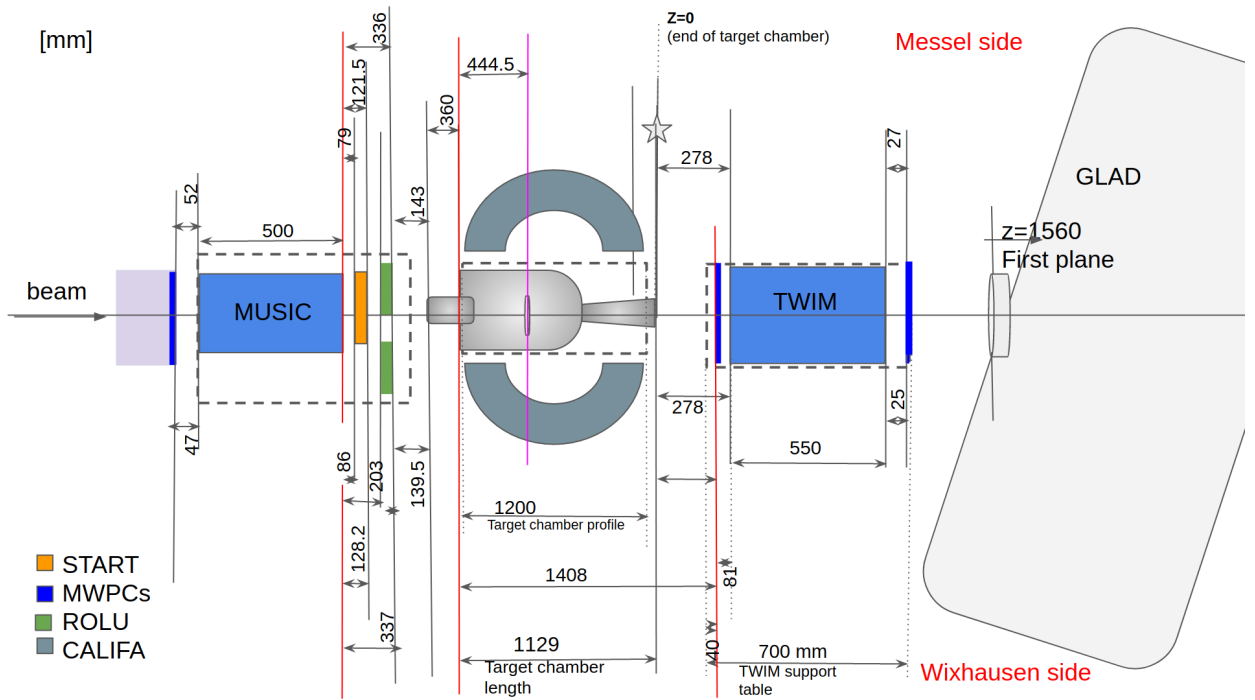
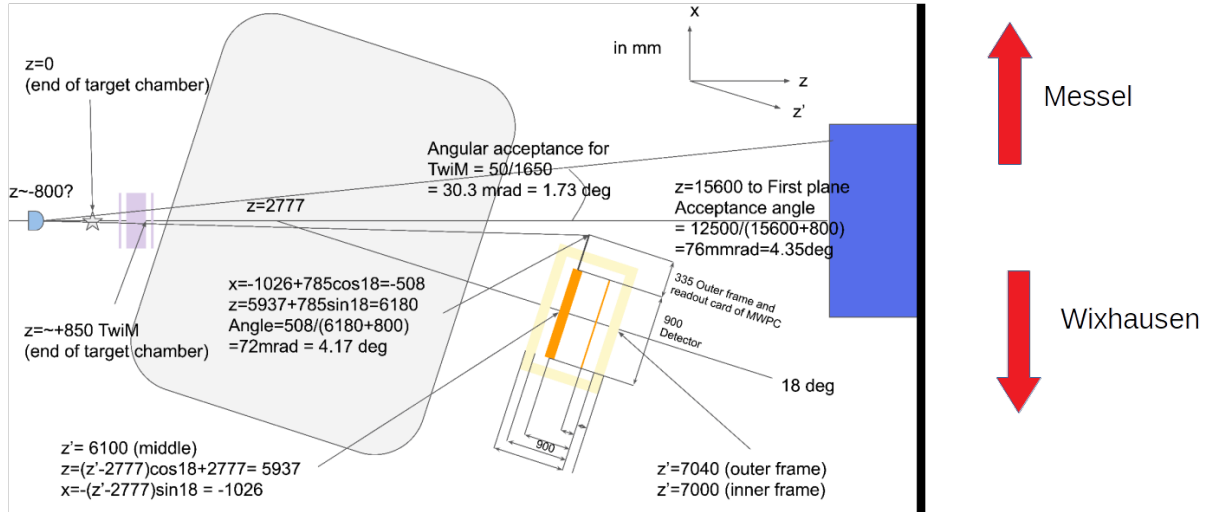


