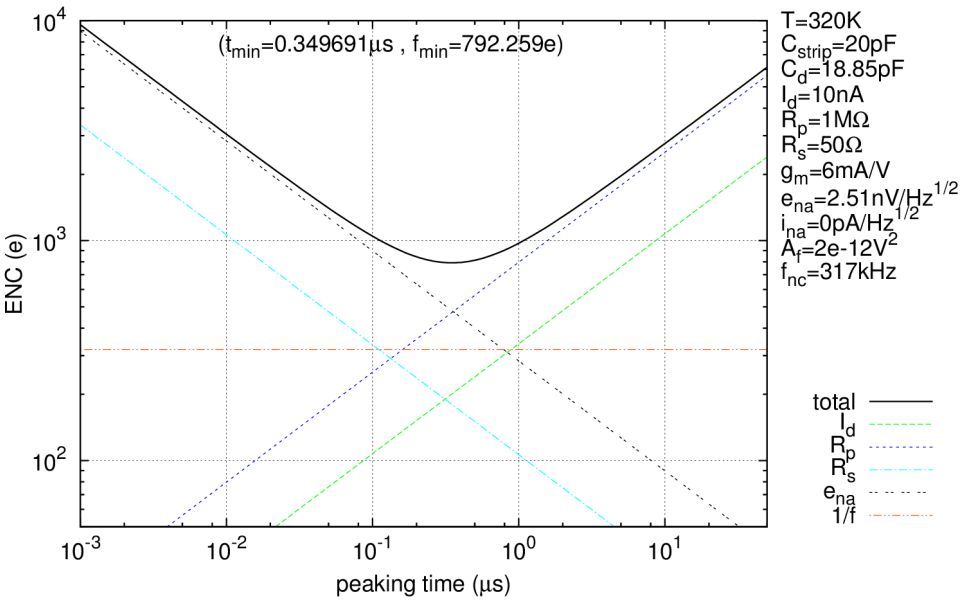
Preamp stage



FE Noise

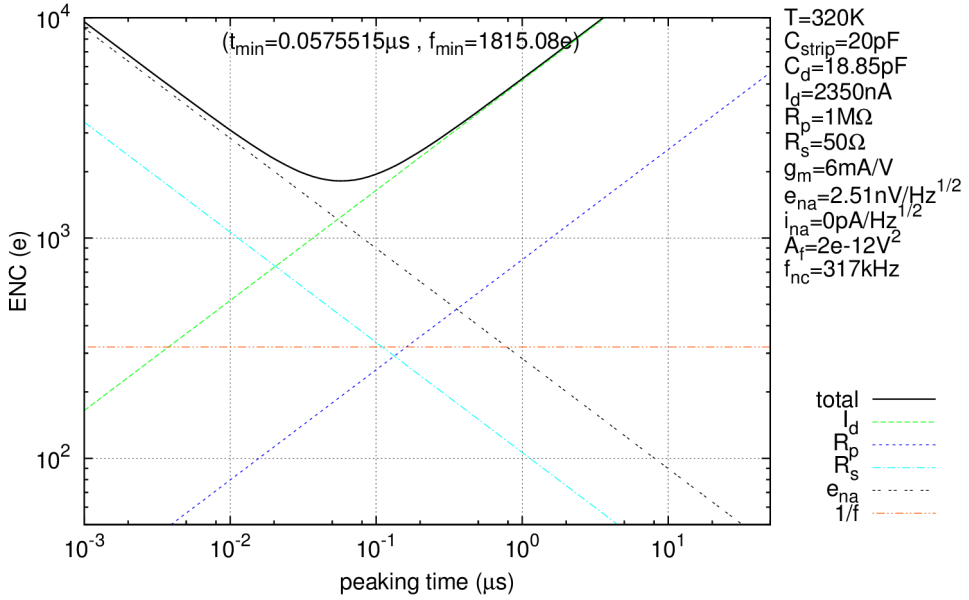


Initial noise figure

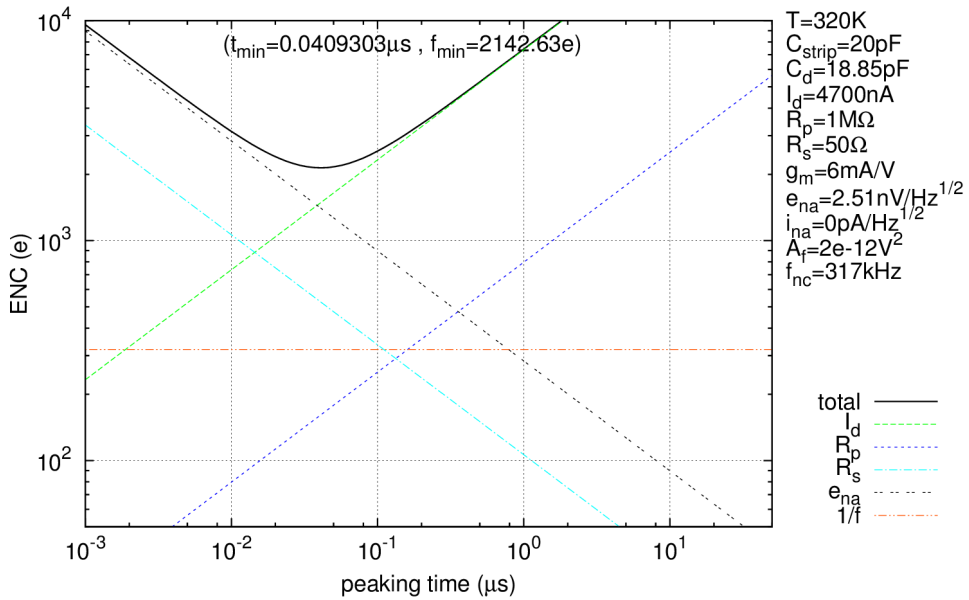


5 Mrad, FE only

FE Noise

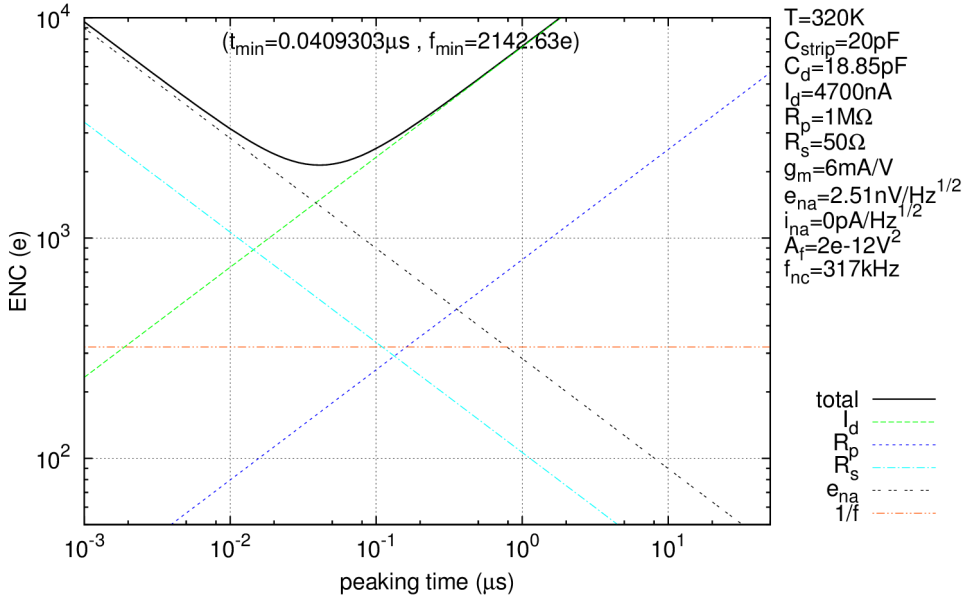


