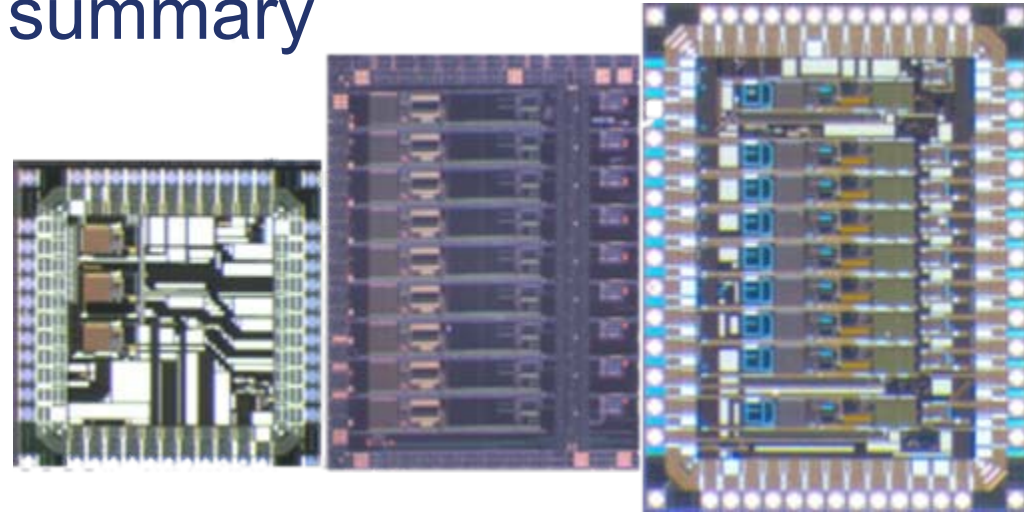


Front-End readout for LAr TPC

- Previous test chip summary
- Test circuit Setup
- Perspectives



GAr : Gaseous Argon @120K

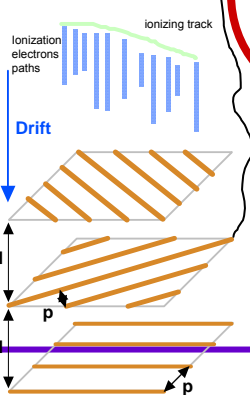
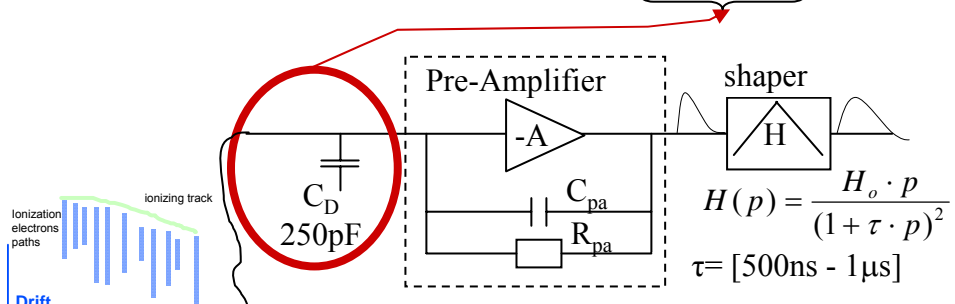
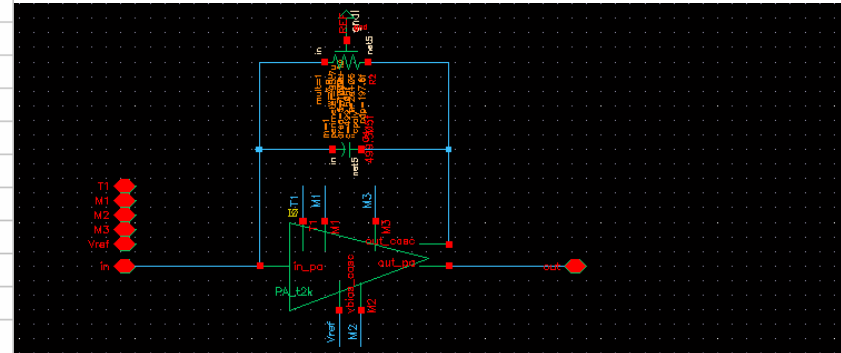
LAr : Liquid Argon @89K

TPC : Time projection Chamber

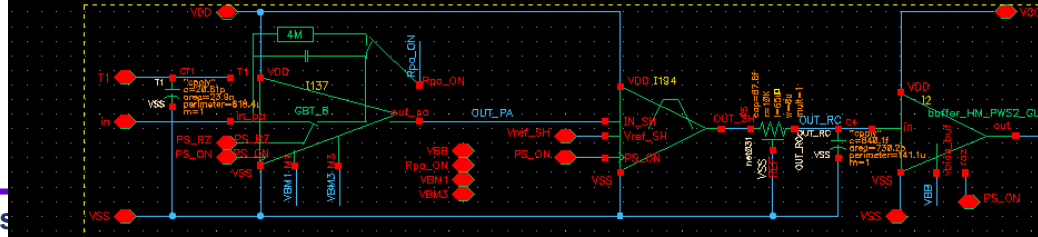
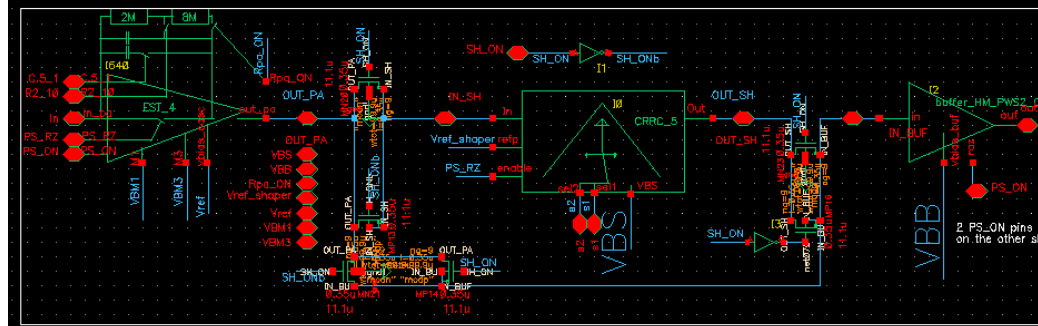


