LISE++ : RESOLUT separator (update 02/28/13)

LISE++ version 9.4.90 *From 30.01.2013*

block "RF buncher" – link to v.9.4.24

Note: RF-buncher block is effective in MC mode

- Initial RESOLUT scheme
- Angular acceptance of the Solenoid block
- Calculated RESOLUT values for ^{25}Al (5 MeV/u) beam
- 1-st Solenoid tuning
- Three gaps RF-buncher in COSY
- Three RF-bunchers in LISE++
- 2-nd Solenoid tuning
- Three RF-bunchers in LISE++ vs. Reaction (separation, transmission)
- RESOLUT : 1 gap RF-buncher solution
- RESOLUT (1 gap RF-buncher) : optimization
- Summary, Outlook

+ update

LISE++ version 9.4.103 *From 28.02.2013*

The code operates under MS Windows environment and provides a highly user-friendly interface.
It can be freely downloaded from the following internet addresses:
http://lise.nscl.msu.edu

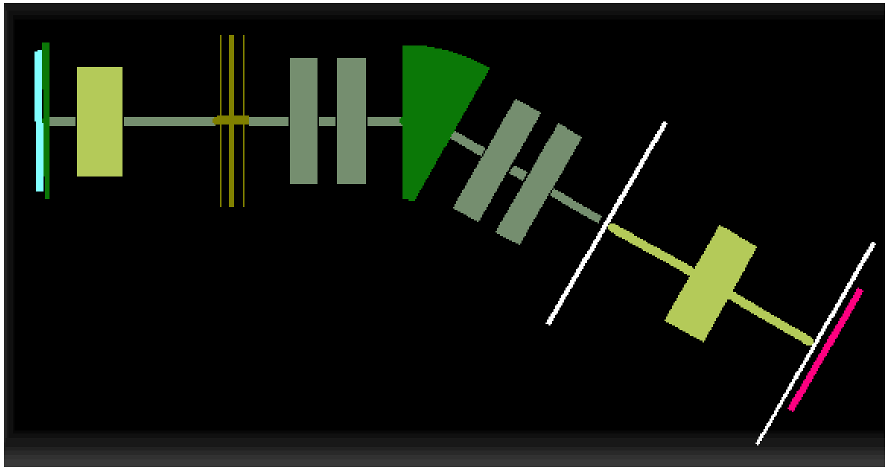
Initial RESOLUT scheme

Tuning dipole to define magnetic rigidity of the separator, Unitary matrix, no slits, zero length

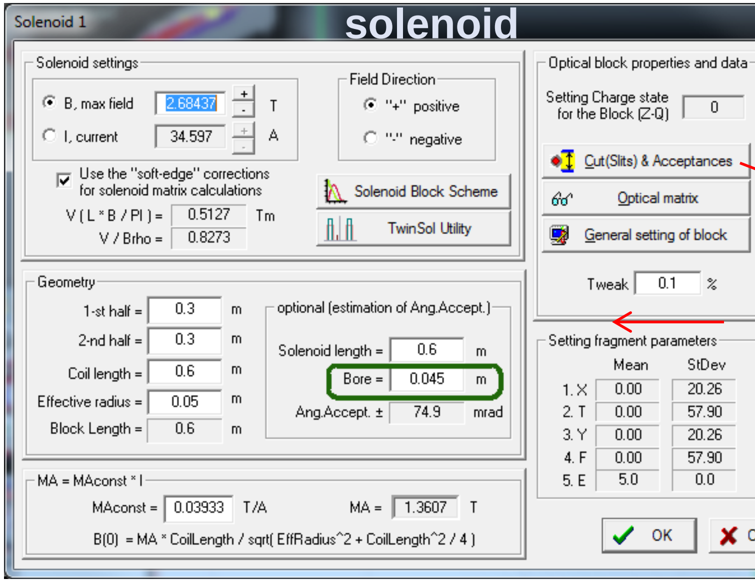
Initial drift+solenoid+drift configuration to define angular acceptance

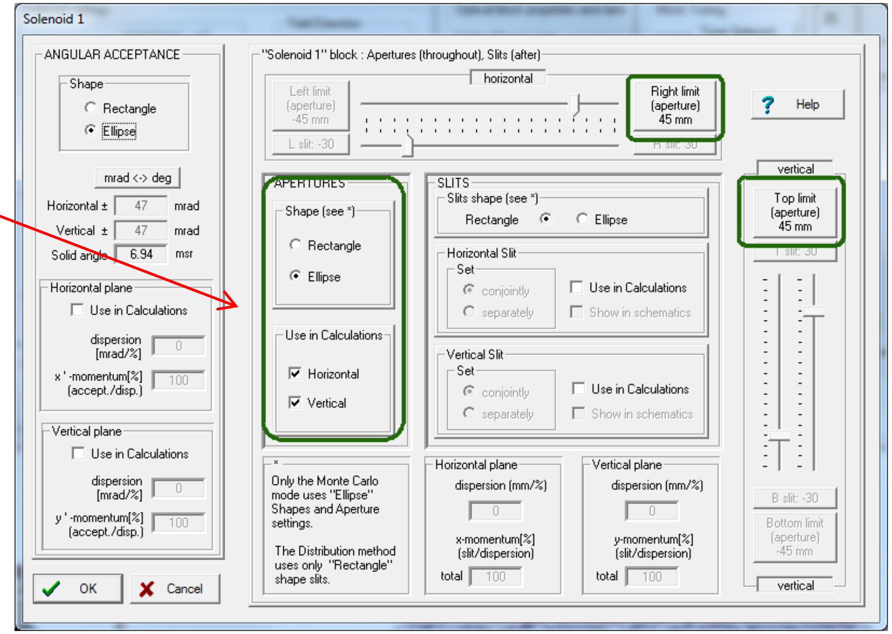
3 gap Rf-buncher was realized as 3 RF bunchers

QQDQQ spectrometer

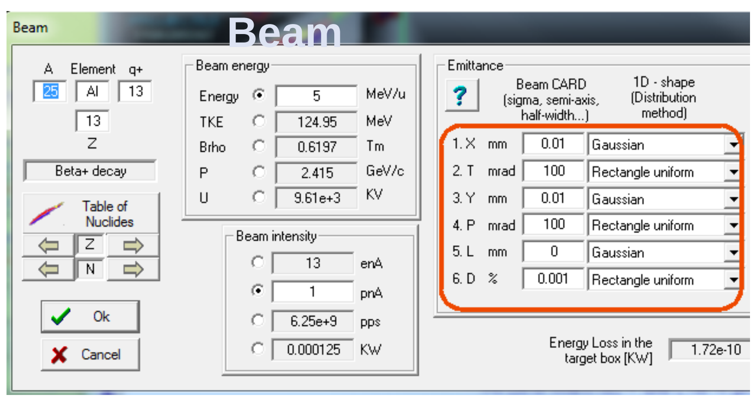


Angular acceptance of the Solenoid block #1

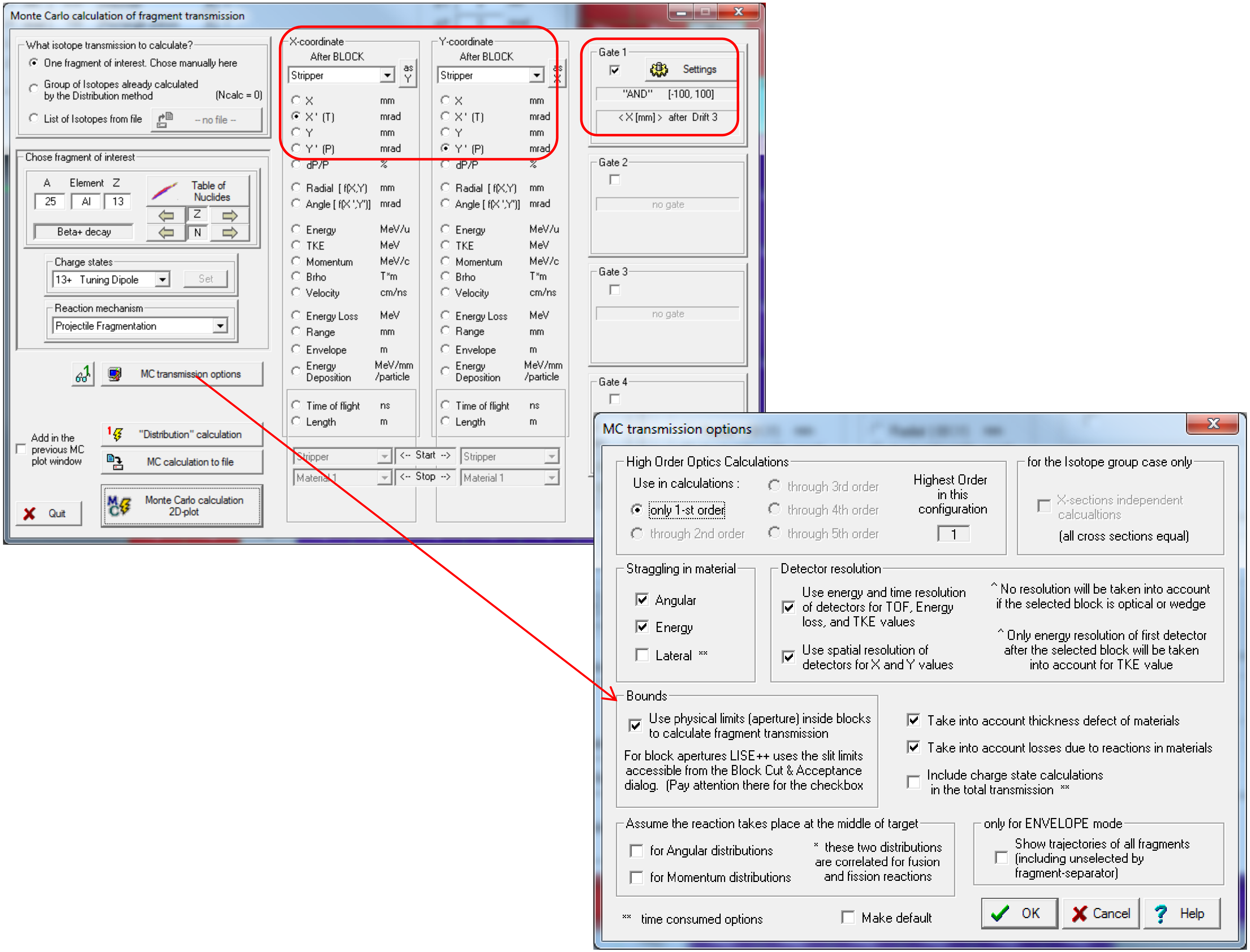




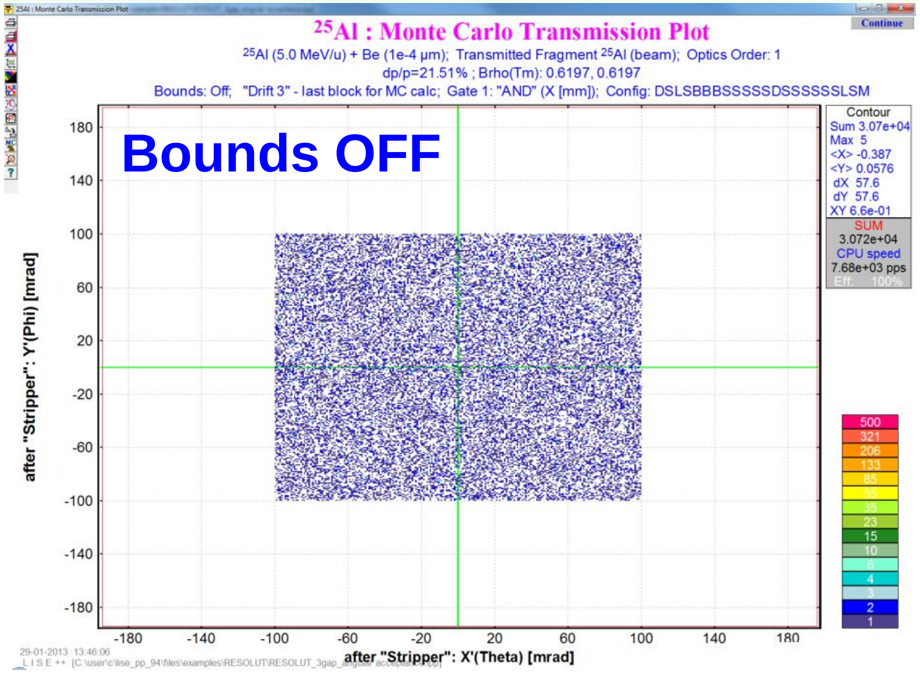
+ Drfit1 & Drift 2 (before and after the solenoid : ellipse apertures +/- 50 mm)

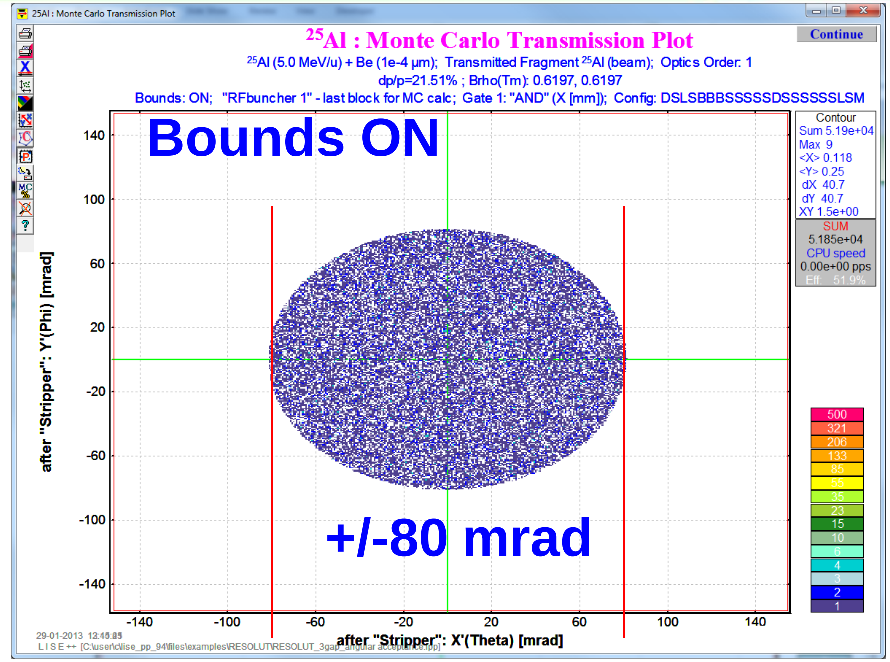


Angular acceptance of the Solenoid block #2

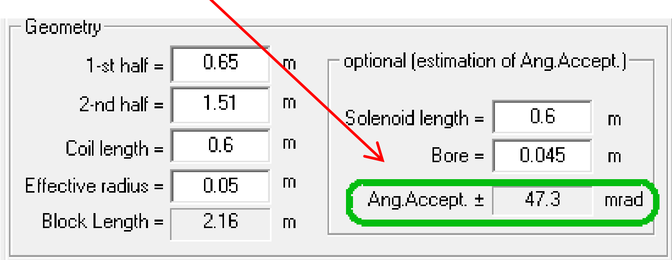


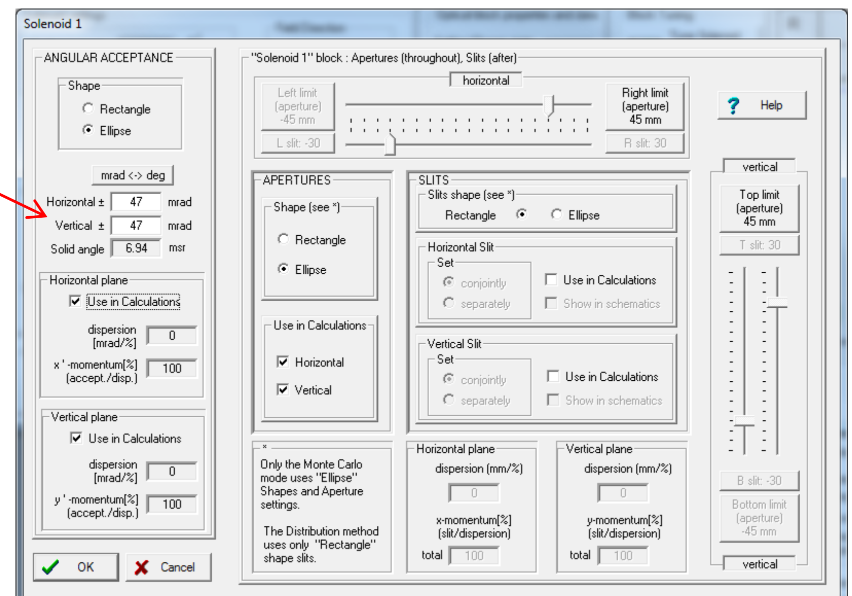
Angular acceptance of the Solenoid block #3



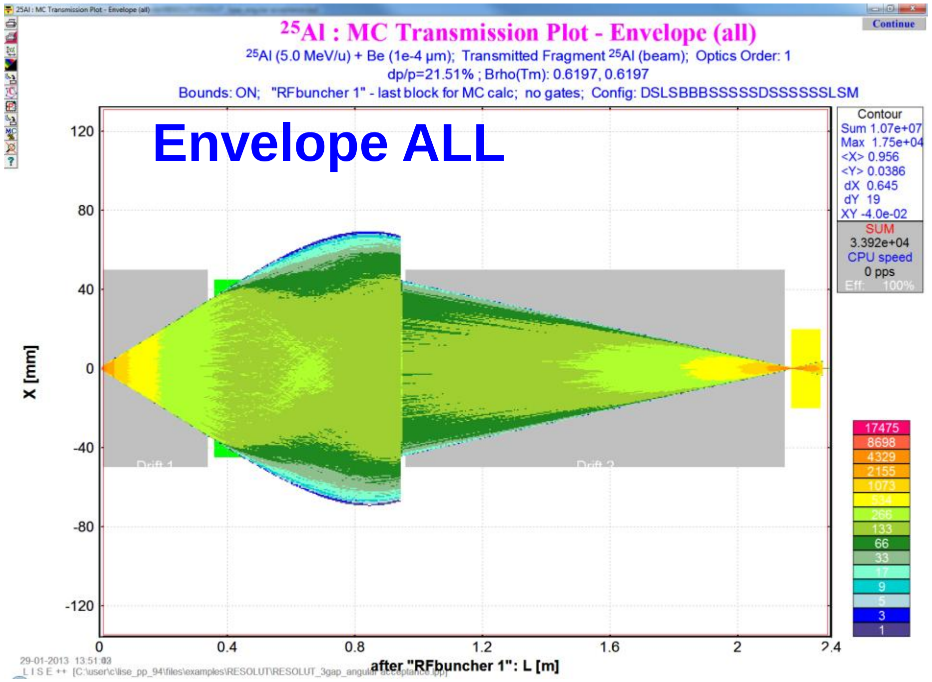


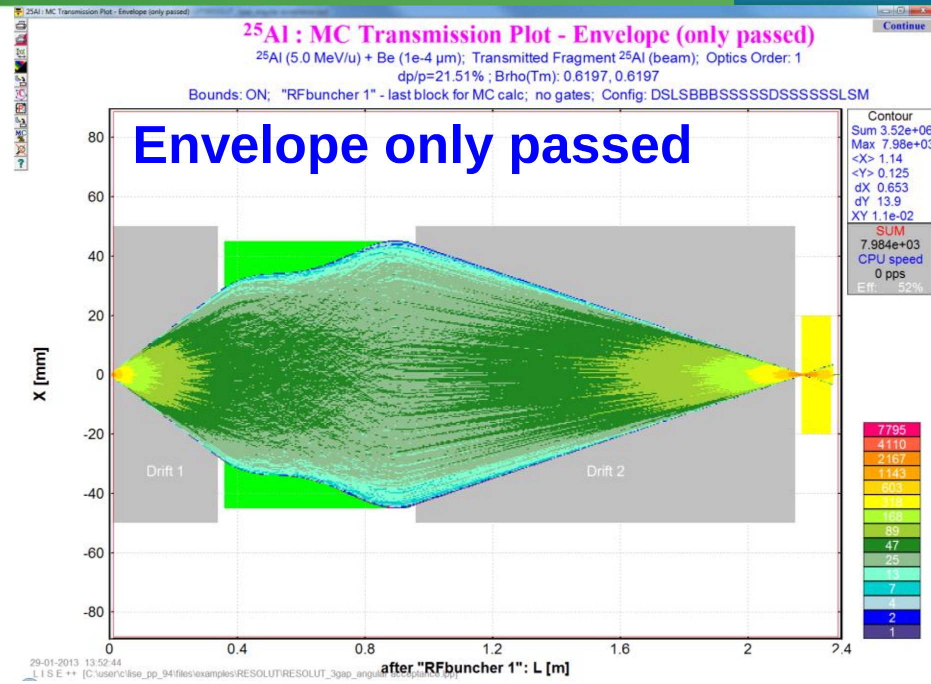
For analytical solution or MC method without bounds it is necessary to set this value (or 47 mrad from geometry without fields) to the Solenoid block acceptance





