A STUDY OF THE PROPERTIES OF THE FRONT-END ELECTRONICS OF THE COMPACT HIGH ENERGY CAMERA (CHEC) PROTOTYPE FOR GAMMA-RAY ASTRONOMY

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OUTLINE

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2. MAIN FOCUS OF THIS STUDY
3. RAW DATA WAVEFORMS
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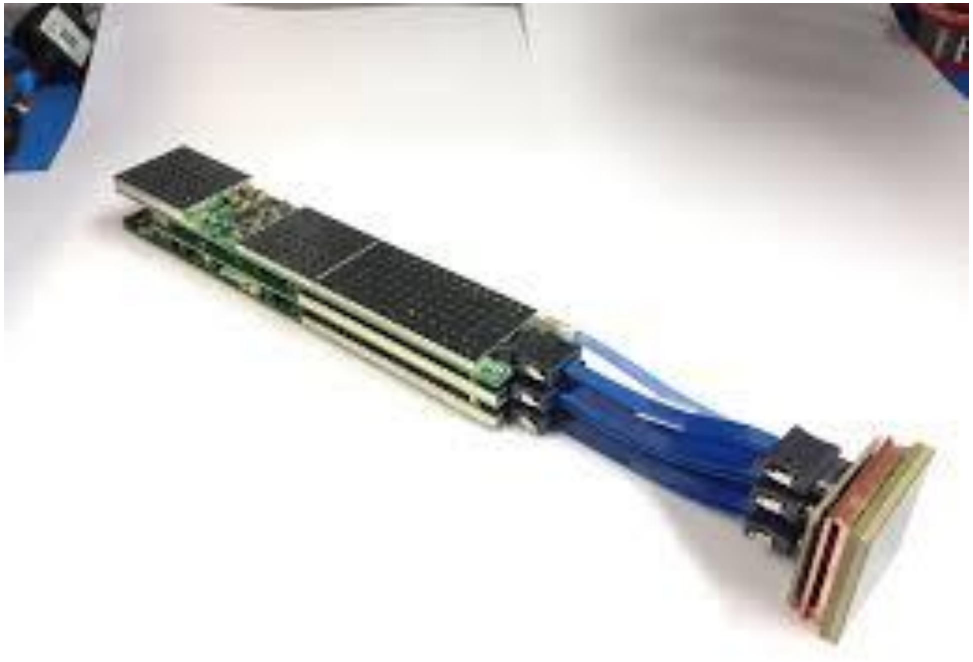
INTRODUCTION TO FRONT-END ELECTRONICS (FEE)

Electronics – key components of modern detector systems.

Purpose of FEE

- Acquire electrical signal from sensor
- Tailor time response to optimise for digitiser input.
- Pulse shaping
- Signal digitization