T2K version 1-2-3

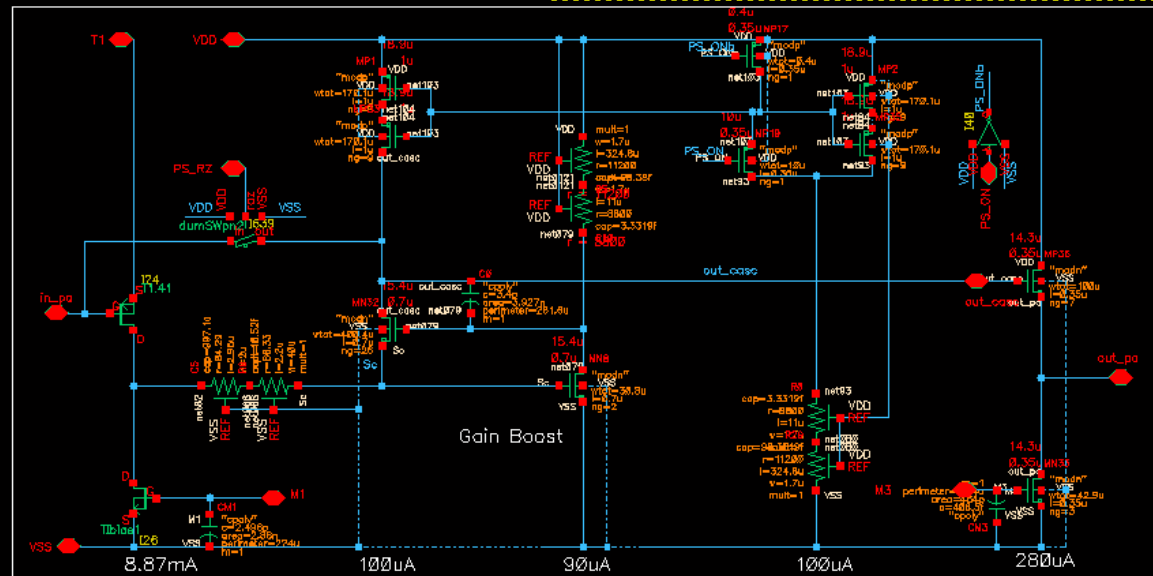
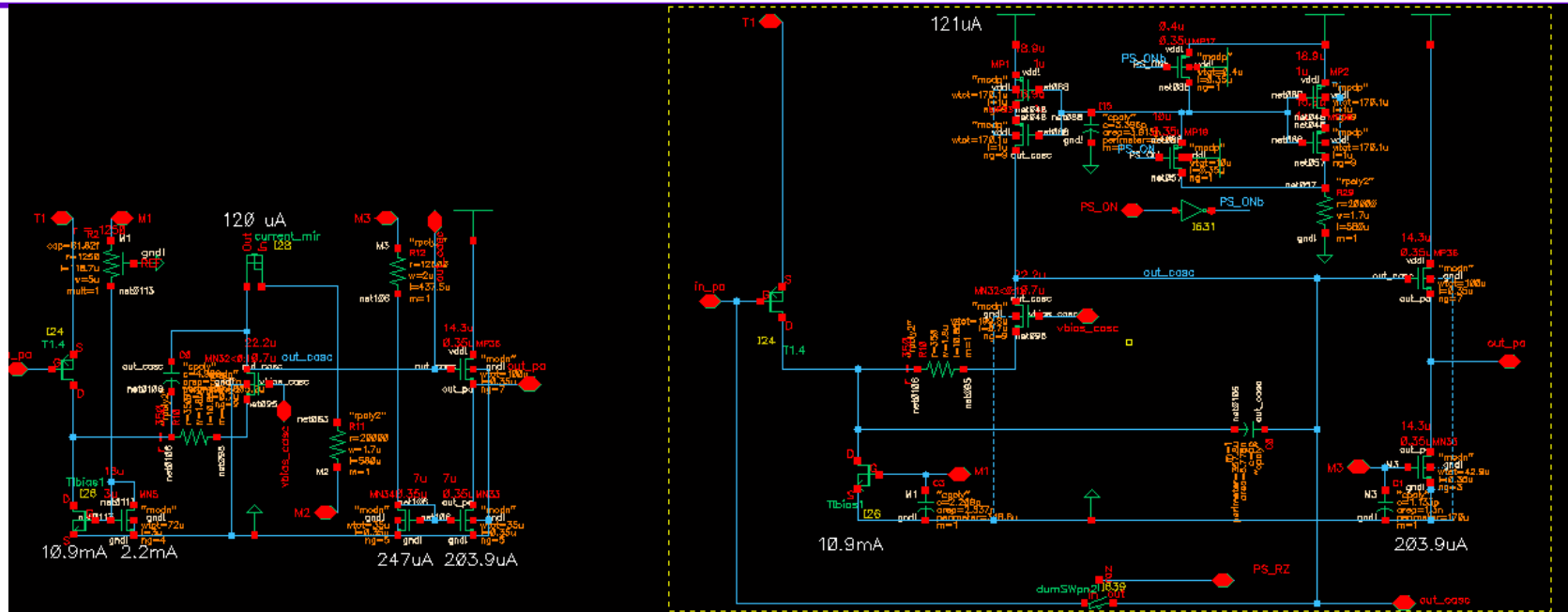
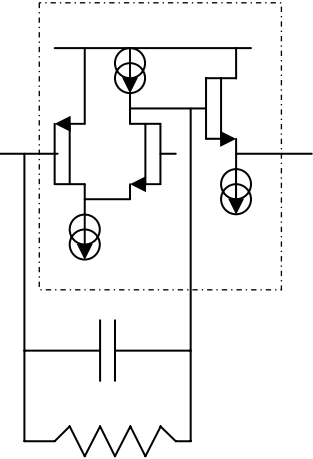
	temp (°C)	GBW (MHz)	Rpa (MΩ)	Cpa (fF)	Tau filter (μs)	peakTime (ns)	ENC_th (e-)	ENC_exp (e-)	Gain_th (mV/fC)	Gain_exp (mV/fC)	X-talk_exp
T2K_V1 PA_TOP	27	593	2 500	-	595 ns	1938	2261	1.25	1.3	~1%	
	-150	972.3	2 500	-	559 ns	1158	1847	1.32	1.4		
T2K_V2 TOP_EST	27	790.4	2 500	-	515 ns	2095	2590	1.27	1.13	~6%	
		10 500	1	924 ns	1338	4071	2257	3.54	2.9		
	-150	10 500	1	1323 ns	1053	2116					
		1275	2 500	-	515 ns	1220	4160	1.35	1.06		
T2K_V3 TOPPING	27	693	4 250	-	[0.5-4]	1367 ns	1161		7.89	7.2	~0.5%
						689 ns	776		2.95	3.2	
	-150	1884	4 250	-	[0.5-4]	1314 ns	590		8.29	9	



