

# **RayStorm Documentation**

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**COLLABORATORS**

	<i>TITLE :</i> RayStorm Documentation		
<i>ACTION</i>	<i>NAME</i>	<i>DATE</i>	<i>SIGNATURE</i>
WRITTEN BY	Andreas Heumann	February 12, 2023	

**REVISION HISTORY**

NUMBER	DATE	DESCRIPTION	NAME

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# Chapter 1

## RayStorm Documentation

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## 1.2 RayStorm Documentation

06 ↔  
August ↔  
↔  
1995 ↔

Demoversion  
by Andreas Heumann and Mike Hesser

Introduction  
Requirements  
Features  
Installation  
ARexx interface  
Examples  
Textures  
Legal Stuff  
Register  
Credits  
Authors  
PC-Version  
Future

## 1.3 Introduction

### INTRODUCTION

RayStorm has been written to be as fast as possible, and use as less memory as possible. Thus we have implemented a octree algorithm, and optimized all calculations as much as we could.

It has been developed on Amiga and also on PC, therefore there also exists a

PC-Version

.

This demo version is limited to a resolution of 160x128, only 2 lightsources and only 17 objects.

The full version is unlimited.

### FUNDAMENTALS ABOUT RAYTRACING

General

Octree

---



Antialiasing

Surfaces

Internals

## 1.4 General

### GENERAL

Raytracing makes it possible to generate fotorealistic pictures of objects.

A raytracer casts a ray form the position of the viewer through a scene and calculates the intersections with the objects in that scene. If a intersection is found, the raytracer decides which color the object at this position has. If the object is reflective or transparent, the raytracer casts new rays from this positon and tests the intersections again and so on ... .

To make the surfaces of the objects more realistic, textures which simulate marble or clouds or water or other surfaces can be used.

## 1.5 Octree

### OCTREE

Simple raytraces determine the intersections with objects by testing all objects. This can lead to long rendering times if there are a lot of objects in the scene.

One solution of this problem is the Octree algorithm. This algorithm divides the scene in eight childcells and every childcell again in eight cells and so on until there are less than one objects in the cell or the maximum depth of the tree is reached.

Octree division

```

      /| z
     /
  /-----/-----/|
 ^ y/      /      / |
 | / left / right / b|
 |/      /      / |a| |
 |-----/-----| f|c|
 |          | r|k|
 |      up      | o| /
 |-----| n|/
 |          | t|
 |      down      | / x
 |-----| /-->

```

## 1.6 Antialiasing

### ANTIALIASING

RayStorm uses a algorithm called 'Adaptive Supersampling' to do antialiasing. This algorithm cast for each pixel which has a high contrast against it's four neighbours new rays which are close to the ray used for the pixel itself. The new color of the pixel is calculated with the supersampled pixels and the gaussian filter.

Example:

Settings: squareroot of number of samples per pixel: 3

```
|-----|-----|-----|
| super- | super- | super- |
| sampled| sampled| sampled|
|         |         |         |
|-----|-----|-----|
| super- |         | super- |
| sampled| pixel  | sampled|
|         |         |         |
|-----|-----|-----|
| super- | super- | super- |
| sampled| sampled| sampled|
|         |         |         |
|-----|-----|-----|
|- Gaussian filter width -|
```

The rendering time increases dramatically if you use antialiasing. The values below depend on the contrast of the picture.

Samplesetting	rendering time
1	x1
2	x4
3	x9
4	x16
...	...

Setting higher than 3 are not leading to significant better results.

## 1.7 Surfaces

### SURFACES

Ambient (set with AMBIENT)

This determines the color of the object in sections, which are in shadow.

Diffuse reflection (set with DIFFUSE)

The diffuse reflection falls off as the cosine of the angle between the normal and the ray to the light. Diffuse reflection determines the

main color of the object (color in Imagine).

Specularly reflected highlights (set with SPECULAR)

Specularly reflected highlights fall off as the cosine of the angle between the reflected ray and the ray to the light source (specular in Imagine)

Specular reflection exponent (set with REFPHONG)

Determines the size of the specularly reflected highlights, the higher the smaller the highlight (hardness in Imagine)

Diffuse transmission (set with DIFFTRANS)

Same as diffuse reflection, but only used if the lightsource is on opposite side of surface. Only applied if tranlucency is not 0.

