Deuteron Polarimetry

With the stable spin axis in COSY oriented along y and assuming parity conservation, the count rate for a given polarization state p at some time interval t of the COSY cycle is

$$\begin{aligned} N(\theta,\phi,p,t) \quad = \quad & L(p,t)\sigma(\theta)\epsilon(\theta,\phi) \\ & (1+\tfrac{3}{2}p_Z(p,t)A_y(\theta)\cos\phi \\ & -\tfrac{1}{4}p_{ZZ}(p,t)A_{xx-yy}(\theta)\cos 2\phi \\ & -\tfrac{1}{4}p_{ZZ}(p,t)A_{zz}(\theta)\ ) \end{aligned} \tag{1}$$

with

p_Z	:	vector polarization
p_ZZ	:	tensor polarization
σ	:	unpolarized cross section
A_y	:	vector analyzing power
A_{xx-yy}, A_{zz}	:	tensor analyzing powers
$\epsilon(\theta,\phi)$	:	detector efficiency
$L(p,t)$	:	luminosity

The indices are:

p = 1,2,3,4,5	:	for polarization states, e.g. $(p_Z, p_ZZ) = (0,0), (1,1), (-1,1), (0,1), (0,-2)$
t = 0,1	:	time interval prior (0) and after spinflip (1)

Strategy

1. Take large data sample (1 shift?) with polarized deuteron beam. Fix polarizations for 2-3 polarization states (information from source needed!!)
   Wit a χ^2-Fit $\Rightarrow$ determine analyzing powers
   $\Rightarrow$ determine efficiencies

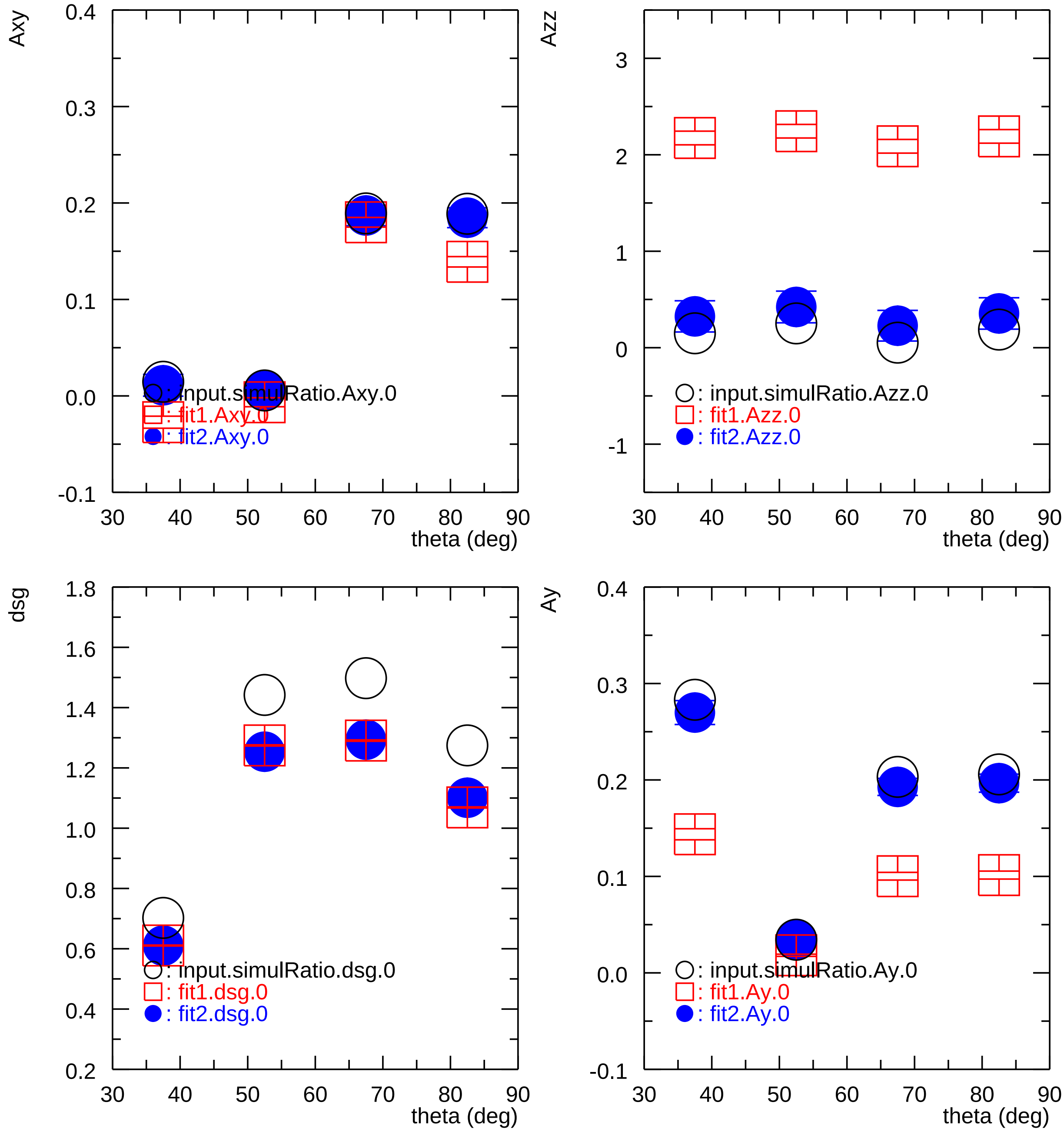
2. For polarization measurements: use these analyzing powers and efficiencies and determine polarizations.