- Dynamic range x40 : $Q_{in}(MIP) = 18\ 000\ e^- (2.7fC)$
- S/N > 10 which mean $ENC \leq 1000\ e^- @250pF$
- Possible pile up

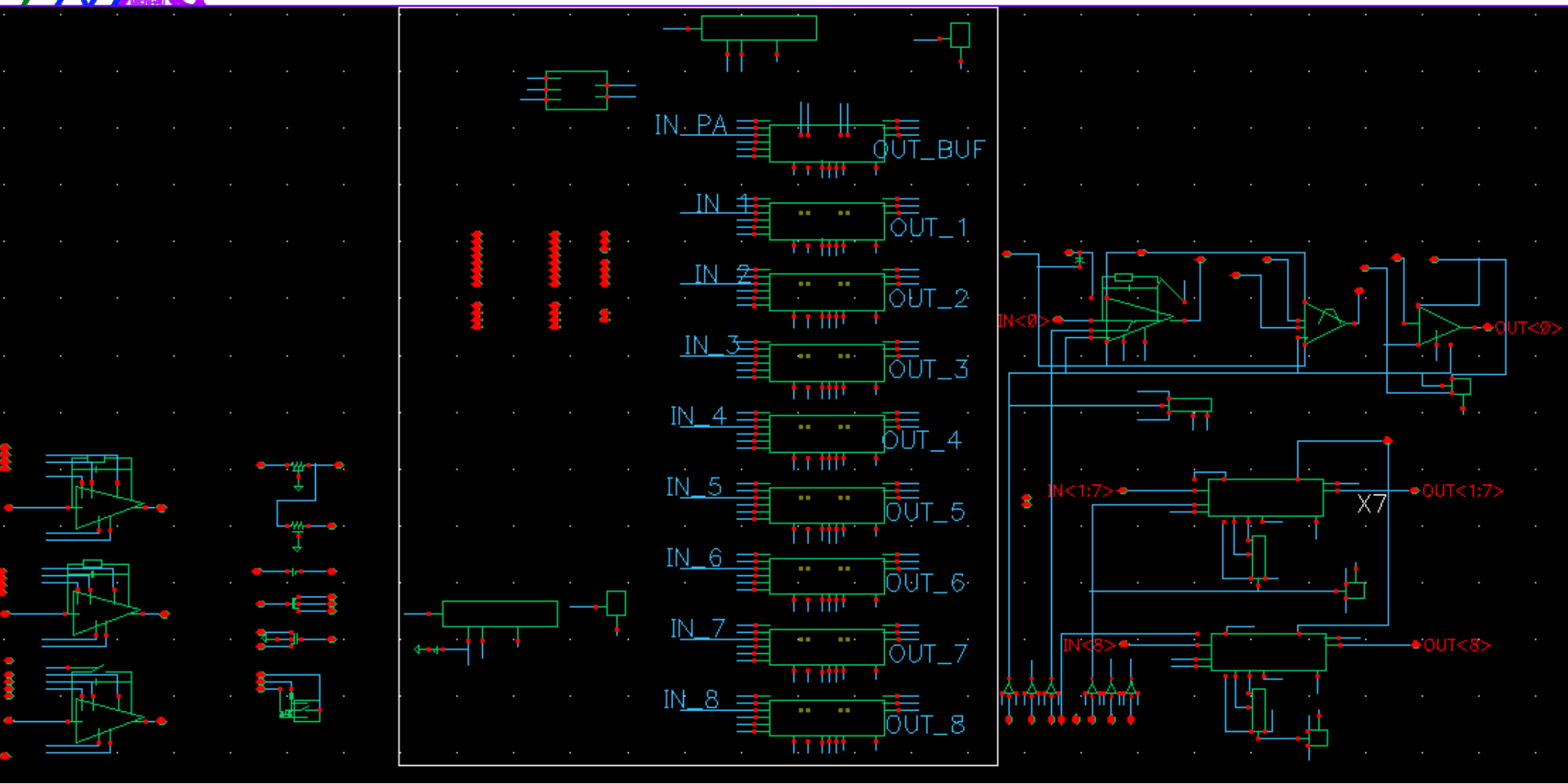


T2K version 1-2-3





T2K version 1-2-3

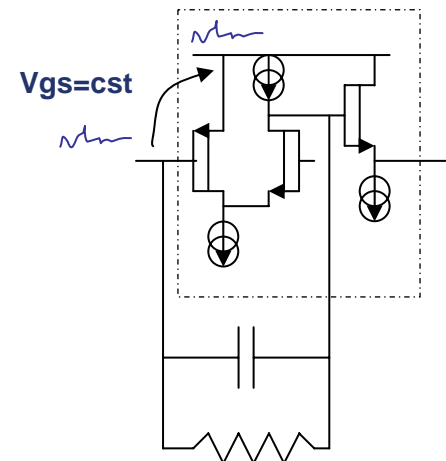




Version 1 : PA_TOP

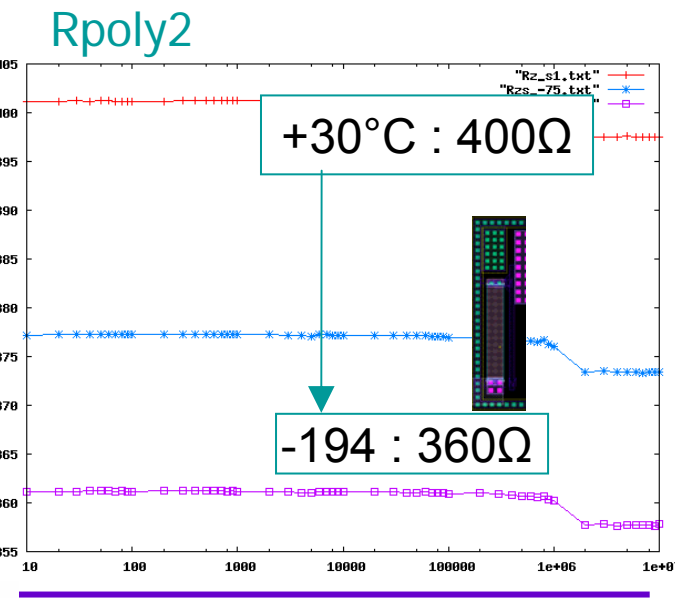
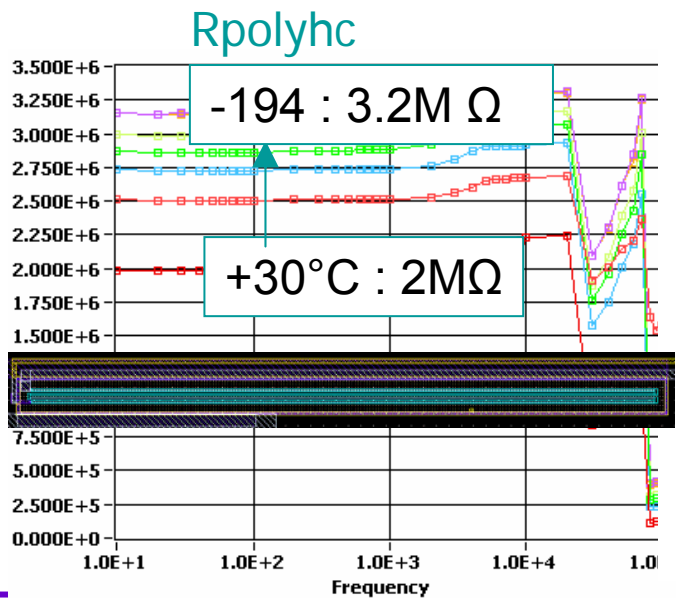
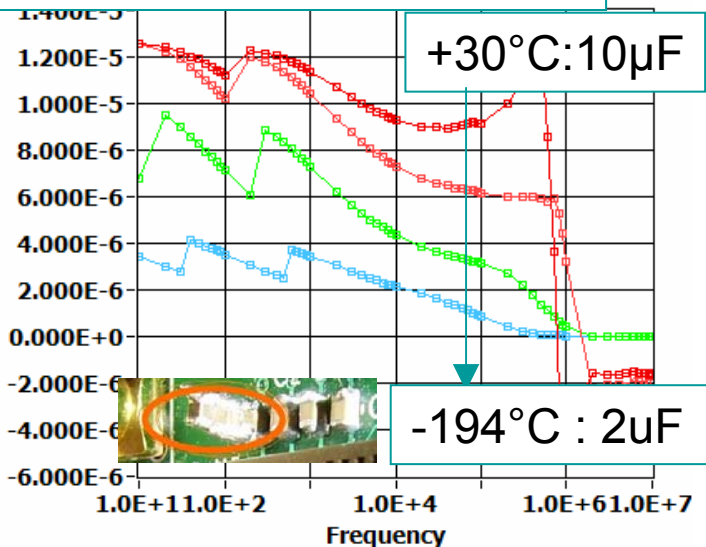
Circuit	2M Ω			
	PA		Shaper 1 μ s	
temperature	th	exp	th	exp
30	2040	2261	1530	1590
-111	1722	1847	1002	1166

$$\begin{aligned} \text{ENC} &= 426.1 + 5.0 * \text{Cdet}; 2\text{M_30_1u} \\ \text{ENC} &= 318.2 + 3.9 * \text{Cdet}; 2\text{M_100_1u} \\ \text{ENC} &= 248.2 + 4.4 * \text{Cdet}; 2\text{M_200_1u} \end{aligned}$$



- ENC= 1166 with external shaper @ 1 μ s
- PA_TOP 1% X-talk
- Baseline slow frequency noise
 - Pure integ ($R_{pa} \infty$) > 20M Ω > 2M Ω ($Z_{in}=R_{pa} // C_{pa} \% A_o$)
 - Not present with battery supply

