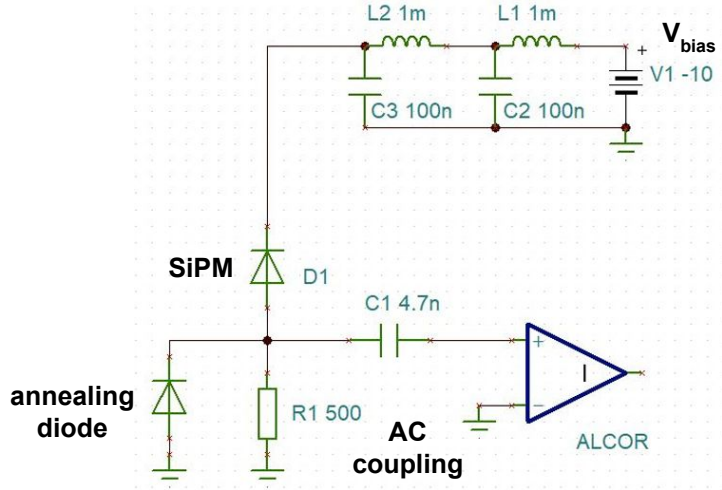
ALCOR simulations with annealing diodes

30.04.2025

Annealing diodes



*Diodi con dimensioni di un **SMD0402** (esternamente) ma footprint ben preciso, consigliato dal costruttore, da utilizzare nel montaggio. Il package è un **SOD882BD**, con una maschera particolare da utilizzare per la solderpaste*

Per le FEB da produrre ora possiamo selezionare 2 diodi "alternativi", ma tra quelli con lo stesso package:

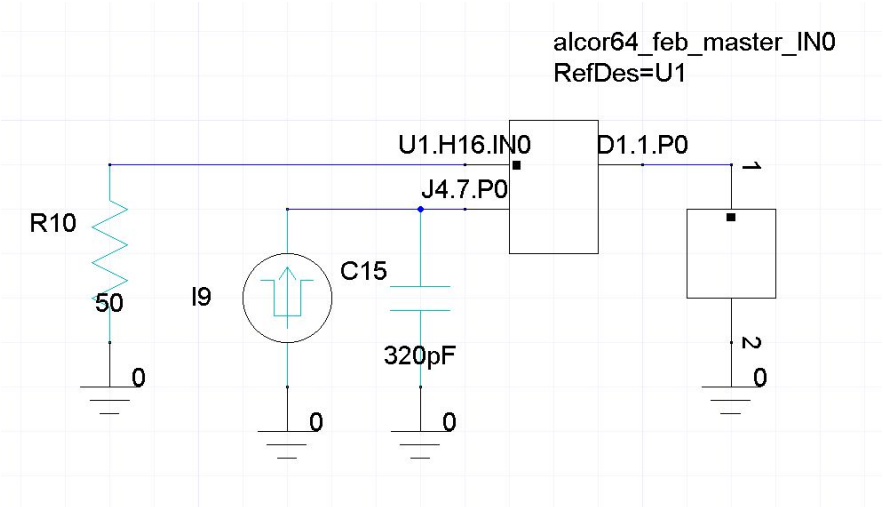
- **BAS30LS** C = 2 pF V_f = 0.85 V → P = 51 mW (I_f = 60 mA)
- **BAS40LS** C = 5 pF V_f = 0.68 V → P = 41 mW (I_f = 60 mA)
- **PMEG4002ELD** C = 14-20 pF V_f = 0.30 V → P = 18 mW (I_f = 60 mA)
- **BAT54LS** C = 10 pF V_f = 0.48 V → P = 29 mW (I_f = 60 mA)