Radius/Momentum Calculation for S444 Experiment February 2020 - Overview

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0.1 The Setup



1 Geometry and relative position of the detectors in the beam direction

Here, the positions are given for the s444 and s467 experiments

z position of the MWPC0: $z_{MW0} = -2520$ mm
z position of the target: $z_T = -684.5$ mm
z position of the MWPC1 in front of the Twin-MUSIC: $z_{M1} = 279$ mm
z position of the middle of the Twin-MUSIC: $z_{Twin} = 553$ mm
z position of the MWPC2 after the Twin-MUSIC: $z_{M2} = 854$ mm
 α tilted angle of GLAD (14 degrees): $= 0.244$ rad
effective length of GLAD: $L_{eff} = 2067$ mm
z middle of GLAD $z_{Gm} = 2577$ mm
horizontal of the central path (18 degree) $\theta_{out0} = \pi/10$ rad
z position of the MWPC3 after GLAD $z_{M3} = 5937$ mm
z position of the ToFWall $z_{ToFW} = 6660.2$ mm

Correspondence between the GLAD current and the magnetic field: $I = 3584$ A, $B = 2.2$ T

Positions of the TOFWPads:

1 \Rightarrow Messel

27 \Rightarrow Wixhausen

2 RUNS used for calibration = SWEEP RUNS without target

RUN	Beam ion	Beam Energy [AmeV]	GLAD current [A]	Comments
36	12C primary	400	1444	before broken motor, here we see that tof is about 5ns faster. So they probably changed the position of the TOF afterwards
37	12C primary	400	1444	it has be seen that motor drive not working
38	12C primary	400	1444	tof is back with new gates *magnet sweep 1444A
39	12C primary	400	1498	
40	12C primary	400	1501	
41	12C primary	400	1501	stopped with 1558 A
42	12C primary	400	1558	
43	12C primary	400	1558	stopped with 1653 A
44	12C primary	400	1653	
45	12C primary	400	1653	stopped with 1748 A
46	12C primary	400	1748	
47	12C primary	400	1748	stopped with 1843 A
48	12C primary	400	1843	
49	12C primary	400	1843	stopped with 1938 A
51	12C primary	400	1938	
52	12C primary	400	1938	stopped with 1444 A
53	12C primary	400	1444	
54	12C primary	400	1444	stopped with 1349 A
55	12C primary	400	1349	
56	12C primary	400	1349	stopped with 1254 A
57	12C primary	400	1254	
58	12C primary	400	1254	stopped with 1159
59	12C primary	400	1159	
60	12C primary	400	1159	stopped with 1064
61	12C primary	400	1064	
62	12C primary	400	1064	stopped with 1444 A
123	12C primary	650	1748	stopped with 1957
124	12C primary	650	1957	
	=	sweeping		
	=	stable GLAD current		

