NEWS ON POSITRON CONVERSION CODE

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Interactive Code for positron conversion

Undulator → target → focusing → post acceleration

Written in 1986-1987; restored in 2007

PROGRAM KONN

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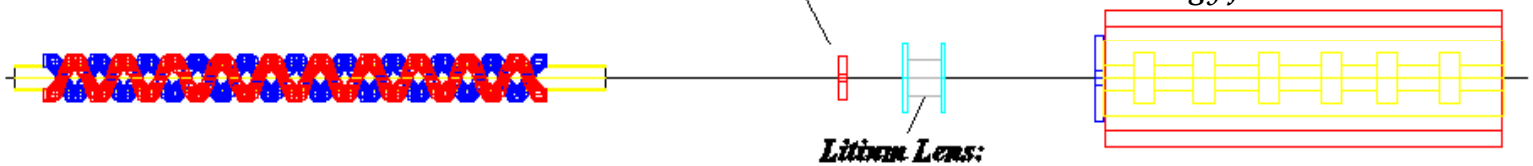
Monte-Carlo simulation of positron conversion

Energy of the beam;
Length of undulator;
Undulator period M=L/λ_u;
K-factor;
Emittance;
Beta-function;
Number of harmonics (four);
Number of positrons to be generated;

Target:
Distance to the undulator
Thickess;
Diameter of target;
Material;
Diameter of hole at center;
Step of calculation

Acceleration:
Distance to the lens;
Length of structure;
Gradient;
Diameter of collimator at the entrance;
Diameter of irices;
External solenoidal field;
Further phase volume captured;