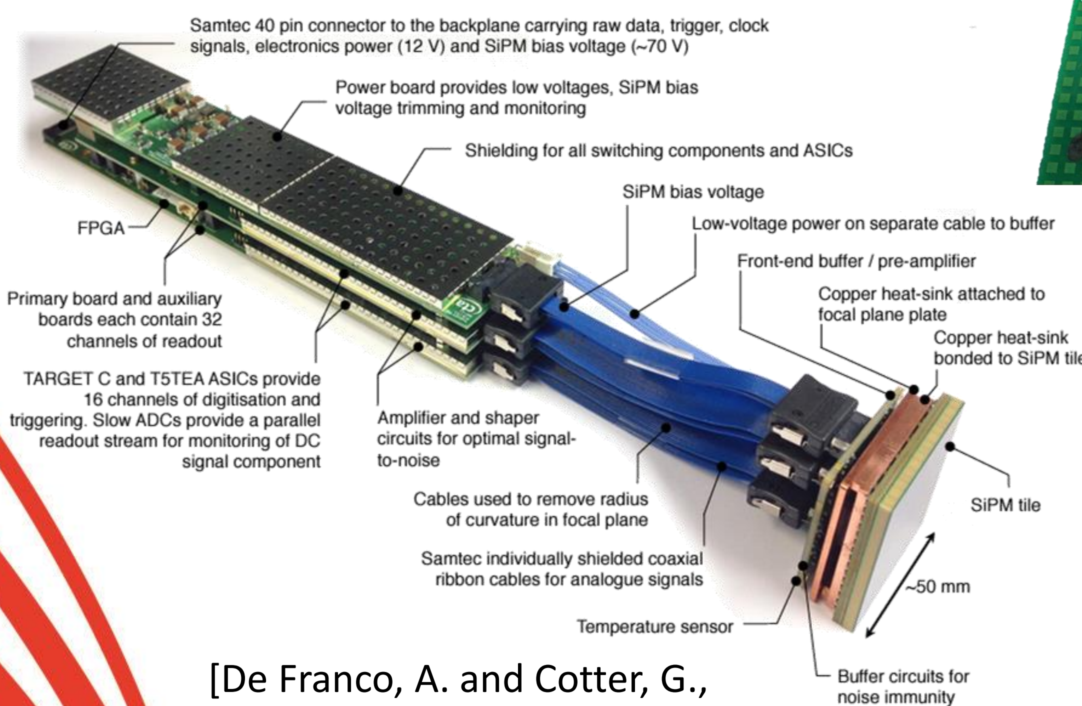


A characteristic CHEC-S FEE module

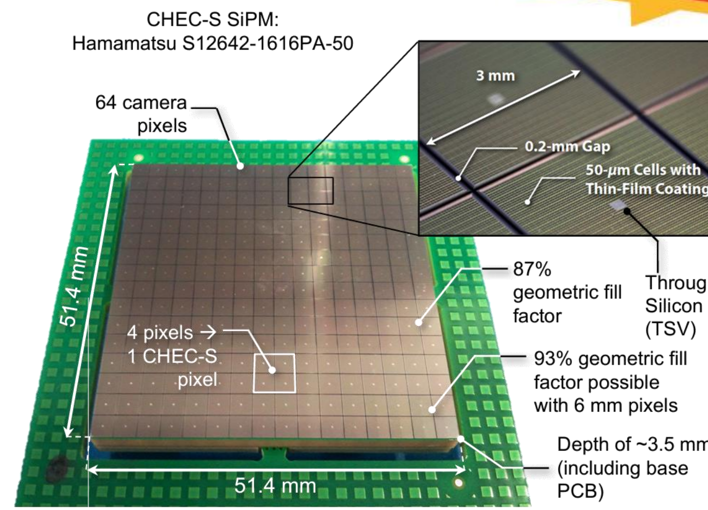
FEE COMPONENTS

Each CHEC-S Silicon Photomultiplier (SiPM) tile contains:

- 256 3 x 3 mm² pixels
- combined in groups of four on a bias board
- to provide the desired camera pixel size.



[De Franco, A. and Cotter, G., 2016. *Journal of Instrumentation*]



[White, R., 2017.*Journal of Instrumentation.]*

Thus each FEE has:

- 64 6mm x 6mm camera pixels
- 64 camera channels
- 1 pulse/channel for a single event