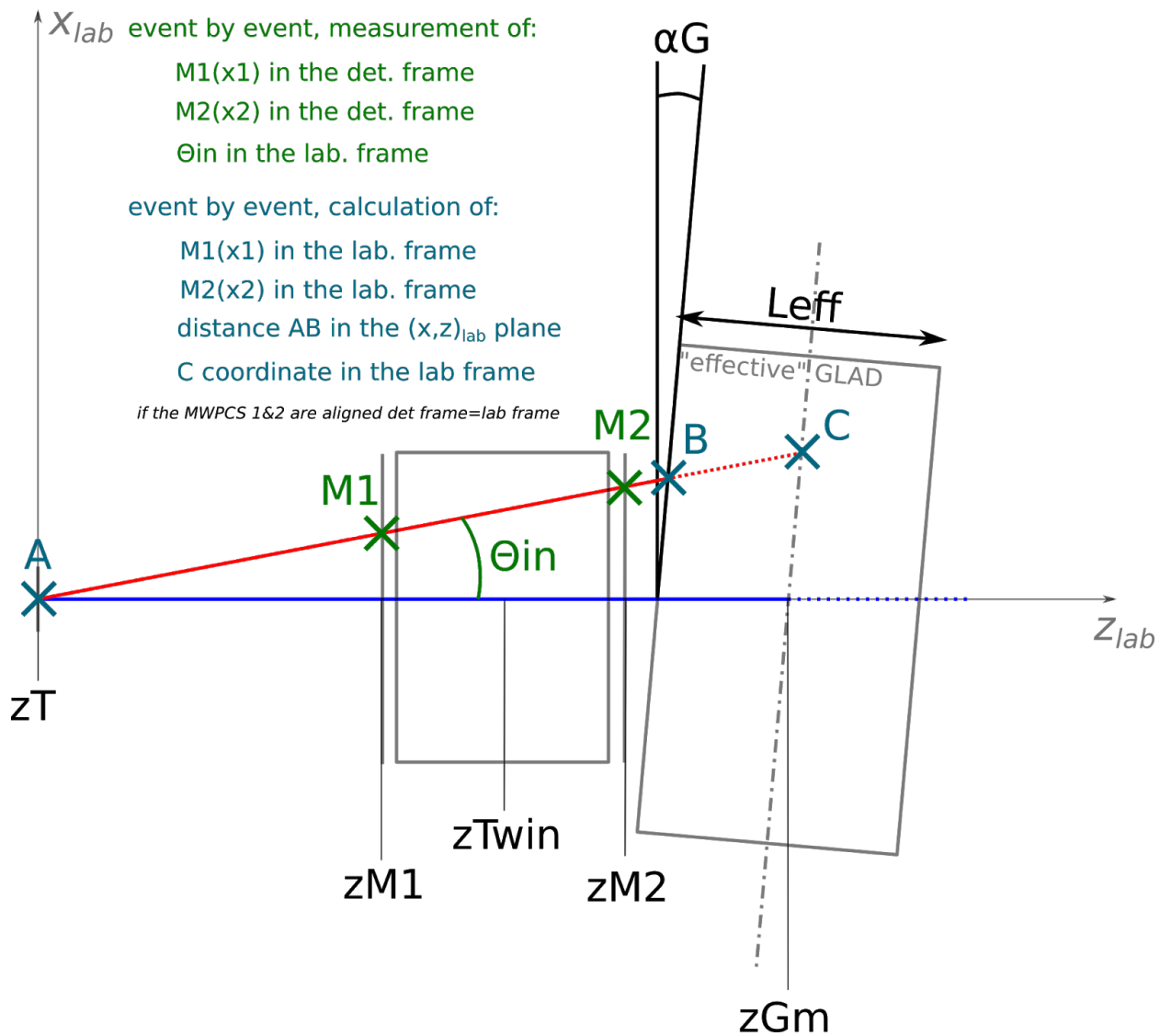
2.0.1 Other RUNS used for various checks:

RUN 70: 2 cm C target
 RUN 80: 10.86 mm C target
 RUN 81: 24.53 mm CH2 target
 RUN 67: 24 mm CH2 target
 RUN 68: 1 cm C target
 RUN 79: 12.29 mm CH2 target
 RUN 75: 21.98mm C target

3 Methods for flightpath reconstruction in the (x,z) plane

3.1 The "Kickplane" method

3.1.1 From MW0 to the entrance of GLAD, the ion is following a straight line



- ⇒ one absolute position before GLAD B and angle θ_{in} (see: 3.1.1)
 ⇒ one absolute position at MWPC3

From this information the angle θ_{out} is constructed in following steps:

1. Extend the straight flightline of the ion before the GLAD.
2. The point of intersection with the "kickplane" (symmetry axis line of GLAD magnet) is the kickpoint C.
3. Draw a straight line between C and the absolute position at MWPC3 = M3.
4. θ_{out} is the positive angle between the z-beam direction and the line between C and M3.

The curvature radius ρ is given by:

$$\rho = \frac{L_{eff}}{2 \cdot \sin\left(\frac{\theta_{in}}{2} + \frac{\theta_{out}}{2}\right) \cdot \cos(\delta)}$$

With δ :

$$\delta = \arctan\left(\left|\frac{\frac{\cos(\theta_{out}) - \cos(\theta_{in})}{\sin(\theta_{out}) + \sin(\theta_{in})} + \tan(\alpha)}{1 - \frac{\cos(\theta_{out}) - \cos(\theta_{in})}{\sin(\theta_{out}) + \sin(\theta_{in})} \cdot \tan(\alpha)}\right|\right)$$