Power supply Decoupling : X5R oxide 10 μ F -> 2 μ F

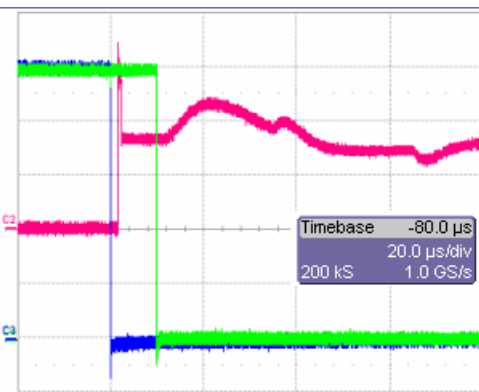
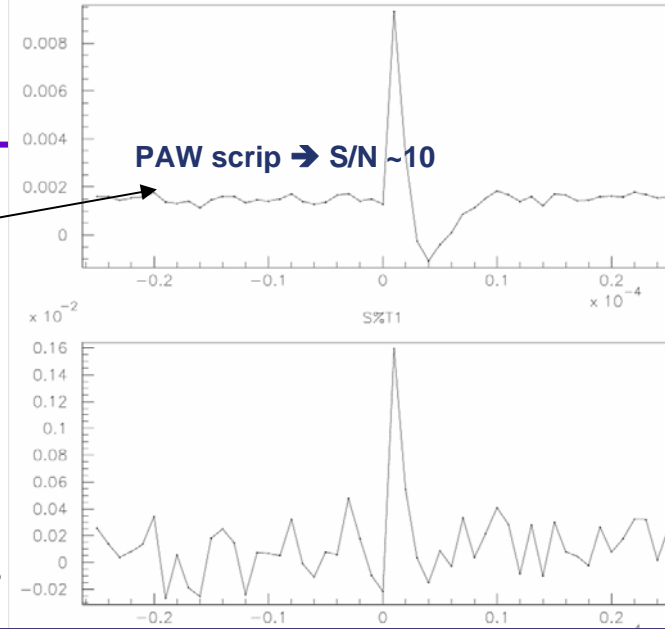




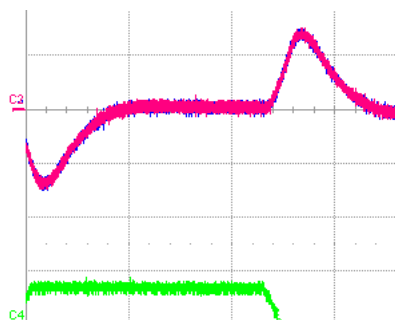
Version 2 : TOP_EST

Version 2 details to be improved

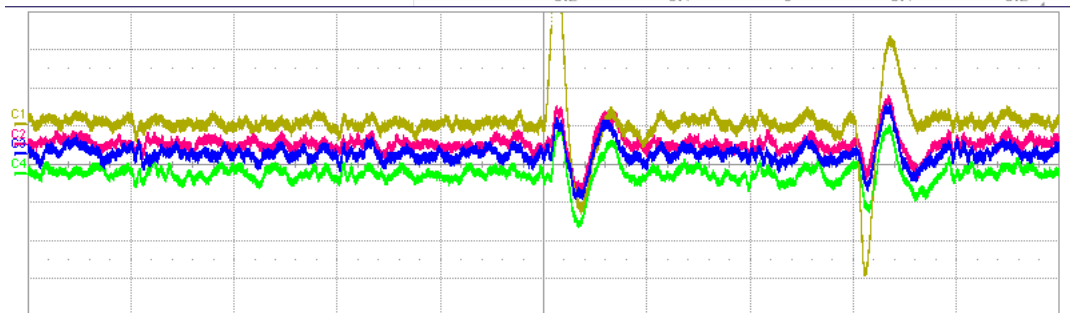
- Common channel baseline noise (offline suppress?)
 - > Direct ENC measures are not correct
- Non fully bi-directional shaper (offset crossing)
- 6% X-talk (common on all channel not only neighbors)
- 50 μ s Power ON



Edouard BECHETOILLE



micro-electronic



Measure value

P1:min(C4)

P2:max(C4)

P3:sdev(C4)

P4:min(C2)

P5:max(C2)

P6:sdev(C2)

-14.1 mV

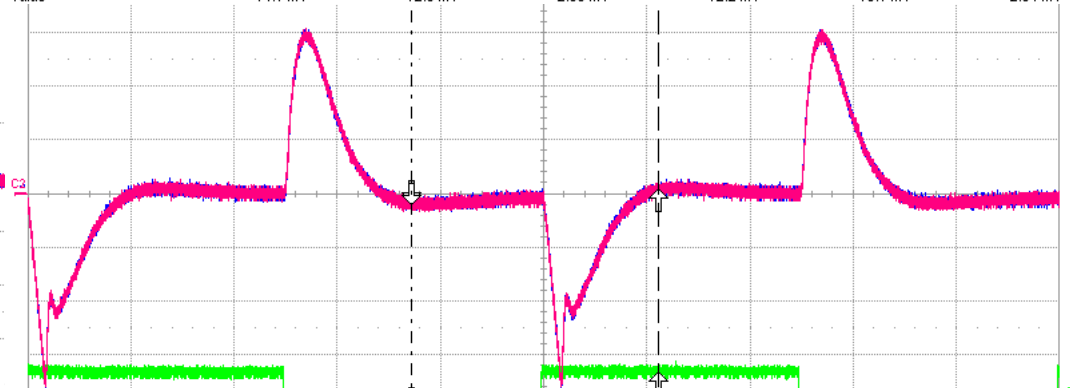
12.8 mV

2.90 mV

-12.2 mV

13.1 mV

2.64 mV



Measure

P1:max(C1)

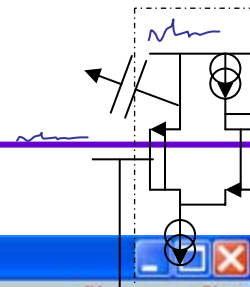
P2:sdev(C3)