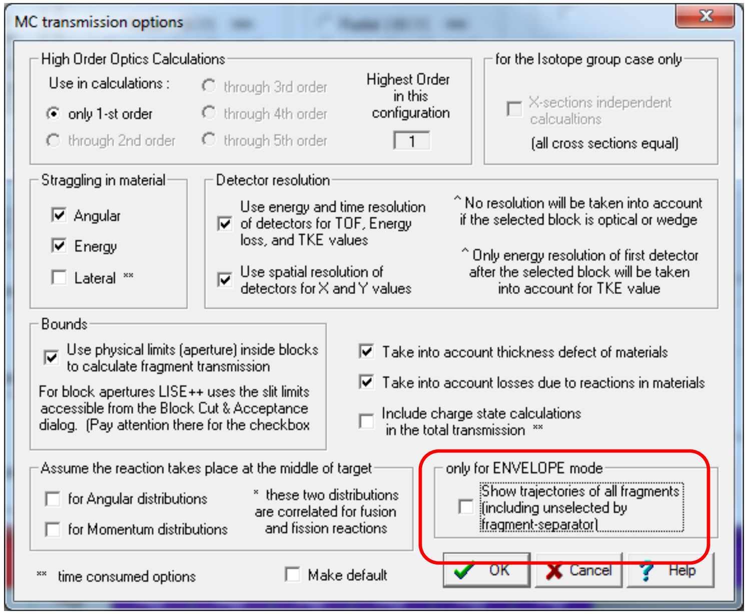
Angular acceptance of the Solenoid block #4





Link to this file

http://lise.nscl.msu.edu/9_4/buncher/RESOLUT_3gap_angular%20acceptance.lpp

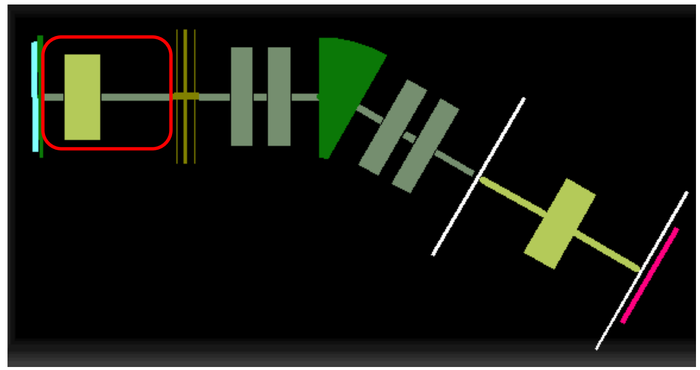


Calculated RESOLUT values for ^{25}Al (5 MeV/u) beam

Abeam=	25		c_speed=	3.00E+08	m/sec
Mbeam=	24.990428		beta=	1.03E-01	
Zbeam=	13		tof=	7.62E-08	sec
Ebeam=	5	MeV/u	dedt=	3.28E+09	
			turns=	7	
LISE++ Brho=	0.619938	Tm			
		Hz	RFF=	119.623	kV
Freq=	9.70E+07	1/sec	Voltage_in_LISE++=	0.478	MV
				4 x V for one gap	
omega=	6.09E+08				
length=	2.36	m			
			MaXGain (V*Q)=	6.22	MeV
TKE=	124.95	MeV	MaxGain/TKE=	5.0%	
Brho (FCU COSY source) =	0.6204303	Tm	phase=	217.9	degrees
they use TKE in source					

		COSY	LISE++ calc	
	coef	value,T	value,T	
S1	4.364	2.7054	2.68	make a small spot at the RF-buncher
S2	3.933	2.4382	2.29	make a small spot at the detector
Q1	-0.48933	-0.3034		
Q2	0.21589	0.1338		
Q3	0.21192	0.1314		
Q4	-0.48933	-0.3034		
S1			2.2	make parralel after the solenoid

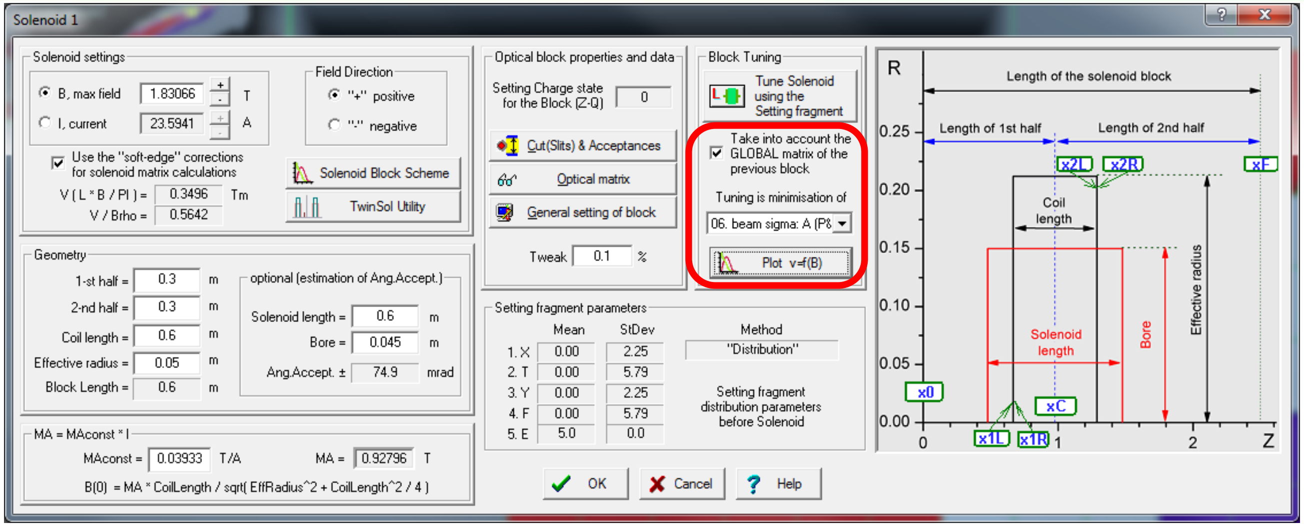
Initial drift+solenoid+drift configuration to define angular acceptance

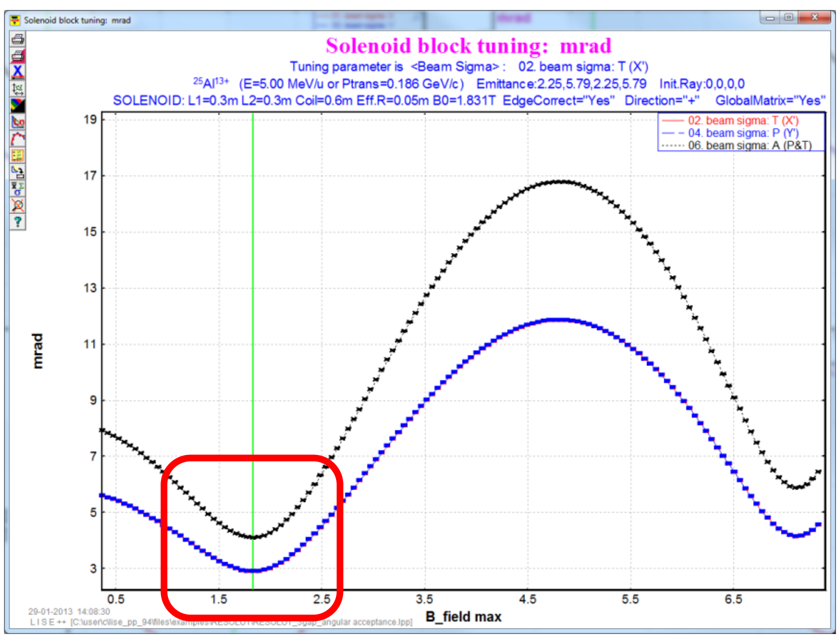


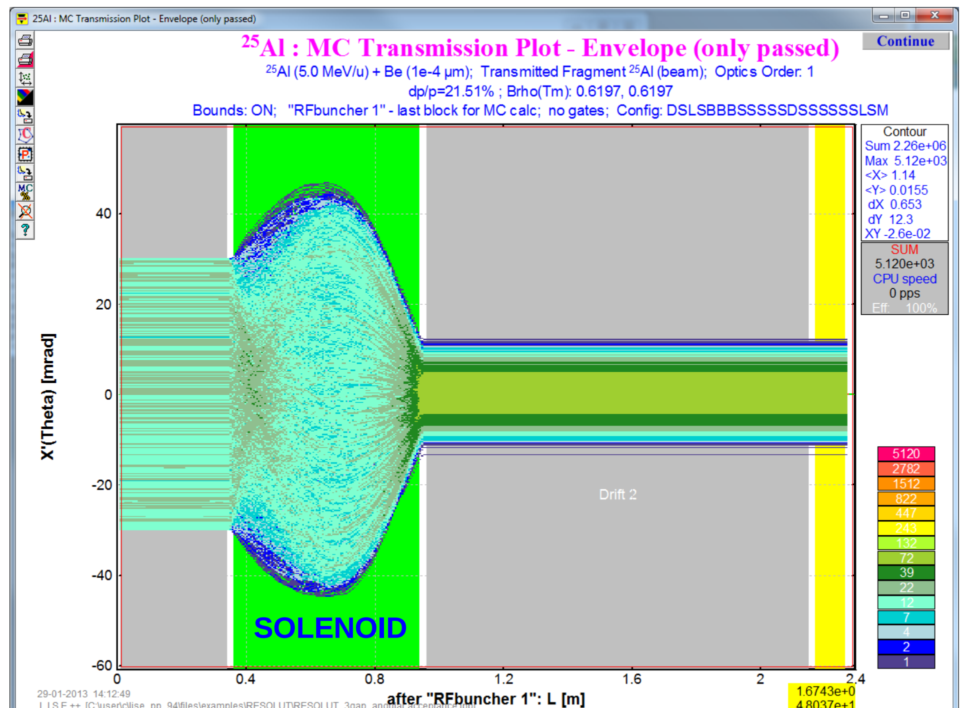
10st solenoid values from the previous slide:

FSU COSY :	2.71 T
LISE++ small object at the RF buncher :	2.68 T
LISE++ makes parallel after solenoid :	1.83 T

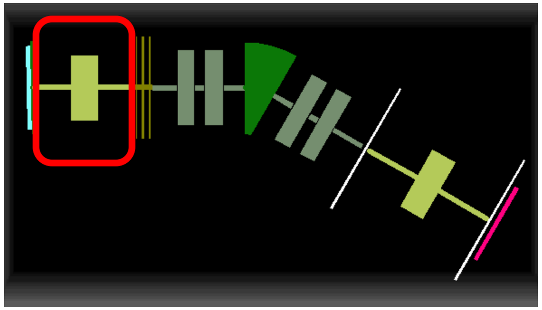
1-st Solenoid tuning : parallel after solenoid



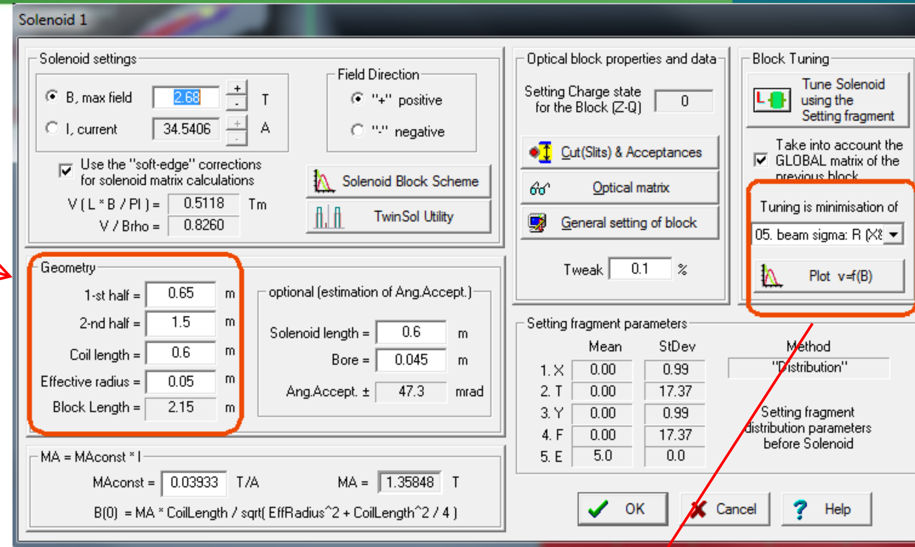




1-st Solenoid tuning : small spot @ RF-buncher (focus)



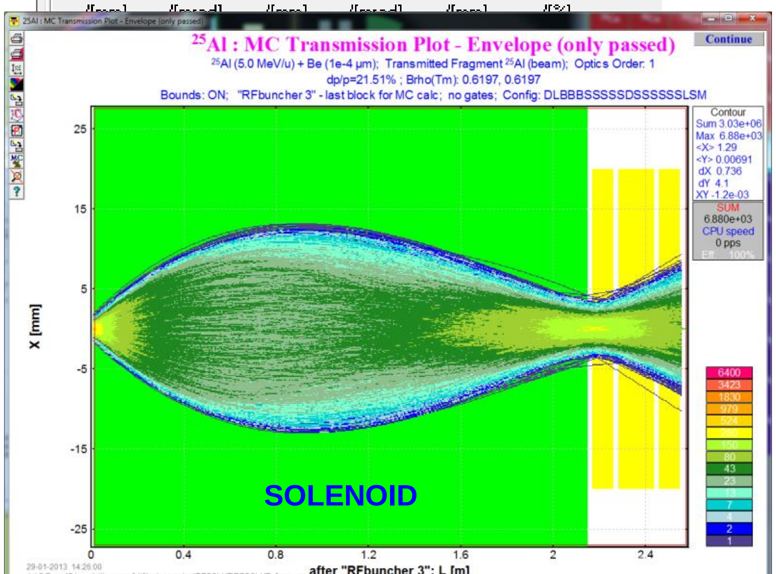
Drifts have been implemented to the Solenoid block

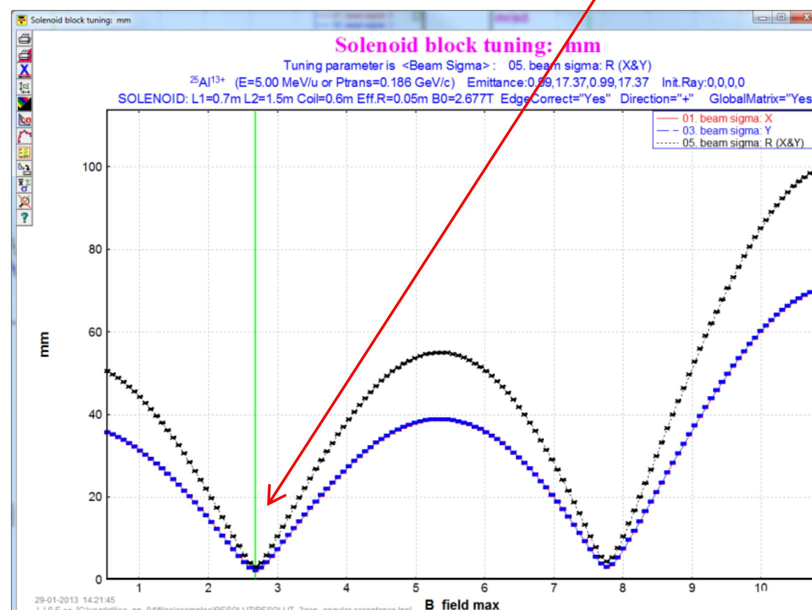


After the solenoid block (B=2.68 T)

Global matrix

-0.60027	0.00433	-2.12804	0.01536	0	0	[mm]
-0.55992	-0.11874	-1.98499	-0.42095	0	0	[mrad]
2.12804	-0.01536	-0.60027	0.00433	0	0	[mm]
1.98499	0.42095	-0.55992	-0.11874	0	0	[mrad]
0	0	0	0	1	0	[mm]
0	0	0	0	0	1	[%]

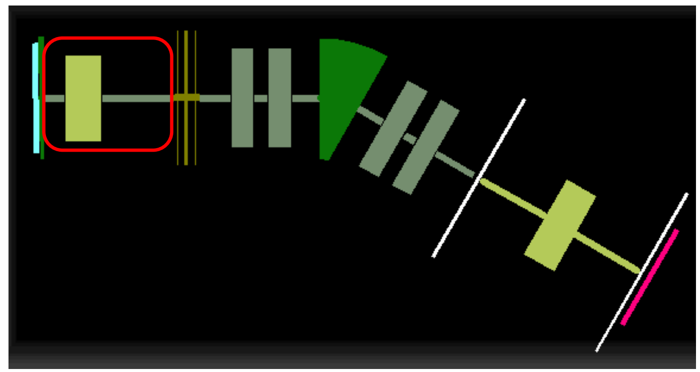




1-st Solenoid tuning

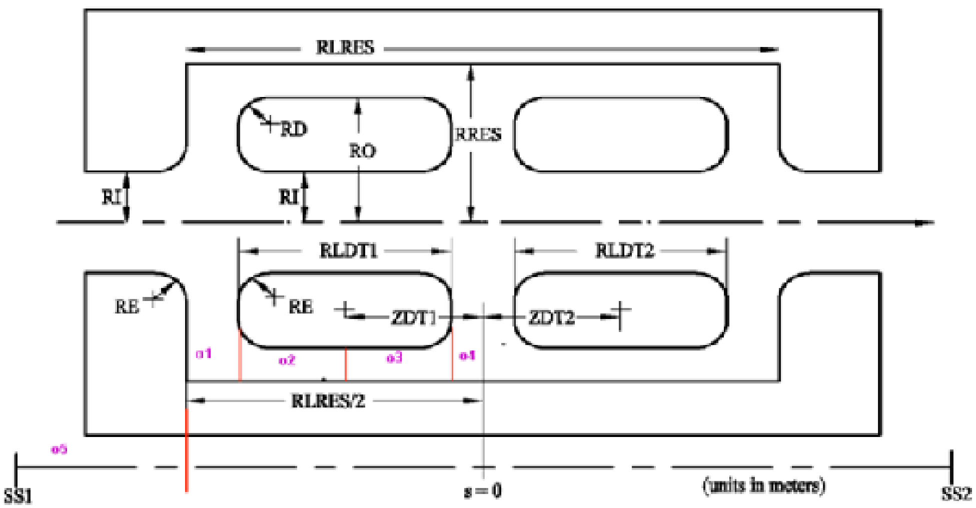
←

Initial drift+solenoid+drift configuration to define angular acceptance



1-st solenoid values from the previous slide:

FSU COSY :	**2.71 T**
LISE++ small object at the RF buncher :	**2.68 T**
LISE++ makes parallel after solenoid :	**2.2 T**



GAPIII1 RI RO RE RD RLRES RRES RLDT1 RLDT2 ZDT1 ZDT2 PAR ; (generates structure file)
THREEGAP SS1 SS2 SCL W PHI RIEST; (calculates map)

Cavity voltage, V = SCL*cos(W*t + PHI)

SCL = max voltage (kV)
W = angular frequency (rad/s)
PHI = relative cavity phase (rad)
RIEST = RI (set the same or smaller)
ZDT1 = center position of tube 1 relative to s = 0.
ZDT2 = center position of tube 2 relative to s = 0.
PAR = +1 for even, -1 for odd voltage symmetry between tubes

Figure B3. Diagram illustrating the parameters of subroutine THREEGAP.

