ranger – a Pattern Recognition Tool for the HERA-B Main Tracking System – Quick Introduction –

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This little document is intended as quick reference to *ranger*. It may serve as a tutorial until a full User's manual is available.

Chapter 1

What is *ranger*?

ranger is a method for pattern recognition and track reconstruction in the HERA-B main tracking system. The ranger program package is still under development, but preliminary versions are available in the HERA-B software pool.

ranger consists of the following subpackages:

- *ranger/ideal* – performs 'fast' track reconstruction, where the pattern recognition assignment is taken from Monte Carlo. Similar to 'fast' or 'local' tools for other experiments eg. at the LHC.
- *ranger/triplet* – responsible for straight-line pattern recognition in the HERA-B pattern tracker
- *ranger/magnet* – performs propagation of track segments in the pattern tracker through the magnetic field
- *ranger/fit* – an approach to an overall track fit

Chapter 2

Status of *ranger*

ranger/ideal is able to do a full track fit from the vertex detector to the begin of the ECAL. Multiple scattering and – in case of electrons – radiation inside the magnet are taken into account. The magnetic field variant – homogeneous or inhomogeneous – is recognized automatically. The multiple scattering correction suffers a little from the incompleteness of the geometry description inside Arte. *ranger/ideal* has been successfully used for a couple of MC analysis works, eg. by Jenny Ivarsson (Lund Univ.) and Matthias Leuthold (Humboldt Univ. Berlin), with subsequent vertex fitting.

ranger/triplet was introduced in *ranger 4.6*. Extensive performance studies have shown that pattern recognition efficiencies better than 96% are obtained for particles from the $B^0 \rightarrow J/\Psi K^0_S$ decay with the standard HERA-B simulation (1 B^0 interaction plus 4 inelastic interactions (on average)) [2].

ranger/magnet was introduced in *ranger 4.7*. This is still a very preliminary implementation. It is quite slow because a lot of time is spent in the Runge-Kutta transport, which has to be fitted more elaborately to our needs. There is currently no final refit of the magnet tracks, so that the track parameters should be regarded as preliminary.

ranger/fit will be relevant when the track segments from vertex detector and main tracker have successfully been merged.

Chapter 3

Usage

Initialization: in Arte 4.3 and 4.4, the *ranger* initialization is not yet done automatically. The user must therefore make sure that the routines **tfkuip()** and **tfinit()** are called prior to the first reconstruction task, eg. in the user routine usinit(). In future, Arte should take care of this.

In the final release, reconstruction will be automatic and the user need only specify if he wants it done or not. At present, it may be very useful to be able to specify what *level* of reconstruction should be performed.

The level of reconstruction should be selected by setting the variable **rlevel_zfpar** before the first invocation of *ranger*, but after invoking **tfinit()**. This can be done in the routine **usinit()**:

```
      subroutine usinit()
      implicit none
#include "zfpar.fi"
      ...
      call tfkuip()  ! if not yet done by Arte
      call tfinit()  !         "
      ...
      rlevel_zfpar = 0 ! for ranger/ideal
      ...
      end
```

The meaning of **rlevel_zfpar** is:

```
      rlevel_zfpar = 0 ! use ranger/ideal [default]
                     1 ! use ranger/triplet (zero degree layers only)
                     2 !          "          (3D track segment)
                     3 ! use ranger/triplet and ranger/magnet
```

Event processing: in Arte 4.3 and 4.4, the *ranger* event processing is not yet called automatically. The user must therefore call *ranger* explicitly:

```
subroutine usevnt()
...
call tfevnt() ! call ranger event processing
...
end
```

Note: in *ranger 4.6*, **tfevnt()** was still called **tfmain()**. In future versions of Arte, *ranger* should automatically be called inside **rcevnt()**.

Tayloring *ranger/ideal***:** normally the 'fast' reconstruction selects charged MC particles above 1 GeV with at least 30 Hits in the z range from 0 to 1500cm. You can taylor this behaviour by calling the routine **tfideal** directly instead of **tfevnt()**:

```
 call tfideal(p_min,hit_min,z_min,z_max,elec_corr)
 real p_min,              ! fit tracks with p>p_min
+     z_min,              ! select hits with z>z_min
+     z_max               !              and z<z_max
 integer hit_min,         ! fit tracks with nhit>hit_min
+        elec_corr        ! electron bremsstrahlung corr flag:
                          !    =-1  no correction
                          !    = 0  use default
                          !    =+1  apply correction
```

Chapter 4

Versions

Version	Released	Important changes	Invocation
4.7	Feb 97	First introduction of ranger/magnet	**`tfevnt()`**
4.6	Dec 96	Triplet algorithm for pattern recognition in pattern tracker behind magnet (ranger/triplet)	**`tfmain()`**
4.5	Nov 96	Handling inhomogeneous field	
4.4	Sep 96	Internal momentum parameter $Q/p_\perp$ Insensitive plane areas in track fit #Iterations set to 1	

Bibliography

[1] R. Mankel, "Application of the Kalman Filter Technique in the HERA-B Track Reconstruction, HERA-B Note 95-239 (1995)

[2] R. Mankel,"Performance Update for Pattern Recognition in the HERA-B Main Tracker", Talk given at the HERA-B week, 5 Feb 1997, Hamburg