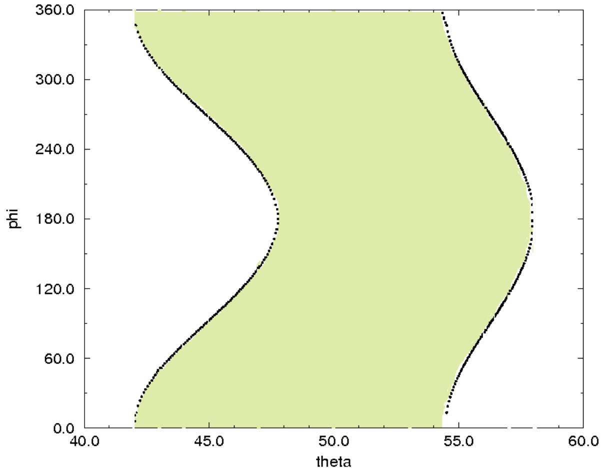
Description of (simple) detector shapes in GOSIA

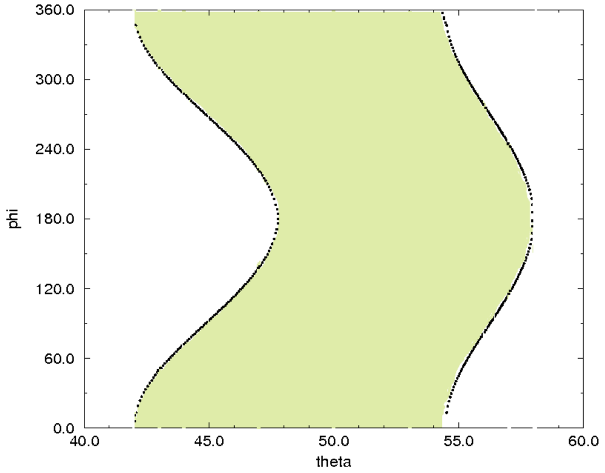


OP,INTG
7,

To be provided in OP,INTG part:

- number of energy meshpoints

Description of (simple) detector shapes in GOSIA

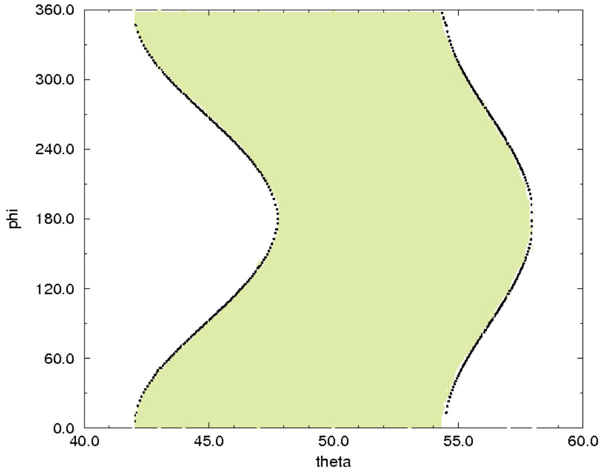


OP,INTG
7,-9,

To be provided in OP,INTG part:

- number of energy meshpoints
- number of θ meshpoints (with „-” sign if we plan to use the $\phi(\theta)$ dependence), no more than 11 points

Description of (simple) detector shapes in GOSIA

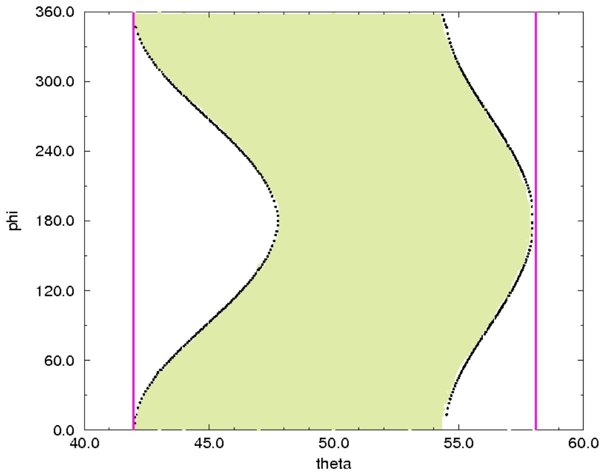


OP,INTG
7,-9, 329.6, 346.7

To be provided in OP,INTG part:

- number of energy meshpoints
- number of θ meshpoints (with „-” sign if we plan to use the $\phi(\theta)$ dependence), no more than 11 points
- minimum and maximum bombarding energy