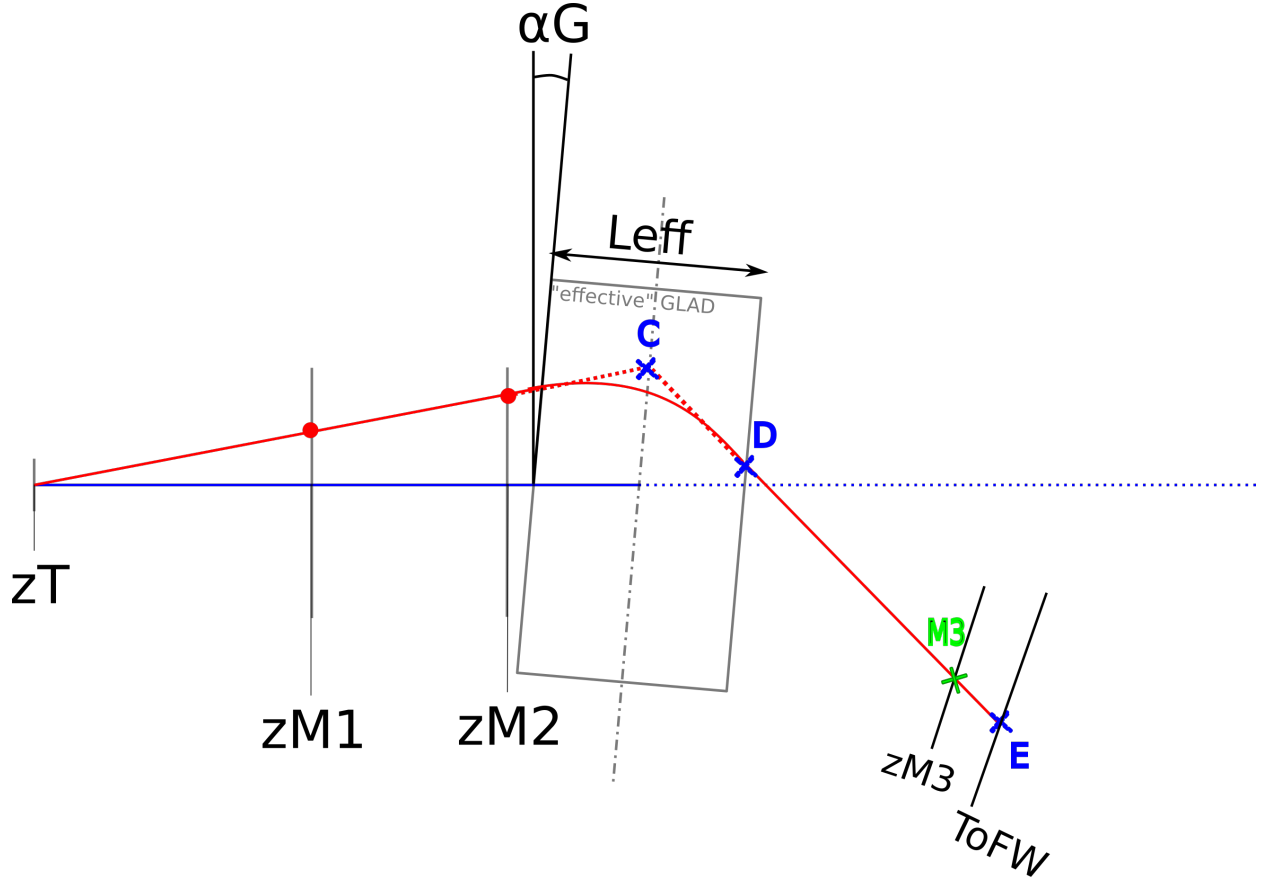
The full derivation can be found in the appendix.

The circular trajectory is given by:

$$\omega = 2 * \left| \arcsin\left[\frac{BD}{2 \cdot \rho}\right] \right|$$

with BD = length of the BD segment

3.1.3 After GLAD up to the TOFW, the trajectory is a straight line



The straight line trajectory from D to E is defined by:

- ⇒ the output angle from GLAD θ_{out}
- ⇒ one absolute position after GLAD in the laboratory frame M3

With this information the straight line trajectory length after GLAD can be measured. It starts at the exit point of GLAD D and follows the straight line (characterized by the angle θ_{out} and the absolute position at MWPC3) until the intersection with the ToFW (middle position of the ToFWall $z_{ToFW} = 6660.2mm$, tilted angle = 18°).

Finally the pathlength in the (x,z) plane from the target position to the ToFW is given by:

$$P = AB + \rho \cdot \omega + DE$$

where:

A = (x,z) position at the target point

B = (x,z) position at the GLAD entry point

D = (x,z) position at the GLAD exit point

E = (x,z) position where the constructed trajectory line hits the ToFW

The assumption in the "Kickplane" method is that the kickpoint for each event lies on the predefined Kickplane, the symmetry axis line of the GLAD magnet.

3.2 The "Fit-Track" method

3.3 The "Optic correction" method