P3:max(Math)

P4:min(Math)

P5:rise(Math)

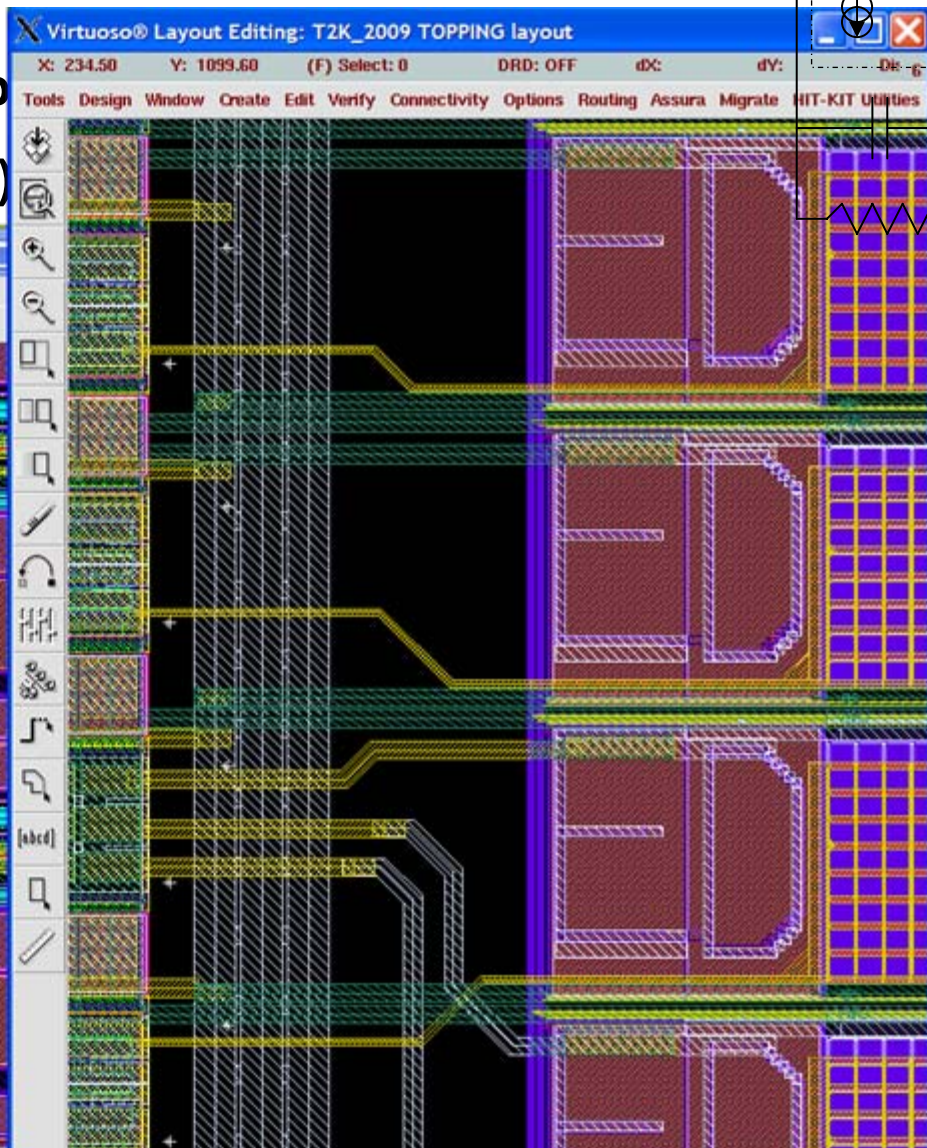
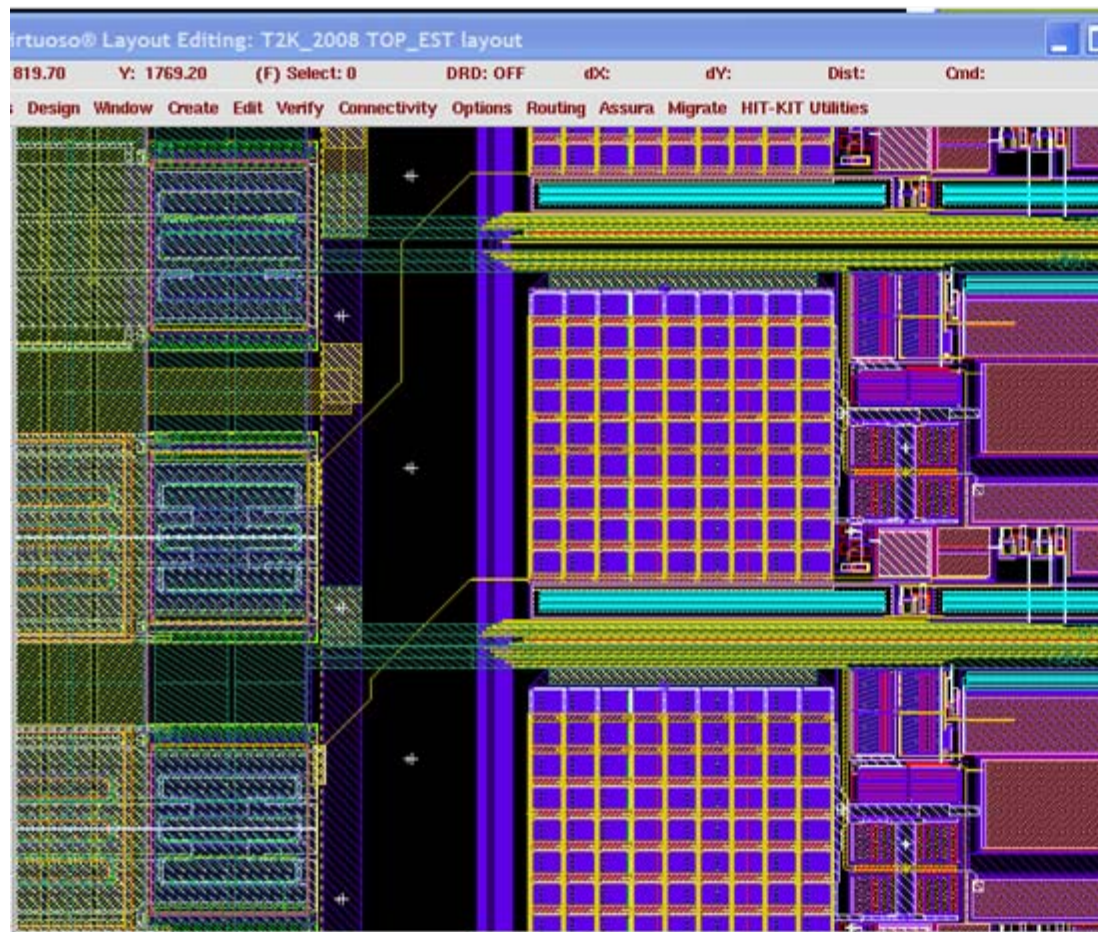
P6:fall(Math)