Description of (simple) detector shapes in GOSIA

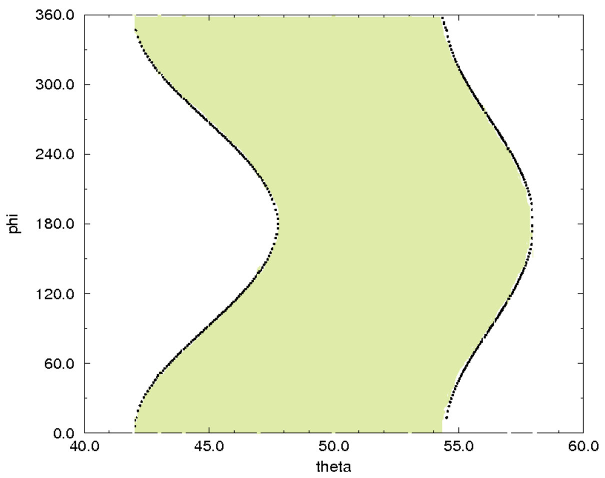


OP,INTG
7,-9, 329.6, 346.7,42.,58.

To be provided in OP,INTG part:

- number of energy meshpoints
- number of θ meshpoints (with „-” sign if we plan to use the $\phi(\theta)$ dependence), no more than 11 points
- minimum and maximum bombarding energy
- minimum and maximum θ angles

Description of (simple) detector shapes in GOSIA

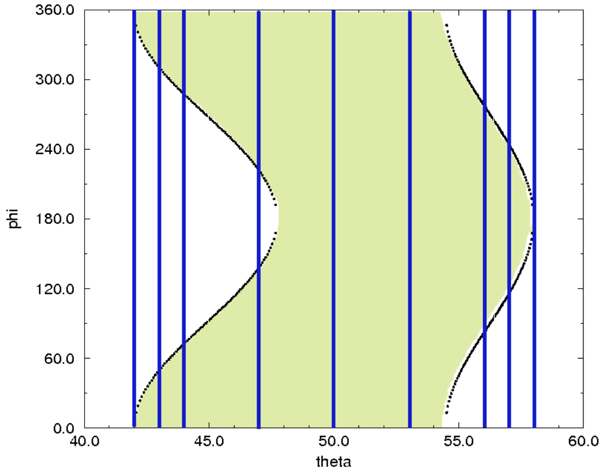


OP,INTG
7,-9, 329.6, 346.7,42.,58.
329 332 335 338 341 344 347

To be provided in OP,INTG part:

- number of energy meshpoints
- number of θ meshpoints (with „-” sign if we plan to use the $\phi(\theta)$ dependence), no more than 11 points
- minimum and maximum bombarding energy
- minimum and maximum θ angles
- energy meshpoints

Description of (simple) detector shapes in GOSIA

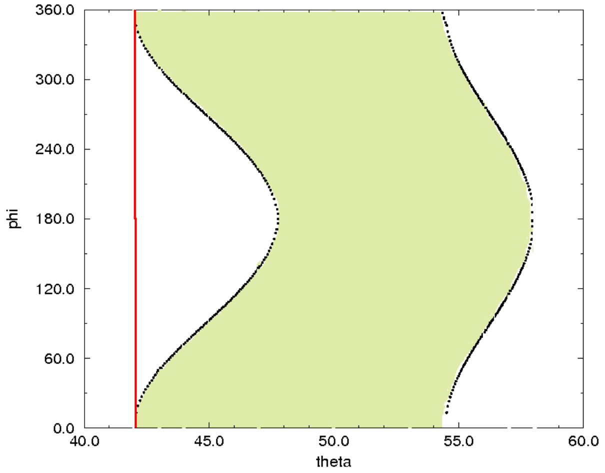


OP,INTG
7,-9, 329.6, 346.7,42.,58.
329 332 335 338 341 344 347
42, 43, 44, 47, 50, 53, 56, 57, 58

To be provided in OP,INTG part:

- number of energy meshpoints
- number of θ meshpoints (with „-” sign if we plan to use the $\phi(\theta)$ dependence), no more than 11 points
- minimum and maximum bombarding energy
- minimum and maximum θ angles
- energy meshpoints
- theta meshpoints: among them minimum and maximum θ angles, more points where the shape is more complicated