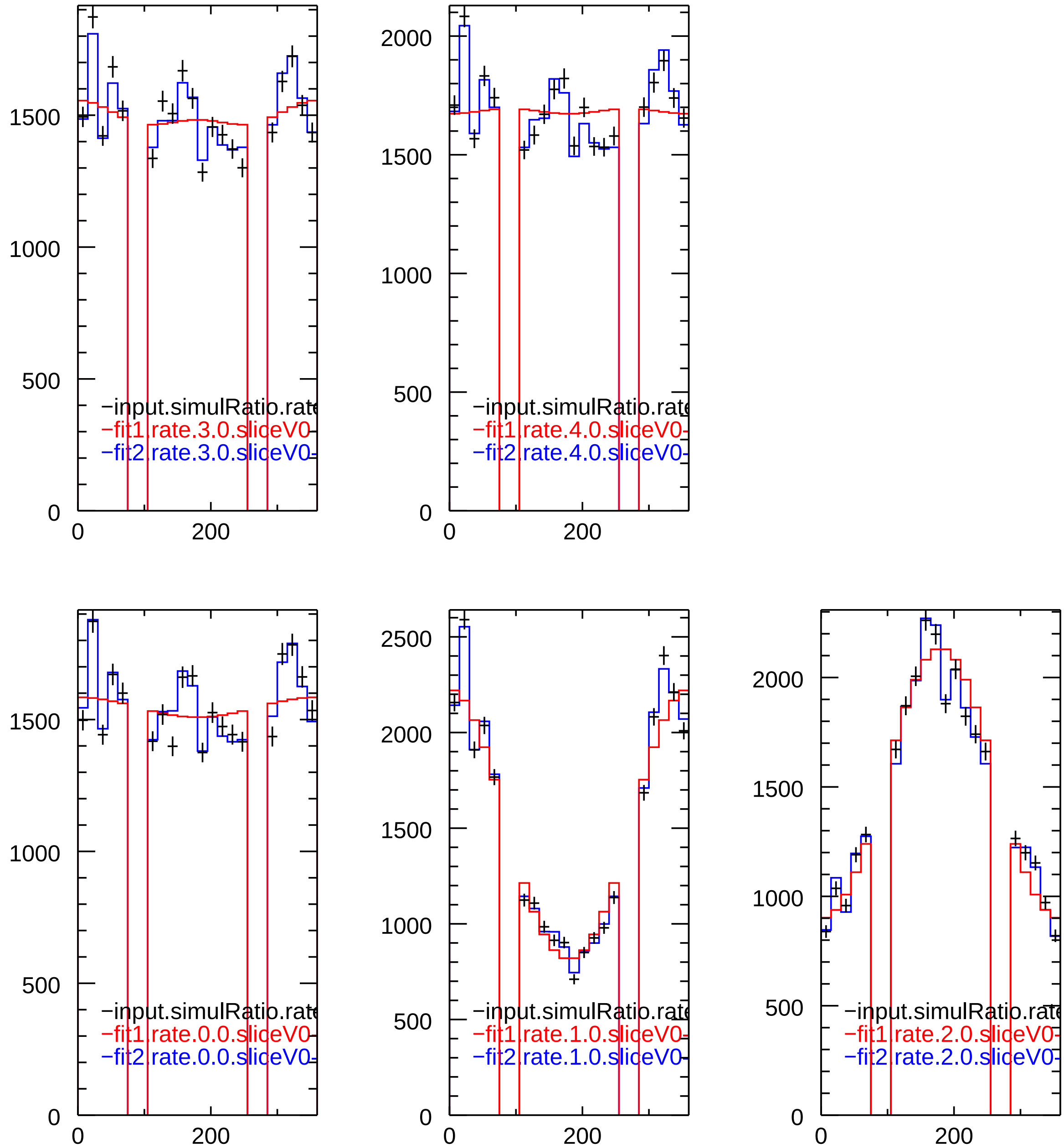
   In a χ^2-fit we can use

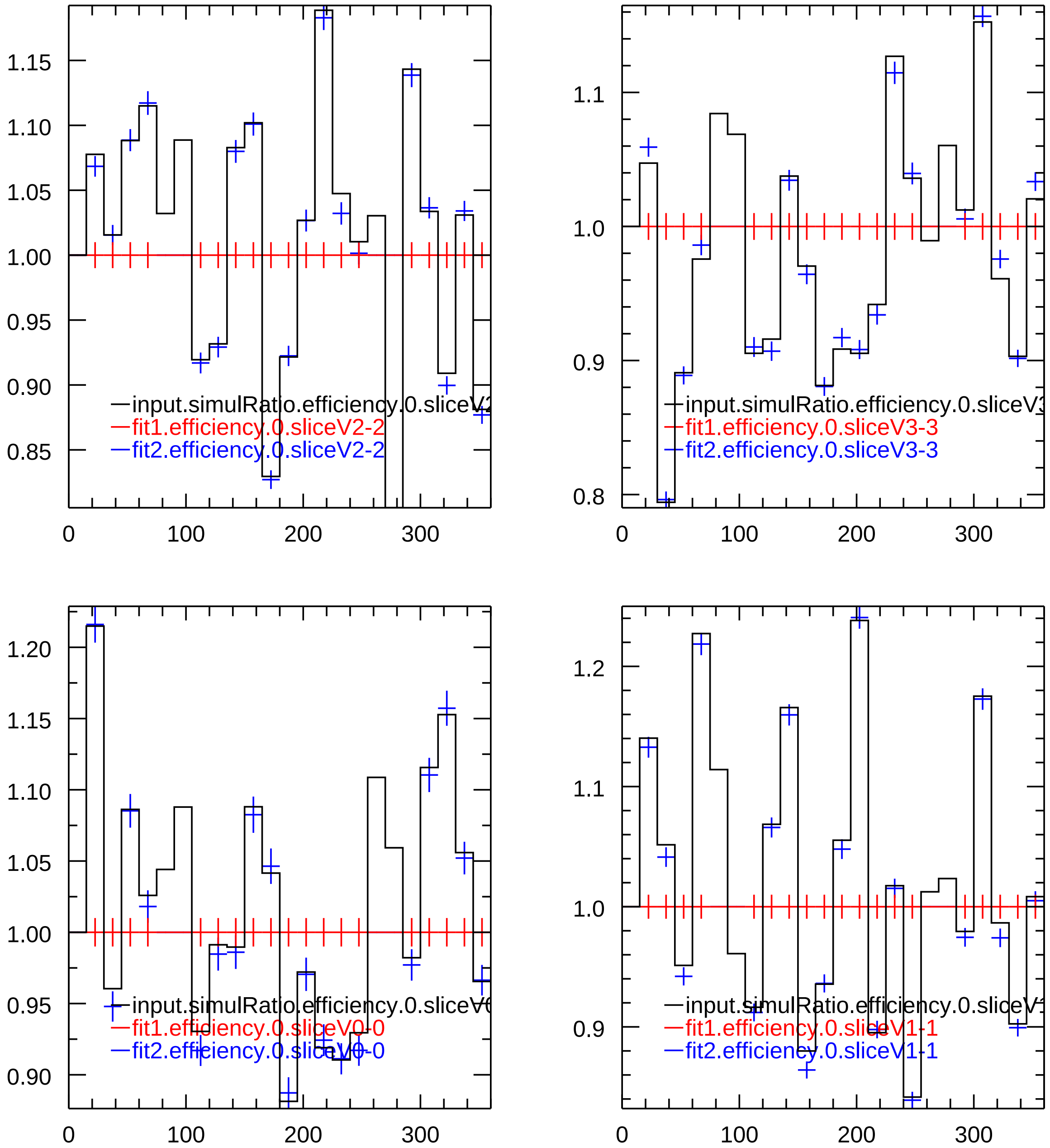
   $$p_Z(p,1) = R_V\, p_Z(p,0) \quad ; \quad p_{ZZ}(p,1) = R_T\, p_{ZZ}(p,0)$$

