

VALIDATION OF VARIABLE RESOLUTION BSDFs IN RADIANCE

TL+FFF – PROJECT NUMBER 1637

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Bartenbach 
research & development

Bartenbach GmbH
Research & Development
Rinner Straße 14
A-6071 Aldrans/Innsbruck
AUSTRIA

David Geisler-Moroder

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I INTRODUCTION

In this document results of the validation of the “Variable Resolution BSDF” approach as presented at the 10th International Radiance Workshop (G.Ward, A.McNeil, “A Variable-resolution BSDF Implementation”) are presented.

Variable-resolution BSDFs are generated with *genBSDF* for the RADIANCE native materials *plastic*, *trans*, and *glass* (isotropic) and *plastic2* and *trans2* (anisotropic). Both, the maximum resolution (1024 x 1024 patches or 4096 x 4096 patches) as well as the number of specular samples (16 or 64) are varied.

The resulting data is reduced with *rttree_reduce* at various degrees (0%, i.e. no reduction, 95%, i.e. reduction by approximately 95%, and 99%, i.e. only about 1% of data left).

For each evaluated material/genBSDF-setting combination 6 images were rendered representing the three degrees of reduction with *rttree_reduce* and 2 settings for the number of specular samples (-ss) in the rendering process (16 or 64).

The renderings were produced with the following *rpict* command:

```
rpict -x 1600 -y 1600 -ab 1 -ad 2048 -as 500 -aa .05 -vf fish.vf -lw 1e-5 -ss 16 / 64 -
ps 16
-pt .05 -st .02 -dt 0 -af xxx.amb
```

Setting the direct threshold (-dt) to zero is crucial to allow direct contributions from every single ray and not to neglect contributions due to a high number of spawn specular rays.

The images are arranged as shown in the following table:

<ul style="list-style-type: none"> • Degree of reduction in <i>rttree_reduce</i>: 0% • Number of specular samples (-ss) in <i>rpict</i>-command: 16 	<ul style="list-style-type: none"> • Degree of reduction in <i>rttree_reduce</i>: 0% • Number of specular samples (-ss) in <i>rpict</i>-command: 64
<ul style="list-style-type: none"> • Degree of reduction in <i>rttree_reduce</i>: 95% • Number of specular samples (-ss) in <i>rpict</i>-command: 16 	<ul style="list-style-type: none"> • Degree of reduction in <i>rttree_reduce</i>: 95% • Number of specular samples (-ss) in <i>rpict</i>-command: 64
<ul style="list-style-type: none"> • Degree of reduction in <i>rttree_reduce</i>: 99% • Number of specular samples (-ss) in <i>rpict</i>-command: 16 	<ul style="list-style-type: none"> • Degree of reduction in <i>rttree_reduce</i>: 99% • Number of specular samples (-ss) in <i>rpict</i>-command: 64

II ISOTROPIC

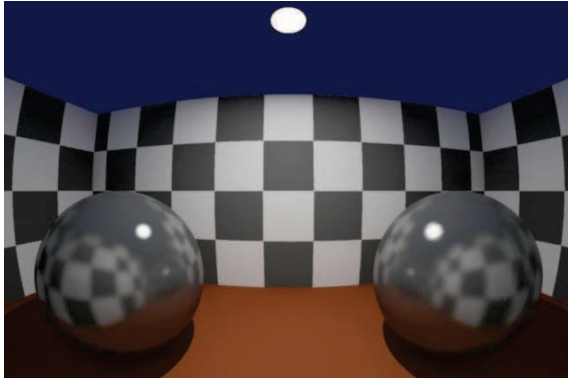
II.1 MATERIAL *PLASTIC*

Material:

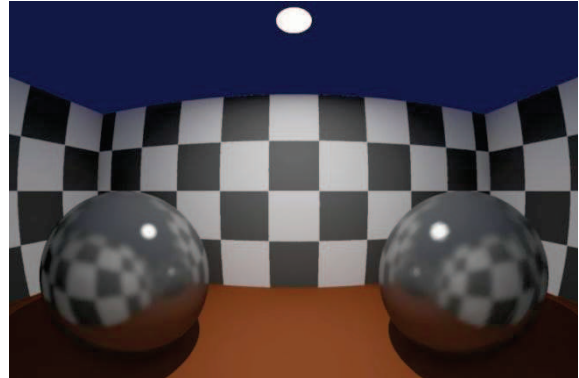
```
void plastic ptest_20_05 0 0 5 .1 .1 .1 .2 .05
```

genBSDF-Call:

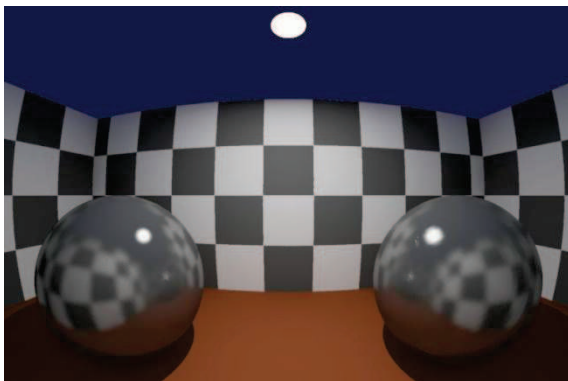
```
genBSDF -n 8 -t3 5 -c 10240 +b -mgf -geom meter -r -ss 16 -f
```



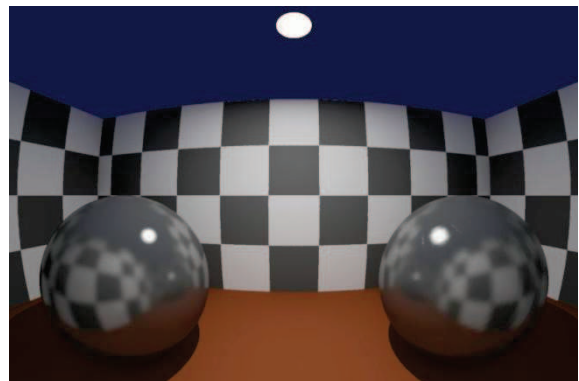
plastic_s20_r05_reduced_0.jpg



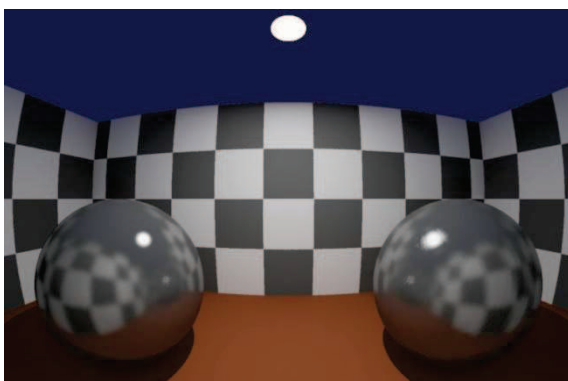
plastic_s20_r05_ss64_reduced_0.jpg



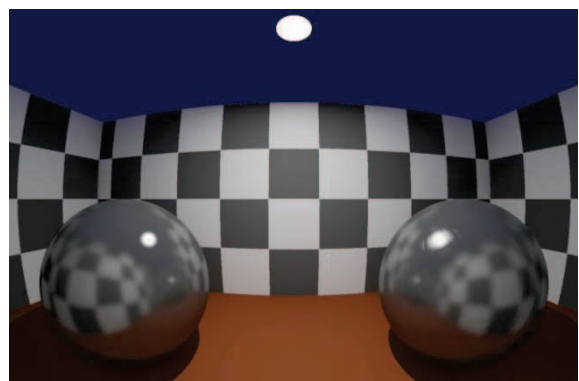
plastic_s20_r05_reduced_95.jpg



plastic_s20_r05_ss64_reduced_95.jpg



plastic_s20_r05_reduced_99.jpg



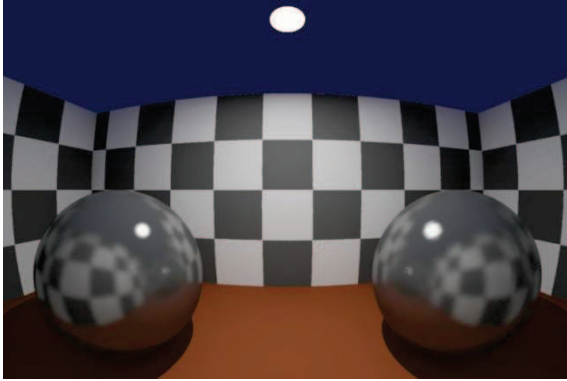
plastic_s20_r05_ss64_reduced_99.jpg

Material:

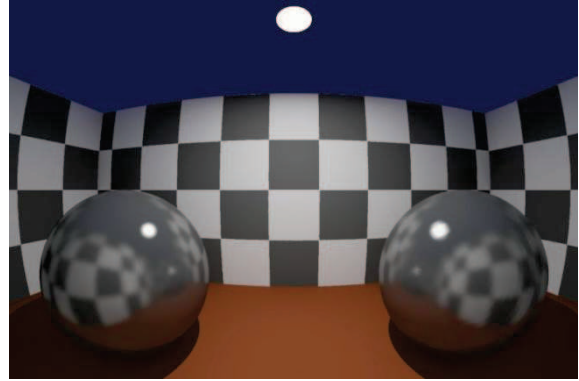
```
void plastic ptest_20_05 0 0 5 .1 .1 .1 .2 .05
```

genBSDF-Call:

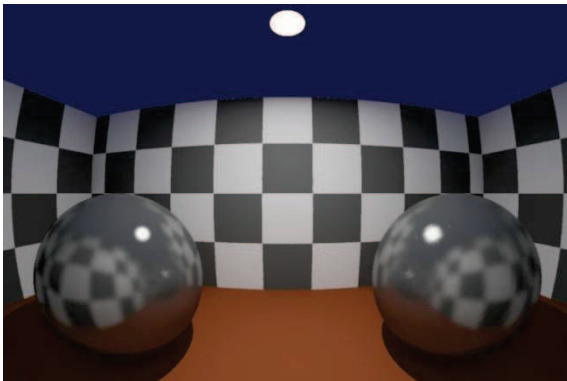
```
genBSDF -n 8 -t3 5 -c 10240 +b -mgf -geom meter -r -ss 64 -f
```



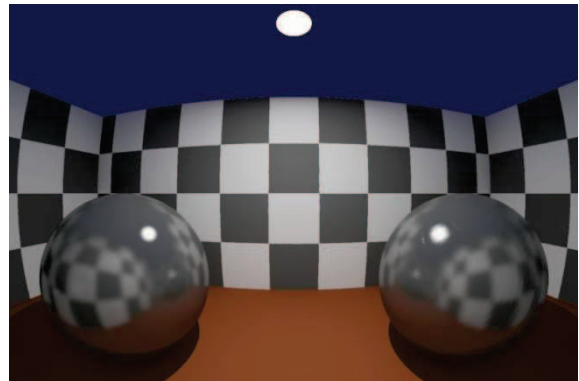
plastic_s20_r05_highSS_reduced_0.jpg



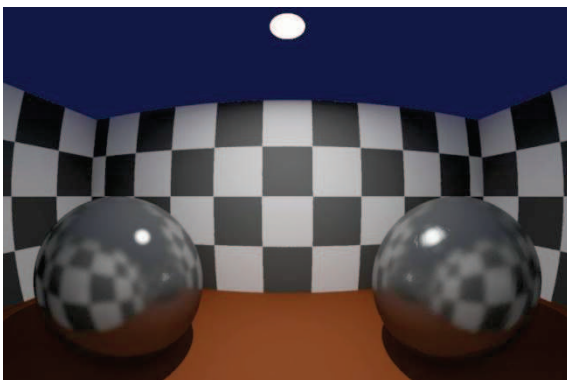
plastic_s20_r05_highSS_ss64_reduced_0.jpg



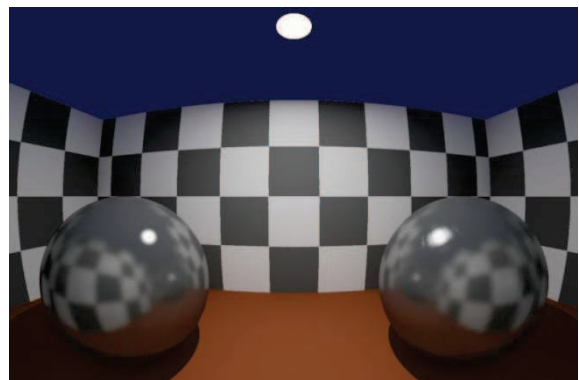
plastic_s20_r05_highSS_reduced_95.jpg



plastic_s20_r05_highSS_ss64_reduced_0.jpg



plastic_s20_r05_highSS_reduced_99.jpg



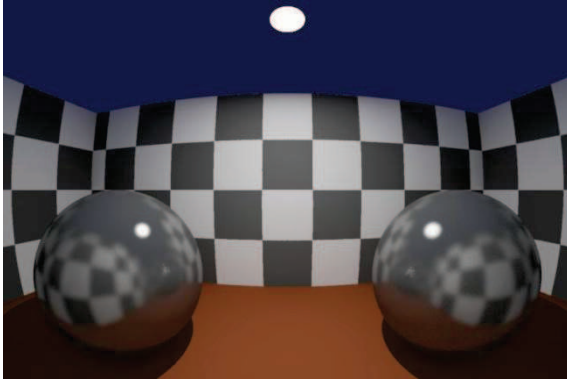
plastic_s20_r05_highSS_ss64_reduced_0.jpg

Material:

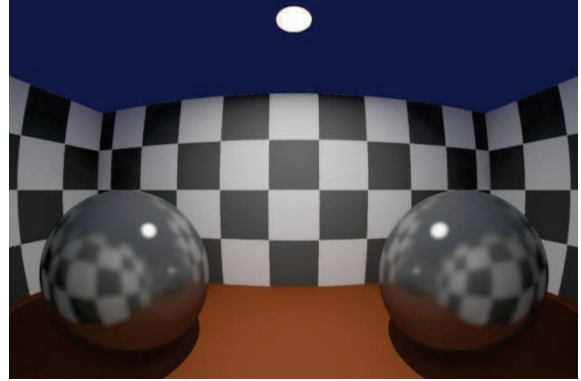
```
void plastic ptest_20_05 0 0 5 .1 .1 .1 .2 .05
```

genBSDF-Call:

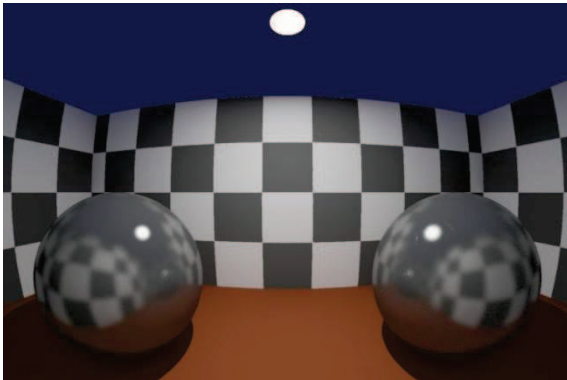
```
genBSDF -n 8 -t3 6 -c 40960 +b -mgf -geom meter -r -ss 16 -f
```



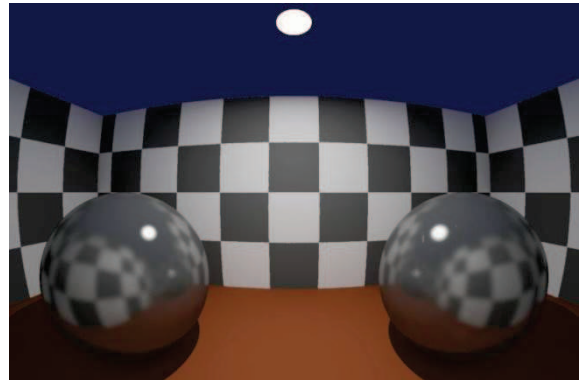
plastic_s20_r05_highRes_reduced_0.jpg



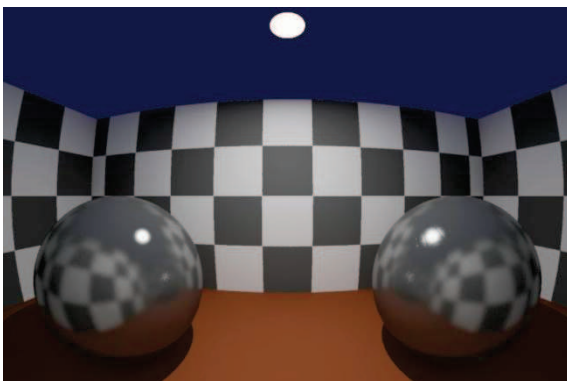
plastic_s20_r05_highRes_ss64_reduced_0.jpg



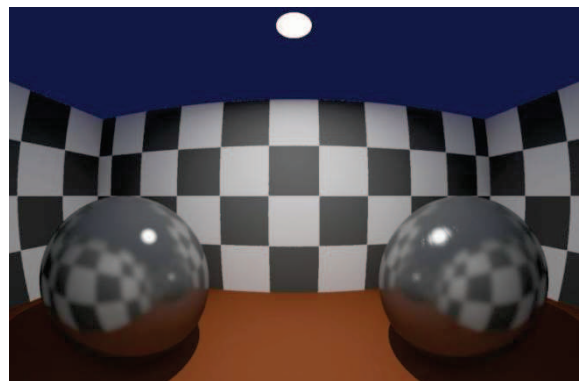
plastic_s20_r05_highRes_reduced_95.jpg



plastic_s20_r05_highRes_ss64_reduced_95.jpg



plastic_s20_r05_highRes_reduced_99.jpg



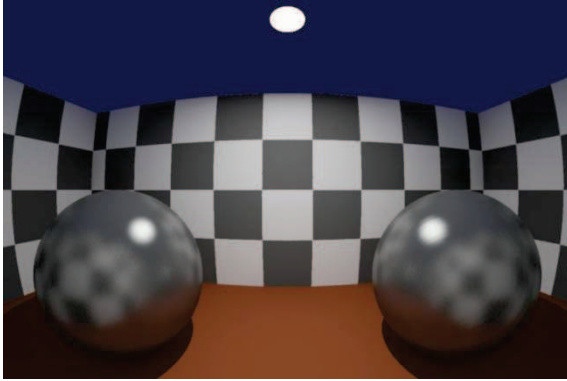
plastic_s20_r05_highRes_ss64_reduced_99.jpg

Material:

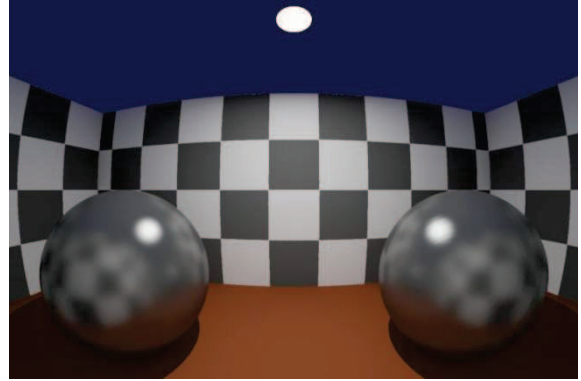
```
void plastic ptest_20_10 0 0 5 .1 .1 .1 .2 .10
```

genBSDF-Call:

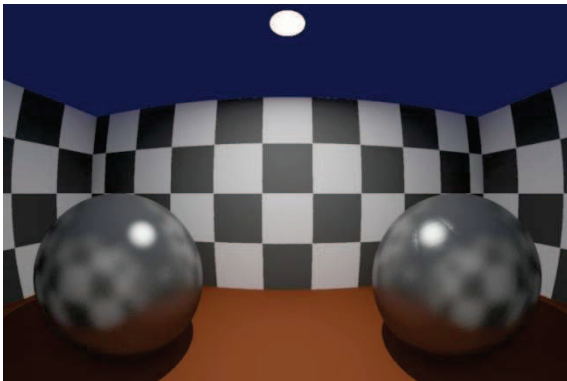
```
genBSDF -n 8 -t3 5 -c 10240 +b -mgf -geom meter -r -ss 16 -f
```



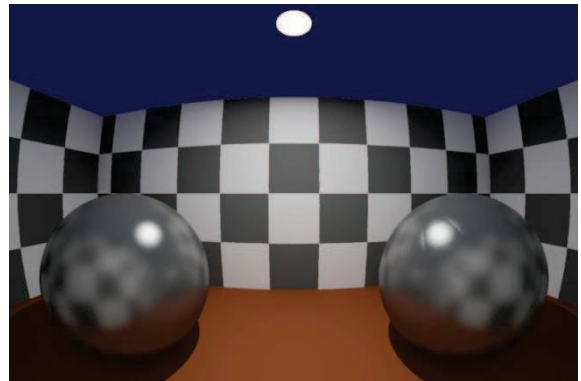
plastic_s20_r10_reduced_0.jpg



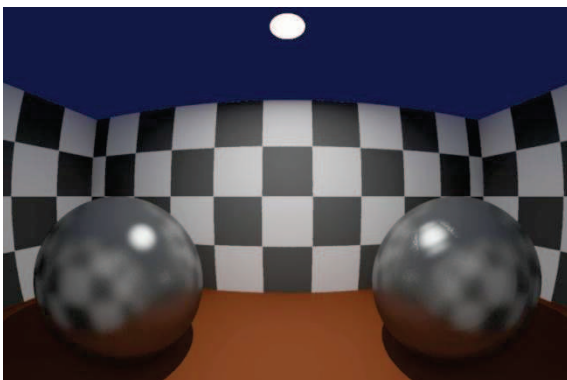
plastic_s20_r10_ss64_reduced_0.jpg



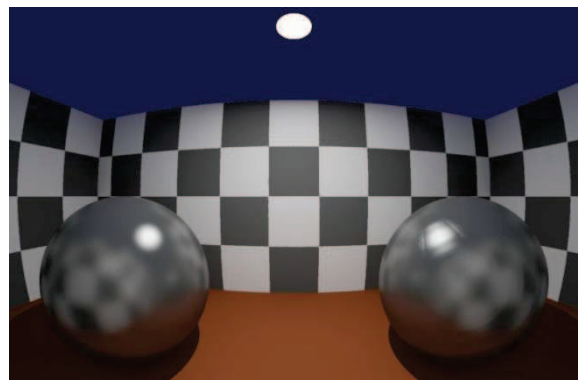
plastic_s20_r10_reduced_95.jpg



plastic_s20_r10_ss64_reduced_95.jpg



plastic_s20_r10_reduced_99.jpg



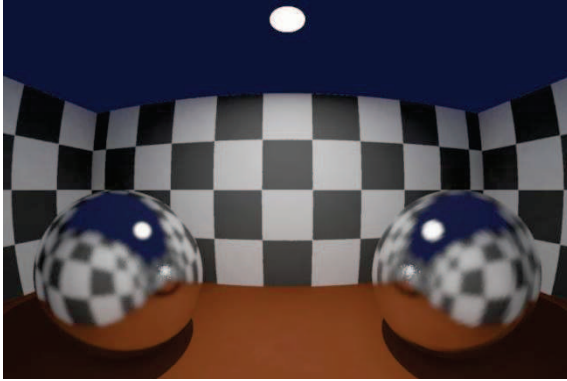
plastic_s20_r10_ss64_reduced_99.jpg

Material:

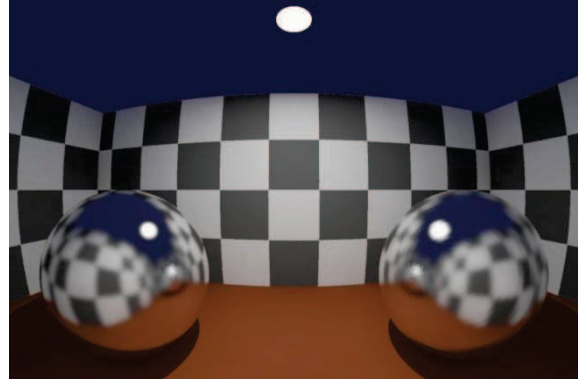
```
void plastic ptest_90_05 0 0 5 .1 .1 .1 .9 .05
```

genBSDF-Call:

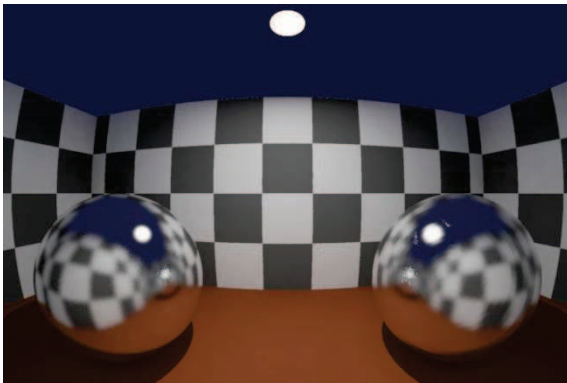
```
genBSDF -n 8 -t3 5 -c 10240 +b -mgf -geom meter -r -ss 16 -f
```



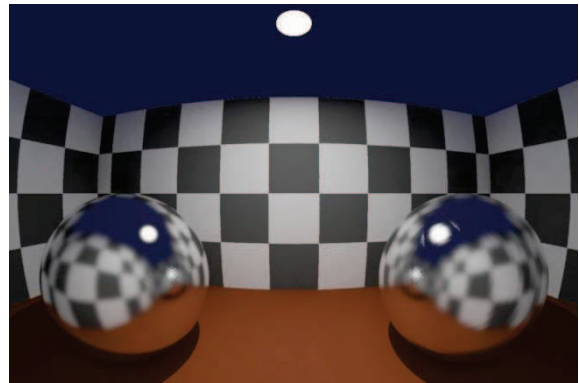
plastic_s90_r05_reduced_0.jpg



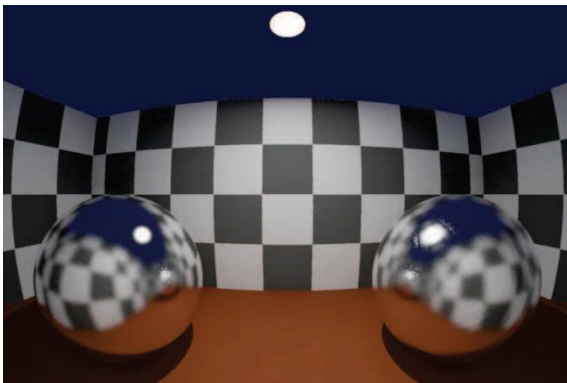
plastic_s90_r05_ss64_reduced_0.jpg



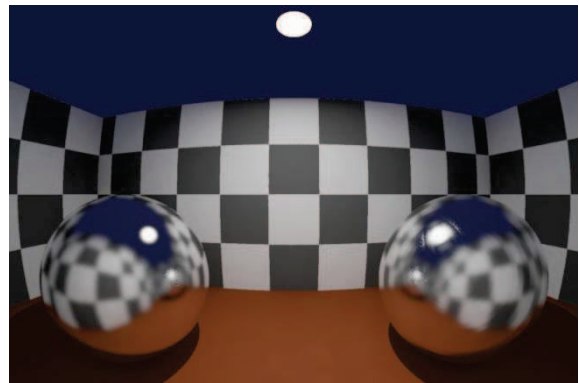
plastic_s90_r05_reduced_95.jpg



plastic_s90_r05_ss64_reduced_95.jpg



plastic_s90_r05_reduced_99.jpg



plastic_s90_r05_ss64_reduced_99.jpg

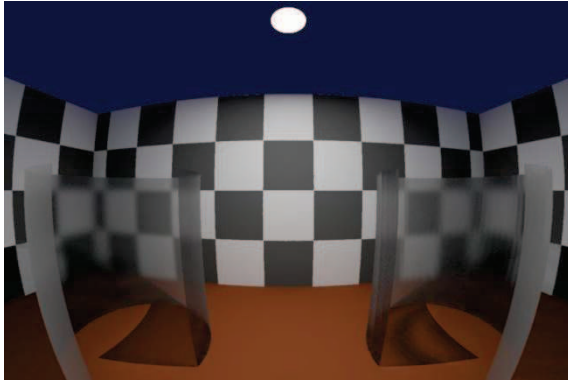
II.2 MATERIAL TRANS

Material:

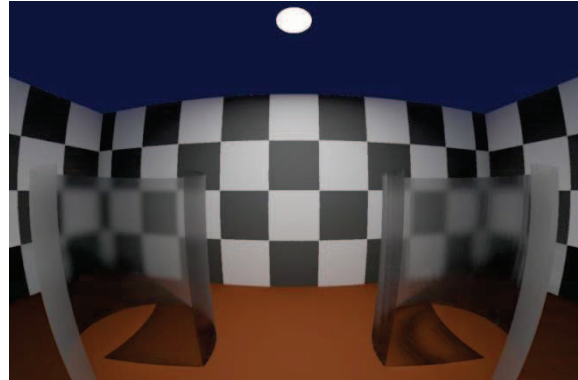
```
void trans ttest_50_05 0 0 7 .8 .8 .8 .0 .05 1.0 .5
```

genBSDF-Call:

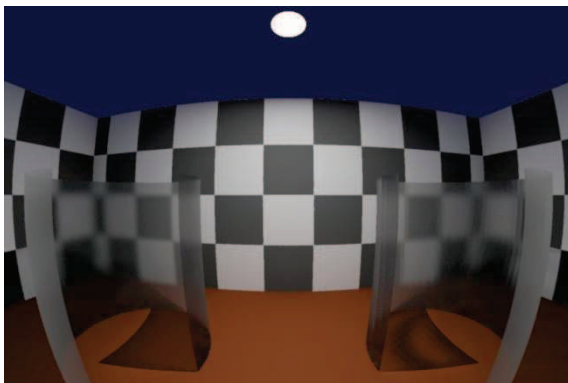
```
genBSDF -n 8 -t3 5 -c 10240 +b -mgf -geom meter -r -ss 16 +f
```



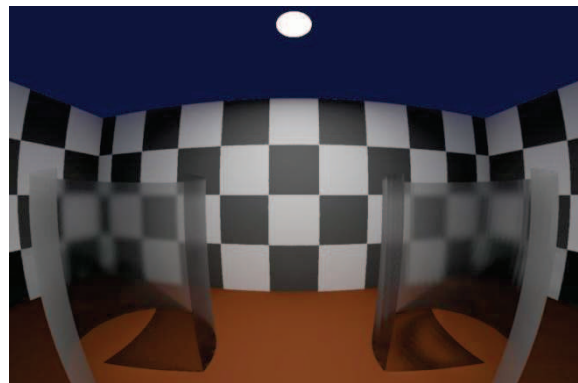
trans_ts50_r05_reduced_0.jpg



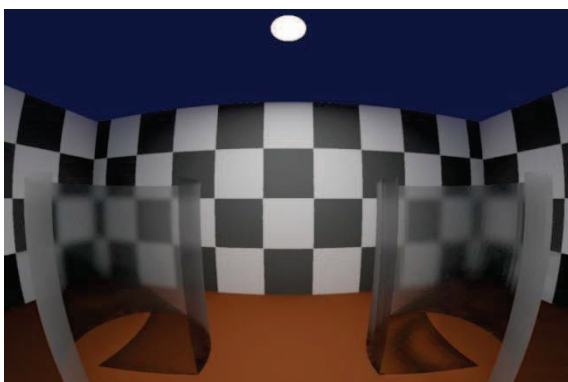
trans_ts50_r05_ss64_reduced_0.jpg



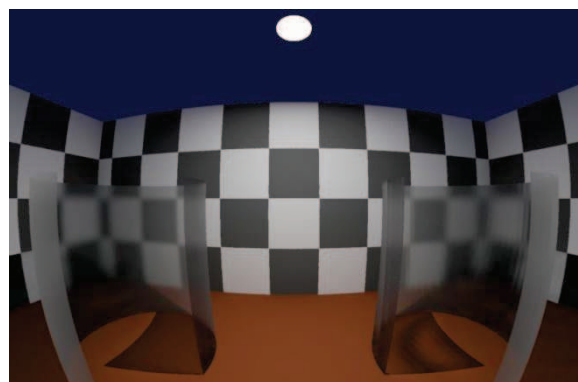
trans_ts50_r05_reduced_95.jpg



trans_ts50_r05_ss64_reduced_95.jpg



trans_ts50_r05_reduced_99.jpg



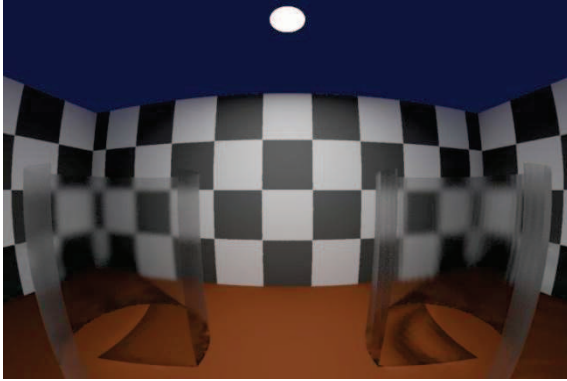
trans_ts50_r05_ss64_reduced_99.jpg

Material:

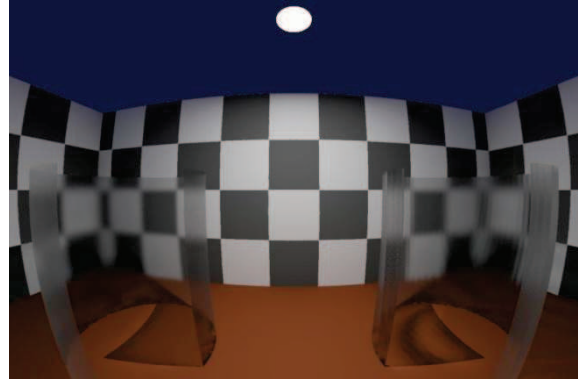
```
void trans ttest_80_05 0 0 7 .8 .8 .8 .0 .05 1.0 .8
```

genBSDF-Call:

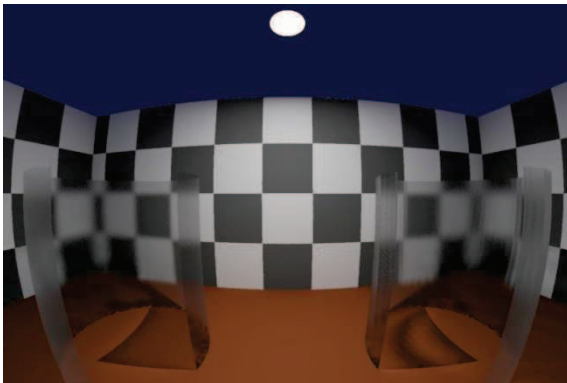
```
genBSDF -n 8 -t3 5 -c 10240 +b -mgf -geom meter -r -ss 16 +f
```



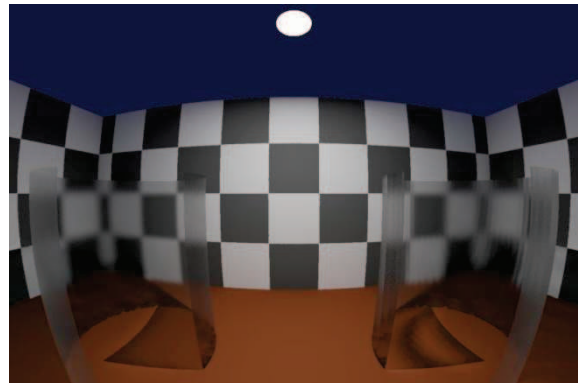
trans_ts80_r05_reduced_0.jpg



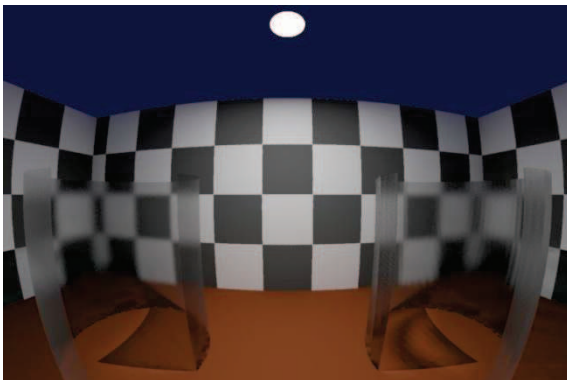
trans_ts80_r05_ss64_reduced_0.jpg



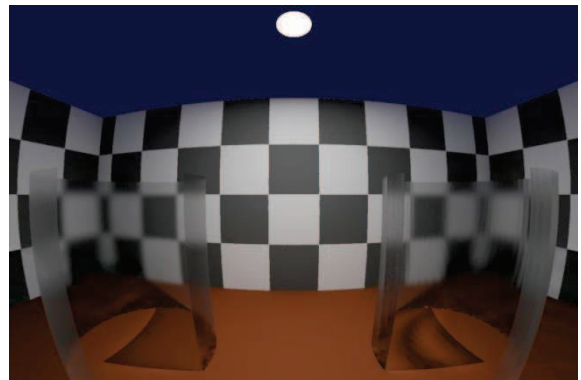
trans_ts80_r05_reduced_95.jpg



trans_ts80_r05_ss64_reduced_95.jpg



trans_ts80_r05_reduced_99.jpg



trans_ts80_r05_ss64_reduced_99.jpg

Material:

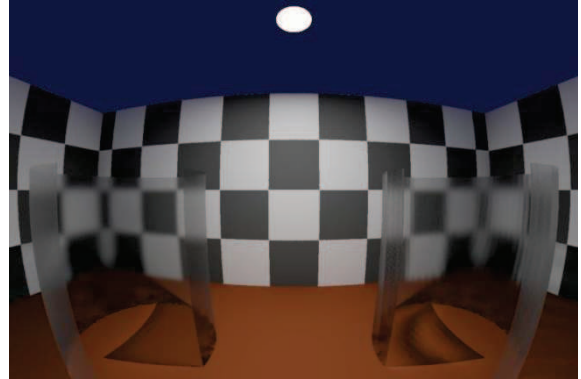
```
void trans ttest_80_05 0 0 7 .8 .8 .8 .0 .05 1.0 .8
```

genBSDF-Call:

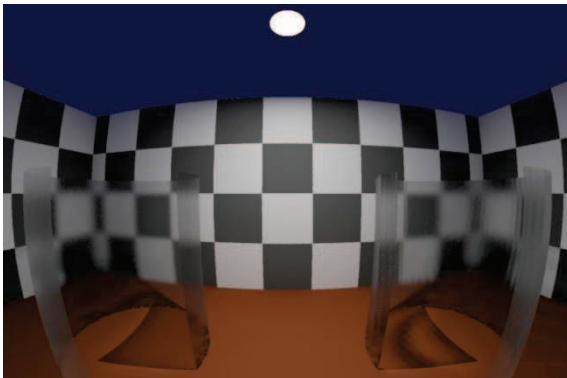
```
genBSDF -n 8 -t3 5 -c 10240 +b -mgf -geom meter -r -ss 64 +f
```



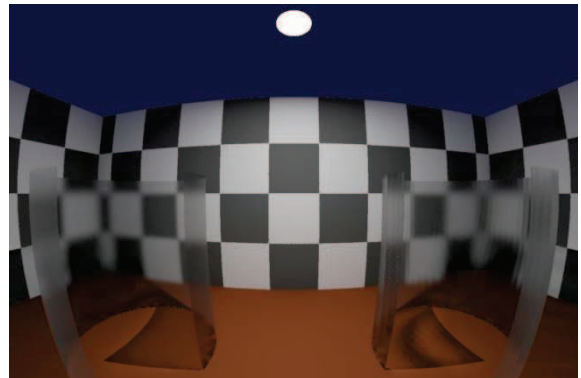
trans_ts80_r05_highSS_reduced_0.jpg



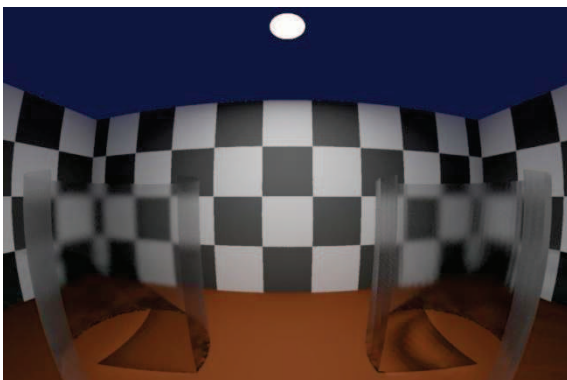
trans_ts80_r05_highSS_ss64_reduced_0.jpg



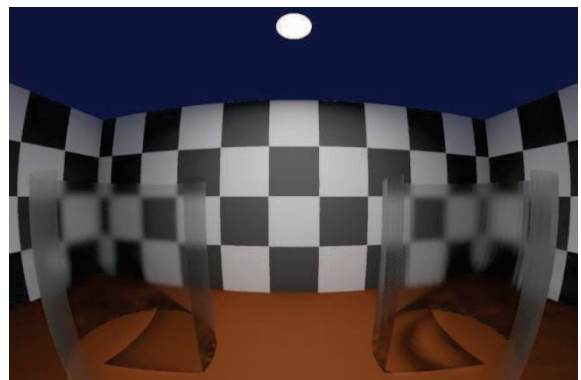
trans_ts80_r05_highSS_reduced_95.jpg



trans_ts80_r05_highSS_ss64_reduced_95.jpg



trans_ts80_r05_highSS_reduced_99.jpg



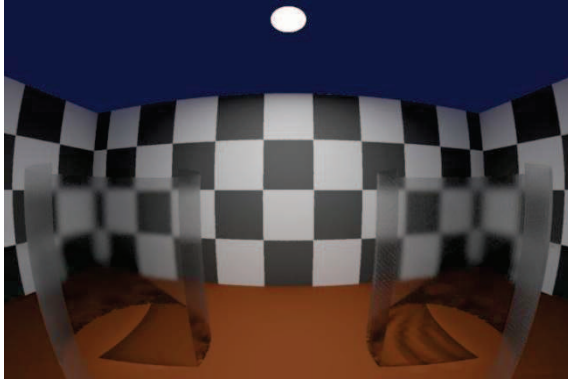
trans_ts80_r05_highSS_ss64_reduced_99.jpg

Material:

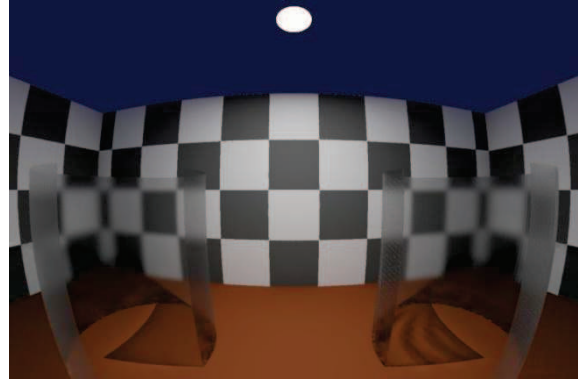
```
void trans ttest_80_05 0 0 7 .8 .8 .8 .0 .05 1.0 .8
```

genBSDF-Call:

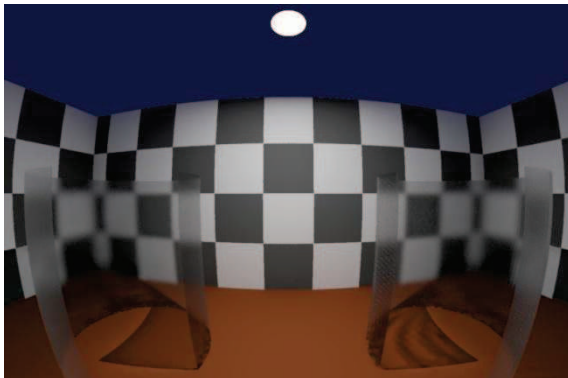
```
genBSDF -n 8 -t3 6 -c 40960 +b -mgf -geom meter -r -ss 16 +f
```



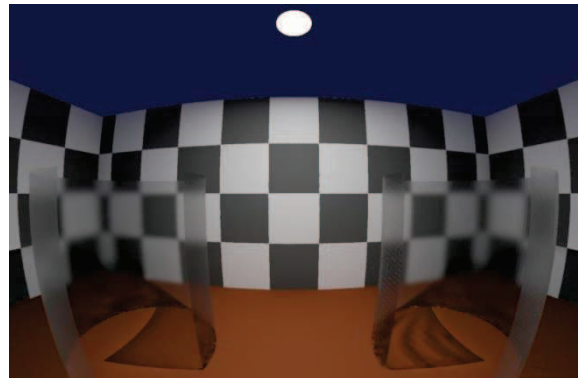
trans_ts80_r05_highRes_reduced_0.jpg



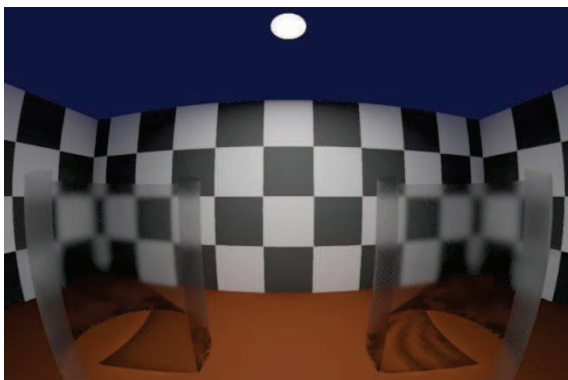
trans_ts80_r05_highRes_ss64_reduced_0.jpg



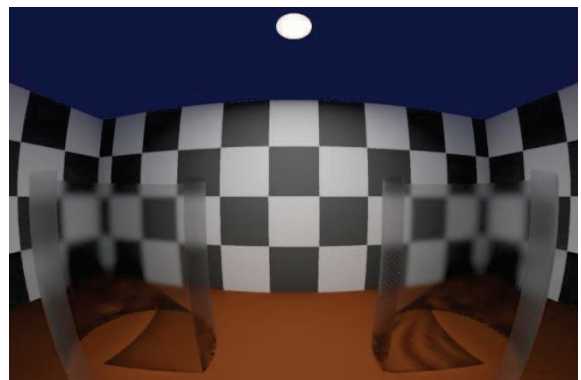
trans_ts80_r05_highRes_reduced_95.jpg



trans_ts80_r05_highRes_ss64_reduced_95.jpg



trans_ts80_r05_highRes_reduced_99.jpg



trans_ts80_r05_highRes_ss64_reduced_99.jpg

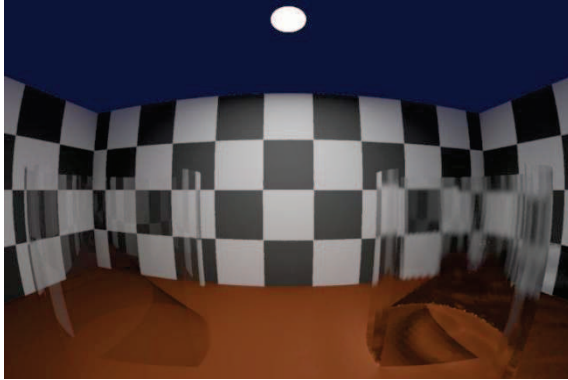
II.3 MATERIAL GLASS

Material:

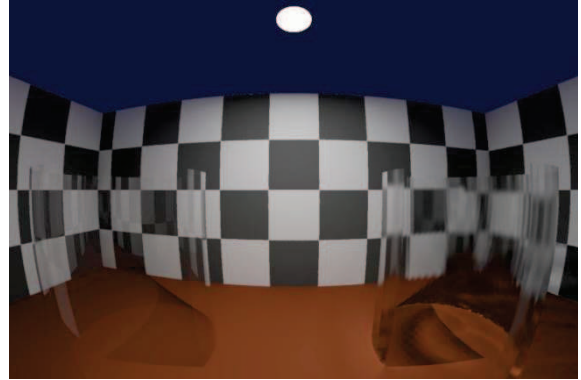
```
void glass gtest_15 0 0 4 1 1 1 1.5
```

genBSDF-Call:

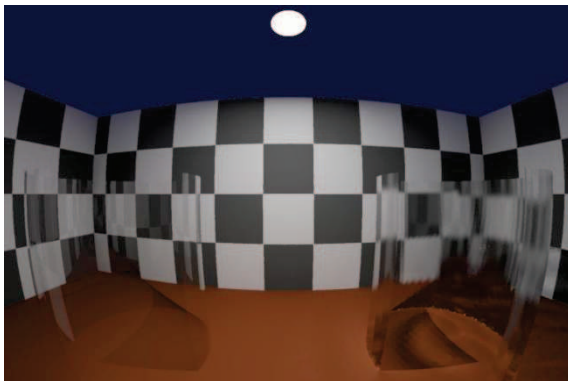
```
genBSDF -n 8 -t3 5 -c 10240 +b -mgf -geom meter -r -ss 16 +f
```



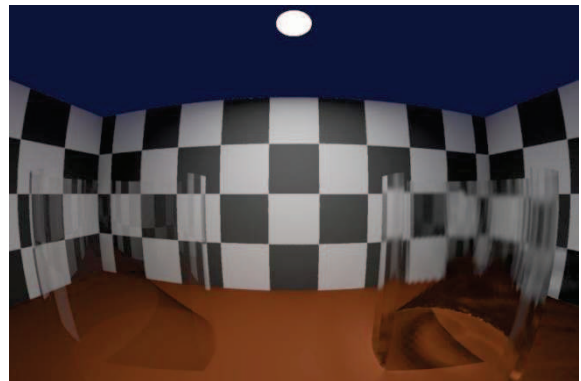
glass_rgb1_n15_reduced_0.jpg



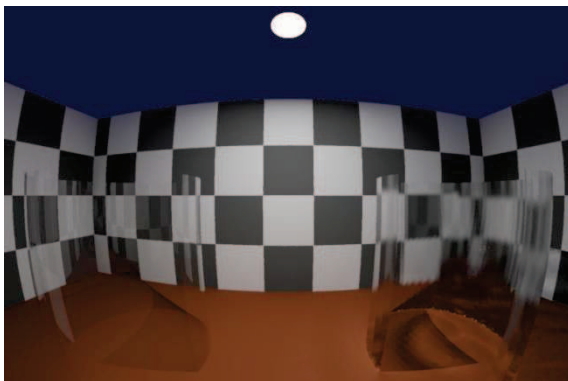
glass_rgb1_n15_ss64_reduced_0.jpg



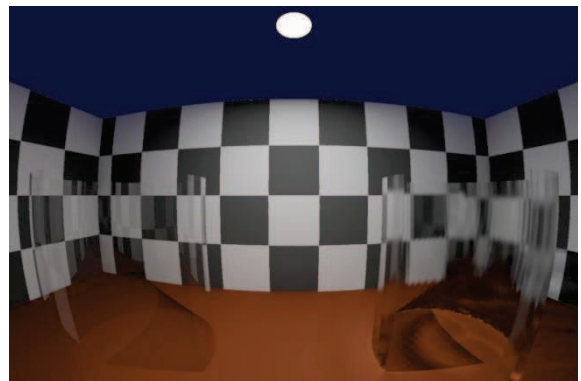
glass_rgb1_n15_reduced_95.jpg



glass_rgb1_n15_ss64_reduced_95.jpg



glass_rgb1_n15_reduced_99.jpg



glass_rgb1_n15_ss64_reduced_99.jpg

III ANISOTROPIC

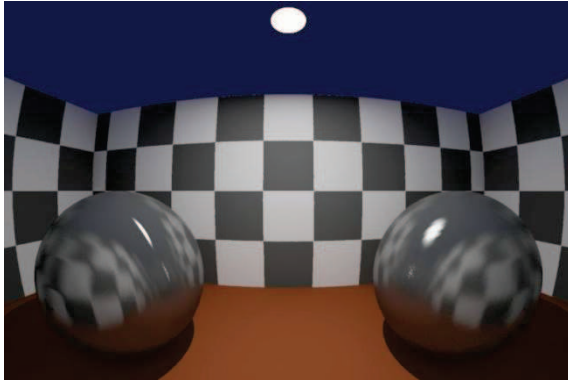
III.1 MATERIAL *PLASTIC2*

Material:

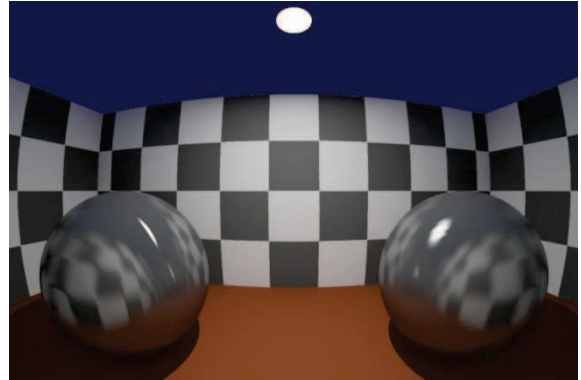
```
void plastic2 ptest2_20_01_10 4 0 1 0 . 0 6 . 1 . 1 . 1 . 2 . 01 . 10
```

genBSDF-Call:

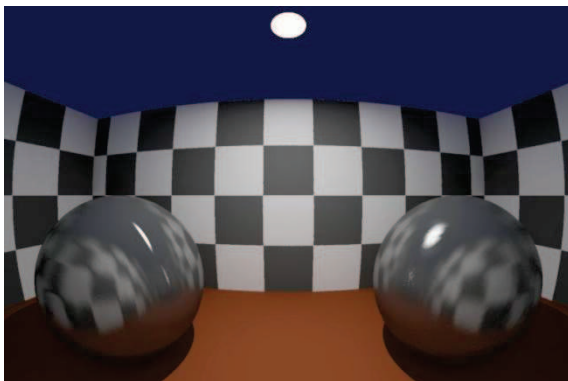
```
genBSDF -n 8 -t4 5 -c 10240 +b -mgf -geom meter -r -ss 16 -f
```



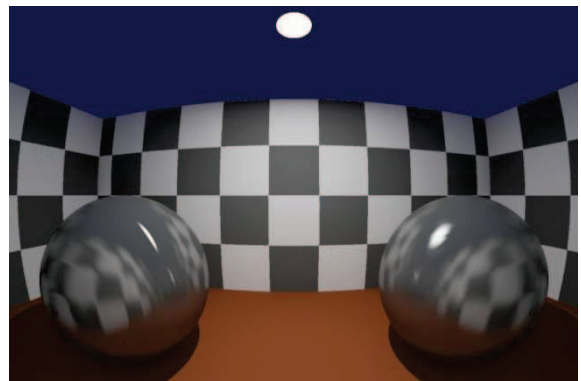
plastic2_s20_r01r10_reduced_0.jpg



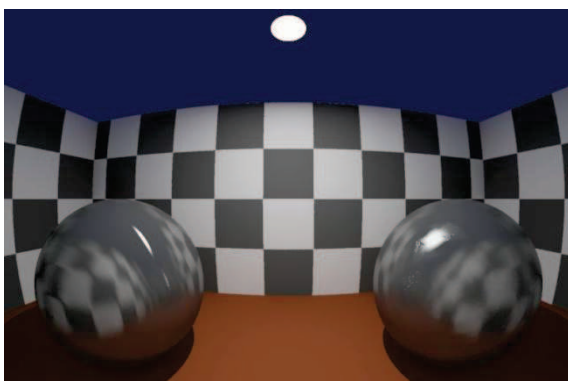
plastic2_s20_r01r10_ss64_reduced_0.jpg



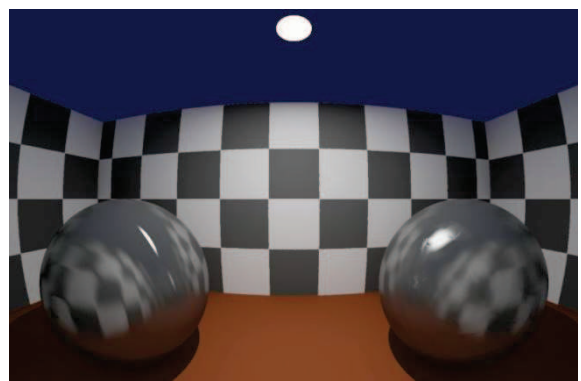
plastic2_s20_r01r10_reduced_95.jpg



plastic2_s20_r01r10_ss64_reduced_95.jpg



plastic2_s20_r01r10_reduced_99.jpg



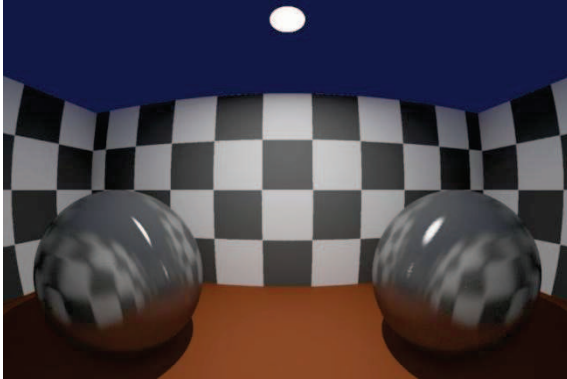
plastic2_s20_r01r10_ss64_reduced_99.jpg

Material:

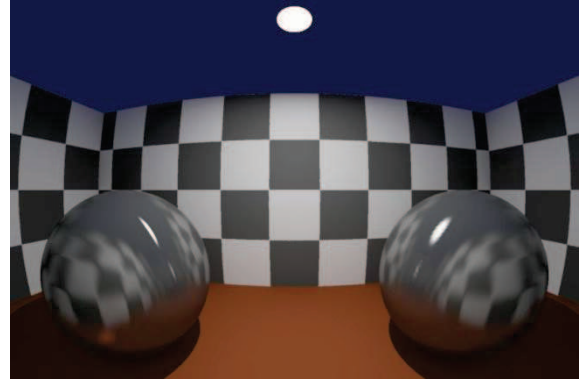
```
void plastic2 ptest2_20_01_10 4 0 1 0 . 0 6 .1 .1 .1 .2 .01 .10
```

genBSDF-Call:

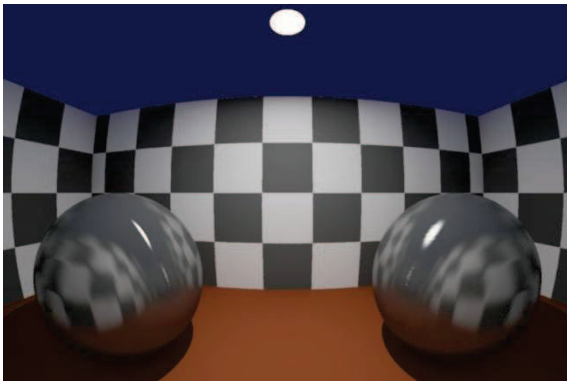
```
genBSDF -n 8 -t4 6 -c 40960 +b -mgf -geom meter -r -ss 16 -f
```



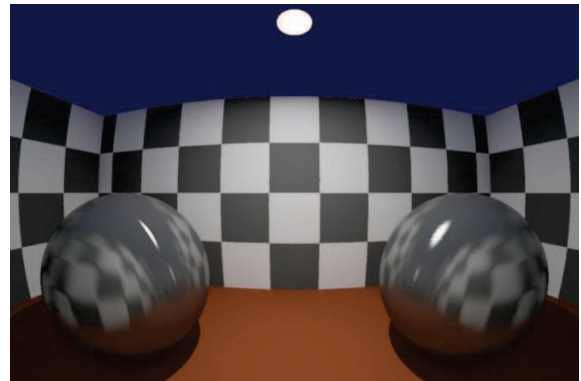
plastic2_s20_r01r10_highRes_reduced_0.jpg



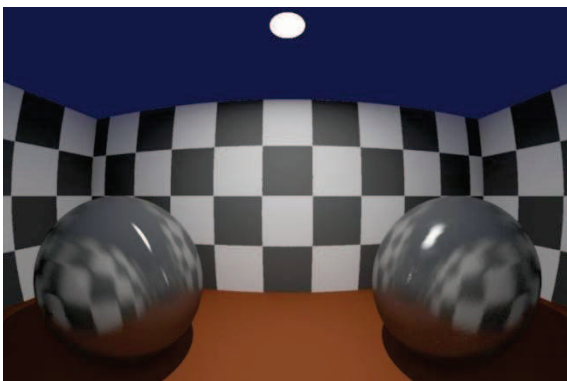
plastic2_s20_r01r10_highRes_ss64_reduced_0.jpg



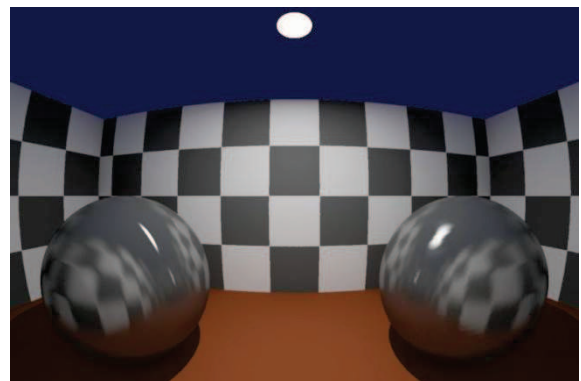
plastic2_s20_r01r10_highRes_reduced_95.jpg



plastic2_s20_r01r10_highRes_ss64_reduced_95.jpg



plastic2_s20_r01r10_highRes_reduced_99.jpg



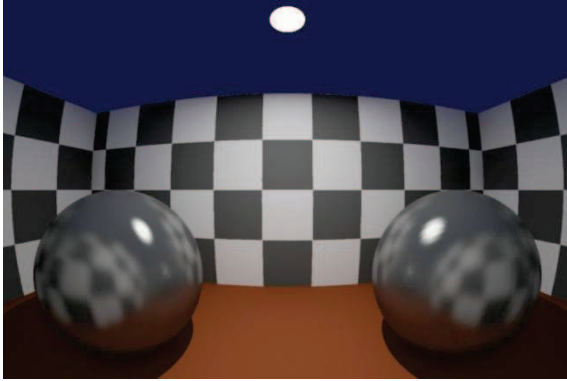
plastic2_s20_r01r10_highRes_ss64_reduced_99.jpg

Material:

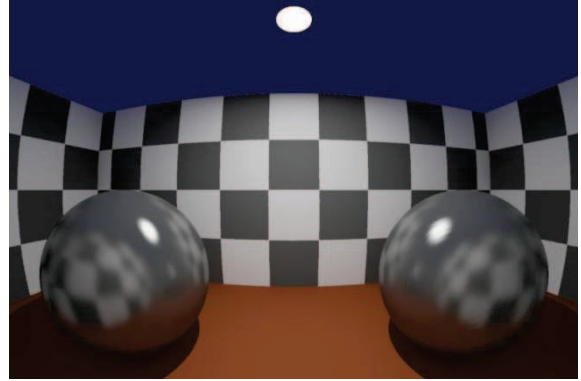
```
void plastic2 ptest2_20_05_10 4 0 1 0 . 0 6 .1 .1 .2 .05 .10
```

genBSDF-Call:

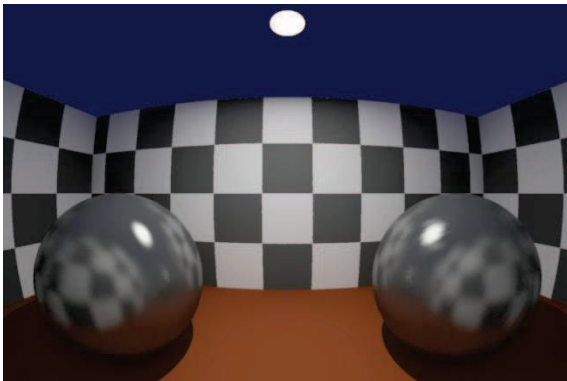
```
genBSDF -n 8 -t4 5 -c 10240 +b -mgf -geom meter -r -ss 16 -f
```



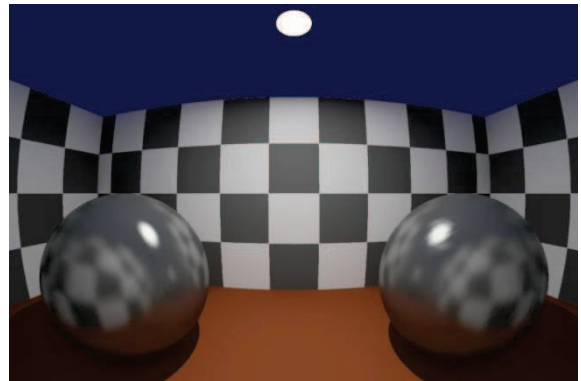
plastic2_s20_r05r10_reduced_0.jpg



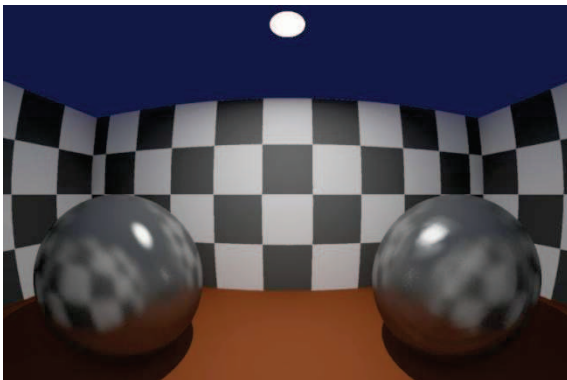
plastic2_s20_r05r10_ss64_reduced_0.jpg



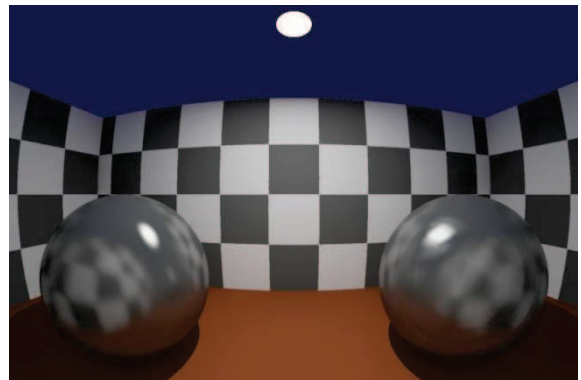
plastic2_s20_r05r10_reduced_95.jpg



plastic2_s20_r05r10_ss64_reduced_95.jpg



plastic2_s20_r05r10_reduced_99.jpg



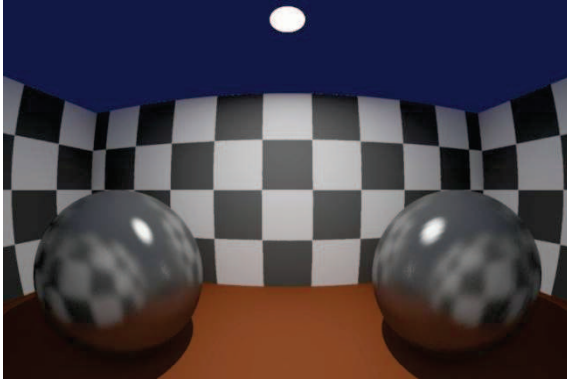
plastic2_s20_r05r10_ss64_reduced_99.jpg

Material:

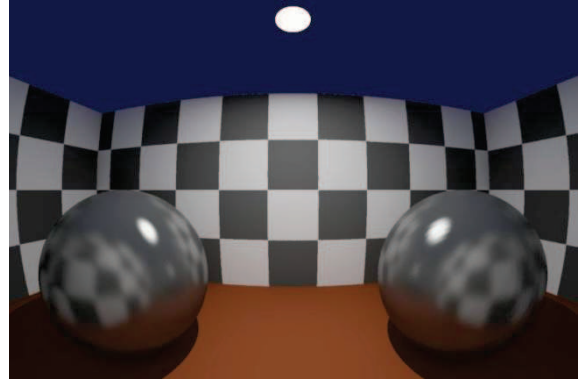
```
void plastic2 ptest2_20_05_10 4 0 1 0 . 0 6 .1 .1 .1 .2 .05 .10
```

genBSDF-Call:

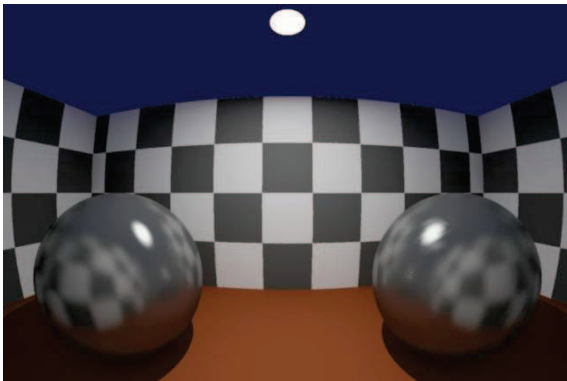
```
genBSDF -n 8 -t4 5 -c 10240 +b -mgf -geom meter -r -ss 64 -f
```



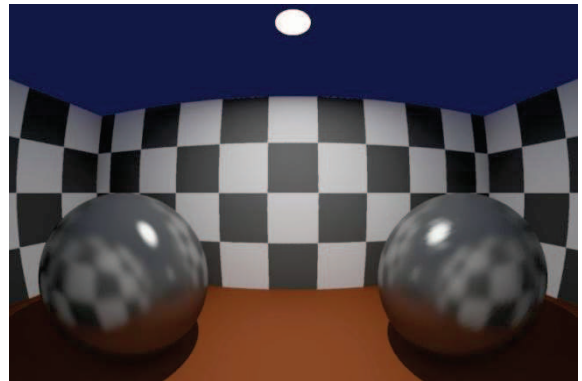
plastic2_s20_r05r10_highSS_reduced_0.jpg



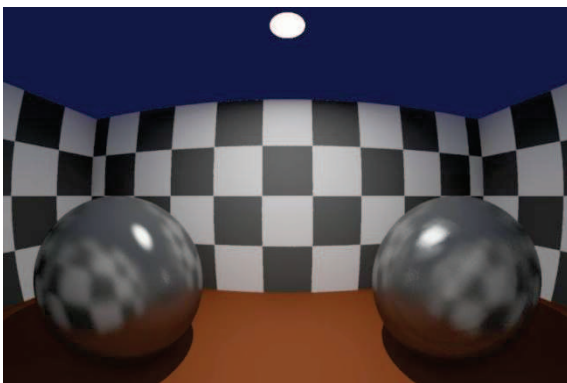
plastic2_s20_r05r10_highSS_ss64_reduced_0.jpg