Description of (simple) detector shapes in GOSIA

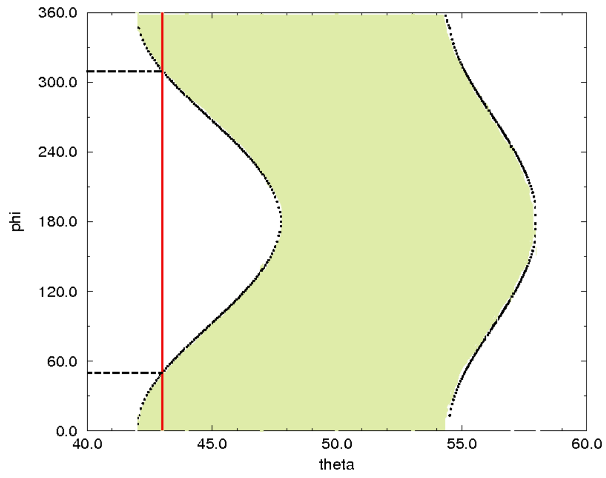


OP,INTG
7,-9, 329.6, 346.7,42.,58.
329 332 335 338 341 344 347
42, 43, 44, 47, 50, 53, 56, 57, 58
2,
0, 2, 358, 360

Then for each of the theta meshpoints we have to give the $\phi_{minimum}$ and $\phi_{maximum}$; if there are two phi ranges, we have to specify 2 such ϕ pairs.

- first point (θ = 42°) – two phi ranges: (0°-2°) and (358°-360°)

Description of (simple) detector shapes in GOSIA

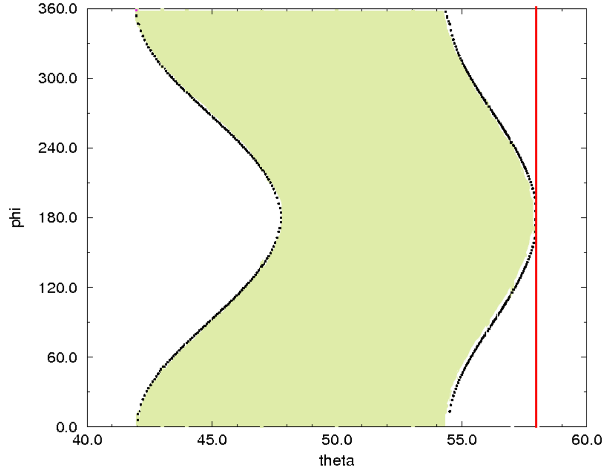


OP,INTG
7,-9, 329.6, 346.7,42.,58.
329 332 335 338 341 344 347
42, 43, 44, 47, 50, 53, 56, 57, 58
2,
0, 2, 358, 360
2,
0, 50, 310, 360

Then for each of the theta meshpoints we have to give the $\phi_{minimum}$ and $\phi_{maximum}$; if there are two phi ranges, we have to specify 2 such ϕ pairs.

- first point (θ = 42°) – two phi ranges: (0°-2°) and (358°-360°)
- second point (θ = 43°) – two phi ranges: (0°-50°) and (310°-360°)
- and so on...

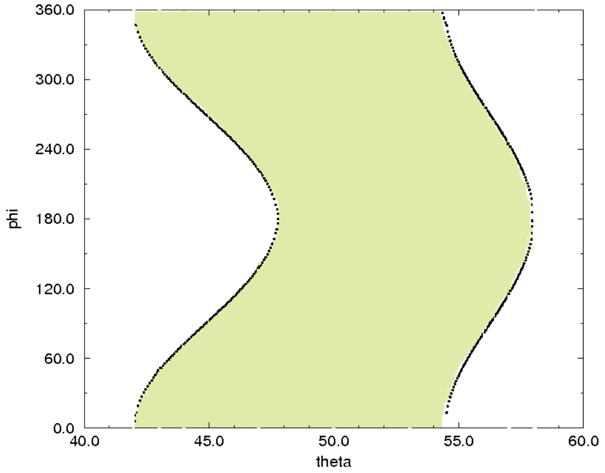
Description of (simple) detector shapes in GOSIA



1,
178, 182

- ...
- last point (θ = 58°) – one phi range: (178°-182°)

Description of (simple) detector shapes in GOSIA

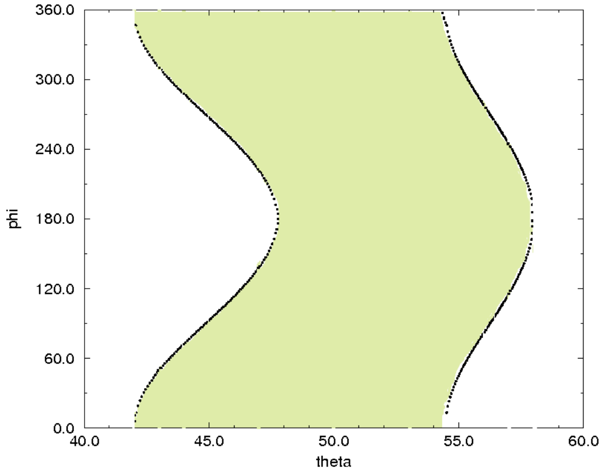


1,
178, 182
7
329 332 335 338 341 344 347
17.23 17.22 17.21 17.20 17.19 17.18
17.17