   and determine R_V and R_T directly.

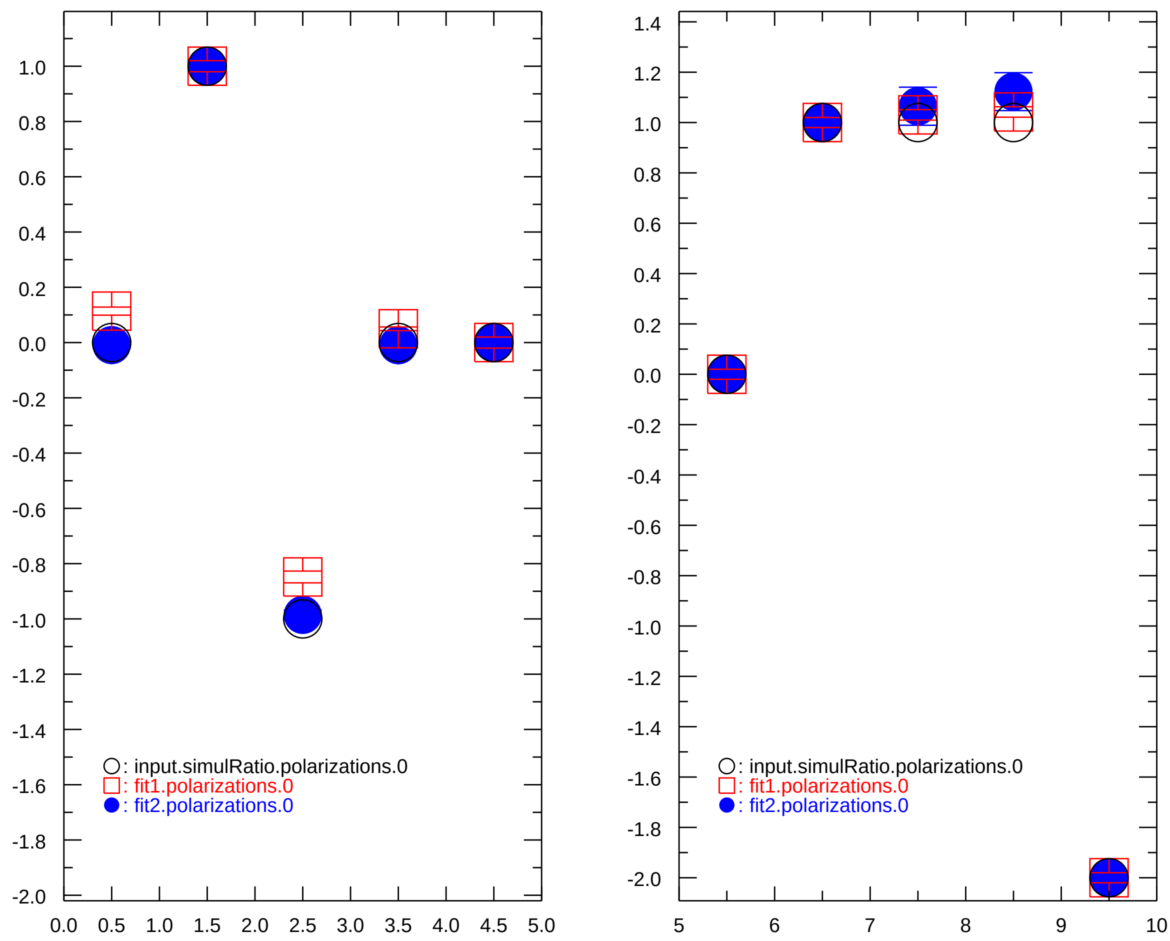
Example: with N = 2M Events, and $A_i \approx 0.15 \pm 0.15$ and $\epsilon = 0.9 \ldots 1.1$ one can obtain $R_V(R_T)$ to a precision of 0.01 (0.02)


