PARAMETERIZATION OF MORE1 BAFFLES

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1. Introduction

In the present version of the Perl scripts that define the More1 baffles[1] the baffle geometry is defined by a set of 950 parameters. In order to develop and study variant baffle geometries, a simpler parameterization is desirable. Fortunately these parameters are extremely redundant and can be reduced to a much smaller set. In the context of a future SoLID software framework a smaller set like this could be regarded as a core description of the geometry, which the simulation and tracking code would use to construct their internal representations of the baffles.

2. Current parameterization

Currently the More1 baffles (and other baffles we have studied) are described by the following parameters or something equivalent:

- Scalars for baffle system as a whole ("system parameters"):
  n_{plate}**:** Number of baffles (= 11)
  Δz**:** Half thickness of each baffle (= 9.0/2, same for all baffles)
  n_{slit}**:** Number of slits (= 30)
  n_{block}**:** Number of radial layers between inner and outer rings (= 20)
  (Total of 4 parameters.)
- Arrays with entries for each baffle ("baffle parameters"):
  z_c**:** z coordinate of baffle center
  $r_{in/in}$**:** Inner radius of inner ring
  $r_{in/out}$**:** Outer radius of inner ring
  $r_{out/in}$**:** Inner radius of outer ring
  $r_{out/out}$**:** Outer radius of outer ring
  $\delta\phi$**:** Angular offset of first slit
  (Total of $6 \times 11 = 66$ parameters.)
- Arrays with entries for each radial layer of each baffle, describing the slit shape and size ("slit parameters"):
  $r_{slit/in}$**:** Inner radius of layer
  $r_{slit/out}$**:** Outer radius of layer
  ϕ^0**:** Starting angle of block
  $\Delta\phi$**:** Angular width of block

[1] e.g. solid_PVDIS_baffle_babarbafflemore1_geometry.pl

(Total of $4 \times 20 \times 11 = 880$ parameters.)

In total there are $4 + 66 + 880 = 950$ parameters describing the baffle geometry.

3. Parameters reduction

Figures 1 and 2 show, respectively, the starting angle and angular width of the slit blocks as a function of radial position. For the odd numbered baffles (numbered starting at 1) the widths vary linearly with radial position up to a certain radius (which differs for each baffle), beyond which the dependence is still linear but with a different slope. The same is true, though more subtly, for the starting angles; the intersection point of the two lines is evidently the same in each baffle as for the angular widths. The even numbered baffles were constructed by interpolation between odd numbered baffles, so they do not show the same two-line behavior. Fits to lines above and below the intersection points are shown for the odd numbered baffles.

The slits for the odd baffles then can be described by 7 numbers — for the starting angles, 2 slopes, 2 intercepts, and an intersection radius, with the constraint that the lines cross at the intersection radius; equivalently, 2 slopes ($m^0_{\phi^0}$ and $m^1_{\phi^0}$), an intersection radius (r_{int}), and the value of the starting angle at the intersection radius (ϕ^0_{int}) — and the same for the widths, but with the intersection radius the same ($m^0_{\Delta\phi}$, $m^1_{\Delta\phi}$, and $\Delta\phi_{int}$). The even baffles can be obtained by interpolation. This reduces the 880 slit parameters to $7 \times 6 = 42$.

Figure 3 shows the z_c dependences of these 7 quantities. For the slopes, the inverse is plotted. ϕ_i, $1/m^0_{\phi^0}$, $1/m^1_{\phi^0}$, and $1/m^1_{\Delta\phi}$ are independent of z_c or nearly so, but for flexibility I will not require this. The only plot that seems to need a fit to anything other than a line is $1/m^0_{\Delta\phi}$, which I have fit with a quadratic. With these fits the 42 slit parameters are further reduced to 15.

