Different Detectors for Time Correlated Single Photon Counting

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DEELS workshop

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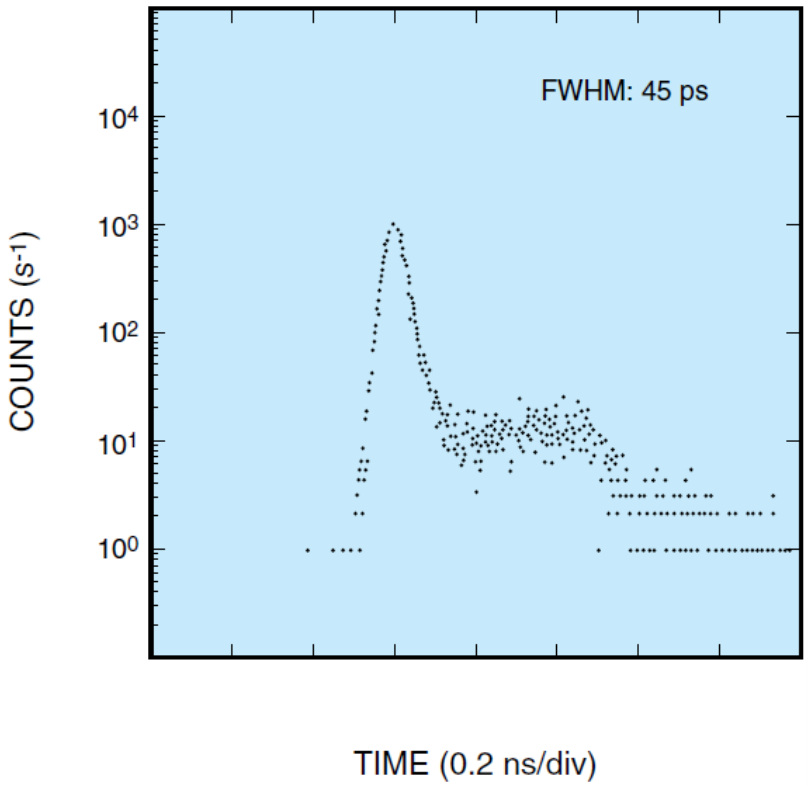
Overview

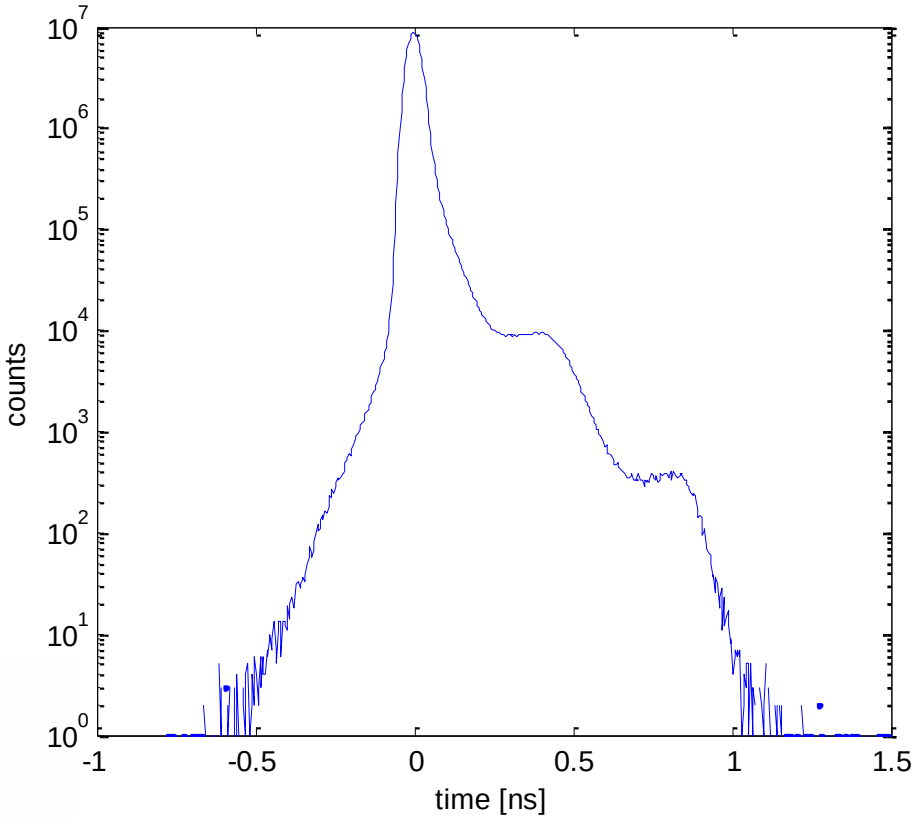
- So far, we've been using TCSPC to measure fill pattern (precise charge in filled bunches) more than single bunch purity.
- More beamlines are starting to use timing and hybrid bunch, anticipate better bunch purity is required
- We are using a PicoHarp 300 with 65536 buckets of 32ps width, 65536 counts depth
- We have acquired various single photon detectors over the years
  - Hamamatsu MCP-PMT R3809U-50
  - id-quantique SPAD id-100-50
  - PicoQuant Hybrid PMA
  - X-ray APD: Hamamatsu S2381 with Picosecond Pulse Labs 5530B bias tee and Femto HSA-X-1-40

