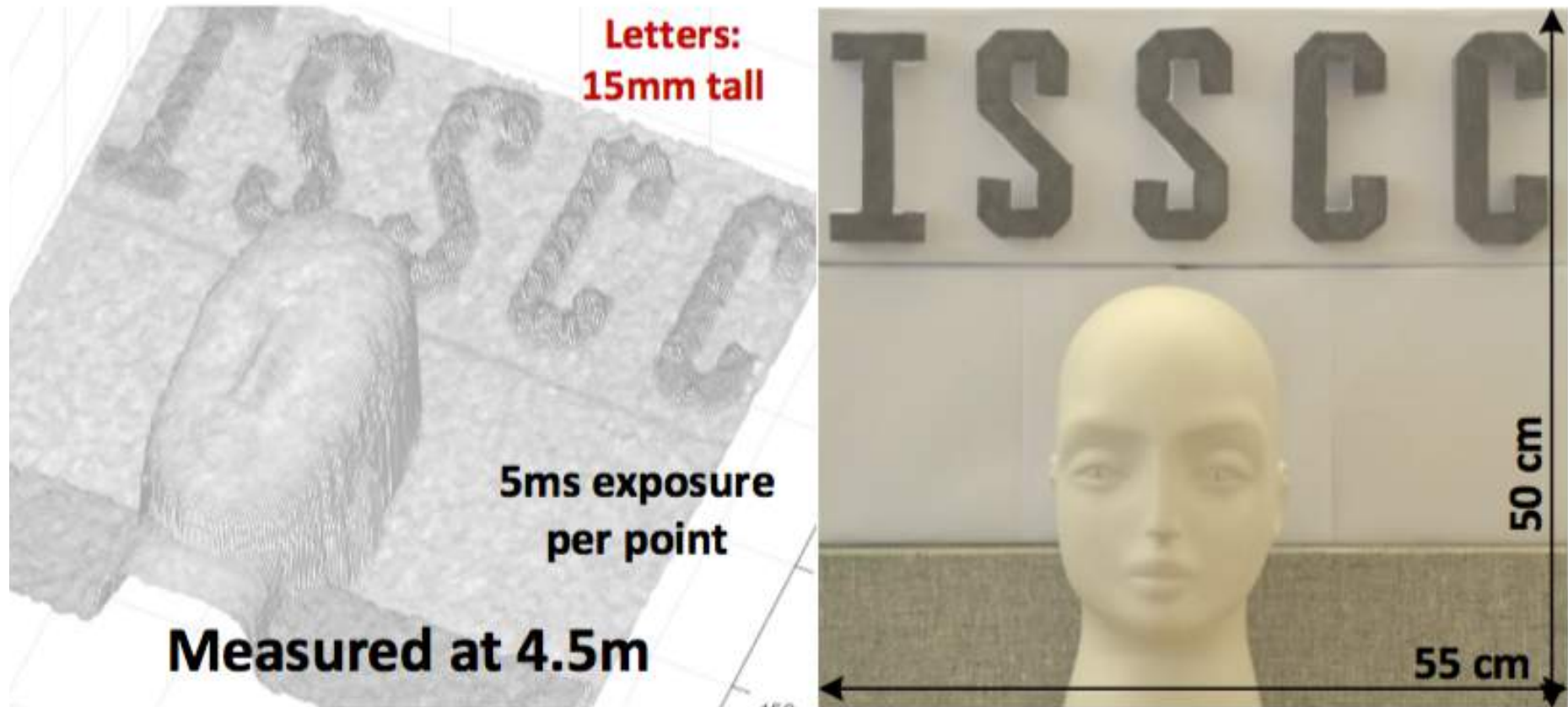


256x256 3D Image Reconstruction



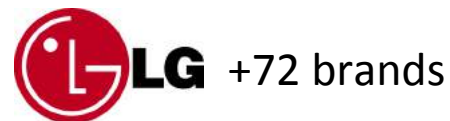
A.R. Ximenes, P.Padmanabhan *et al.*, *ISSCC*, 2018

SPADs Are Now in Products

- A SPAD component in every smartphone by 2018
- A SPAD component in every car by 2020

