SECONDARY BEAMS AND EXPERIMENTAL AREAS

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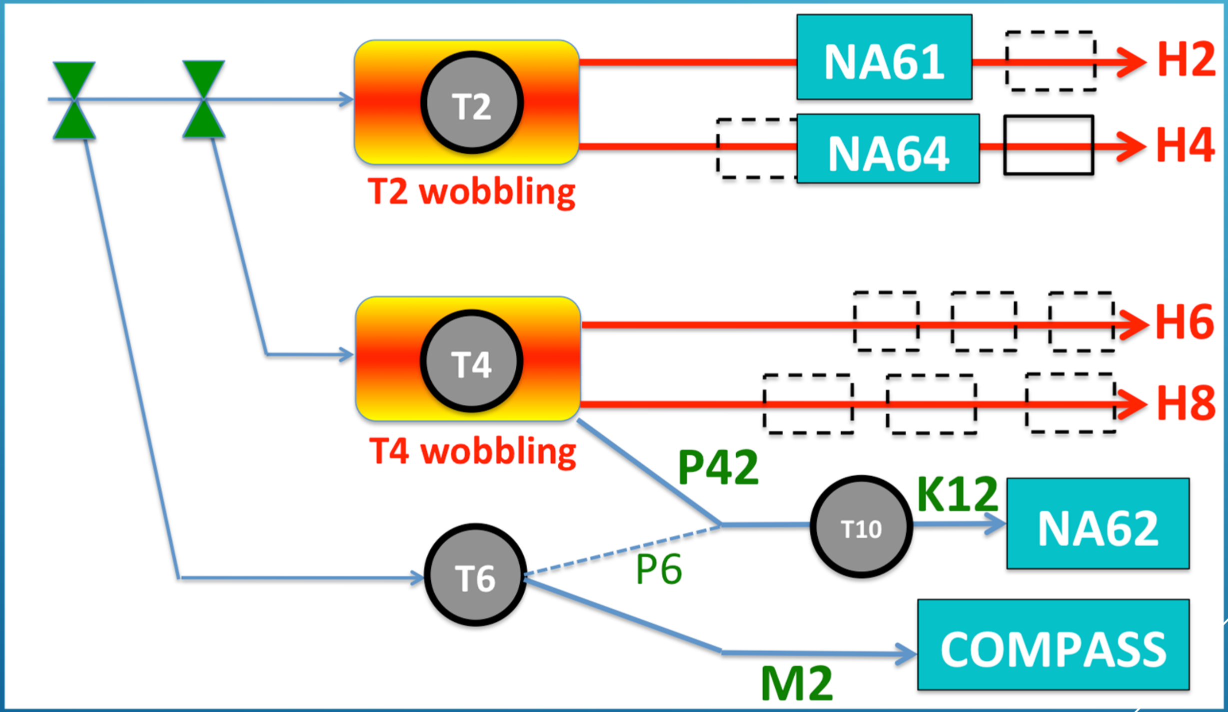
EXPERIMENTAL AREAS GROUP

- Fixed Target experiments
- Advantages and Disadvantages of Fixed Target
- Mainly the East and North areas



BEAMLINE TRANSPORT

- The experimental area group is also responsible for the beamline transport, as we saw wednesday at COMPASS
- Several machines are used:
  - Quadrupole magnets
  - Dipole magnets
  - Detectors
- Computer programs

BEAM FOCUS

$$\begin{pmatrix} X_1 \\ X_1' \end{pmatrix} = \begin{pmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{pmatrix} \begin{pmatrix} X_o \\ X_o' \end{pmatrix} = \begin{pmatrix} R_{11} X_o + R_{12} X_o' \\ R_{21} X_o + R_{22} X_o' \end{pmatrix}$$

e.g. : Drift space L: $\begin{pmatrix} 1 & L \\ 0 & 1 \end{pmatrix}$ Quadrupole: $\begin{pmatrix} 1 & 0 \\ -1/f & 1 \end{pmatrix}$

(f = focal length)

$$\begin{pmatrix} 1 & L_3 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ {}^1/_{f2} & 1 \end{pmatrix} \begin{pmatrix} 1 & L_2 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ -{}^1/_{f1} & 1 \end{pmatrix} \begin{pmatrix} 1 & L_1 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} X_o \\ X_o' \end{pmatrix}$$