MCP-PMT IRF short scale

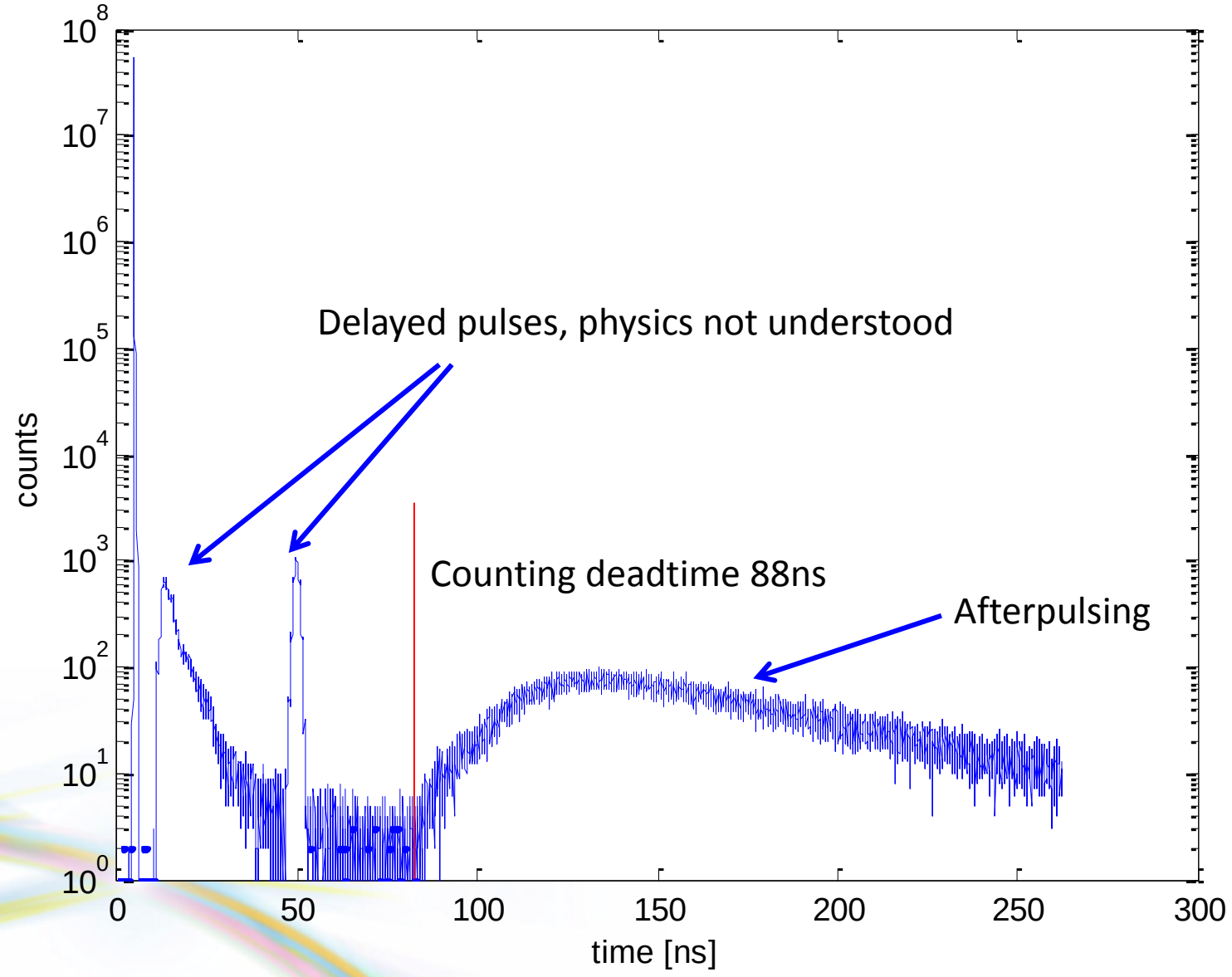
Datasheet



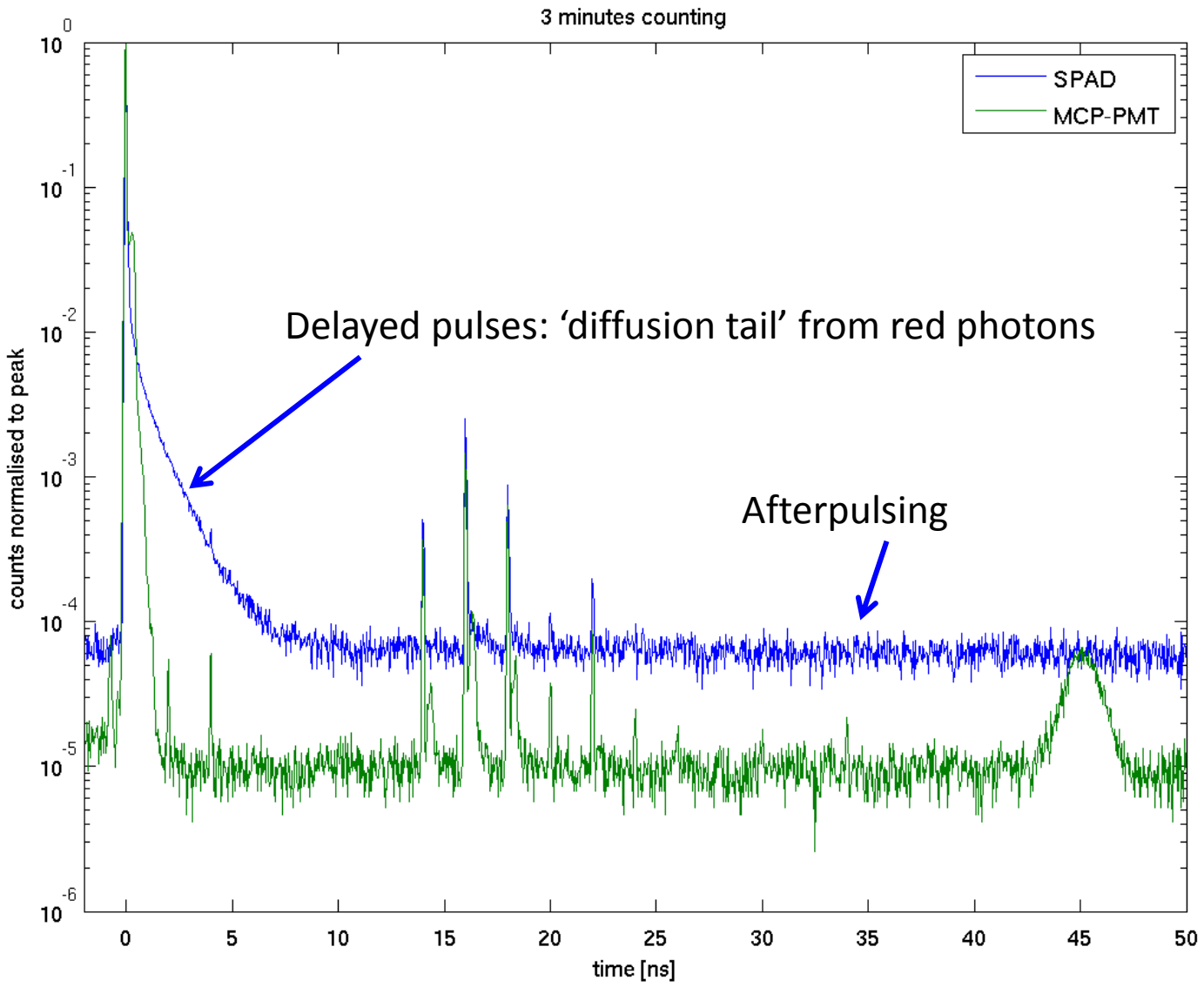
Our measurement with pulsed laser