5e13 n-eq. sensor

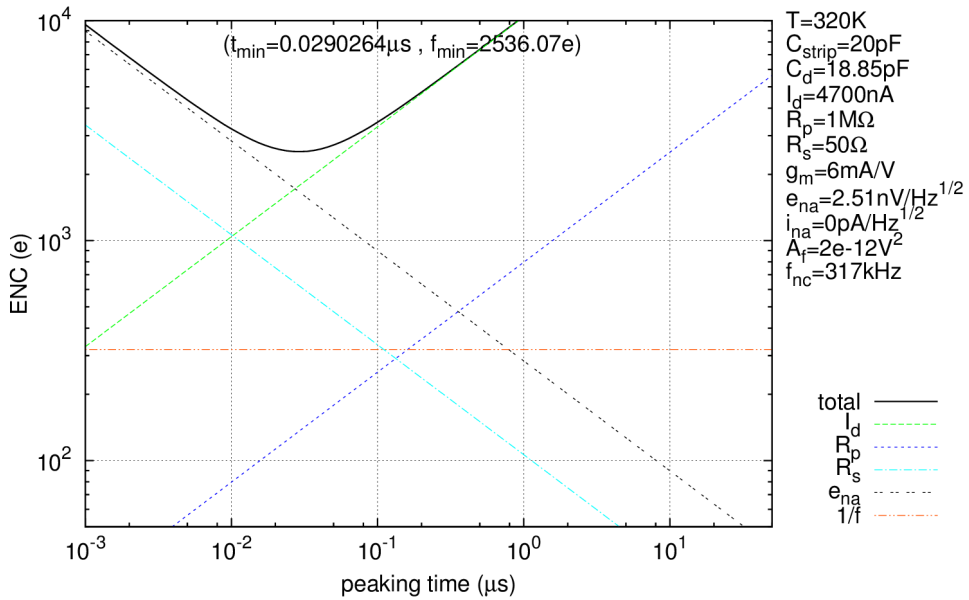


1e14 n-eq

FE Noise



1e14 n-eq. Poly-Si biased sensor

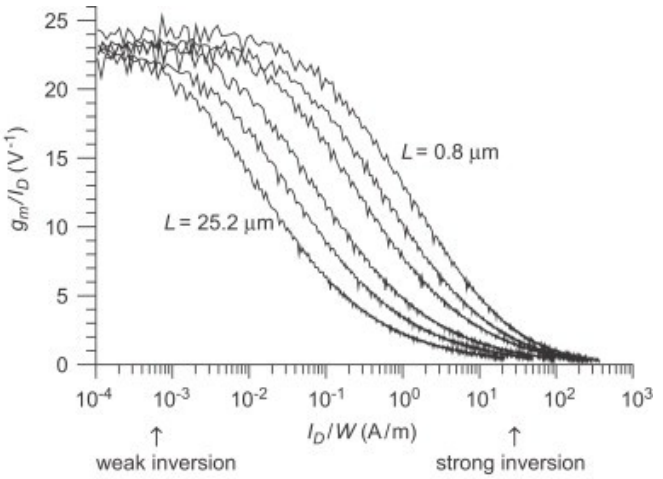


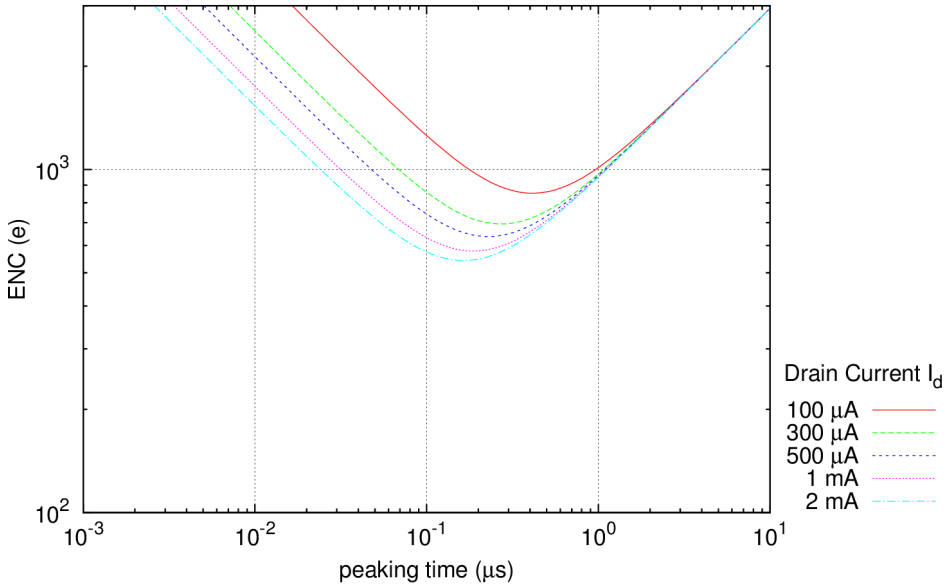
