

FULLY DIFFERENTIAL OPAMP

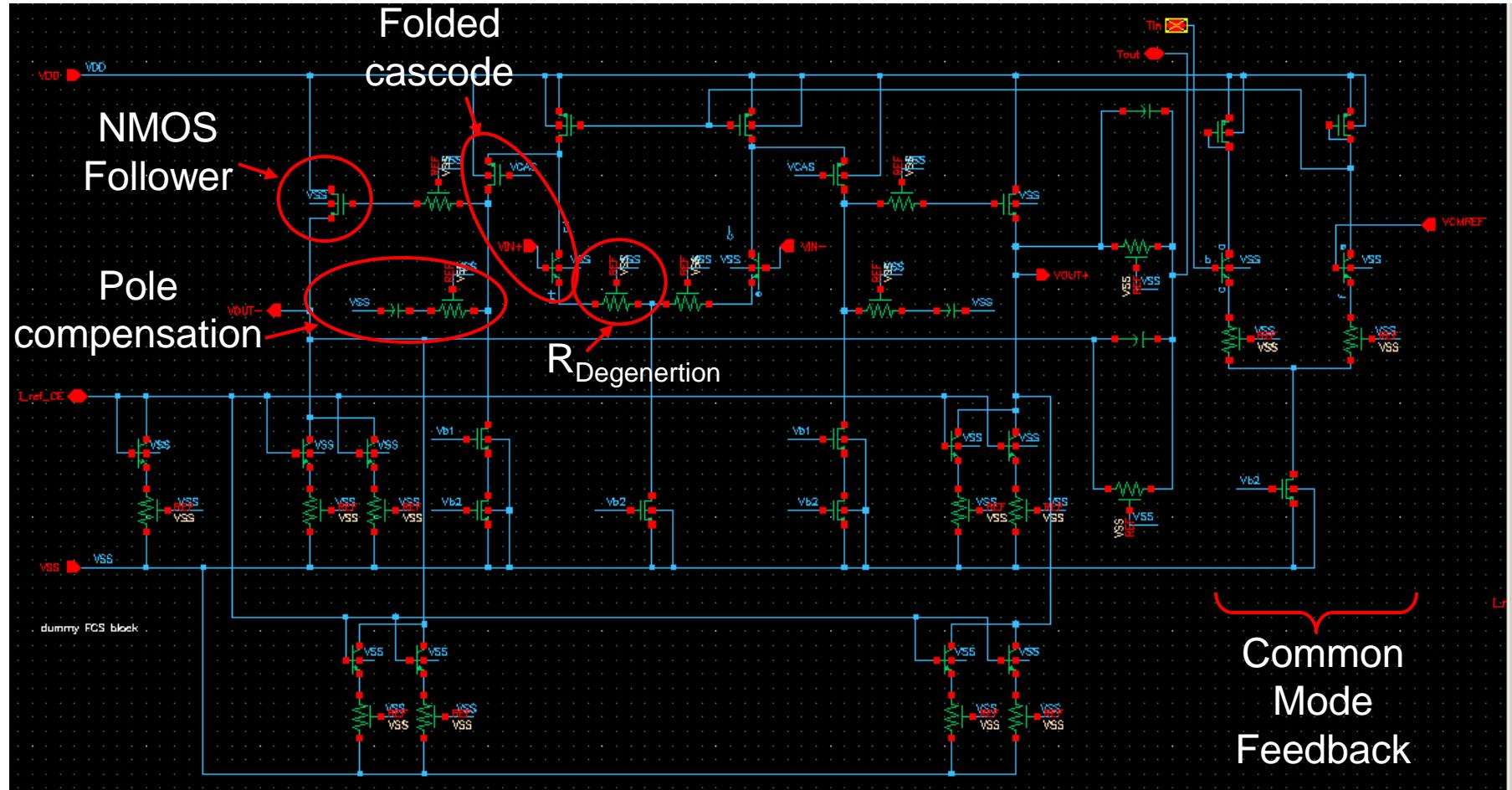
Eduardo Picatoste
Calorimeter Electronics Upgrade Meeting

Specifications

- Specifications of the fully differential operational amplifier to be used on the integrator stage:
 - Gain bandwidth $GBW > 500\text{MHz}$
 - Phase margin $> 65^\circ$
 - Common mode control
 - Slew rate $> 2 \text{ V}/\mu\text{s}$
 - $V_{CM} \sim 1.5 \text{ V}$

