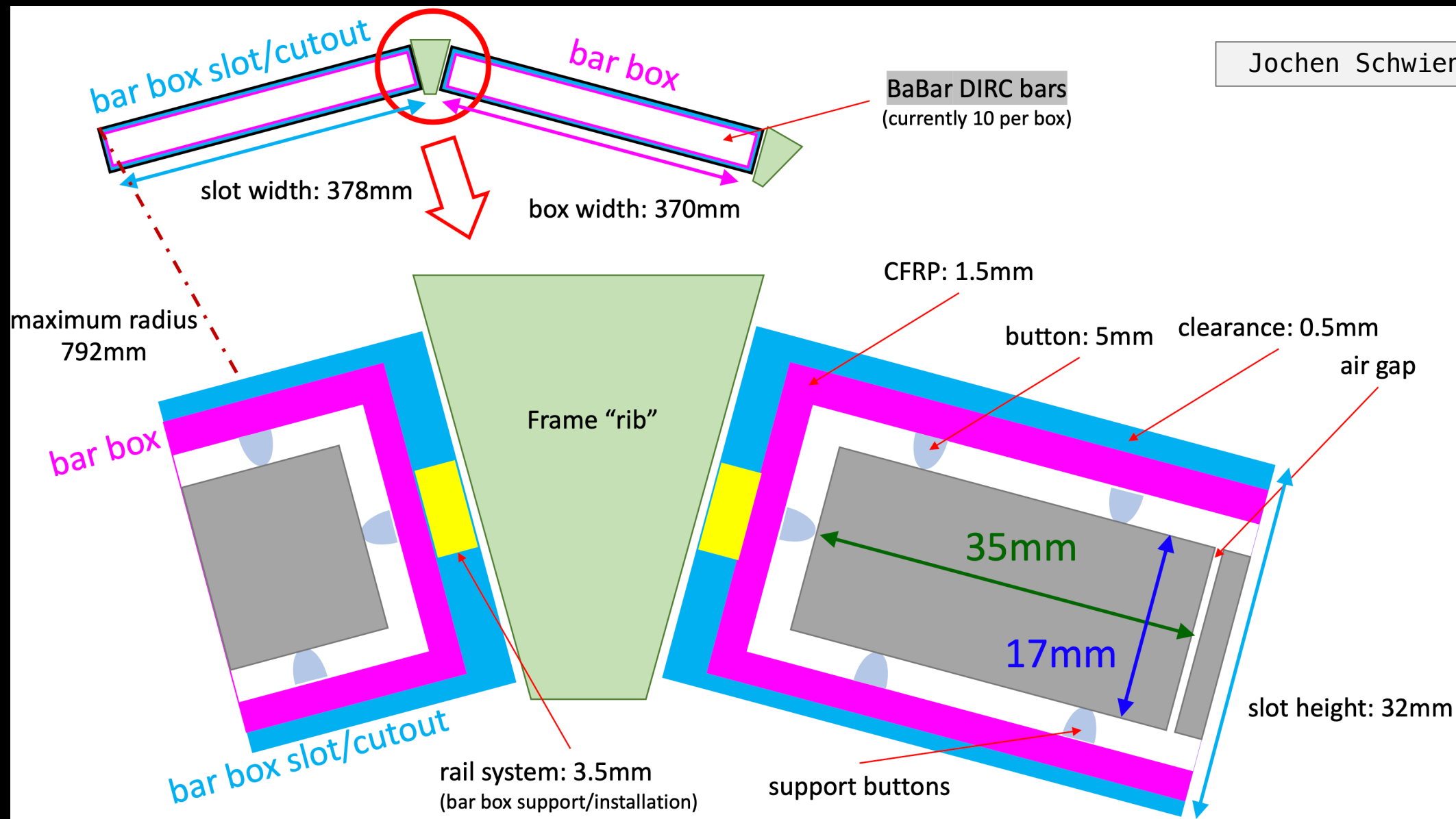


geometrical ϕ efficiency estimates

Jochen Schwiening



Jochen Schwiening

792	maximum outer slot radius (top left corner of slot/cutout)
7	bar box rails: 2*3.5
13	buttons (2*5) plus CFRP (2*1.5)

35	bar width/lens width
32	thickness of slot (31 bar box, 2*0.5 clearance)
0.15	air gap between bars
120	HRPPD width
110	HRPPD active width

# sectors	12	16	18	24
full width (slot+rib)	410.0	309.1	275.1	206.8
outer rib width	33	24.75	22	16.5
slot width	377.0	284.4	253.1	190.3
bar box width	370.0	277.4	246.1	183.3
active width	357.0	264.4	233.1	170.3

max # bars/sector	10.2	7.5	6.6	4.8
max # HRPPD/sector width	3.1	2.3	2.1	1.5

minimum inner slot radius	737.2	747.1	749.8	754.3
radial space required	55	45	42	38

middle bar centerline radius	753.2	763.1	765.8	770.3
centerline circumference	4733	4795	4812	4840

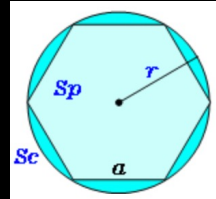
integer # bars/sector	10	7	6	4
total #bars	120	112	108	96

active bar width	4200	3920	3780	3360
fraction of circle covered by bars	88.7%	81.8%	78.6%	69.4%

# HRPPDs/sector width	3	2	2	1
active fraction of width covered	89.2%	79.3%	89.4%	60.0%

→ bar width = 34.865mm in eicdirc

NBOXES



→full (y) widths of each sector set using the **circumscribed** circle with radius $R = 792.1\text{mm}$

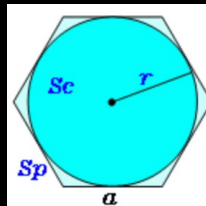
BARDEPTH=17.

BARINNERR=BARCENTERR-BARDEPTH/2.

BARCENTERR

70 + (5-7) cm

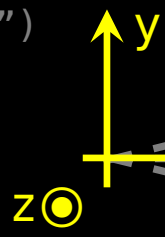
NBARS



→estimate of geometrical efficiency using the **inscribed** circle ("circumference fraction")

geometry

("y is ϕ ")



