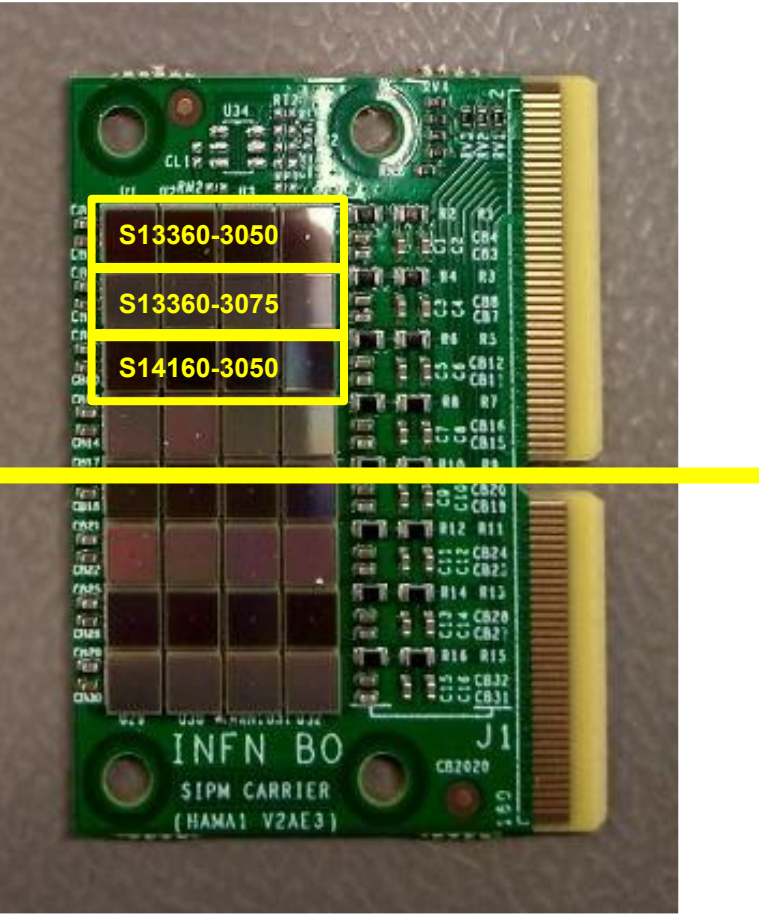
SiPM sensors for irradiation campaign 2023

EIC_NET elettronica

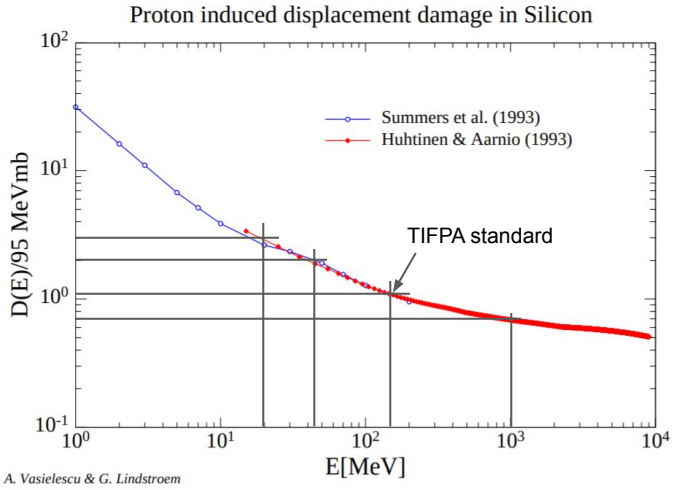
New LIGHT SiPM carriers



- **1x4 LIGHT carrier**
  - keep same boards designed in 2020
  - populate 2 / 3 rows
    - 4 sensors / row
  - sensors from Hamamatsu
    - 4x S13360-3050
    - 4x S14160-3050
    - 4x S13360-3075 (perhaps)
- **perform different type of irradiation/annealing studies**
  - one LIGHT carrier for each study
- **keep a minimal statistical sample for each study**
  - 4 sensors / type