GAPIII1 0.019 0.05 0.01 0.01 0.35 0.198 0.1 0.1 -0.088 0.088 -1. ;

THREEGAP -0.2 0.2 RFF 9.7E7*2.*PI PHI*DEGRAD 0.019 ;

RI= 0.019
RO= 0.05
RE= 0.01
RD= 0.01
RLRES= 0.35
RRES= 0.198
RLDT1= 0.1
RLDT2= 0.1
ZDT1= -0.088
ZDT2= 0.088
PAR= -1 odd

SS1= 0.2
SS2= 0.2

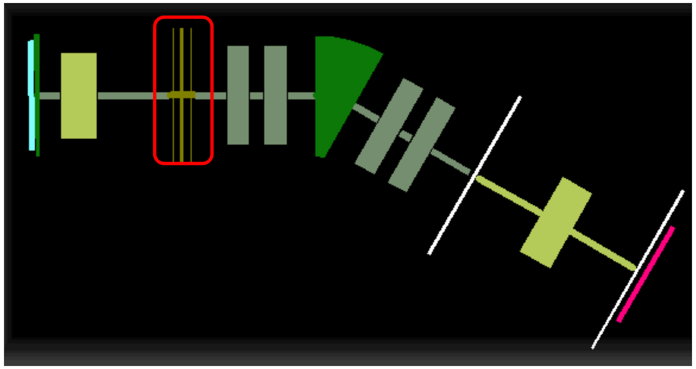
o1	0.037	RLRES/2 - RLDT1 - o4
o2	0.05	RLDT1 / 2
o3	0.05	RLDT1 / 2
o4	0.038	ZDT1 - o3
o5	0.025	SS1 - RLRES/2

			L
d1a	0.025	o5	0.025
gap1	0.037	o1	0.062
d1b	0.05	o2	0.112
			0.112
d2a	0.05	o3	0.162
gap2	0.076	2*o4	0.238
d2b	0.05	o3	0.288
			0.288
d3a	0.05	d1b	0.338
gap3	0.037	gap1	0.375
d3b	0.025	d1a	0.400

reduced one gap geometry

od2a	0.162	SS1 - gap2/2
ogap2	0.076	gap2
od2b	0.162	od2b

RESOLUT_3gap.lpp



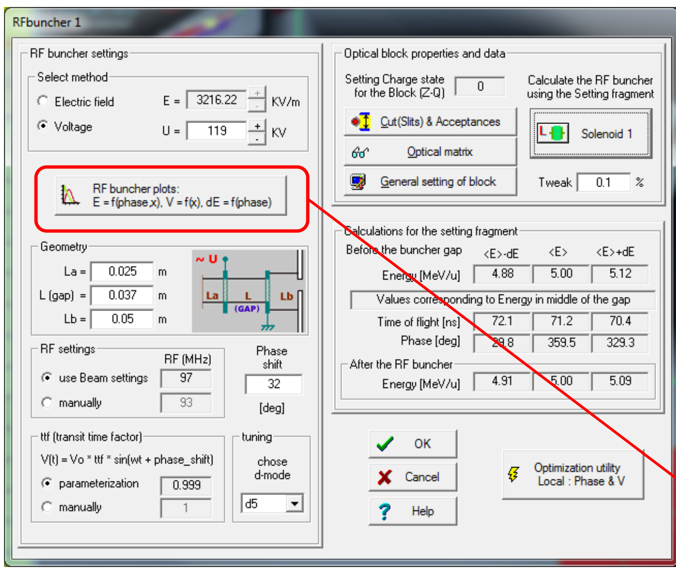
COSY 3 gaps :

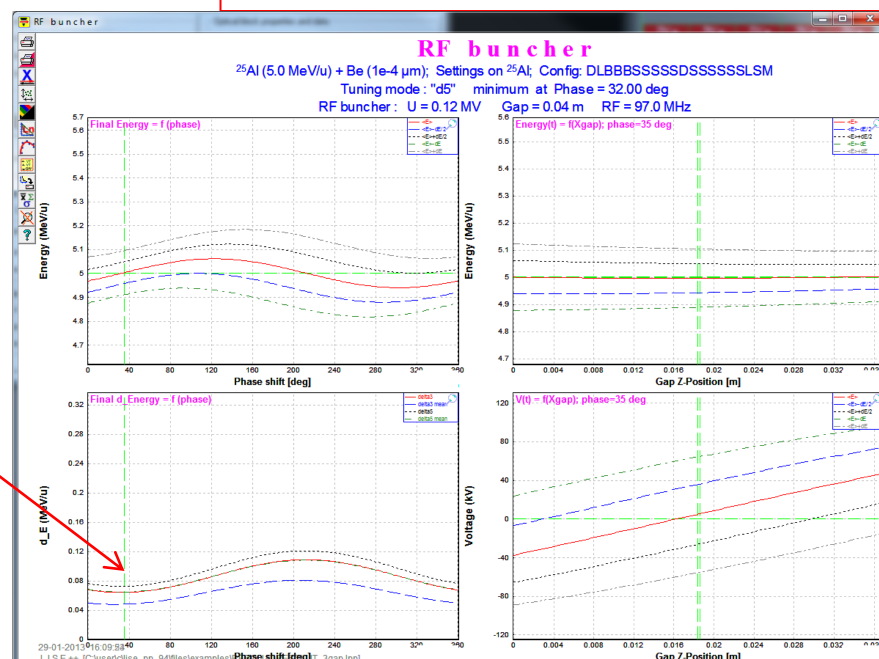
Gap	Gap Size	Bias
1	D	+V
2	2D	-2V
3	D	+V

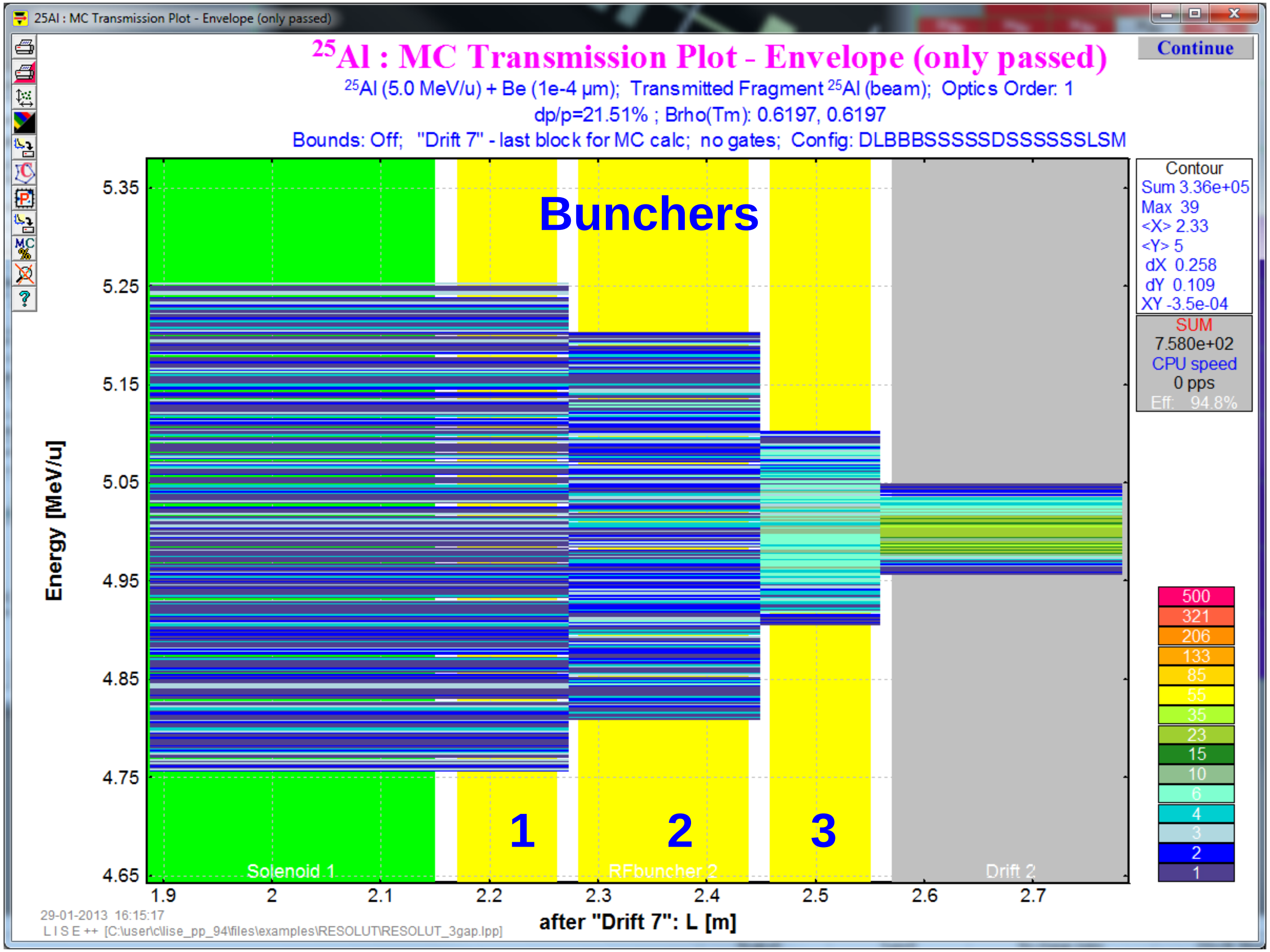
LISE++ 3 bunchers:

Buncher	Gap Size	Bias	Phase
1	D	V	a
2	2D	2V	a+180
3	D	V	a

First buncher

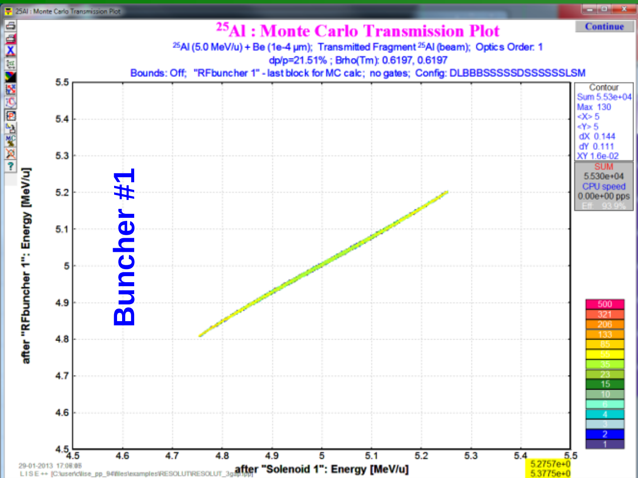


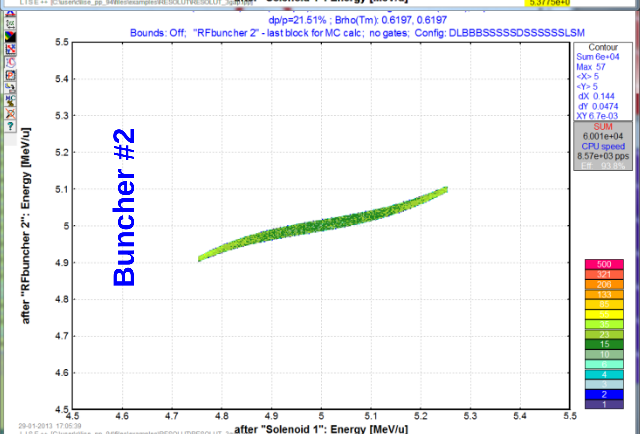


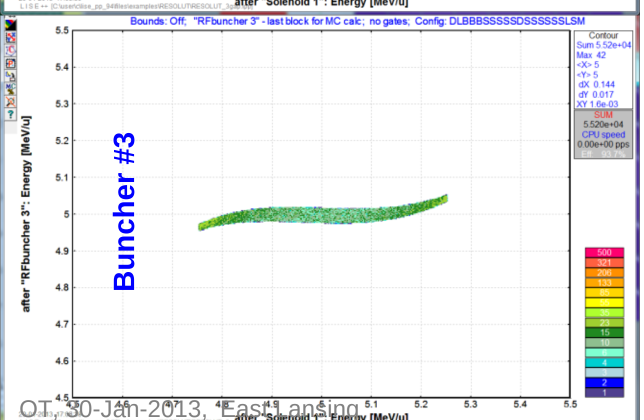


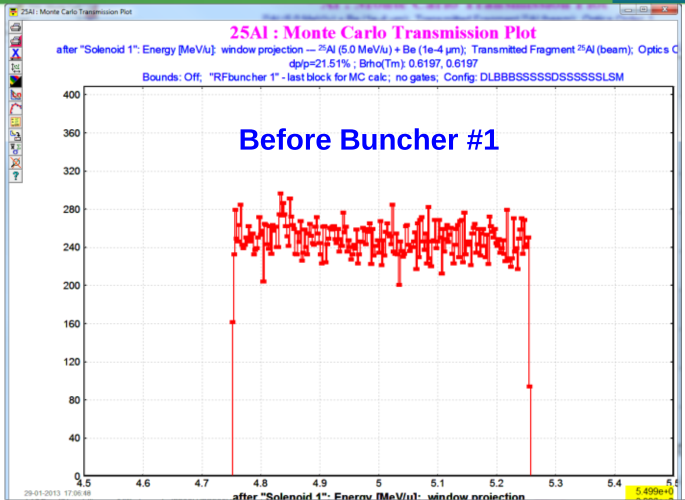
File: RESOLUT_3gap.lpp

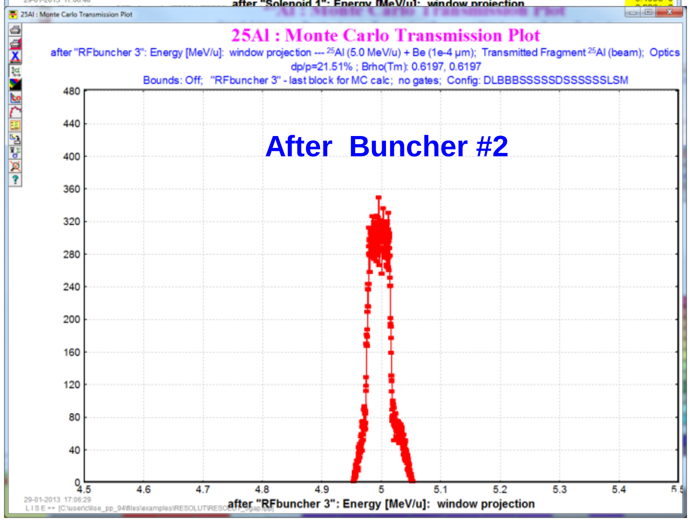
Three gaps RF-buncher in COSY → Three RF-bunchers in LISE++





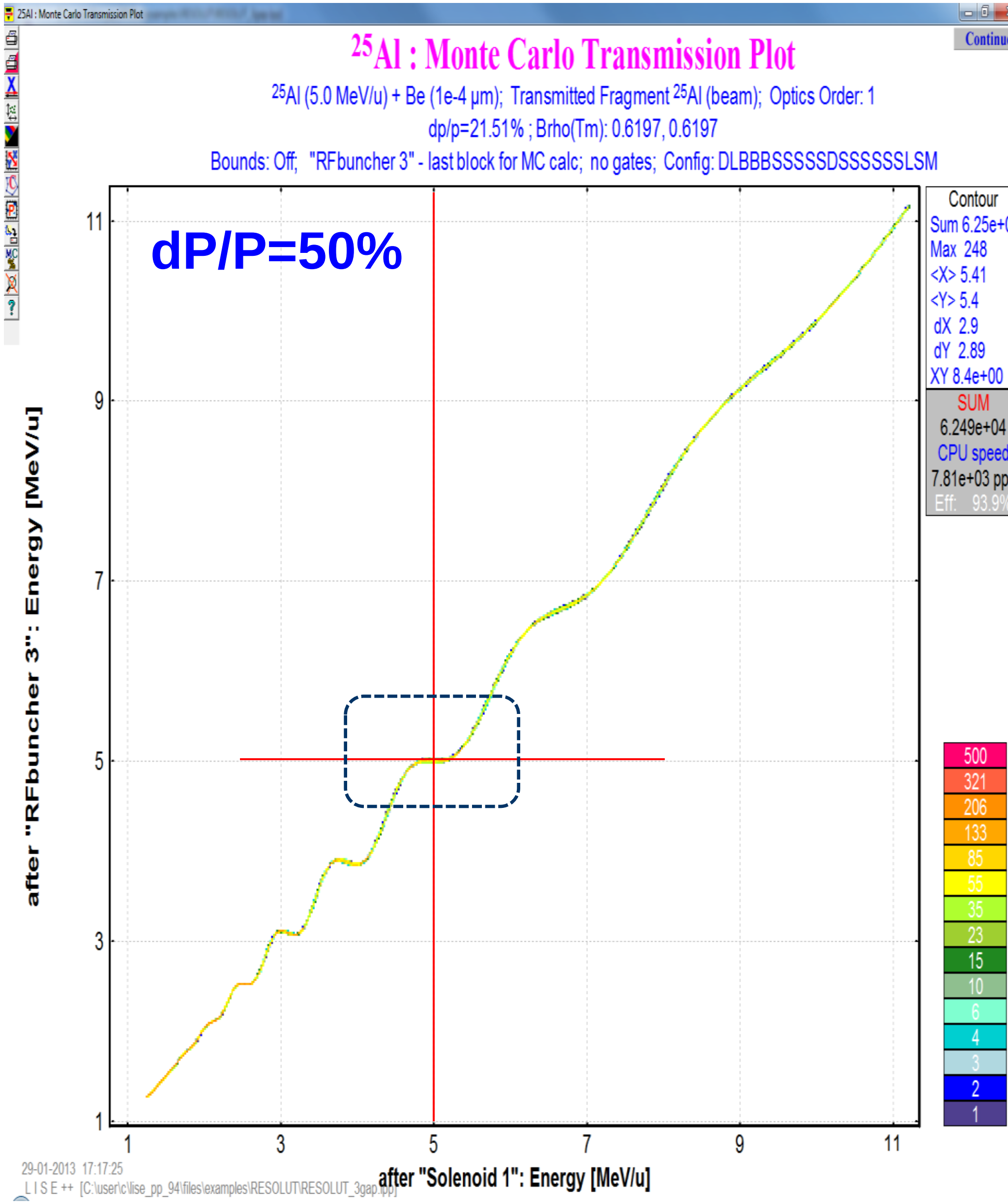


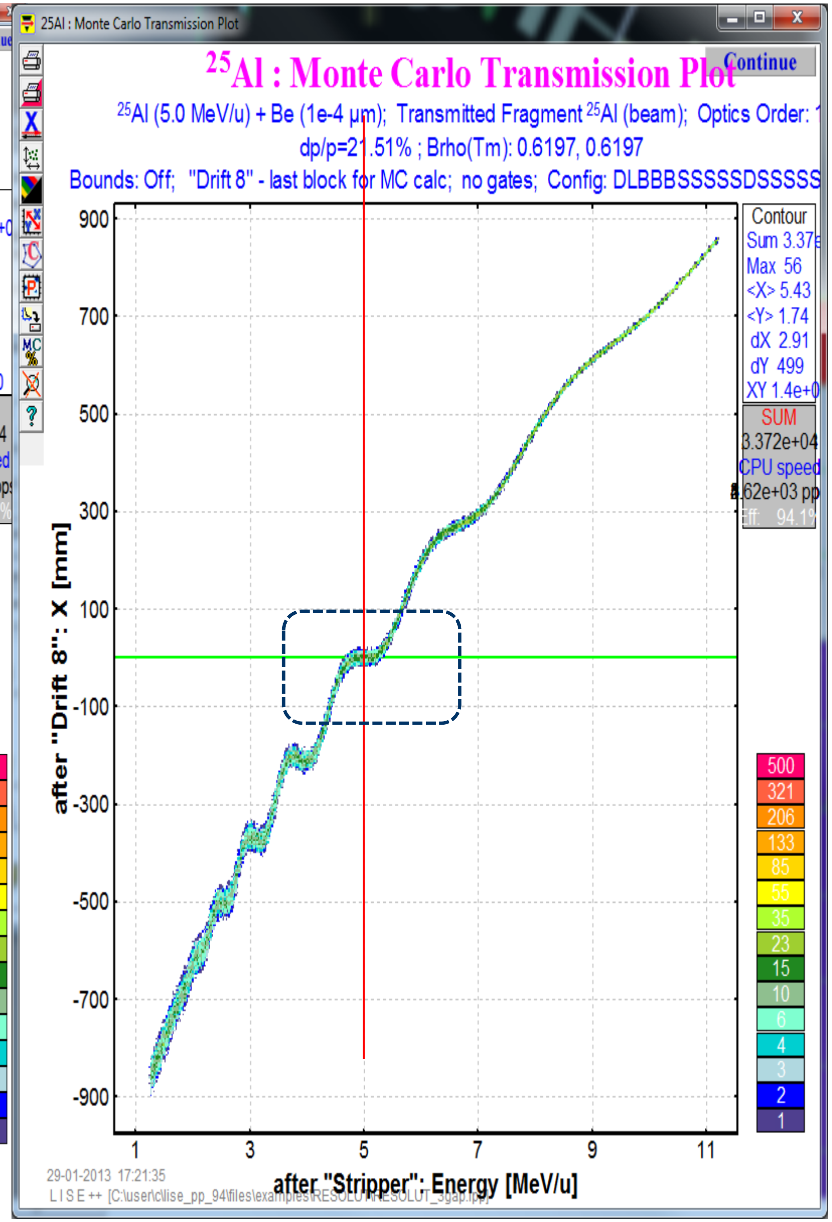




	StDev
Before Buncher#1	0.144
After Buncher #1	0.111
After Buncher #2	0.0474
After Buncher #3	0.017