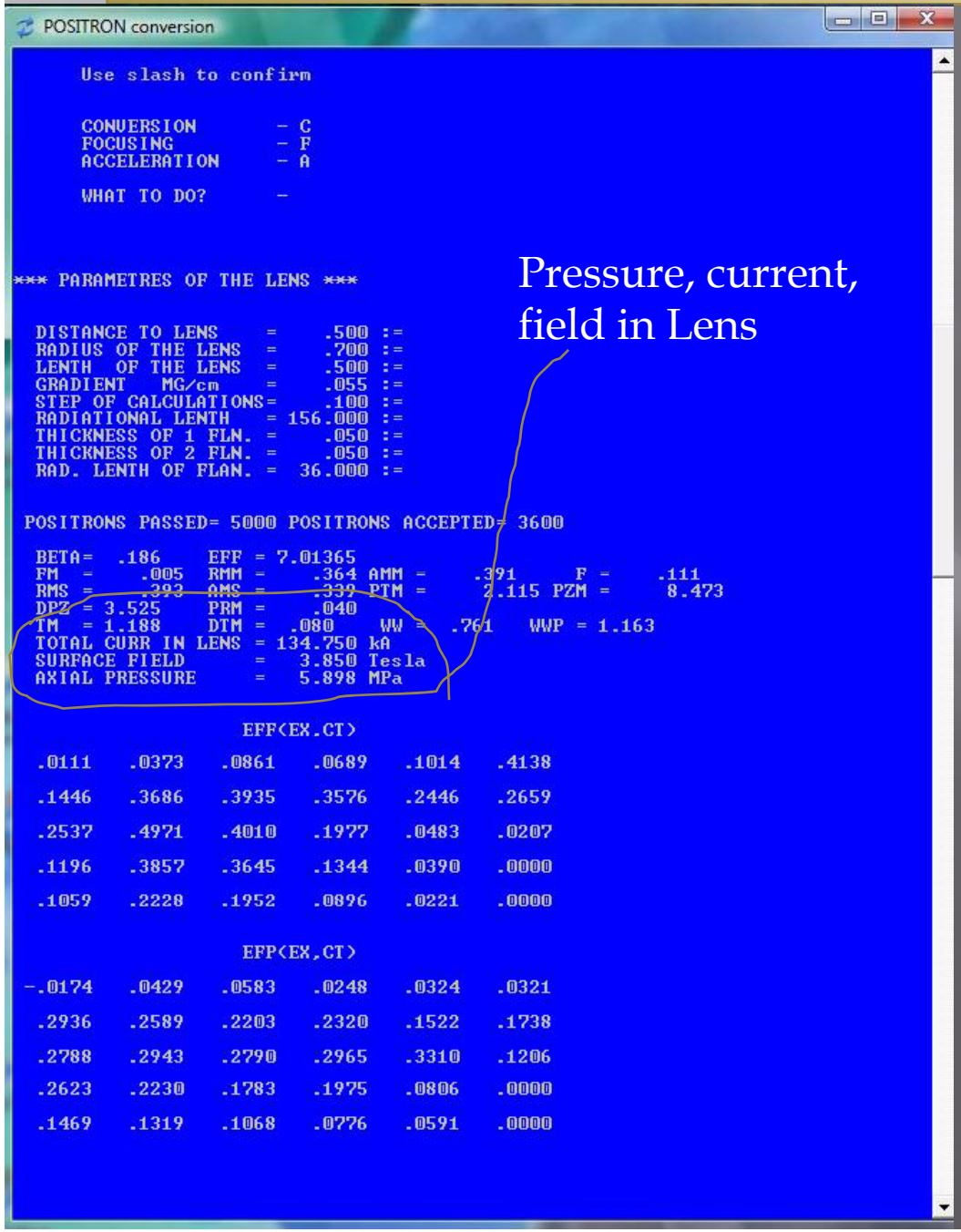
Energy filter



Litium Lens:
Distance to the target;
Length;
Diameter;
Thicness of flanges;
Material of flanges;
Gradient;
Step of calculations;

CALCULATES at every stage:
Efficiency in given phase volume;
Polarization in given phase volume;
Beam dimensions;
Phase-space distributions;
Beam lengthening;
Energy spread within phase space;

KONN at a glance



Pressure, current, field in Lens

- Particles described by 2D array (matrix). One parameter numerates particles, the other one numerates properties associated with each particle: energy, polarization, angles to axes; position
- Code has ~1500 rows;
- Possibility for the file exchange with statistical Code JMP;

Generation of parameters at radiation point

D7 is the distance between undulator and the target

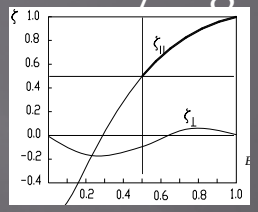
```
AK=K0
DSTN=AL0*DRAND(0)          ! AL0 IS THE LENGTH OF UNDULATOR
SSC=AL0/2.-DSTN            ! DISTANCE FROM CENTER OF UNDULATOR TO EVENT
BTA=BT+SSC**2/BT           ! BETA AT THE POINT OF EVENT, BT IS IN CROSSIVER
W7=D7+DSTN                  ! DISTANCE TO THE TARGET FROM EVENT
R=DSQRT(ABS(BTA*EPS*DRAND(0)))  !RADIAL POSITION OF ELECTRON
TETA=DSQRT(ABS(EPS/BT*DRAND(0)))! THIS ANGLE IS THE SAME; MODULE OF ANGLE
FI=PI*DRAND(0)                  ! AZIMUTHAL ANGLE
DR=W7*TETA
R=DSQRT(ABS(R*R+DR*DR-2.*R*DR*DCOS(FI)))
```

Position of photon at the target

Formulas of undulator radiation used for generation of probability of radiation and probability for polarization at the point of event

Polarization effects implemented in KONN

```
!   POLARIZATION CURVE APPROXIMATION
!                                   EP=POSITRON ENERGY/ Egamma-2mc2
      EP4=EP-0.4
      EP6=EP-0.6
      PP=0.305+2.15*EP4
      IF(EP.LT.0.4)PP=PP-0.05*EP4-2.5*EP4**3
      IF(EP.GT.0.6)PP=PP-0.55*EP6-2.65*EP6**2+0.7*EP6**3   ! PP=PP-0.55*EP6-2.6*EP6**2
      IF(PP.GT.1.)PP=1.                                    Sentinel
!
```



Depolarization occurs due to spin flip in act of radiation of quanta having energy $0 < \hbar\omega_\gamma \le E_1$ where E_1 stands for initial energy of positron. Depolarization after one single act

$$D = 1 - \left| \frac{d\sigma_{\gamma e}(\zeta_1,\zeta_1) - d\sigma_{\gamma e}(\zeta_1,-\zeta_1)}{d\sigma_{\gamma e}} \right| = \frac{\hbar^2\omega_\gamma^2 \cdot [1 - \frac{1}{3}\zeta_{1\parallel}^2]}{E_1^2 + E_2^2 - \frac{2}{3}E_1E_2}$$

