



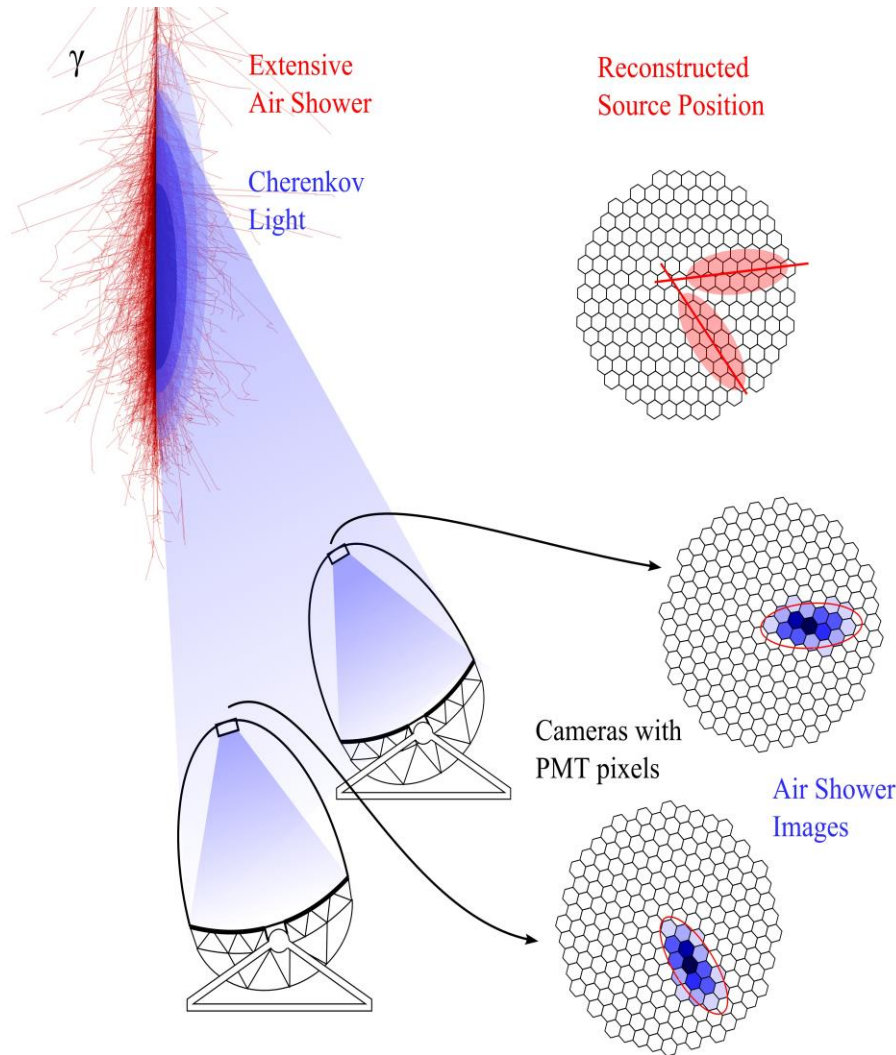
# 3<sup>rd</sup> ASTERICS-OBELICS Workshop

23-25 October 2018, Cambridge, U.K.

## Benchmarking CTA low level data formats

J.L. Contreras

# Data processing in VHE



Compute a single  $\gamma$ -ray direction + energy

From many videos

And suppress 1000 Cosmic Rays on

“how they look like”

Christian Fruck

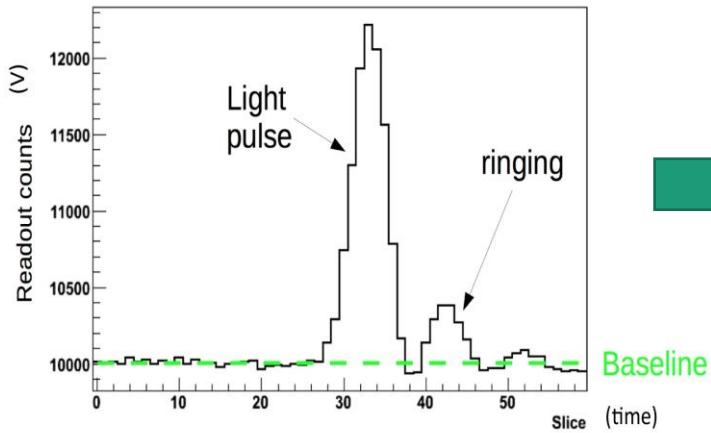
23/10/2018

J.L. Contreras

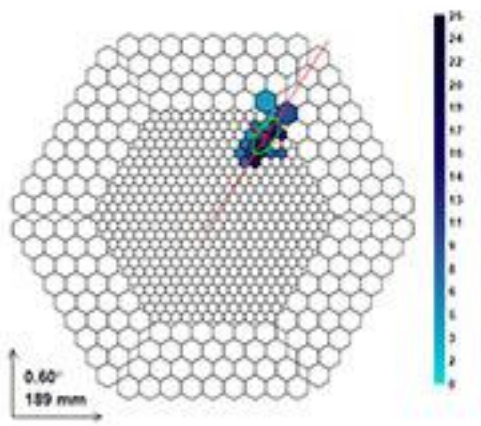
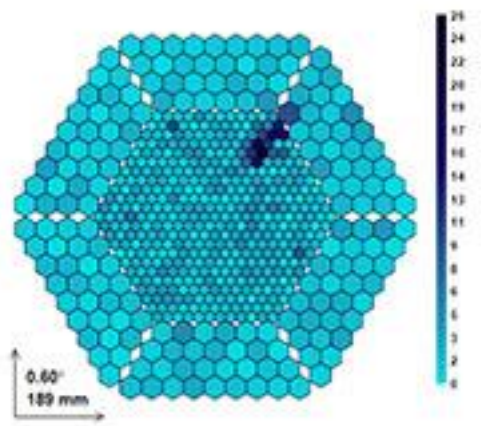
2