Input of stopping powers:

- number of meshpoints
- energy meshpoints
- stopping powers

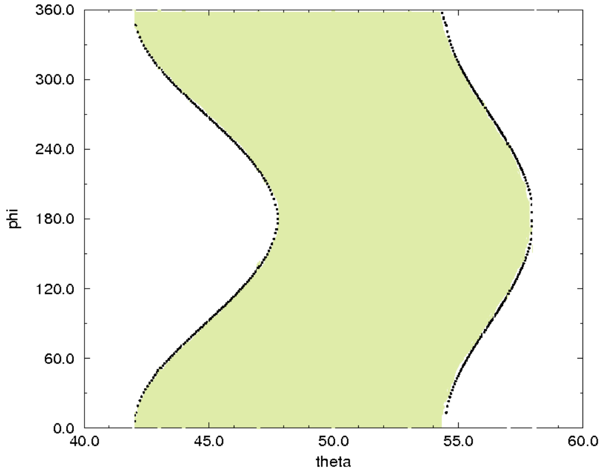
Description of (simple) detector shapes in GOSIA



7
329 332 335 338 341 344 347
17.23 17.22 17.21 17.20 17.19 17.18
17.17
10,

- stopping powers
- number of subdivisions of energy used for integration (even number, maximum value 50)

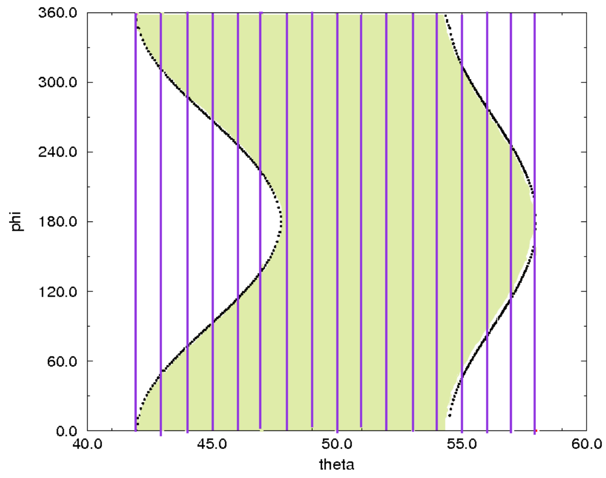
Description of (simple) detector shapes in GOSIA



7
329 332 335 338 341 344 347
17.23 17.22 17.21 17.20 17.19 17.18
17.17
10,-16

- stopping powers
- number of equal subdivisions of energy used for integration (even number, maximum value 50)
- number of equal subdivisions of theta used for integration (even number, maximum value 50, with „-” sign if we use the $\phi(\theta)$ dependence). Here: sixteen ranges, 1 degree each.

