

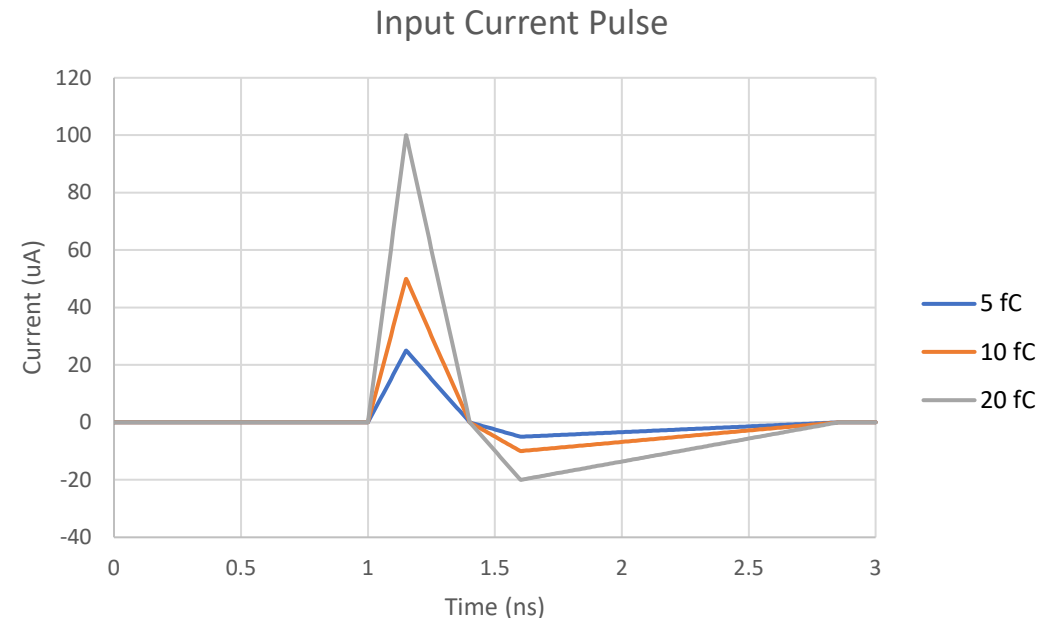
ASROC: A custom SiGe amplifier/discriminator IC designed for AC-LGAD readout

Current design is focused on 10 ps timing resolution with low power consumption (as low as 300 μW / channel for preamp + discriminator). Design would need modification for very high frame rates (dead time of around 10 ns)

AC-LGAD characteristics used in readout electronics simulation/design:
200-300 fF input capacitance
10 ps TOA variation due to Landau fluctuations

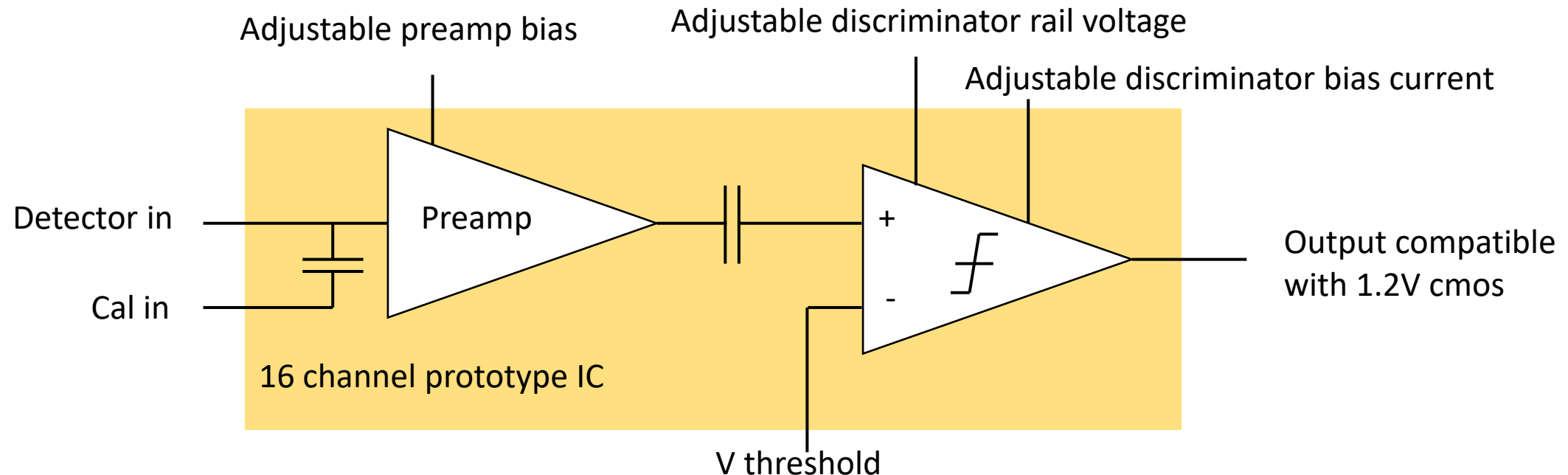
Pulse shape:

- Rise time = 150 ps
- Fall time = 250 ps
- Under shoot = 20 % pulse amplitude



Topology:

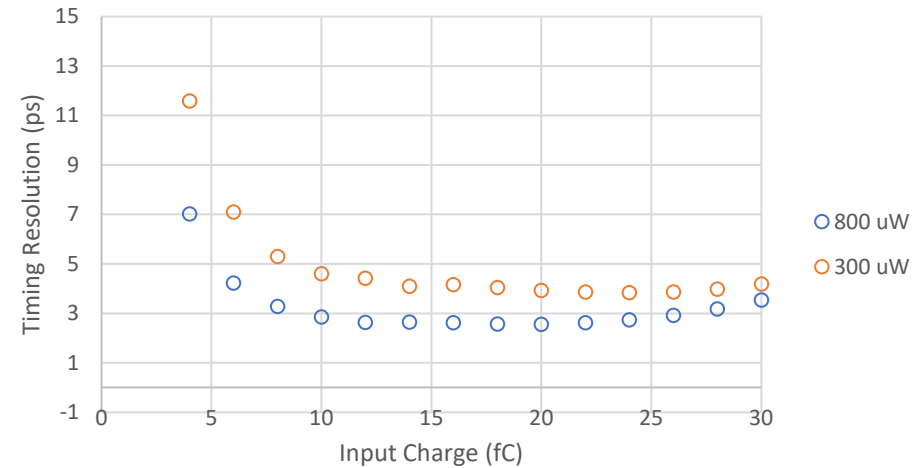
- Simple common emitter transimpedance front end using 10 GHz Tower Semi SiGe
- optimized for low power, not analog bandwidth
- very economical process
- Custom discriminator circuit designed for low quiescent current in temperature stable environments, moderate frame rates



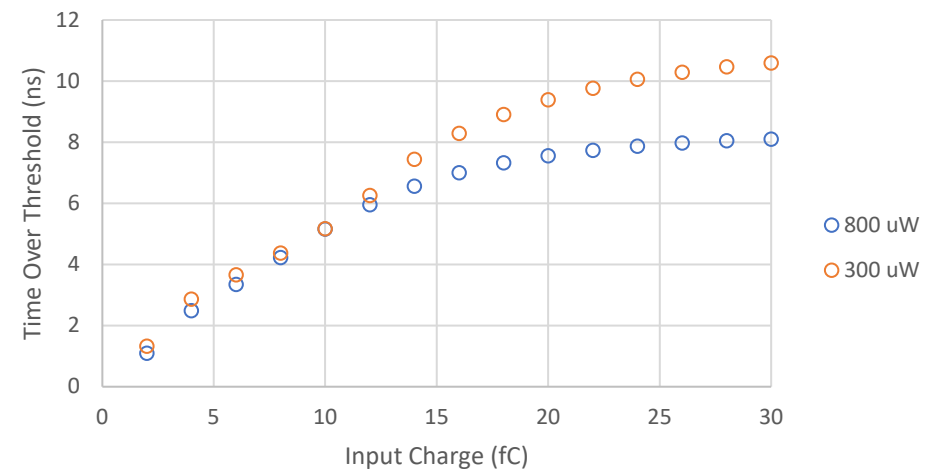
Electronics Jitter:

- Internal goal of 10 ps electronics jitter for 4 fC input – power can be saved by sacrificing small input timing resolution
- Preamp power, discriminator rail voltage, and discriminator bias are all adjustable and full parameter space has not been explored/optimized.
- These power/channel data are a few reasonable samples from this space, better performance is possible.