BEATCH

- Geometry of the beam
- You can do it on paper, but beatch can calculate it for you
- We didn't use Beatch a lot, we calculated and drew the geometry by hand

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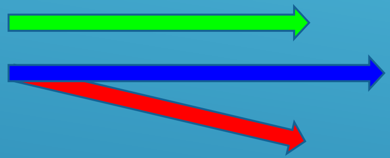
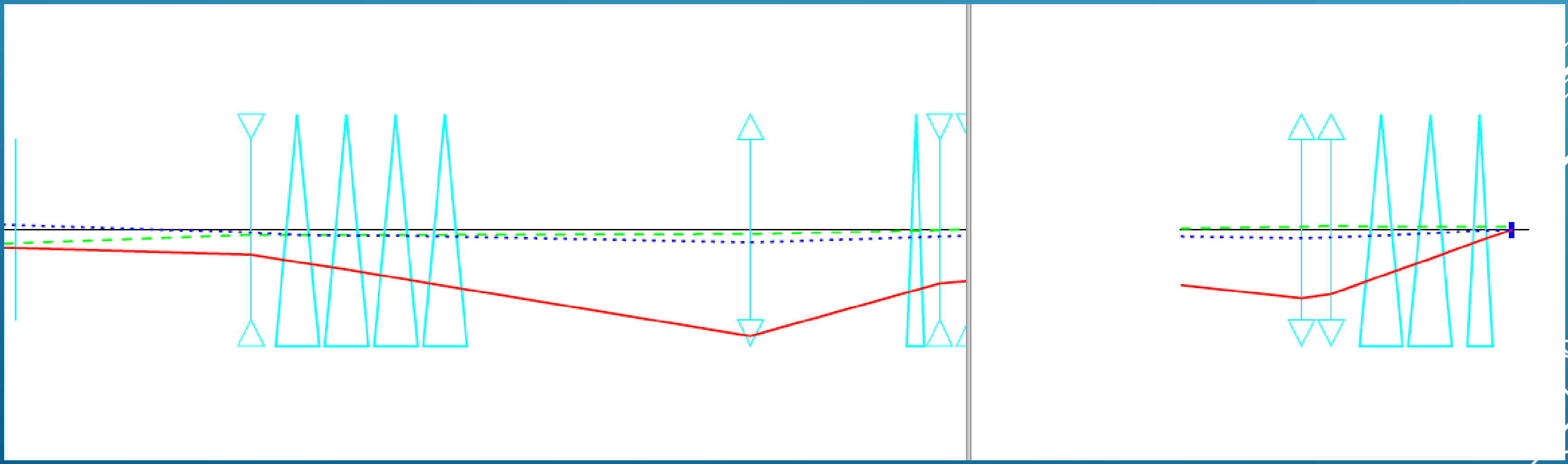
TRANSPORT AND BEAMPLOT

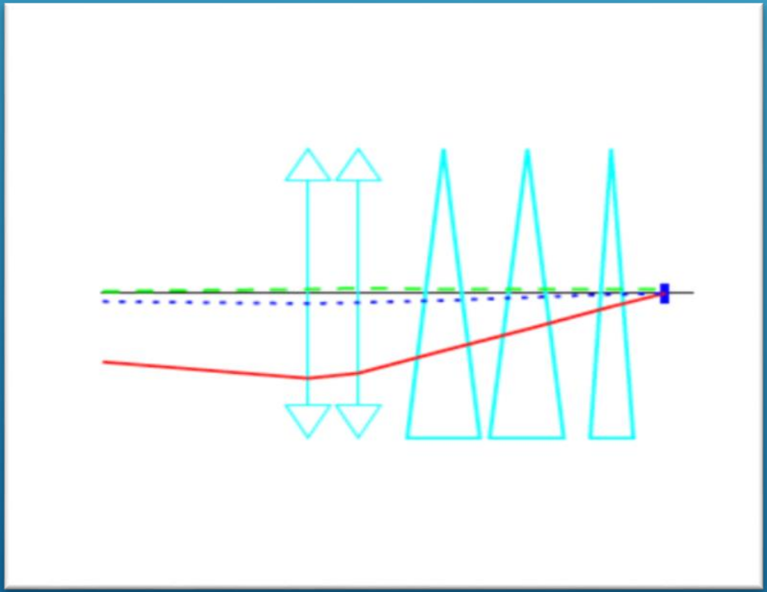
- Optics of the beam
- Not every particle in the beam behaves the same
- Deviations in momentum, initial position and initial angles
- Transport does the calculations, beamplot visualizes three of said particles with deviations