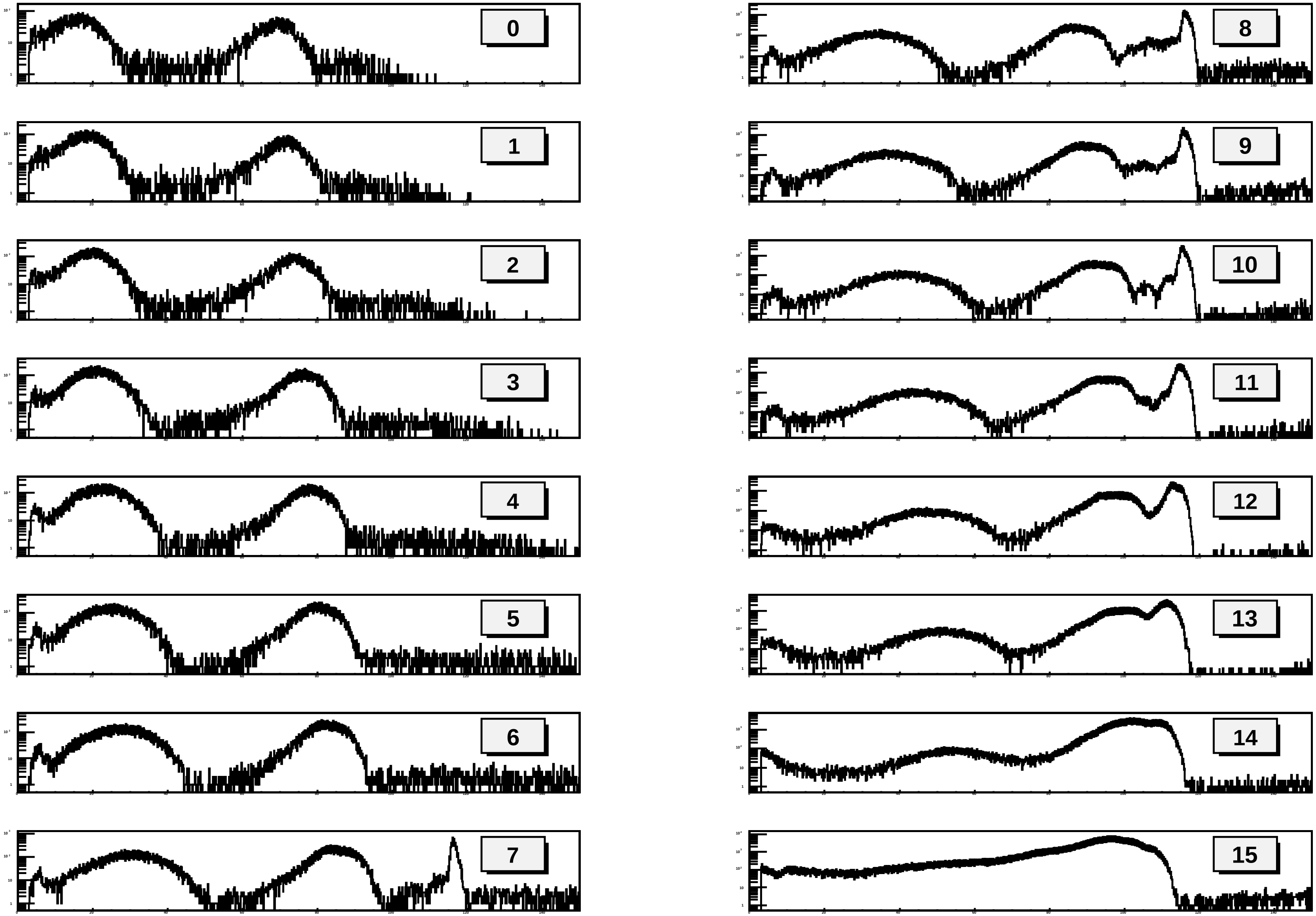
Description of (simple) detector shapes in GOSIA



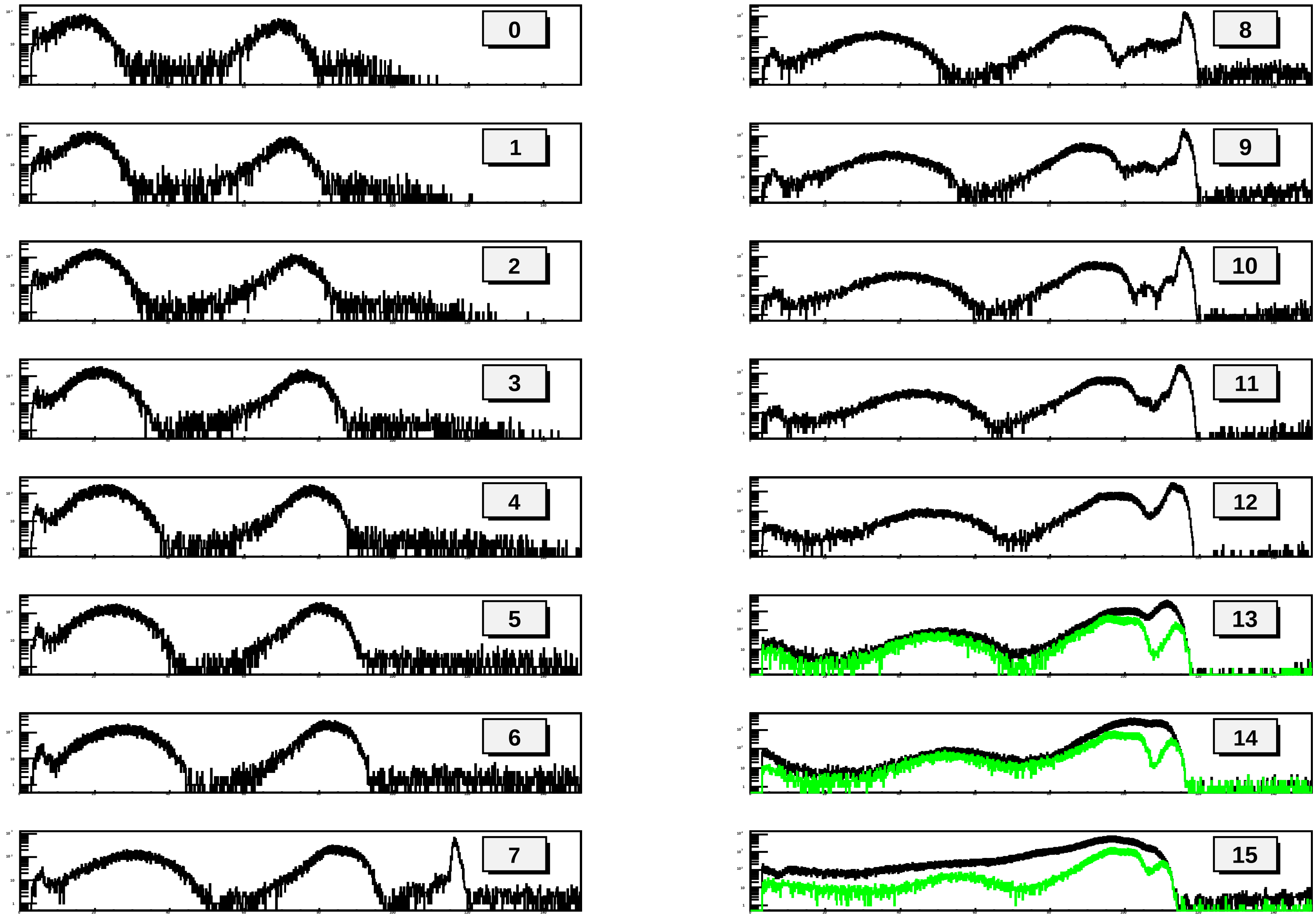
7
329 332 335 338 341 344 347
17.23 17.22 17.21 17.20 17.19 17.18
17.17
10,-16
4, 100,144,186,226,276,360,360,360,
360,360,360,360,270,196,130,4