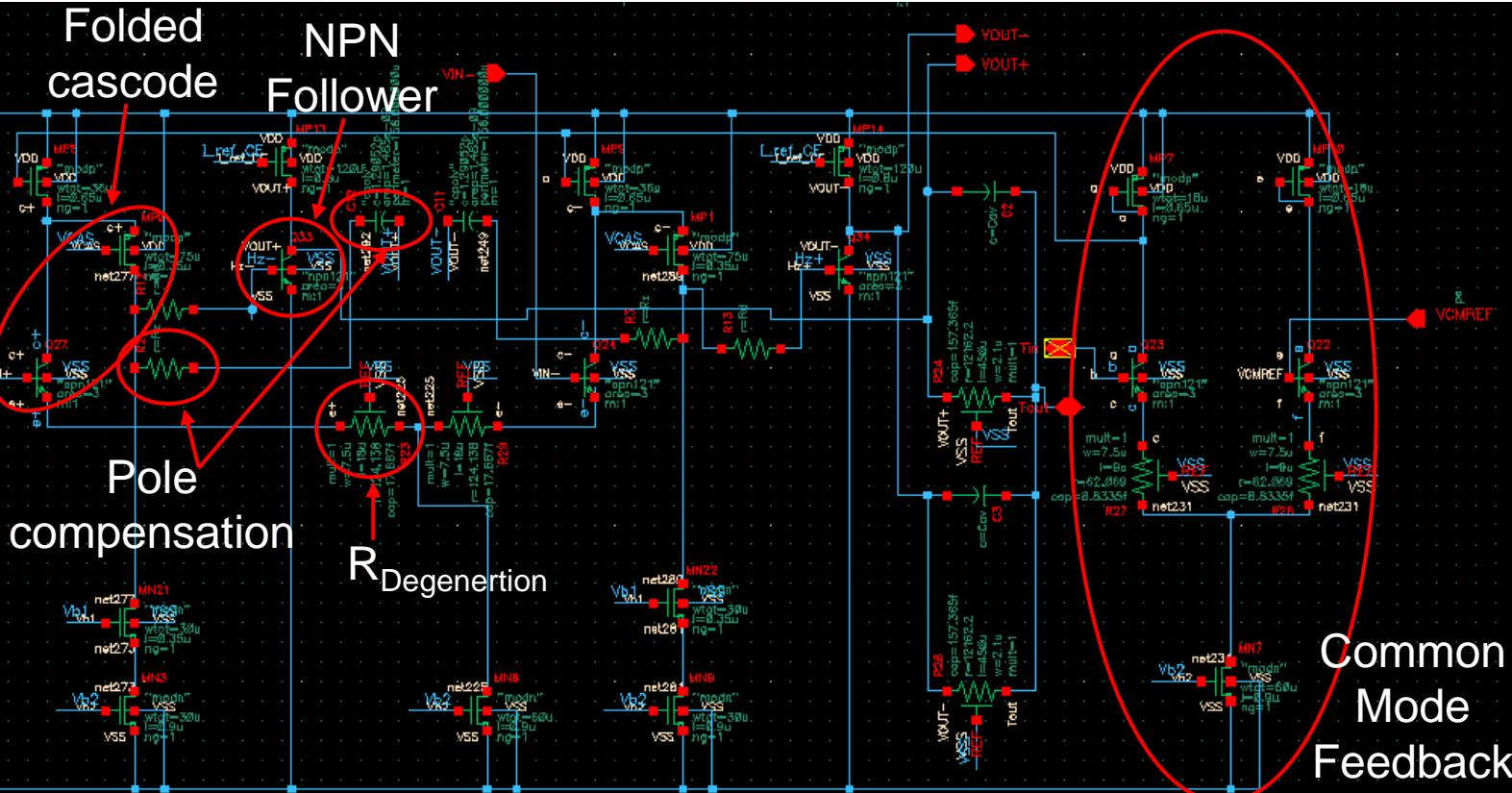
Design A

- Fully differential OpAmp



