LASSIE: The Large Analogue Signal and Scaling Information Environment for FAIR

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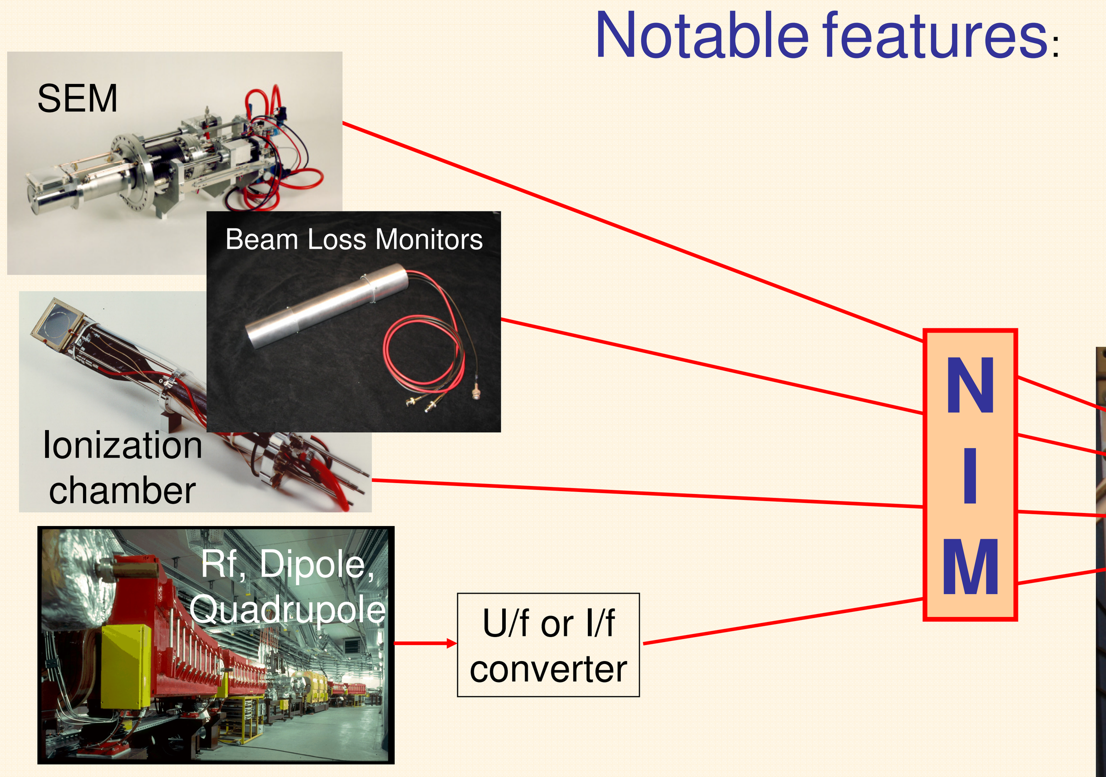
Abstract

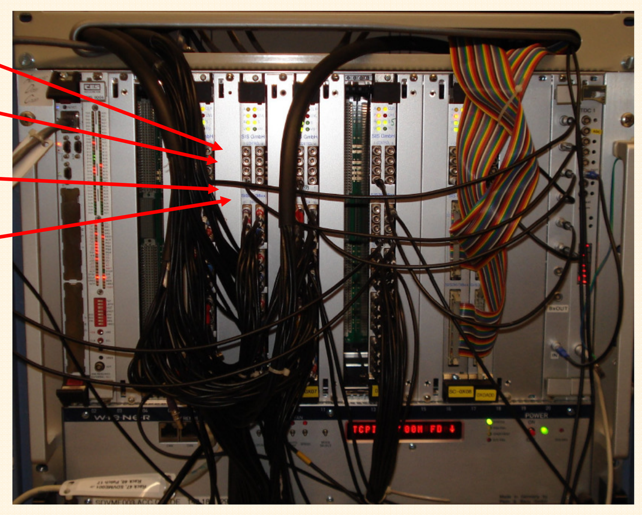
At FAIR, the Facility for Antiproton and Ion Research, several new accelerators and storage rings such as the SIS 100, HESR, CR, the inter-connecting HEBT beam lines, S-FRS and experiments will be built. All of these installations are equipped with beam diagnostic devices and other components, which deliver time-resolved analogue signals to show status, quality and performance of the accelerators. These signals can originate from particle detectors such as ionization chambers and plastic scintillators, but also from adapted output signals of transformers, collimators, magnet functions, rf cavities and others.