Three gaps RF-buncher in COSY → Three RF-bunchers in LISE++





Three RF-bunchers in LISE++

Advantages:

- It Can be use for all velocities
- Realistic simulation

Disadvantages:

- Difficult to find a phase
- It is necessary manually to set this phase for all bunchers
- It is impossible to make simultaneously optimization for all three bunchers.

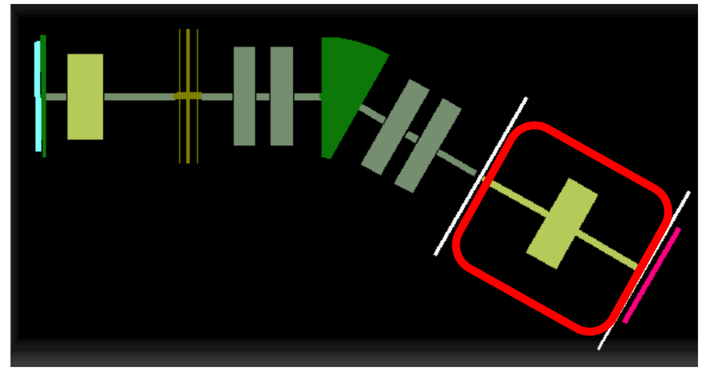
Solutions:

- Creation the ThreeGap block
- Creation configurations with one RF-buncher* which can be reproduced main properties current configurations and used for optimization

* it has been realized. See RESOLUT_1gap.lpp slides

2-nd Solenoid tuning

2^{nd} - solenoid

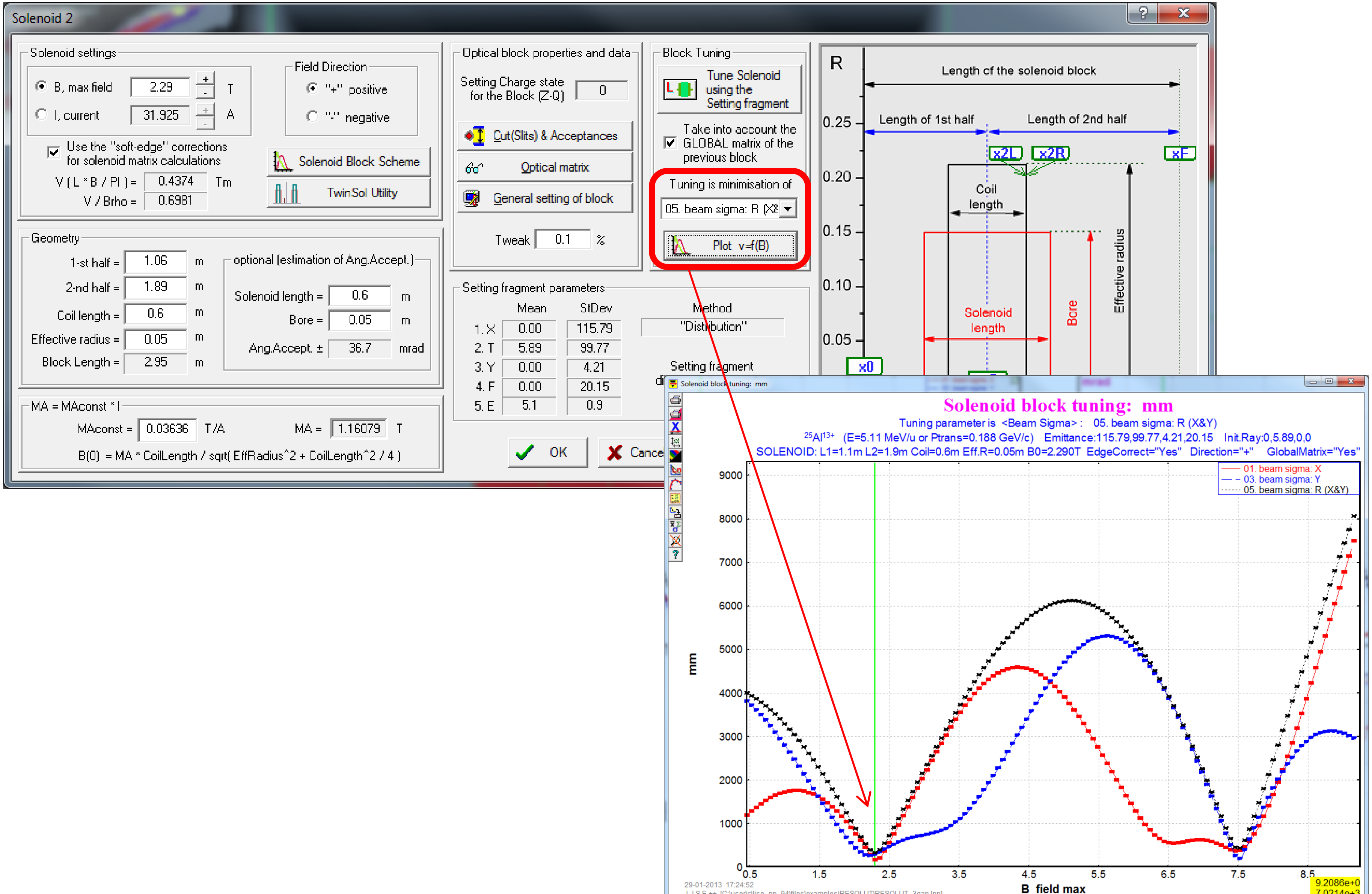


2nd solenoid values from the previous slide:

FSU COSY : 2.44 T

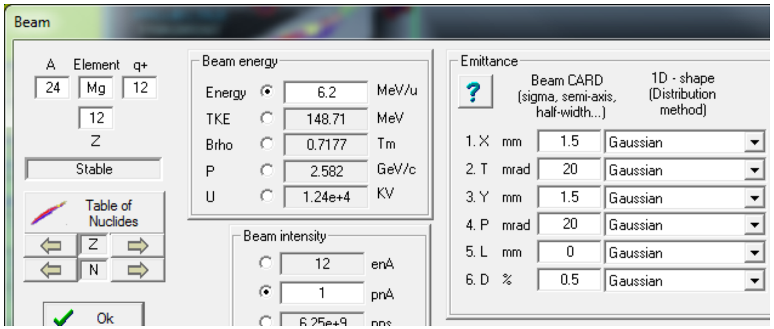
LISE++ small object at the solenoid : 2.29 T

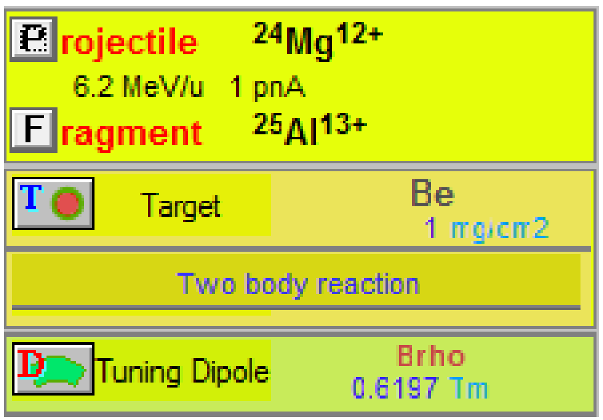
2-nd Solenoid tuning



Three RF-bunchers in LISE++ vs. Reaction (separation, transmission)

File: RESOLUT_3gap_reaction.lpp

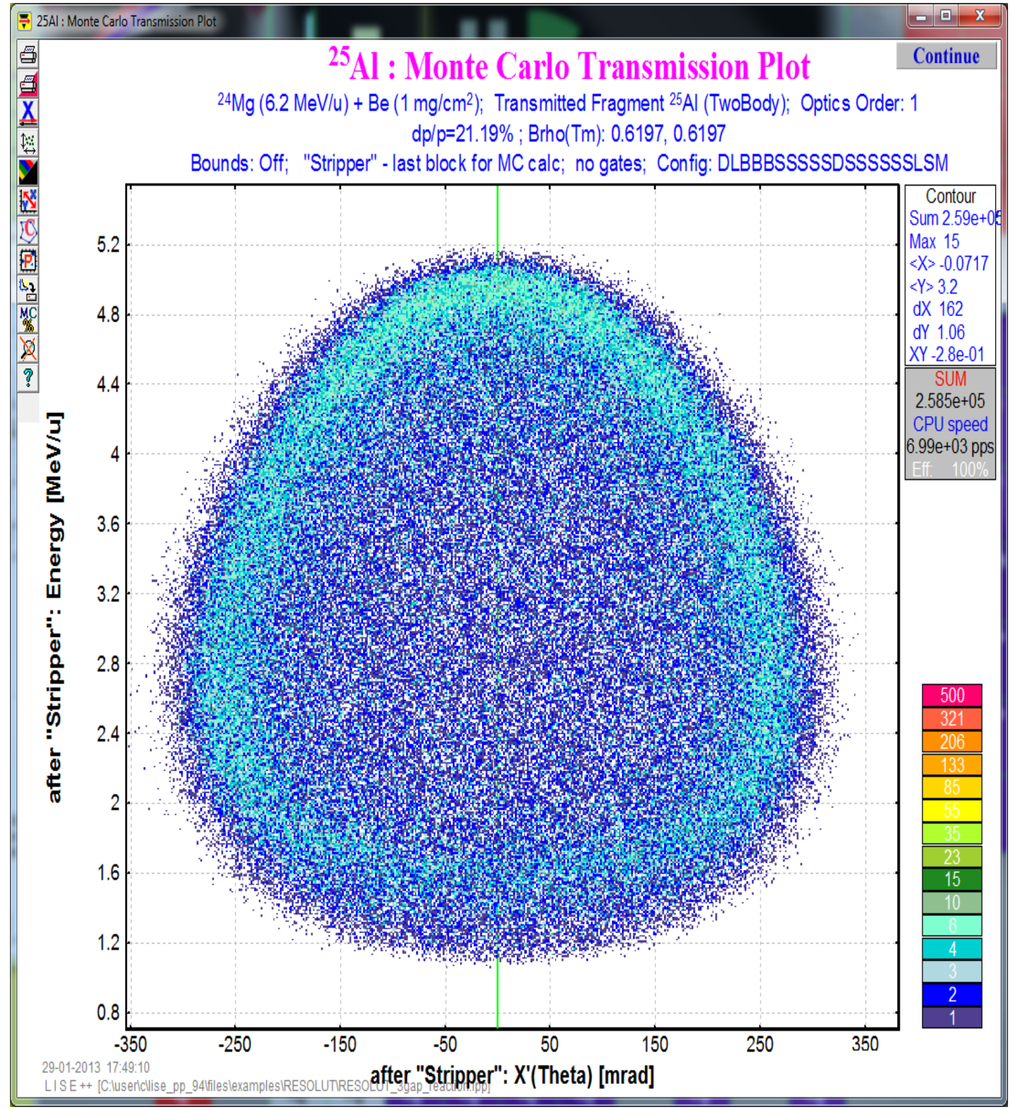




Primary beam is taken into account, but Think about other reactions.

EPAX cross section have been used for Two-body reactions

After target



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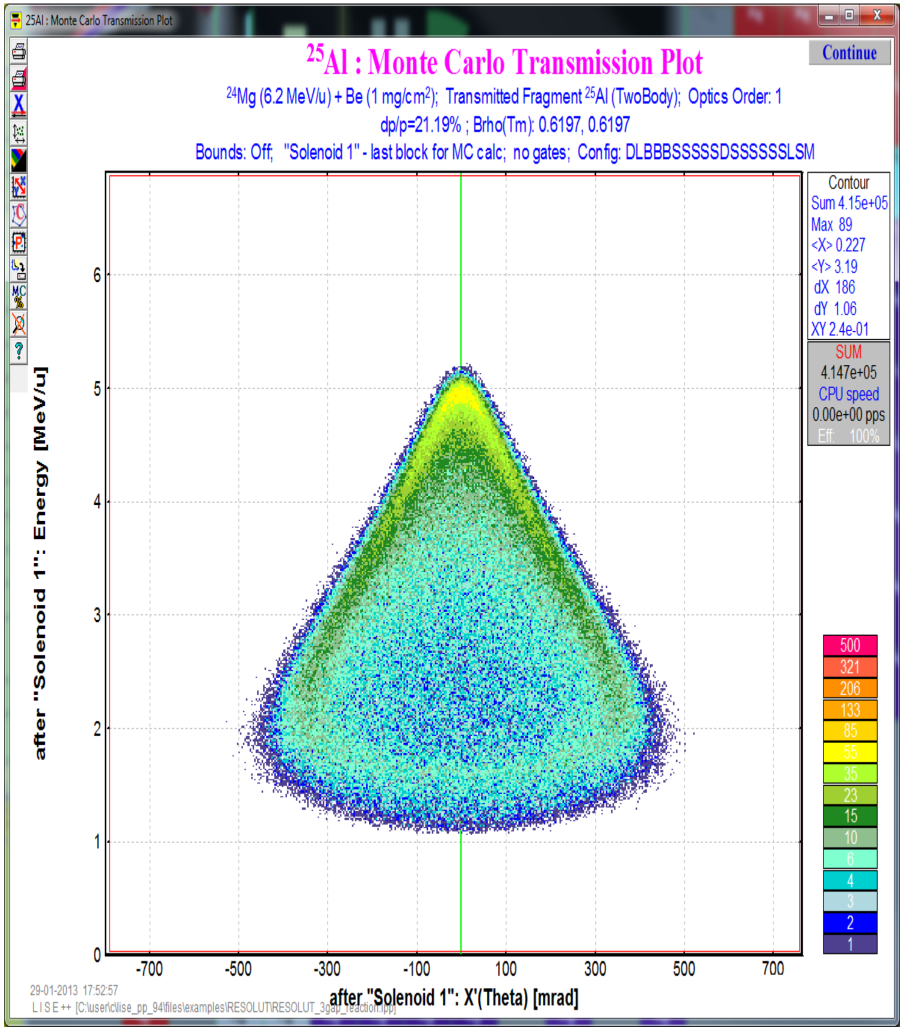
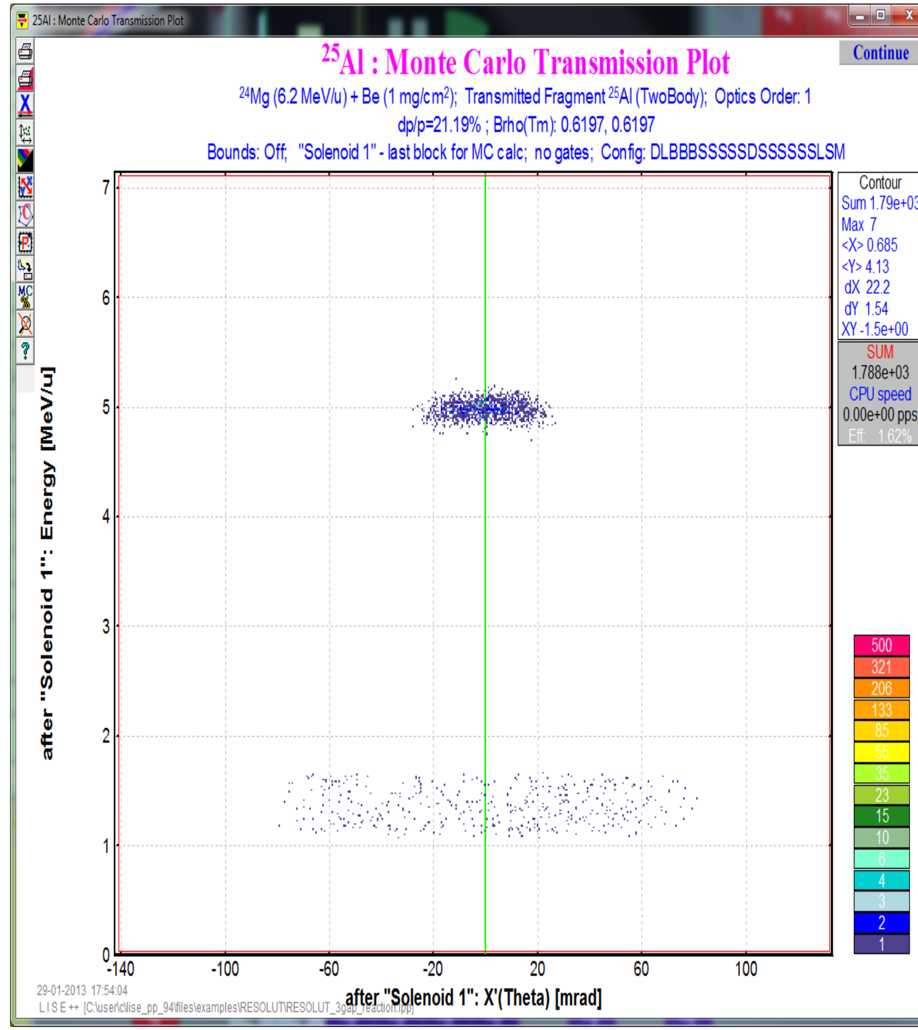
LISE++

