Status of ADRIANO2 R&D in T1604 Collaboration*

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ABSTRACT

A novel high-granularity, dual-readout calorimetric technique (ADRIANO2) is under development as part of the research program of the T1604 Collaboration[1]. The building block of such a calorimeter comprises a pair of optically isolated, small tiles made of scintillating plastic and lead glass. The prompt Cerenkov light from the glass can be exploited to perform high resolution time measurements while the high granularity provides good resolution of the spatial components of the shower. Dual-readout compensation and particle flow techniques applied to the plastic and lead glass sections should provide excellent energy resolution as well as PID particle identification, making ADRIANO2 a 6D detector suited for High Energy as well as High Intensity experiments. A report on the ADRIANO2 project, current and future R&D plans by T1604 Collaboration, and the construction status of a new prototype will be presented.

The dual-readout calorimeter concept

A dual-readout calorimeter consists of two calorimeters with different properties sharing the same volume and providing two independent energy measurements of a shower. Compared to traditional single-readout devices, a dual-readout provides a binocular view of the shower. The two measurements can be used to compensate event-by-event the energy measurements.

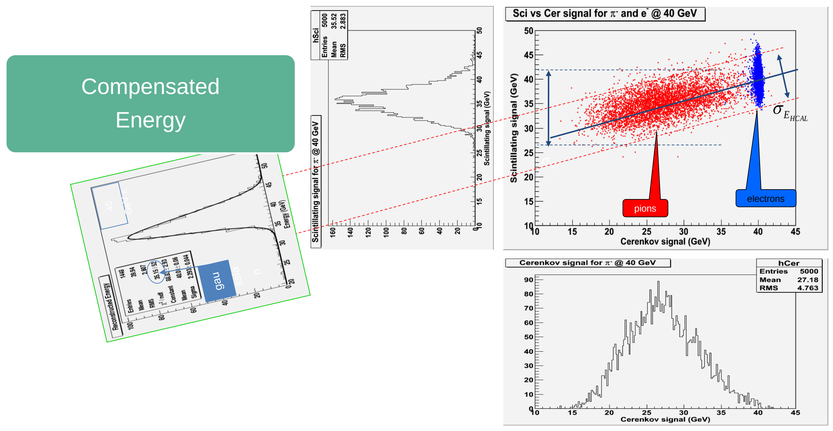

Figure 1. Energy compensation with dual-readout techniques

The measured energy is a rotation of the independent measurements providing a more precise measurement.

$$E_{HCAL} = \frac{\eta_S \cdot E_S \cdot (\eta_C - 1) - \eta_C \cdot E_C \cdot (\eta_S - 1)}{\eta_C - \eta_S} \qquad \left(\eta_S = \left(\frac{e}{h}\right)_S \;;\; \eta_C = \left(\frac{e}{h}\right)_C\right)$$

If $\eta_S \neq \eta_C$ then the system can be solved for E_{HCAL}

The ADRIANO2 dual-readout calorimeter

ADRIANO2. ADRIANO2 is a high-granularity (HG) version of ADRIANO. The long strips are replaced by small tiles and the light readout is obtained with SiPM directly coupled to them.

ADRIANO Advantages

- Fewer readout channels
- More economical to fabricate
- Applicable to high and low energy

ADRIANO2 Advantages

- Dual-readout + PFA
- 50 psectime resolution for TOF
- E, position, time, PID (6D detector)
- Prompt response from C can feed L0 trigger
- Polarimetry measuremnts

The ADRIANO2 glass tiles

ADRIANO2 prototype. 3x3 cm^2 tiles of different thickness being tested

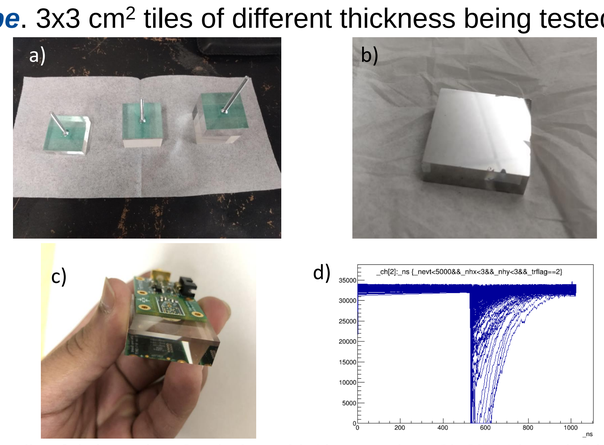

Figure 6. a) glass tiles fabricated at Cat-i-glass. b) Al sputtering. C) SiPM board. D) signals from SiPM.

FEE and DAQ

- Porka board with Gali+ preamp
- Sampic digitizer and Petiroc-2a ASIC

Figure 7. FEE Porka boards (left), Sampic digitizer, CAEN DT5550W with Petiroc2a ASIC

The ADRIANO dual-readout technique

ADRIANO. It consists of a sandwich of lead-glass (providing Cerenkov light) and plastic scintillator (providing Scintillation light) strips, readout through WLS fibers.

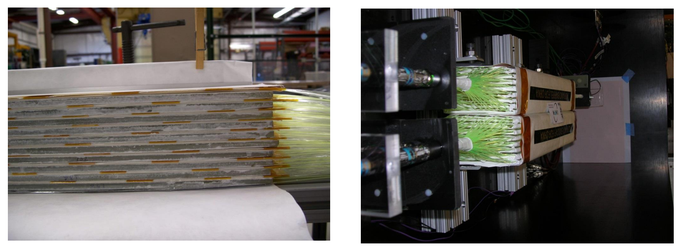

Figure 2. Three ADRIANO prototypes, 1.1 m long.

