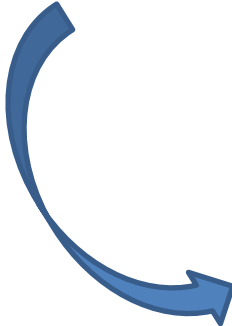


HV system for HyperK and E61

A. Evangelisti, A. Boiano, G. De Rosa (INFN-Na)

Constrains in HyperK and E61

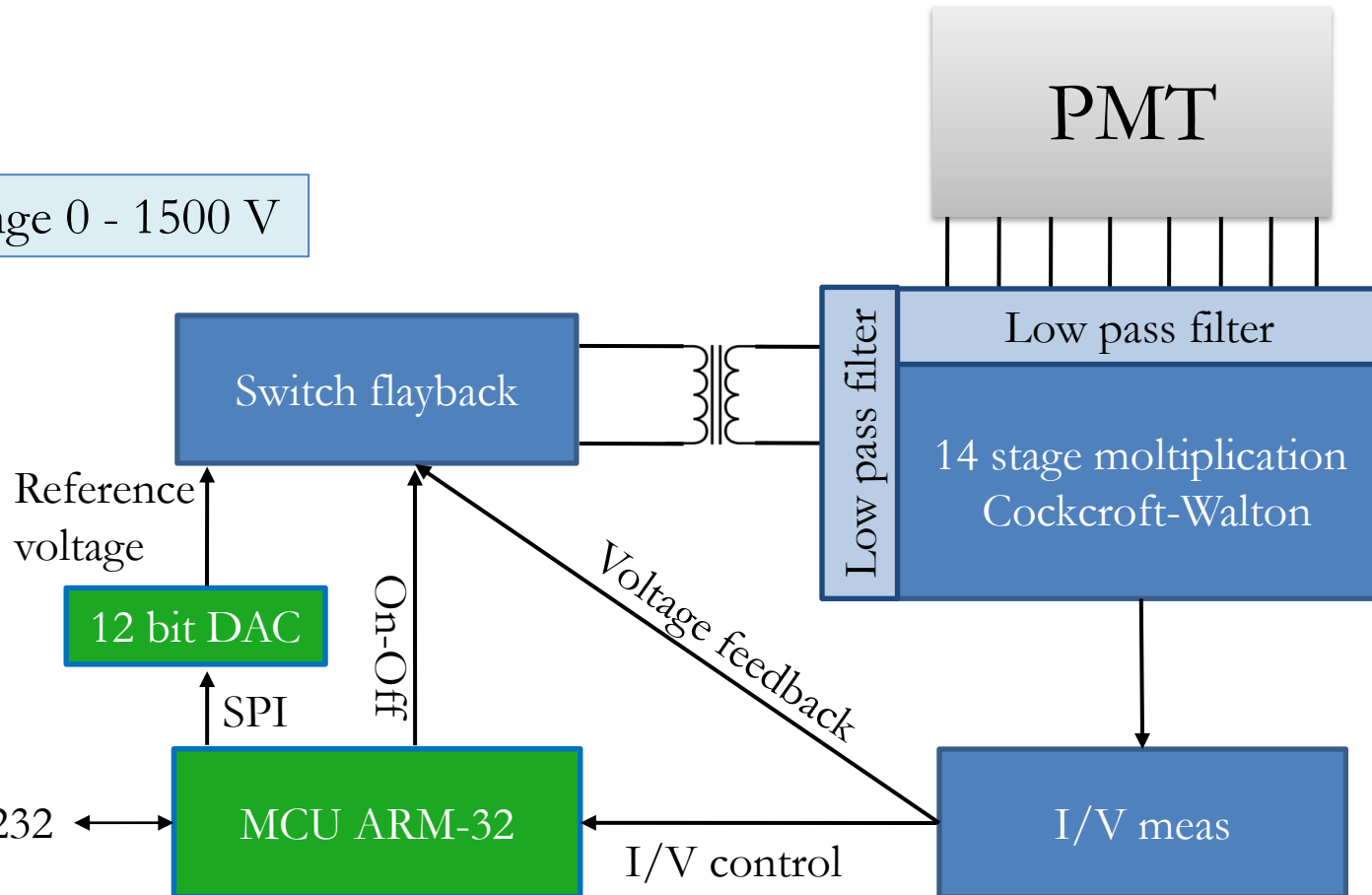
- Severe power budgeting: 3-4W for the full mPMT
- Stable high voltage for all the dynodes.
- Voltage range (0 – 1500V)



