Naming Convention for eRHIC Beamline Elements (Draft 1)

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1 Introduction and Purpose

This document describes a system for assigning a unique name to each element in the eRHIC beamlines.

The names are anticipated to be used in tracking codes and survey layouts for the magnets. Names that are unique for each element become particularly important when tracking with a specific set of errors or corrections applied.

1.1 Granularity

The components of eRHIC will probably end up being identified by several naming systems but these naming schemes fall into three broad categories:

- Many elements have the same name: for instance a repeating lattice defined as 10*(F,O,D,O) would contain ten each of F and D and twenty O's.
- Each element has exactly one name: each name will refer to one clearly defined object in the accelerator, which can be located on the basis of its name alone. In the example above, the magnets would could be called F1, F2 ... F10 and D1, D2 ... D10.
- One element can have many names: for instance magnet serial numbers. A given magnet may be replaced, meaning the same element of the accelerator now has a different serial number. Another example is if a multi-pass lattice is "unwrapped" into a linear description where the beam can encounter the same element again but with a different identifier.

This system described in this document falls into the second category: it is a one-to-one naming of the elements in the eRHIC beamline. At present it applies to 'elements', which are objects the beam encounters, rather than 'components', which could be much more numerous depending on the definition.

1.2 Scope

This naming scheme may be applied to almost all new beamline elements installed for the eRHIC project, particularly as it can be extended in a custom way for different subsystems as explained in section 3. It is anticipated that existing RHIC components, such as the magnets of the hadron blue ring that collides with the electrons, will retain their old names to avoid confusion.

2 Generic Element Name Structure

For illustration, below is an element name defined by this document's system:

F2_12S_52QF

This is the QF (focussing quadrupole) magnet in the 52nd cell of the 12 o'clock straight section (12S) of the high-energy FFAG (FFAG number 2, or F2). These specific notations for parts of the accelerator will be defined in later sections. This section, however, defines some generic guidelines that *all* element names should follow, which are given in the subsections below.

2.1 Left-to-Right Hierarchy

As element names are read from left to right, each number or letter group should refer to a successively smaller piece of the accelerator. In the example above, F refers to all electron FFAGs, F2 refers to the second (higher energy) one, F2_12 refers to the part of that FFAG installed in the 12 o'clock area of the RHIC tunnel and so on. This leads to the substring 52QF to identify the magnet element within the straight section, since the cell identified by 52 is larger than the magnet QF and so the cell number must come first. Other common lattice numbering systems (such as the LHC's [1]) would use a name like QF52 for this magnet, if they follow a [element type].[location] system. However, to remain hierarchical, the eRHIC system will be [location].[element type].

This strict naming hierarchy gives some benefits when processing the element names using computerised systems. For example, controls software often presents the machine as a tree, starting at the largest systems and successively breaking down to the individual components. It also means a natural sort of the name strings will tend to group them into sections.

Finally, if the beamline elements are subdivided into engineering components of some sort, the hierarchy can unambiguously be extended by adding _partname to the end of the name, where partname uniquely identifies the subcomponent within the element. Thus eRHIC can use a [location].[element type].[subcomponent] system for identifying pieces within elements.

2.2 Formatting Issues

Underscores will often be added to the names in order to improve readability. The example above could be written as F212S52QF without any underscores, or as F_2_12_S_52_QF with underscores separating every level of the hierarchy. However, a straw poll of the eRHIC team found that neither of these is an improvement, so underscores will be added only in some places.

Some computer codes may not allow underscores, so it is essential that the names remain unambiguous if all the underscores are removed. Importantly, if there are consecutive blocks of numbers, such as FFAG number 2 and clock position 12 above, the second and subsequent numbers must be zero-padded as necessary to give them a fixed length. So 8 o'clock in FFAG2 would be written as F2_08 or F208 and not F2_8 or F28. With the ambiguity resolved, the whole digit block can be interpreted as a number 100*(FFAG number)+(clock position).

Consecutive blocks of letters must similarly remain unambiguous, so it is not allowed to give different elements names like A_BC and AB_C. This should be resolved on a case-by-case basis, with making the letter blocks fixed length being a solution that always works.

3 eRHIC Naming Domains

The first letter of an element name has the special role of distinguishing between entirely different domains of the eRHIC accelerator complex. In this way, a different local system can be used within each domain without having to worry about name collisions. This sort of system is used very extensively at the LHC (see [1], Annex 1: *List of Systems*). At present, eRHIC has defined letters for the major subsystems below:

- `L` = The electron linac.
- `F` = The FFAG beamlines for accelerating and decelerating electrons.
- `E` = The highest-energy beamline for electrons that passes through the interaction region.
- `S` = The splitter following the electron linac straight and immediately before the FFAGs.
- `M` = The merger immediately after the FFAGs and before the electron linac straight.
- `I` = The electron injector, which joins the straight section after `M` and before `L`.
- `D` = The electron dump, which is after `L` and before `S`.

Letters are also reserved for the following other sections, if they are needed:

- `A` = The electron abort section, if distinct from the low-energy dump.
- `H` = New eRHIC-specific hadron beamlines going through the interaction region (the existing RHIC magnets will retain their old names).
- `C` = Beamlines of new cooling systems required for eRHIC.

The rest of this document contains sections defining the naming scheme within each domain. These may be added to over time.