Simulated energy resolution. It consists of a sandwich of lead-glass (providing Cerenkov light) and plastic scintillator (providing Scintillation light) strips, readout through WLS fibers.

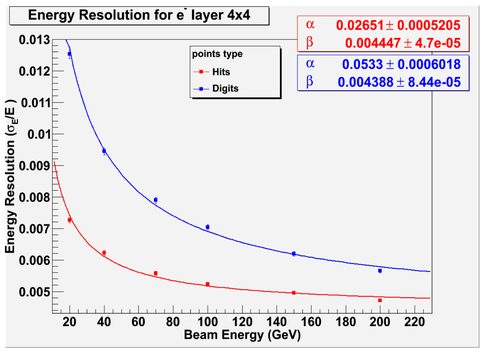

Figure 3. EM energy resolution simulated with Ilcroot.

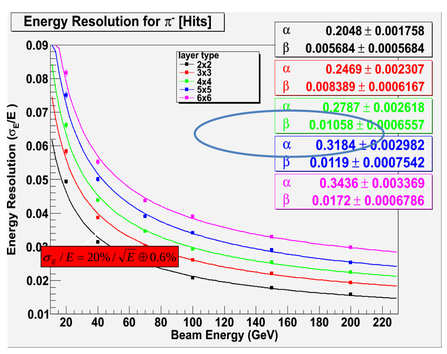

Figure 5. Hadron energy resolution simulated with Ilcroot.

PID with ADRIANO. Comparing S vs C the particle Identification can be achieved with much higher precision than with a single-readout calorimeter.

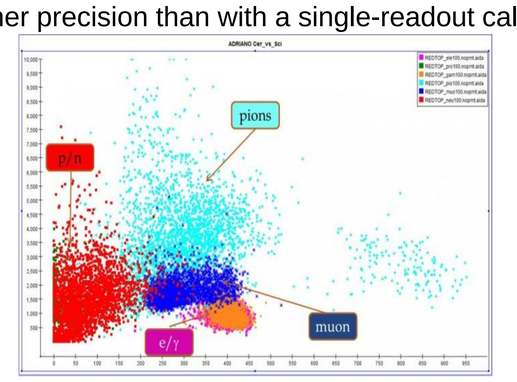

Figure 4. Particle identification from the comparison between the scintillation vs. Cherenkov signals in the ADRIANO calorimeter for simulated particles with E_{kin} = 100 MeV

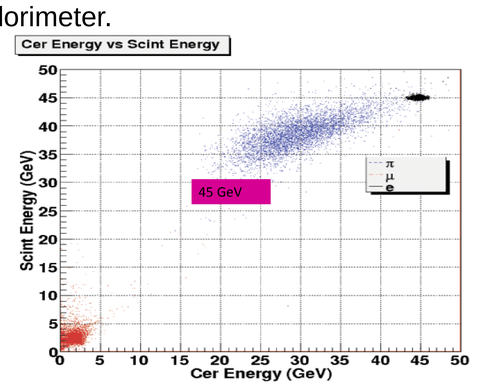

Figure 5. Particle identification from the comparison between the scintillation vs. Cherenkov signals in the ADRIANO calorimeter for simulated particles with E_{kin} = 45 GeV

Measured light yield. Thirteen ADRIANO prototypes tested in the 10years of life of T1015.

Prototype	Year	Glass	gr/cm^3	L. Y./GeV	Notes
5 slices, machine grooved, unpolished, white	2011	Schott SF57HHT	5.6	82	SiPM readout
5 slices, machine grooved, unpolished, white, v2	2011	Schott SF57HHT	5.6	84	SiPM readout
5 slices, precision molded, unpolished, coated	2011	Schott SF57HHT	5.6	55	15 cm long
2 slices, ungrooved, unpolished, white wrap	**2011**	**Ohara BBH1**	**6.6**	65	
5 slices, scifi silver coated, grooved, clear, unpolished	2011	Schott SF57HHT	5.6	64	15 cm long
5 slices, scifi white coated, grooved, clear, unpolished	2011	Schott SF57HHT	5.6	120	
2 slices, plain, white wrap	2011	Ohara	7.5	"	DAQ problem
10 slices, white, ungrooved, polished	2012	Ohara PBH56	5.4	30	DAQ problems
10 slices, white, ungrooved, polished	2012	Schott SF57HHT	5.6	76	
5 slices, wifi Al sputter, grooved, clear, polished	2012	Schott SF57HHT	5.6	30	2 wls/groove
5 slices, white wrap, ungrooved, polished	2012	Schott SF57HHT	5.6	158	Small wls groove
ORKA barrel	**2013**	**Schott SF57**	**5.6**	4500	molded
ORKA endcaps	**2013**	**Schott SF57**	**5.6**	8000	molded
10 slices – 6.2 mm thick, scifi version	**2014**	**Schott SF57**	**5.6**	N.A.	molded
10 slices – 6.2 mm thick, sci-plate version	**2014**	**Schott SF57**	**5.6**	N.A.	molded

Expectations and conclusions

ADRIANO2 brings together dual-readout, PFA, high-granularity and fast timing to the next generation of high intensity and high energy experiments.