- stopping powers
- number of equal subdivisions of energy used for integration (even number, maximum value 50)
- number of equal subdivisions of theta used for integration (even number, maximum value 50, with „-” sign if we use the $\phi(\theta)$ dependence). Here: sixteen ranges, 1 degree each.
- total phi range for each subdivision (seventeen points)

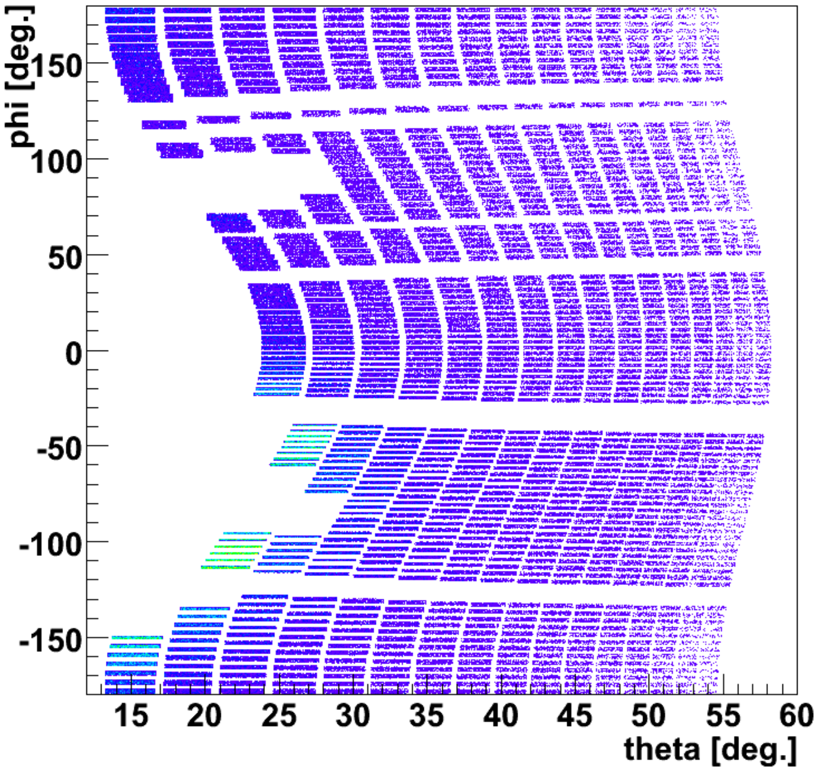
Recoil and scattered beam identification