FOCAL POINT OF P42

- Transport is used, the last three quadrupoles before the focal point are made variable in strength
- Transport then tries to find a solution
- The program failed the first time, because it came up with a solution in which a magnet would be stronger than possible
- Second time we put in a limit → program found an acceptable solution



BEAM FOR KLEVER

- K^0_L and Λ both decay into π^0
- KLEVER tries to measure the decay of K^0_L
- Λ is background noise
- Λ decays faster than K^0_L
- If the detector is placed correctly → less background
- Still too much background
- Bigger angle on primary target → particles with less energy
- Less energy → better

WHY ARE PARTICLES WITH LESS ENERGY BETTER? (1/2)

- Mean life Λ ($2{,}632 \times 10^{-10}$ s) is way shorter than mean life K^0_L ($5{,}116 \times 10^{-8}$ s)
- Angle of 2,4 mrad → energies are high (Λ > 130 GeV & K^0_L > 80 GeV) and their mean lifes are different for observers (relativity)
- Makes mean life Λ = $3{,}08 \times 10^{-8}$ s and mean life K^0_L = $8{,}24 \times 10^{-6}$ s
- Average distance before decay is 9,24 m for Λ and 2,47 km for K^0_L
- Still too much background, because detector has to be placed at less than 1 km

$$\beta = \frac{p}{\sqrt{p^2 + m^2}}$$

$$\tau' = \tau \times \gamma$$

$$\gamma = \frac{1}{\sqrt{1 - \beta^2}}$$

WHY ARE PARTICLES WITH LESS ENERGY BETTER? (2/2)

- Angle of 8,0 mrad → resulting energies are much lower (Λ → 70 GeV & K^0_L → 40 GeV) and their mean lifes for observers are much lower as well
- Average travelling distance drops to 4,95 m for Λ and 1,23 km for K^0_L
- Much more of the Λ is already gone before the detector, and more of the K^0_L decays inside the detector
- A lot less background, and the decay of the K^0_L is better measurable

$$\beta = \frac{p}{\sqrt{p^2 + m^2}}$$

$$\tau' = \tau \times \gamma$$

$$\gamma = \frac{1}{\sqrt{1 - \beta^2}}$$

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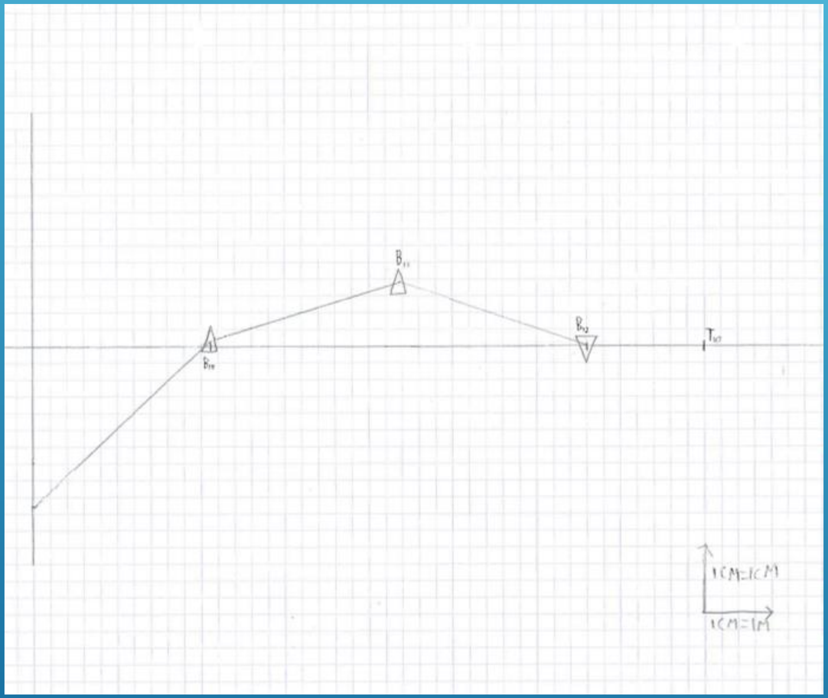
THE FINAL ASSIGNMENT (1/2)