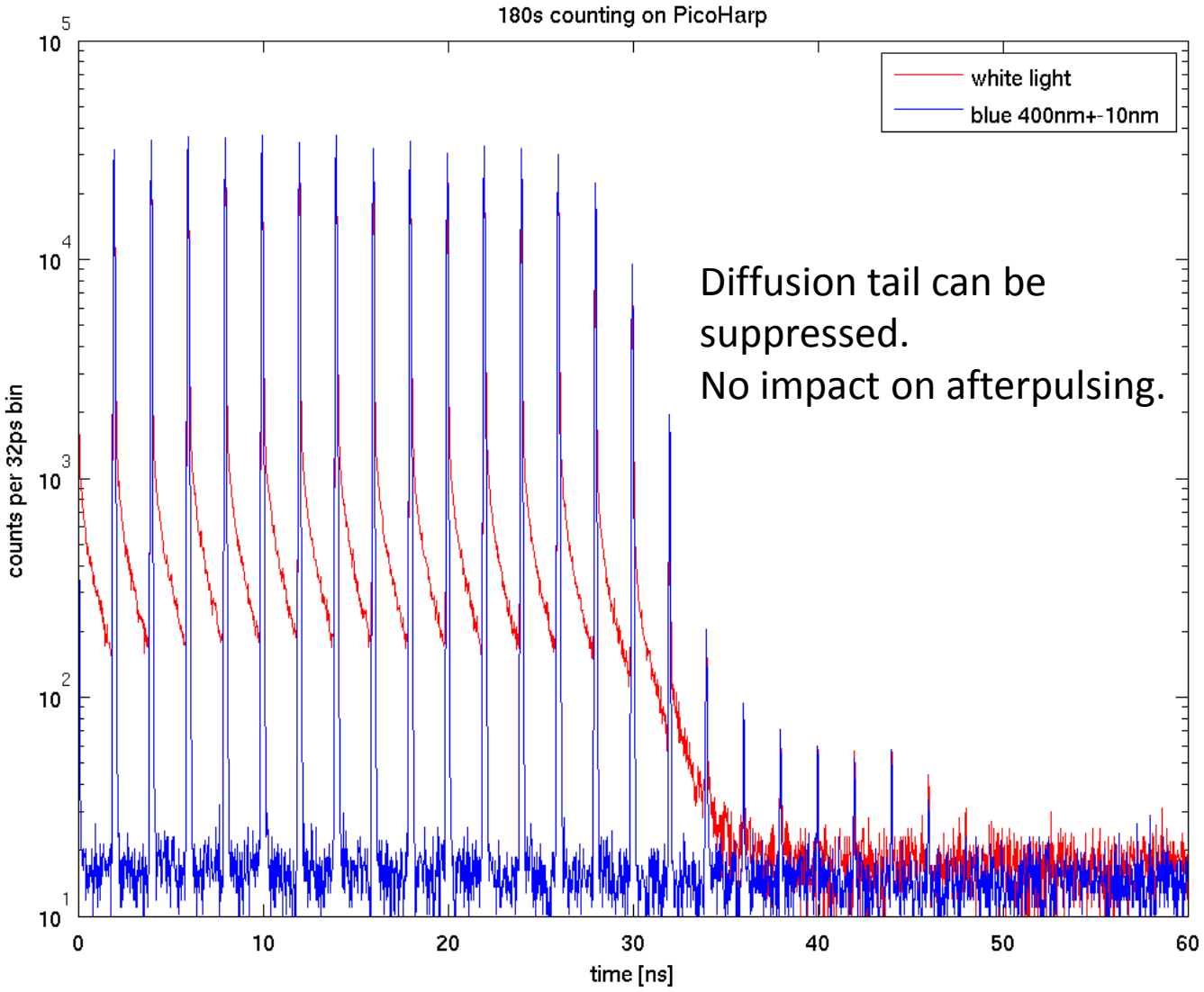
MCP-PMT IRF long scale



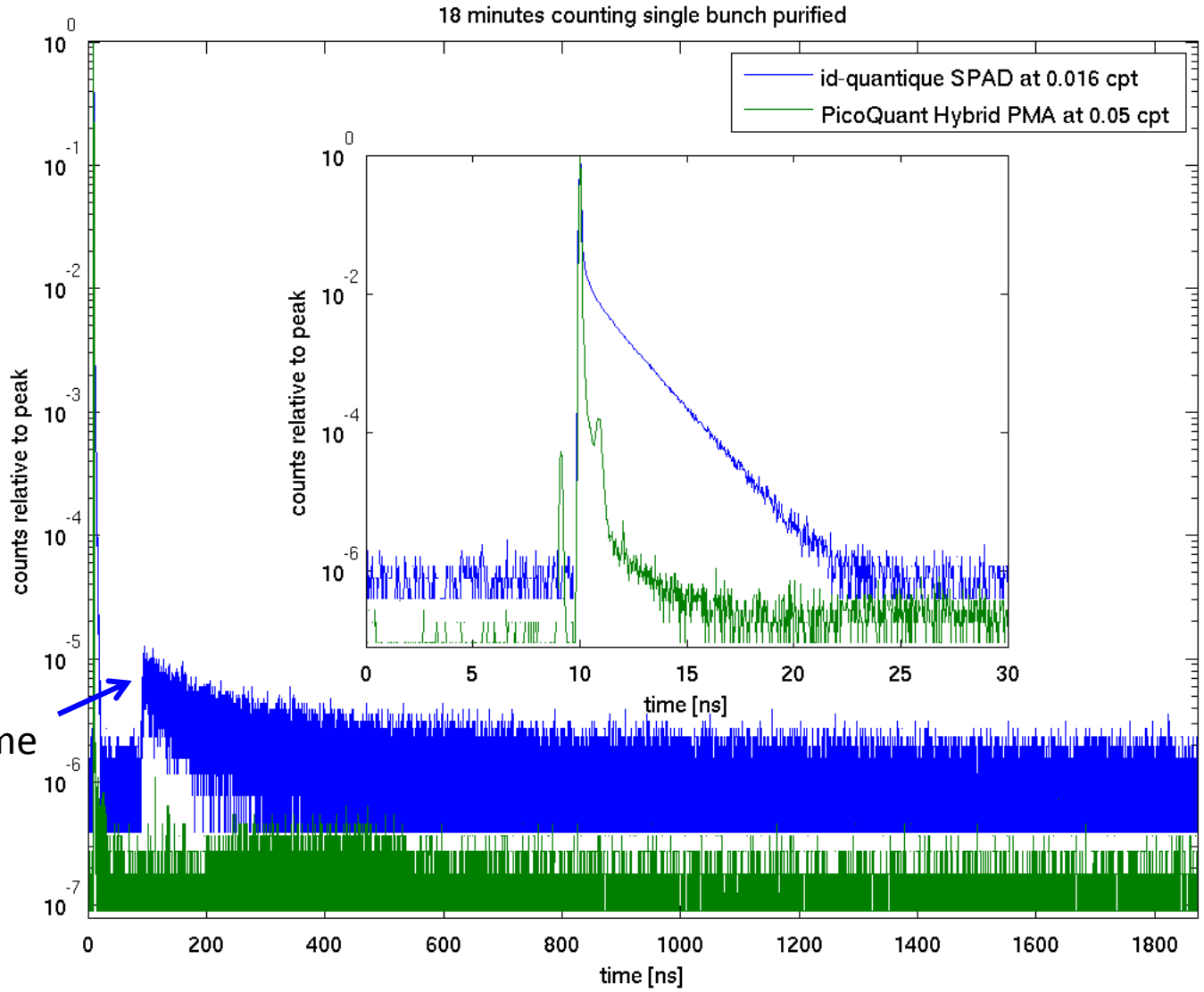
SPAD v MCP-PMT



SPAD white v blue