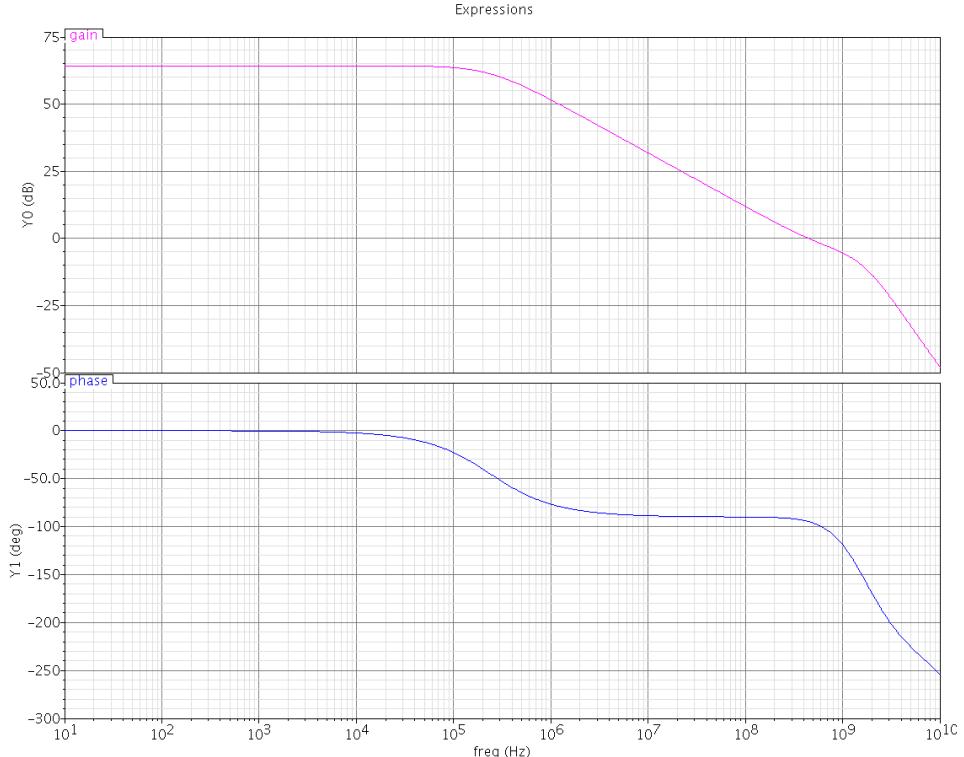
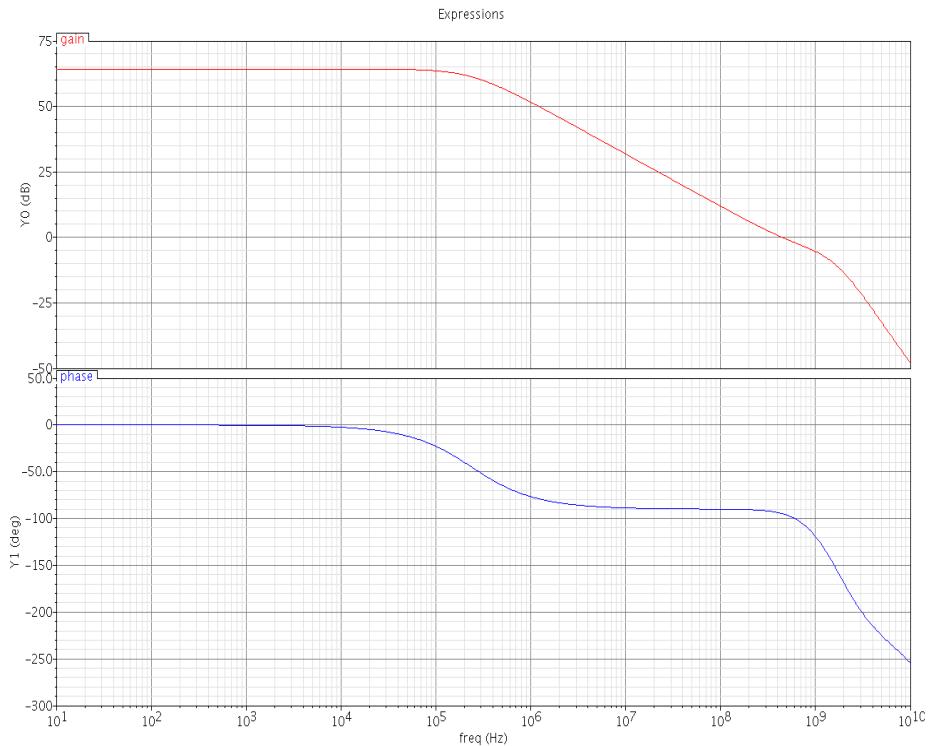
Design B