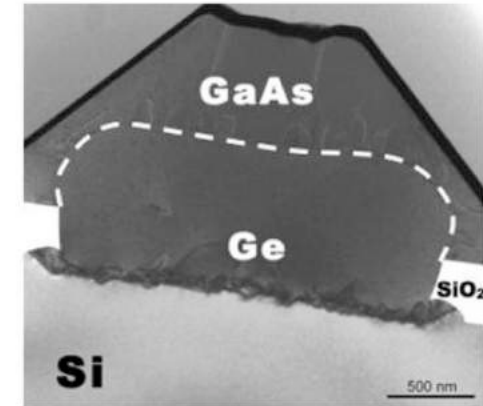


forimtech
fiber optic radiation imaging tec

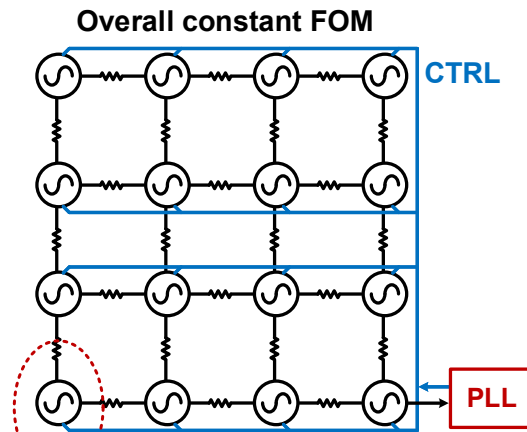


Perspectives for 2020

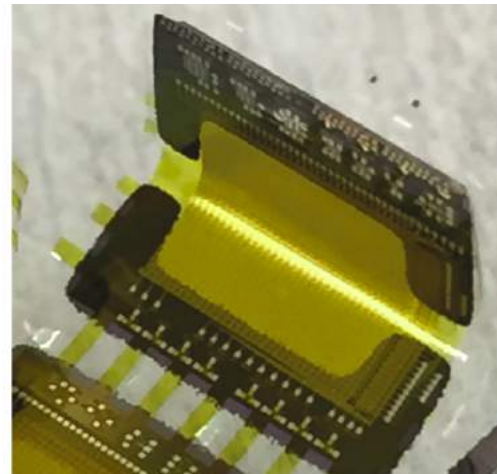
- Sub-65nm CMOS
- Large, scalable designs (Lego™ approach)
- Backside illumination (BSI) 3D IC
- New Materials (InP, GaAs, Ge, polymers)
- Small pixels, low noise, μ lenses



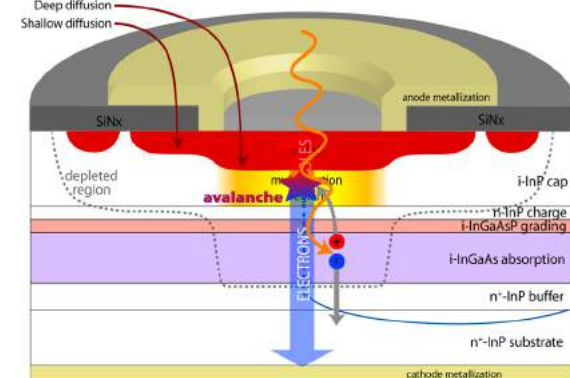
Sammak, Aminian, Charbon, Nanver, IEDM11