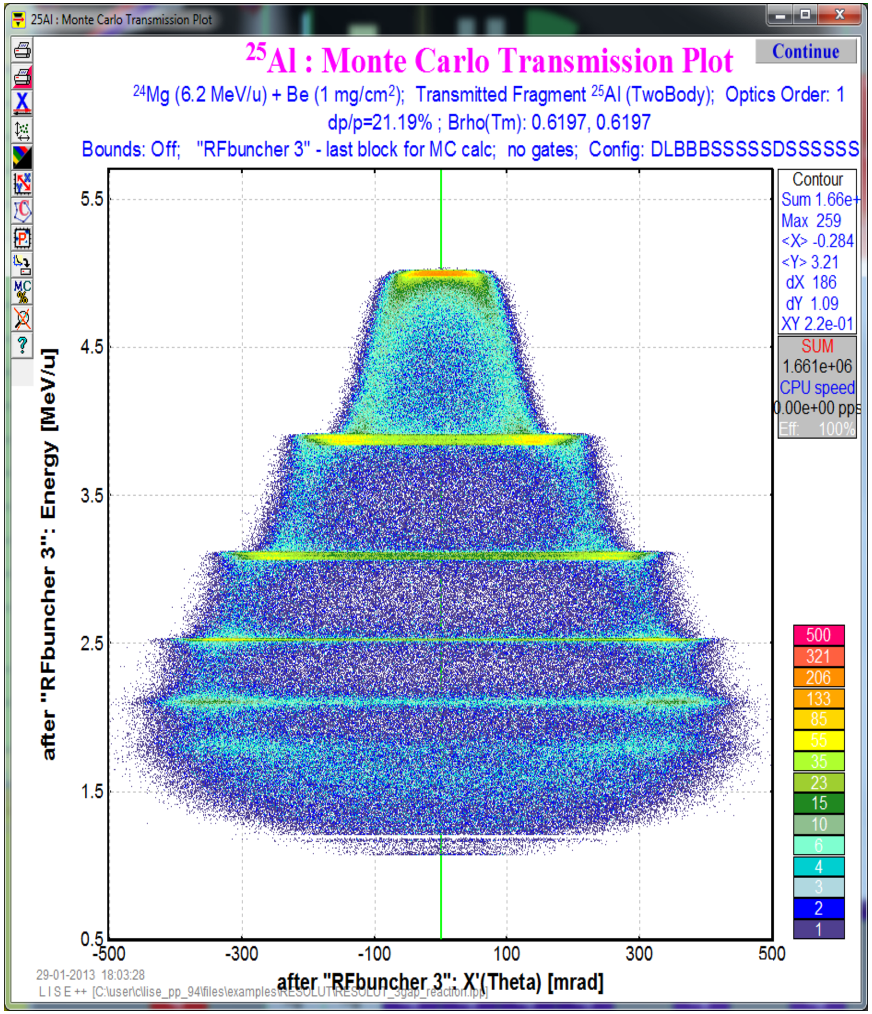
After the 1st solenoid without angular acceptance



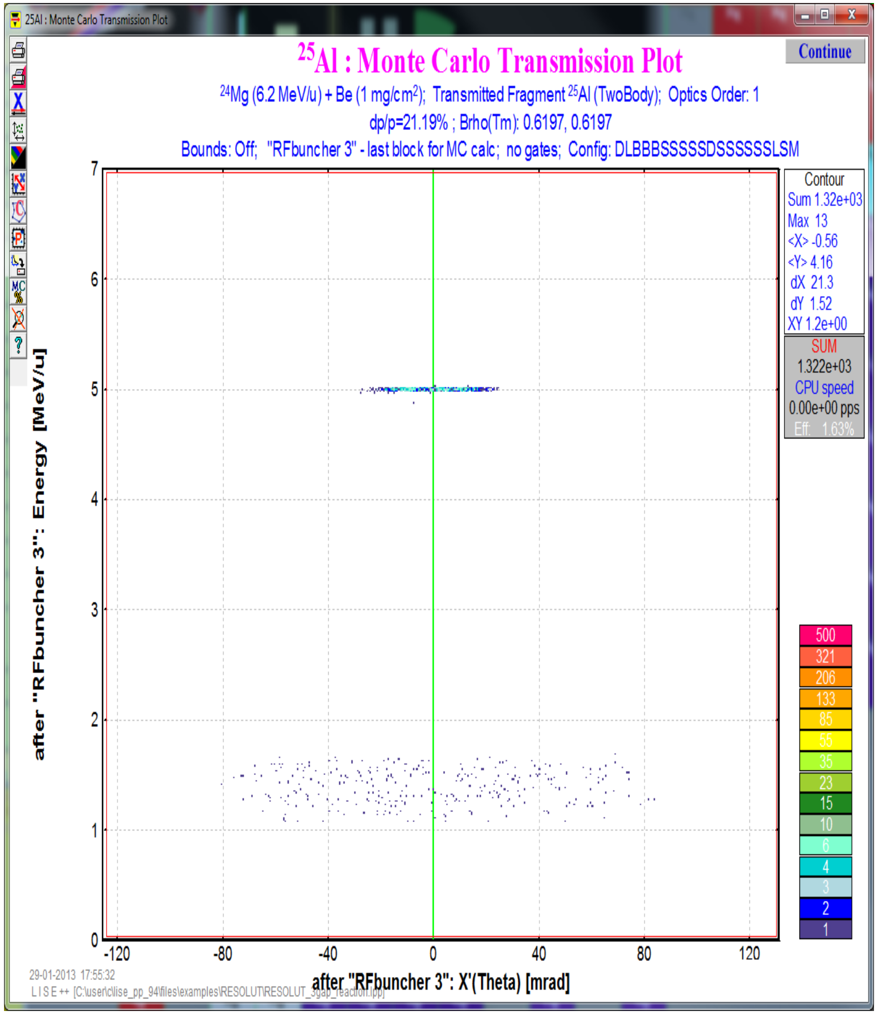
After the 1st solenoid with angular acceptance



After the 3 gap buncher without angular acceptance

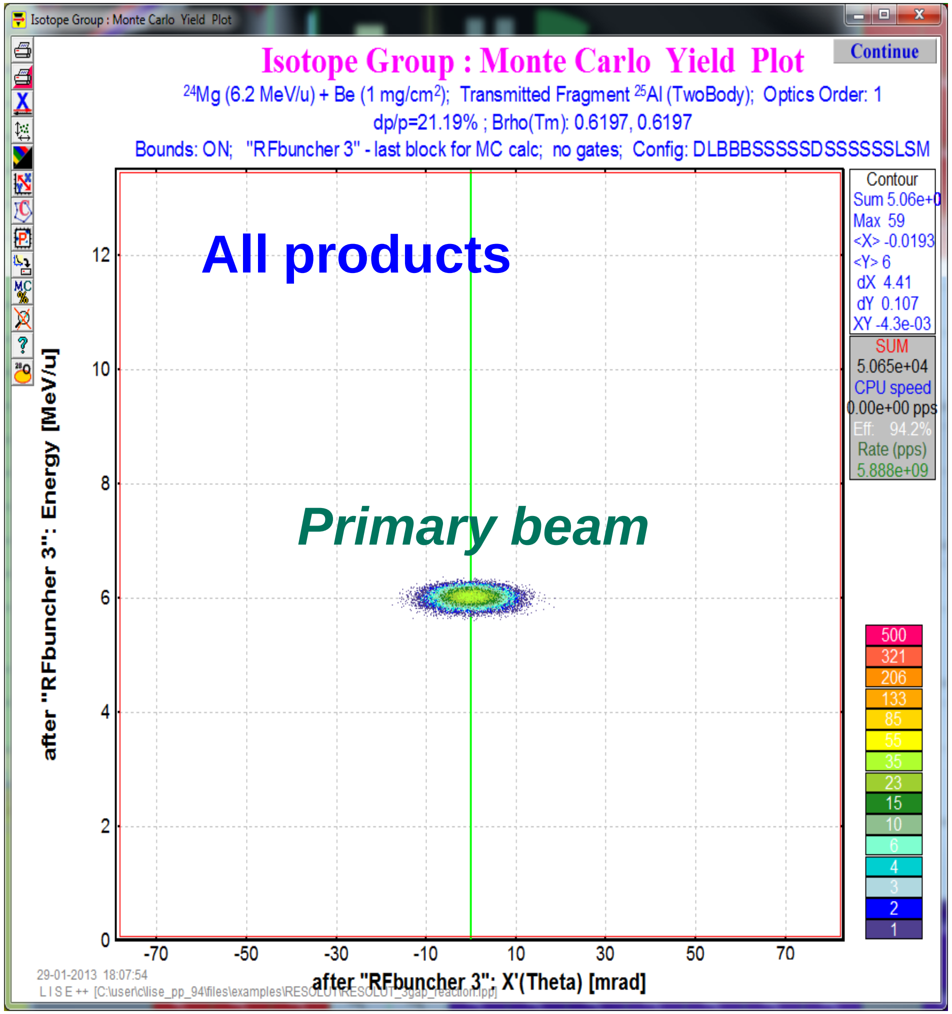


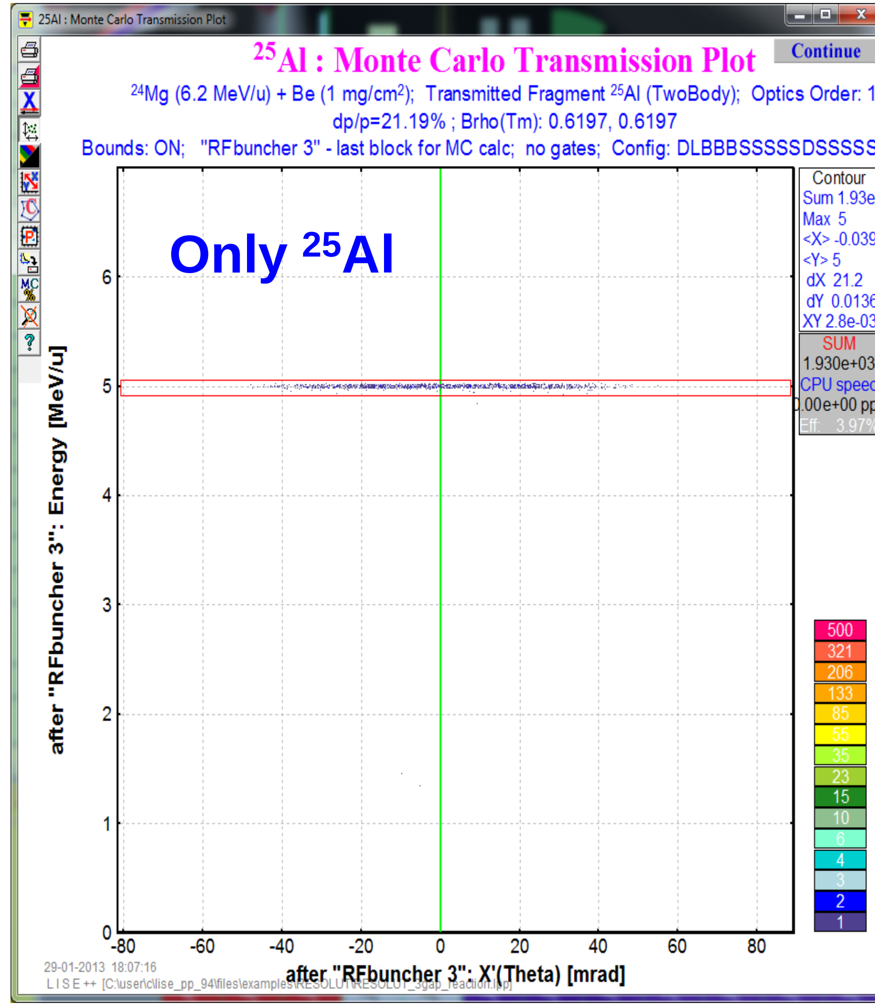
After the 3 gap buncher with angular acceptance



+/- 47 mrad acceptance, Transmission 1.6%

After the 3 gap buncher without angular acceptance, But taken bounds into account

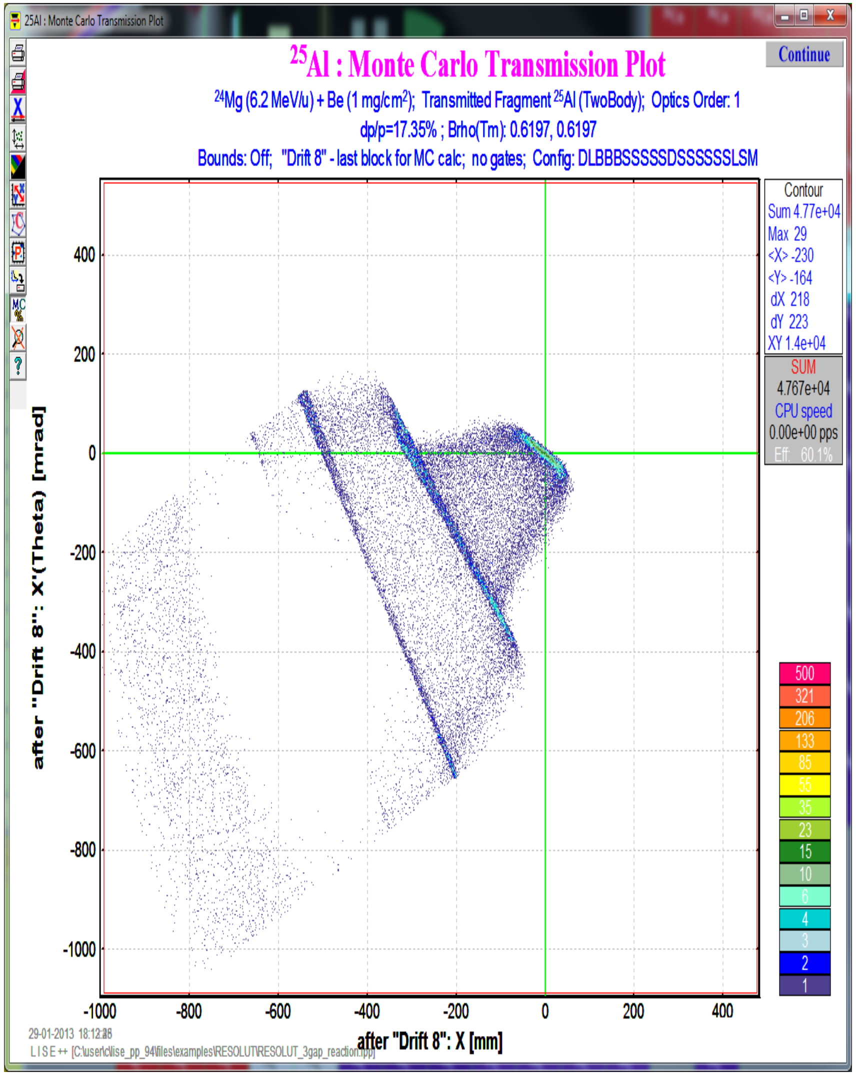




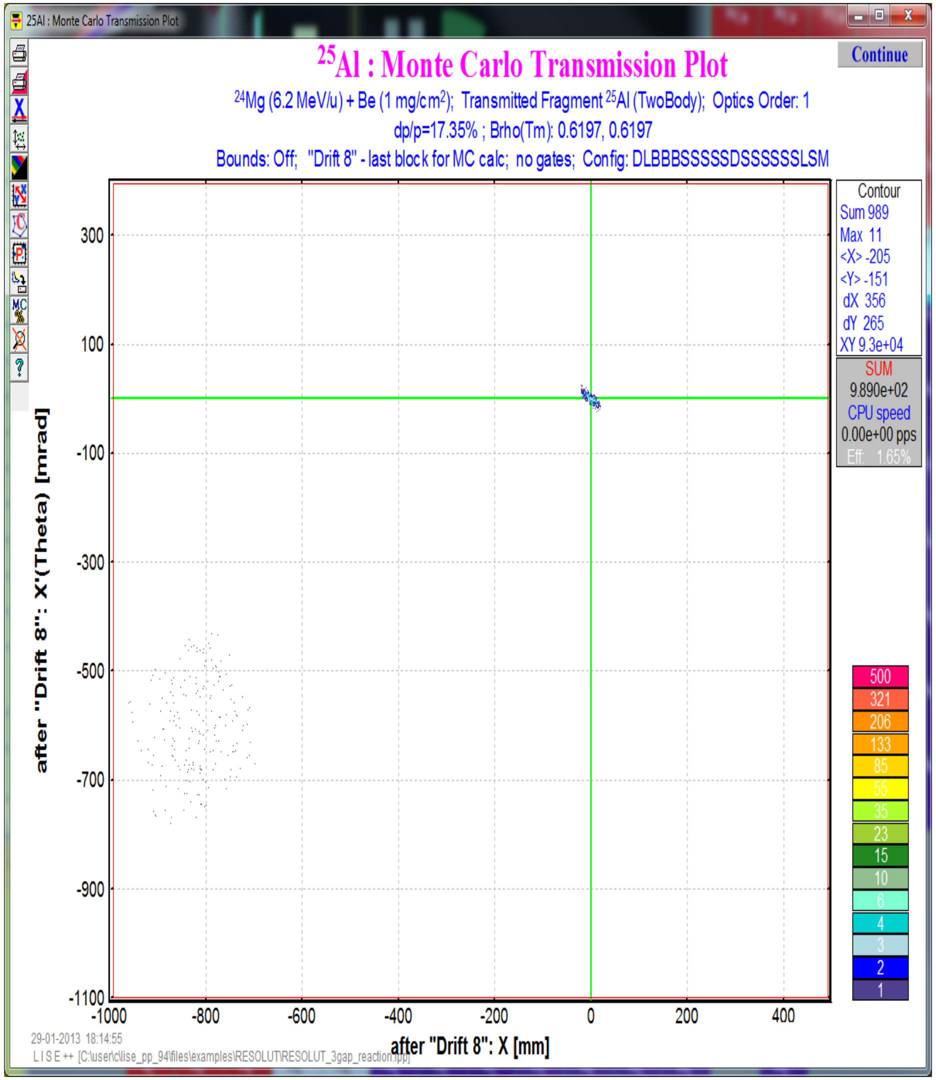
Transmission 4.0%

Three RF-bunchers in LISE++ vs. Reaction (separation, transmission)