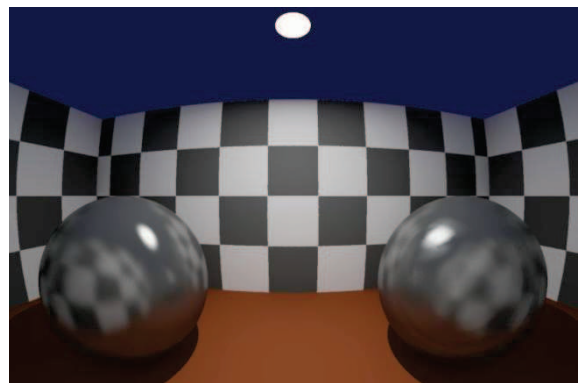
plastic2_s20_r05r10_highSS_reduced_95.jpg



plastic2_s20_r05r10_highSS_ss64_reduced_95.jpg



plastic2_s20_r05r10_highSS_reduced_99.jpg



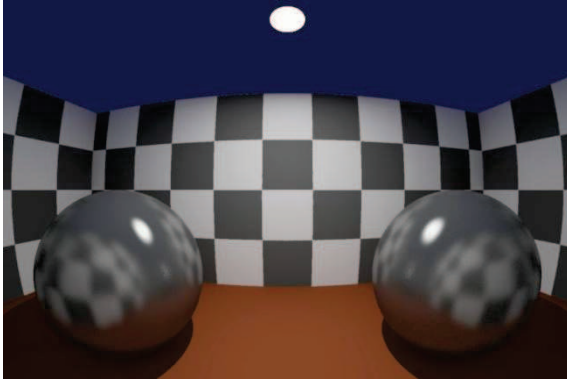
plastic2_s20_r05r10_highSS_ss64_reduced_99.jpg

Material:

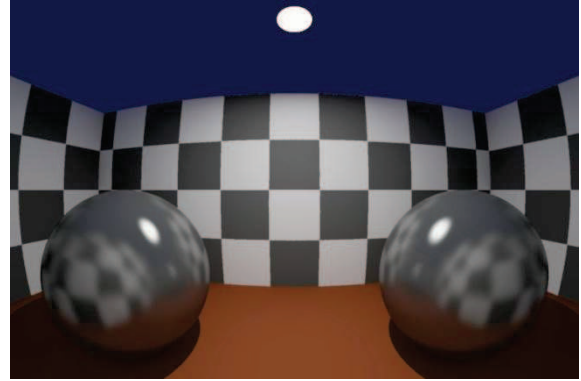
```
void plastic2 ptest2_20_05_10 4 0 1 0 . 0 6 .1 .1 .1 .2 .05 .10
```

genBSDF-Call:

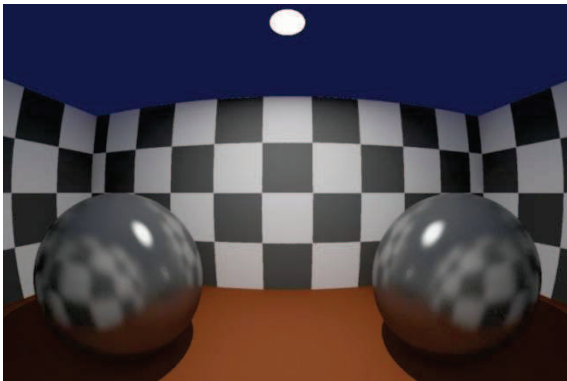
```
genBSDF -n 8 -t4 6 -c 40960 +b -mgf -geom meter -r -ss 16 -f
```



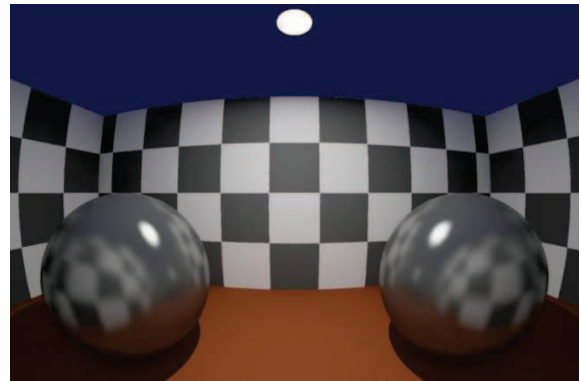
plastic2_s20_r05r10_highRes_reduced_0.jpg



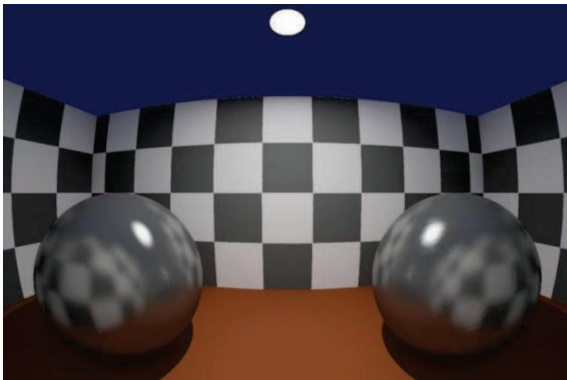
plastic2_s20_r05r10_highRes_ss64_reduced_0.jpg



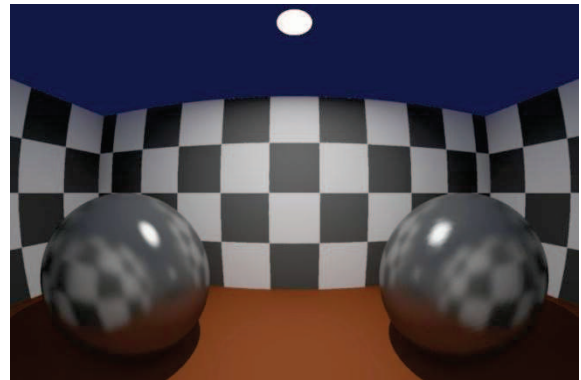
plastic2_s20_r05r10_highRes_reduced_95.jpg



plastic2_s20_r05r10_highRes_ss64_reduced_95.jpg



plastic2_s20_r05r10_highRes_reduced_99.jpg



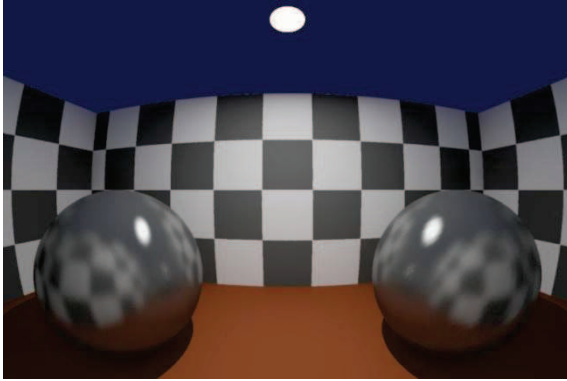
plastic2_s20_r05r10_highRes_ss64_reduced_99.jpg

Material:

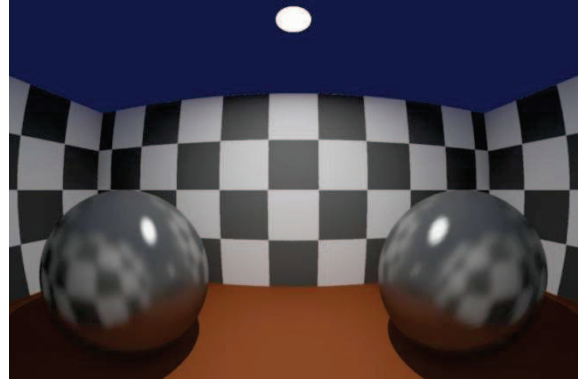
```
void plastic2 ptest2_20_05_10_rot30 4 0.57735 1 0 . 0 6 .1 .1 .1 .2 .05 .10
```

genBSDF-Call:

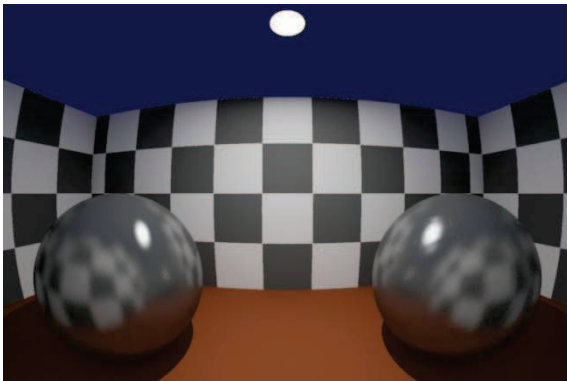
```
genBSDF -n 8 -t4 5 -c 10240 +b -mgf -geom meter -r -ss 16 -f
```



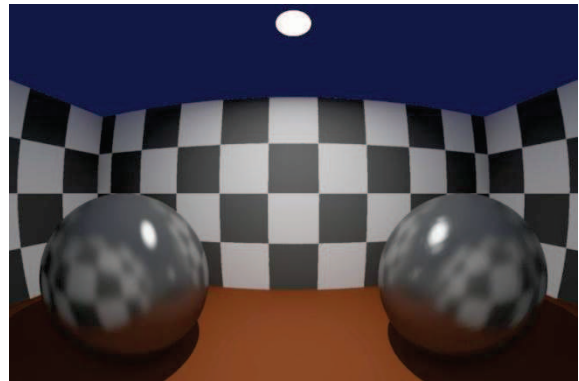
plastic2_s20_r05r10_rot30_reduced_0.jpg



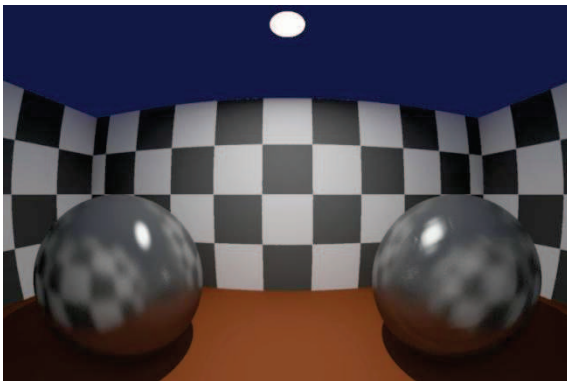
plastic2_s20_r05r10_rot30_ss64_reduced_0.jpg



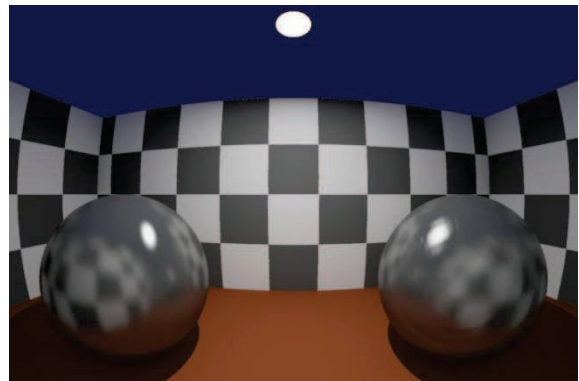
plastic2_s20_r05r10_rot30_reduced_95.jpg



plastic2_s20_r05r10_rot30_ss64_reduced_95.jpg



plastic2_s20_r05r10_rot30_reduced_99.jpg



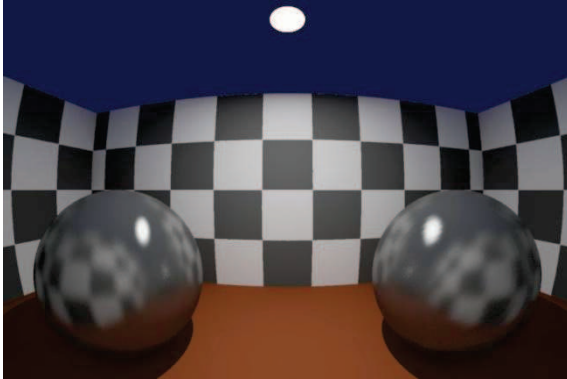
plastic2_s20_r05r10_rot30_ss64_reduced_99.jpg

Material:

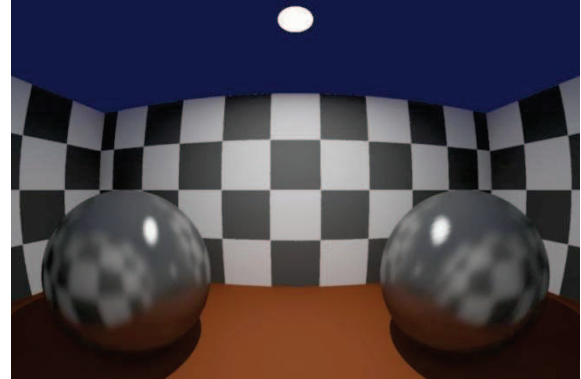
```
void plastic2 ptest2_20_05_10_rot45 4 1 1 0 . 0 6 .1 .1 .1 .2 .05 .10
```

genBSDF-Call:

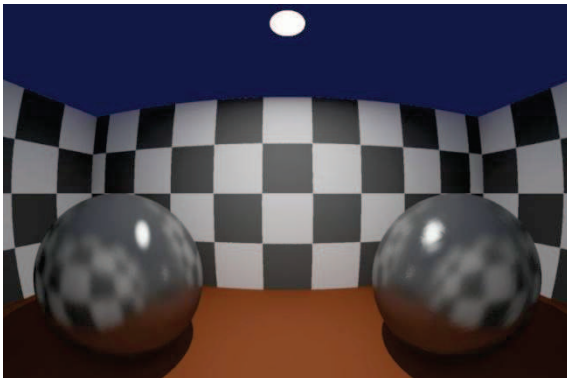
```
genBSDF -n 8 -t4 5 -c 10240 +b -mgf -geom meter -r -ss 16 -f
```