Ximenes, Padmanabhan, Charbon, IISW, 2017



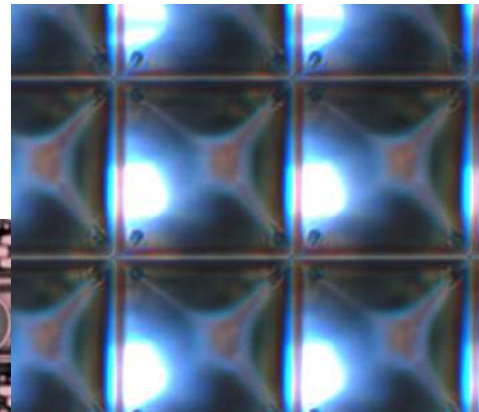
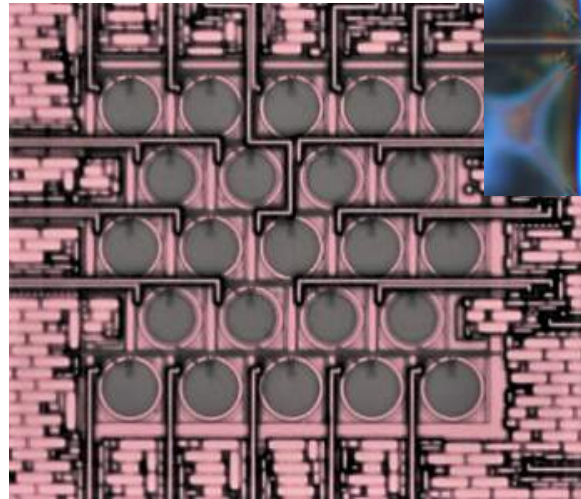
Sun, Ishihara, Charbon, IISW, 2017



Tosi et al, 2012

The Simplest Detector

- 23 pixels, independently accessible
- An FPGA connected to it with programmable counters and TDCs
- Easy to synchronize
- Easy to use



