Real-Time Analysis Discussion: On-Site Data Deduction

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Target Data Levels: R0 → DL0

- Required reduction factor **~100**
- Data reduction process must be **reversible**
- DL0 data families
  - **Event (EVT)** } 80–90%
  - Calibration (CAL) } 10–20% (acquired at lower frequencies)
  - Technical (TECH)

Types of Data Reduction

1. Waveform reduction/integration
2. Pixel selection (zero-suppression, RoI/VoI selection)
3. Suppression of background events
4. Data compression (lossless)

1. Waveform Reduction (1)

- Most cameras record signal as function of time in each pixel
- Reduce waveform to a few parameters (amplitude, time, width, …) used in high-level analysis

LST: 125 → 15 Bytes

- Requires real-time knowledge of:
  - Pedestal values & timing calibration
  - Reconstructed image orientation & time gradient estimate

  } **Implications for calib.**
  - Understanding of use of waveform shape in reconstruction and gamma/hadron separation
- **Reduction factor per pixel ~10**

8.3 for LST

1. Waveform Reduction (2)

- ACTL criterion for planning purposes:
  - Complete waveform for 3% (on average) of pixels
  - Time-integrated waveform for all others

	Relative data rate due to	
	3% complete waveforms (125 Bytes/pixel)	**97% integrated waveforms (15 Bytes per pixel)**
LST	**21%**	**79%**

- **Reduction factor** for whole camera read-out: **6.8**
- **Majority of data volume** comes from **integrated waveforms**

2. Pixel Selection (1)

- Large FOV → **only a small fraction of pixels contain useful information**
- **Discard pixels without useful information** early → save processing & storage
- Requires pre-calibration & preliminary image reconstruction

2. Pixel Selection (2)

<u>Approach</u>

1. Apply image cleaning
   - Test different algorithms (tail-cuts, iterative tail-cuts (MAGIC), wavelets, SVD, ...)
2. Store values from
   - **all selected pixels**,
   - additional **boundary region** of thickness **N**, and
   - any **pixels above X pe**
   - Determine optimal N and X from simulations (LST optimization)
   - Additional pixels necessary if cleaning thresholds change later on due to re-calibration

2. Pixel Selection (3)

Performance study

- Low-level parameters: width, length, multiplicity, …
- High-level parameters: energy bias and resolution, angular resolution, sensitivities, …
- Using simulations with different levels of NSB

3. Background Suppression

- Vast majority of events are **initiated by protons or helium nuclei** → can be discarded at low energies without loss of science
- Required – pre-calibration & preliminary event reconstruction
  – confidence level on the background hypothesis
- **Very-high-amplitude** always of interest (spectra of heavy cosmic-ray nuclei) → simple threshold criterion (~400 pe) for storage
- Weak γ/hadron separation power for threshold events (most numerous)
- **Factor ~2 reduction**

4. Data Compression

- Factor ~2 without loss of sensitivity
- Final compression factor depends on the previous level of data reduction

Strategy for LST-1 Commissioning

- **Performance** of reduction will be studied on **commissioning data**, in which **all raw data will (be attempted to) be stored**.
- After performance verification, data reduction will be applied on-site (on-the-fly).
- For additional checks, **every N^{th} (N~100) event will be kept in full** form.