After the MQ4 without angular acceptance,

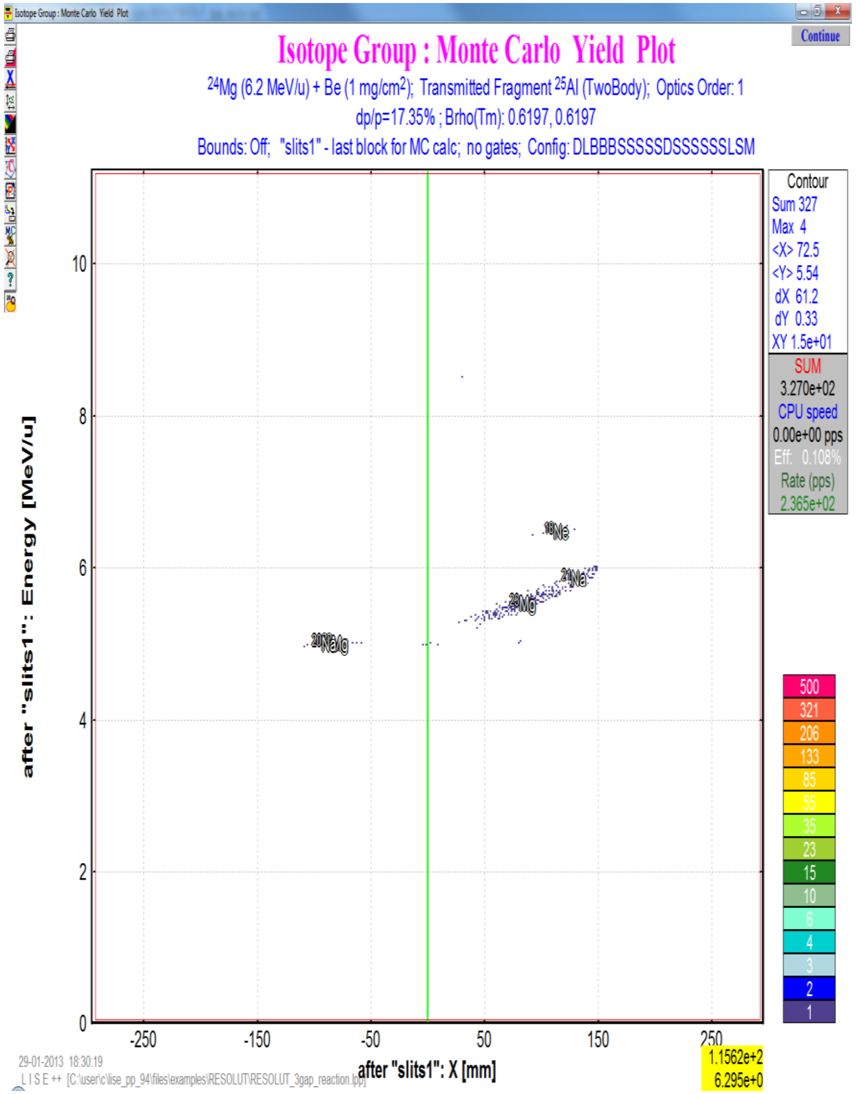


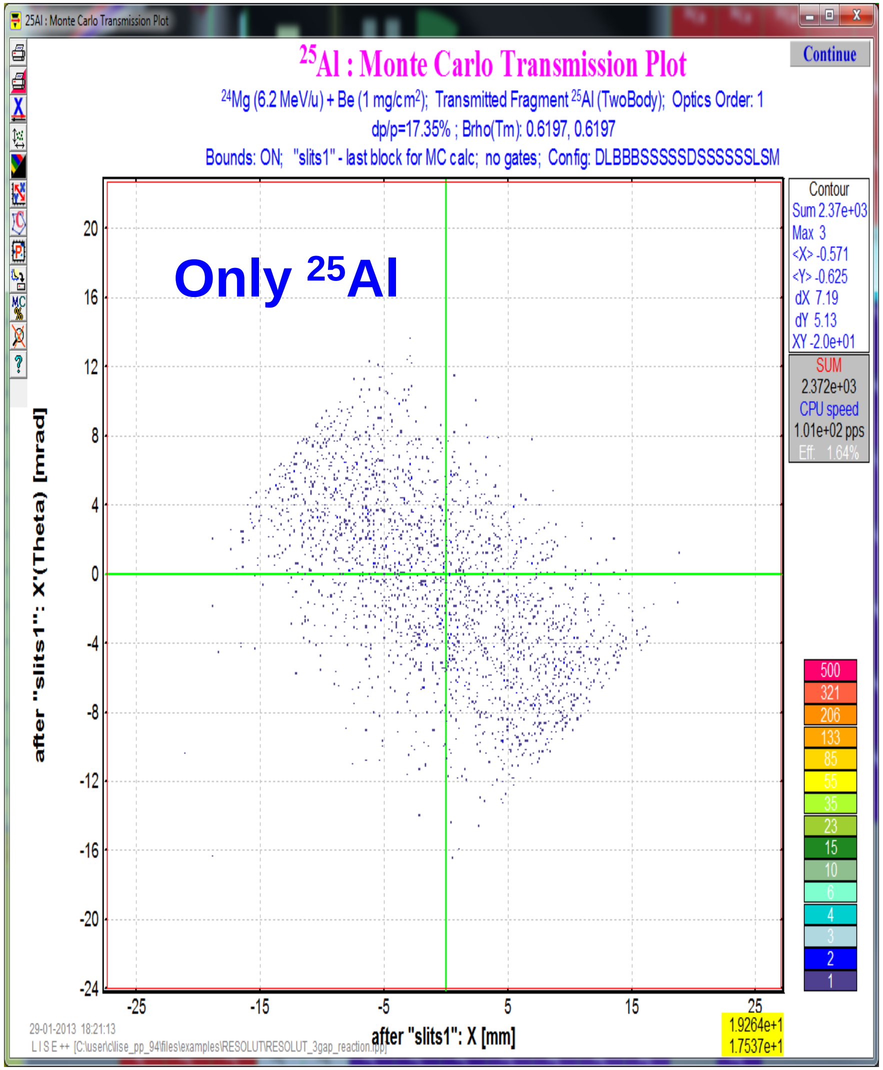
After the MQ4 without angular acceptance,



+/- 47 mrad acceptance,
Transmission 1.6%

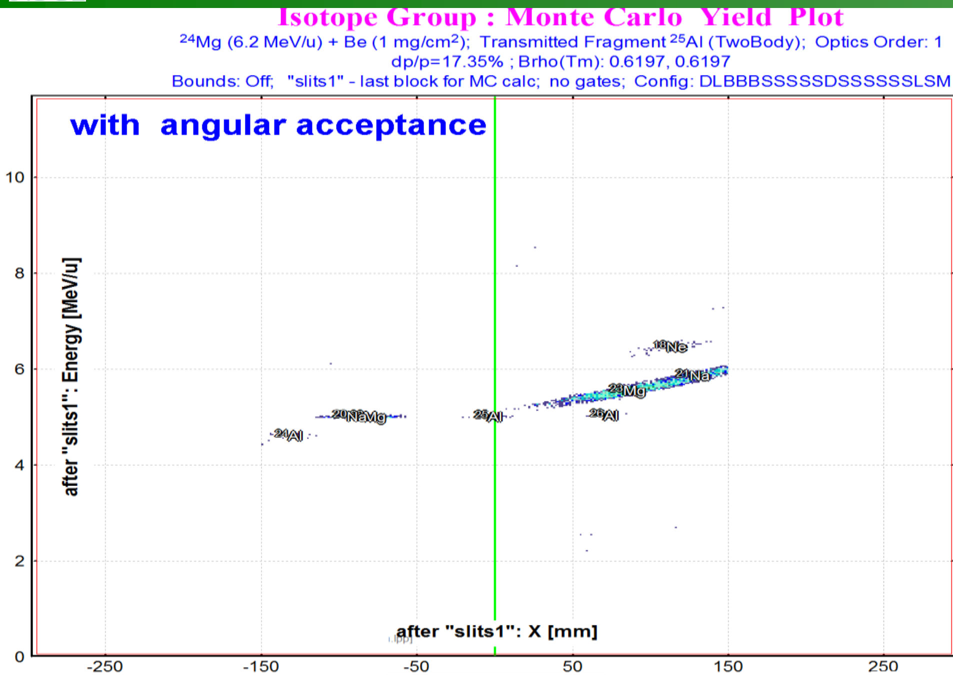
After the slits1 without angular acceptance, But taken bounds into account

