The RAM-file and the programs to create it

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This document describes the process and the programs used to create the RAM data file.

1 Introduction

To separate Pions from Kaons in the final states of the reaction $\pi^- p$, Experiment 852 has added a segemented Cerenkov-counter, called *C9* and a Hodoscope, *H9* for the extension run in 1997, scheduled to start beginning of April.
For an online Kaon-identification and reduction of the DAQ-rate a fast trigger decision is made by two sets of 3-dimesional RAM-arrays, here called *RAMs* for short. Each RAM-dimension [1] occupies 7 bits in the RAMs address space, which corresponds to 128 channels, numbered from 0 to 127. These coordinates of the RAMs are filled with the hits from multi-element detectors. A detailed description of the assignments to the RAMs will follow in the next chapter.
The RAM triggers, if simultaneous hits in the assigned detectors correspond to an (x,y,z)-address in the RAM that is set. The process of programming the RAMs, that is whether a given address in a RAM can be associated with a physical track in the detectors, will be explained in the later chapters.
A more detailed descrition of the RAM and its performance can be found in [1].

[1] For simplicity the 3 dimensions of each RAM are also called x-, y- and z-coordinates, respectively

2 Detector-Assignments to the RAM-coordinates

The following assignments to the RAM-coordinates are currently used:

Detector	*Region used*	*ganging* [a]
TPX1	wire #241 to 368	2 [b]
TPX2	wire #217 to 472	2
TPX3	wire #33 to 672	5
$\overline{C9}$/H9 and H9	The 32 channels are going directly into the RAM	one-to-one translation

[a] Ganging means that several wires of the chambers can be translated to one RAM-address

[b] The listed ganging for TPX1 fills only 64 channels. This is because there will be a charge separation in the RAMs (see Fig. 1 and Fig. 2)

Table 1: Assignments of wirechamber- and $\overline{C9}$/H9-channels to the RAM-channels.

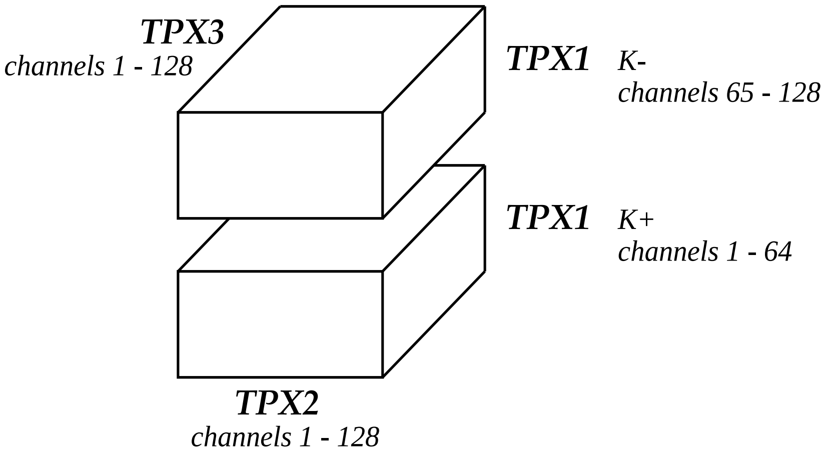

Figure 1: Assignment of detectors to RAM#1, also called *TPX1-RAM*

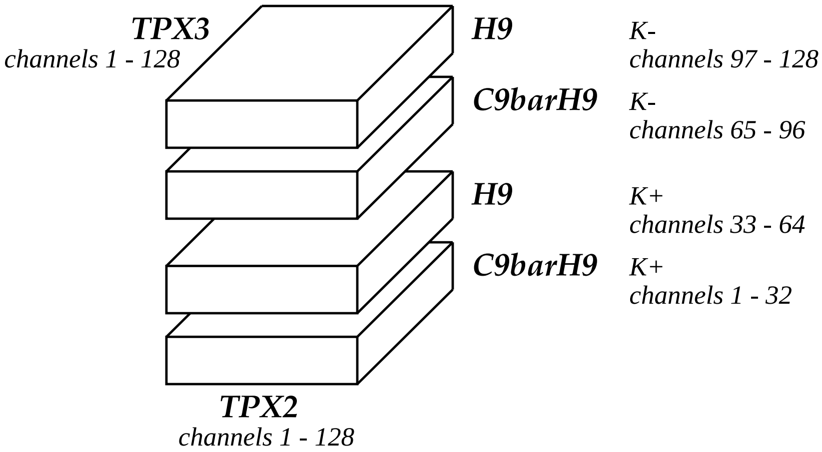

Figure 2: Assignment of detectors to RAM#2, also called *H9-RAM*

3 The Software to fill the RAMs

This section describes the steps that are necessary to create the RAM data-file. Currently the following programs are being used:

- `kaon_4vecs` creates momentum 4-vectors and vertex-positions for Kaons.
- `mkitp_kaon` converts the output of `kaon_4vecs` to itape-format.
- `SaGen` creates hits in the detectors.
- `ramView` creates the RAM-channels.
- `dentist_RAM` fills holes in the RAM-files.
- `add_RAM` adds two RAM-files together.
- `convert_RAM` converts the output of `ramView` to the format used by the RAM.