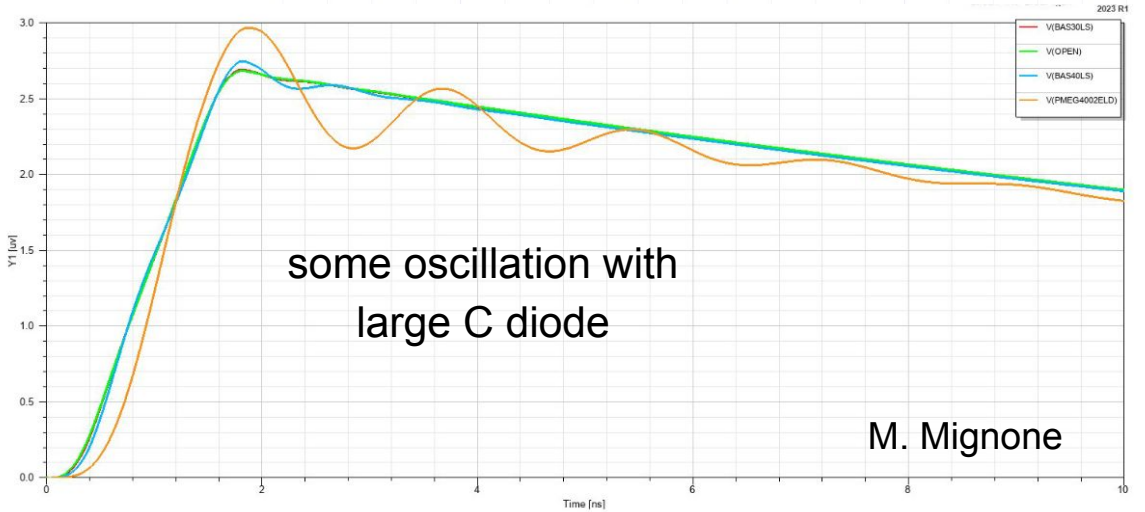
Simulazioni per vedere diversa risposta in funzione della capacità del diodo, che può caricare la linea di ingresso tra SiPM e ALCOR