Turning now to the 66 baffle parameters, again the 30 even baffle parameters are interpolated from the 36 for the odd baffles. The z_c positions are evenly spaced, so these 6 baffle parameters can be replaced by 2 system parameters: The z coordinate of the center of the baffle system (z^0_c) and a spacing (Δz_c). The quantities $r_{in/in}$, $\Delta r_{in} \equiv r_{in/out} - r_{in/in}$, $\Delta r_{out} \equiv r_{out/out} - r_{out/in}$, $r_{out/out}$, and $\delta\phi$ are shown as functions of z_c with linear fits in figure 4. Deviations from linearity are especially evident for Δr_{in} and Δr_{out}. Less apparent to the eye but still significant are deviations in $r_{in/in}$, the inner radius of the inner ring: This ring has been thinned relative to the others (down to almost nothing). While the $r_{out/out}$ fit is good, it should be noted there is a constraint here which the fit might not respect: the largest radius must fit within the solenoid. Altogether, trying to reduce these final 30 parameters to a set of slopes and intercepts is problematic. It may be feasible, even preferable, to design baffles whose radii and ϕ offsets (mostly) vary linearly with z_c, but the More1 baffles cannot adequately be modeled this way. I therefore leave these as 30 separate parameters.

4. Conclusion

With these parameterizations, to a good degree of accuracy the More1 baffle geometry can be described by 6 system parameters, 30 baffle parameters, and 15 slit parameters, for a total of 51 instead of the current 950. Values are given in Tables 1 – 3.

Table 1. System parameters

Symbol	**Name**	**Value**	**Units**	**Remarks**
n_{plate}	Nplate	11	–	Number of baffles
Δz	Dz	4.5	–	Half thickness of each
n_{slit}	Nslit	30	–	Number of slits per baffle
n_{block}	Nblock	20	–	Number of radial layers per slit
z_c^0	zc0	110.0	cm	z coordinate of center of baffle system
Δz_c	Dzc	14.0	cm	Spacing between baffles