I.M. Antolovic *et al.*, *Optics Express*, 2018

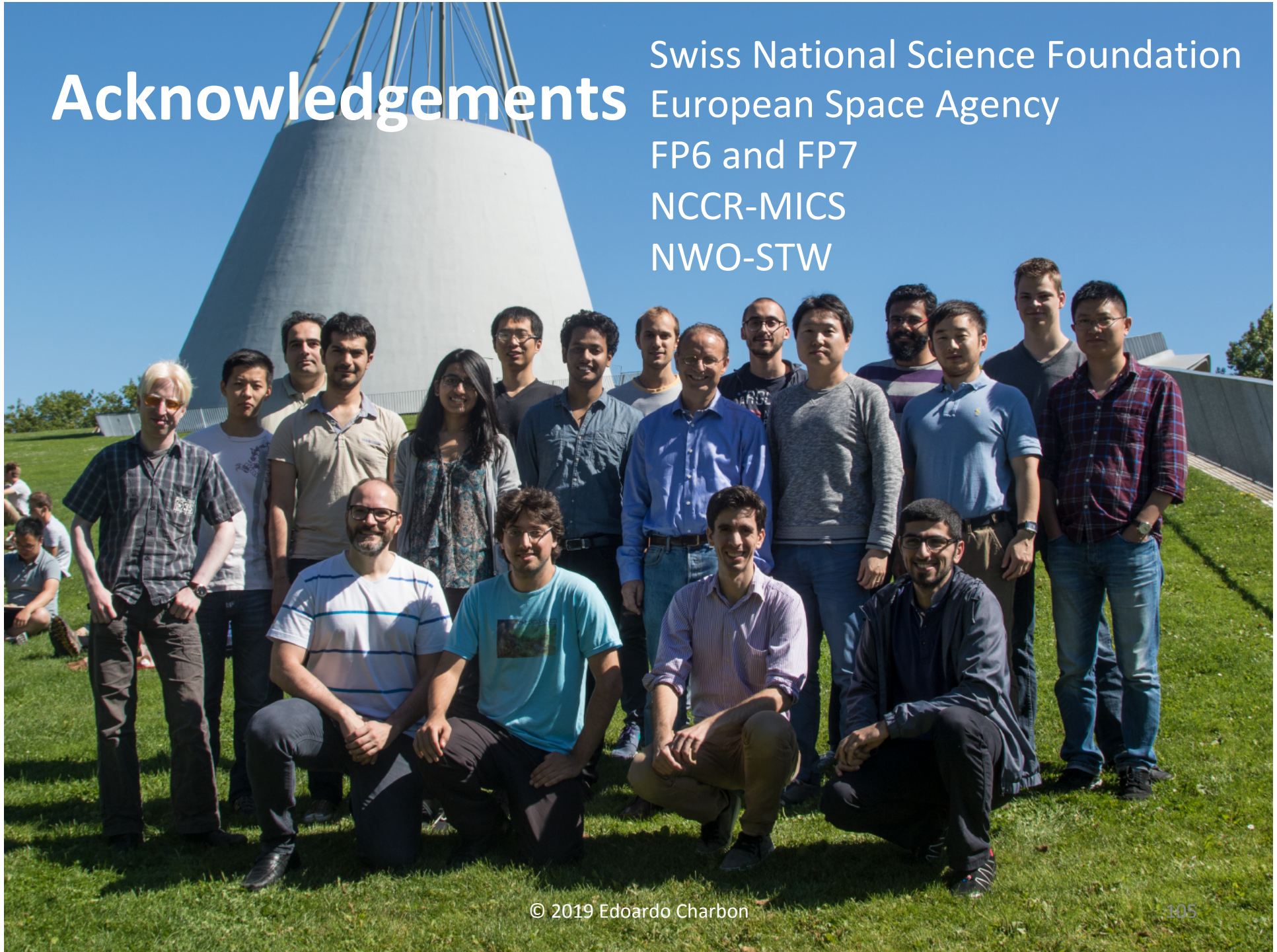
Conclusions

Take-home Messages

- SPAD image sensor peculiarities and architectures
- Modularity is an important ingredient to large photonic systems and even the technology of a cellphone camera will do
- One can actually make a product (and money) out of SPAD image sensors

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Swiss National Science Foundation
European Space Agency
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NCCR-MICS
NWO-STW