Axy
0.4
0.3
0.2
0.1
0.0
-0.1
30 40 50 60 70 80 90
theta (deg)
: input.simulRatio.Axy.0
: fit1.Axy.0
: fit2.Axy.0
Azz
3
2
1
0
-1
30 40 50 60 70 80 90
theta (deg)
: input.simulRatio.Azz.0
: fit1.Azz.0
: fit2.Azz.0
dsg
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
30 40 50 60 70 80 90
theta (deg)
: input.simulRatio.dsg.0
: fit1.dsg.0
: fit2.dsg.0
Ay
0.4
0.3
0.2
0.1
0.0
-0.1
30 40 50 60 70 80 90
theta (deg)
: input.simulRatio.Ay.0
: fit1.Ay.0
: fit2.Ay.0


−input.simulRatio.rate
−fit1 rate.3.0.sliceV0-
−fit2 rate.3.0.sliceV0-
−input.simulRatio.rate
−fit1 rate.4.0.sliceV0-
−fit2 rate.4.0.sliceV0-
−input.simulRatio.rate
−fit1 rate.0.0.sliceV0-
−fit2 rate.0.0.sliceV0-
−input.simulRatio.rate
−fit1 rate.1.0.sliceV0-
−fit2 rate.1.0.sliceV0-
−input.simulRatio.rate
−fit1 rate.2.0.sliceV0-
−fit2 rate.2.0.sliceV0-
0
200
500
1000
1500
2000
2500



input.simulRatio.efficiency.0.sliceV2
fit1.efficiency.0.sliceV2-2
fit2.efficiency.0.sliceV2-2
input.simulRatio.efficiency.0.sliceV3
fit1.efficiency.0.sliceV3-3
fit2.efficiency.0.sliceV3-3
input.simulRatio.efficiency.0.sliceV0
fit1.efficiency.0.sliceV0-0
fit2.efficiency.0.sliceV0-0
input.simulRatio.efficiency.0.sliceV1
fit1.efficiency.0.sliceV1-1
fit2.efficiency.0.sliceV1-1


○: input.simulRatio.polarizations.0
□: fit1.polarizations.0
●: fit2.polarizations.0
○: input.simulRatio.polarizations.0
□: fit1.polarizations.0
●: fit2.polarizations.0

Rate Considerations

EDDA DAQ rate: $\approx 1kHz$. For measurements with the fiber-target the duty cycle is of the order 10-20%.

$\Rightarrow$: $\approx$ 500k Events/hour on tape $\Rightarrow$: $>$ 50k Events/hour in the online display

Items for the Run Plan

- Choose lower energy?
  e.g. p = 2000MeV/c (T = 866.27 MeV)
  $\Rightarrow \beta = 0.7294, \gamma = 1.4618, \gamma G = -0.2085, f_c = 1.1895$ MHz, $f_R = 0.9415$ MHz
  Note: especially tensor analyzing powers may be larger!
- Allocate time to take large sample of scattering data ($>$ 1shift) with 5 different polarization states.
- After that we need some time for data replay, to find out what are effcient cuts on the data to select events classes with sizeable analyzing powers. This will possibly result in changes for the trigger.