A Cockcroft-Walton (CW) voltage multiplier circuit to generate multiple voltages to drive the PMT dynodes starting from the 5 voltage supply, as in Km3Net (P. Timmer, E. Heine, H. Peek, **JINST** 5 (2010) C12049)

HV Board block diagram

HV Range 0 - 1500 V



MCU:
ARM-32 STM32L011F4U
Ultra-low-power ARM Cortex-M0+

V full scale = 1500 V (resolution 0.4V)
I full scale = 16.5 μ A (resolution 4 nA)

HV Board prototypes

Two HV board prototypes have been realized

The first circuit shown those problems:

- High ripple on HV
- High noise on signal output
- Very fast transient on switch

Problem solved in second prototype

HV Board Test

HV circuit switching noise test

HV board V1 switching
noise @ 1500 V:
4mV (~ 6pC)



HV board V2 switching
noise @ 1500 V:
500μV (~ 1pC)

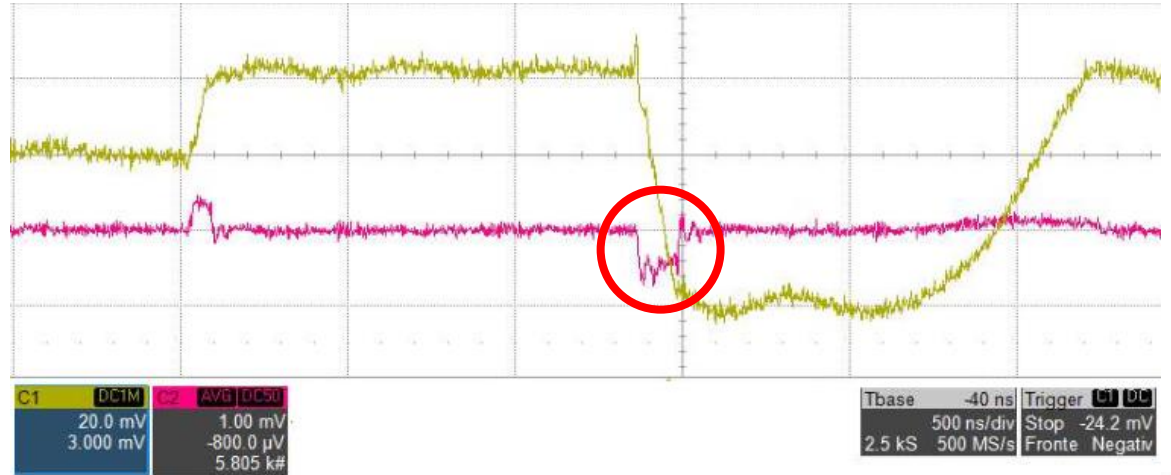


HV Board Test

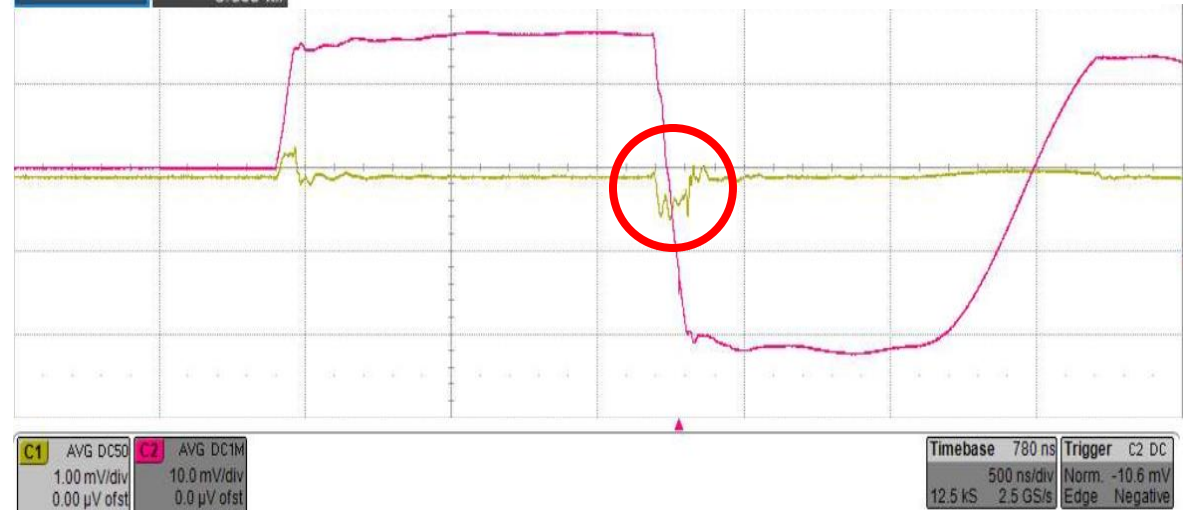
HV circuit switching noise test

HV board V2 switching noise @ 1500 V:
500 μ V (~1pC)