They will be described in detail on the next pages.

3.1 The Program `kaon_4vecs`

This program creates momentum 4-vectors and the 3-vector of the vertex-position of a Kaon. The main option is:

<u>`--enableRandomGenerator` :</u>

Currently this option is used in creating the RAM-files. The events are created randomly within the specified boundaries:

- The range of the inverse of the momentum in the (xz)-plane:
  In the experiment the measured quantity in the TPX-chambers is NOT the total momentum, but the momentum in the (xz)-plane. The y-component of the momentum remains undetermined in the trigger. This is why the loop is done over P_{xz}, instead of the total momentum. In addition the deflection in x is proportional to $\frac{1}{P_{xz}}$, which is why we choose to select random events from a flat $\frac{1}{P_{xz}}$- instead from a flat P_{xz}-distribution. This procedure should fill the RAMs much faster, as the high-momentum tracks do not bend as much as the low-momentum ones, which means that much less high-momentum than low-momentum tracks are needed. A simple calculations shows that the number of created events from a flat $\frac{1}{P_{xz}}$-distribution has a $\frac{1}{(P_{xz})^2}$-dependance in P_{xz}, which is the desired effect.
- An earlier study showed, that the x- and y-component of the momentum are limited to the given default-boundaries. Therefore the default-values need not be changed.
  Both, P_x and P_y are chosen from flat distributions.
- The vertex-position is chosen from a flat distribution over the target-radius and over the z-position. In the `-Vrmax,zmin,zmax`-option only the maximum radius and the downstream and upstream z-position of the target need to be specified.
- The `-M`-option stells the program how many events should be created.

IMPORTANT NOTE: In the 1997 extension run of E852 the target will be shifted from the x=0 position, to accomodate for the $\frac{3}{4}$-field. The center-position of the target is at $(x, y) = (2.33cm, 0cm)$. This value is hardwired into the `kaon_4vecs`-program and automatically added to the vertex-positions. Only in the case of the single vertex option (`-v1`-option) the written vertex is exactly the one given as an input in the `-Vxpos,ypos,zpos`-option. IN ALL OTHER CASES THE VALUE OF 2.33cm IS ADDED TO THE X-POSITION OF THE VERTEX AUTOMATICALLY!

3.2 The Program `mkitp_kaon`

This program converts the output of the **`kaon_4vecs`** program to an itape-format. Momentum of the incoming π^- beam and the charge of the kaon are added.
Two options have to be specified:

- <u>`−Rrun#`</u>
  For Monte Carlo simulations of the 1997 extension run of E852 the run# is 12000.

- <u>`−K#`</u>
  If # = 1 the values read in from the output-file of the **`kaon_4vecs`** program are treated as values from K^+ events. The default # = 0 treats them as K^- events.

Note that one has to run this program ALWAYS TWICE for a given output-file from **`kaon_4vecs`**, once for the K^+ case and a second time for the K^- case.

3.3 The Program `SaGen`

This is the E852 Montecarlo-tracking information generator. It creates hits in the different detector-components of Experiment 852. There are several options that have to be set:

- <u>`−Rrun#`</u>
  For Monte Carlo simulations of the 1997 extension run of E852 the run# is 12000.

- <u>`−fQ`</u>
  This option specifies the magnetic field used in the program. For the 1997 extension run of E852 the field is planned to be $\frac{3}{4}$ of its full value.

- <u>`−Aoffset`</u>
  The Detector Endcap Array (DEA) is shifted from its x=0 position to shadow the Lead Glass Detector downstream. The value proposed for the 1997 run is `offset`=0.04cm [2].

- <u>`− − disableMissingMomentum`</u>
  As the Proton or the neutron in the reaction is missing, **`SaGen`** calculates the momentum of the missing particle from the missing momentum of the reaction. However, in the case when we use the output of the **`kaon_4vecs`** program, we use the reaction $\pi^- p \to K^\pm N^\mp$, where N indicates some nucleonic, strangeness carrying particle. The tracking of N is not necessary

and would complicate the analysis of the Kaon. It is therefore omitted, by turning off the automatic generation of the missing particle in `SaGen`.