1e14 n-eq. Punch-Through biased sensor

FE Noise

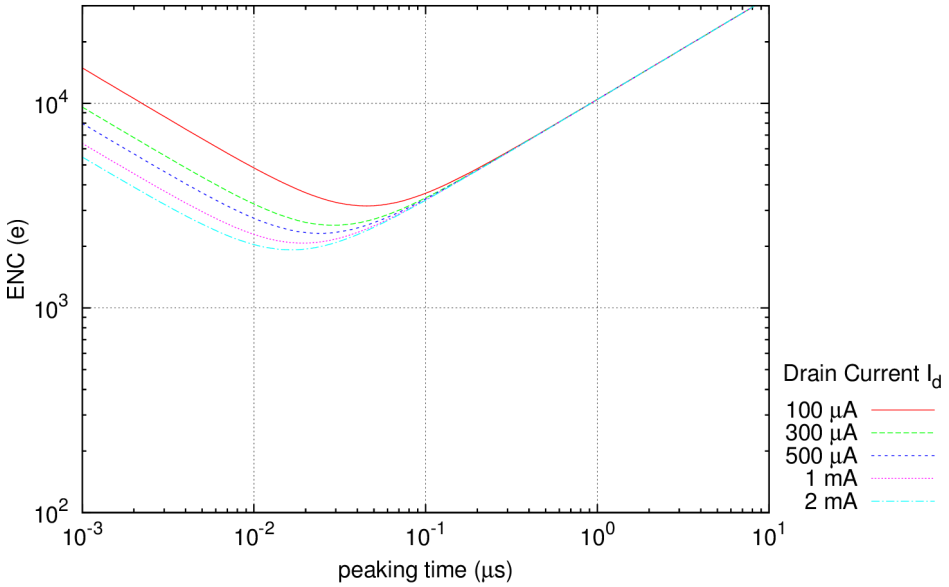
Var. M1 drain current

$$q_{na}^2 = 4kT\gamma_n \frac{1}{g_m}\frac{C_d^2}{\tau} + A_f C_d^2$$





Initial (no irrad.)



1e14 n-eq.