$$\text{SECTORDPHI}/2 = \pi/\text{NBOXES}$$

BARINNERR

SECTORY

BARPLANEY

BARPLANEWIDTH

SECTORGAP

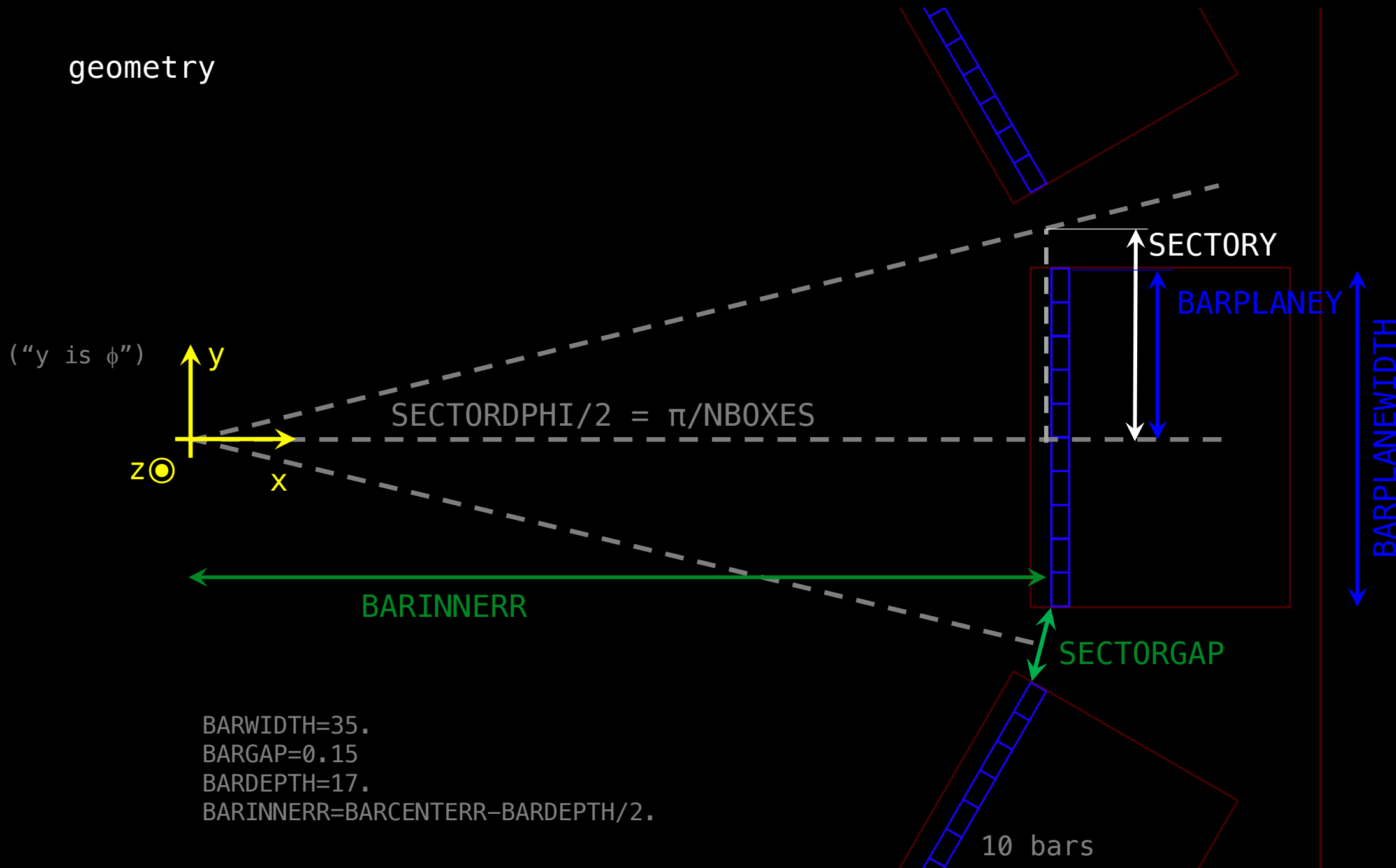
BARWIDTH=35.

BARGAP=0.15

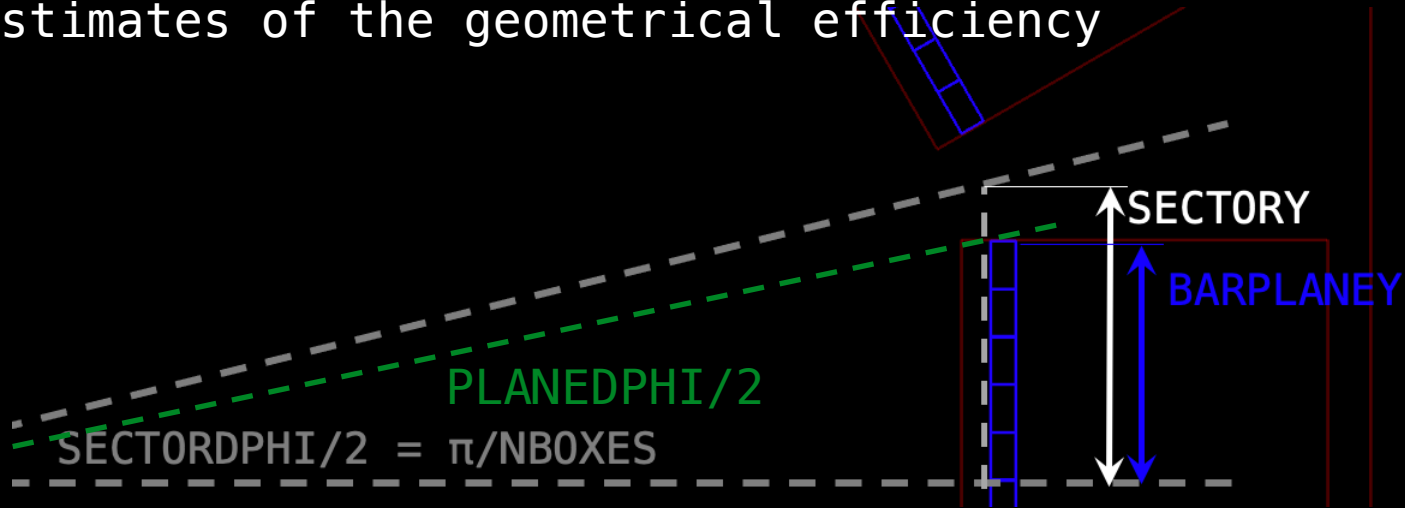
BARDEPTH=17.

BARINNERR=BARCENTERR-BARDEPTH/2.

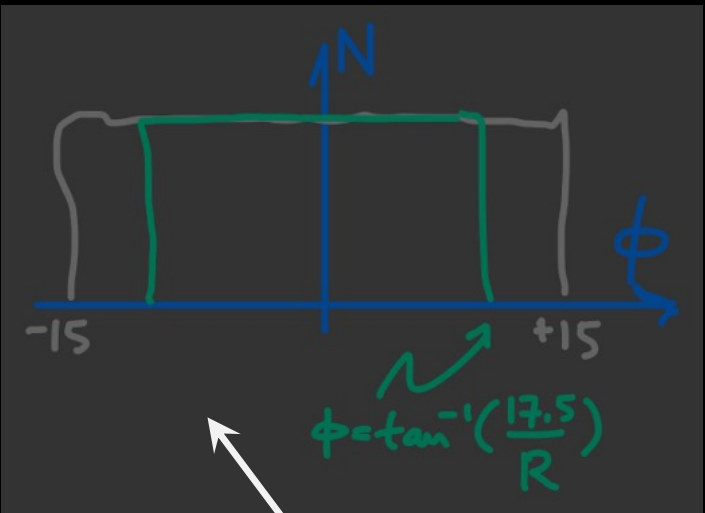
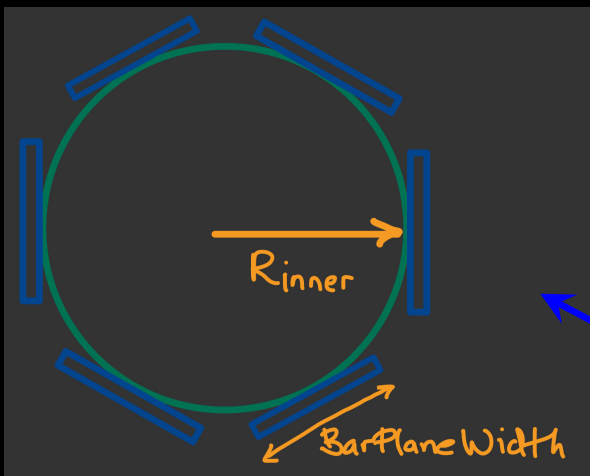
10 bars