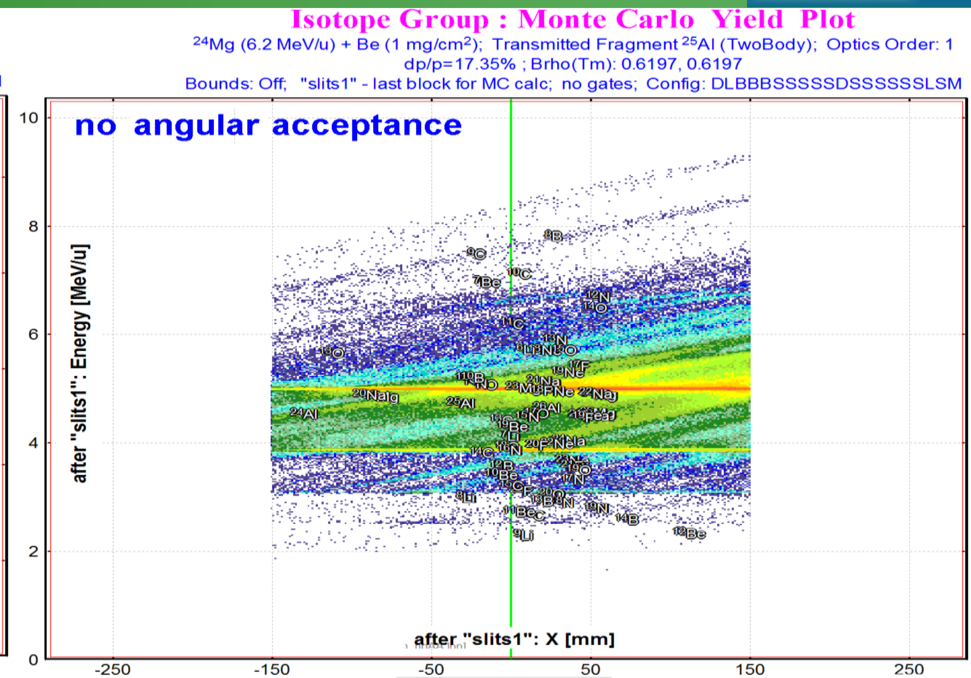


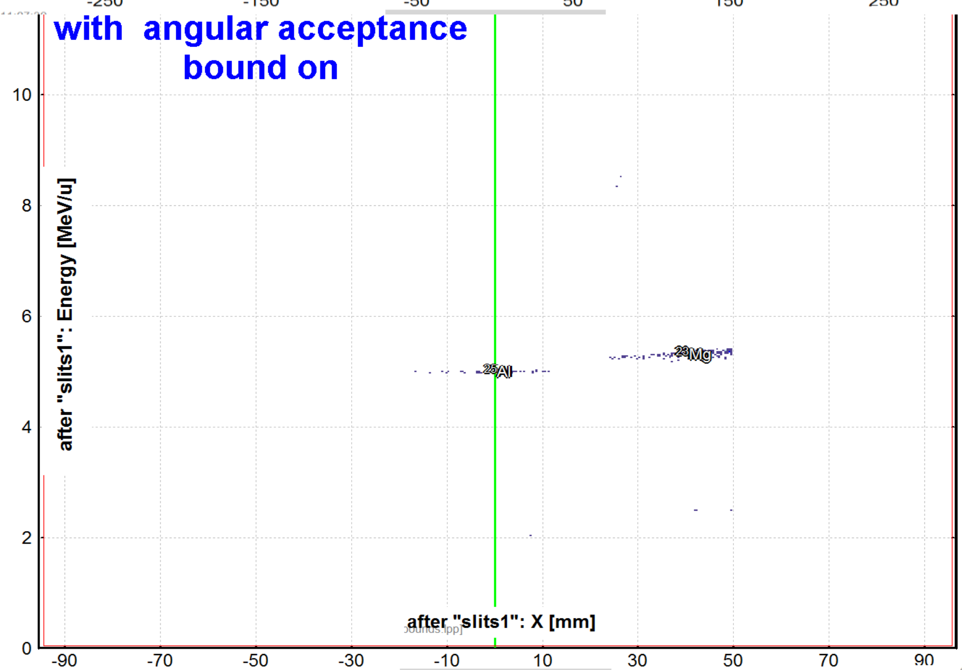


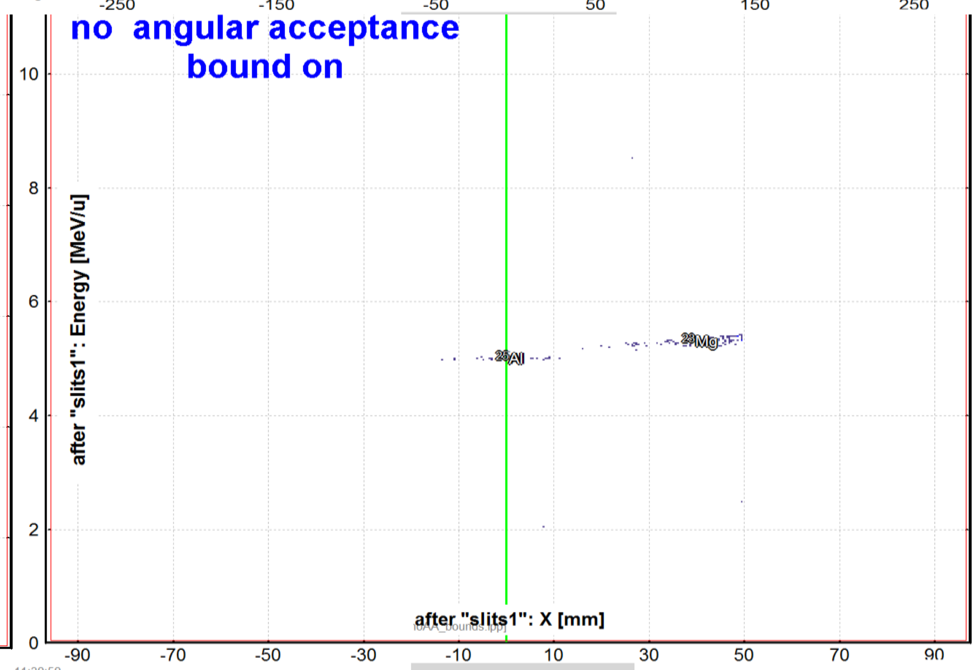
Transmission 1.6%

RESOLUT : transmission, separation

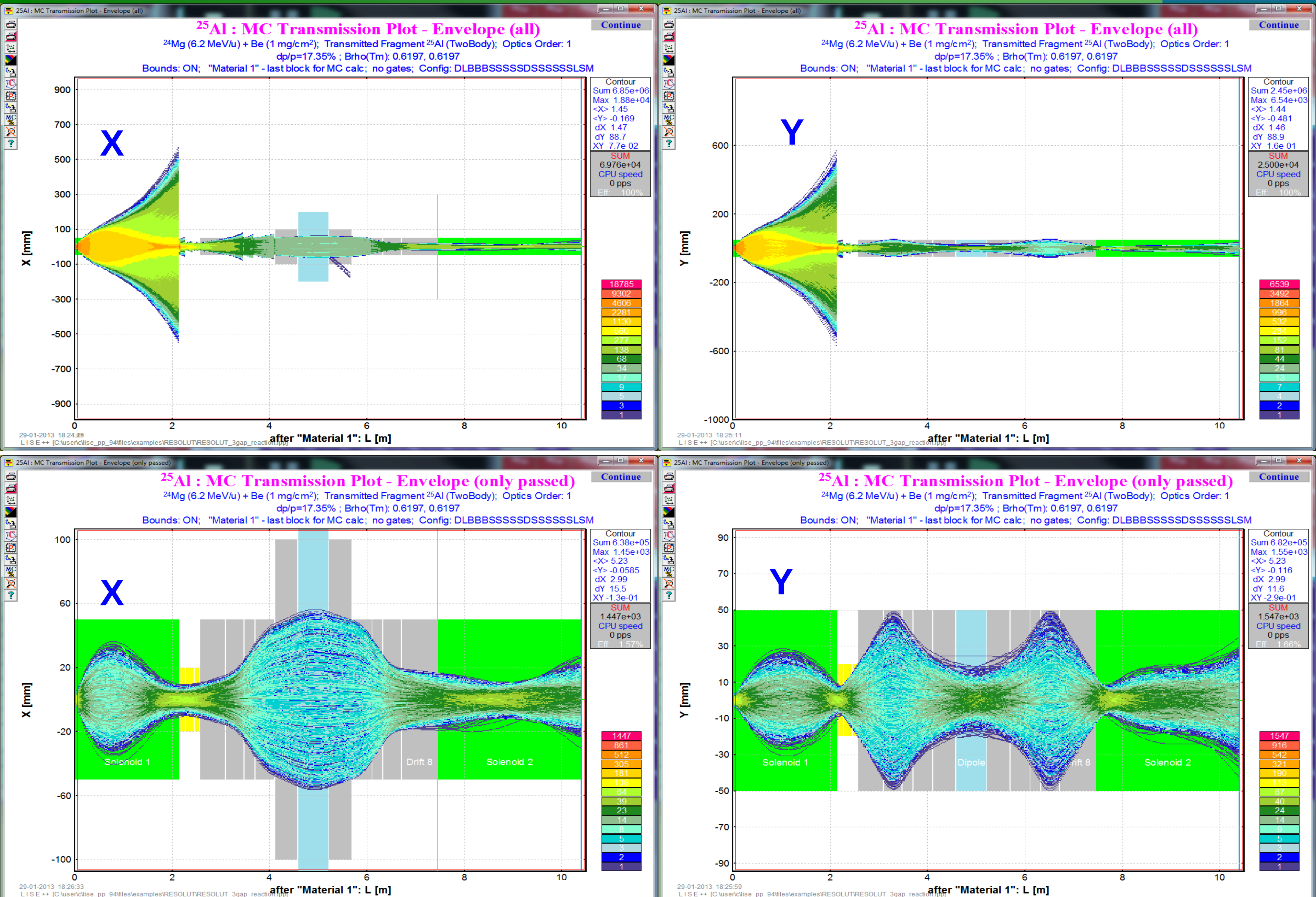




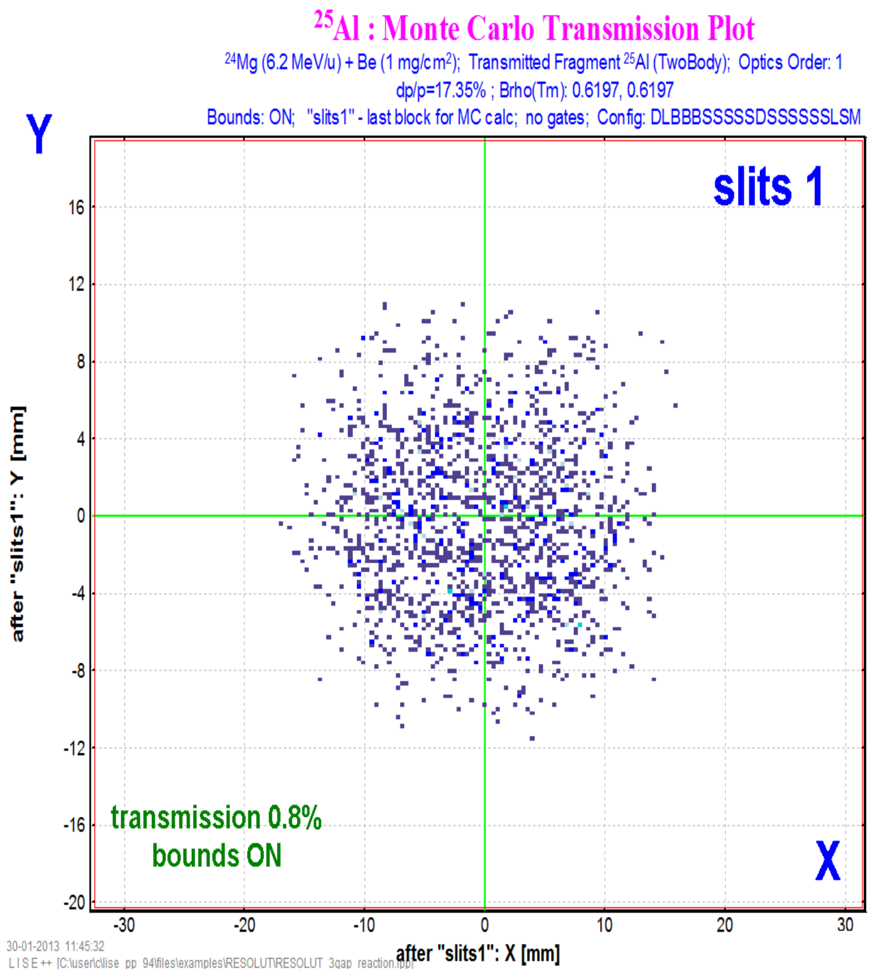


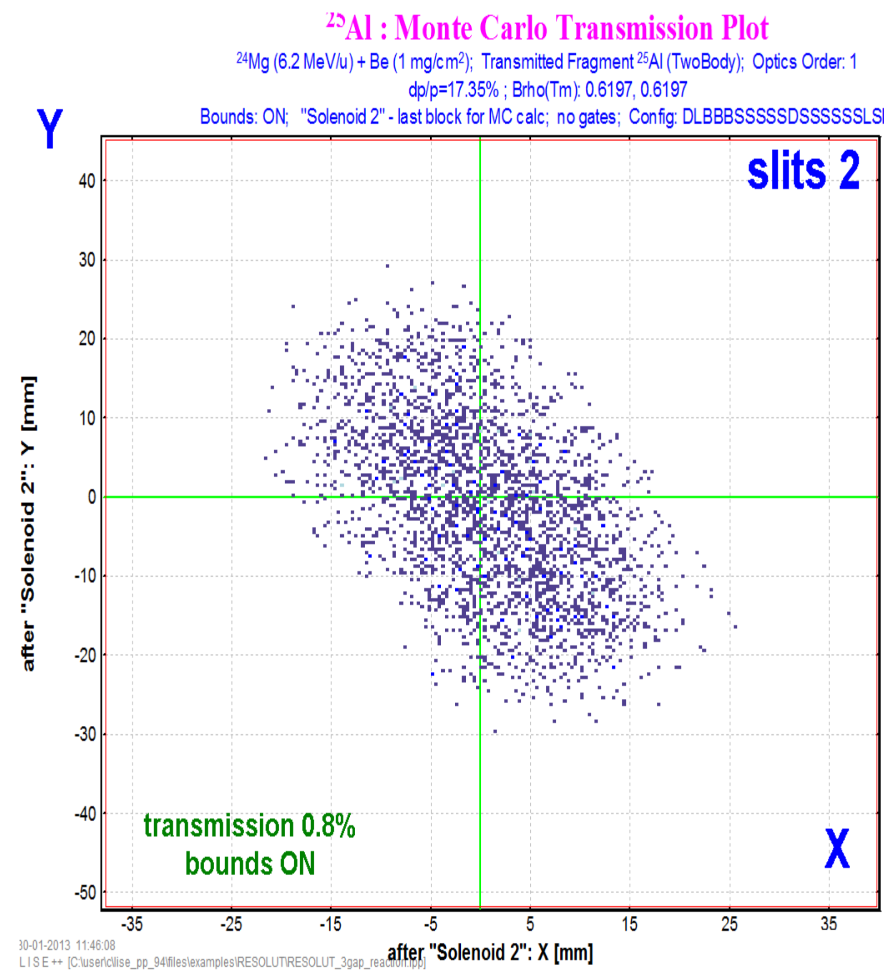


Three RF-bunchers in LISE++ : ^{25}Al envelopes



Three RF-bunchers in LISE++ : ^{25}Al transmission

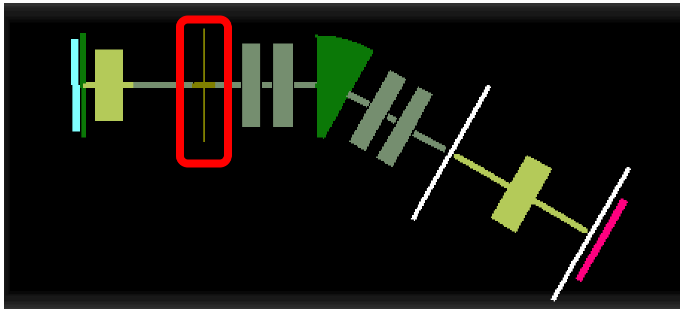




RESOLUT : One gap RF-buncher solution in LISE++

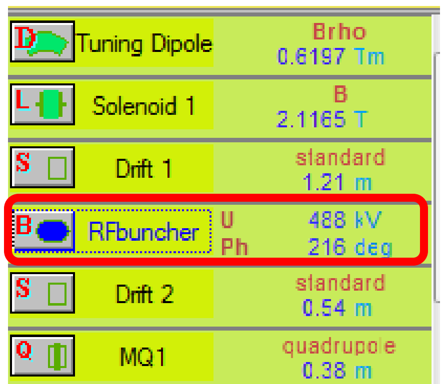
MICHIGAN STATE UNIVERSITY LISE++

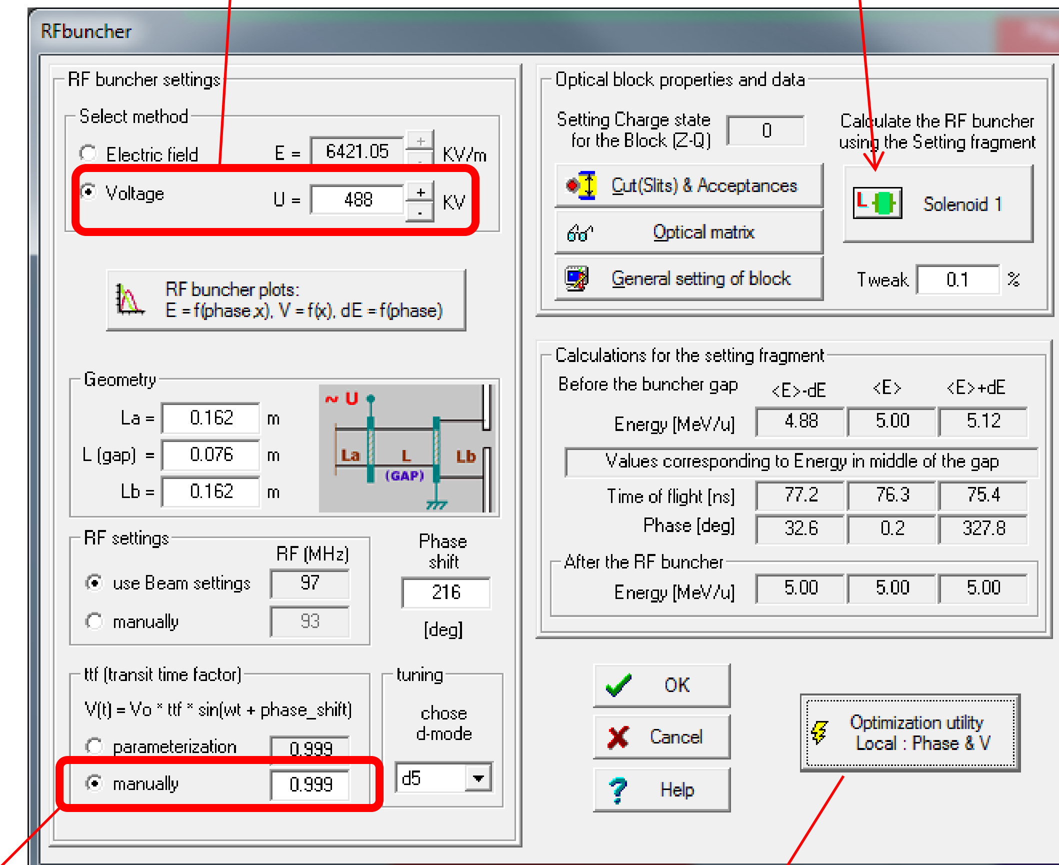
RESOLUT_1gap.lpp



Should be used factor 4 relatively nominal voltage

Click this button to set the phase corresponded to smallest d-value



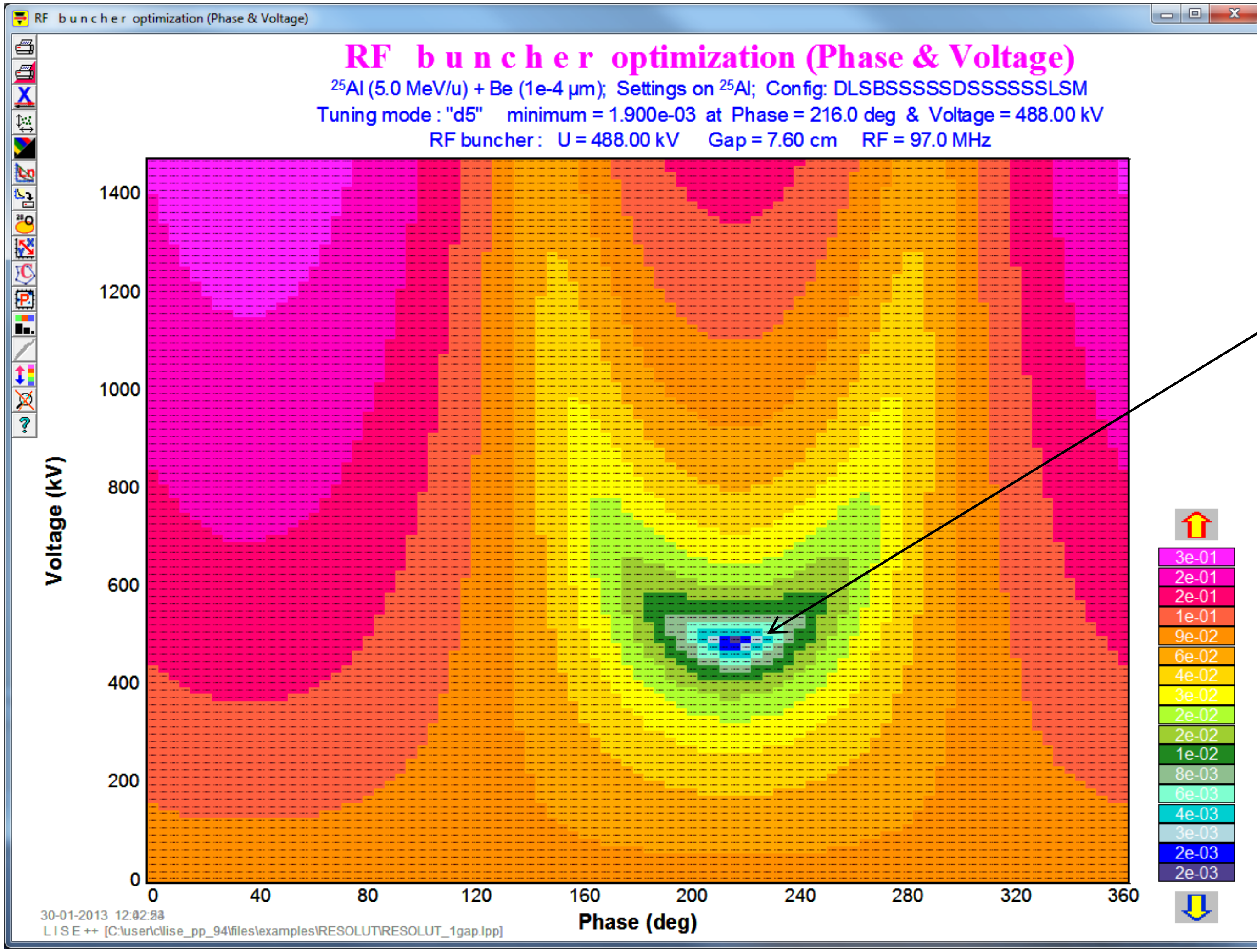


Main advantage of this configuration is possibility to use the LISE++ built-in optimization procedures

Pay attention for the factor in this configuration

See the next slide

RESOLUT : optimization

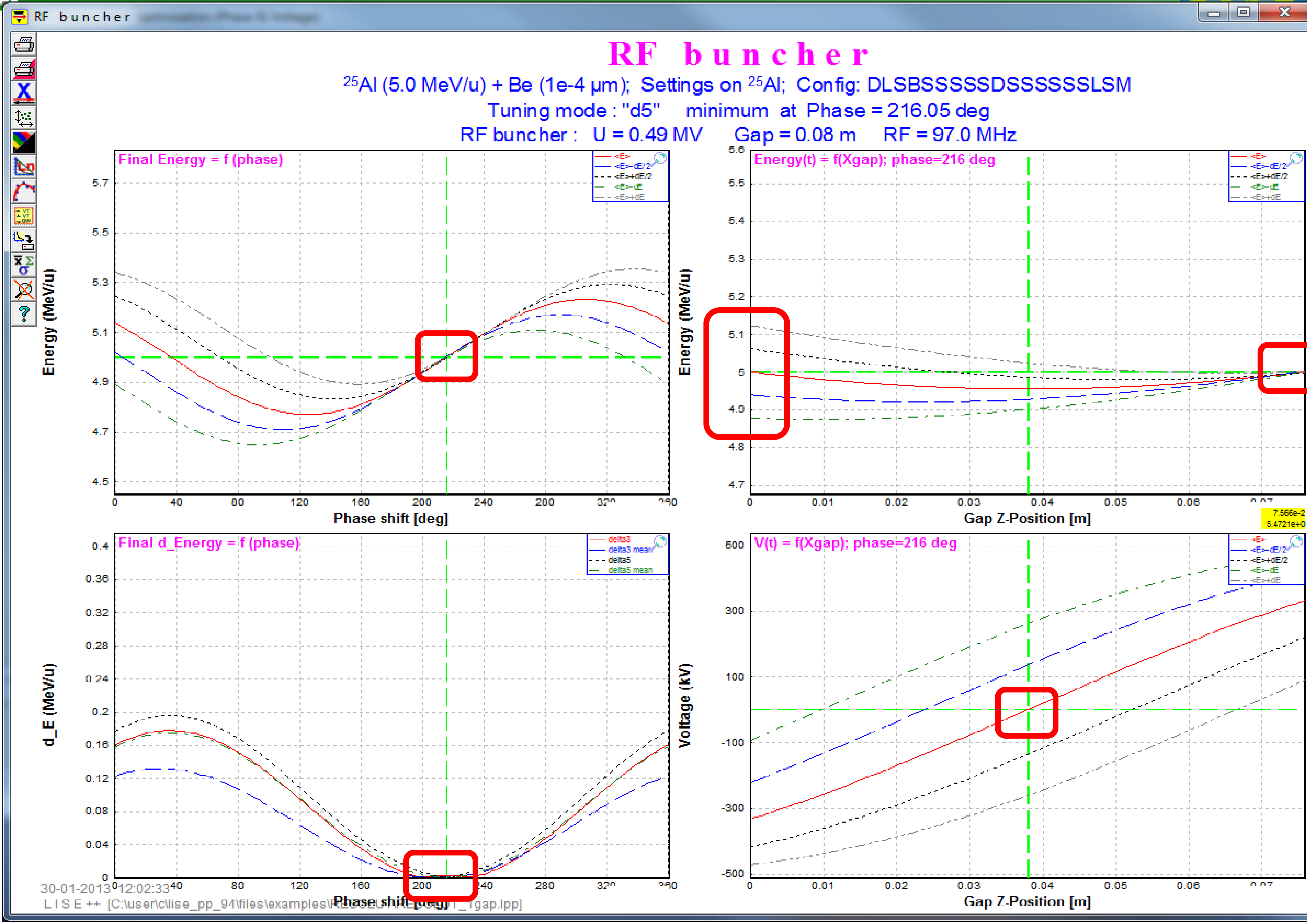


488 kV
216 degrees

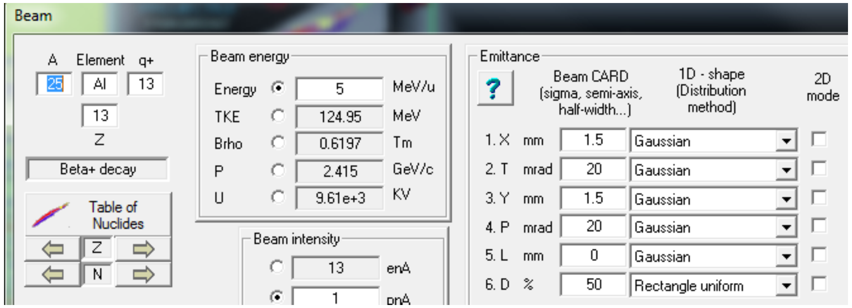
488 kV in this mode corresponds to 122 kV nominal value.

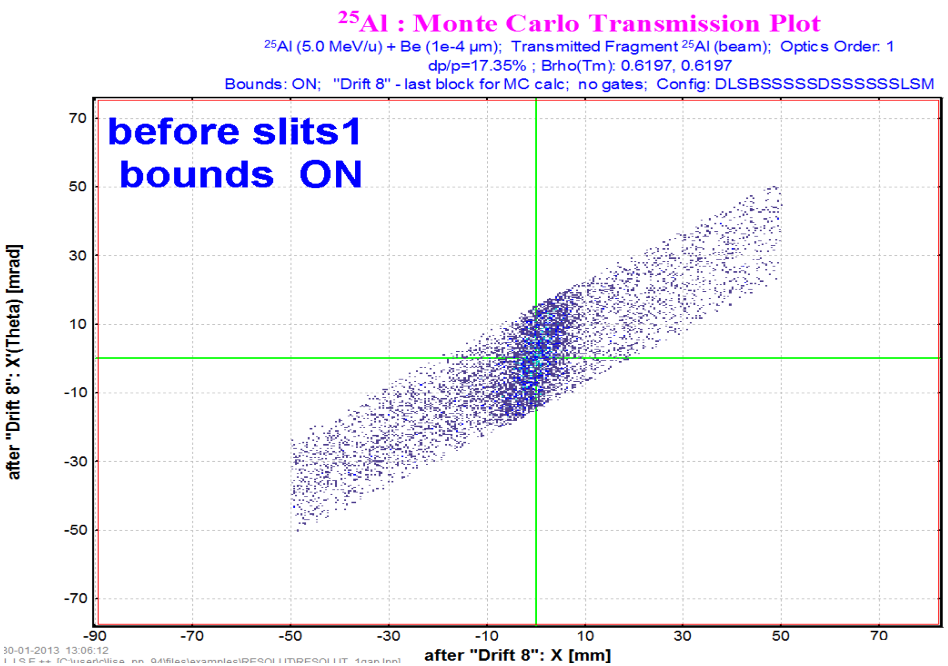
From FSU COSY file
V= 119.6 kV
(see page 7)