# Low Level data in CTA: DLO

- Lowest data level recorded.
- Done by stressed “Camera Servers”



Each pixel records a pulse at  $\approx 1 \text{ sample/ns}$



An image is extracted for each camera and later on *cleaned* offline

# Data Volume

- Each pixel  $O(2000)$  of each telescope  $O(10)$  participating in the event records several  $O(40)$  samples of the light pulses.
- Event size =  $N_{\text{tel}} \times N_{\text{pix}} \times N_{\text{samples}} \times 2\text{-}3 \text{ Bytes}$   
 $\approx 300 \text{ kB/evt.}$
- Evt Rate  $\approx 40 \text{ kHz (CTA-S) / 15 kHz (CTA-N)}$ .
- Data Volume  $\approx 30 \text{ PB/yr (After 1st reduction)}$ .

# Formats proposed so far in CTA

- Compressed Fits (ZFITS) Université de Genève  
Presently used for first Data (LST-)
- Format based on HDF5 In development...
- ACTIO MPIK Heidelberg K. Benlöhner
- PRUN LAPP Annecy P.

# Relevance for other fields

- No obvious alternative to FITS in Astronomy.
  - First release in 1993. Last one in August 2018
  - Endorsed by NASA and IAU
  - Several limitations
  - See special number of Astronomy & Computing 12/2015 e.g: “Astronomical data formats: What we have and how we got here”. J.Mink .
- HDF5 looks like the best candidate, but presents several issues
- CTA is working on a document to evaluate Data Format requirements: size, ease of processing, parallelism, support ...

# Tender for subcontracting in March 2018

## Activity foreseen in UCM ASTERICs Budget since proposal

- Develop a format for Atmospheric Cherenkov Astronomy based on HDF5.
- Provide libraries to read/write and convert from/to this H5 format.
- Benchmark formats proposed in CTA.
- Study applicability to other observatories.
- Support

# Quasar RS

- The contract was awarded to Quasar SR on August 2018



- Enterprise born from ESA incubator, experience with support to space missions, astronomical software in general





# Work so far

- First versión of H5 format available
- Conversion to/from ZFITS ready
- Waiting for feedback, detailed requirements and more format specifications

# Acknowledgement

H2020-Astronomy ESFRI and Research Infrastructure Cluster (Grant Agreement number: 653477).

# Backup

# Estimation of CTA Data Rates

An estimation of CTA RAW Data Volumes at DATA (Storage) Level										J.L.C.	R.d.R	N.N.	Date	07/04/2015
Green cells	Input	White	Calculations	Yellow	Result									
CTA-S MC Prod 2	Rate (Hz)	Hours/Y	All/prot	LST/ev	MST/ev	SST/ev	SCT	Samples	Size Int					
	39941	1314	1	0,5421	1,826	0,6149	0,6523	0,03	15					
	Tel. type	NTel in 2K	NTel S	Window (ns)	samples/ns	B/samp	HDR	Size/pixel	Pixels	Size int	NTel/Trig			
	LST	4	4	30	1,0	4	5	125	1.855,0	15	0,54			
	MST-NECT	12	12	60	1,0	4	5	245	1.855,0	15	0,91			
	MST-FL	12	12	88	0,25	2	5	49	1.764,0	15	0,91			
	SST-2M-G	24	24	100	1,0	2	5	205	2.048,0	15	0,20			
	SST-2M-AS	24	24	100	0	0	0	7	2.368,0	7	0,20			
	SSt-1M-DG	24	24	100	0,25	2	5	55	1.300,0	15	0,20			
	MST-SCT	26	0	60	1,00	2	5	125	11.328,0	15	0,00			
				Array Data Rate. Sampled pixels			Array Data Rate. Integrated pixels			Total Data Rate		GB/s		
		MC Stereo Ev Rate/tel	Goal Stereo Ev Rate/Tel	Pix Samp	Gb/s	Evt S(kB)	Pix Int	Gb/s	Evt S(kB)	Gb/s Tot	Evt S(kB)			
Array 2KC trig. rate	39941	LST	5.413	7.000	56	1,56	7	1799	6,05	27	7,6	34	1,0	
		MST-NECT	3.039	3.039	56	3,98	14	1799	7,87	27	11,9	41	1,5	
		MST-FL	3.039	3.039	53	0,76	3	1711	7,49	26	8,2	28	1,0	
		SST-2M-G	341	341	61	0,82	13	1987	1,95	30	2,8	42	0,3	
		SST-2M-AS	341	341	71	0,03	0	2297	1,05	16	1,1	17	0,1	
		SSt-1M-DG	341	341	39	0,14	2	1261	1,24	19	1,4	21	0,2	
		MST-SCT	0	2.500	340	0,00	42	10988	0,00	165	0,0	207	0,0	
						7,29			25,7		32,9		4,1	
Vol/Year (1314h)						4,3	PB		15,2	PB	19,5	PB		
Vol South/year		19,5PB							5,0Gb/s	x1,2=	6,0			

# An Scheme of ZFITS