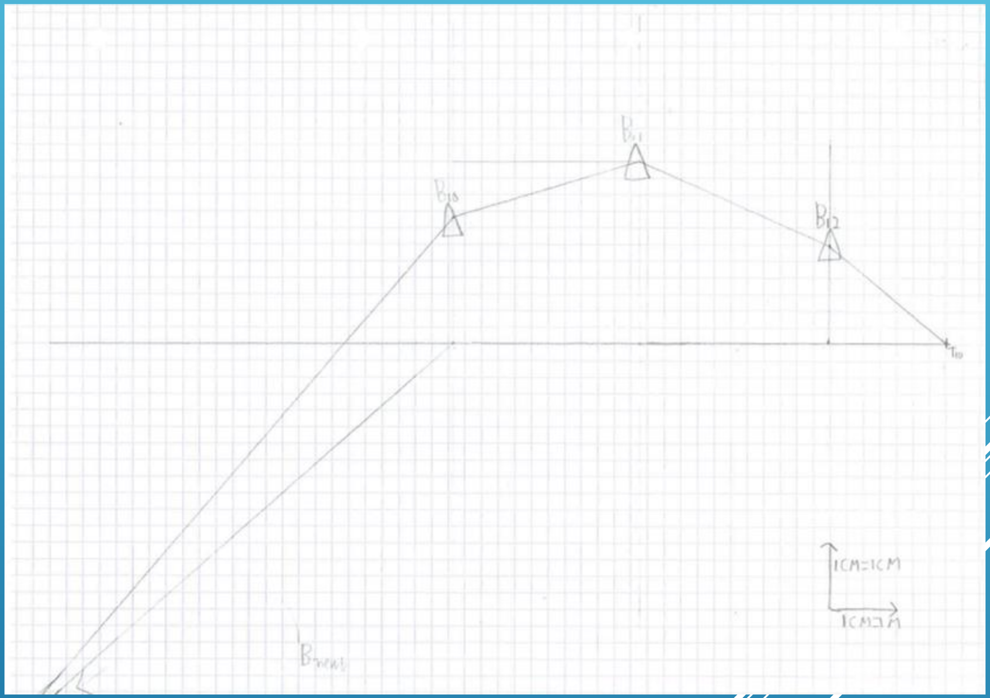
- As stated before, we had to change the impact angle from 0 mrad to 8 mrad.
- To do so, an extra magnet had to be inserted about 61 metres before the target.
- This also changed the optics of the beam, so we used transport to change to currents in the magnets, so the focal point was exactly at T10.

THE FINAL ASSIGNMENT (2/2)

We had to go from this...



... to this



THE FINAL TRANSPORT FILE

```
5.0C  2.99   10.7   40.0  "Q19"   ;
3.0   17.000 ;
20.0  90.0 ;
4.0   1.00  10.67 0.0  "NEWB" ;
20.0 -90.0 ;
3.0 0.75 ;
5.0B  2.99  -5.91613  40.0  "Q20" ;
3.0   0.44 ;
5.0B  2.99  -5.91613  40.0  "Q20" ;
3.0   15.320 ;
5.0A  2.99   6.97733  40.0  "Q21" ;
3.0   0.44 ;
5.0A  2.99   6.97733  40.0  "Q21" ;
3.0  1.105 ;
3.0  0.0  "TR10" ;
3.0  0.665 ;
20.0  90.0 ;
2.0 -0.286 ;
```

The input

```
715.730  3
720.730  4  B8      9.5339
721.390  3
726.390  4  B8      9.5339
727.049  3
732.049  4  B9     -3.9275
732.709  3
737.709  4  B9     -3.9275
768.889  3
771.879  5  Q19    49.1970
788.879  3
789.879  4  NEWB    1.0670
790.629  3
793.619  5  Q20   -42.1072
794.059  3
797.049  5  Q20   -42.1072
812.369  3
815.359  5  Q21    41.1586
815.799  3
818.789  5  Q21    41.1586
819.894  3
819.894  3  TR10
820.559  3
825.559  4  B10    -9.2905
826.219  3
831.219  4  B11    -9.2905
832.927  3
835.927  4  B12    -4.6668
838.059  3
838.059  3  T10
838.059  3  T10
```

The output

Thank you all for listening!

Any questions?

Special thanks to Lau Gatignon and the EN-EA group!