A new C6D6 detector with SiPM readout

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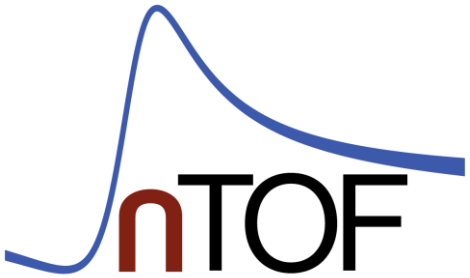
C. Guerrero, J. Lerendegui-Marco, J.M.Quesada (US)
F. Calviño, A. Casanovas, A. Tarifeño-Saldivia (UPC)
The n_TOF Collaboration



European Research Council
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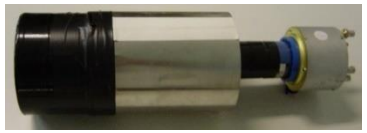
Consejo Superior de Investigaciones Científicas

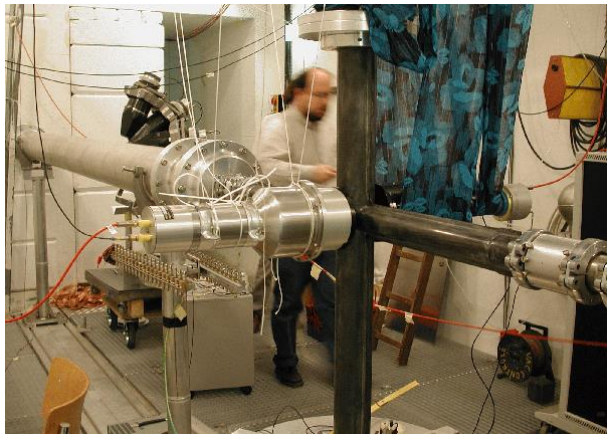
Outline:

- Brief evolution of the C6D6 zoo @ n_TOF
- Objectives of a new C6D6 design
  - Neutron sensitivity
  - Electrical signal response
  - B-field insensitivity
- Pros- and cons of the new design
- Proposed prototype development and tests

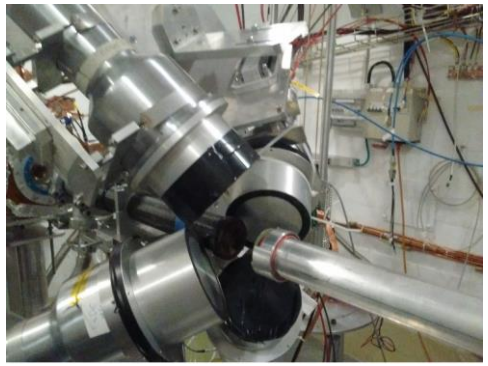
Brief evolution of C6D6 detectors at n_TOF:

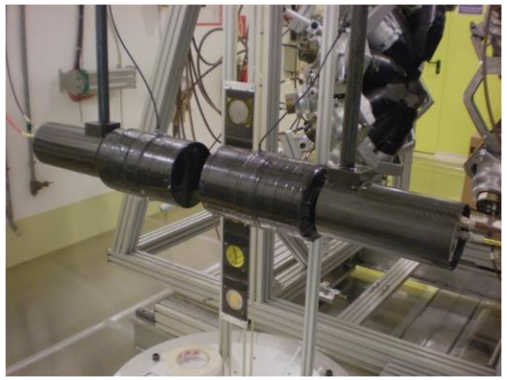


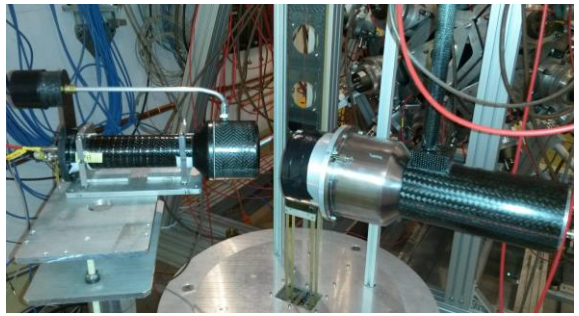
2001-2005



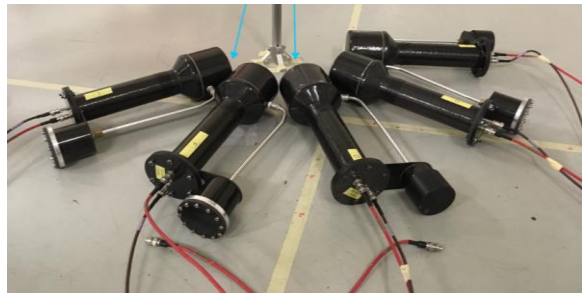
2000

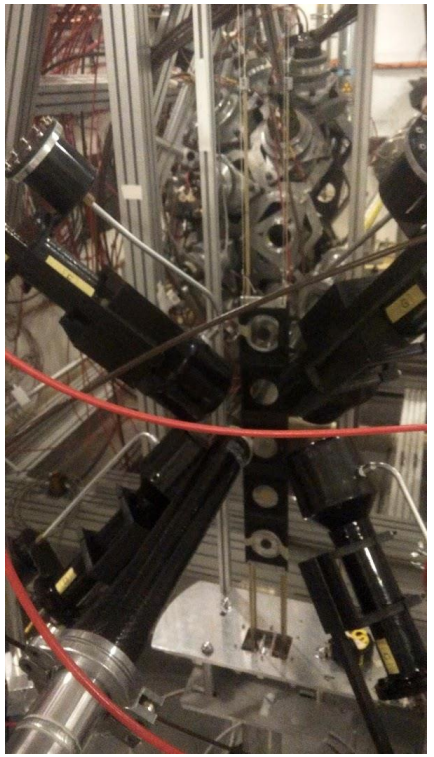


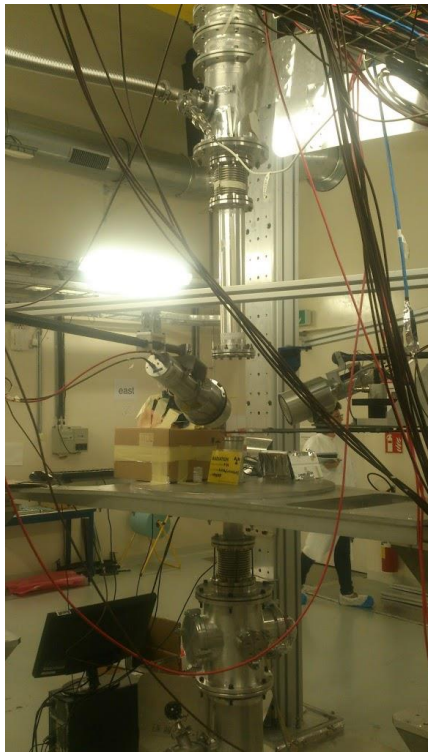




2009-2012







2015-2018

time

C6D6/SiPM goals:

→ Further **reduce the intrinsic Neutron Sensitivity** (compared to state-of-the-art C6D6)

→ Better **suited for high CRs and γ-flash (EAR2)** by reducing volume (1/4 L6D6)→ Better suited for high En-range