To visualize and precisely correlate the time axis of all input signals, a dedicated FESA based data acquisition and analysis system named LASSIE, the Large Analogue Signal and Scaling Information Environment, is currently being developed. The main operation mode of LASSIE is currently pulse counting with latching VME scaler boards. Future enhancements for ADC, QDC, or TDC digitization in are foreseen. The concept, features and challenges of this large distributed DAQ system are presented here.

LASSIE: General Concept & Hardware

Notable features:
- pulse counting
- distributed sources
- time correlation
- software oscilloscope
- tool-set of GUIs

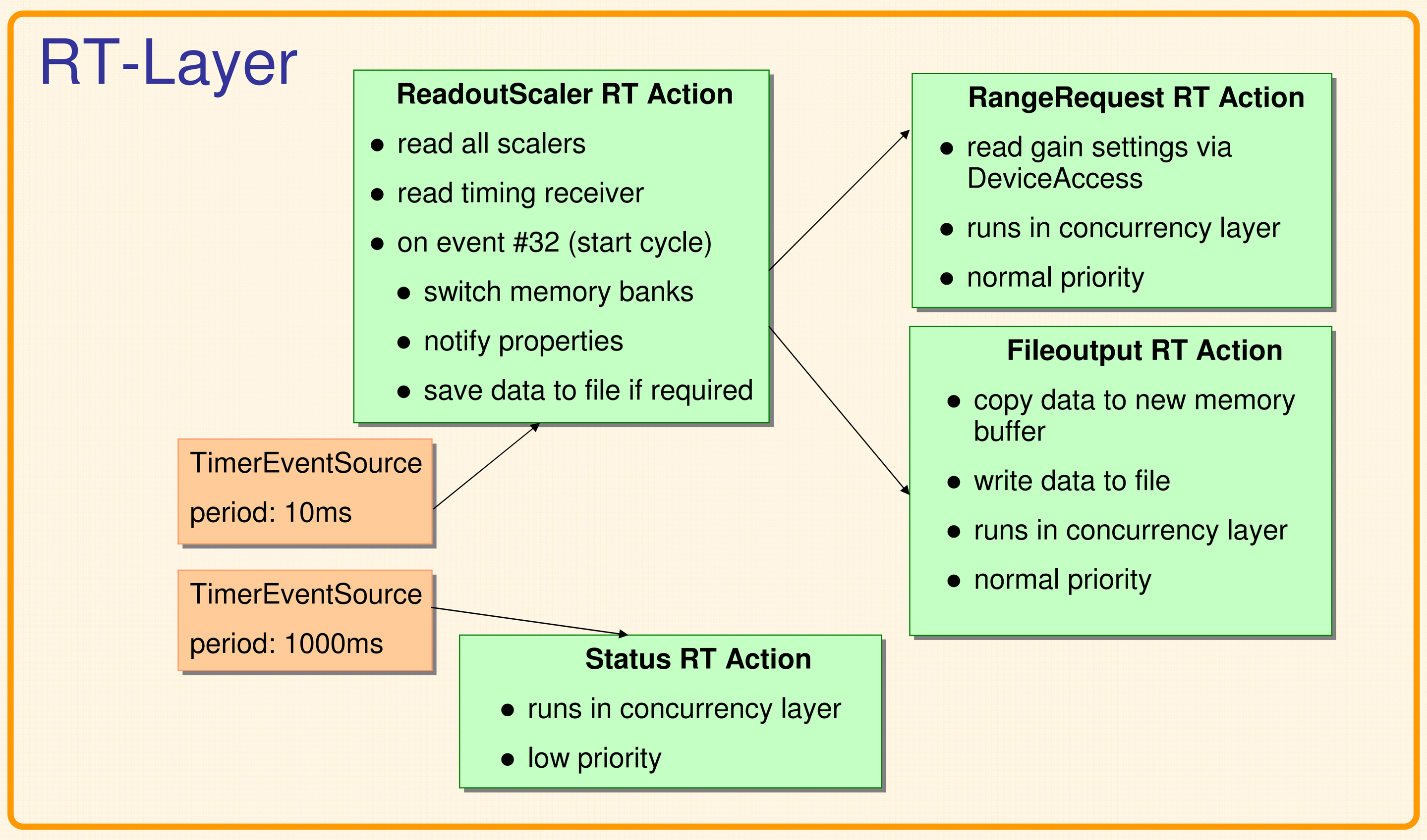




Example VME crate with SIS3820 Multi-scaler boards. The CPU hosts the LASA (Large Scaler Array) Fesa class.