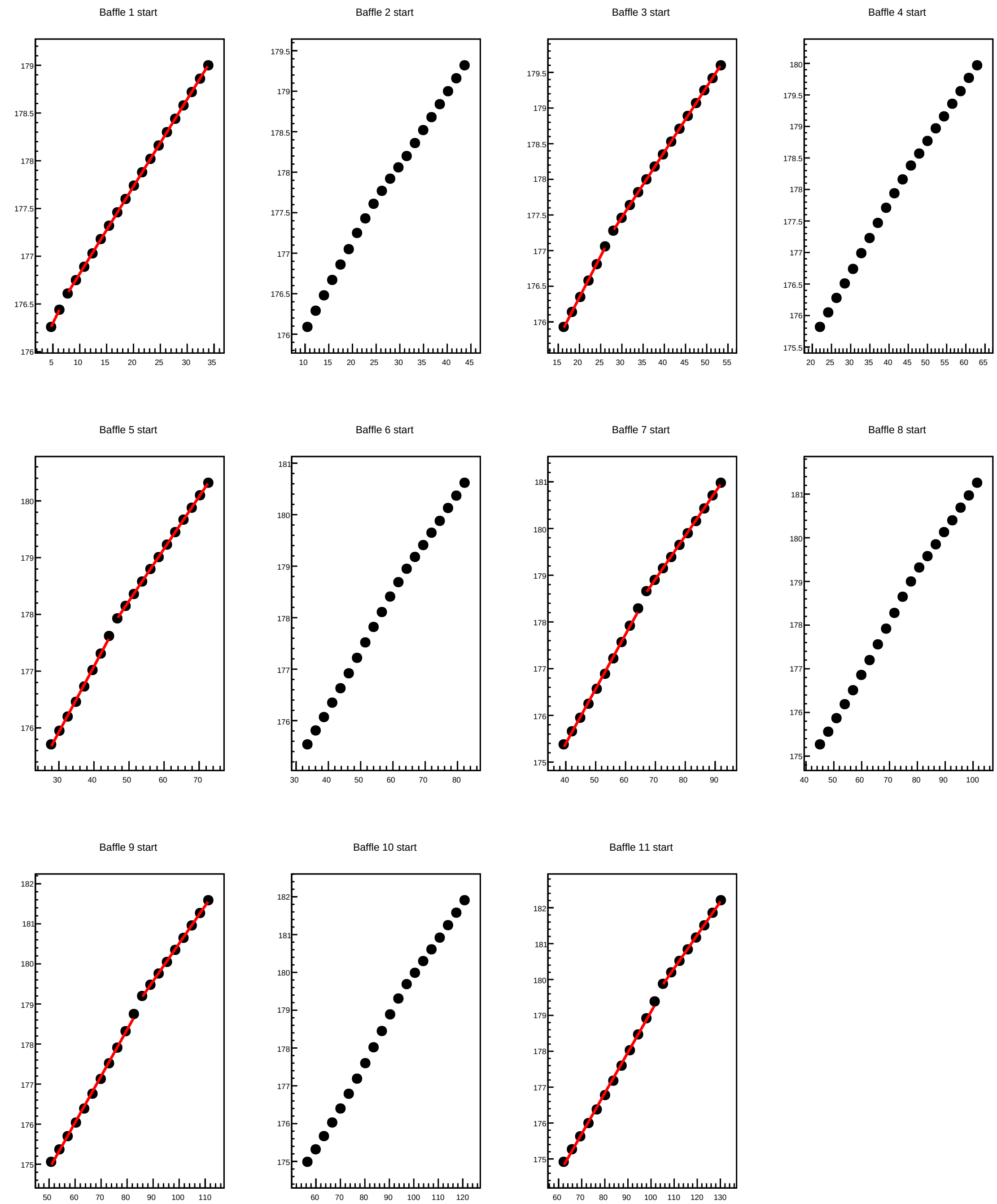

FIGURE 1. **(Dots) baffle starting angles vs. radial position; (lines) fits to two straight lines, one above and one below an intersection radius, for odd numbered baffles.**