Energy after radiation

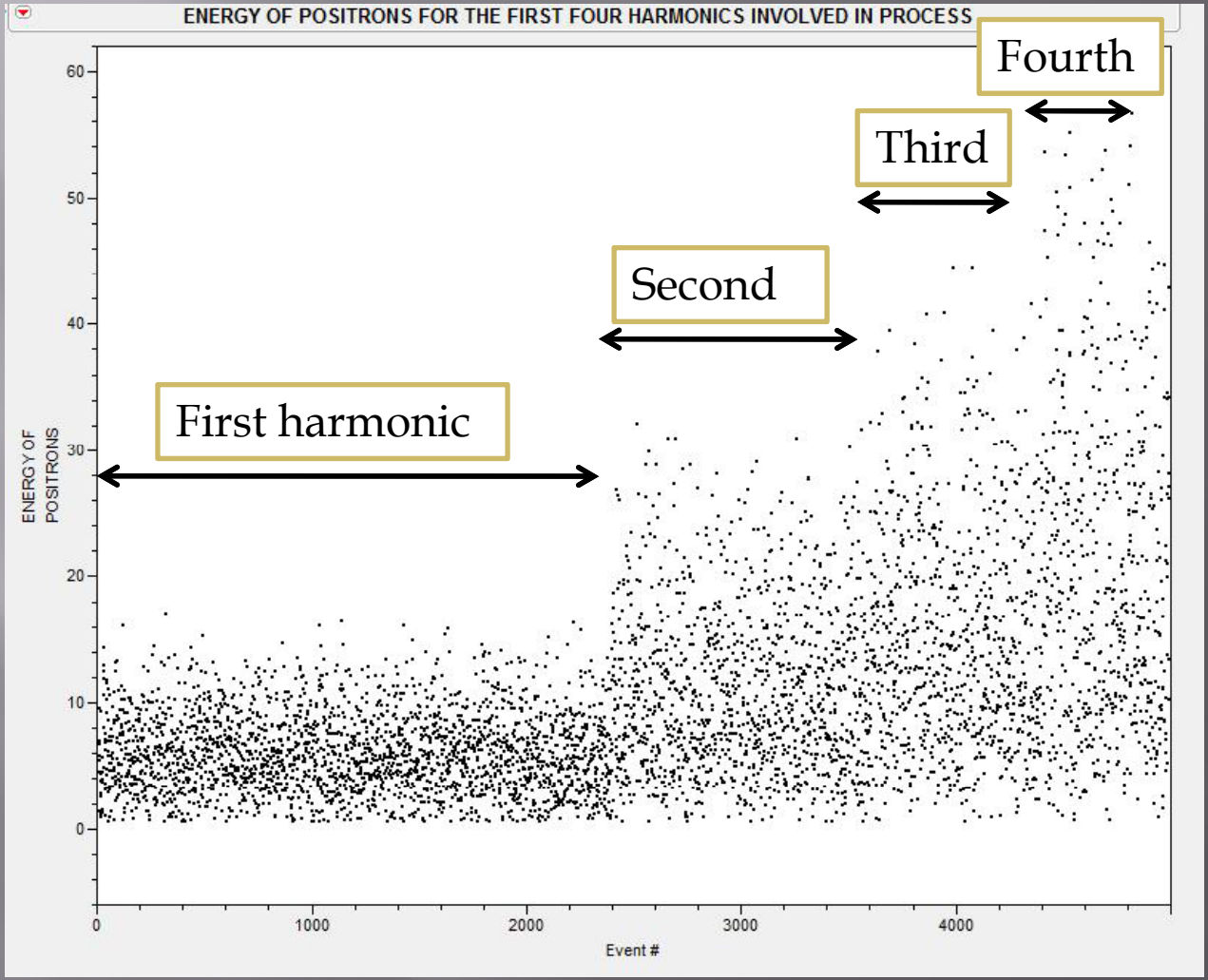
Where $d\sigma_{\gamma e}(\zeta_1,\zeta_1)$ stands for bremstrahlung cross section without spin flip, $d\sigma_{\gamma e}(\zeta_1,-\zeta_1)$ –the cross section with spin flip and $d\sigma_{\gamma e}$ is total cross section.

$$L_{dep} \cong \frac{1}{n\int D(\vec{p}_1,\zeta_1)d\sigma} \longrightarrow L_{dep} \cong \frac{2X_0}{1 - \frac{1}{3}\zeta_\parallel^2} \cong 3X_0$$

