The $\mathbf{E} \times \mathbf{B}$ -Effect and its correction.

- The effect
- The first order Taylor expansion
- Comparison of the results
- Impact on the $p_\perp$ resolution

he effect is well known and reads most
uitively if written as follows:

$$= \frac{e}{m}\tau E \frac{1}{1+(\omega\tau)^2}\left(\hat{\mathbf{E}} + \omega\tau[\hat{\mathbf{E}} \times \hat{\mathbf{B}}] + (\omega\tau)^2(\hat{\mathbf{E}} \cdot \hat{\mathbf{B}})\hat{\mathbf{B}}\right)$$

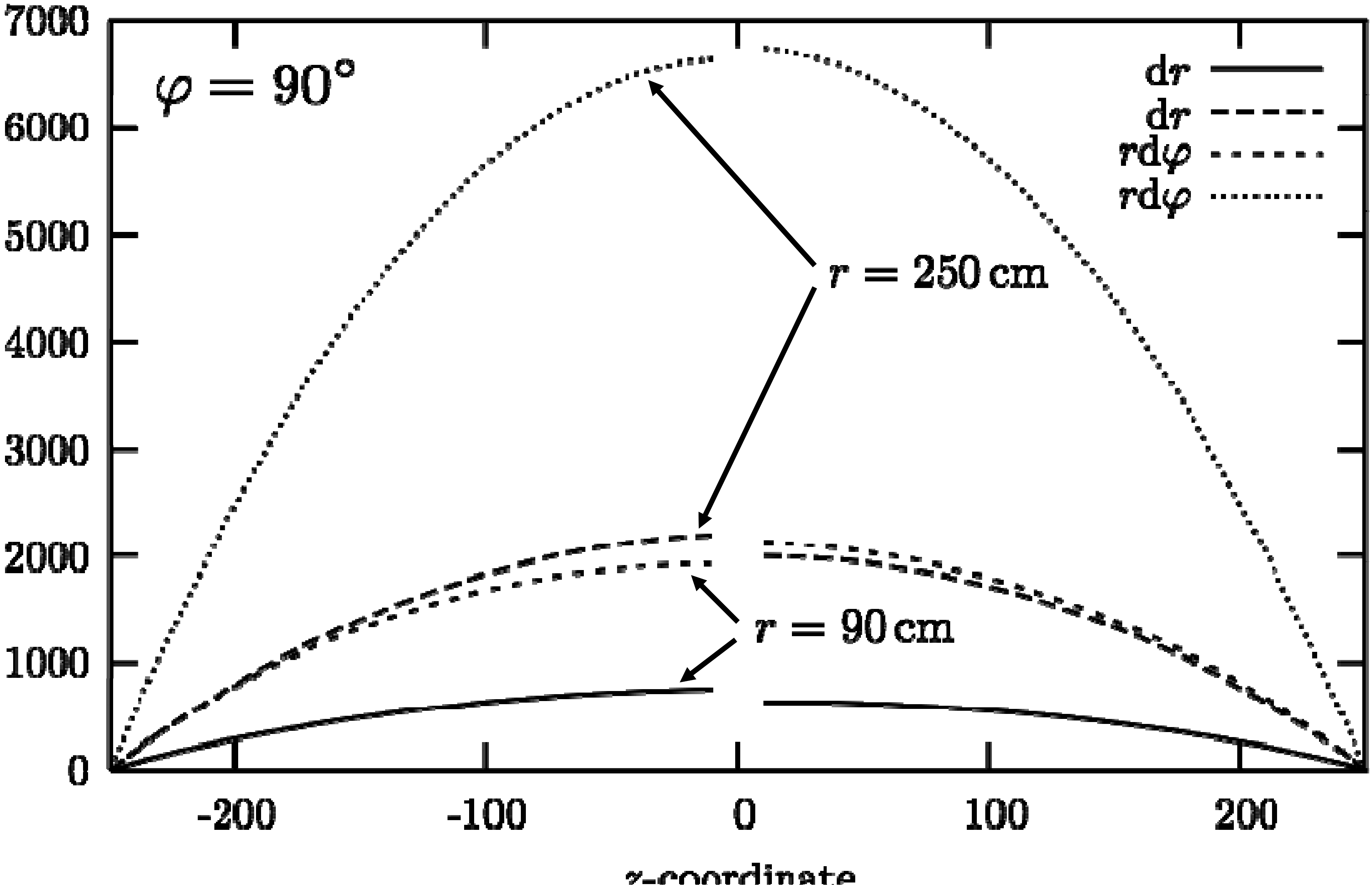
g a charged particle drifting in a gas volume accommodating an electromagnetic field
by $\mathbf{E}$ and $\mathbf{B}$) yields to equation of motion as follows:

$$m\frac{\mathrm{d}\mathbf{u}}{\mathrm{d}t} = e\left(\mathbf{E} + \mathbf{u} \times \mathbf{B}\right) - K\mathbf{u} \quad . \tag{1}$$

art is the Lorentz force whereas the second is due to the friction the particle perceives
which can be modelled as Stoke's friction [7].
escales where this motion becomes quasi-stationary, i. e. $\frac{\mathrm{d}\mathbf{u}}{\mathrm{d}t} \approx 0$, one obtains for the
locity:

$$\mathbf{u} = \frac{e}{m}\tau E \frac{1}{1+(\omega\tau)^2}\left(\hat{\mathbf{E}} + \omega\tau[\hat{\mathbf{E}} \times \hat{\mathbf{B}}] + (\omega\tau)^2(\hat{\mathbf{E}} \cdot \hat{\mathbf{B}})\hat{\mathbf{B}}\right) \quad , \tag{2}$$

sees from where the name of the effect originates. This is the first approximation.



7000
6000
5000
4000
3000
2000
1000
0
-200
-100
0
100
200
$\varphi = 90^\circ$
$\mathrm{d}r$
$\mathrm{d}r$
$r\mathrm{d}\varphi$
$r\mathrm{d}\varphi$
$r = 250\,\mathrm{cm}$
$r = 90\,\mathrm{cm}$
z-coordinate

aylor expansion leads to:

$$B_x, \Delta B_y, B_z + \Delta B_z) = \frac{\mu E_z}{1+(\omega\tau)^2} \begin{pmatrix} \omega\tau\mu\Delta B_x - \mu\Delta B_y \\ \omega\tau\mu\Delta B_y + \mu\Delta B_x \\ 1+(\omega\tau)^2 \end{pmatrix} + \mathcal{O}(\Delta B_i \Delta$$

e Alice TPC omega-tau at 0.5T ~ 0.33

e typical Bx/Bz ratio ~+-0.02

e dominant correction part follow ExB vector

ping all the integration, with the additional
proximation:

$\approx \int_{r_{z,0}}^{Z_{end}}$ one ends up with formula (where drz
full drift length)

$$\Delta r_x = \frac{\Delta r_z}{1+(\omega\tau)^2}\left(\omega\tau\mu\overline{B}_x - \mu\overline{B}_y\right)$$

$$\Delta r_y = \frac{\Delta r_z}{1+(\omega\tau)^2}\left(\omega\tau\mu\overline{B}_y + \mu\overline{B}_x\right)$$