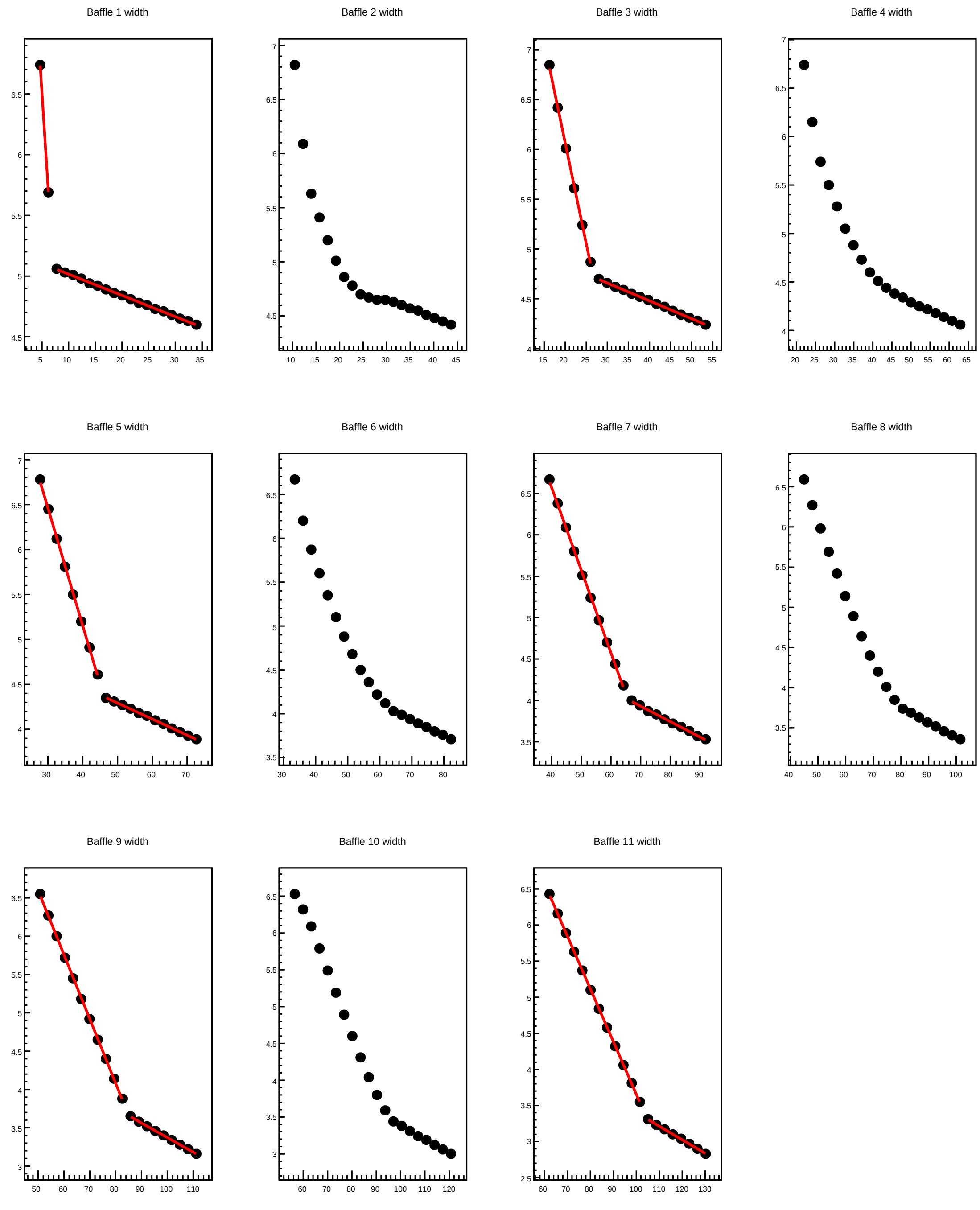

FIGURE 2. **(Dots) baffle angular widths vs. radial position; (lines) fits to two straight lines, one above and one below an intersection radius, for odd numbered baffles.**