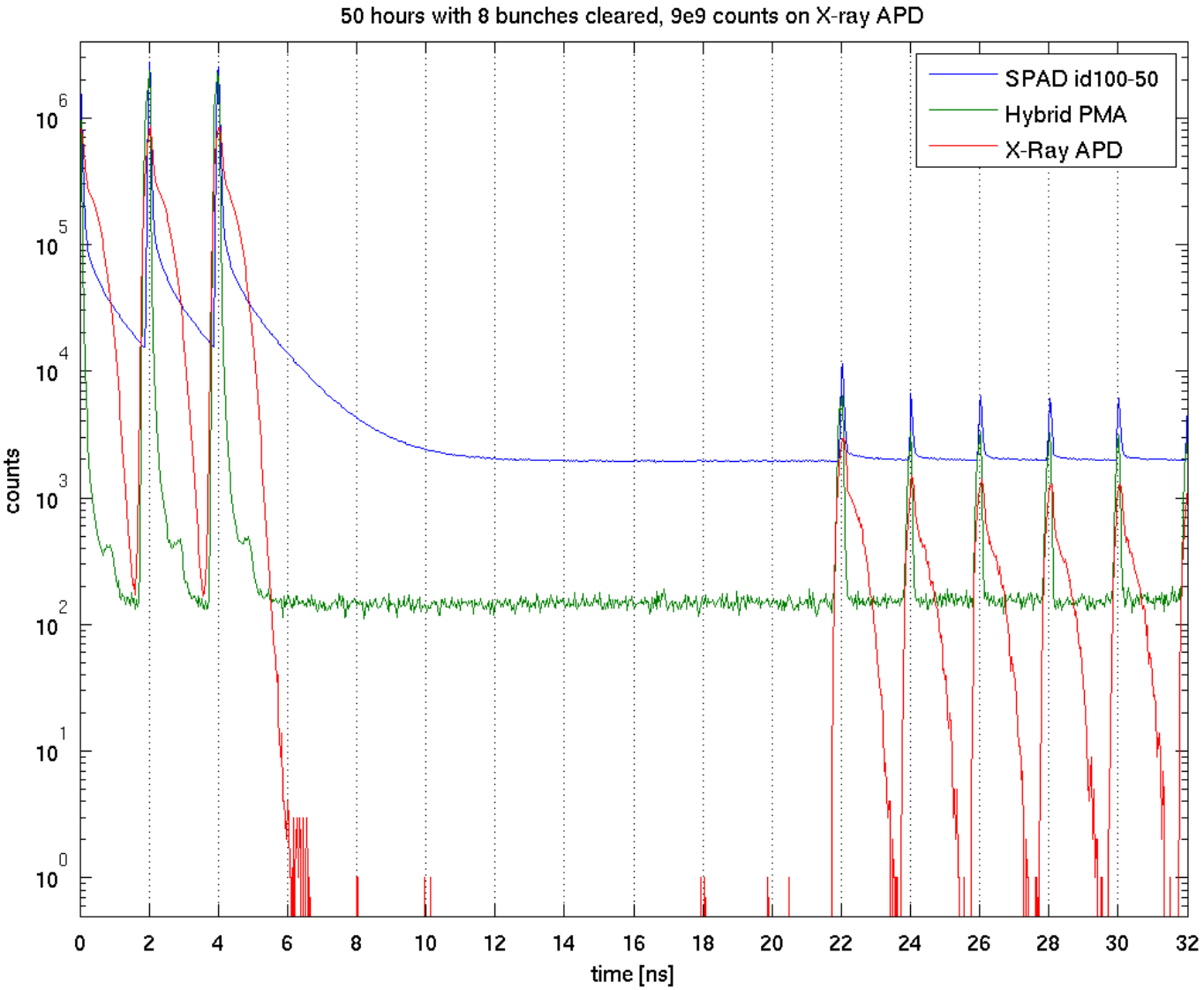


SPAD v PMA



Afterpulsing after deadtime

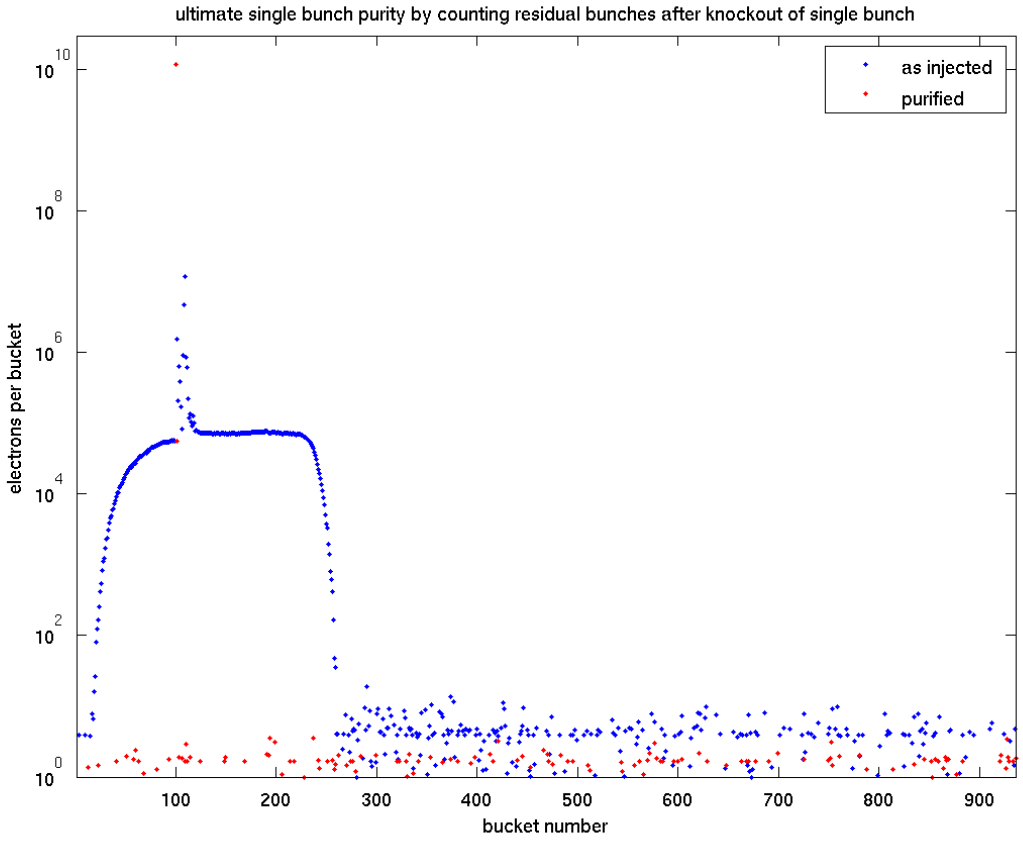
SPAD v PMA v X-ray APD

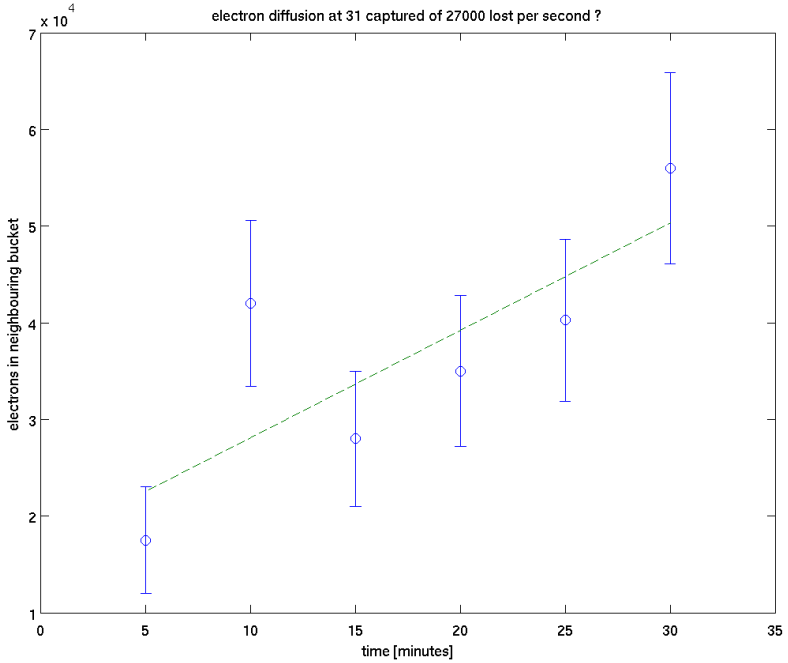