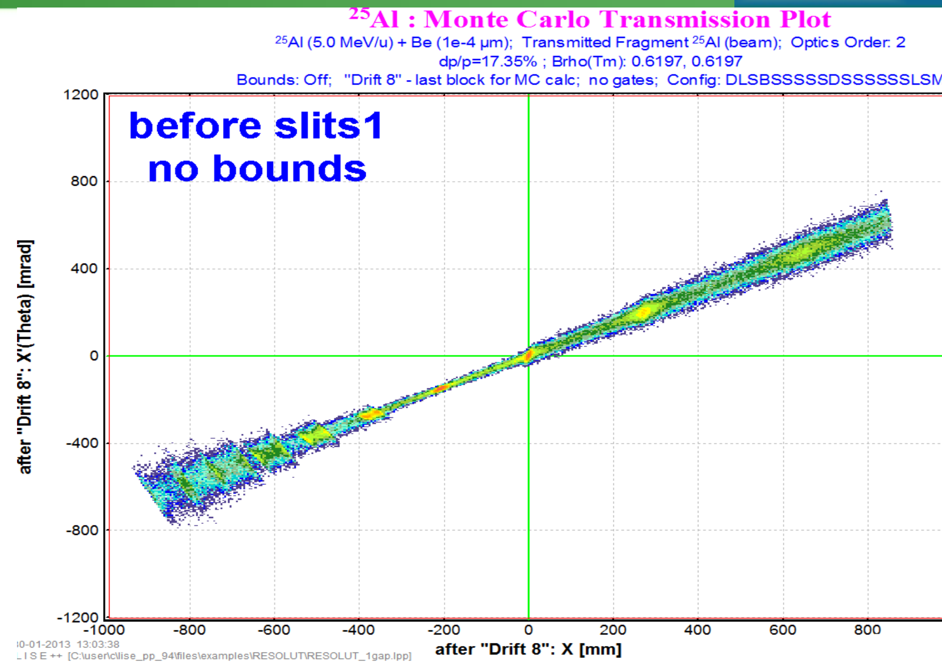
RESOLUT : RF buncher plots

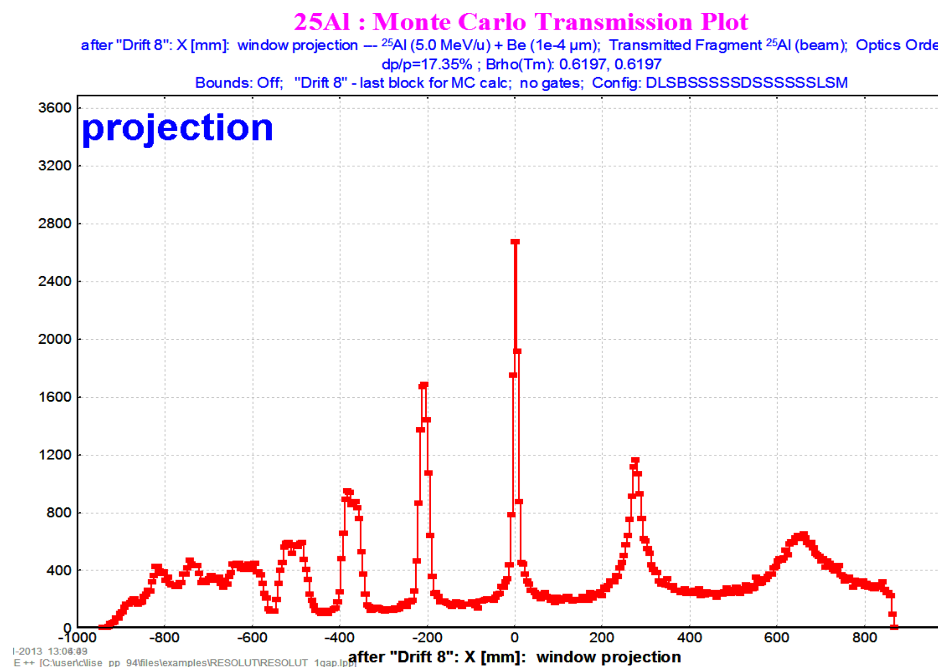


RESOLUT : One gap RF-buncher solution in LISE++



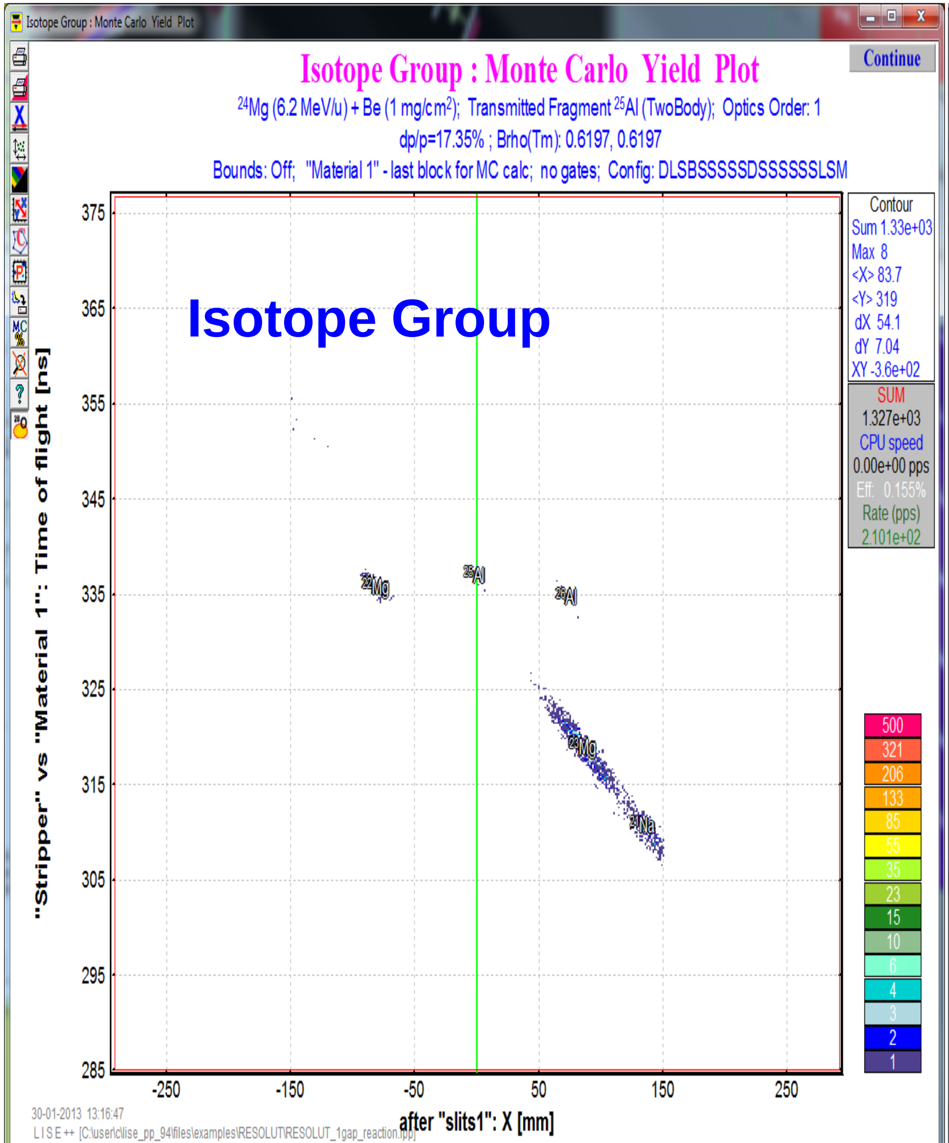


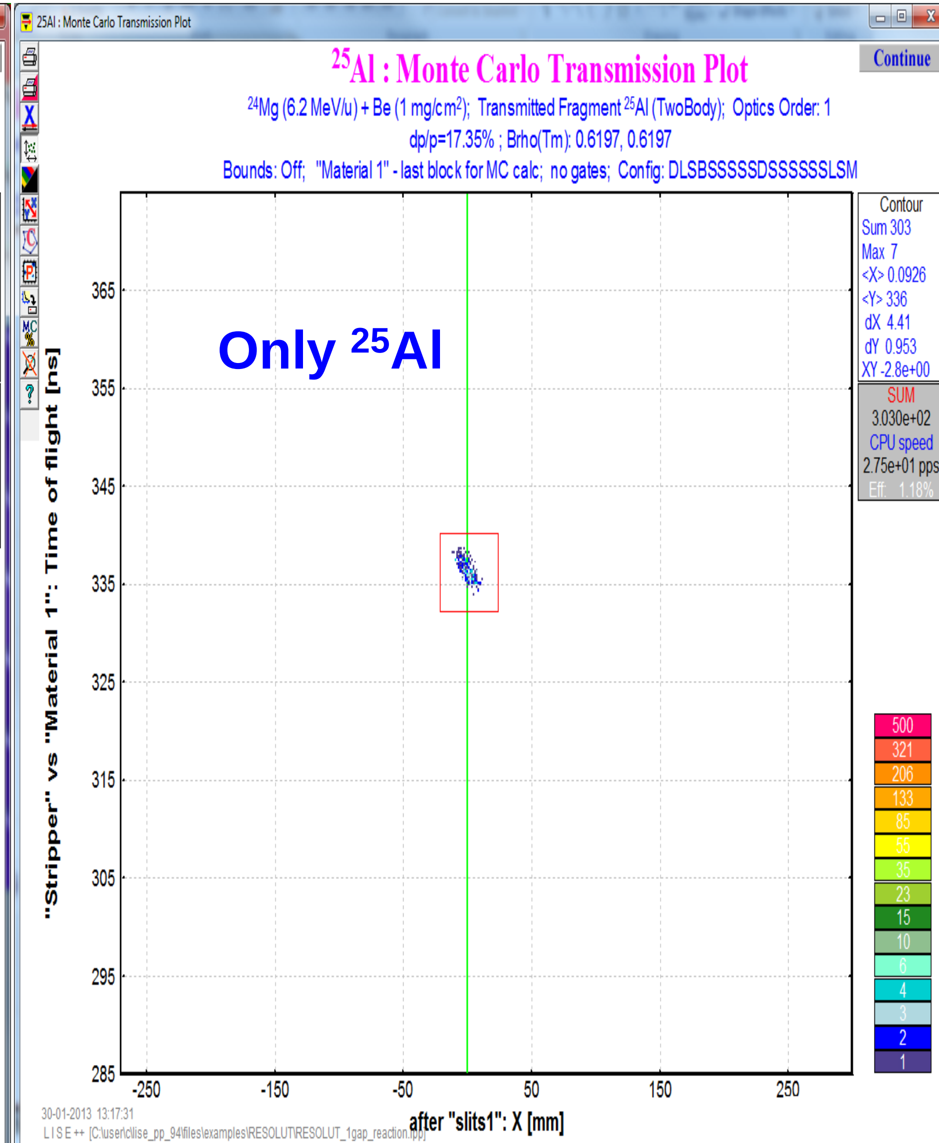




RESOLUT (One gap RF-buncher) : fragment transmission

After the Slits1 with angular acceptance, Bounds OFF





Transmission values are identical in RESOLUT_1gap & RESOLUT 3_gap

Summary, Outlooks

- The RESOLUT separator configurations can be used in Monte Carlo mode to simulate experiments, fragment transmission and separation
- Analytical solutions for optimization of RF-buncher in RESOLUT separator configuration (1 gap solution) can be used to tune Three-gap RF buncher (Bias, Phase)
- It is recommended in the case of fragment velocity beta~0.1 to use the Separator configuration with 1-gap solution in order to have optimization tools working properly

- 1 gap RF-buncher "Distribution" solution will be done soon (now it is acting as a drift block for transmission calculations)
- MC solution for the RF-buncher should be checked for large angles
- ? Consider creation of blocks "2gap RF-buncher" and "3gap RF-buncher" by analogy with COSY
- ? Consider implementation of V=V0*f(R,Z) in MC calculations
- Apertures, acceptances should be checked

Finally… version 9.4.87

FSU's request (Prof.I.Wiedenhoever)

Information from Prof.I.Wiedenhoever and discussions with Dr.M.Portillo and Prof.G.Rogachev are very appreciated.

configurations:
config/other/RESOLUT_1gap.lcn
config/other/RESOLUT_3gap.lcn

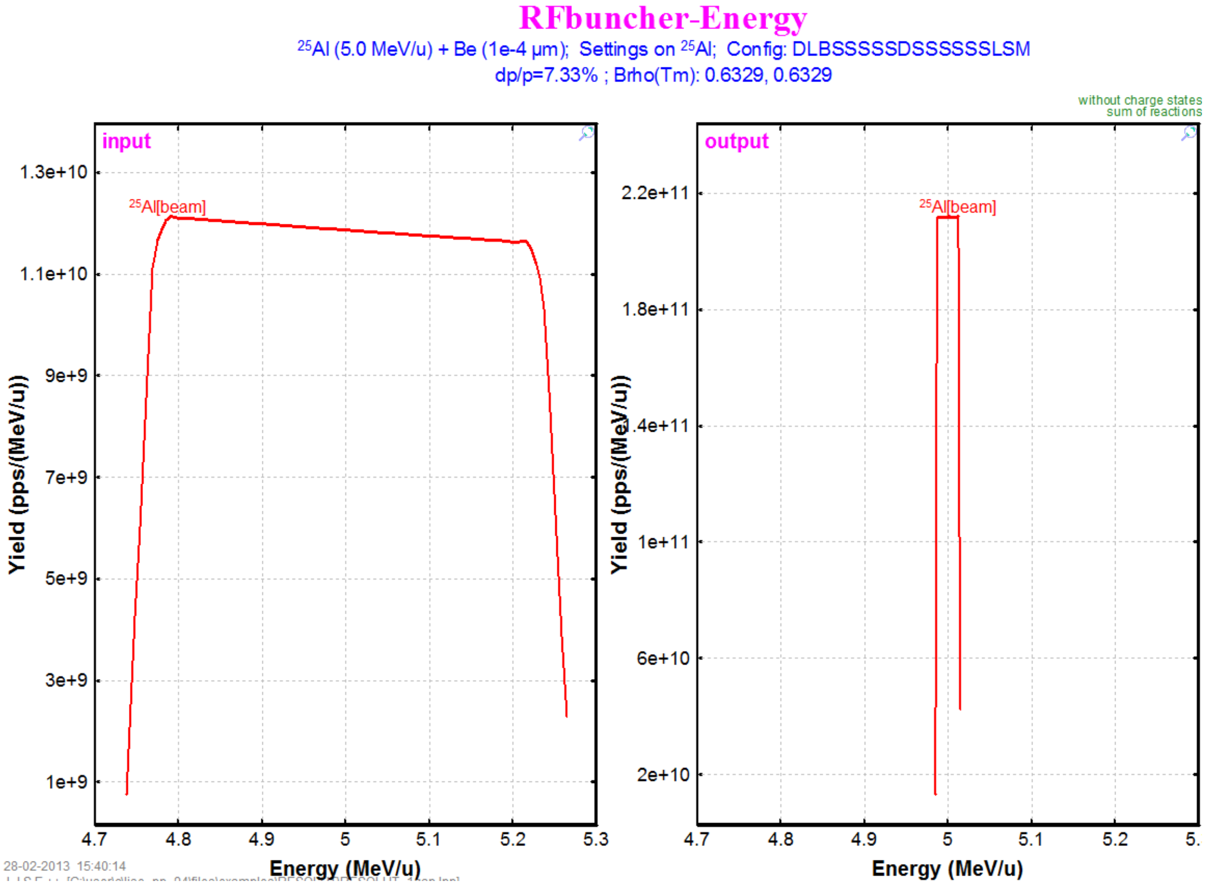
example files:
examples/RESOLUT/RESOLUT_1gap.lpp
examples/RESOLUT/RESOLUT_1gap_reaction.lpp
examples/RESOLUT/RESOLUT_3gap.lpp
examples/RESOLUT/RESOLUT_3gap_reaction.lpp

This file http://lise.nscl.msu.edu/9_4/buncher/9_4_87_buncher.pdf

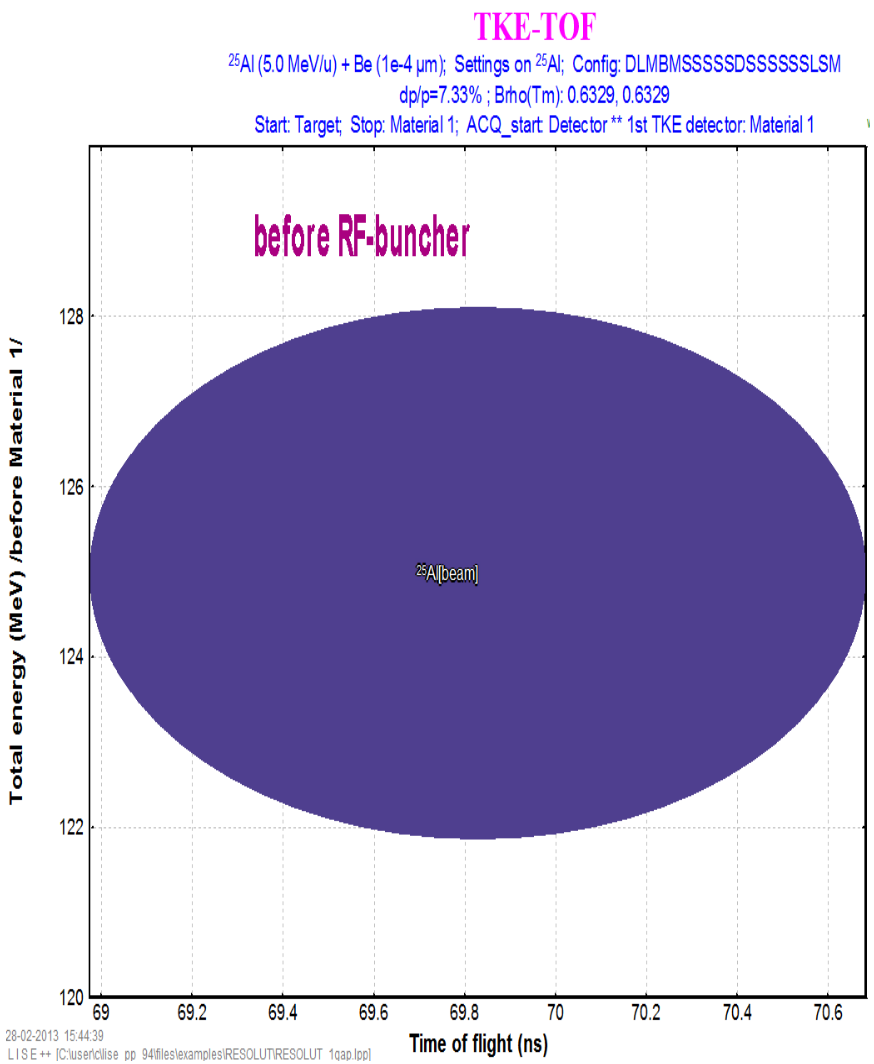
- **configurations revision**

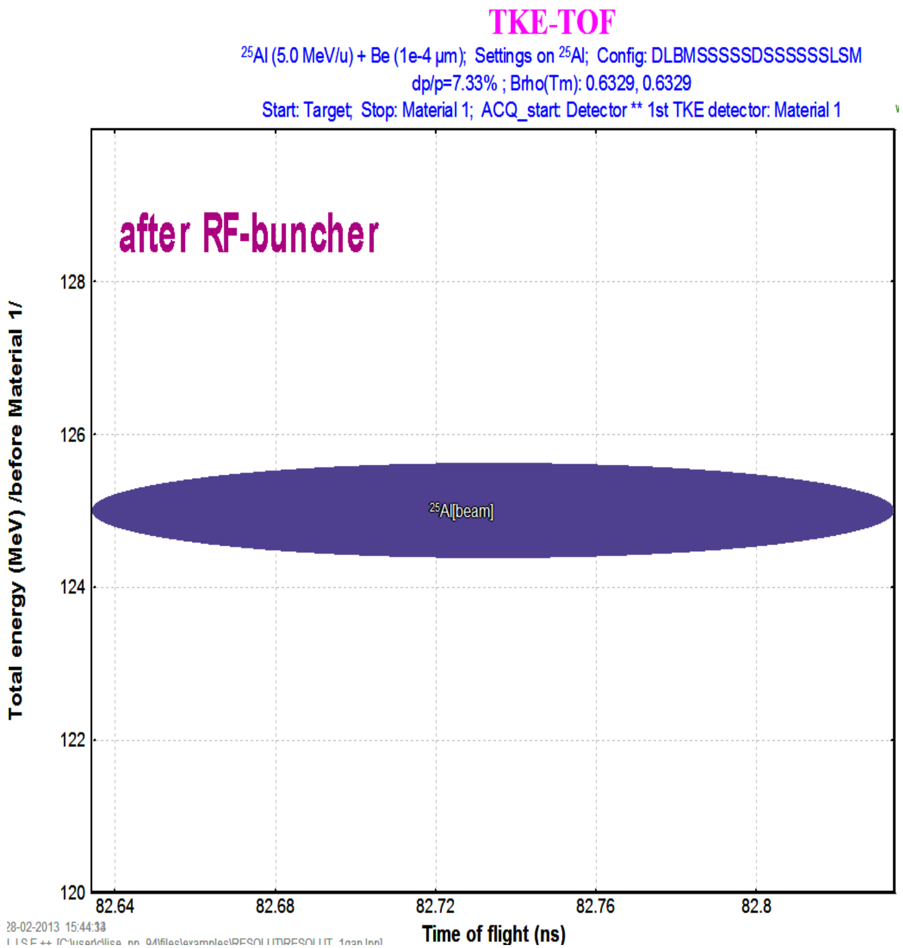
  Do not use angular acceptance for a Solenoid block!
  Angular acceptances +/-47 mrad moved to the "tuning dipole" block

- **RF-buncher transmission analytical calculations**



- **Graph_goodies (ellipse plot)**





Pseudo Monte Carlo plot is under construction

Next steps for version 9.6

- develop the Timing component for the Distribution4 class