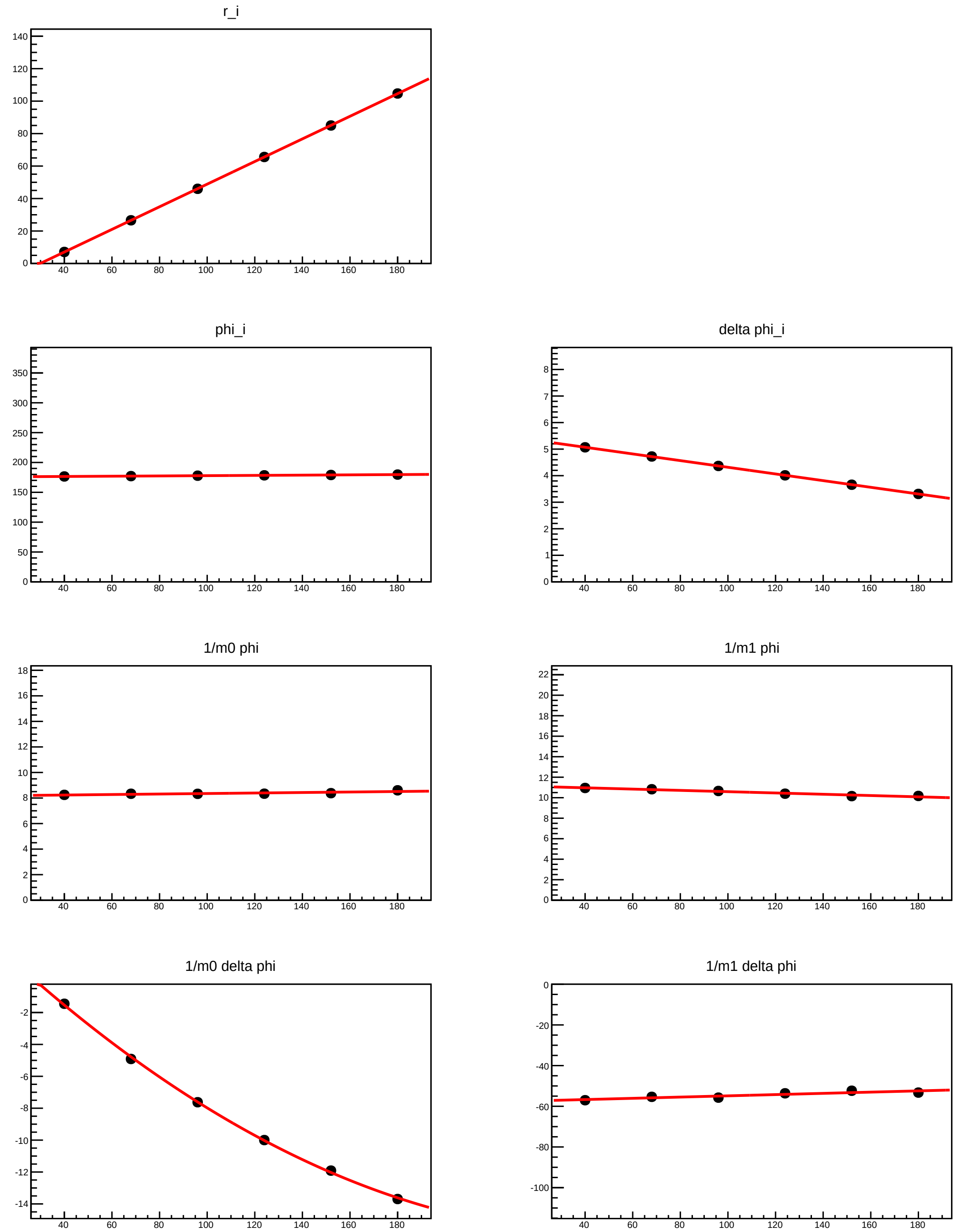

FIGURE 3. **(Dots) baffle slit parameters (r_i, ϕ_i, $\Delta\phi_i$, $1/m^0_\phi$, $1/m^1_\phi$, $1/m^0_{\Delta\phi}$, $1/m^1_{\Delta\phi}$) vs. z_c for odd numbered baffles; (lines) fits to straight lines or in the case of $1/m_0^{\Delta\phi}$ a quadratic.**