- Fully differential OpAmp



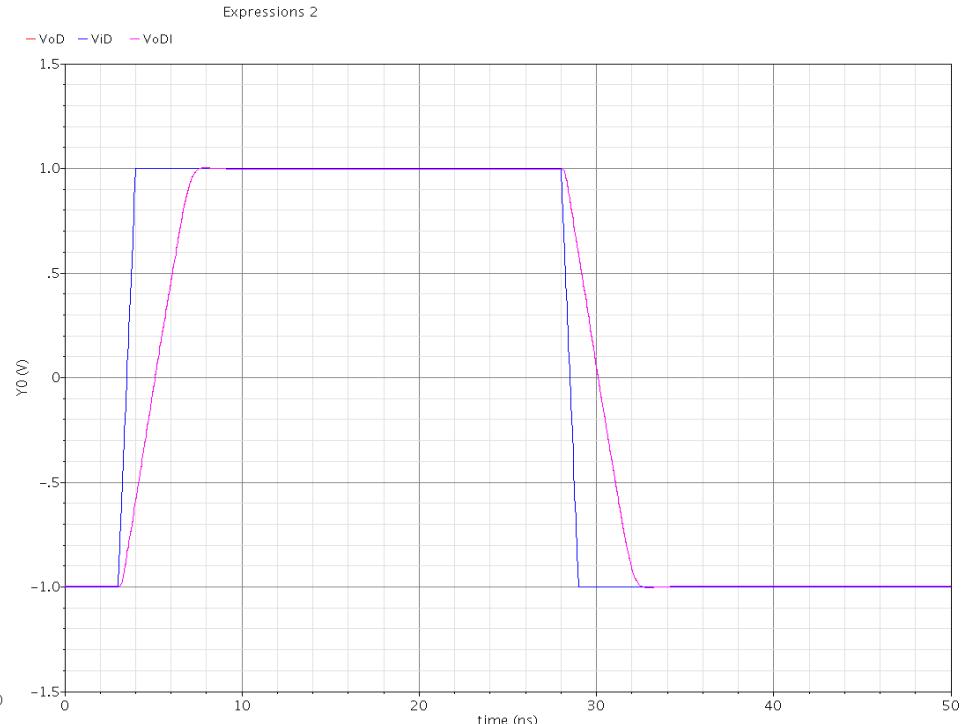
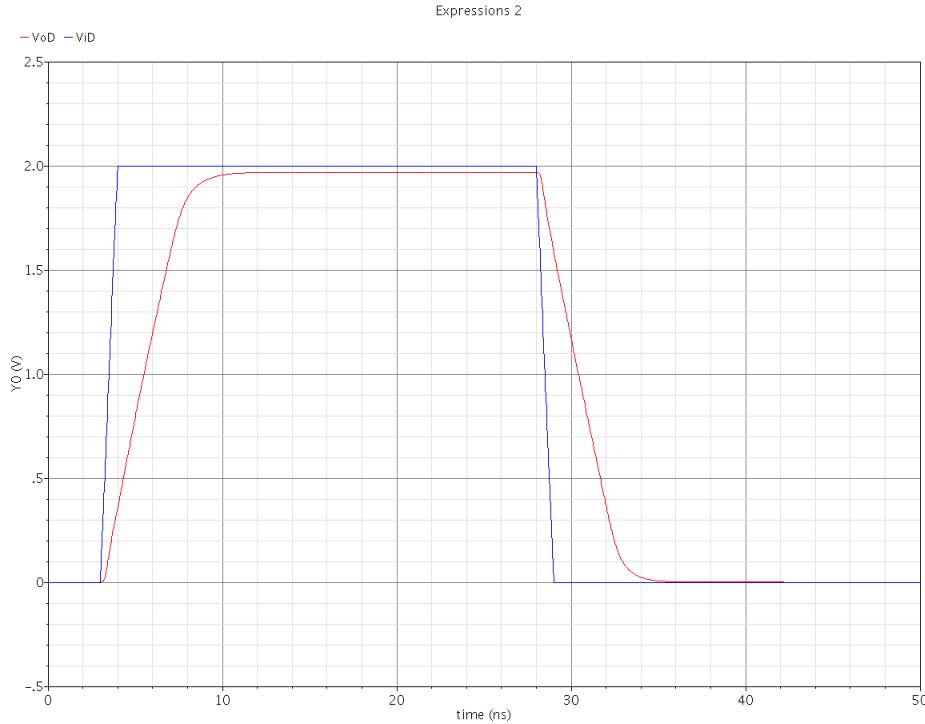
Gain, phase, and phase margin

- NMOS follower design (A):
 - Gain LF = 64.3 dB
 - BW = 237.5 KHz
 - GBW = 390.5 MHz
 - PM = 85.2°
- NPN follower design (B):
 - Gain LF = 75.8 dB
 - BW = 100.7 KHz
 - GBW = 587.5 MHz
 - PM = 84.1°



Slew Rate

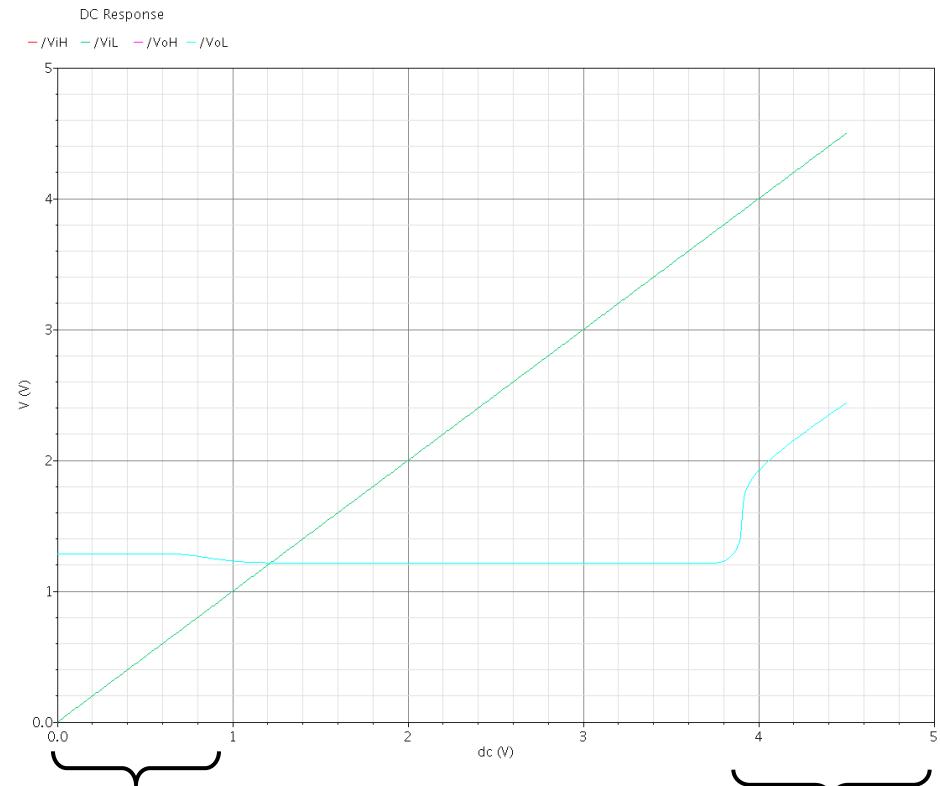
- NMOS follower design (A):
 - Rise time $t_r = 4.0 \text{ ns}$
 - Overshoot = 8 μV
 - SR = 396.3 V/us
- NPN follower design (B):
 - Rise time $t_r = 3.1 \text{ ns}$
 - Overshoot = 5.2 mV
 - SR = 515 V/us