Detector Comparison

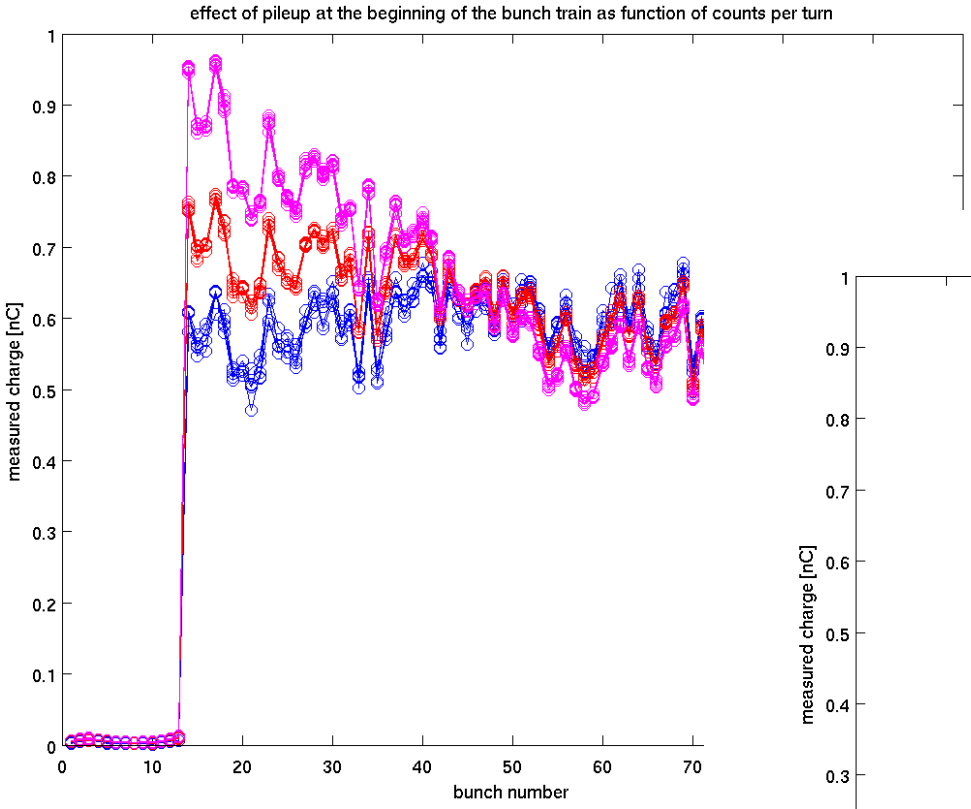
Detector	IRF FW 10e-1 [ps]	IRF FW 10e-5 [ps]	Dark Counts [1/s]	After-pulsing [%]	Cost (Year)	Remarks
MCP-PMT R3809U-50	100	1250	1	0.5	GBP12000 (2005)	External HV
SPAD id-100-50	170	19000 white 800 blue?	60	1.2	CHF 4200 (2010)	Fully integrated, TTL pulse out, 5V supply
Hybrid PMA	150	1100	24	0.05	€10000 (2013)	Peltier cooled, 12V supply
X-ray APD S2381	950	2500	0!	0?	GBP55+700+1550 (2013)	120V supply