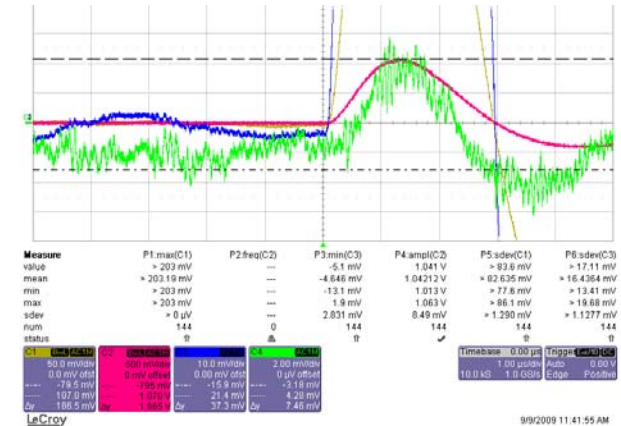
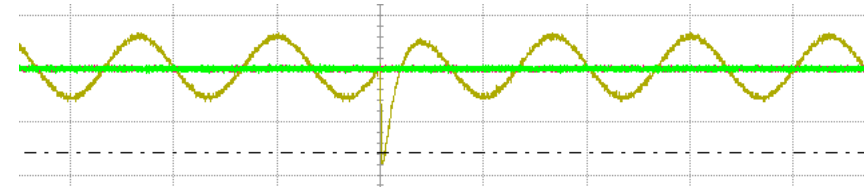
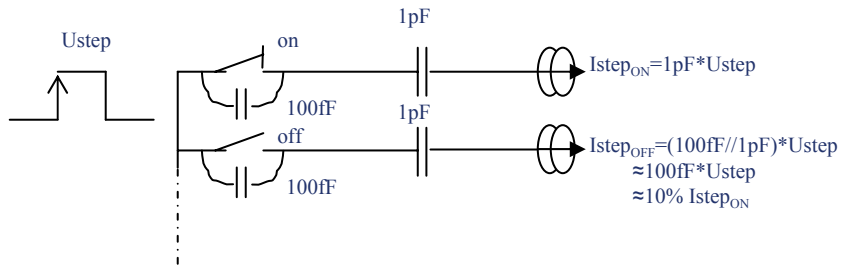


Minimize Z_{in} \Rightarrow increase Gain \Rightarrow Gain Boost

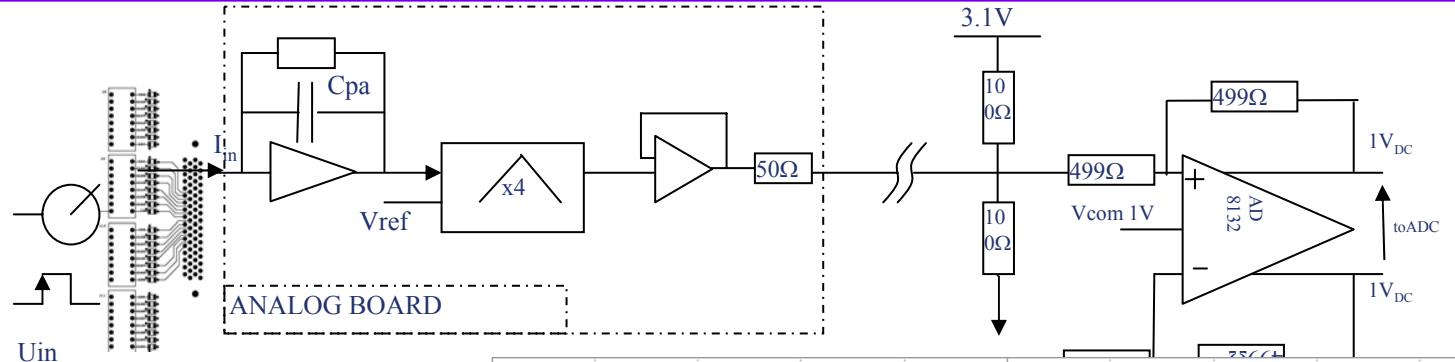
Filter the source of the input transistor with 20p

'Star' layout for VDD nets (MET4 too resistive ?)