Pulse width 25 ns and 2V high

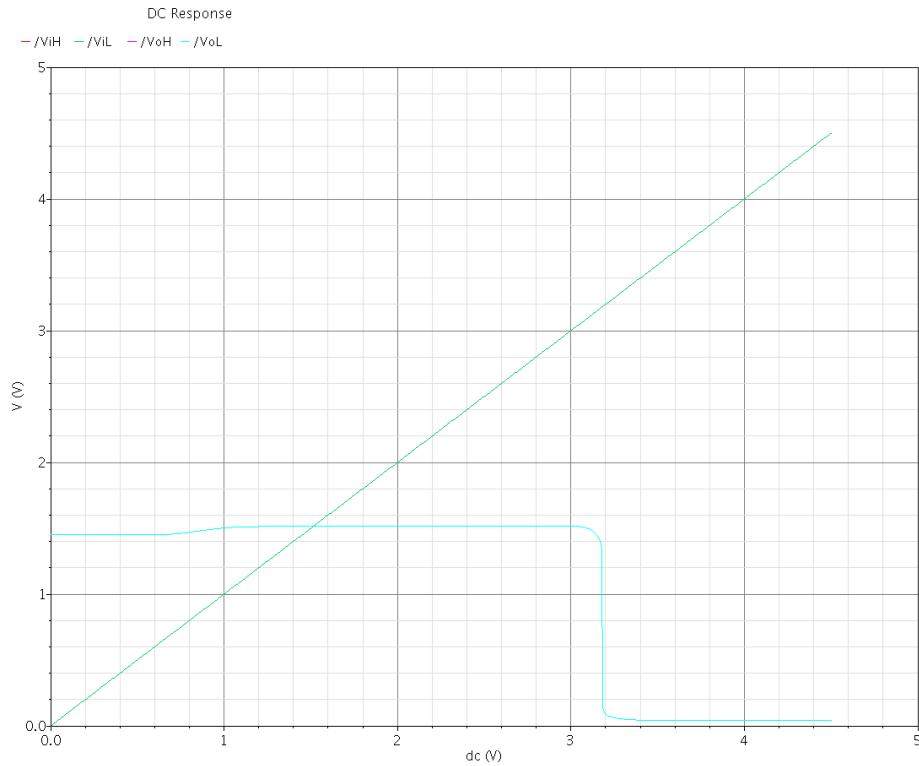
DC studies: input CM range

- NMOS follower design (A):



NMOS current source not in saturation

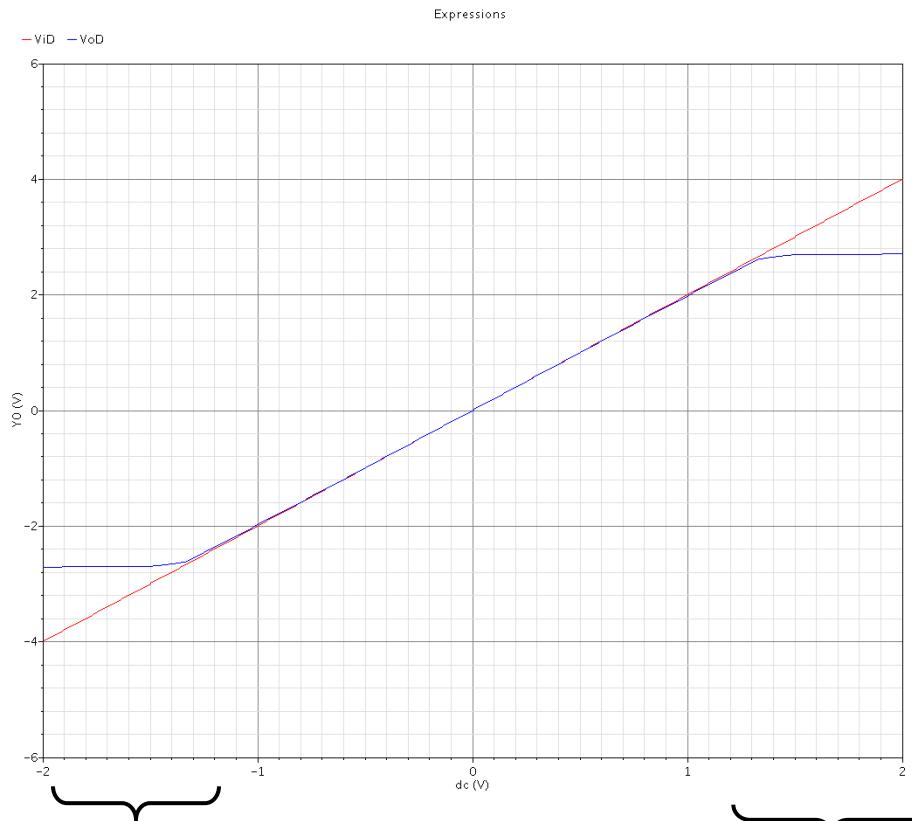
- NPN follower design (B):