estimates of the geometrical efficiency



$$\frac{Nboxes * BarPlaneWidth}{2\pi R_{INNER}}$$



angle fraction
circumference fraction

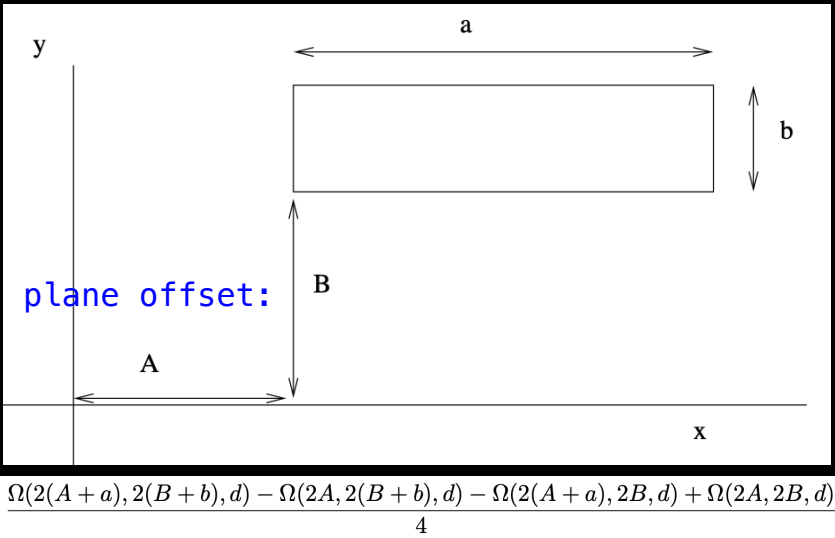
Solid Angle of a Rectangular Plate

Richard J. Mathar*
Max-Planck Institute of Astronomy, Königstuhl 17, 69117 Heidelberg, Germany
(Dated: February 21, 2014)

The solid angle covered by a rectangular plate of length a and width b at a distance d to the observer is calculated.

plane centered:

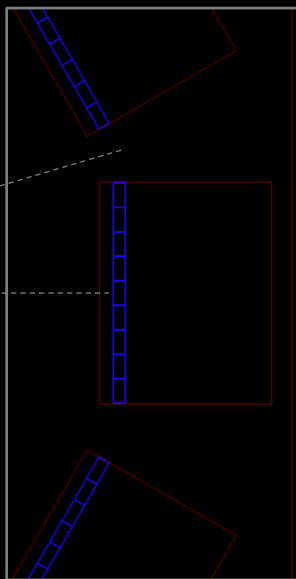
$$\Omega(a, b, d) = 4 \arccos \sqrt{\frac{1 + \alpha^2 + \beta^2}{(1 + \alpha^2)(1 + \beta^2)}}.$$
$$\alpha = a/2d, \quad \beta = b/2d$$



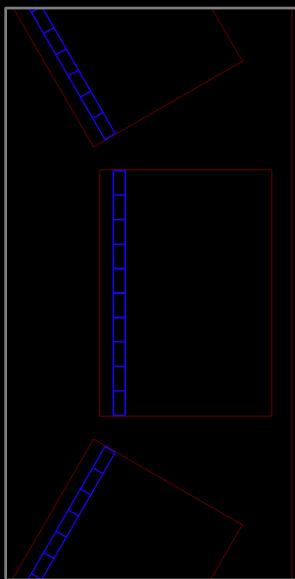
compare these two “simple” estimates
with a simple G4 code inc. fields

12 boxes
 $\Delta\phi/2=15\text{deg}$

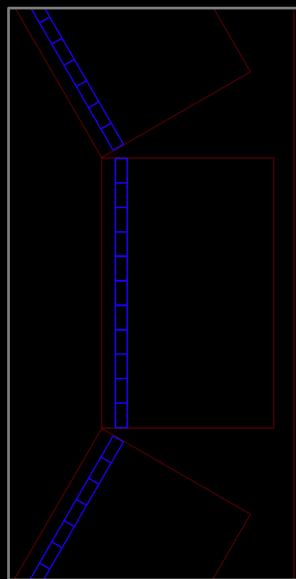
$\Delta\phi/2$



9 bars

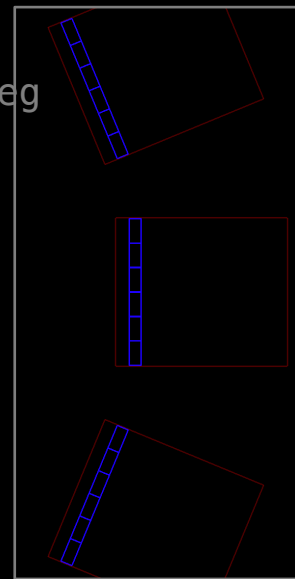


10 bars

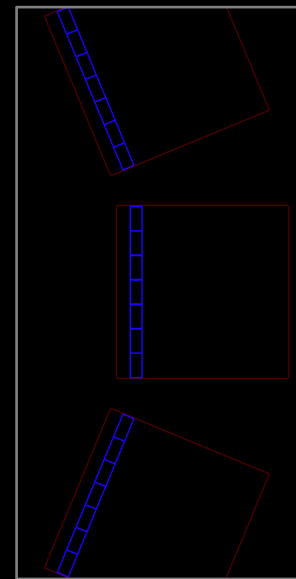


11 bars

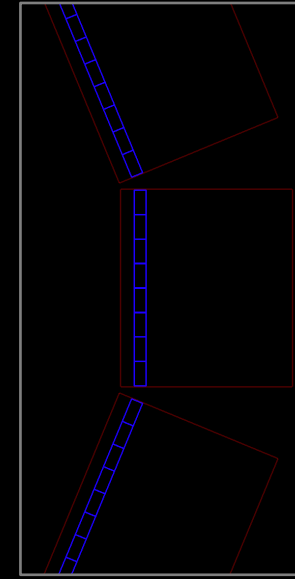
16 boxes
 $\Delta\phi/2=11.25\text{deg}$