EXPERIMENTAL SETUP

Pulse generator

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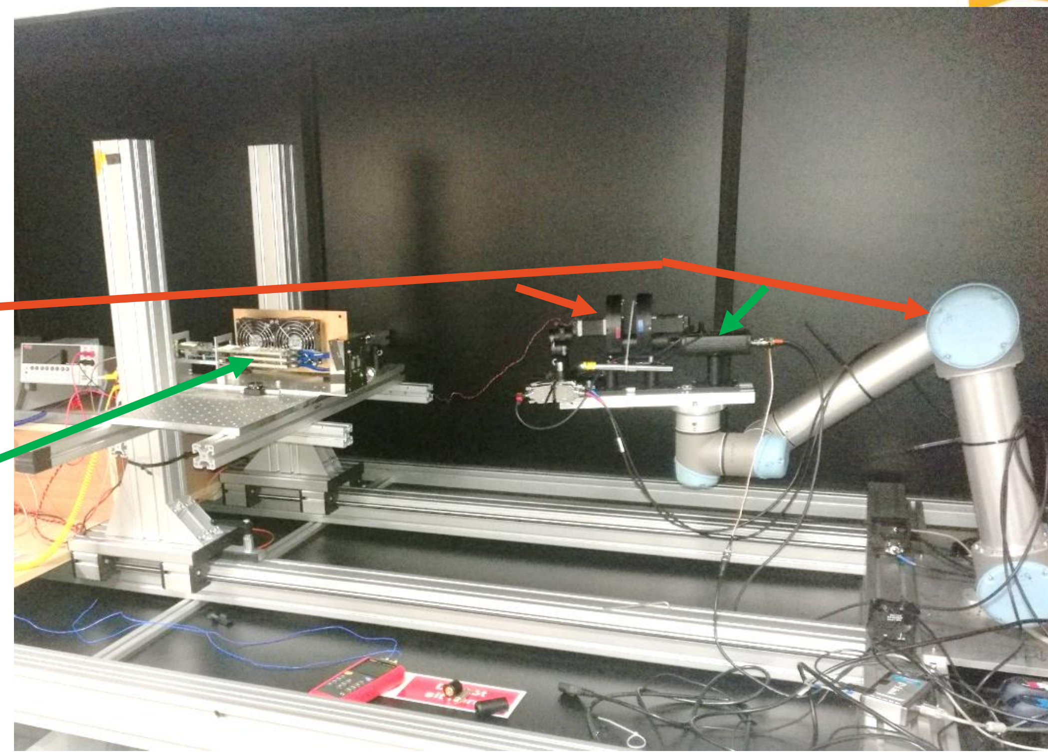
Robot arm + laser pointer and Filters

↓

FEE module

↓

Computer C++, Python and ROOT



Picture: FEE Lab module in test at the University of Leicester, UK.

EXPERIMENT PROCEDURES

- A controlled laser pulse at 1kHz, and 650 nm was fed to the SiPM with 1000 pe/ns for 128 ns.
- The signal is then integrated in a preamplifier
- and fed to a pulse shaper
- The pulse then gets digitized for storage and measurement
- A script is then run to obtain the amplitude values from the raw data waveforms
- The amplitude is then anlysed further for parametarisation