Input
NPN tr in
saturation

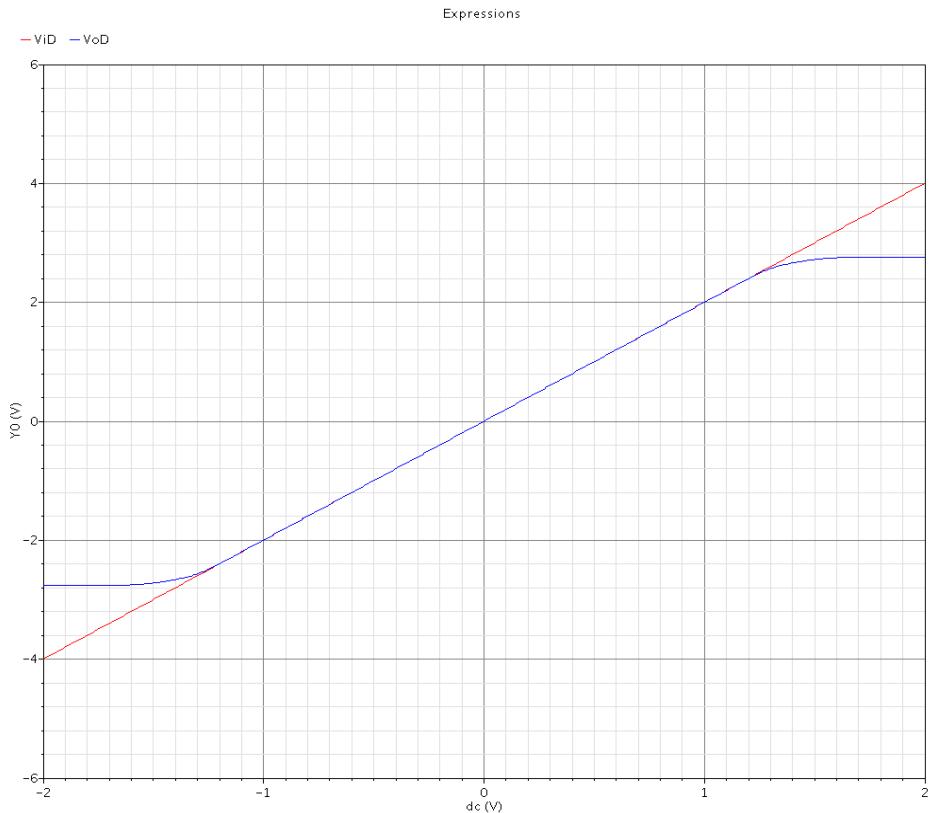
DC studies: output DC range

- NMOS follower design (A):