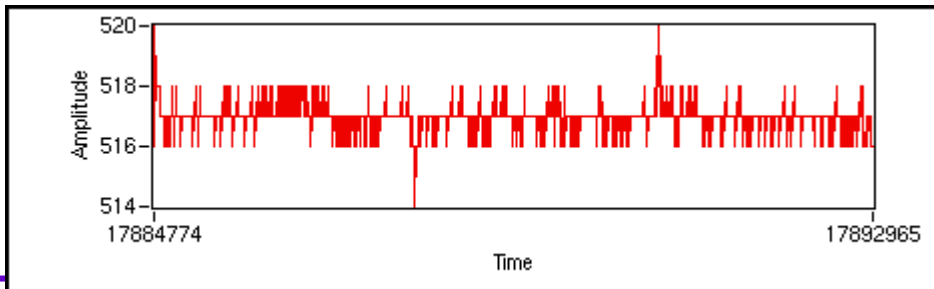
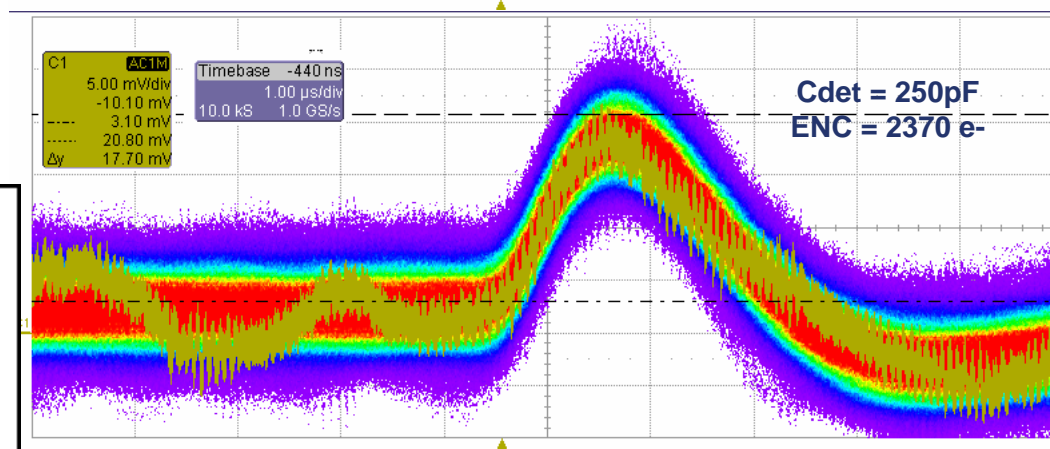
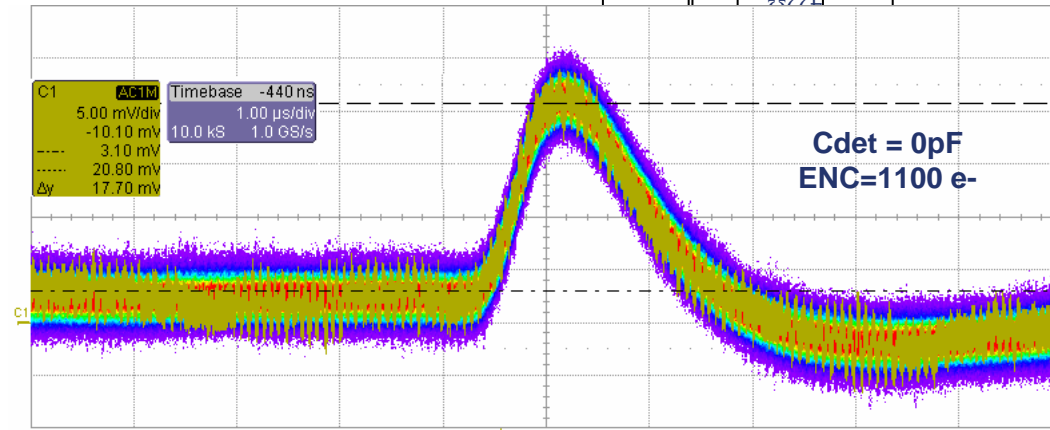
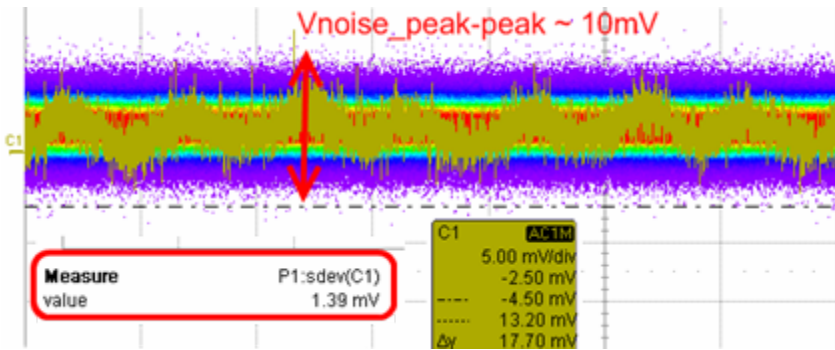




- Multi-channel Injection setup X-talk
- ‘ON chip’ X-talk : 0.5%
- TOPPING details to be improved
 - circuit resonates in cold temperatures ‘sometimes’
 - Improved setup shielding
 - Gain (mV/fC) needs to be improved (7mV/fC → 30mV/fC)
 - Peak tot peak ENC needs to be improved
- On going test ...



- Auto-trigger DAQ
 - → peak to peak noise instead of rms noise



Setup de test

- Avoid tantalum capacitances when *dropped* in liquid N2 (additional disturbances after re-warming)
- Ceramic capacitance decreases with temperature, but still behave correctly. 10 000 μF chemical works.
- Solder package (JLCC/PLCC might shrink/unconnect)
- Shielding/grounding

Skill pad box generator

- A simple pad-box generator is use as a start base for simple power supply chips (one VDD, one gnd)
 - generate rapidly layout, schematic and symbol.
 - (dbCreateInst cv (dbOpenCellViewByType padLib cadr(cListL) lay) nil (list isL*dX isH*dX+isL*sizeH) RL)