6 bars

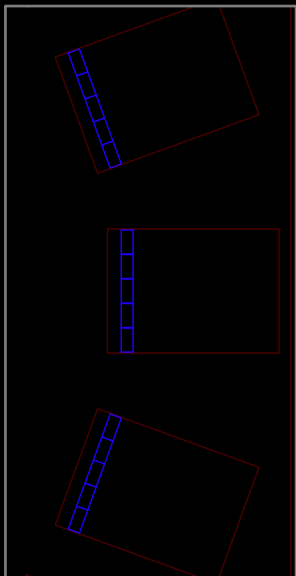


7 bars

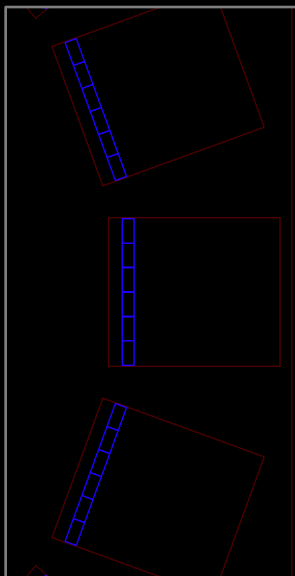


8 bars

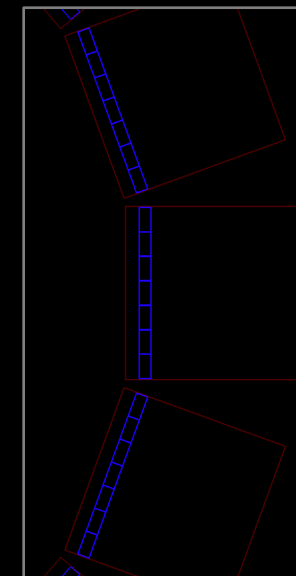
18 boxes
 $\Delta\phi/2=10\text{deg}$



5 bars

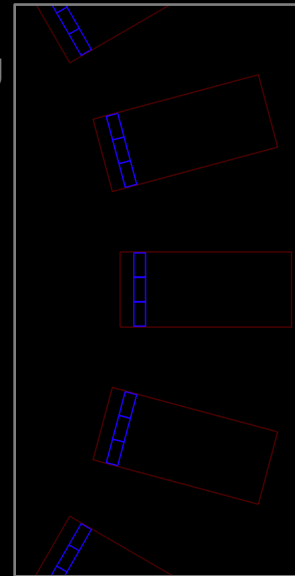


6 bars

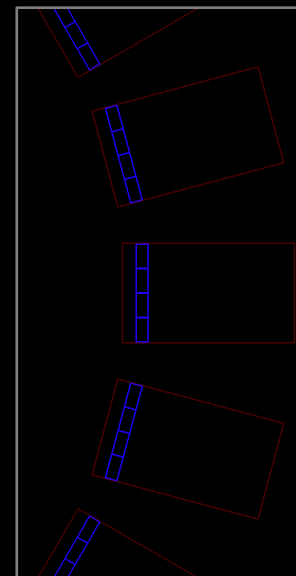


7 bars

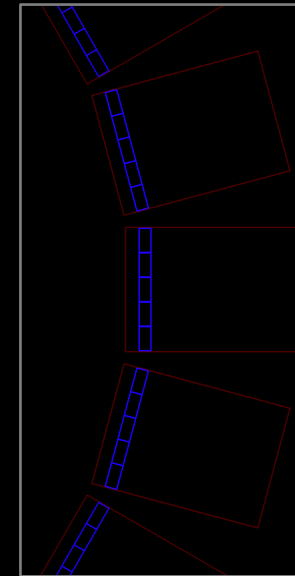
24 boxes
 $\Delta\phi/2=7.5\text{deg}$



3 bars

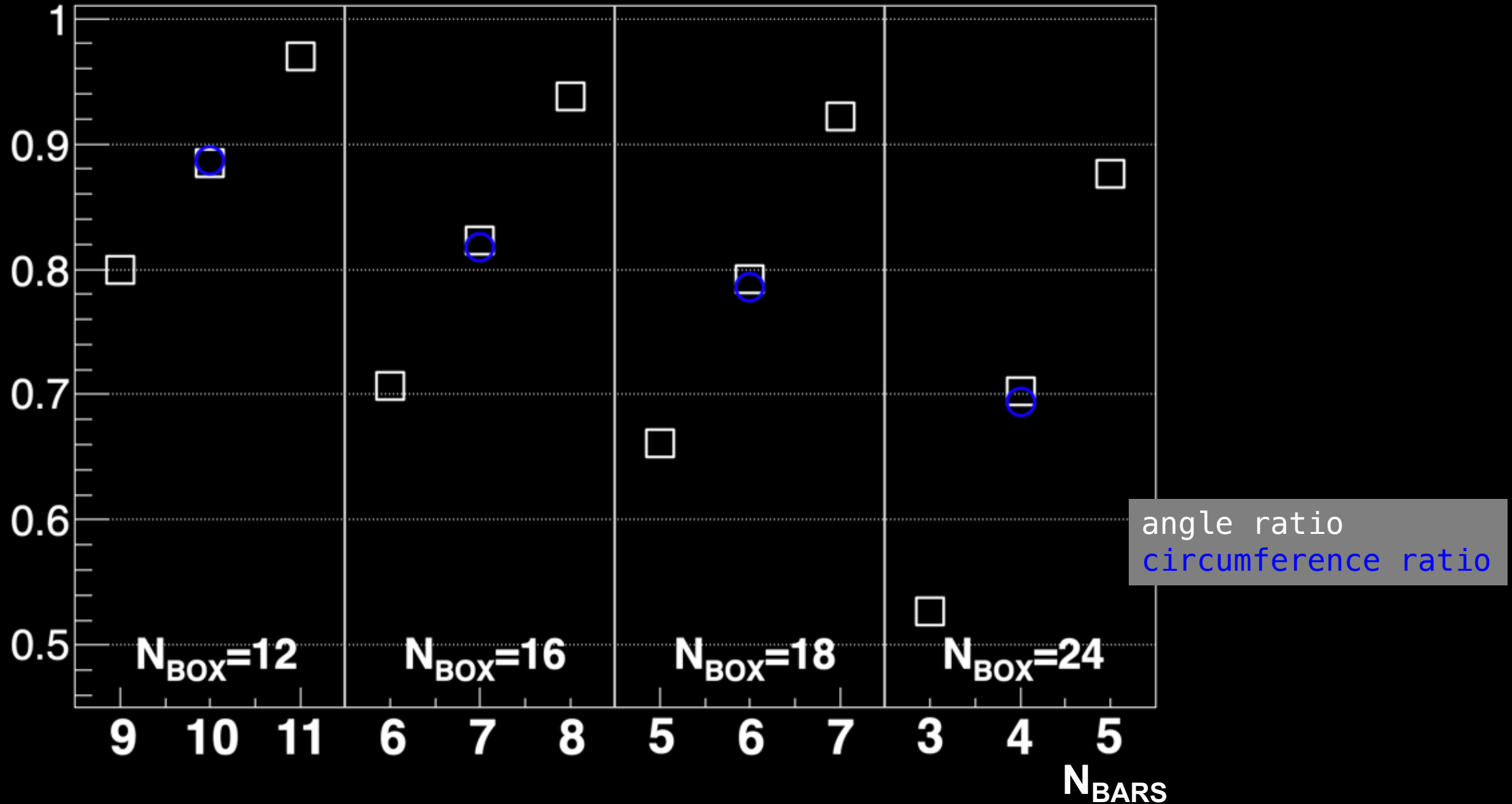


4 bars

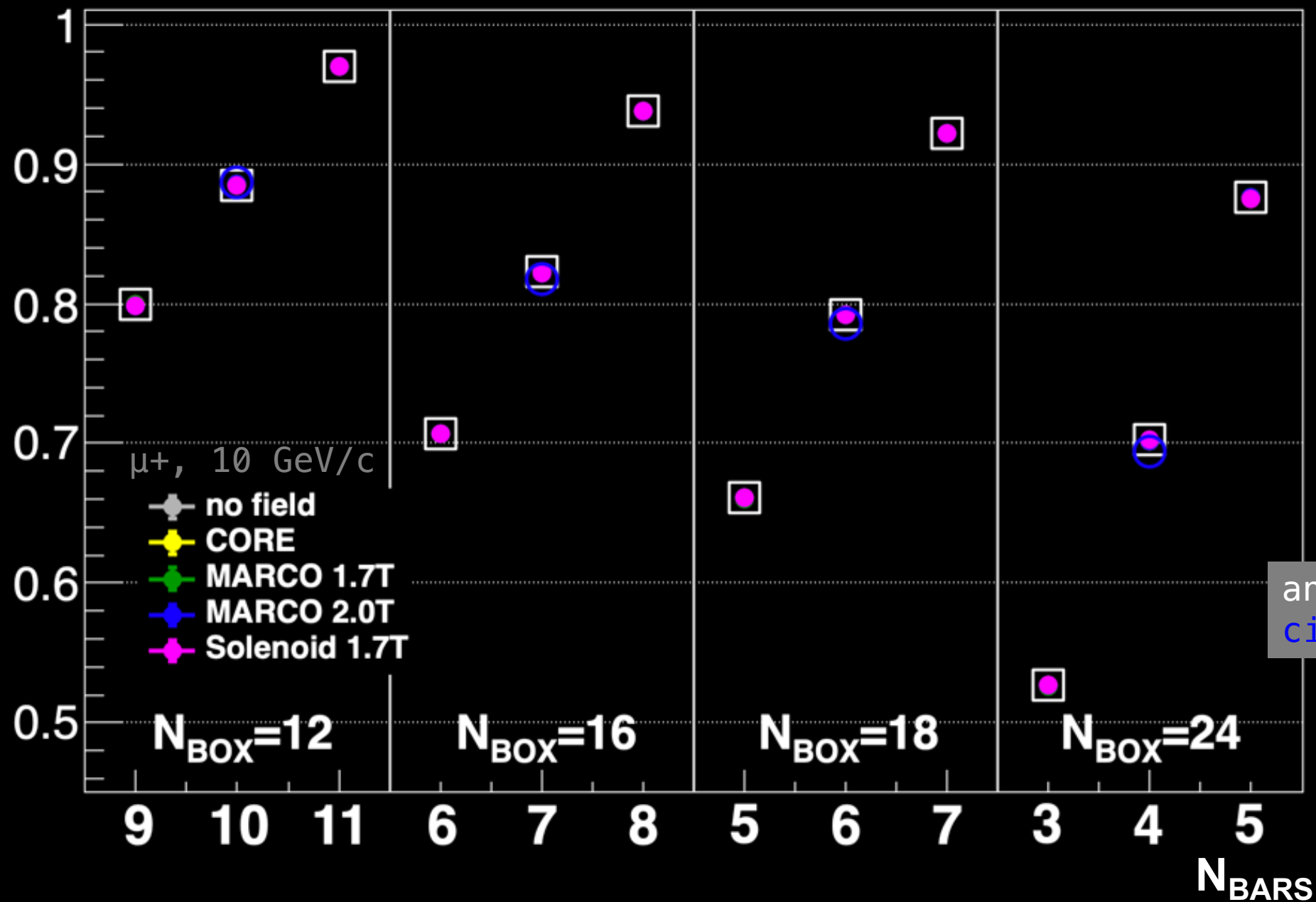


5 bars

simple estimates of geometrical efficiency



simple estimates of geometrical efficiency, and G4 “measurement”



ϕ -efficiency estimates

$p < \sim 2 \text{ GeV}/c$: magnetic field impacts the geometrical efficiency

$p > \sim 2 \text{ GeV}/c$: field-off and field-on are $\sim$ indistinguishable

if $p > \sim 2 \text{ GeV}$, the ratio of two ϕ -angles is the geometrical efficiency:

$$\text{efficiency} = \frac{\text{atan}([\text{BarPlaneWidth}] / 2. / \text{BARINNERR})}{\pi / \text{NBOXES}}$$

or

$$\text{efficiency} = \frac{\text{atan}([\text{NBARS} * \text{BARWIDTH} + (\text{NBARS} - 1) * \text{BARGAP}] / 2. / \text{BARINNERR})}{\pi / \text{NBOXES}}$$

B A C K U P

phi acceptance

w.j. llope
hpDIRC mtg
7/24/23

two codes

both run well on both osx and unix (WSU Grid)
geant4 v. 10.6.3 and 11.1.1

eicdirc

12 boxes, 10 bars/box, Rinner=700.
five fields
throw $0.5 < p < 10$ GeV/c μ^+
efficiencies: geometrical, pixel hits, proper PID, ...

simpler version

Nboxes, Nbars, etc set at command line
five fields
world includes only Bars. Code is stupefyingly fast
efficiencies: geometrical

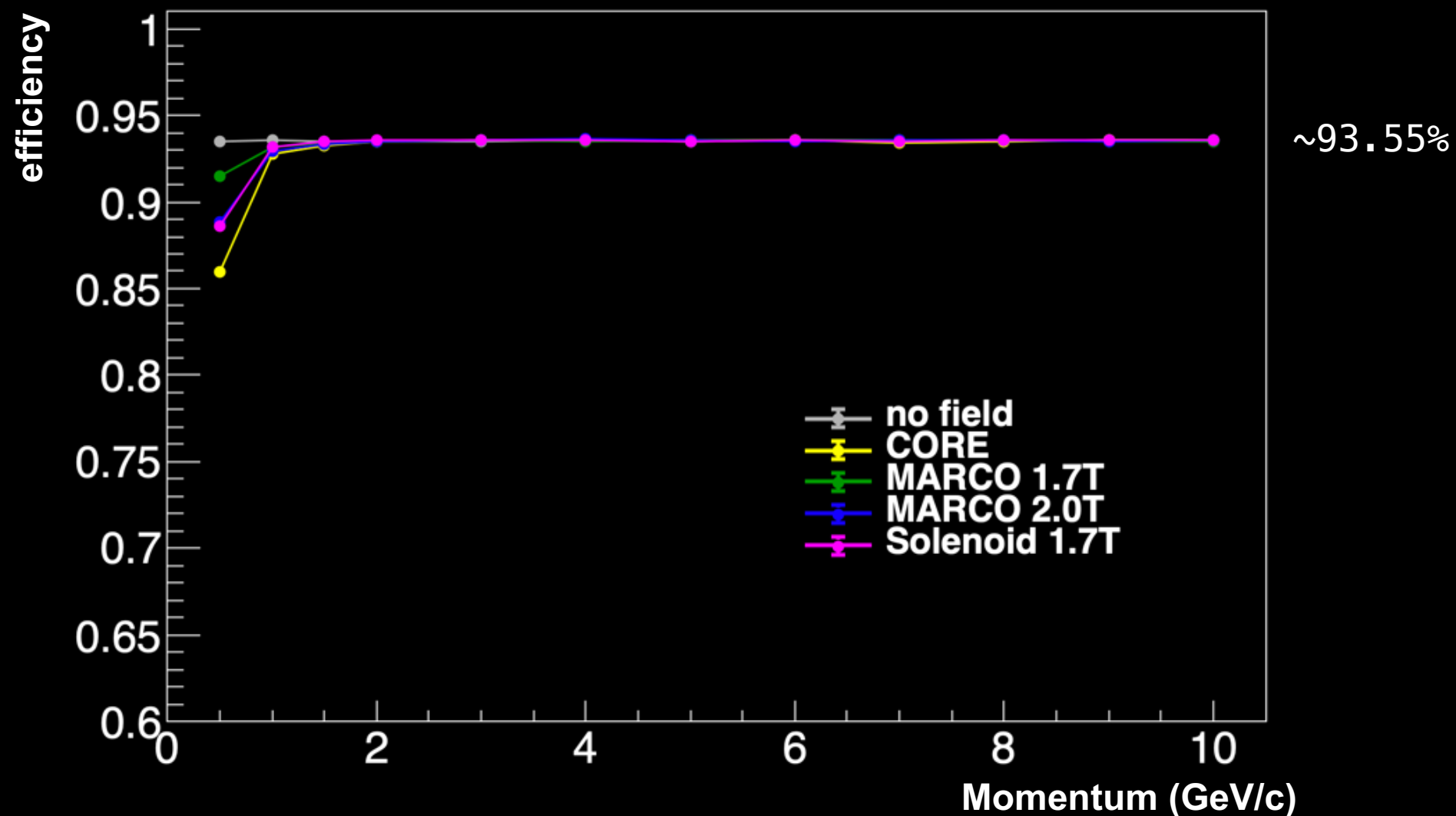
```
./B2a_run -x $PARTNAME -p $MOMN -g $GEOMETRY -seed $rsdn -field $FIELD -e $NEV -runstring $RUNSTRING -b 1  
            $\mu^+$            10.0       2406           [0,...,4]   ~1M
```