Input NPN tr
for V_{in-} in
saturation

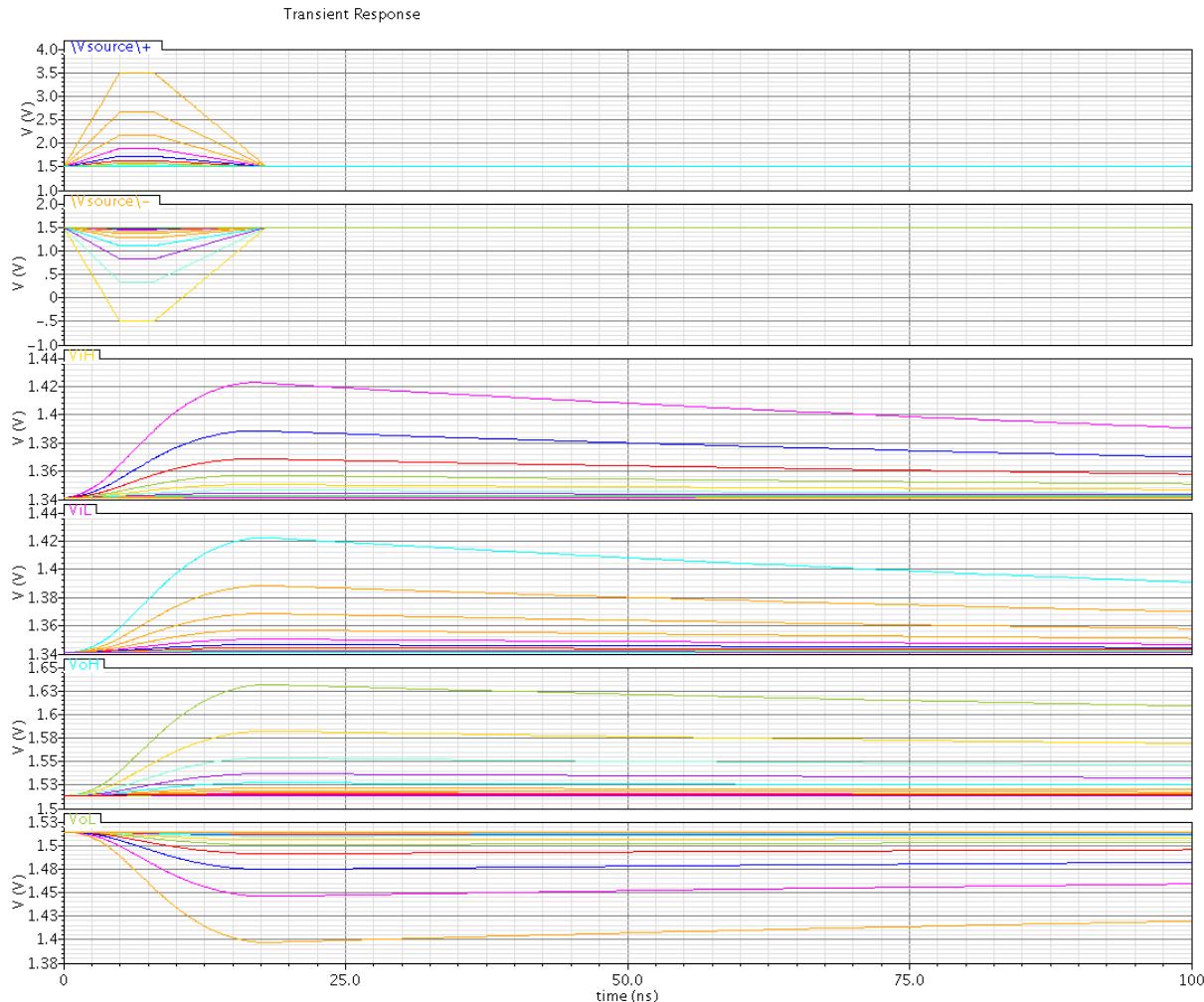
- NPN follower design (B):