Recoil and scattered beam identification

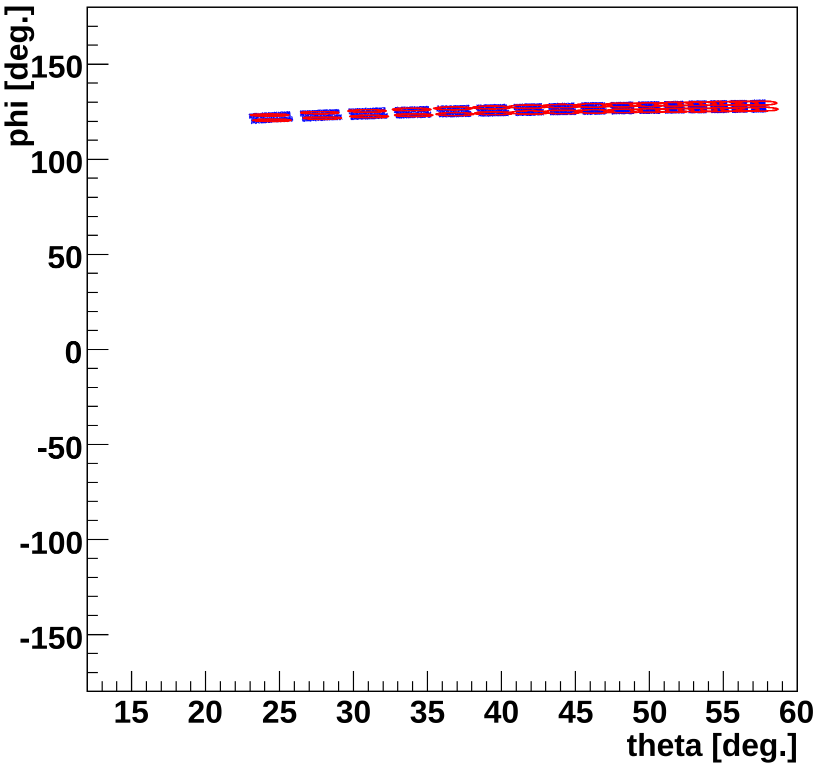


Detector shape on (theta,phi) plane



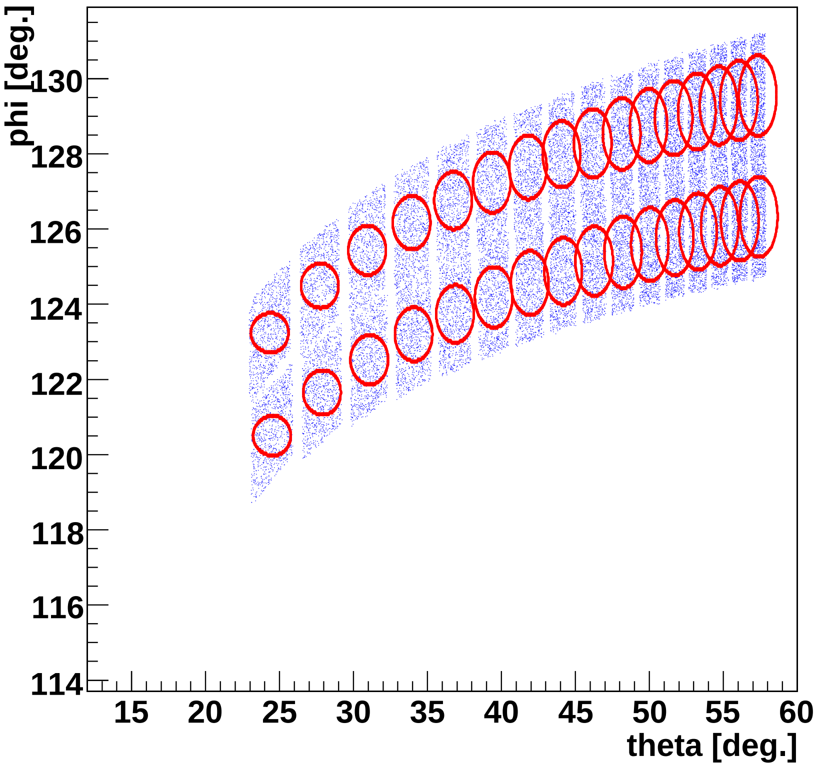
- a much more complicated detector shape
- ”standard” OP,INTG – limitation to 11 theta meshpoints
- an idea to use option ”PIN”

Description of more complicated detector shapes



- each detector pixel (1456 in total) described as a small single circular detector:
  OP,INTG
  4, 3, 105, 117 57.3, 129.5, 1.27
  104.7, 109.1, 113.5, 118.
- angular range covered by a single detector chosen to reproduce the Rutherford cross section

Description of more complicated detector shapes



- each detector pixel described as a small single circular detector
- more flexibility in description of complicated shapes
- results of integration using the standard OP,INTG procedure and this approach differ by less than 4%

