Cascode – schematic

- biasing:
  - 1: VCascAmpBias (main power consumption)
    - more power, more speed
  - 2: VCascAmpLoad
    - DAC < 250: fastest risetimes, overshoots
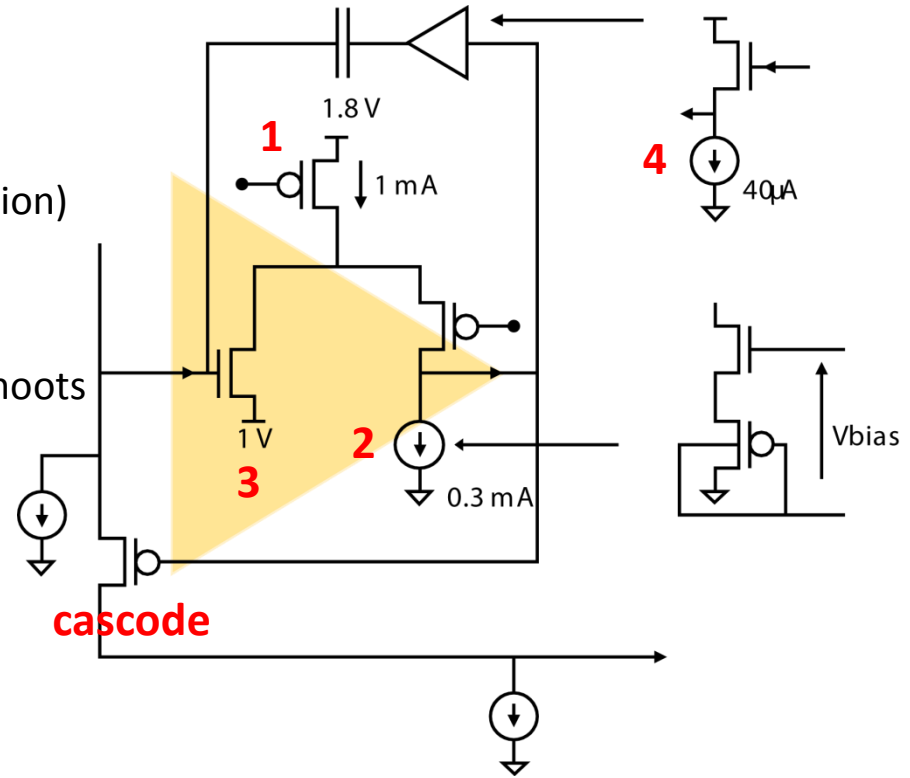   - DAC ~ 300: optimal
    - DAC > 350: speed loss
  - 3: VCascVSS (amp ground)
  - 4: VCascAmpSF (compensation)
    - DAC = 250

- total speed also depends on current flowing through cascode transistor
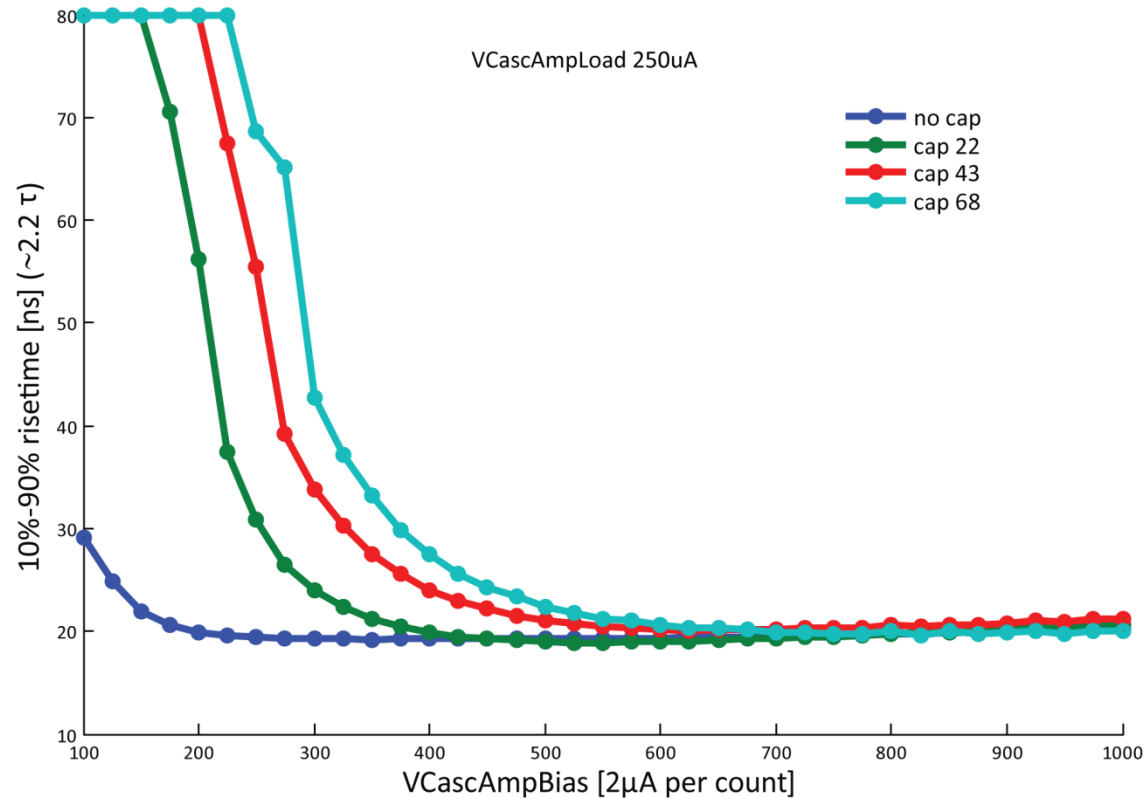 - good results with minimum 10µA
  - maximum(!) 50µA working range
  - DEPFET has ~100µA drain current -> subtract some current in front of cascode

