A new C6D6 detector with SiPM readout

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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:

2000

2001-2005

2009-2012

2015-2018
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

→ Clean electrical output signals (no VDs → no rebounds → To be tested in the lab during LS2) → **Reliable PSA**

→ Fast response, comparable or better than PMTs → Well suited for neutron-TOF

→ By construction, **insensitive to B-fields** (unlike PMTs), no need for mu-metal

→ Low voltage supply (+30V bias, may even think of battery powered detectors for reducing noise loops)
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→ Aspect 1: neutron sensitivity

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

→ Aspect 1: neutron sensitivity


➢ Low Sensitivity:
  ➢ 20h-long simulations, $10^8$ neutrons
  ➢ Maximized geometrical efficiency:
    2$\pi$ emitting source at <1mm from detector

N_TOF Collaboration Meeting, 7 October 2014
Aspect 1: neutron sensitivity


- Analysis of main contributions to neutron sensitivity of the L6D6:
  
  - PMT is main contributor (E< 500keV)
  
  - CF main contribution 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:

Rebounds

Impedance mismatch 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 50x50mm²
- 1/4th of L6D6 volume (four of these make one L6D6)
C6D6/SiPM Project summary: Pros & Cons, Next steps

Pros:

→ **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
→ Clean electrical output signals (no VDs → no rebounds → To be tested in the lab during LS2)→ **Reliable PSA**
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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)