Annealing diode simulations

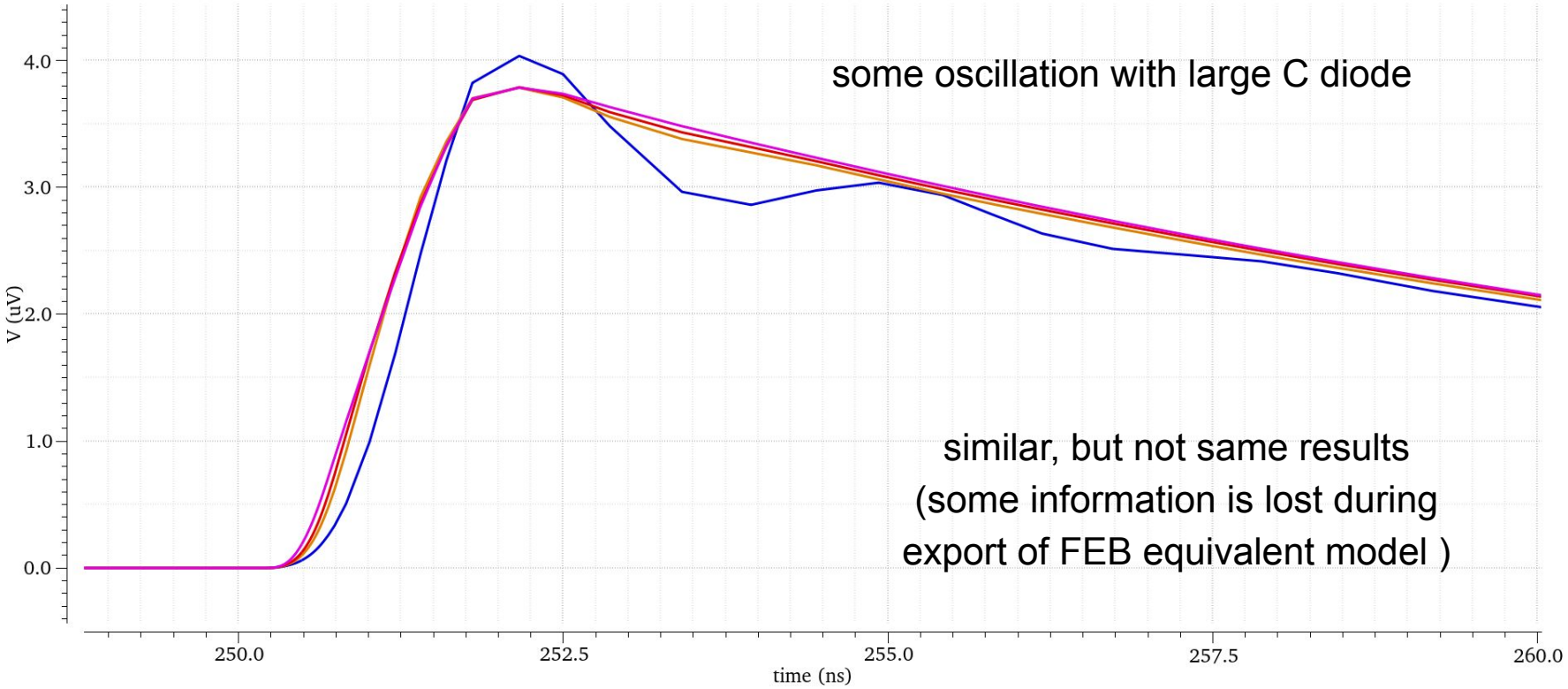
Simulations done by Marco

- **FEB** model for input IN_0: includes *470 Ω resistance* and *4.7 nF capacitor*, routing between SiPM connector and pad for ALCOR BGA, extra pin for *annealing diode*
- **Annealing diodes** SPICE model
- Current generator + detector capacitance
- 50 Ω termination resistor





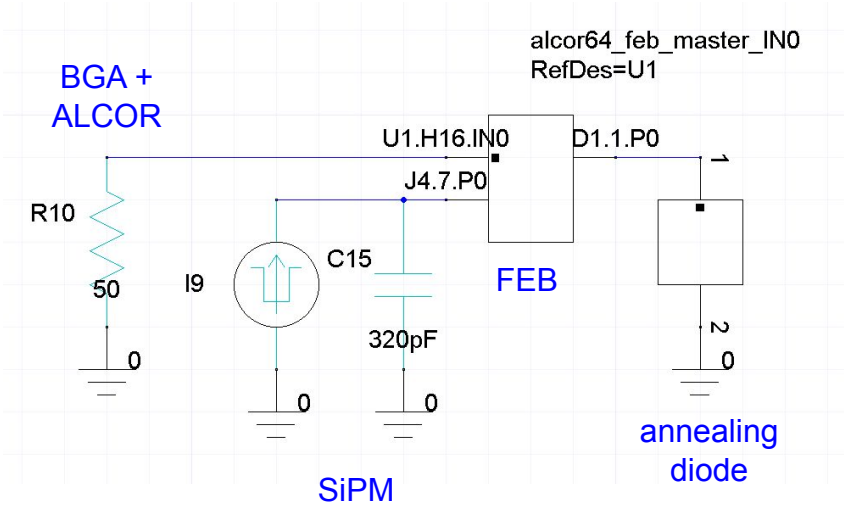
Cadence simulation with ideal circuit (no ALCOR)