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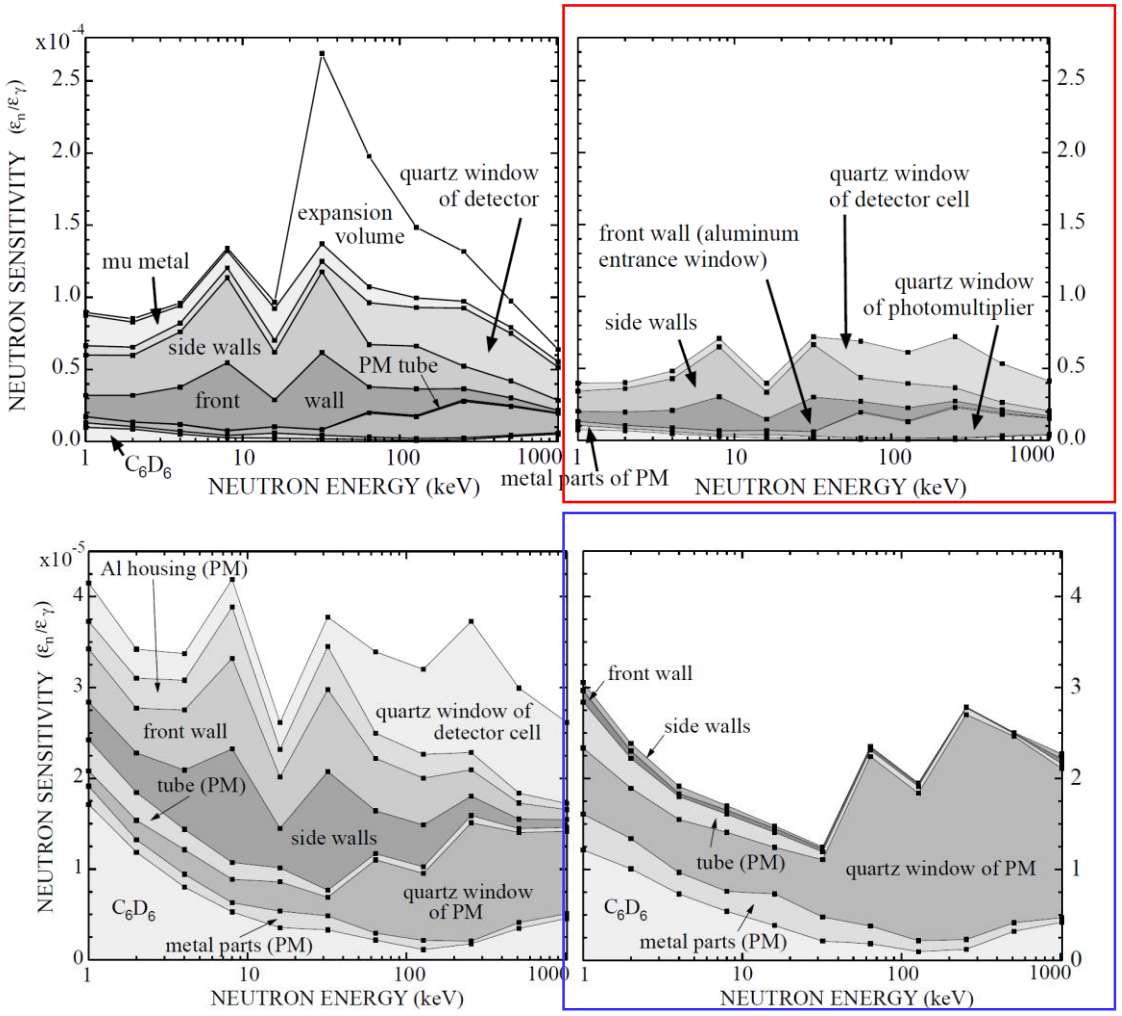
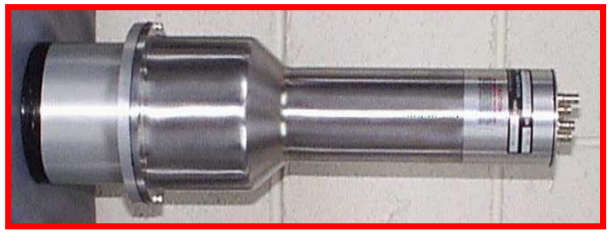
C6D6/PMT Neutron sensitivity: could it be improved further?