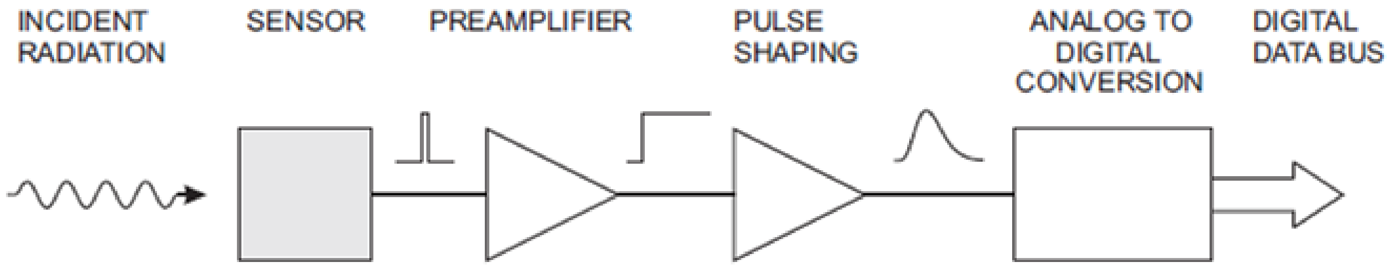
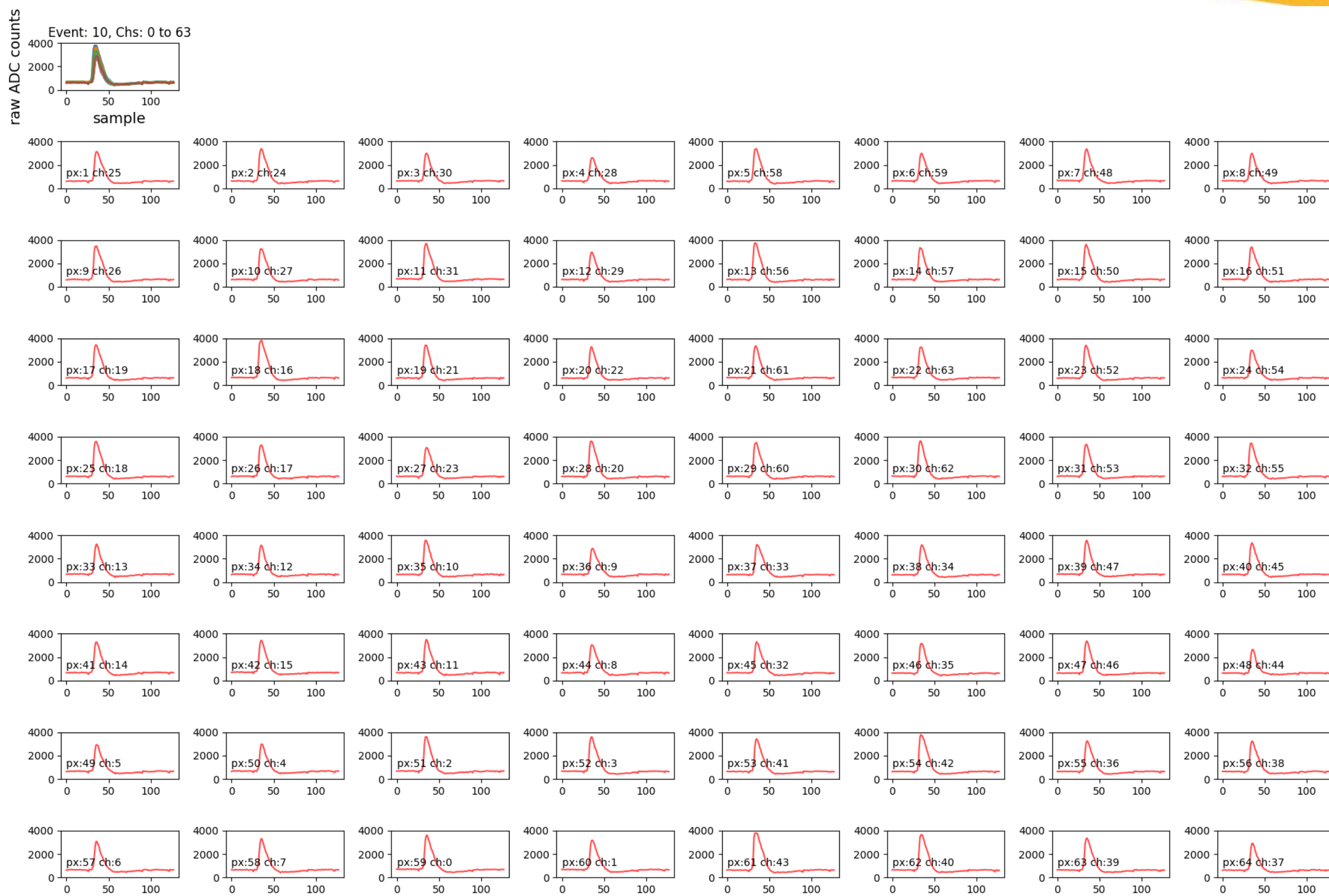


Figure 1: Basic detector functions: Radiation is absorbed in the sensor and converted into an electrical signal. This low-level signal is integrated in a preamplifier, fed to a pulse shaper, and then digitized for subsequent storage and analysis.