<http://aqua.epfl.ch>

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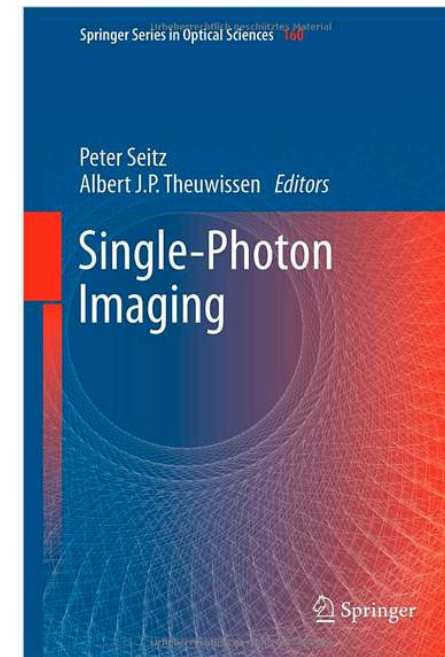
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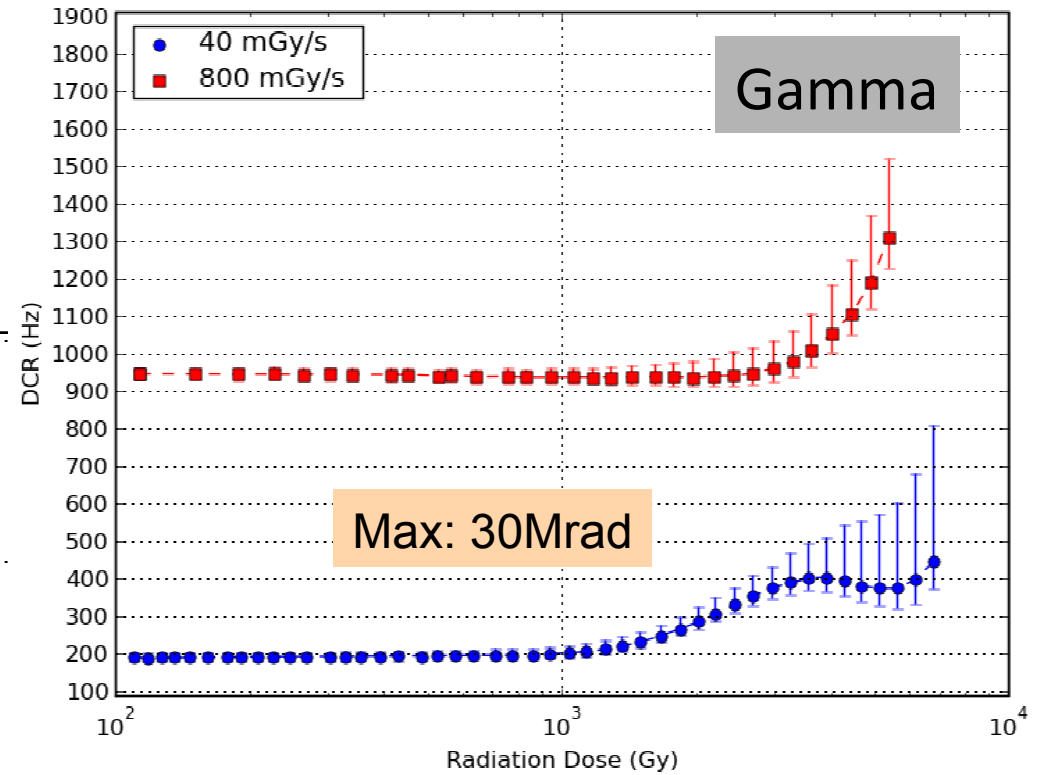
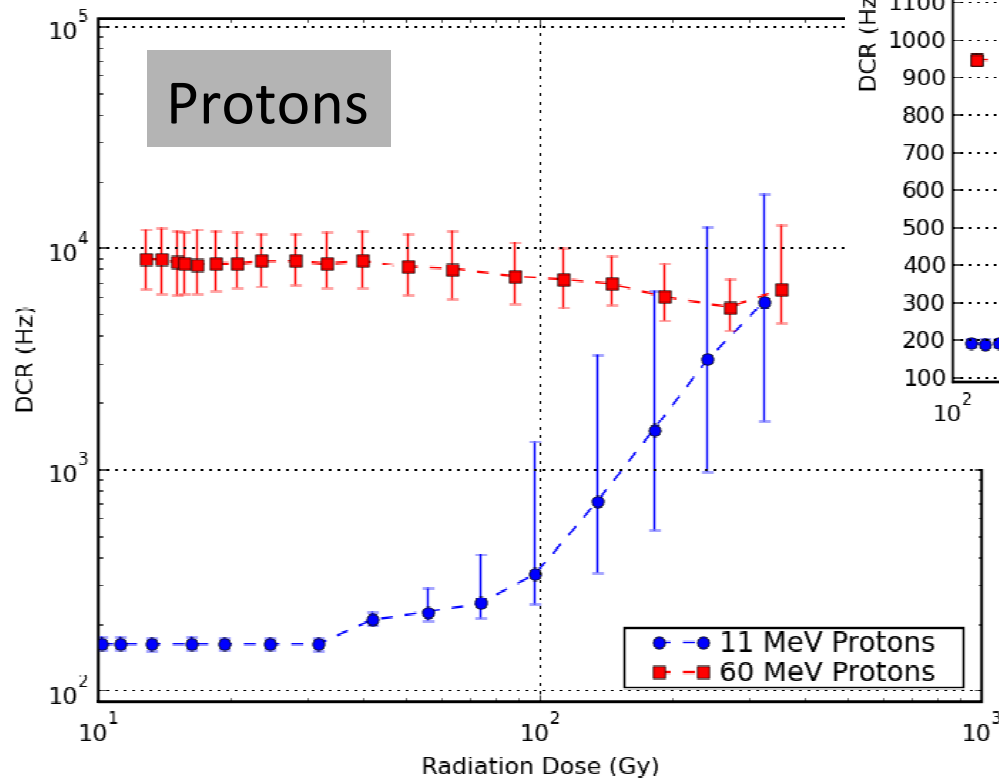
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BACKUP

SPADs Under Heavy Irradiation



L Carrara, E. Charbon, *et al.*, ISSCC 2009

Back to our Laser Photon Bunch Problem

Photon distribution in a laser bunch follows order-statistics

$$f_{k:n}(t) = n \binom{n-1}{k-1} f(t) F(t)^{k-1} (1-F(t))^{n-k}$$

$f_{k:n}(t)$: k-th order statistics

$f(t)$: probability density function

$F(t)$: cumulative density function

Assumptions:

- Each photon is stat. independent
- The pulse has a Gaussian p.d.f.