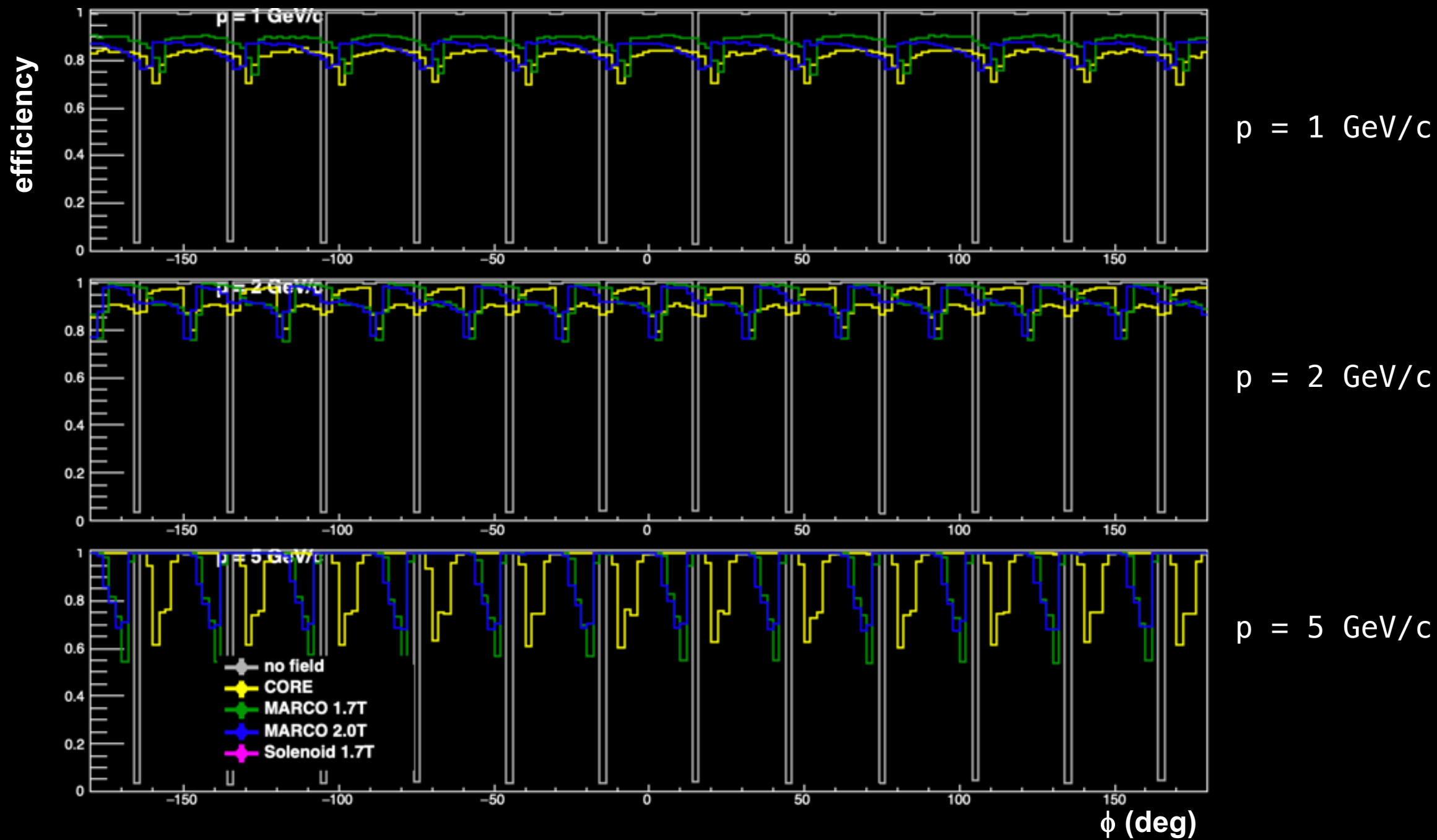
Results from eicdirc code

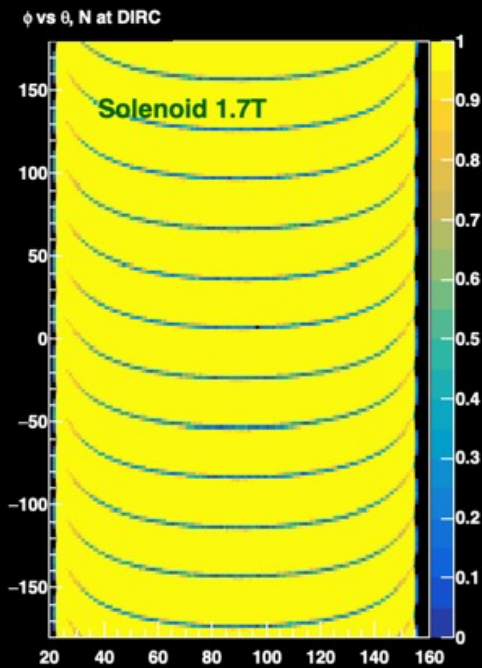
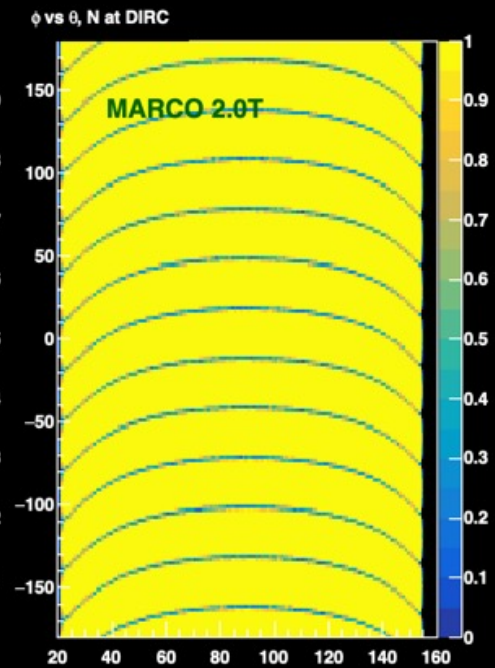
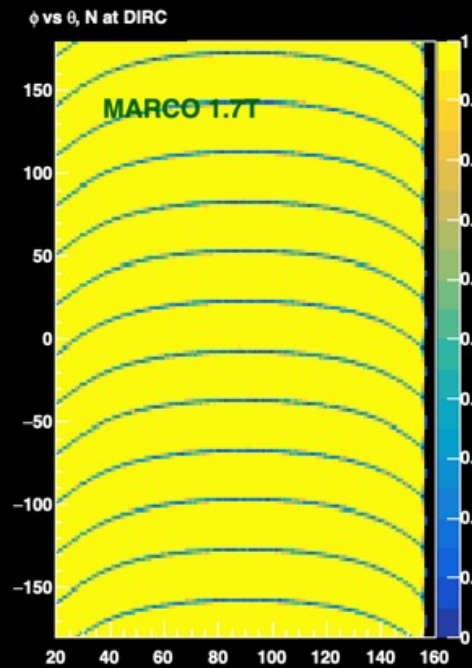
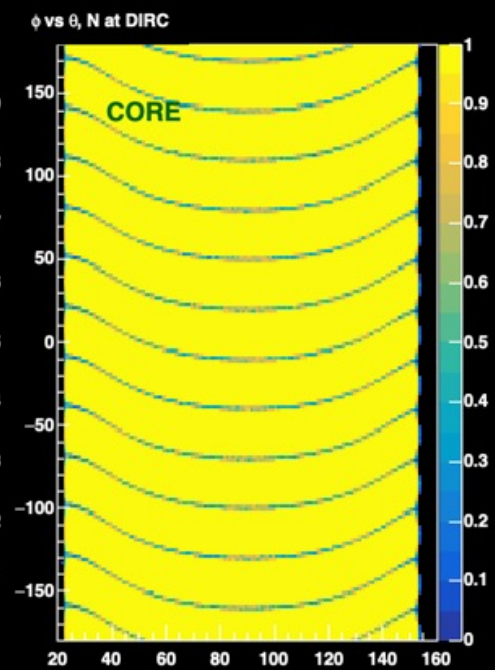
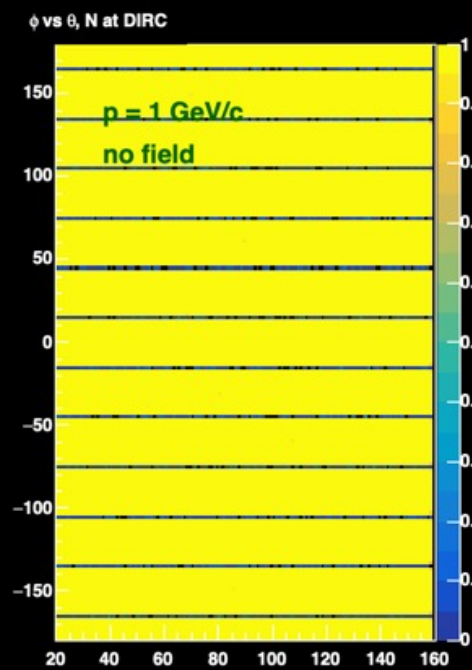
wDirc mother volume shadowed edge bars in neighboring boxes (fixed)

fRadius = 700. (to front face of "middle bar", Rinner)