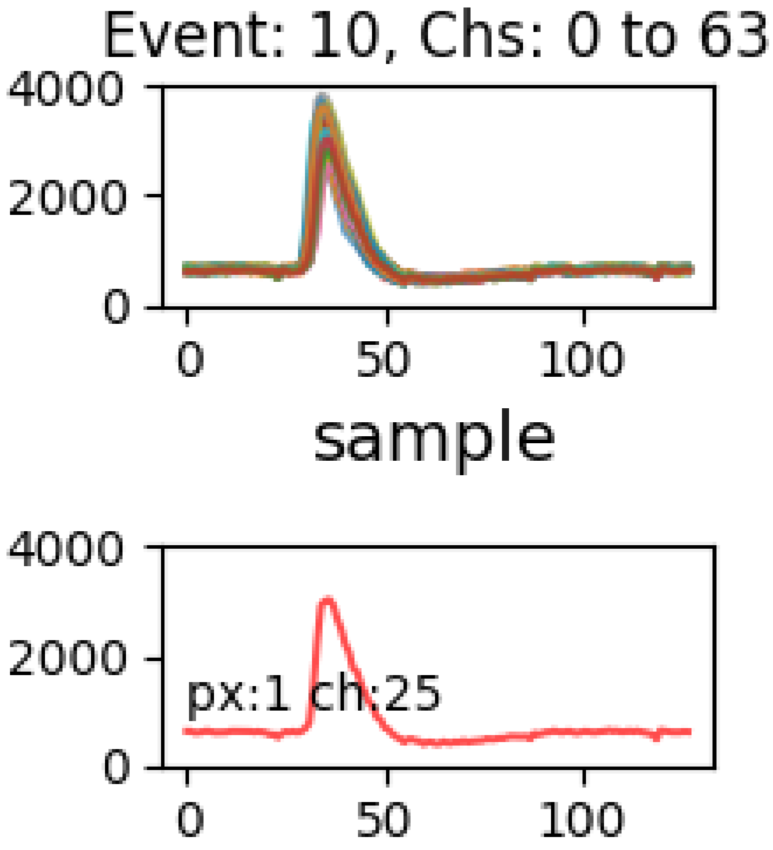
[Spieler, H., 2003. *Proc.2003 ICFA School on Instrumentation]*

RAW DATA WAVEFORMS



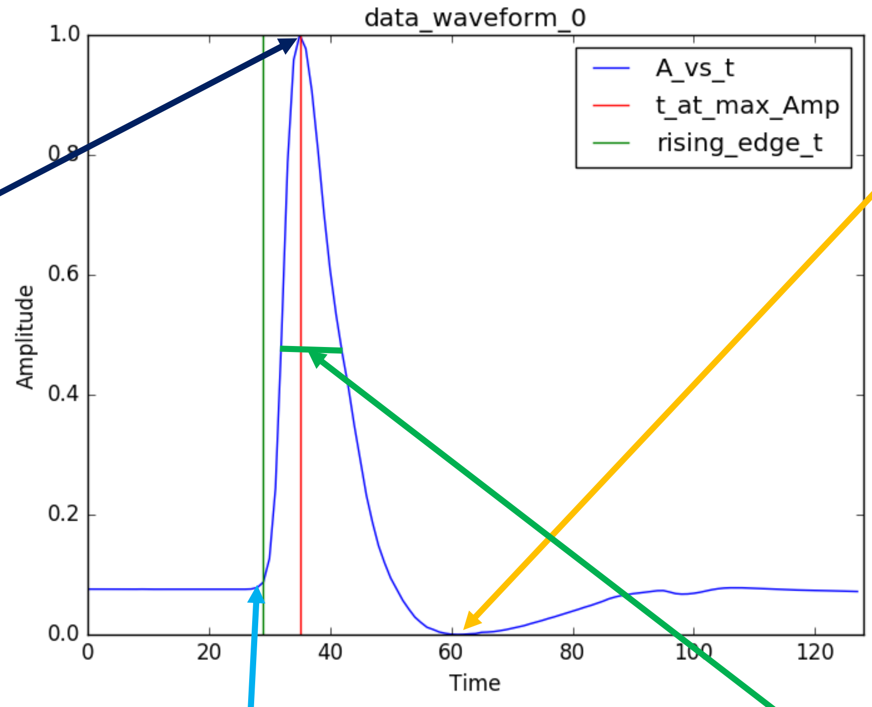
RAW DATA WAVEFORMS CONT…

Blow-up of a single pixel event plus the averaged waveform



ANALYSIS PROCEDURE

- Obtains the maximum amplitude from the data and prints the time at the peak.
- Calculates the rise time of the pulse.