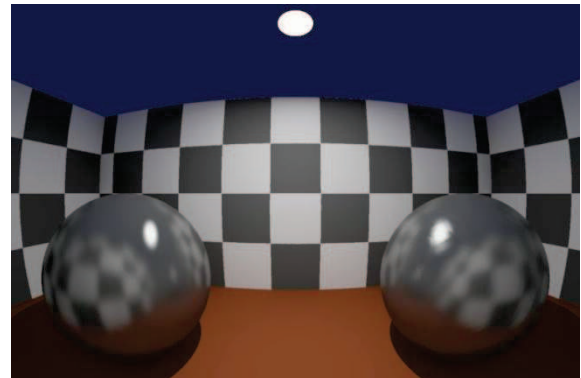
plastic2_s20_r05r10_rot45_reduced_0.jpg



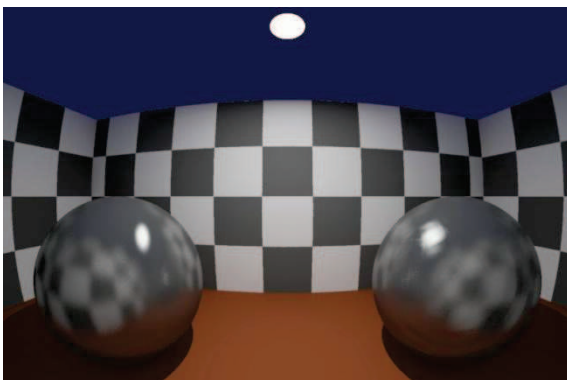
plastic2_s20_r05r10_rot45_ss64_reduced_0.jpg



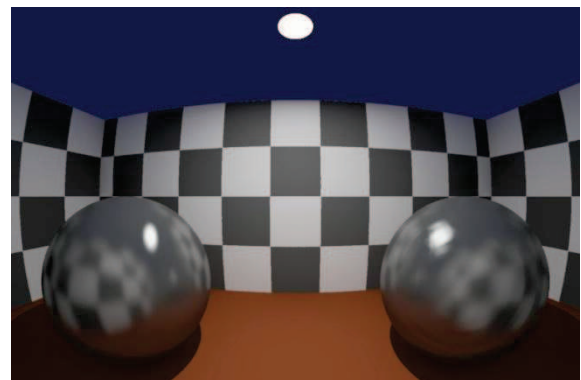
plastic2_s20_r05r10_rot45_reduced_95.jpg



plastic2_s20_r05r10_rot45_ss64_reduced_95.jpg



plastic2_s20_r05r10_rot45_reduced_99.jpg



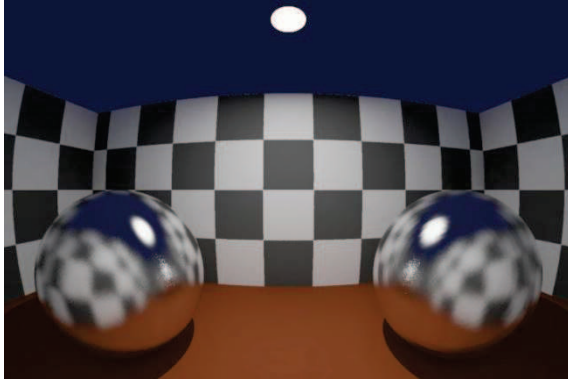
plastic2_s20_r05r10_rot45_ss64_reduced_99.jpg

Material:

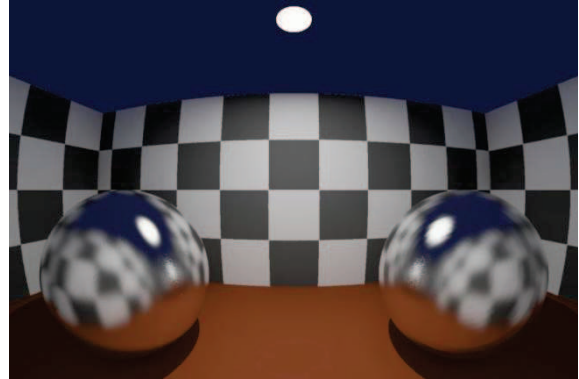
```
void plastic2 ptest2_90_05_10 4 0 1 0 . 0 6 .1 .1 .9 .05 .10
```

genBSDF-Call:

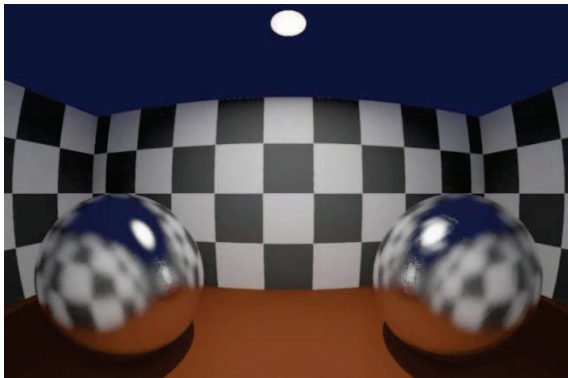
```
genBSDF -n 8 -t4 5 -c 10240 +b -mgf -geom meter -r -ss 16 -f
```



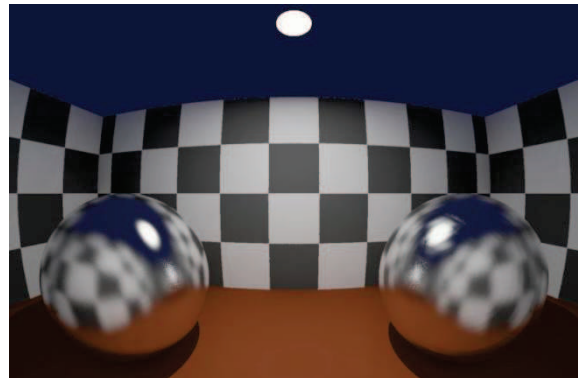
plastic2_s90_r05r10_reduced_0.jpg



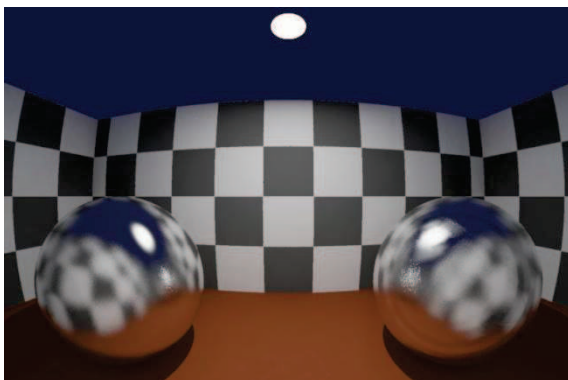
plastic2_s90_r05r10_ss64_reduced_0.jpg



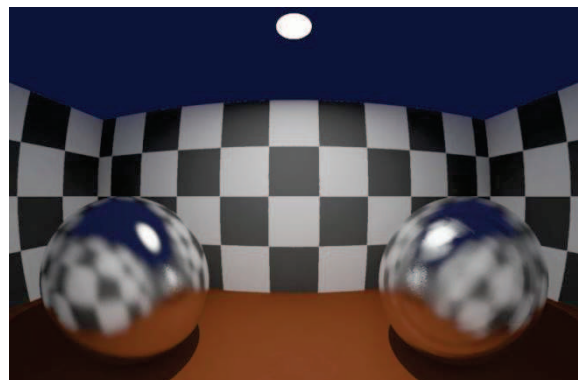
plastic2_s90_r05r10_reduced_95.jpg



plastic2_s90_r05r10_ss64_reduced_95.jpg



plastic2_s90_r05r10_reduced_99.jpg



plastic2_s90_r05r10_ss64_reduced_99.jpg

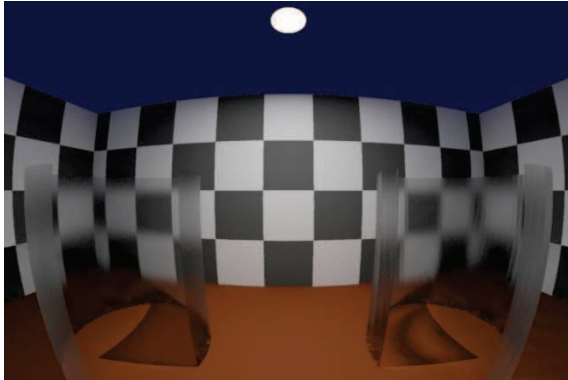
III.2 MATERIAL TRANS2

Material:

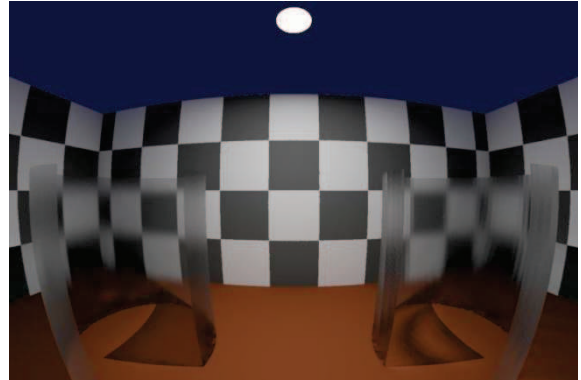
```
void trans2 ttest2_80_01_10 4 0 1 0 . 0 8 .8 .8 .8 .0 .01 .10 1.0 .8
```

genBSDF-Call:

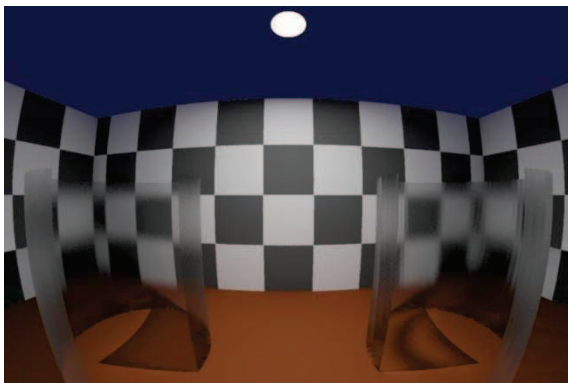
```
genBSDF -n 8 -t4 5 -c 10240 +b -mgf -geom meter -r -ss 16 +f
```



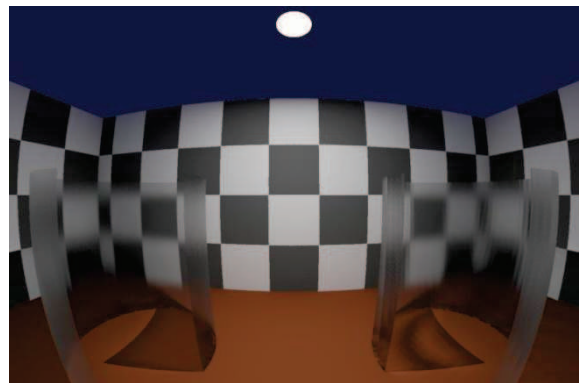
trans2_ts80_r01r10_reduced_0.jpg



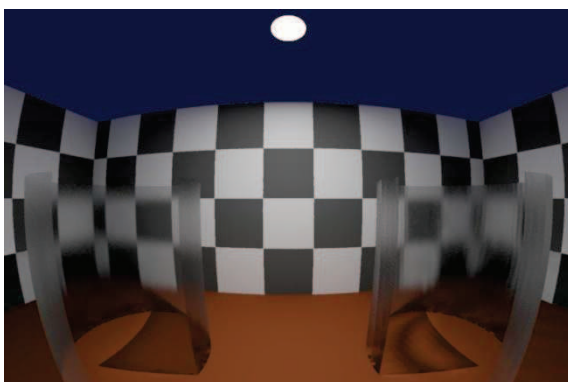
trans2_ts80_r01r10_ss64_reduced_0.jpg



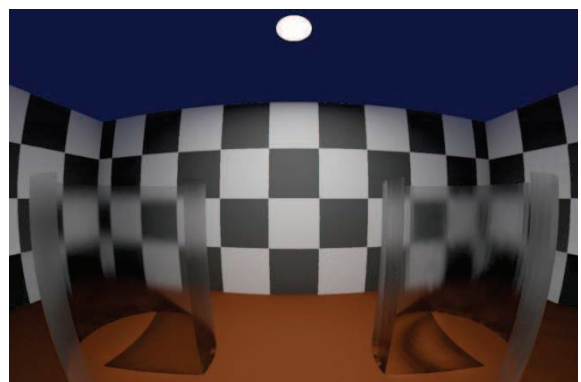
trans2_ts80_r01r10_reduced_95.jpg



trans2_ts80_r01r10_ss64_reduced_95.jpg



trans2_ts80_r01r10_reduced_99.jpg



trans2_ts80_r01r10_ss64_reduced_99.jpg

Material:

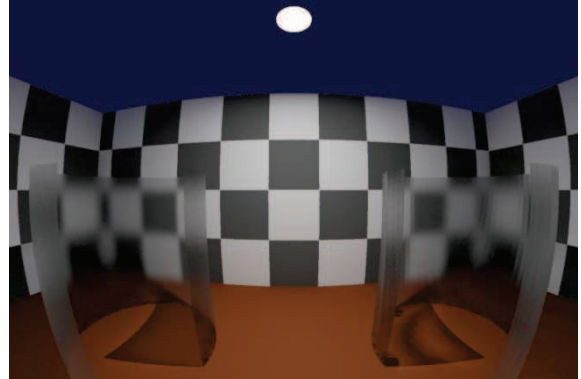
```
void trans2 ttest2_80_05_10 4 0 1 0 . 0 8 .8 .8 .8 .0 .05 .10 1.0 .8
```

genBSDF-Call:

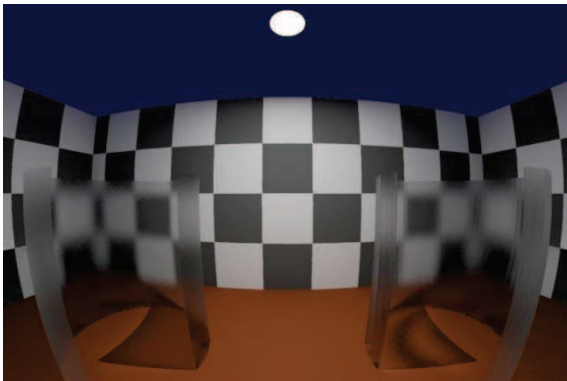
```
genBSDF -n 8 -t4 5 -c 10240 +b -mgf -geom meter -r -ss 16 +f
```