Voltage ratio 3:1:1



Voltage ratio 3:2:1

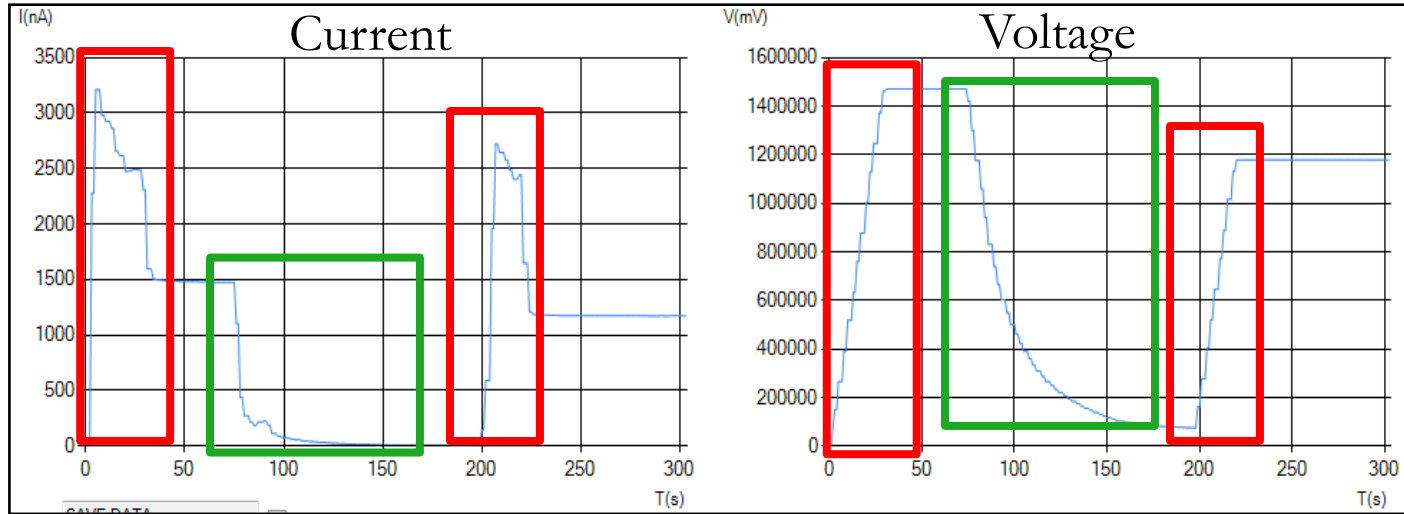


HV Board improvement

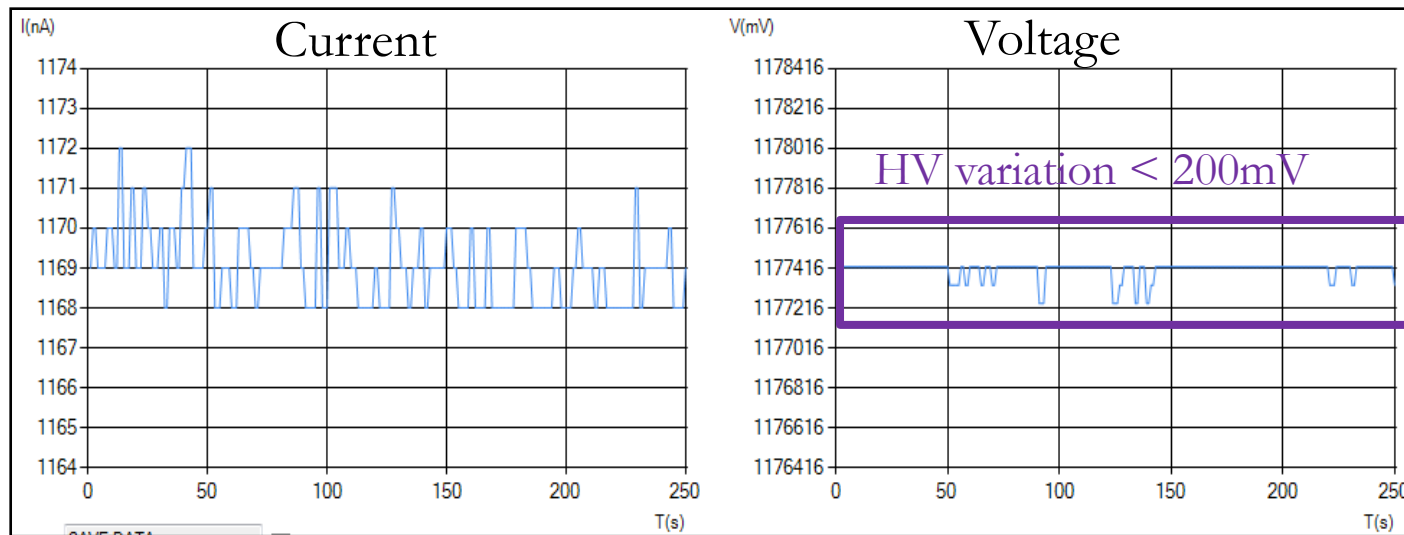
- Low pass filter for each dynode with particular attention to the last three stage.
- Separated ground between power supply and signal.
- Multilayer board studied to minimize the ground coupling.
- Particular attention to the placement of the component on the PCB to minimize the length of the route that is a noise source.
- Low pass filter on the output of the Switch flyback transformer to smooth the fast component of the switch.
- Dedicated circuit on the output of the switch mosfet to increase the rise time of the pulse (from 50 ns to 140 ns)