→ Aspect 1: neutron sensitivity





R.Plag et al. Nucl. Instr. Meth. A 496, Issue 2, p. 425-436 (2004).

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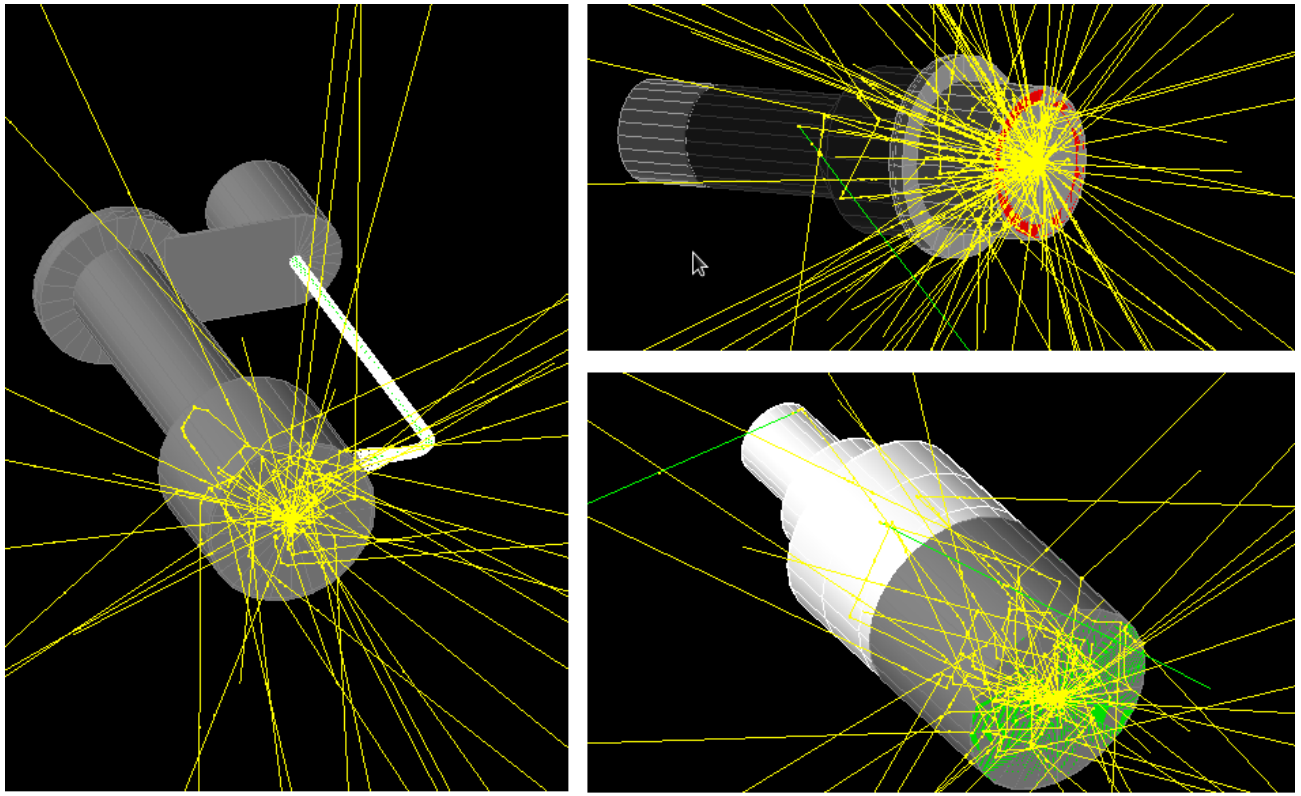
→ Aspect 1: neutron sensitivity

L6D6 Response to Neutrons (C. Guerrero & J.Lerendegui-Marco, US):

N_TOF Collaboration Meeting, 7 October 2014

- Low Sensitivity:
  - 20h-Long simulations , 10^8 neutrons
  - Maximized geometrical efficiency:

    2π emitting source at <1mm from detector



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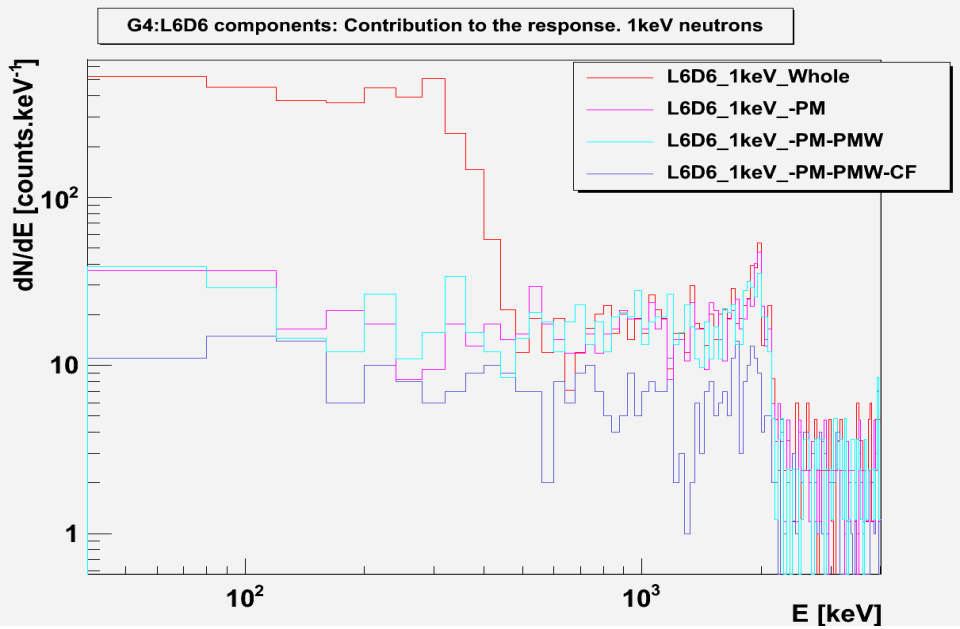
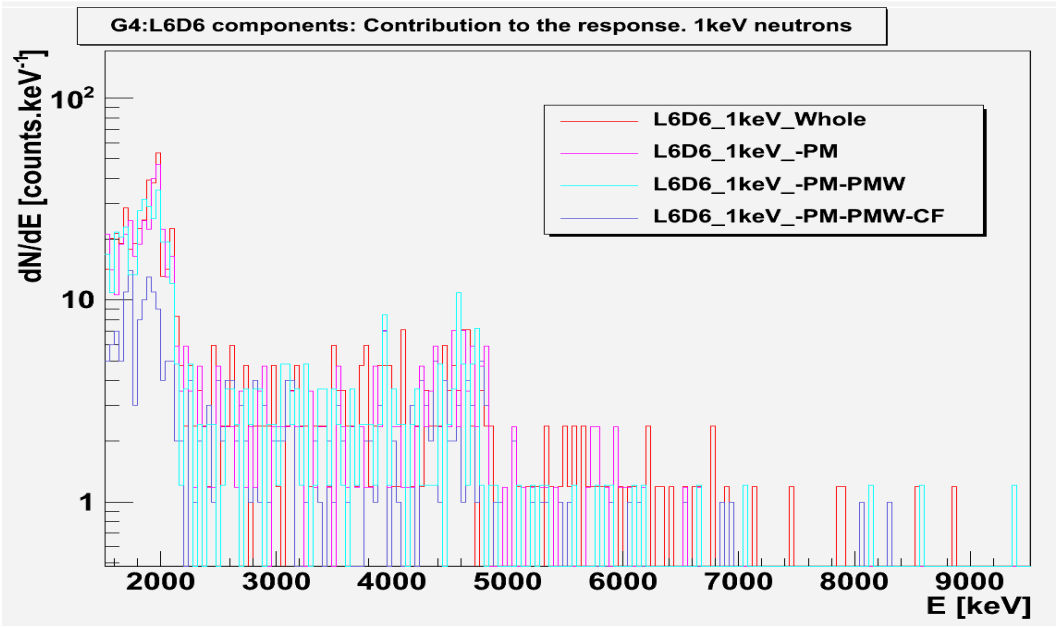
L6D6 Response to Neutrons (C. Guerrero & J.Lerendegui-Marco, US):