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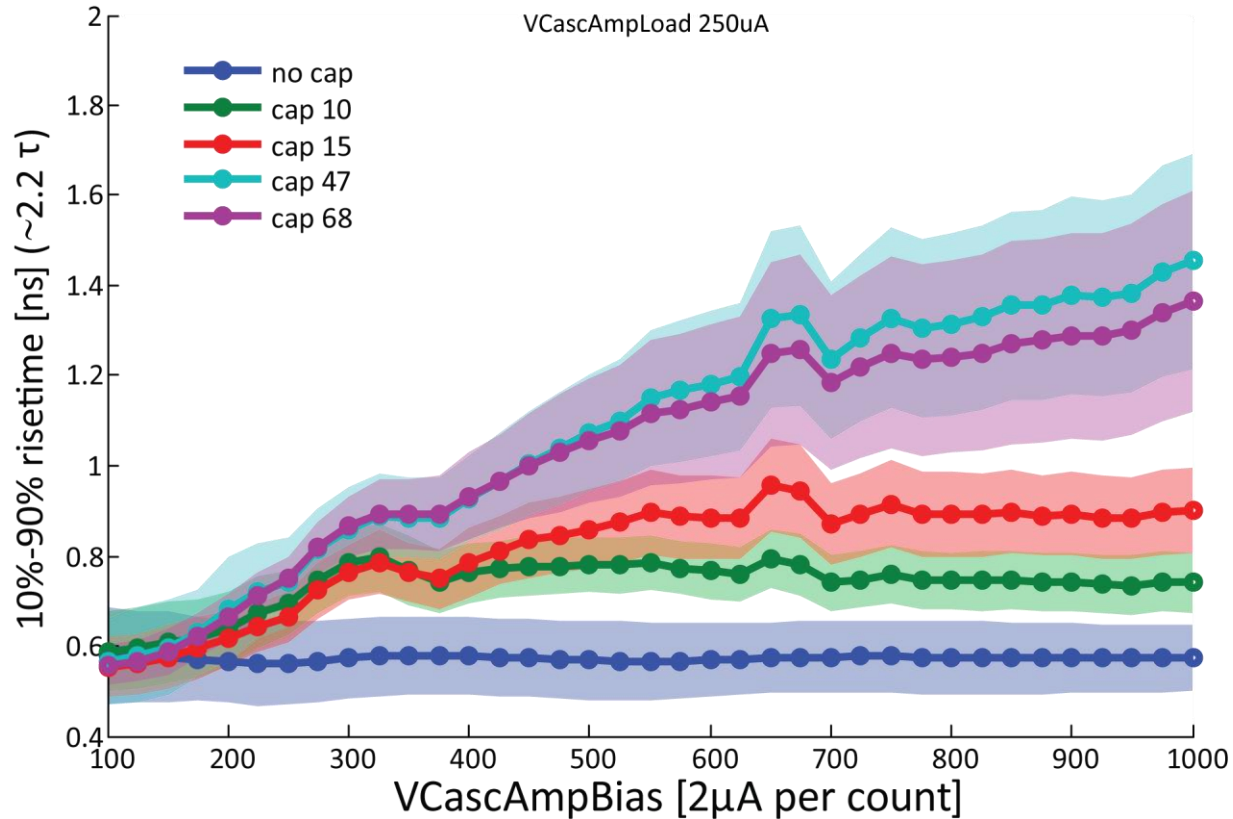
Cascode – dynamic speed measurements