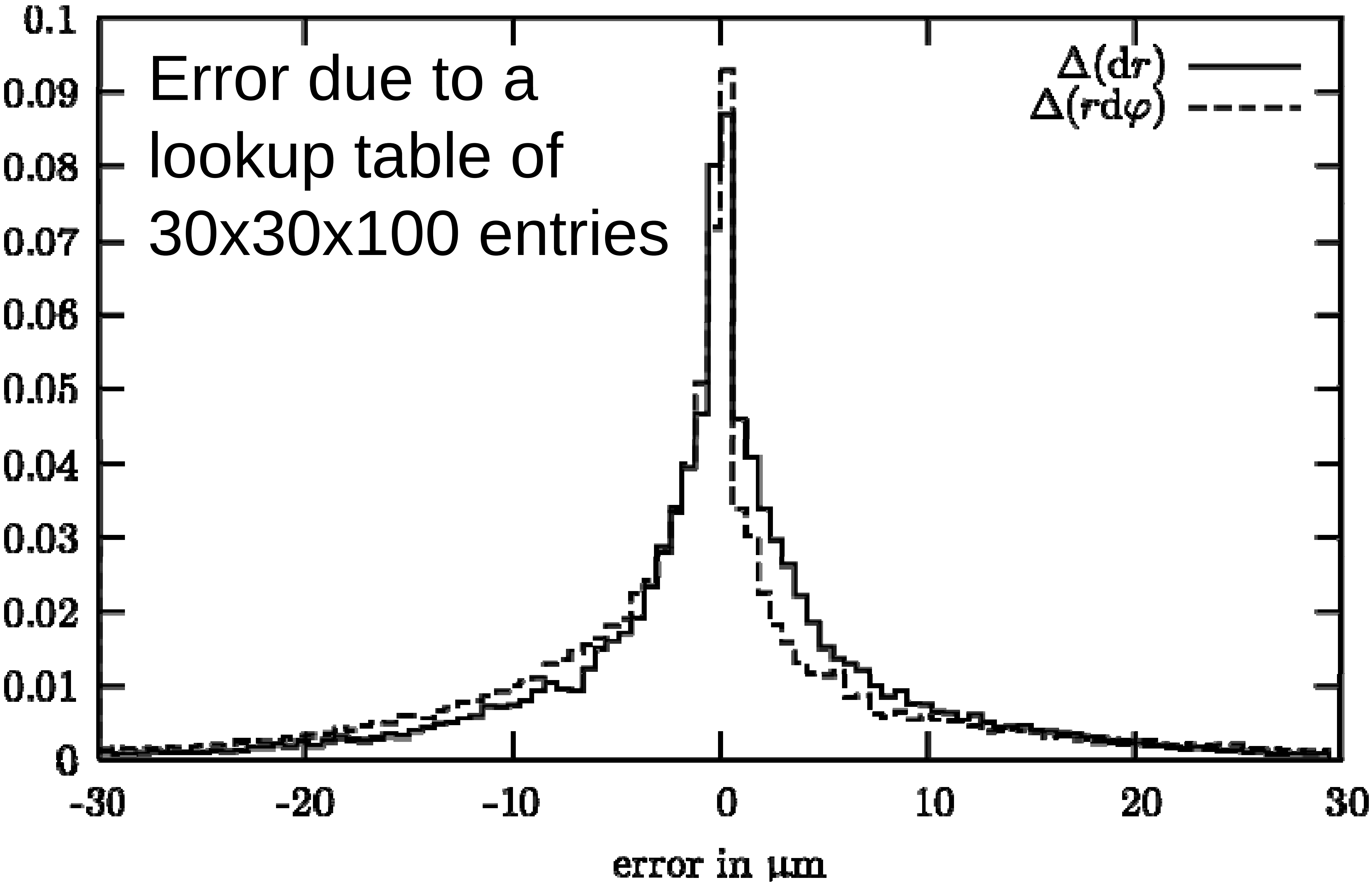
$$r_x = \frac{\Delta r_z}{1+(\omega\tau)^2}\left(\omega\tau\mu\overline{B}_x - \mu\overline{B}_y\right)$$

$$r_y = \frac{\Delta r_z}{1+(\omega\tau)^2}\left(\omega\tau\mu\overline{B}_y + \mu\overline{B}_x\right)$$

e $\overline{B}_{x,y}$ denote the mean magnetic field
mponent, over drift length. Current
plementation – the numerical integrals are
culated, and stored in the Lookup table.
ng measured field map, possible (to be
plemented) to use directly integrals of
ebyshev polynoms

Two different implementations:

- “AliTPCExBExact”
  - Solves the DGL numerically (slow)
  - Uses an lookup table
- “AliTPCExBFirst”
  - Uses the first order formula
  - Speed up by pre-computation of the integrals


Error due to a lookup table of 30x30x100 entries
Δ(dr)
Δ(rdφ)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
-30
-20
-10
0
10
20
30
error in µm

```
PCExB:public TObject {

liTPCExB() {};
id Correct(const Double_t *position,Double_t *corrected)=0;
id CorrectInverse(const Double_t *position,Double_t *corrected)
AliTPCExB,0)
```

```
PCTransform:public AliTransform {

ransform();
AliTPCTransform();
oid Transform(Double_t *x,Int_t *i,UInt_t time,
                    Int_t coordinateType);
(AliTPCTransform,1)
```

```
void
AliTPCTransform::Transform(Double_t
*x,Int_t *i,UInt_t time,
                          Int_t coordinateType
  // input: x[0] - pad
  //        x[1] - pad row
  //        x[2] - time in us
  //        i[0] - sector
  // output: x[0] - x (all in the rotated global
coordinate frame)
  //        x[1] - y
  //        x[2] - z
  Int_t row=TMath::Nint(x[1]);
  Int_t pad=TMath::Nint(x[0]);
  Int_t sector=i[0];
  AliTPCcalibDB* const
calib=AliTPCcalibDB::Instance();
  Double_t xx[3];
```

The precision of the B measurement ~10 Gauss (on 5 Gauss) – possible B field rotation +5 Gauss in absolute value (not so important for ExB correction)

The E field (field cage) supposed to be aligned in respect with the main component of B field

The omega tau

The precision of the lookup tables can be verified with lasers in scan with different B-fields

- The unknown rotation angle and omega-tau can be fitted. (The algorithm not yet tested).

- The exact calculation can be used together with a lookup table.
- The first order approximation gives comparable results==>
  - Possible to use analytical integrals of polynoms==>
    - Possible to fit unknown parameters (rotation angle and omega-tau)