Timing Resolution vs. Input Charge



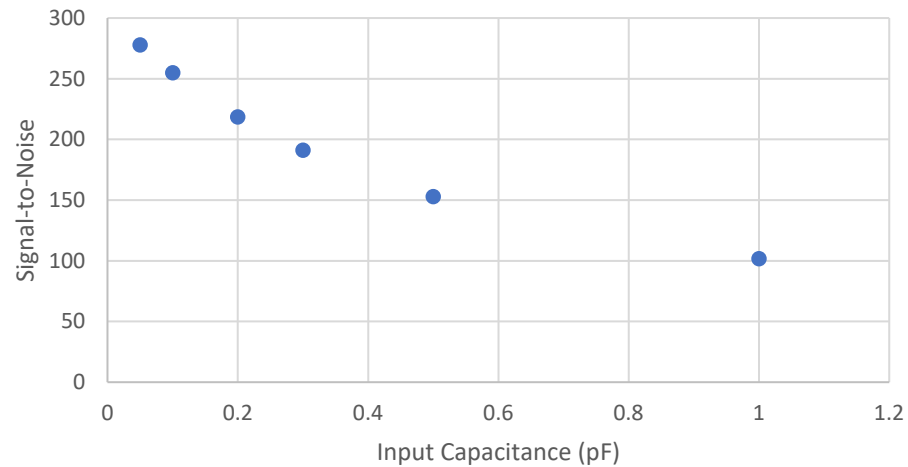
Time Over Threshold vs. Input Charge



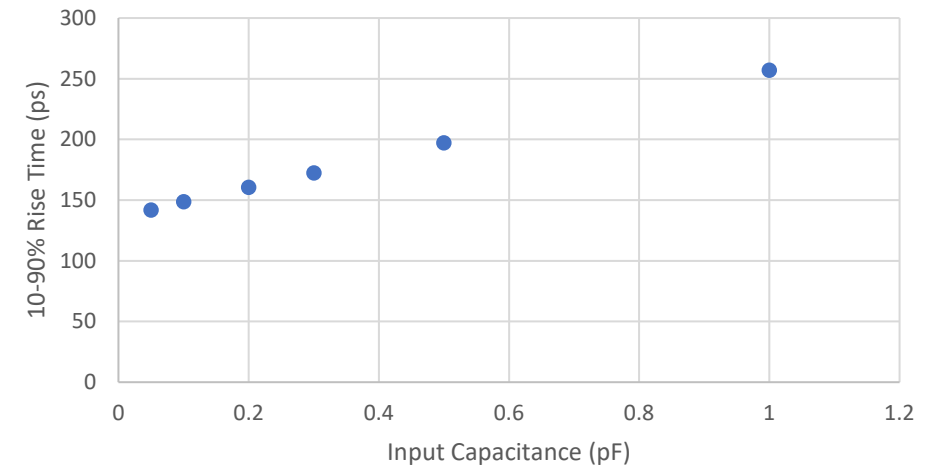
Performance vs input capacitance:

- Input capacitance increases noise, decreases rise time
- AC-LGAD low input capacitance is very welcome
- Signal-to-noise shown is for 10 fC pulse and 800 uW/channel configuration

Preamp Signal-to-Noise vs. Input Capacitance

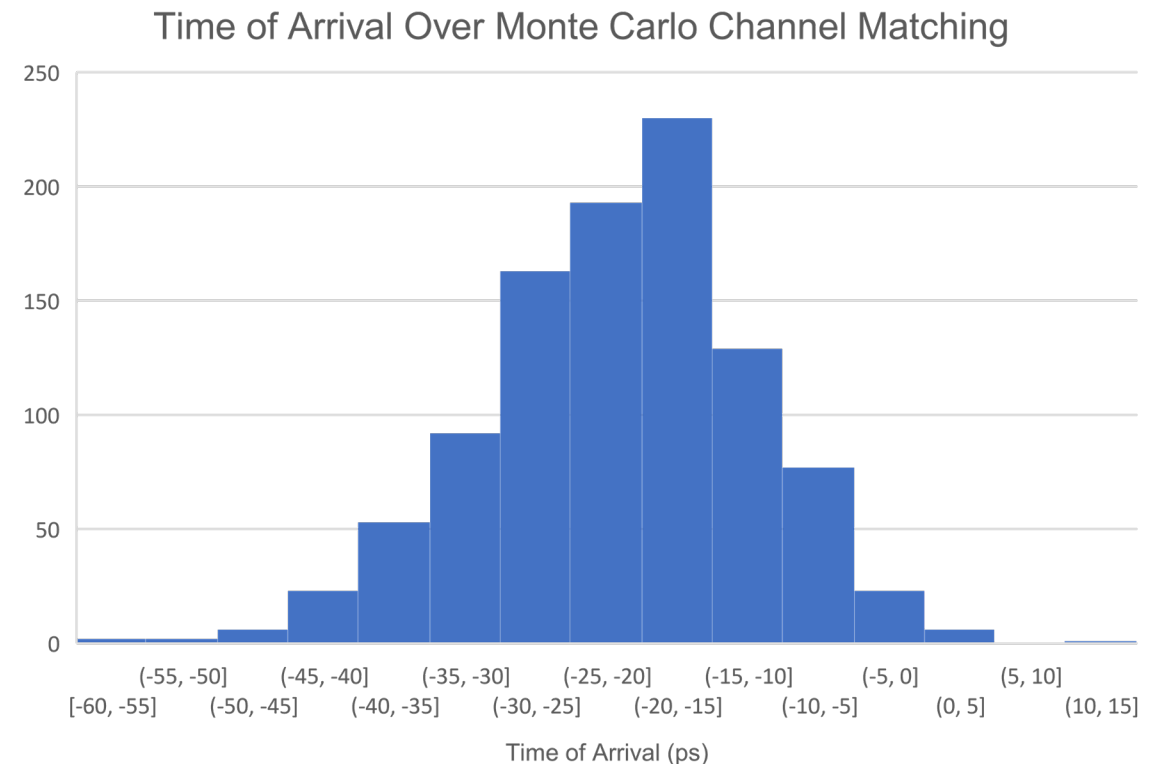


Preamp Rise Time vs. Input Capacitance



Channel Matching:

- Individual channels could be calibrated, but design goal was to have channel variation not dominate timing resolution with zero channel to channel calibration
- Corrected time of arrival has a standard deviation of 10 ps over Monte Carlo simulations for 10 fC input charge and 800 μ W power configuration



Thanks!