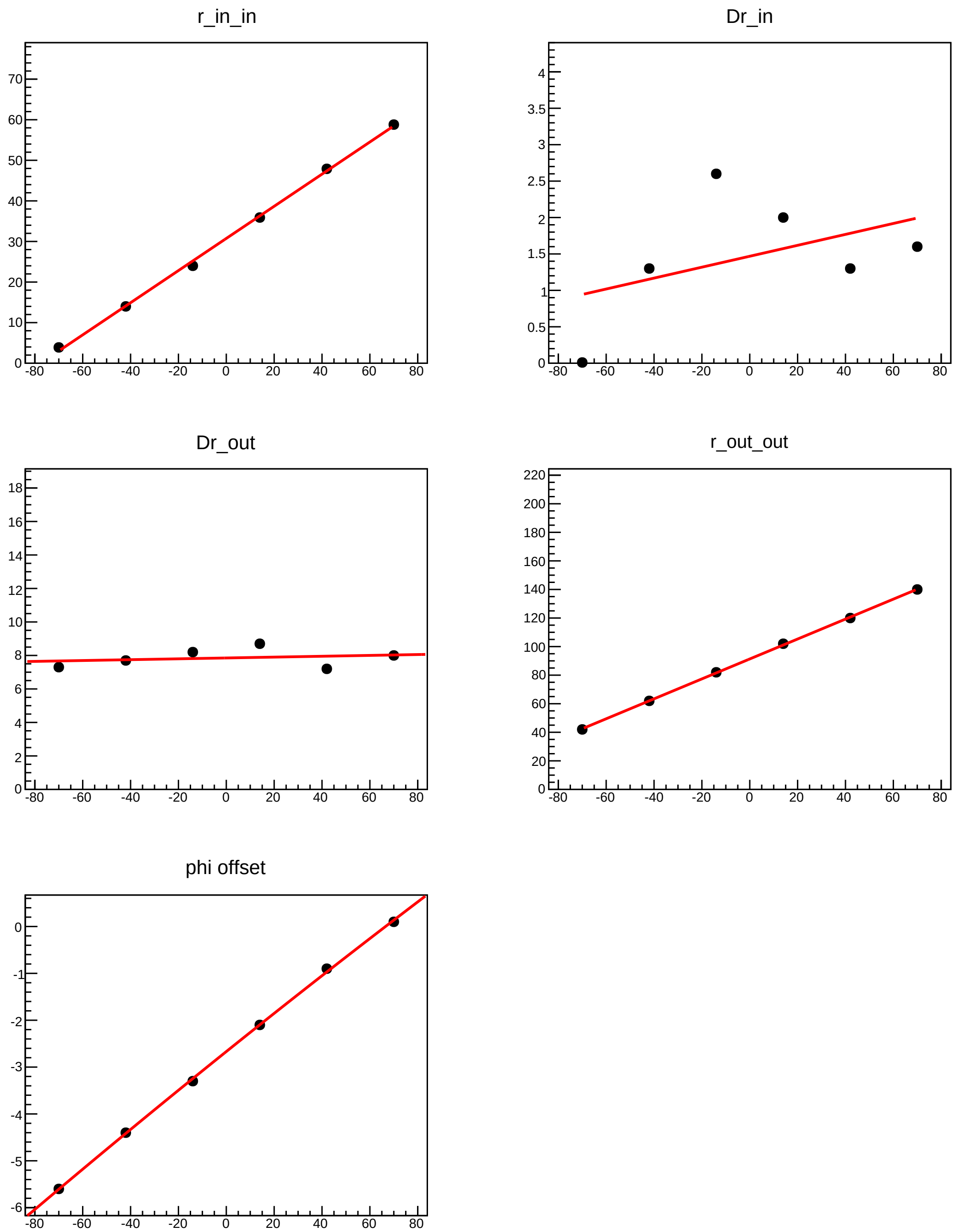

FIGURE 4. **(Dots) baffle parameters (r_{in}^{in}, Δr^{in}, Δr^{out}, r_{out}^{out}, $\delta\phi$) vs. z_c for odd numbered baffles; (lines) fits to straight lines. For r_{in}^{in} and Δr^{in} the first baffle is omitted from the fit, as is the last baffle for r_{out}^{out}.**

Table 2. Baffle parameters

Symbol	**Name**	**Value**	**Units**	**Remarks**
$r_{in/in}$	rinin1	3.89	cm	Inner radius of inner ring
	rinin3	14	”	”
	rinin5	24	”	”
	rinin7	35.9	”	”
	rinin9	47.9	”	”
	rinin11	58.8	”	”
$r_{in/out}$	rinout1	3.9	cm	Outer radius of inner ring
	rinout3	15.3	”	”
	rinout5	26.6	”	”
	rinout7	37.9	”	”
	rinout9	49.2	”	”
	rinout11	60.4	”	”
$r_{out/in}$	routin1	34.7	cm	Inner radius of outer ring
	routin3	54.3	”	”
	routin5	73.8	”	”
	routin7	93.3	”	”
	routin9	112.8	”	”
	routin11	132	”	”
$r_{out/in}$	routout1	42	cm	Outer radius of outer ring
	routout3	62	”	”
	routout5	82	”	”
	routout7	102	”	”
	routout9	120	”	”
	routout11	140	”	”
$\delta\phi$	offset1	-5.6	rad	ϕ offset of first slit
	offset3	-4.4	”	”
	offset5	-3.3	”	”
	offset7	-2.1	”	”
	offset9	-0.9	”	”
	offset11	0.1	”	”

TABLE 3. Slit parameters

Symbol	**Name**	**Value**	**Units**	**Remarks**
$c_0[r_{int}]$	c0_rint	55.83	cm	Parameters for r_{int} linear fit
$c_1[r_{int}]$	c1_rint	0.6967	–	”
$c_0[\phi^0_{int}]$	c0_phiint	178.1	rad	Parameters for ϕ^0_{int} linear fit
$c_1[\phi^0_{int}]$	c1_phiint	0.02252	rad/cm	”
$c_0[\Delta\phi_{int}]$	c0_Dphiint	4.19	rad	Parameters for $\Delta\phi_{int}$ linear fit
$c_1[\Delta\phi_{int}]$	c1_Dphiint	-0.01257	rad/cm	”
$c_0[1/m^0_{\phi^0}]$	c0_im0phi	8.372	cm/rad	Parameters for $1/m^0_{\phi^0}$ linear fit
$c_1[1/m^0_{\phi^0}]$	c1_im0phi	0.001967	1/rad	”
$c_0[1/m^1_{\phi^0}]$	c0_im1phi	10.53	cm/rad	Parameters for $1/m^1_{\phi^0}$ linear fit
$c_1[1/m^1_{\phi^0}]$	c1_im1phi	-0.006294	1/rad	”
$c_0[1/m^0_{\Delta\phi}]$	c0_im0Dphi	-8.868	cm/rad	Parameters for $1/m^0_{\Delta\phi}$ quadratic fit
$c_1[1/m^0_{\Delta\phi}]$	c1_im0Dphi	-0.08631	1/rad	”
$c_2[1/m^0_{\Delta\phi}]$	c2_im0Dphi	0.0002641	1/(rad cm)	”
$c_0[1/m^1_{\Delta\phi}]$	c0_im1Dphi	-54.56	cm/rad	Parameters for $1/m^1_{\Delta\phi}$ linear fit
$c_1[1/m^1_{\Delta\phi}]$	c1_im1Dphi	0.03047	1/rad	”