Nboxes = 12, NBars = 10

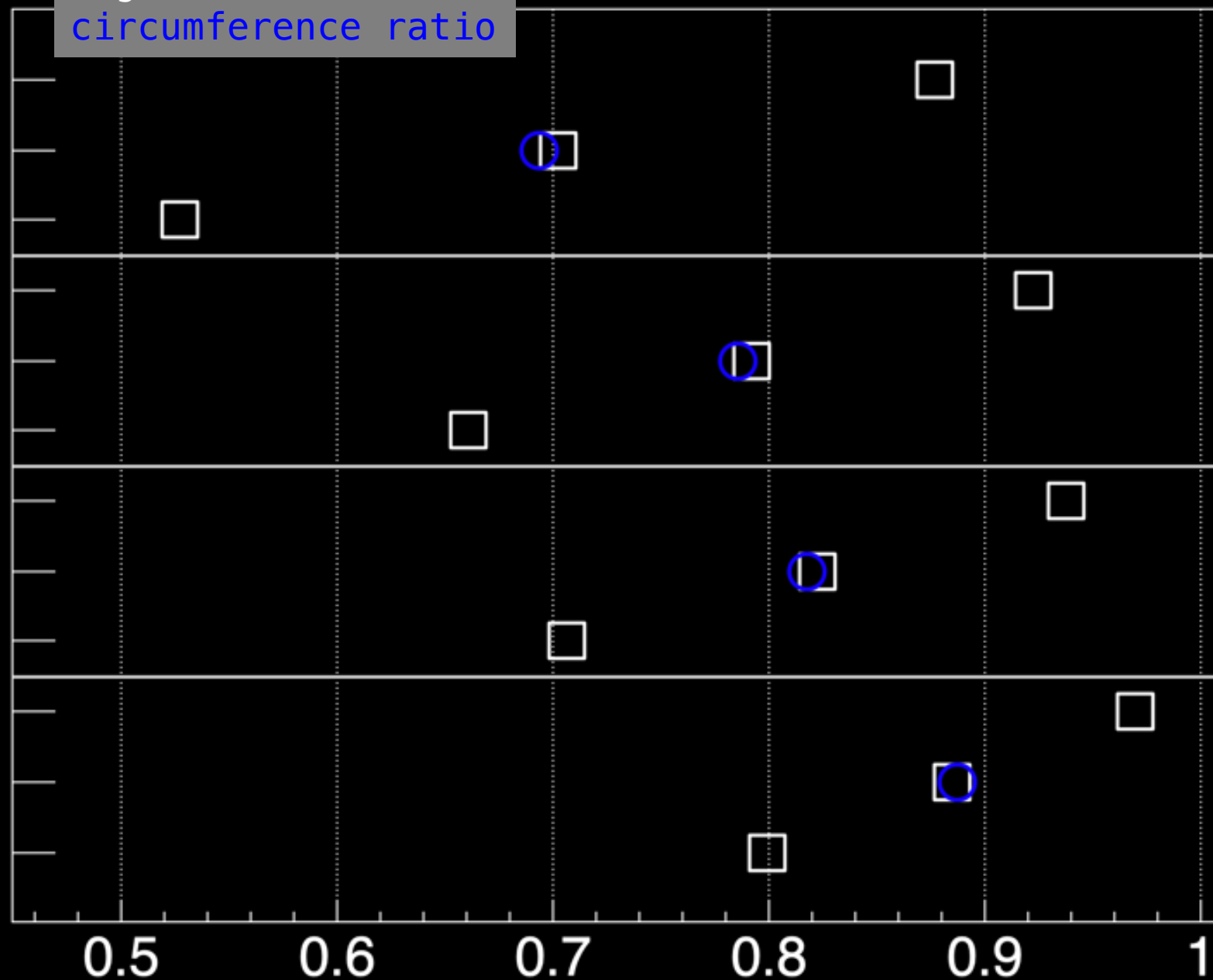






angle ratio
circumference ratio

$N_{\text{BOX}}=24, N_{\text{BAR}}=5$
 $N_{\text{BOX}}=24, N_{\text{BAR}}=4$
 $N_{\text{BOX}}=24, N_{\text{BAR}}=3$
 $N_{\text{BOX}}=18, N_{\text{BAR}}=7$
 $N_{\text{BOX}}=18, N_{\text{BAR}}=6$
 $N_{\text{BOX}}=18, N_{\text{BAR}}=5$
 $N_{\text{BOX}}=16, N_{\text{BAR}}=8$
 $N_{\text{BOX}}=16, N_{\text{BAR}}=7$
 $N_{\text{BOX}}=16, N_{\text{BAR}}=6$
 $N_{\text{BOX}}=12, N_{\text{BAR}}=11$
 $N_{\text{BOX}}=12, N_{\text{BAR}}=10$
 $N_{\text{BOX}}=12, N_{\text{BAR}}=9$

