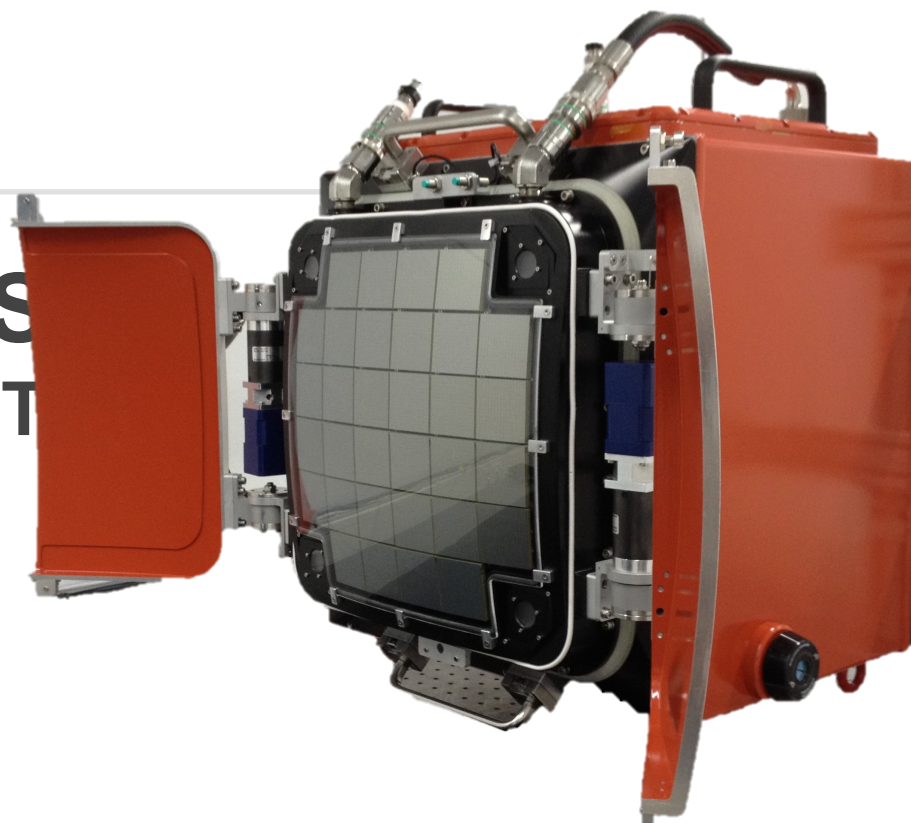


# Evaluation of CHEC-S

## A high-speed camera for CT



**Connor Duffy**

Fermi Summer School, June 6 2018

University of Leicester

MPIK

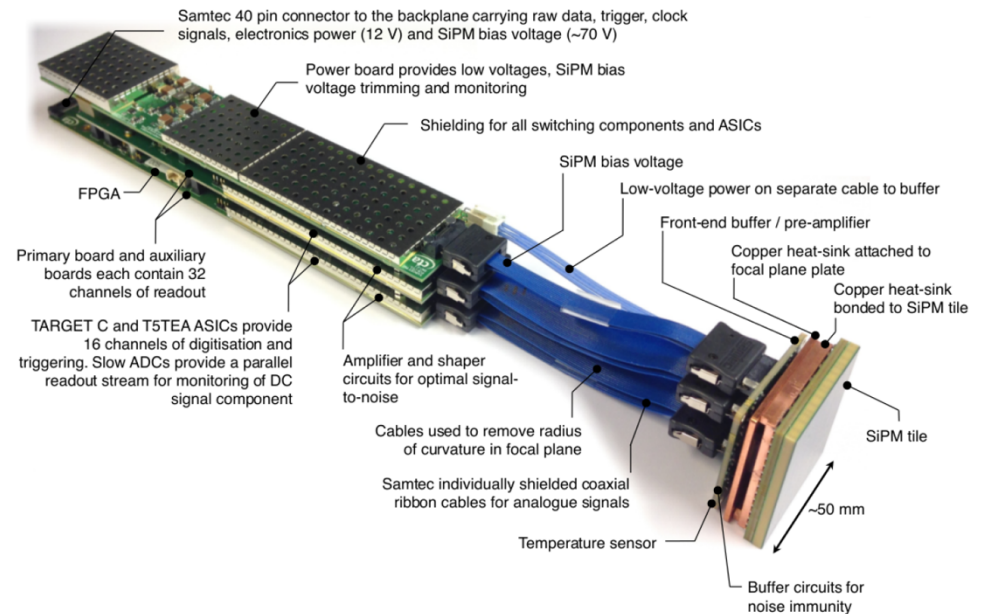
Advisors: Jon Lapington, Richard White



# Front-End Electronics (FEE) – TARGET Module



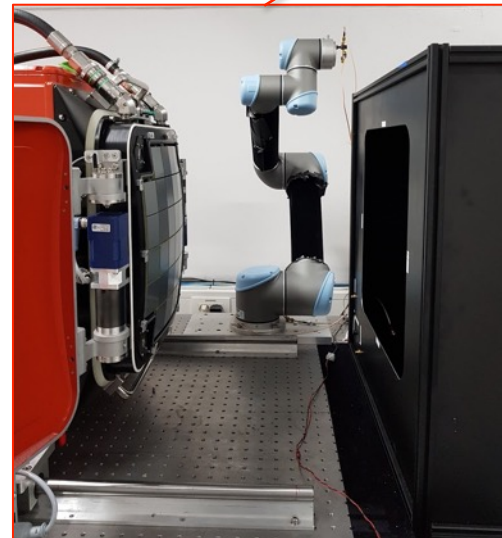
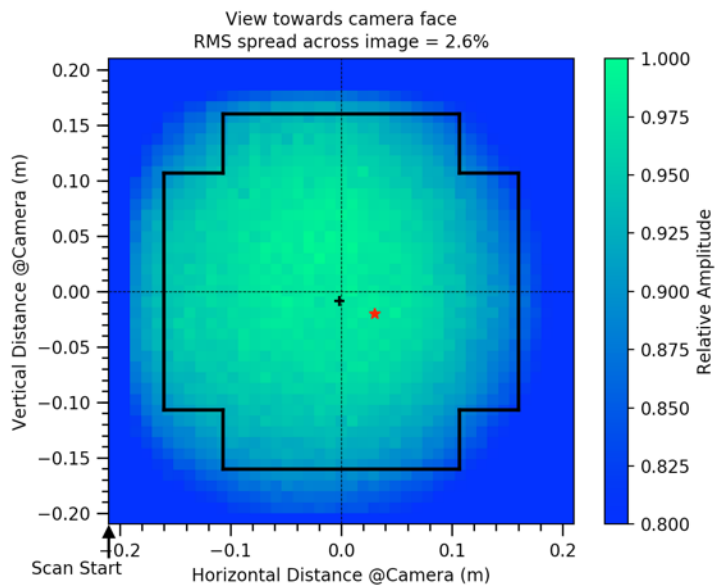
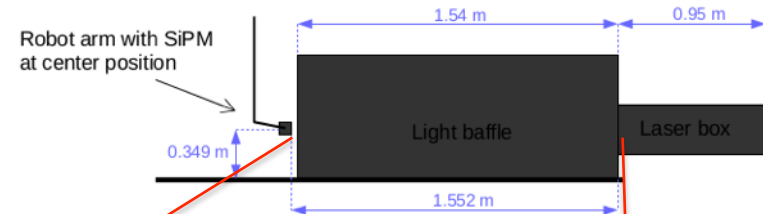
- TeV Array Readout Electronics with GSa/s sampling and Event Trigger (TARGET)
  - Similar modules in two Camera designs
    - GCT (SST)
    - SCT (MST)
  - Provide initial shaping and amplification of analogue signal from SiPM for optimal signal-to-noise ratio
  - TARGET C and T5TEA ASICs provide 16 channels of digitisation and triggering
  - ADCs provide a parallel readout for monitoring of the DC signal component
  - Reverse bias voltage and voltage trimming for SiPM tiles and HV groups