- Generate current step function
- Sample this step function with ADC
- Change phase relationship between input step and sample strobe
  - timestep 1.67 ns
  - oversample with 1000 points per step

- DCD runs @300MHz (s-c-s 160ns) to clearly see risetimes

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Cascode – risetime

- For reference, power based on chip total, per channel:
  - @500: 5.5mW   @600: 5.6mW   @1000: 6.4mW
- 20ns limit is still under investigation (current memory cells / risetime of internal current injection / overcompensation of cascode / ….)

- settings chosen for rise behaviour without overshoot
- vdda 1900, vcavss 1050, CascAmpLoad 250 CascAmpSF 250 InjBias 100 InjSig 95
- 300MHz readout speed → 160ns sample-clear-sample

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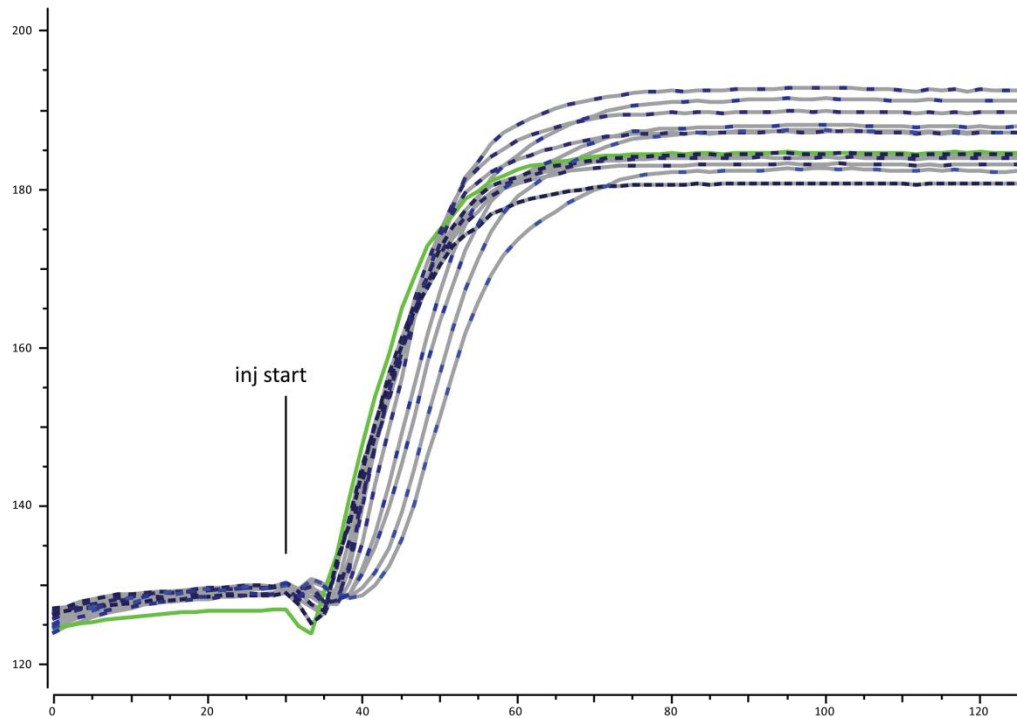
Cascode – noise

VCascAmpLoad 250uA

- no cap
- cap 10
- cap 15
- cap 47
- cap 68

10%-90% risetime [ns] (~2.2 τ)

VCascAmpBias [2µA per count]

- For these optimized, however very specific settings:
- ➔ @600: for 68pF capacitance, risetime of 20ns with ~ 1.1 LSB noise, 5.6mW/channel total