➢ Analysis of main contributions to neutron sensitivity of the L6D6 :



PMT is main contributor (E< 500keV)



CF main cotribution at ~2.2 MeV

→ Thus, avoiding PMT (thereby reducing also total amount of CF) should help to reduce NS further down(!)

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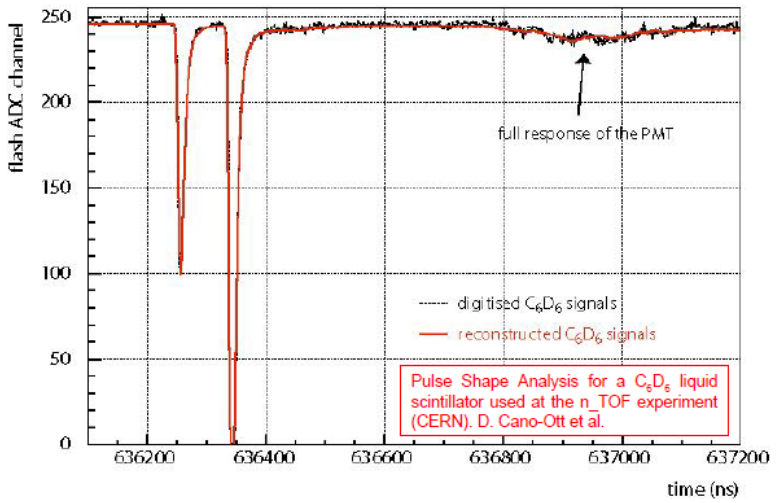
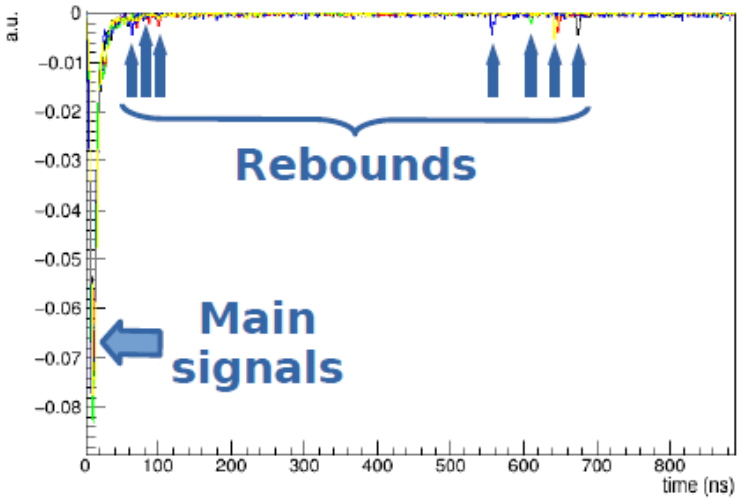
C6D6/PMT response: affected by artifacts (rebounds) probably arising from PMT's Voltage Divider:

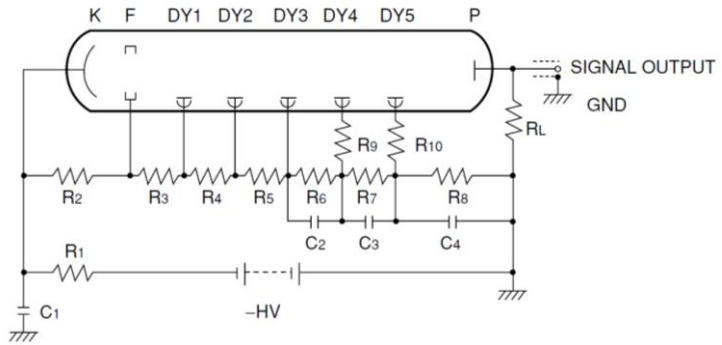
→ Aspect 2: ringing and rebounds produce a "dirty" electrical response