System specs:
- 192 channels in one VME crate
- Struck SIS3820 scaler boards
- VME MEN A20 CPU Core 2 Duo, 1.5 GHz
- typical sampling rate at 0.1 - 1 kHz
- maximal sampling rate of selected channels up to 1 MHz
- measurement over full synchrotron cycle (0.5 - 30 sec)
- correlation with machine events
- measurement during spill pause (selftest)
- online selection of channels
- data storage for offline analysis

FESA Data Acquisition: LASA Class Design



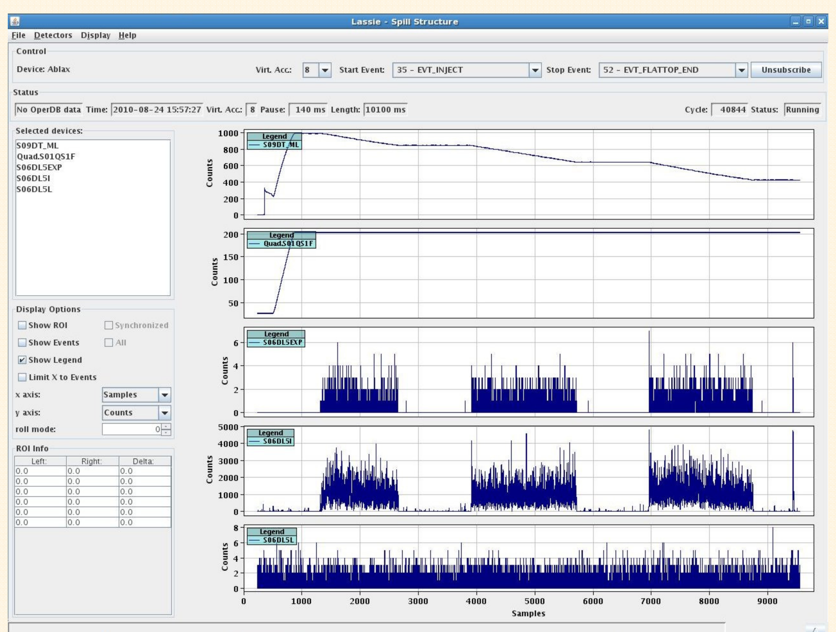
Custom memory management:
- allocates fixed percentage (typically 50%, set in instantiation file) of memory
- adaptable to changing number of channels and sampling rates
- two memory banks allow reading of old cycle data while acquiring data of the new cycle
- uses the fact, that RDA can handle arbitrary array sizes

FESA class not really multiplexed:
- data for each virtual accelerator is send to GUI
- GUI responsible for selecting which accelerator to display
- display time only as long as current cycle time
- change to real multiplexed operation in work