4 Domain `F`: FFAGs

Elements in the FFAGs have names of the general form

$$\texttt{F}n\texttt{\_}hhT\texttt{\_}cMM$$

e.g. `F2_12S_52QF`, where:

- n = The FFAG number, in order of ascending energy. Currently this can either be `1` for the low-energy FFAG, or `2` for the high-energy FFAG.
- hh = The clock position sector in the tunnel, padded to two digits from `01` up to `12`.
- T = The type of FFAG section. There are more than 12 FFAG sections, so the clock position is not sufficient to identify them. They are given a single letter depending on type: `A` = arc; `S` = straight; `M` = matching transition between arc and straight; `B` = straight including a detector bypass; `C` = straight including a crossover from the inside to the outside of RHIC or vice versa.
- c = The cell number within the FFAG section, starting from `1` and increasing in the direction the electron beams travel. This resets at the beginning of each new section.

- MM = The magnet or drift name within the cell. There are two (displaced) quadrupole magnets called `QF` and `QD` and two drifts named `DS` and `DL`.

In the current lattice, the beginning of the cell is at the midpoint of drift `DL`, which corresponds to the longer drift if they differ in length. So in the lattice definition file, the cell is (`DLH`,`QD`,`DS`,`QF`,`DLHH`), where `DLH` and `DLHH` are the two halves of drift `DL`.

4.1 eRHIC FFAG Section Names

The naming of FFAG sections, corresponding to substring hhT in the middle of the overall name is shown in figure 1. Note that the electrons in eRHIC go anticlockwise and the linac straight is

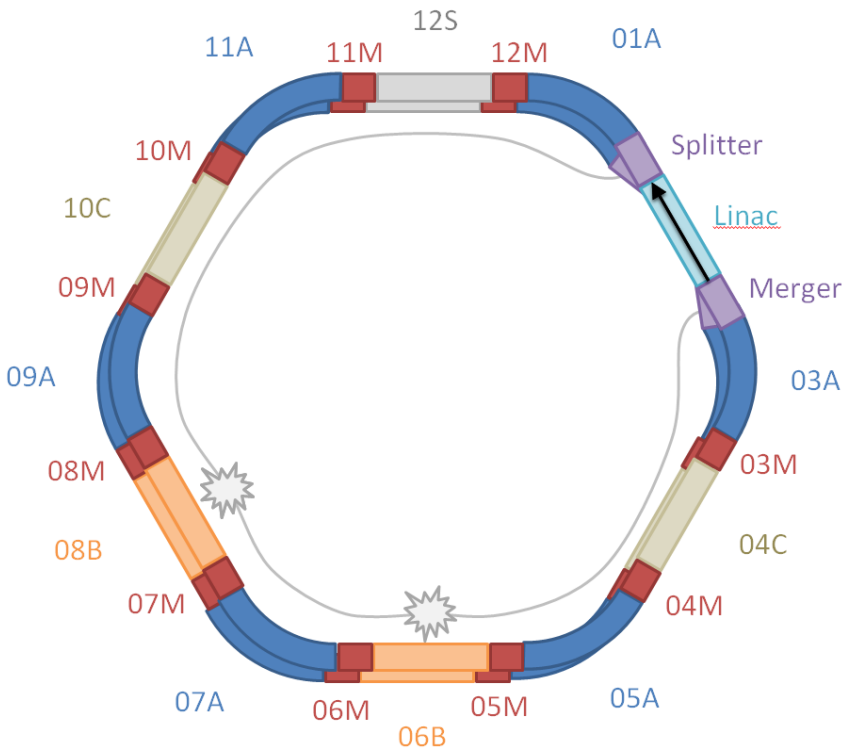

Figure 1: FFAG section names consist of a two digit clock position and a section type letter.

at 2 o'clock, so the first section to be encountered after the splitter is the 1 o'clock arc `01A`. This is followed by the matching section `12M` and the 12 o'clock straight `12S`. The electrons continue around the ring in this manner until they get to the 3 o'clock arc `03A`, which is immediately before the merger.

Some asymmetry has to be introduced in order to give clock position numbers to the matching sections. Here the clock positions are extended clockwise, so the matching section is numbered the same as the arc or straight immediately anticlockwise of it.

5 Domains S and M: Splitter and Merger

The splitter and merger are distinguished by having different domain letters but are essentially the same inside, so they will both use the same internal naming scheme. The lattices are currently still being designed but two example names are given below.

S08_Q5 MDCOM2

These would correspond to the fifth quadrupole in the eighth line of the splitter and the second common dipole of the merger, respectively. Note that the name Q5 is OK if it means "fifth quadrupole in the line" but should be 5Q if there is a regular cell structure and it means "the quadrupole in the fifth cell", in order to preserve the hierarchy.

The general form of these names is

$$(\mathtt{S} \text{ or } \mathtt{M})(ll\_EE \text{ or } CC)$$

where:

- ll = The line number, in order of ascending energy, padded to two digits. So in the current 12-turn design, this is 01 for the lowest-energy line up to 12 for the highest energy.
- EE = Element name within a single-energy line.
- CC = Name of common elements such as the splitting dipole itself, which span several or all energies.

The element names EE and CC are still under definition.

References

[1] *Quality Assurance Definition: Equipment Naming Systems*, Roberto Saban *et al.*, LHC Project Document No. LHC-PM-QA-204.00 rev 1.0, available from http://lhc-proj-qawg.web.cern.ch/lhc-proj-qawg/CD-ROM/Quality/QA204.pdf.