PMT + Voltage Divider:

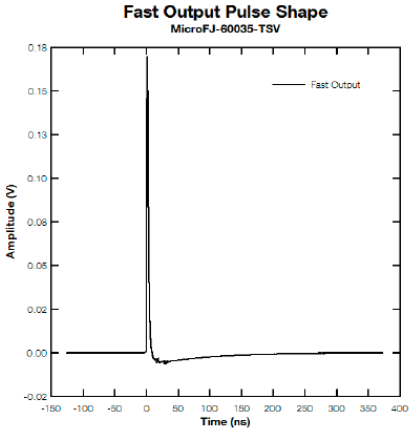


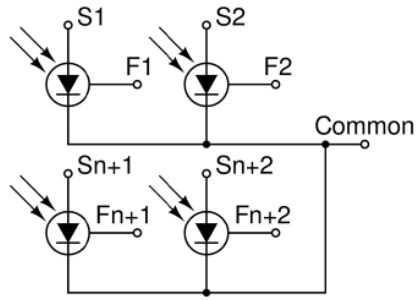


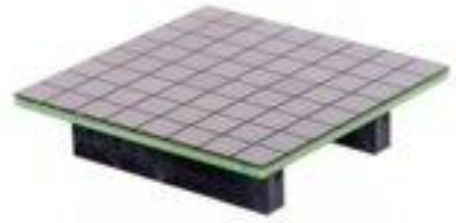
impedance missmatch issues due to voltage divider



SiPM:







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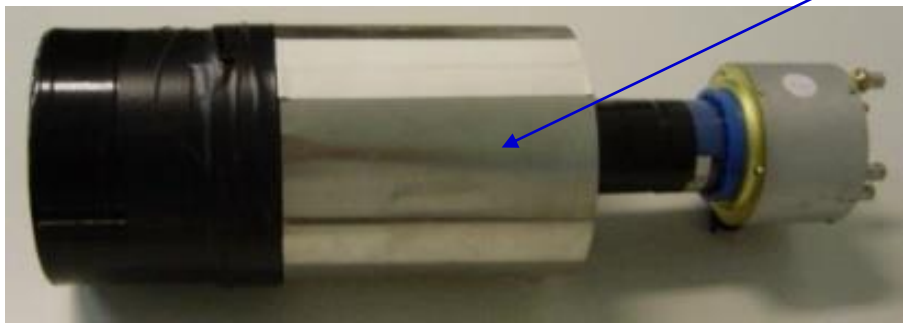
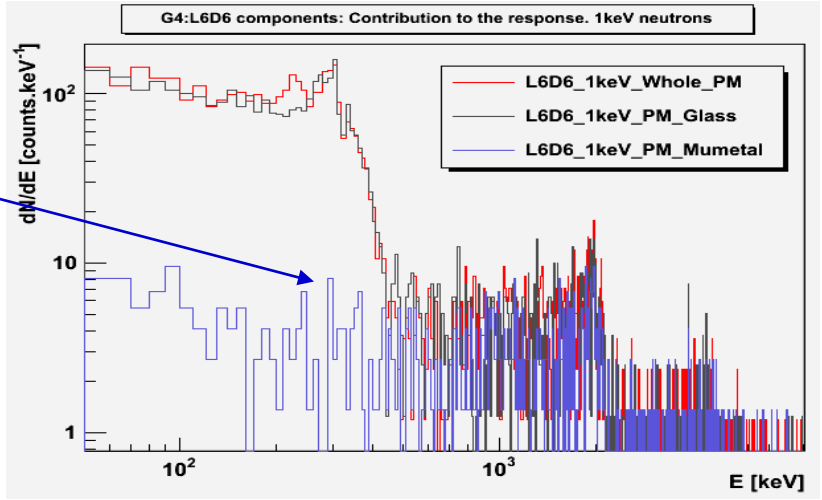
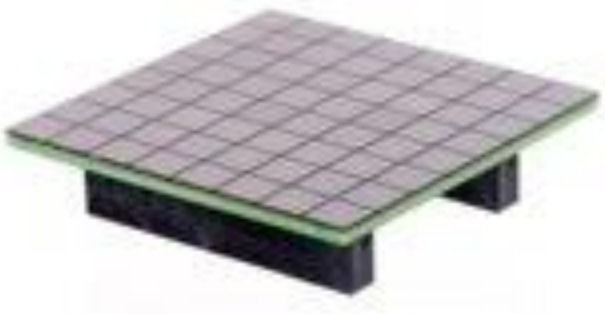
C6D6/PMT B-field sensitivity: can we avoid it?