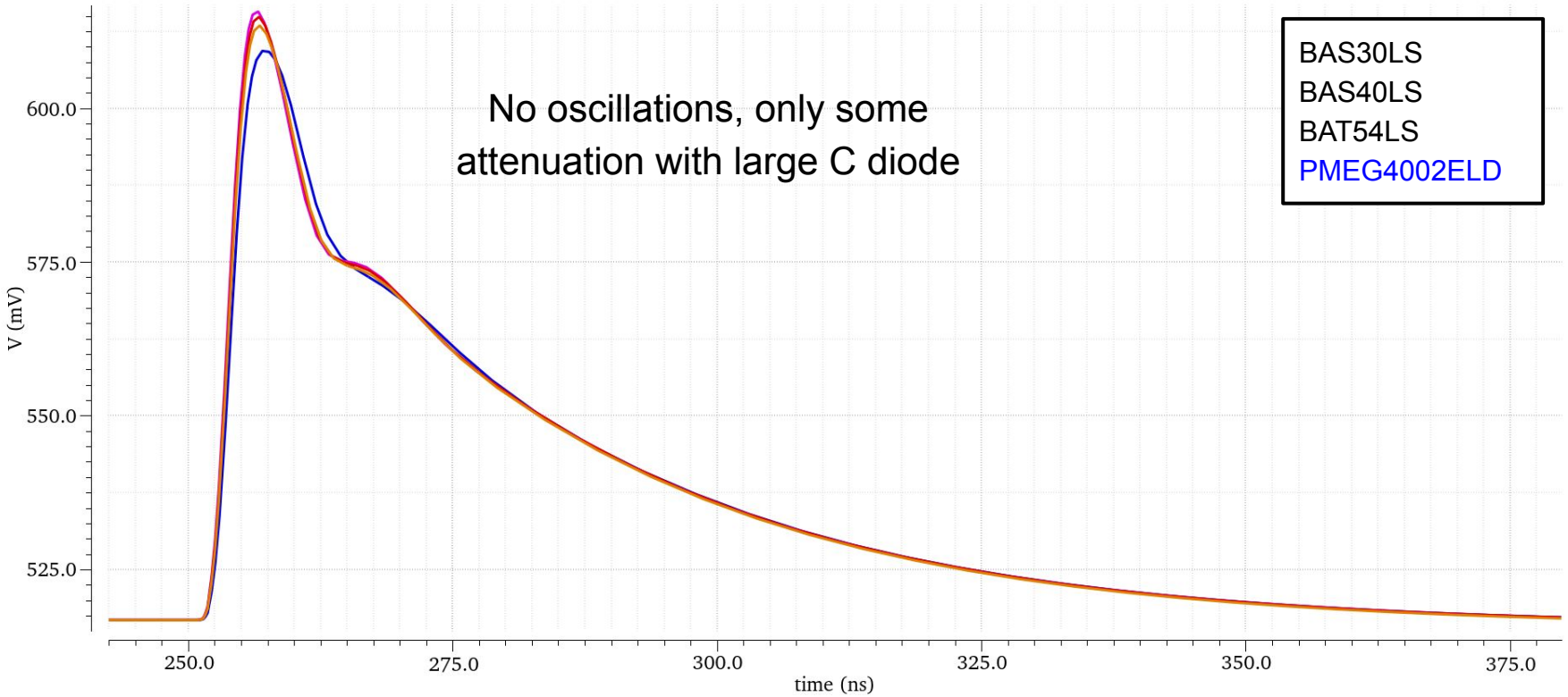
Annealing diode simulations

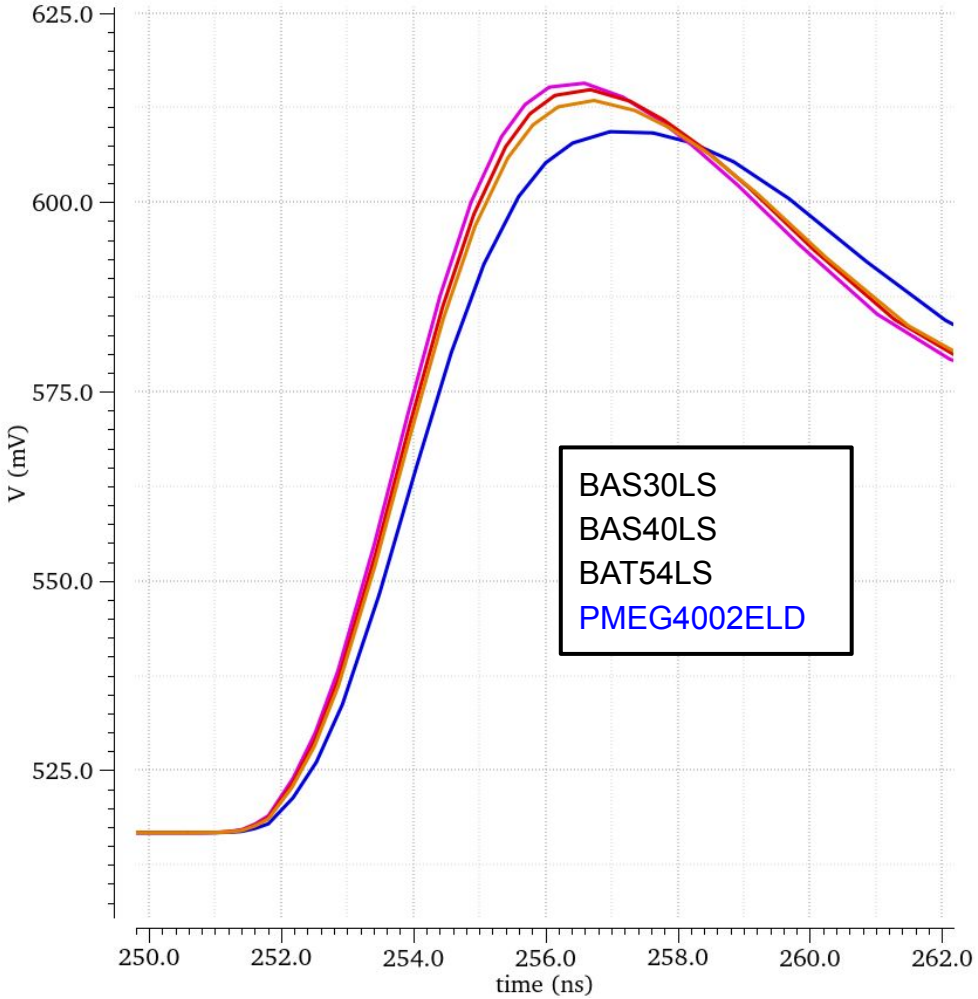
Simulate real ALCOR response with different model of annealing diodes