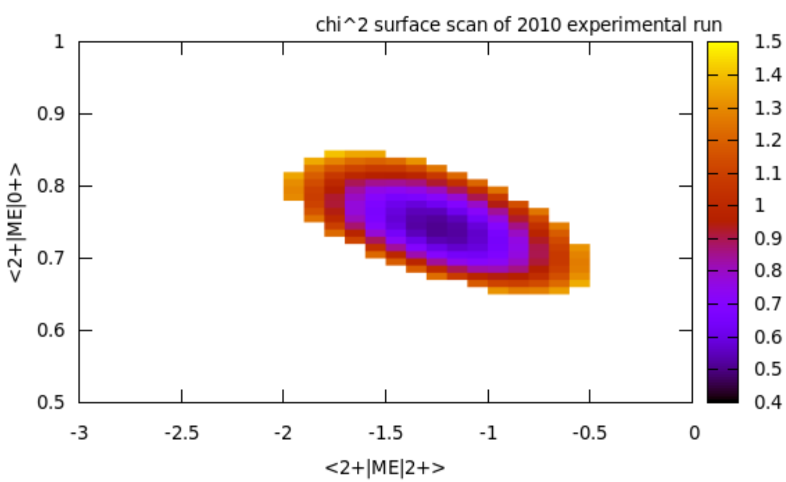
Normalisation to the target excitation

- if only one combination of beam and target is used, one can use GOSIA2 (available at www.slcj.uw.edu.pl/gosia)
- two input files have to be prepared: one for target, one for beam
- in principle all steps (integration etc.) are possible, but it is better to use GOSIA2 for minimisation only
- GOSIA2 minimises χ^2 function for the target (this includes calculation of normalisation factors) and then uses the same normalisation factors as as starting point when it starts minimising χ^2 for the beam
- after several iterations best set of normalisation factors found
- for high CM angles - diagonal matrix element for the target important

$$eQ_{sp} = \sqrt{\frac{16\pi}{5}} \frac{1}{\sqrt{2I+1}} (I, I, 2, 0|I, I) \langle I \| \hat{M}(E2) \| I \rangle$$

Limitations of GOSIA2

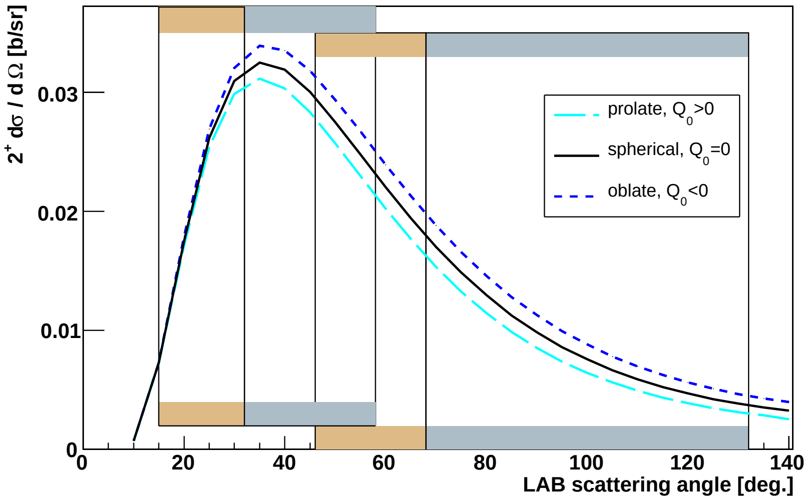
- data collected on more than one target
- error calculation – „by hand”
- if one-step excitation for both target and projectile, one can use standard error progression (contributions from:
  - uncertainty of target yield
  - uncertainty of projectile yield
  - uncertainty of the B(E2) of the target)
- if several angular ranges and quadrupole moment important – χ^2 surface map



- χ^2 calculated for various combinations of Q and B(E2) for the beam
- contributions to the total χ^2 both from beam and target fit

- if more than 2 matrix elements involved – almost impossible!

Possible solution



- lowest angular range – influence of quadrupole moment negligible $\rightarrow$ determination of $B(E2;2_1^+ \rightarrow 0^+)$
- information from other bins + data collected on Pb target $\longrightarrow$ determination of quadrupole moment of the 2_1^+ state and other B(E2)'s using standard GOSIA
- relative normalization of the bins based on target excitation

Relative normalization of the bins

```
EXPT
5,18,44
-47,109,111,22,3,1,0,0,360,0,1
-47,109,111,-120,3,1,0,0,360,0,1
-47,109,111,-100,3,1,0,0,360,0,1
-47,109,111,40,3,1,0,0,360,0,1
-82,208,155,-110,3,1,0,0,360,0,5
CONT
LCK,
0,0
PRT
13,1
```

```
OP,YIEL
(...)
2,1
1
.05
180
1
.05
2.4
1
.05
3.3
1
0.05
28
1
0.05
1
3
```