HV Board Test

Rump up and
Rump down
observed with
Voltage&Current
monitor



Run observed
with
Voltage&Current
monitor



HV Board Characteristics

HV circuit power consumption

Maximum power dissipated for
single HV channel @1500V:

12.5 mW

In a mPMT with 26 channel:

$26 \times 12.5 \text{ mW} = 325 \text{ mW}$



HV Board Characteristics

V meas I meas

Switch flyback

POWER DISSIPATION(Worst case)

V measurement:

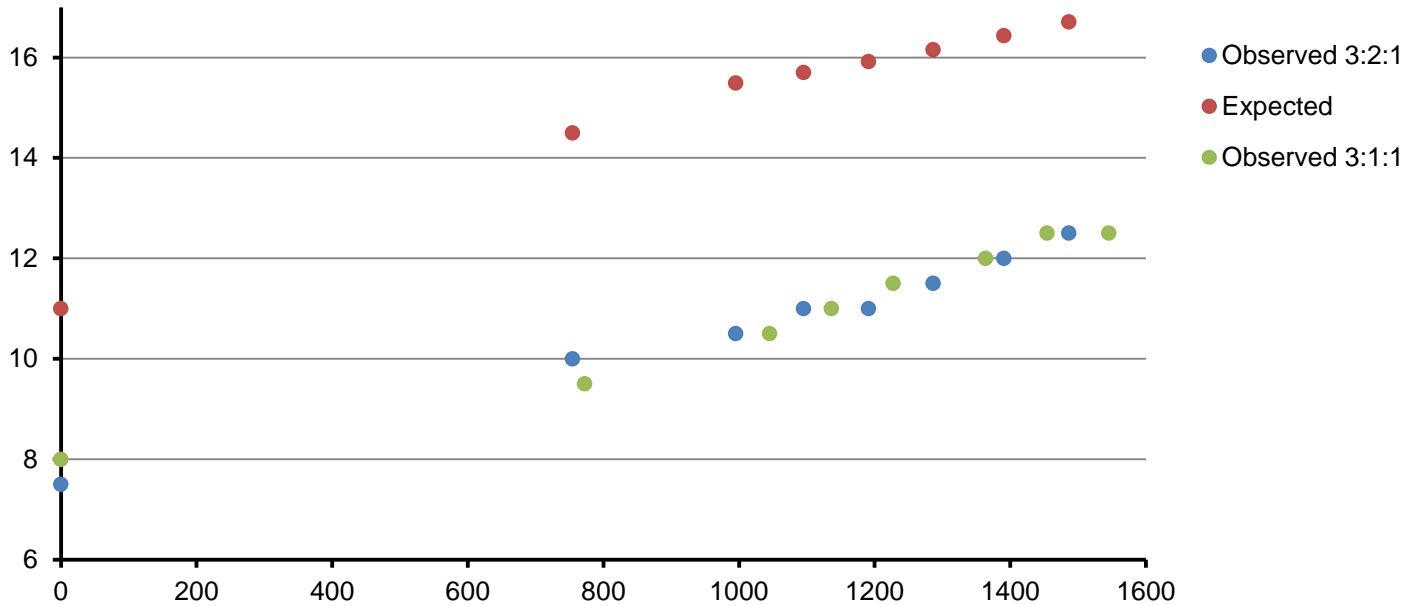
Resistive load (1500 V) \sim 2.2 mW

Operational amp 5 mW

I measurement:

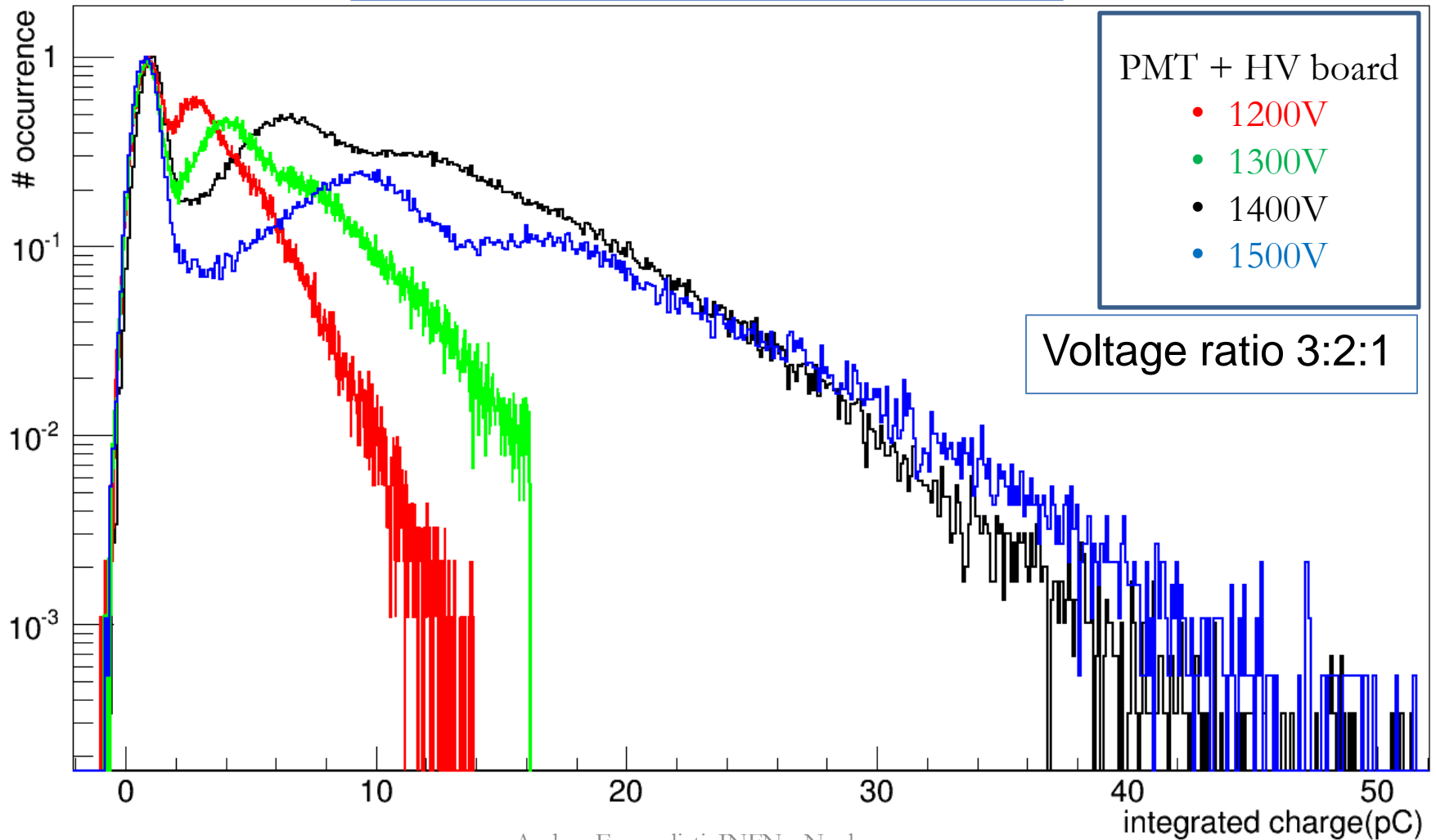
Operational amp 5 mW

Switch flyback: Power consumption 3.5 mW



HV Board Test

PMT & HV circuit signal test



Conclusion

- Two signal to set and two signal to control the HV board
- Second prototype for Voltage Multiplier Circuit developed debugged and tested at INFN-Na.
- Two possible voltage ratio(3:2:1 and 3:1:1)
- HV circuit tested on a R12199-02 PMT and compatible with the R14374 PMT.