- **SiPM** model: S13360_3050, OV = 3 V
- **FEB** Spectre model for input IN0: includes *470 Ω resistance* and *4.7 nF capacitor*, routing between SiPM connector and pad for ALCOR BGA, extra pin for *annealing diode*
- **Annealing diodes** SPICE model
- **BGA** equivalent model for one input
- **ALCOR** front-end



ALCOR analogue output





Time resolution

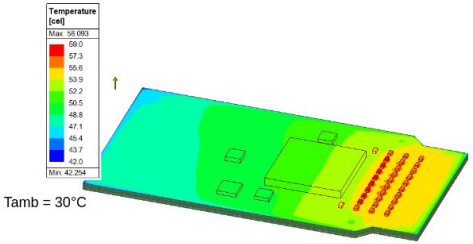
- **BAS30LS** σ_t = 74 ps
- **BAS40LS** σ_t = 77 ps
- **BAT54LS** σ_t = 79 ps
- **PMEG4002ELD** σ_t = 87 ps

Large C diode slightly reduces signal slope and thus time resolution

Reminder: thermal simulations

These diodes are similar to PMEG4002ELD and BAT54LS

ALCOR64_FEB Master
(Annealing CDBQC0240L-HF = 0.30V @50°C x 60mA => 18mW)

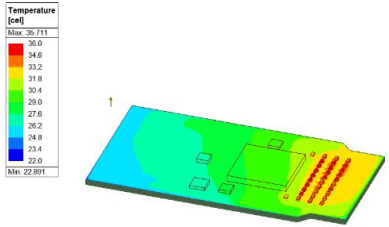


-DIODI:
64 x 18 mW
Tmax = 58°C

-BGA:
Tmax = 53°C
Tmean = 52°C

-PCB(Top):
Tmax = 58°C
Tmean = 51°C

-PCB(Bot):
Tmax = 58°C
Tmean = 51°C



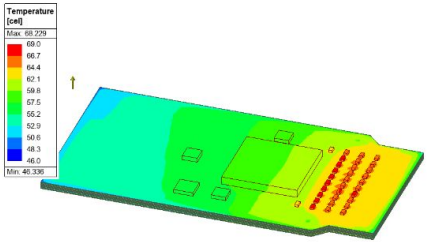
-DIODI:
64 x 18 mW
Tmax = 36°C

-BGA:
Tmax = 31°C
Tmean = 30°C

-PCB(Top):
Tmax = 35°C
Tmean = 29°C

-PCB(Bot):
Tmax = 35°C
Tmean = 29°C

ALCOR64_FEB Master
(Annealing CDBQR54-HF = 0.430V @75°C x 60mA => 26mW)

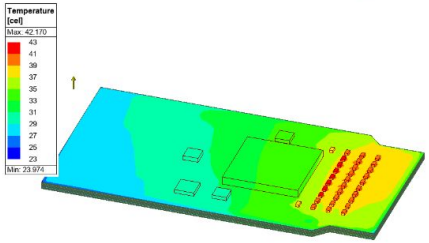


-DIODI:
64 x 26 mW
Tmax = 68°C

-BGA:
Tmax = 61°C
Tmean = 59°C

-PCB(Top):
Tmax = 67°C
Tmean = 57°C

-PCB(Bot):
Tmax = 68°C
Tmean = 57°C



-DIODI:
64 x 26 mW
Tmax = 42°C

-BGA:
Tmax = 35°C
Tmean = 33°C

-PCB(Top):
Tmax = 42°C
Tmean = 32°C

-PCB(Bot):
Tmax = 42°C
Tmean = 32°C

M. Mignone

Summary

- Best diodes seem to be:
  - *PMEG4002ELD* (lowest temperature)
  - *BAT54LS* (better time resolution)
- Repeat simulations:
  - use different R and C values for AC-coupling circuit
  - include also ALCOR parasitics (post-layout)
  - thermal simulations with new diode models (*BAT54LS* and *PMEG4002ELD*)

- Is it really impossible to put the annealing diodes on the SiPMs board?