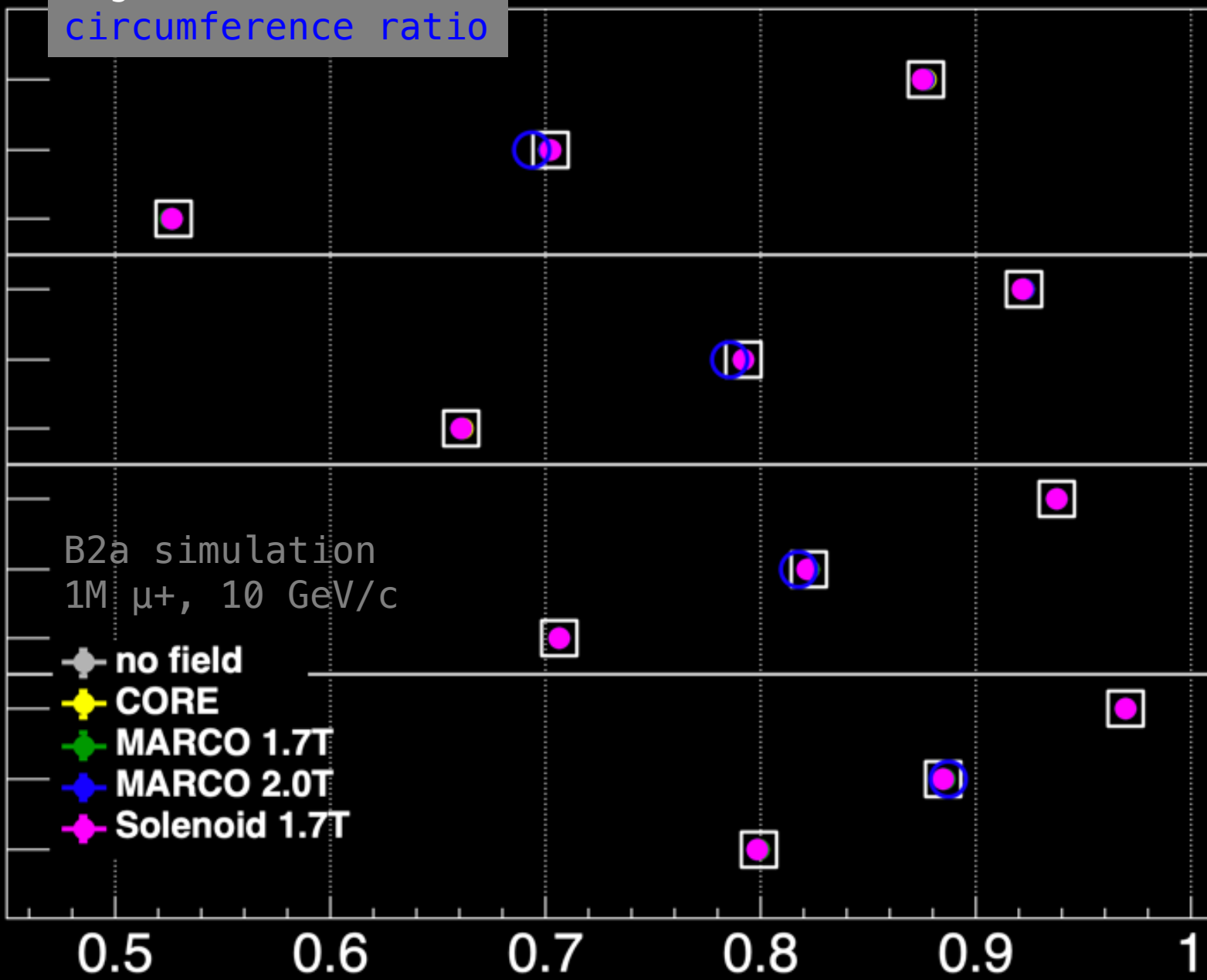


$N_{\text{BOX}}=24, N_{\text{BAR}}=5$
 $N_{\text{BOX}}=24, N_{\text{BAR}}=4$
 $N_{\text{BOX}}=24, N_{\text{BAR}}=3$
 $N_{\text{BOX}}=18, N_{\text{BAR}}=7$
 $N_{\text{BOX}}=18, N_{\text{BAR}}=6$
 $N_{\text{BOX}}=18, N_{\text{BAR}}=5$
 $N_{\text{BOX}}=16, N_{\text{BAR}}=8$
 $N_{\text{BOX}}=16, N_{\text{BAR}}=7$
 $N_{\text{BOX}}=16, N_{\text{BAR}}=6$
 $N_{\text{BOX}}=12, N_{\text{BAR}}=11$
 $N_{\text{BOX}}=12, N_{\text{BAR}}=10$
 $N_{\text{BOX}}=12, N_{\text{BAR}}=9$

angle ratio
 circumference ratio

B2a simulation
 1M μ^+ , 10 GeV/c

- no field
- CORE
- MARCO 1.7T
- MARCO 2.0T
- Solenoid 1.7T



μ^+ , $p = 10 \text{ GeV}/c$

BARWIDTH = 35. mm
BARGAP = 0.15 mm

NBOX NBAR

BARINNERR (mm)

BARPLANEY (mm)

SECTORGAP (mm)

total

SECTORDPHI/2 (deg)

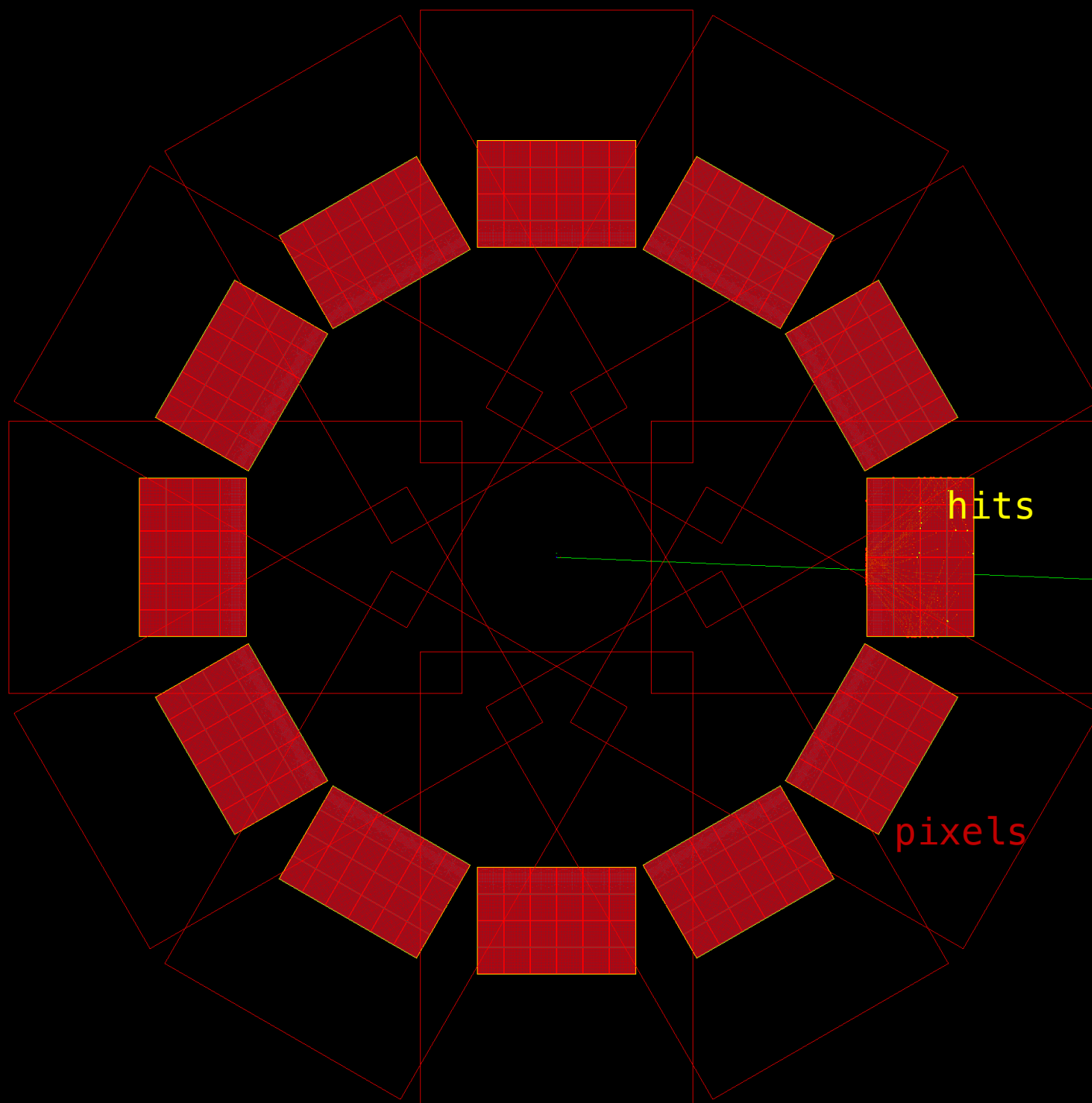
PLANEDPHI/2 (deg)

EFFICIENCY

12	9	744.7	158.1	80.1		15.0	12.0	0.799
12	10	744.7	175.7	46.1		15.0	13.3	0.885
12	11	744.7	193.2	12.2	~5.7in	15.0	14.5	0.970
16	6	754.6	105.4	87.7		11.3	7.9	0.707
16	7	754.6	122.9	53.3		11.3	9.3	0.823
16	8	754.6	140.5	18.8	~12in	11.3	10.5	0.938
18	5	757.3	87.8	90.1		10.0	6.6	0.661
18	6	757.3	105.4	55.5		10.0	7.9	0.792
18	7	757.3	122.9	20.8	~14.7in	10.0	9.2	0.922
24	3	761.8	52.6	94.5		7.5	4.0	0.527
24	4	761.8	70.2	59.6		7.5	5.3	0.702
24	5	761.8	87.8	24.8	~23.4in	7.5	6.6	0.877

yellow rows: same parameters as the columns in Jochen's table

lDirc mothers



hits

100GeV μ^+

pixels

10k 100GeV μ^+ -- Number Pixel Hits/Event