- `−−enableH9`
  This flag turns on the simulation of the H9-detector.

- `−o@″programname″`
  `SaGen` supports the option to pipe the output into another program. This has the advantage, that one does not have to store the rather big output-files of `SaGen`. If the program `programname` has some commandline-options, then the programname and the options have to be embraced by quotation marks. In our case the `programname` will be `ramView`, which is described in the next subsection.

3.4 The Program `ramView`

The program `ramView` converts the hits in the chambers and H9 into RAM-channels and writes them to a file. There are some other (unused for creating the RAM-file) options, that can be used to do studies on the RAM-hits. For the creation of the RAM-hits the following options have to be set:

- `−K#`
  The assignment of the RAM-channles to wires in TPX1 is different for K^+ and K^- (see Fig 1). The way this is handeled in the `ramView`-program is, that the ganging is read from two different input-files for K^+ and K^-, respectively. The `-K1` option handles the K^+-case, the `-K0` the K^--case[2].

- `−G1`
  For studies of the geometrical acceptance of the ganging used in the RAM, there is an option, which prints out hits only if **all** chambers and detectors, that go into the RAM have a hit, i.e TPX1, TPX2, TPX3 and H9 all must have a hit to be accepted. This is managed by the `-G1` option, which is **NOT** the default. For the creation of the RAM-file this flag must be on[3].

- `−Rfilename`
  This option gives the output filename of the RAM-channels.

As mentioned above there are some other options, which can be used to do studies on the accepted or rejected[4] events. Also the format of the events, that are written to file can be determined.
For monitoring purposes one should write at least a part of the created events

[2] The latter is the default.
[3] The default `-G0` prints events if **any** of the 3 chambers TPX1-3 has a hit.
[4] Rejected means, that an event hits all chambers, but lies outside the area that is used in the RAM-ganging.

to file.
For further information use the `-h` option in ramView.

3.5 The Program `add_RAM`

In the process of creating the RAM-files for the H9-RAM and the TPX1-RAM it is necessary to add RAM-files. Some examples where this has to be done are the output of the hole-filling program `dentist_RAM` and the original file, or the adding of the two files for K^+ and K^- for each of the two RAMs. Also if the Dispatcher is used to run the `SaGen -o@''ramView''` program then the output is split up into several files, which have to be added together.
This can be done with the program `add_RAM`:

- `-M#`
  This option specifies which RAMs one wants to add. The default `-M1` adds two H9-RAMs and the `-M0` two TPX1-RAM.
- `-OFilename1`
  `-TFilename2`
  These two flags specify the input filenames, i.e the names of the files that should be added together.

3.6 The Program `dentist_RAM`

This program fills holes in the RAM.
If for any two coordinates in the RAM, say for example x and y, the z addresses are not continously filled, the RAM is said to have a hole[5].
Because we use random-generated events to fill the RAM it is possible to leave such holes in the RAM. The program `dentist_RAM` fills these holes.

- `-K#`
  Again different modes have to be chosen for K^+ and K^-. Like always the default `-K1` is for the K^+ and the `-K0` is for the K^-.
- `-M#`
  This option specifies for which RAM one wants to fill holes. The default `-M1` fills the holes in the H9-RAM and the `-M0` fills the holes in the TPX1-RAM.

IMPORTANT NOTE: This program writes the positions of the HOLES only! To get the complete RAM-file, one has to run `add_RAM` with the input RAM-file and the output of `dentist_RAM`!!
Also there are special cases where holes are not filled completely, so `dentist_RAM` has to be run several times!

[5] Unless of course this gap corresponds to physics or detector geometry.

3.7 The Program `convert_RAM`

This program finally converts the format that was used throughout the creation-process into the format that the RAMs use as input. The format is rather complicated and is described in great detail in [3].
There are three option that have to be set:

- `-M#`
  This option specifies which RAM one wants to convert. The default `-M1` converts the H9-RAM and `-M0` converts the TPX1-RAM.
- `-iFilename1`
  `Filename1` is the input-filename.
- `-oFilename2`
  `Filename2` is the output-filename.

References

[1] R. Hackenburg, M8085 RAM Link User's Guide, Brookhaven MPS note 77 (1985).

[2] The calculation was done by A. Ostrovidov and the results can be found on the web under:
http://lemond.phy.bnl.gov/~e852/documentation/coordinates.html.

[3] J. Kuhn, Format of the RAM-file, 1996.