- vdda 1900, vcavss 1050, CascAmpLoad 250 CascAmpSF 250 InjBias 100 InjSig 95
- 300MHz readout speed → 160ns sample-clear-sample
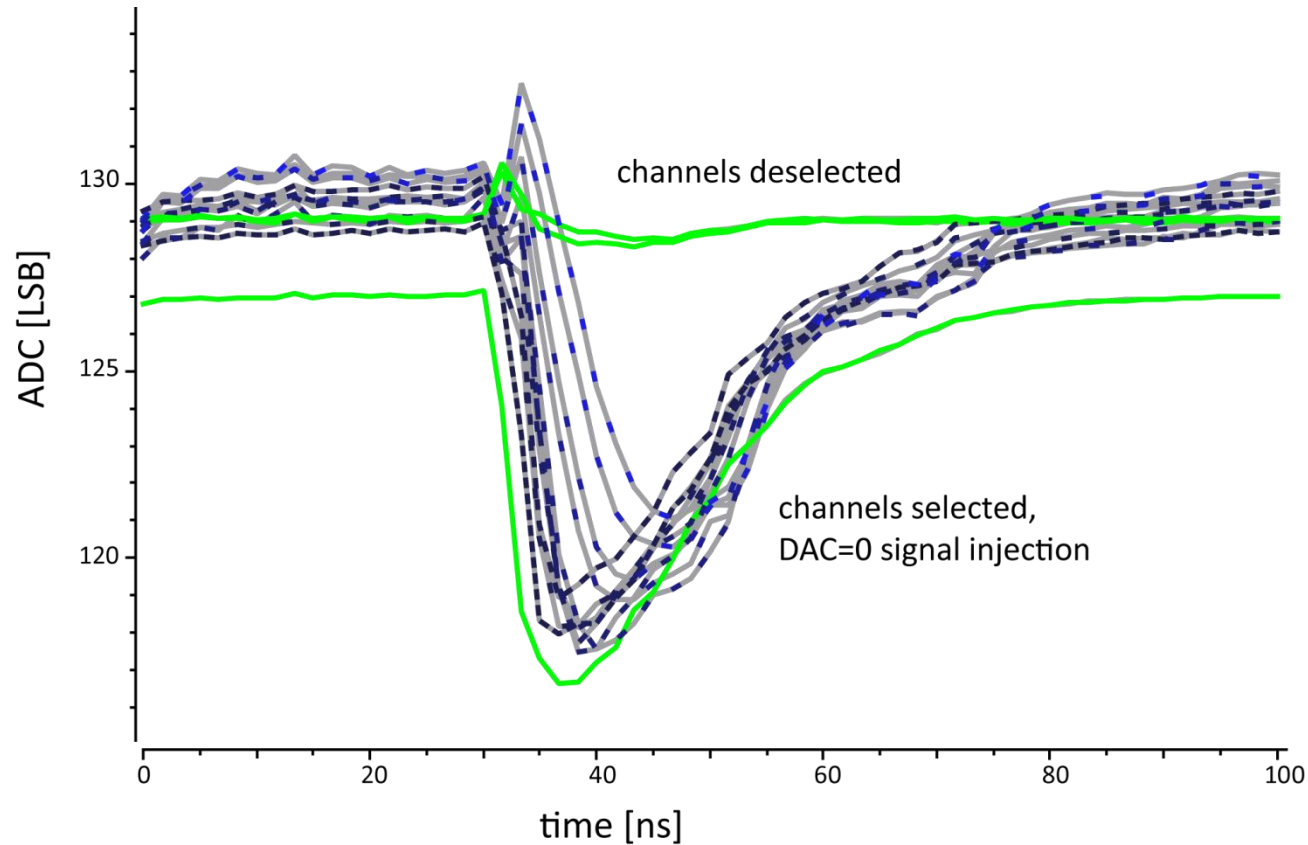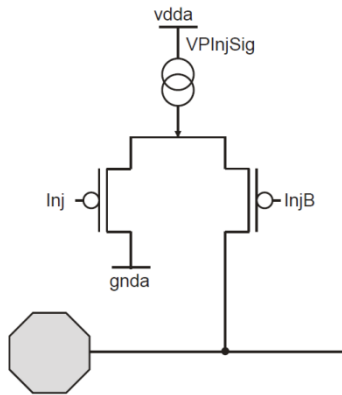
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Cascode – measurement issues

- charge injection with current step (see slide)
- overshoots: artificially faster risetimes, longer settling time

- Delays for higher capacitance: (slow settings)
- Possible due to undershoot / charge injection

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Cascode – charge injection / crosstalk