# Laser Qualification



- Beam uniformity
  - Laser collimated onto diffusers (50° & 20°)
  - Reference SiPM used to scan beam
    - Return to beam center between scan points to remove temperature effects
  - Resulting uniformity
    - RMS 2.6%
    - Range across camera area ~10%
    - Can be corrected offline



Robot arm with reference SiPM

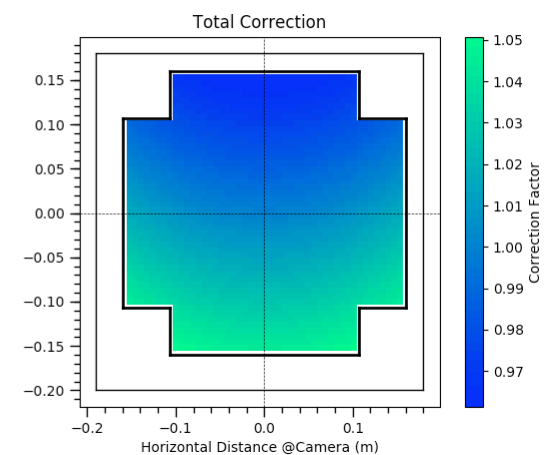
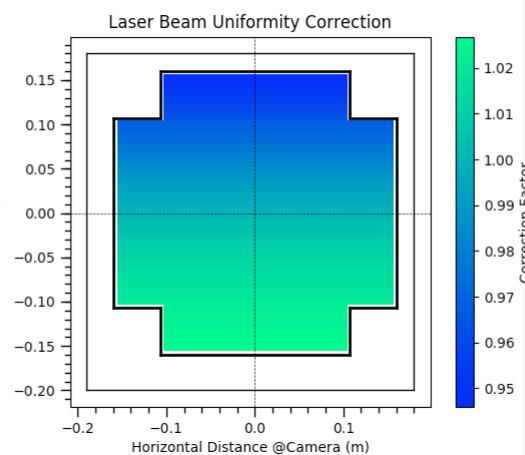
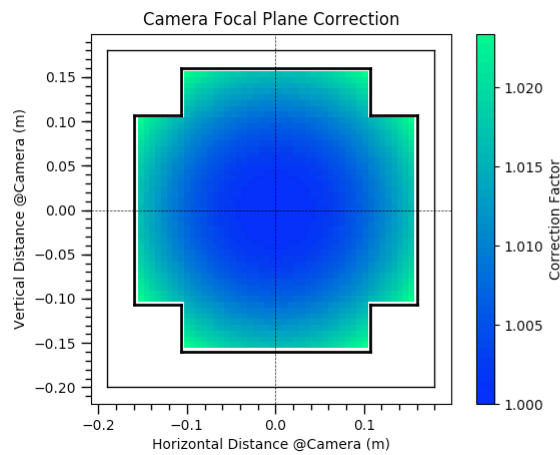
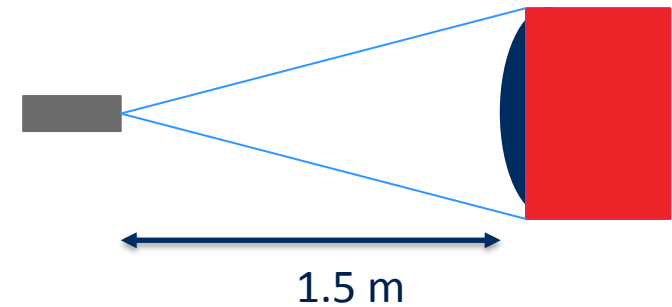