Input NPN tr
for V_{in+} in
saturation

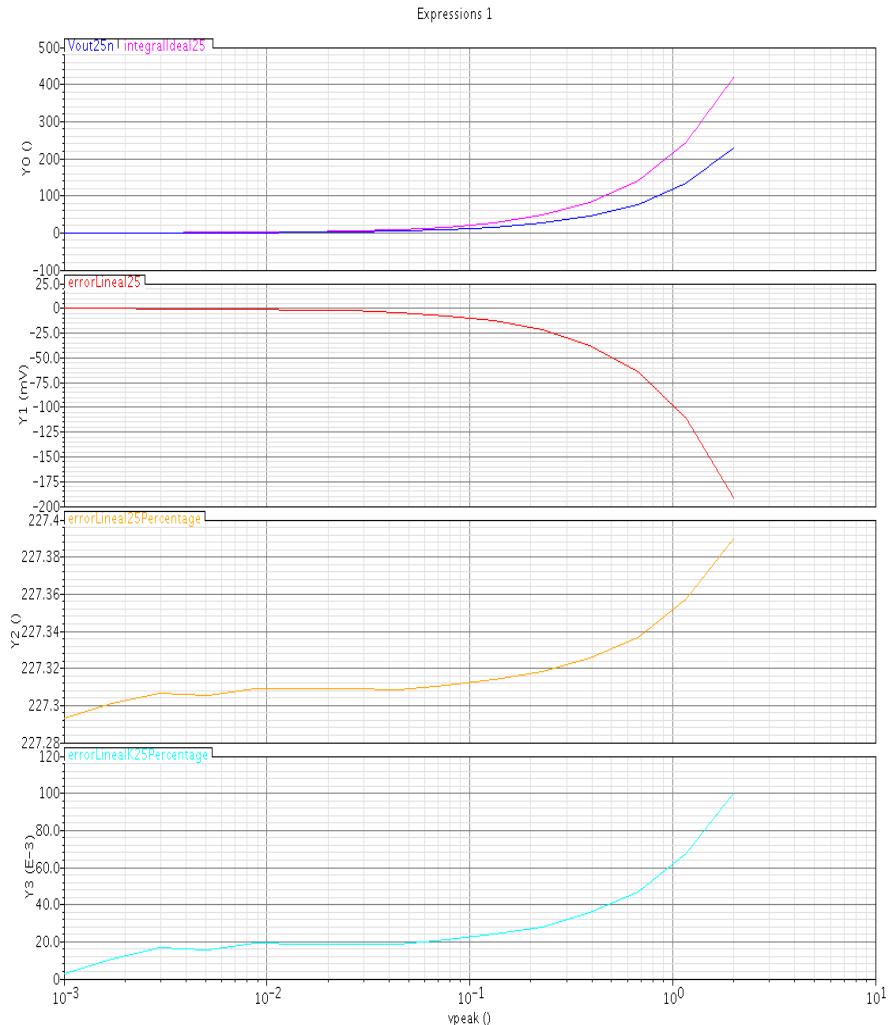
Linearity

- NMOS follower design (A):

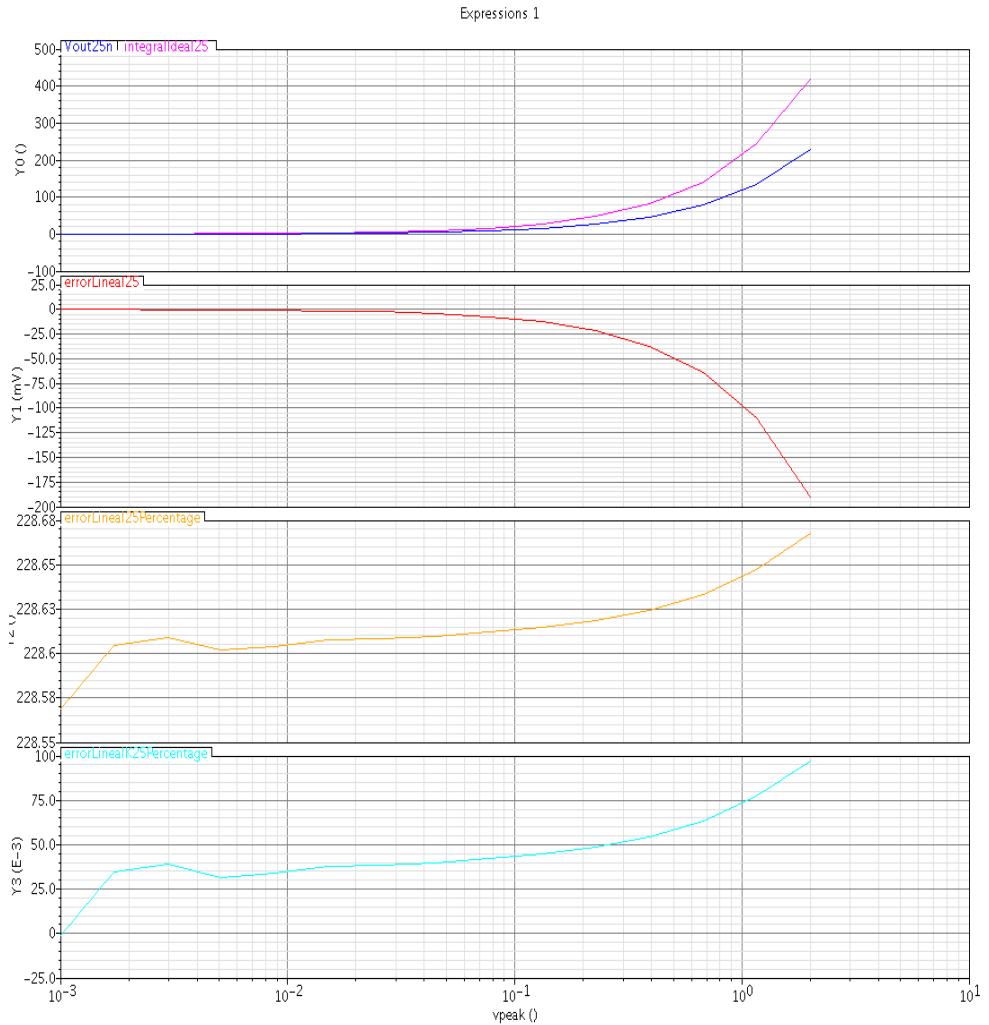


Linearity

- NMOS follower design (A):



- NPN follower design (B):



Characteristics

- Obtained using Spectre simulations
- Specs:
 - GBW > 500MHz
 - PM > 65°
 - Common mode control
 - SR > 2 V/μs
 - $V_{CM} \sim 1.5$ V

Parameters	Cascode+NMOS	Cascode+CSNPN
Gain LF (dB)	64.3	75.79
BW (KHz)	237.5	100.7
GBW (MHz)	391.4	587.5
PM (°)	83.85	84.11
Rise time tr (ns)	3.95	3.1
Overshoot (mV)	0	255
SR (V/us)	396.3	515
In stage min (V)	1.35	1.24
In stage max (V)	3.75	3.04
Out stage min (V)	-1.33	-1.24
Out stage max (V)	1.33	1.24
in max, 1% lin (V)	2	2