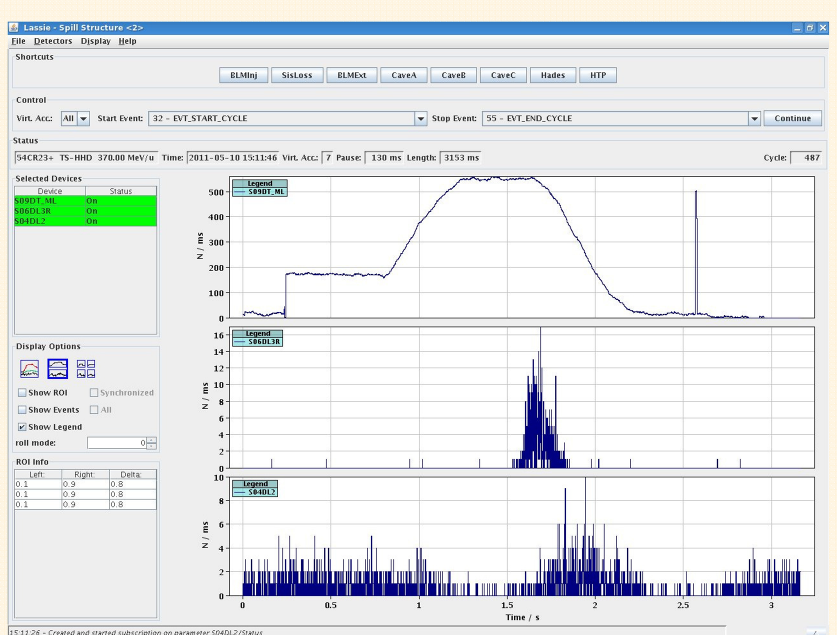
LASSIE Tools

Spill Structure Tool

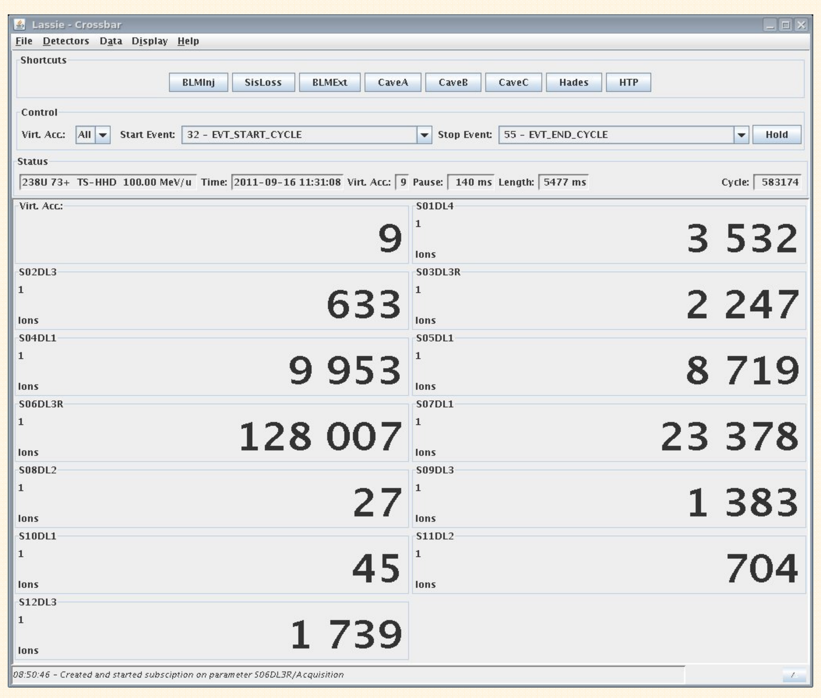
Used to correlate signals as a function of time. In combination with fast sampling (up to 1MHz) a good tool to observe the spill structure. The first picture below shows a sequential slow extraction off the synchrotron with signals from a beam transformer, a magnet and three beam loss monitors. It is clearly visible, that beam losses only occur during extraction.



Another example of the spill structure analysis is given below. With end of the acceleration flattop (1st graph, transformer) the losses at the extraction section rise significantly (2nd graph, BLM). The losses at the electrostatic septum are low (3rd graph, BLM)