Obtains the minimum amplitude value and calculates the undershoot value of the pulse.

Calculates the mean and standard deviation for each of the waveforms

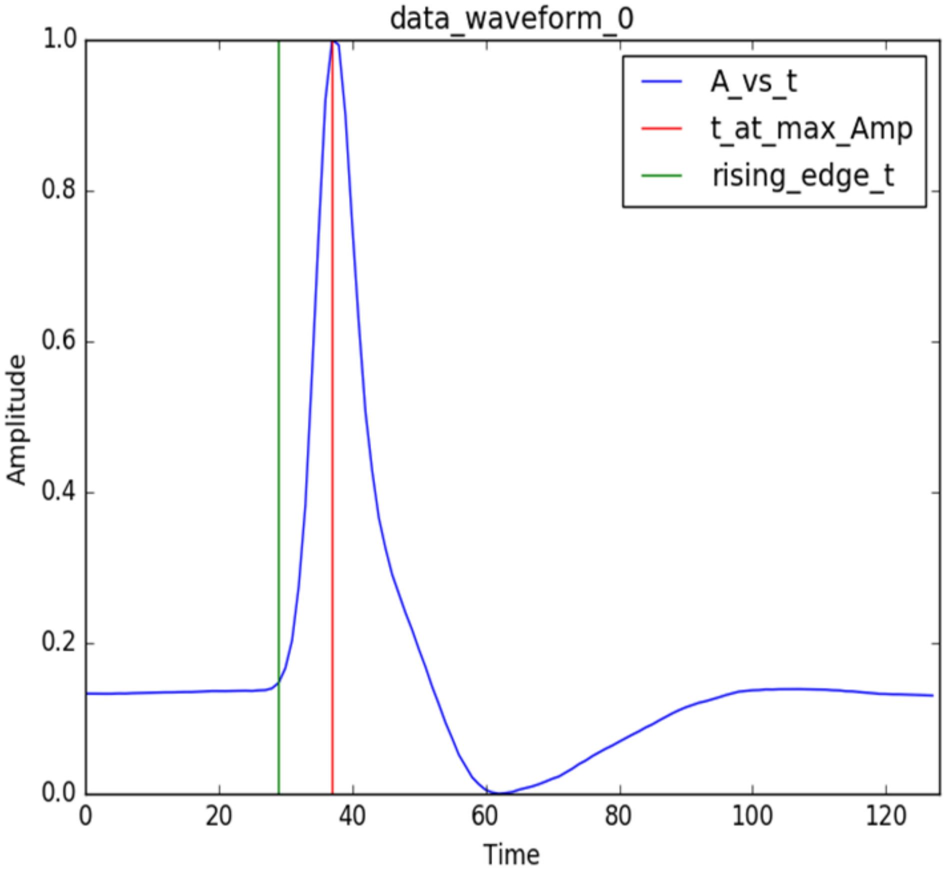
Calculates the baseline and time at threshold values in order to get the rising edge of the pulse.

Calculates the Full Width at Half Maximum

WHAT HAS BEEN DONE

- Examined the output waveforms of the digitised shaped signal from the preamplifiers

- Parameterised the preamplifier pulse shape for a single event.



Current result observations

- The rise times for all the files analysed thus far are in the range of 7ns and 10ns.
- FWHM are in the range of 8 and 10 ns.

OUTLOOK

Calculate the following values:

- Baseline, time at threshold, FWHM, mean, standard deviation and rise time of averaged amplitude data for each channel.

Establish an automated waveform analysis procedure that will:

- Point out faulty preamplifier channels

- Determine the nature of the faulty channel depending on the values of the pulse peak and pulse width.

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THANK YOU!

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