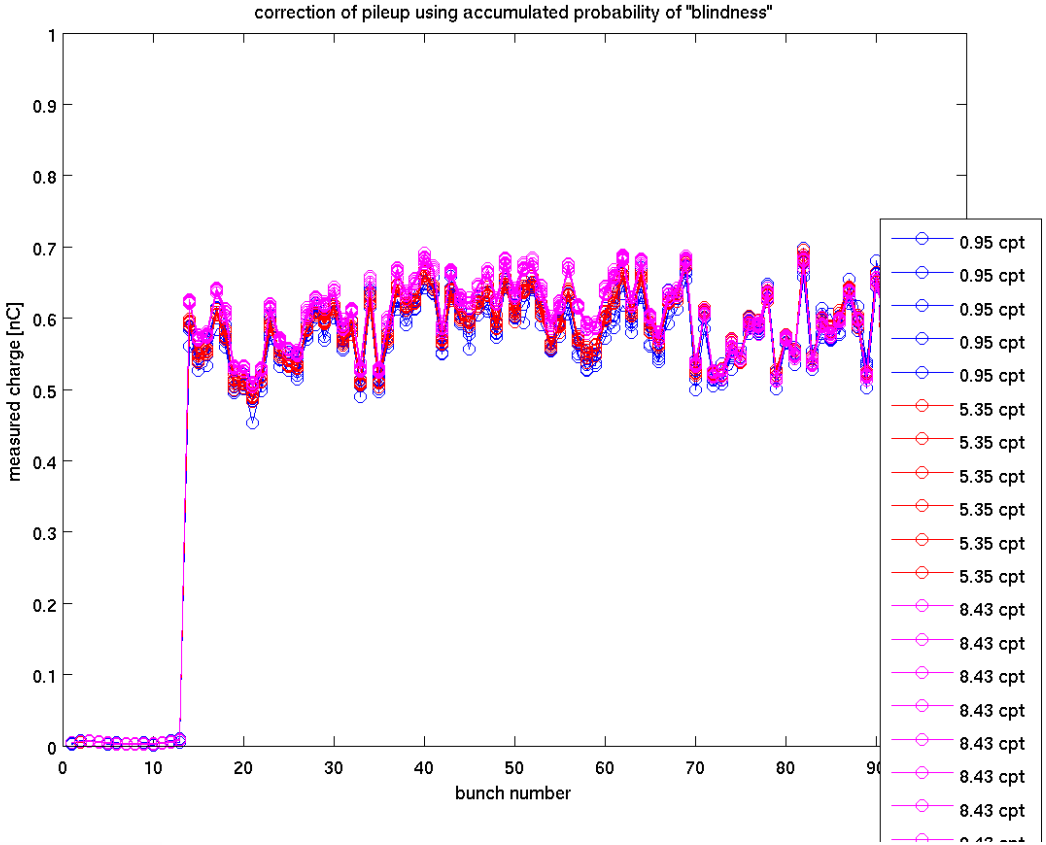
Injected v 'Purified' Single Bunch





Pile up correction





Summary/Open Issues

- Hybrid PMA best visible photon detector, but X-ray photon APD is best of all (no news).
- Visible light also easy at lowest beam currents, just take out ND filters.
- For X-ray APD, currently, need to chose threshold for counting high, otherwise dark counts. Then only 0.1 counts per turn at full current. Sees only scatter from Al window.