Rad. length

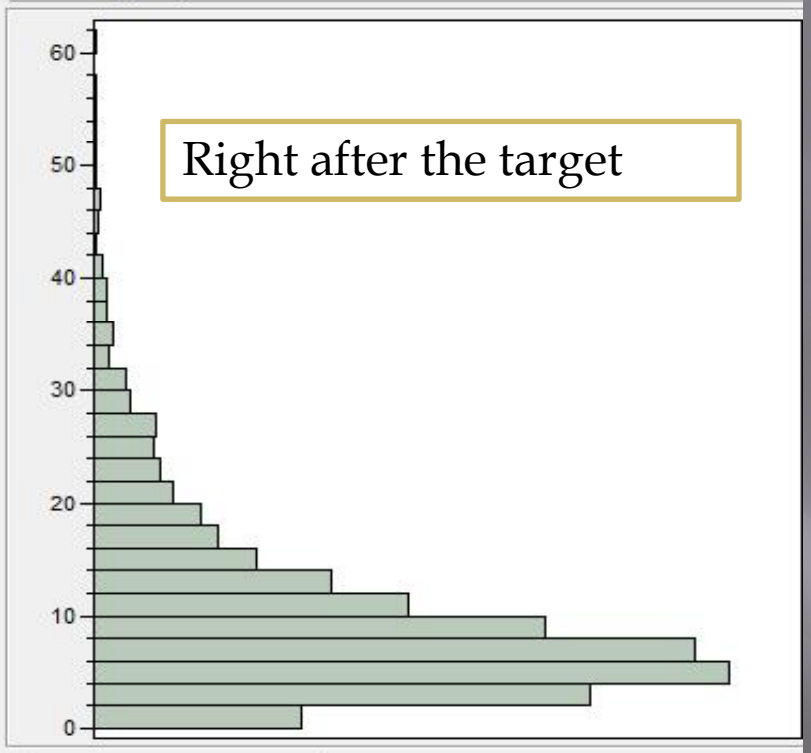
Depolarization in a target ~5%

It is possible now to operate with array of particles and theirs properties in JMP



Example: energy for each particle generated by 1-4th harmonics of Undulator

Energy of positrons



Right after the target

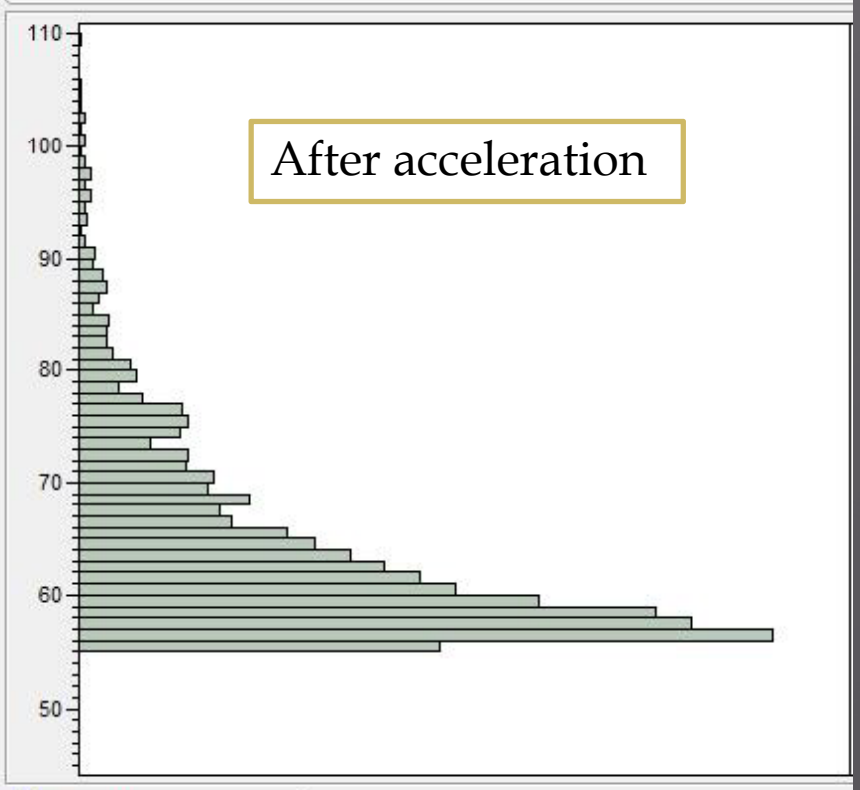
Quantiles

100.0%	maximum	60.683
99.5%		46.404
97.5%		32.906
90.0%		21.547
75.0%	quartile	12.992
50.0%	median	7.785
25.0%	quartile	4.747
10.0%		2.845
2.5%		1.141
0.5%		0.594
0.0%	minimum	0.512

Moments

Mean	10.286008
Std Dev	8.2902435
Std Err Mean	0.1172652
upper 95% Mean	10.5159
lower 95% Mean	10.056117
N	4998

ENERGY DISTRIBUTION AFTER 50 MeV ACCELERATION



After acceleration

Quantiles

100.0%	maximum	109.85
99.5%		98.90
97.5%		87.87
90.0%		76.23
75.0%	quartile	68.09
50.0%	median	61.24
25.0%	quartile	57.81
10.0%		56.36
2.5%		55.72
0.5%		55.56
0.0%	minimum	55.50

Moments

Mean	64.163305
Std Dev	8.6498982
Std Err Mean	0.16854
upper 95% Mean	64.49379
lower 95% Mean	63.832821

CONCLUSIONS

Code is under constant improvement;

Introduced file exchange between KONN and statistical code JMP7

Inserted quick evaluation of lens parameters such as current, pressure field at the surface;

Introduced energy filter at low and at high energy (right after the target and after acceleration);

Soon will be introduced solenoidal lens;