→ Aspect 3: mu-metal & magnetic fields screening

mu-metal



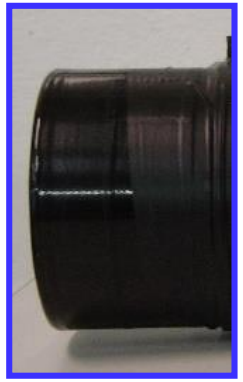


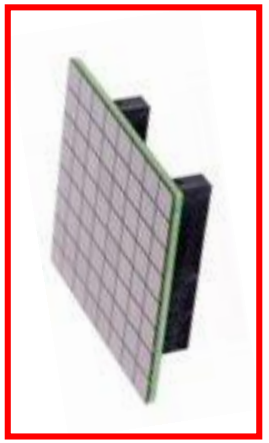


From conventional C6D6/PMT towards C6D6/SiPM: the proposal to develop a new C6D6

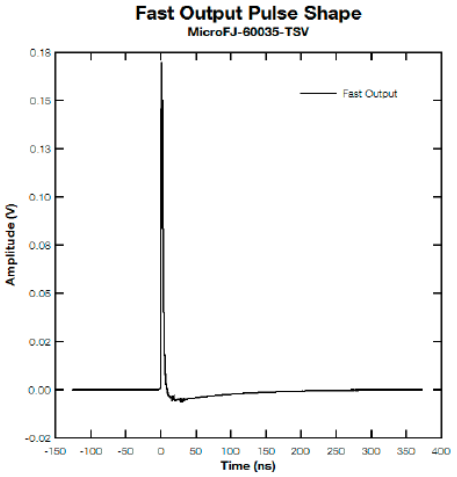
→ Aspect 1: “dirty” signal response
→ Aspect 2: neutron sensitivity (PMT)
→ Aspect 3: B-field sensitivity (mu-metal)

Replace PMT+VD by SiPM





“Mock” prototype of IFIC-C6D6: i6D6
→ 250 ml C6D6
→ SiPM Sensl 50x50mm^2
→ 1/4th of L6D6 volumen (four of these make one L6D6)



C6D6/SiPM Project summary: Pros & Cons, Next steps

Pros:

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Cons:

- → Need 4 channel Digitizers per 1L volumen (4 times the # channels than same efficiency with L6D6)
- → Needs some development, in particular a customized C6D6 Carbon Fiber cell
- → Thermal dependency of the SiPM – gain (there are simple solutions)

C6D6/SiPM development: next steps

- → **Prototype** replacing Bicron PMT by SiPM and tests with sources (IFIC/CERN) for:
  - → gain-stability, resolution, count-rate capability
- → Neutron sensitivity study at CNA using n-beam
- → Study of the neutron-sensitivity via MC (US/C.Guerrero,J.Lerendegui)