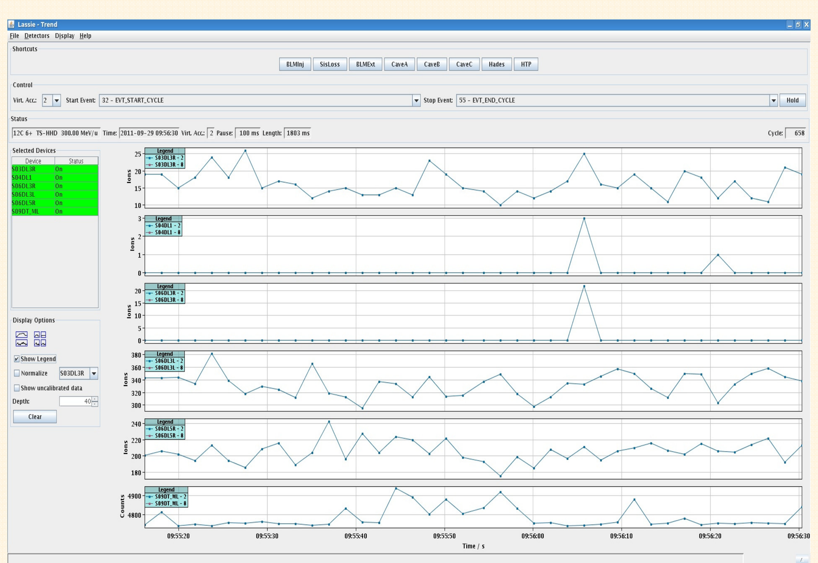
Counter Tool



Most of the experiments and users of beams need to know the amount of particles on their target. This information is provided by the counter tool. It shows the integral sum-up of all particles per cycle.

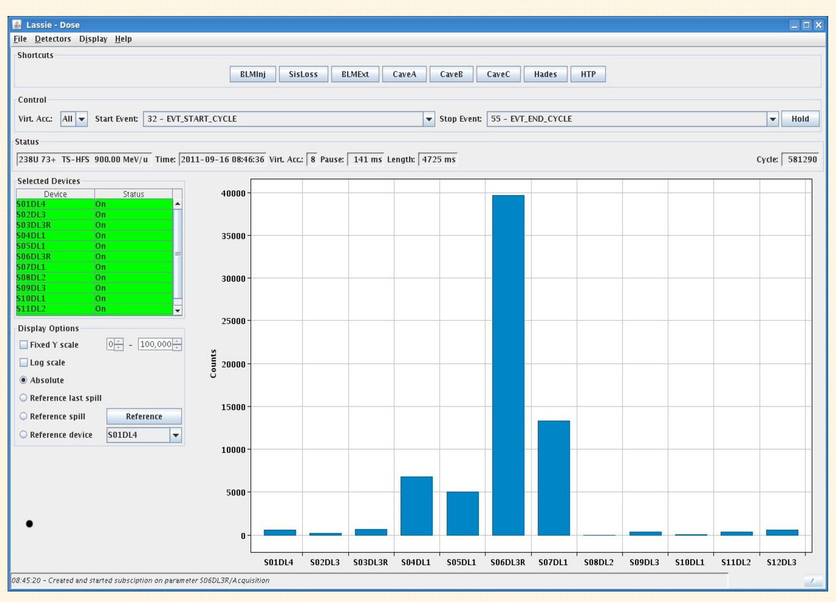
Trend Tool

To optize beam settings on a cycle-to-cycle base the trend tool is very helpful. All final counter values are added to their history graphs after a complete cycle. It can be used to optimze to lower or higher values.