Beam collimated through diffusers

# Laser Qualification



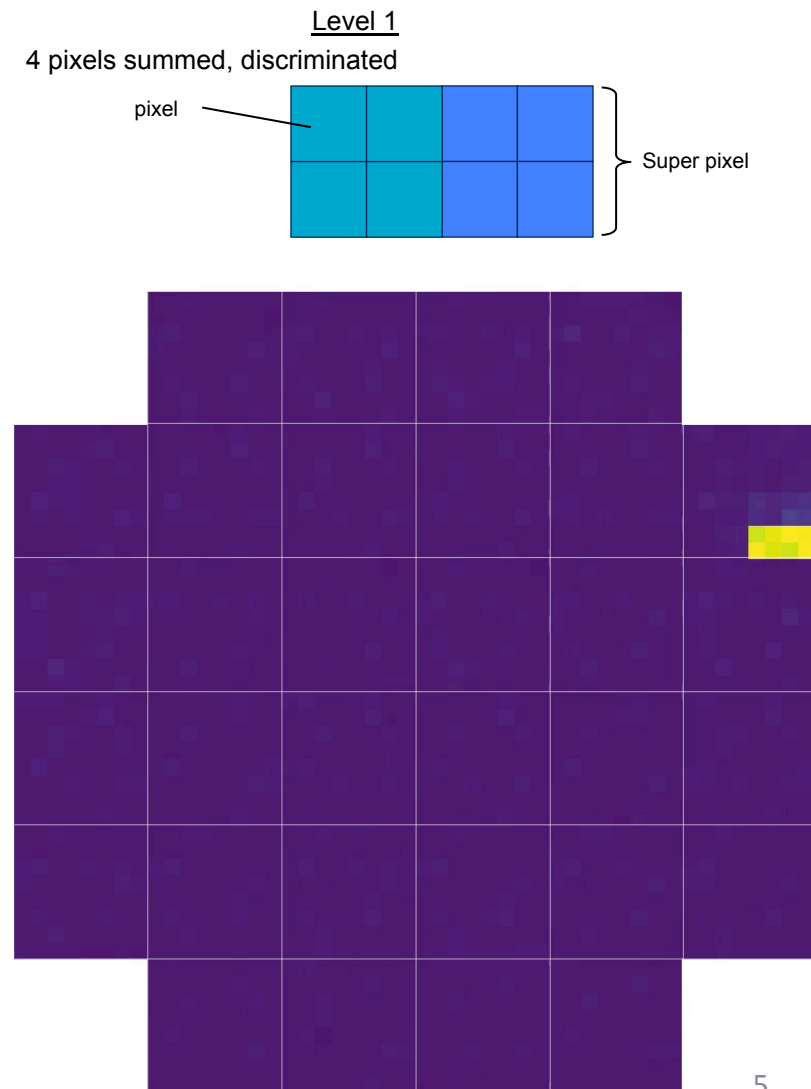
- Correction for curved focal plane
  - Variation in intensity for pixels at the edges of the focal plane
  - Approximated as sphere with  $R_{curve} = 1.0\text{ m}$ 
    - Effect of tiling focal plane negligible
- Correction for beam non-uniformity
  - Reduces range of spread to  $\sim 2\%$



# Trigger/HV Mapping



- Trigger
  - 512 'super pixels'
  - Disabled / enabled via 512 bit pattern in BP FW
- SiPM bias voltage (HV)
  - 512 'hv groups'
  - Set via 8-bit DAC on each TM
- Functional verification
  - End-to-end mapping verified in single test
  - Generate 1910 valid SP combinations
  - For each combination
    - Enable SP in BP
    - Set HV to matching HV groups
    - Fire laser
    - Internally trigger camera
  - Plot shows waveform amplitude in every pixel at each step
    - Steps that do not trigger the camera have the SP/HV groups that were enabled in red
    - Some SP / HV groups do not trigger



# Next Steps



- CHEC-S Camera Validation
  - Ongoing performance testing of CHEC-S
- On-telescope testing - Mt. Etna, Sicily
  - CHEC-S to be on telescope during autumn 2018 for a period of observations using the ASTRI telescope structure
- 2018
  - Current state of SST uncertainty to end with council decision on harmonization/merger/redesign





cherenkov  
telescope  
array

# Questions?