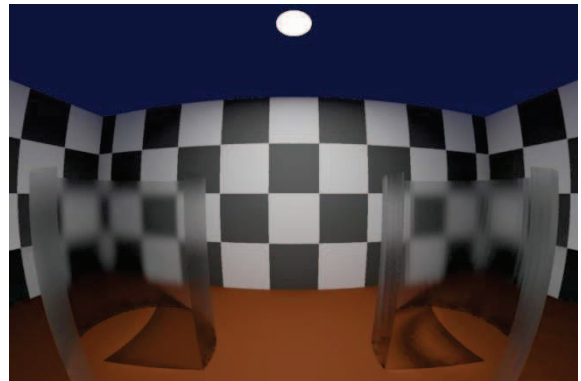
trans2_ts80_r05r10_reduced_0.jpg



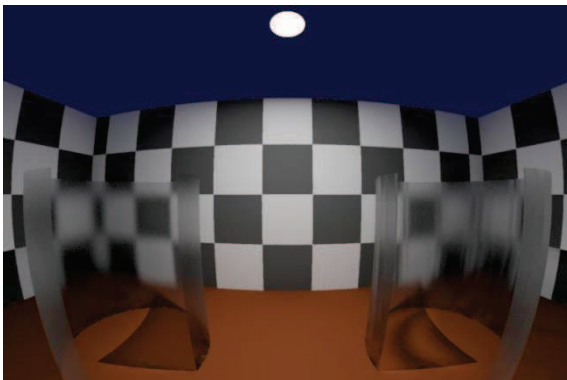
trans2_ts80_r05r10_ss64_reduced_0.jpg



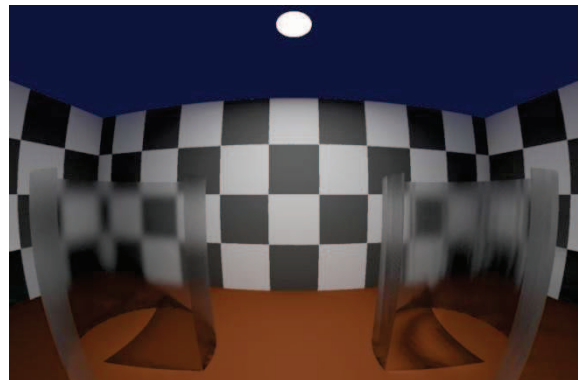
trans2_ts80_r05r10_reduced_95.jpg



trans2_ts80_r05r10_ss64_reduced_95.jpg



trans2_ts80_r05r10_reduced_99.jpg



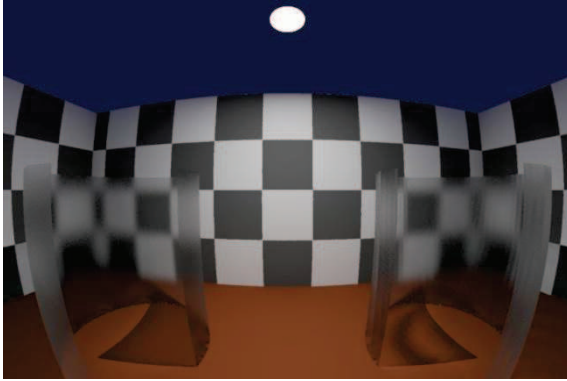
trans2_ts80_r05r10_ss64_reduced_99.jpg

Material:

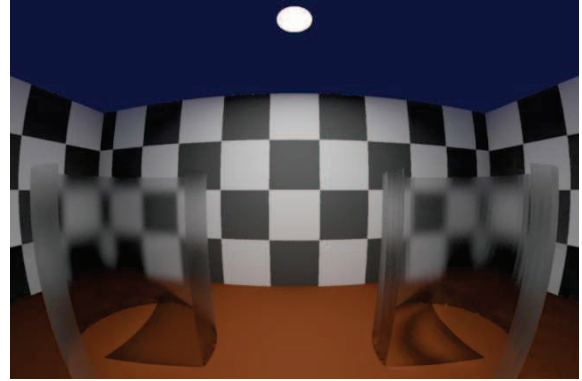
```
void trans2 ttest2_80_05_10 4 0 1 0 . 0 8 .8 .8 .8 .0 .05 .10 1.0 .8
```

genBSDF-Call:

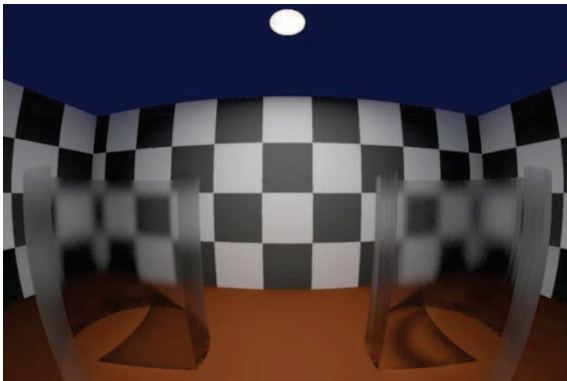
```
genBSDF -n 8 -t4 5 -c 10240 +b -mgf -geom meter -r -ss 64 +f
```



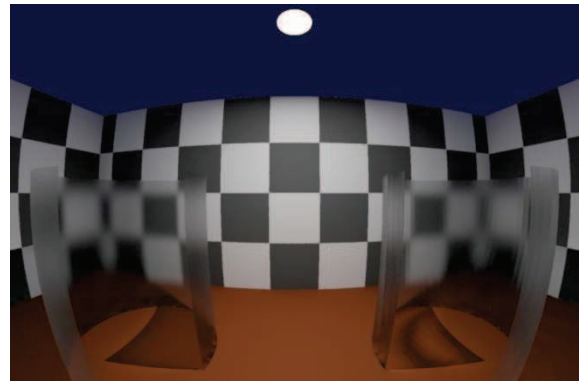
trans2_ts80_r05r10_highSS_reduced_0.jpg



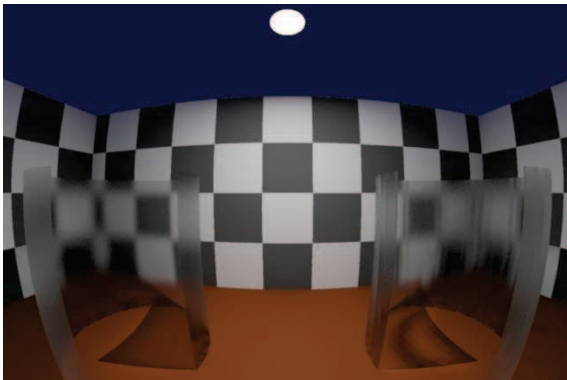
trans2_ts80_r05r10_highSS_ss64_reduced_0.jpg



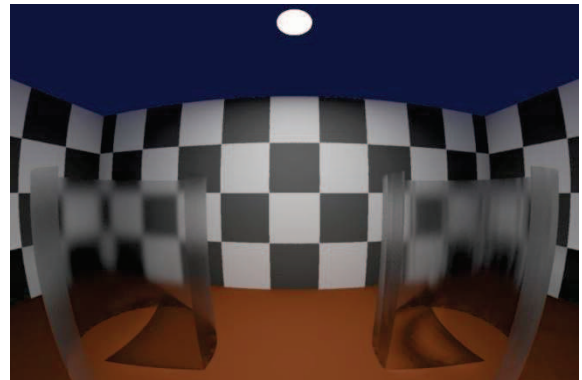
trans2_ts80_r05r10_highSS_reduced_95.jpg



trans2_ts80_r05r10_highSS_ss64_reduced_95.jpg



trans2_ts80_r05r10_highSS_reduced_99.jpg



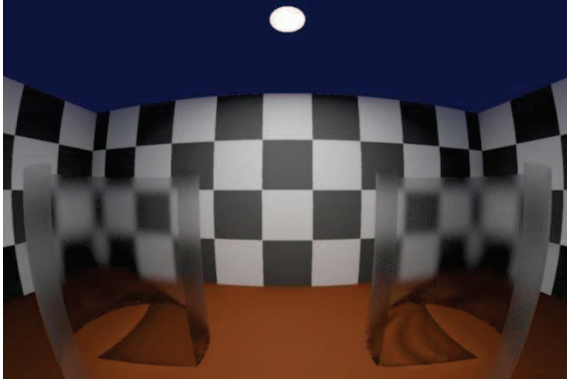
trans2_ts80_r05r10_highSS_ss64_reduced_99.jpg

Material:

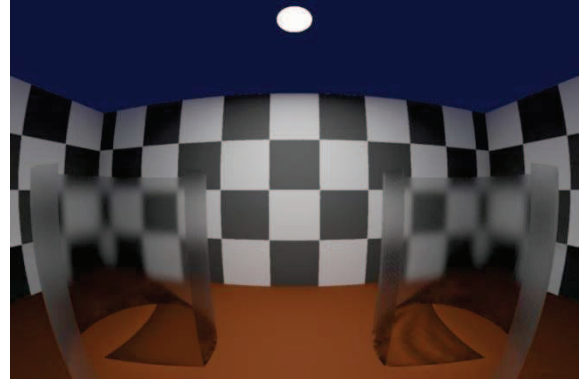
```
void trans2 ttest2_80_05_10 4 0 1 0 . 0 8 .8 .8 .8 .0 .05 .10 1.0 .8
```

genBSDF-Call:

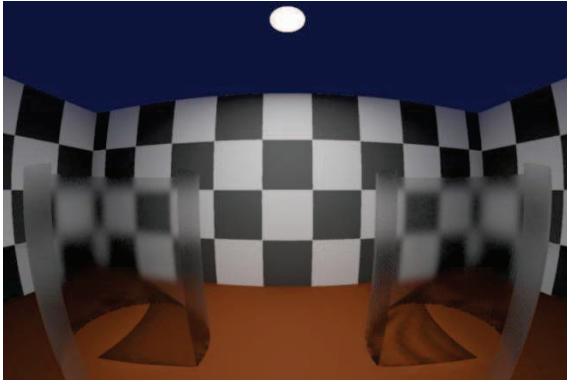
```
genBSDF -n 8 -t4 6 -c 40960 +b -mgf -geom meter -r -ss 16 +f
```



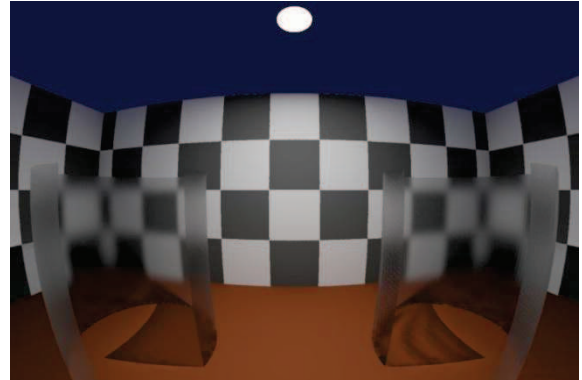
trans2_ts80_r05r10_highRes_reduced_0.jpg



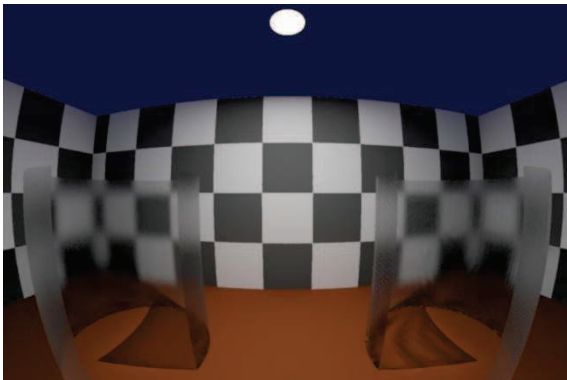
trans2_ts80_r05r10_highRes_ss64_reduced_0.jpg



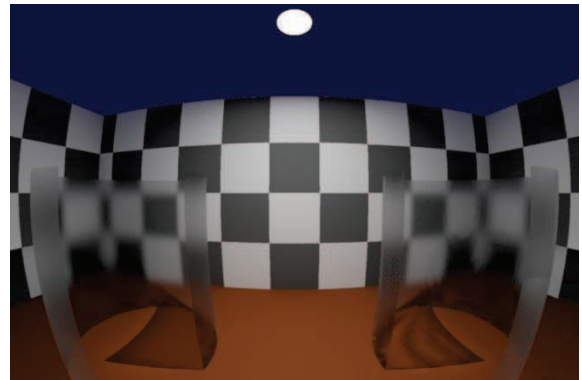
trans2_ts80_r05r10_highRes_reduced_95.jpg



trans2_ts80_r05r10_highRes_ss64_reduced_95.jpg



trans2_ts80_r05r10_highRes_reduced_99.jpg



trans2_ts80_r05r10_highRes_ss64_reduced_99.jpg

IV CONCLUSION

In general, the “Variable Resolution BSDF” approach yields results that are comparable to RADIANCE’s native materials. The differences that can be observed between both models are believed to be due to the general restrictions of a patch-based BSDF approach.

Depending on the degree of reduction used in *rttree_reduce* and the simulation parameters used in *genBSDF* and the *rpict* rendering the differences vary.

- Reducing data at a very high degree (e.g. 99%) in *rttree_reduce* results in artifacts around direct specular highlights.
- Independent of the degree of reduction using a higher maximum resolution reduces both artifacts around direct specular highlights and blurred indirect specular reflections.
- The concentrically aligned projected BSDF patches can be observed in the renderings as concentric patterns on the reflecting spheres and the transmitting cylinders or as variations in the transmitted light. Higher maximum BSDF resolutions result in less pronounced patterns.
- Due to the axis-aligned BSDF patches artifacts around direct specular highlights are more pronounced for anisotropic materials direction vectors that are not axis-aligned.
- Higher numbers of specular samples in the call to *genBSDF* (BSDF generation) result in slightly smoother indirect specular reflections from the BSDF material. This becomes more important for highly specular materials.
- Higher numbers of specular samples in the call to *rpict* (rendering process) result in smoother indirect specular reflections for both the native and the BSDF materials. This becomes more important for highly specular materials.

In a first cycle increasing the number of specular samples (i.e. *-ss 64* instead of *-ss 16*) seemed to decrease the albedo of both the native materials as well as the BSDF material. This phenomenon needs was further evaluated and traced back to an improper setting of the direct threshold (*-dt*). Setting this parameter to *-dt 0* forced all direct contributions to be evaluated and thus removed the brightness differences between *-ss 64* and *-ss 16*.

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David Geisler-Moroder
Bartenbach GmbH