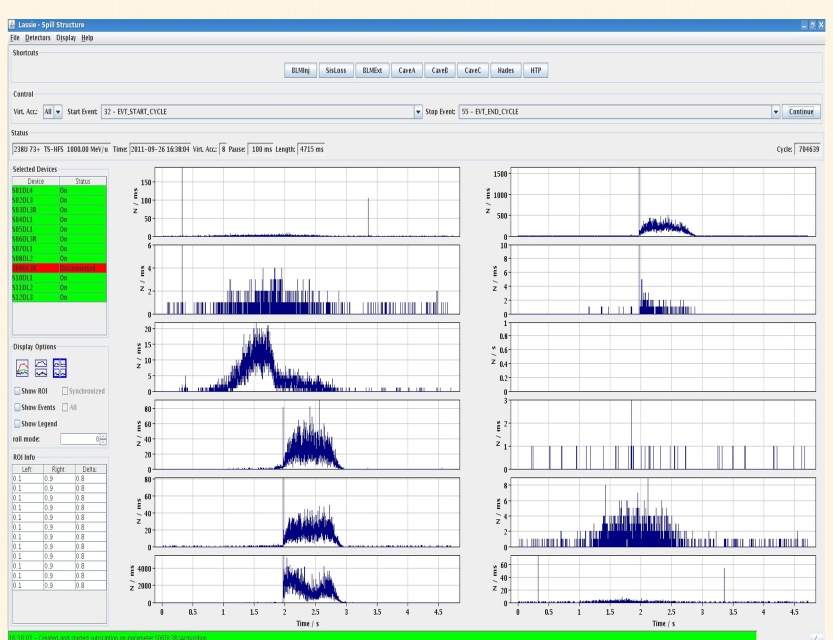


BLM Tools

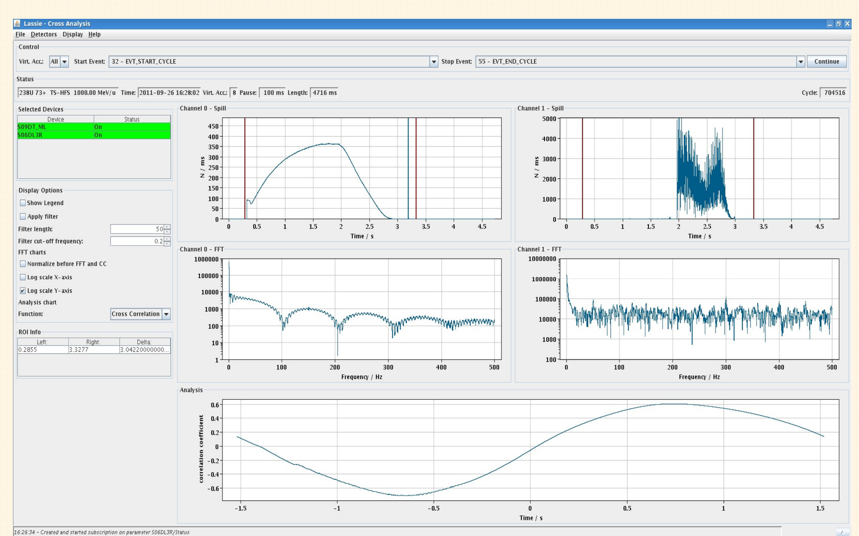
The so-called dose tool (1st picture below) provides a fast view on many channels simultaneously. A counter change to worse or better after each cycle can be recognized immediately. Different types of scaling and normalization are available.



The spill structure tool (picture below) provides a setting for beam loss monitors of all 12 synchrotron sections at the SIS18 at GSI to observe all potential beam loss locations simultaneously. Here the count rate as a function of time gives further information of the type and moment of beam loss.

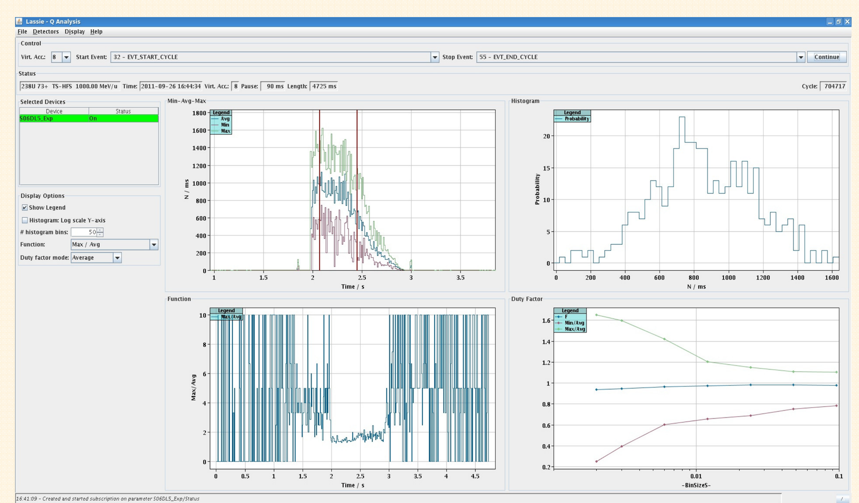


Expert Tools



To optimize the beam e.g. the particle distribution within a spill some expert tools were developed. First, the cross analysis tool (picture above) provides on the one hand FFT analysis for deeper understanding of selected signals and on the other hand a way to cross correlate two signals on a time base. Here a synchrotron transformer is correlated with a BLM at the extraction line. Good correlation can be seen for the time of the extraction approx. 0.7s shifted to the right.

The quality analysis tool (picture below) is used to optimize the spill structure. The spill data measured with the BLM can be used to calculate the count-rate ratios of minimum to average and maximum to average values. The "Function" graph shows for the time between 2 and 3 seconds a ratio of approx. 2 or below, which is already acceptable for the most experiments. It can be also optimized with view on the "Histogram" graph. The particle distribution gets better with a small peak, which shall not be 0 on x-axis.



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