Irradiation studies

- **with protons at different energies**
  - test NIEL scaling hypothesis of radiation damage with energy
  - test annealing cure has same effectiveness
  - 2 or possibly three energies
    - 150 MeV, 40 MeV, 20 MeV
    - would be nice also 1 GeV
- **with reactor neutrons**
  - test NIEL scaling hypothesis and annealing effectiveness is same as for protons
  - central reactor flux has both fast and slow neutron component
    - possibly different damage
    - irradiate in central reactor channel
      - both fast and slow
    - irradiate in peripheral channel
      - fast component suppressed
- **at different levels of fluence**
  - 10^9, 10^{10}, 10^{11} neq in one shot
  - 10^9 repeated irradiation/annealing cycles



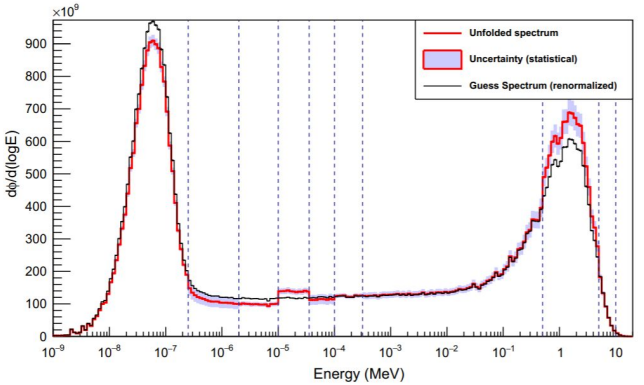


Fig. 12 Unfolded neutron flux spectrum in Central Channel at 100 kW power (same plot description as Fig. 10)

Boards and sensors needed

Irradiation		Annealing					N boards	N SiPM
Particle	Energy	Oven	Online	Forward	Inverse	Else		
Fluence	10^9	x	x	x	x	x		
	10^{10}	x						
	10^{11}	x						
Neutrons	central	3	1	1	1	1	14	56
	peripheral	3	1	1	1	1		
Protons	150 MeV	3	1	1	1	1	16	64
	40 MeV	3						
	20 MeV	3						
	1 GeV	3						

Needed	30	120
Spares	5	30
Total	35	150

comparison across different radiation field types performed for three levels of fluence

for each type

Boards and sensors needed

Fluence	10^9	x	x	x	x	x		
	10^{10}	x						
	10^{11}	x						
Irradiation		**Annealing**					**N boards**	**N SiPM**
Particle	**Energy**	**Oven**	**Online**	**Forward**	**Inverse**	**Else**		
Neutrons	central	3	1	1	1	1	14	56
	peripheral	3	1	1	1	1		
Protons	150 MeV	3	1	1	1	1	16	64
	40 MeV	3						
	20 MeV	3						
	1 GeV	3						
							Needed	30	120
							Spares	5	30
							Total	35	150

comparison of different annealing methods performed only for 10^9 fluence levels

for each type

Summary

- **35 SiPM carrier LIGHT boards**
  - one board for each irradiation / annealing study
  - mount on same board different sensor types
    - 4 sensors / type
- **150 SiPM sensors for each type**
  - S13360-3050VS (25 EUR + IVA / sensor = 4.5 kEUR)
    - the workhorse and baseline
  - S13360-3075VS (assume same price as 3050 = 4.5 kEUR)
    - small SPADs do not help with DCR
    - larger SPADs will give higher PDE
  - S14160-3050HS (20 EUR + IVA / sensor = 3.7 kEUR)
    - not as good but higher PDE
    - cheaper
- **Total cost for sensors = 13 kEUR**
  - more than the assigned 10 kEUR
    - cut a bit the program
      - 3 sensors / type instead of 4 = 8.5 kEUR
      - buy 75 S13350-3075 instead of 150 = 10 kEUR
      - buy 75 S14160-3050 instead of 150 = 11 kEUR
    - spend more money