- Sample input current step, with InjSig=0
- Channels selected (EnInj) show undershoot
- deselected ch's quiet
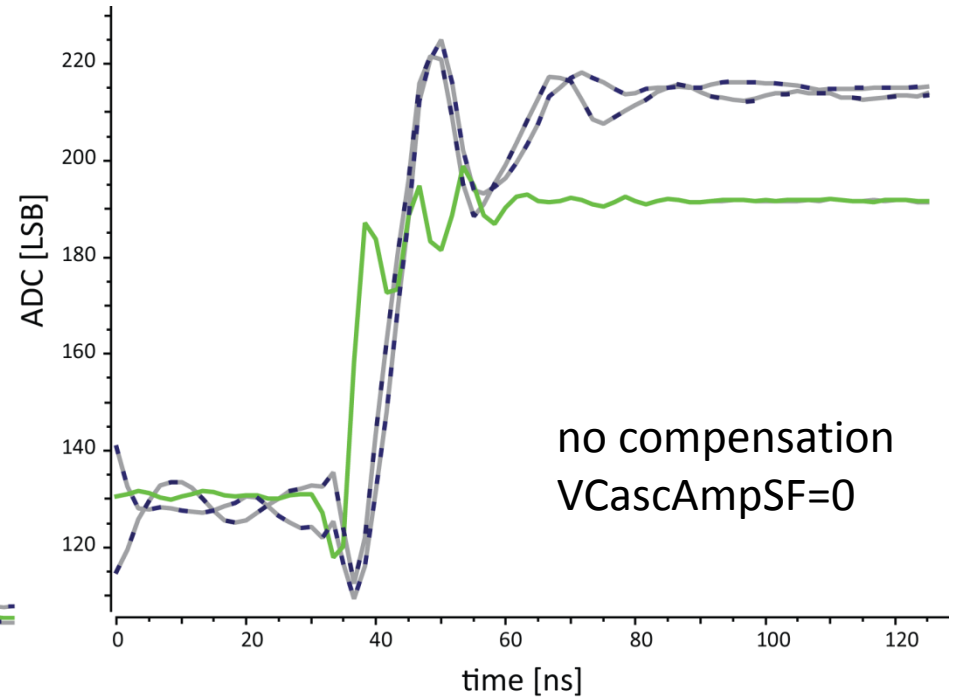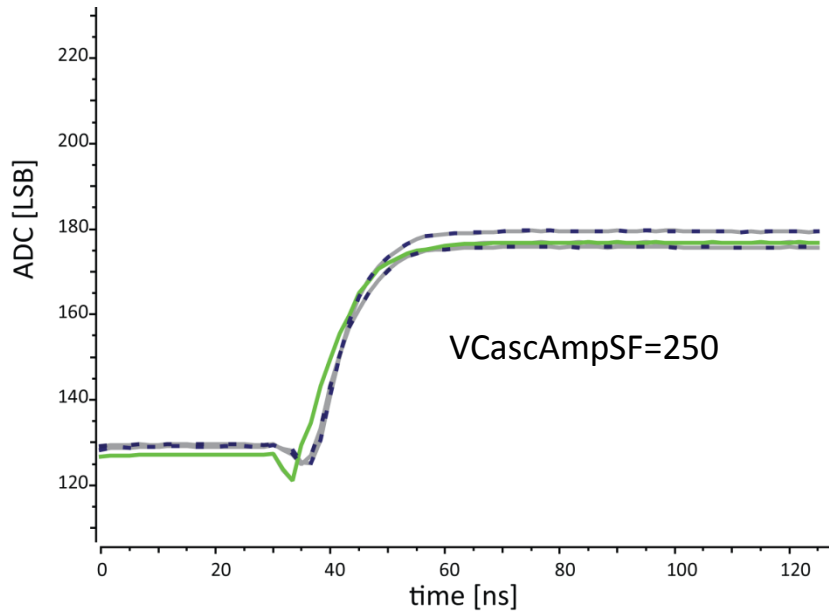- green channels: no capacitance

- ➢ most likely charge injection due to InjB transistor (InjB goes 1➔ 0)

- vdda 1900, vcavss 1050, CascAmpBias 500 CascAmpLoad 150 CascAmpSF 250 InjBias 95 InjSig 0 "casc charge injection.ini"

Cascode – compensation

- fast settling based on VCascAmpSF
- Optimization still under investigation

no compensation
VCascAmpSF=0

VCascAmpSF=250

- vdda 1900, vcavss 1050, CascAmpBias 500 CascAmpLoad 200 CascAmpSF 250 InjBias 200 InjSig 80 "sf compensation.ini"

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