Specular transmission (set with SPECTRANS)

Same as specular reflection, but only used if the lightsource is on opposite side of surface. Only applied if tranlucency is not 0.

Specular transmission exponent (set with TRANSPHONG)

Same as specular reflection exponent, but only used if the lightsource is on opposite side of surface.

Specular transmittance (set with TRANSLUC)

Specular transmittance.

Transparency (set with TRANSPAR)

Transparent color (filter in Imagine).

Reflectivity (set with REFLECT)

Reflective color (reflect in Imagine).

Transmission attenuation (set with TRANSATTU)

(fog in Imagine).

Index of refraction (set with REFRINDEX)

Determines how the ray through transparent objects is refracted, the higher the more (index of refraction in Imagine).

Is calculated with the formula

$$\text{index} = \frac{\text{lightspeed in vacuum}}{\text{lightspeed in object}} .$$

## 1.8 Internals

### INTERNALS

Memory requirements

```
Triangle:      142 Bytes (flat shaded)
               178 Bytes (Phong shaded)
Sphere:        58 Bytes
Plane:         66 Bytes
Surface:       118 Bytes + length of name
Screenbuffer:  4 Bytes per pixel
```

Memory requirements of the octree depends on the scene.

## 1.9 Requirements

### REQUIREMENTS

- (1) You will need at least Kickstart 2.0 and a 68020 processor and a mathematical coprocessor (68881/882 or internal 68040/060 version).

The faster the better :-).

- (2) ShowObj was written using  
MUI  
. So you need  
muimaster.library V2.0+ or later to run ShowObj.

Tested with:

A2000 68040/30, 9MB, 250+250MB HD, Merlin Gfx-board

A2000 68030/14, 68882/20, 4MB, 720+52MB HD

## 1.10 Features

### FEATURES

- Fast. About 20% faster than Imagine.
  - ARexx-port. RayStorm can be used by all programs with the ARexx-port.
  - Imagine compatible. RayStorm is designed to be almost compatible to Imagine. It can load Imagine objects and use Imagine textures.
  - Octree algorithm used for rendering.
  - Antialiasing possibility (adaptive supersampling).
  - Image can be saved as 24Bit IFF-ILBM file.
  - Three builtin object types: sphere, plane and triangle.
-

- Three light types: ambient, point and spot.
- Depth of field

## 1.11 Installation

### INSTALLATION

There is a installation script included in the archive which uses the Commodore Installer. Run it to install RayStorm.

## 1.12 ARexx Interface

### AREXX INTERFACE

Address

The ARexx-address of RayStorm is 'RAYSTORM'.

Parameter conventions:

- /S - Switch.
- /N - Number.
- /A - Required.

All other numeric parameters are floating point numbers.

ARexx commands

General

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Animation

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Alphabetically sorted

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ANTIALIAS

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SPECTRANS

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---

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 SPOTLIGHT  
 STARTRENDER  
 -T-  
 TEXTUREPATH  
 TRANSATTU  
 TRANSEXP  
 TRANSLUC  
 TRANSPAR  
 TRIANGLE  
 -W-  
 WINTOFRONT

### 1.13 antialias

ANTIALIAS

Arguments:      SAMPLES/N/A      squareroot of number of samples per  
    pixel (max. 8)  
    WIDTH                    width of gaussian filter  
    CONTR,CONTG,CONTB    max. allowed contrast  
 Description:    Sets antialiasing parameters (see  
    Antialiasing  
    )  
 Default:         ANTIALIAS 1 1.8 51 38 76

### 1.14 brushpath

BRUSHPATH

Arguments:      PATH/A                    pathname  
 Description:    Defines the path where to search brushes.

### 1.15 cleanup

CLEANUP

Arguments:      none  
 Description:    Deletes all defined objects, lightsources and surfaces

---

## 1.16 display

DISPLAY

!!! CAUTION !!!  
THIS COMMAND ISN'T RELEASED IN THIS VERSION YET  
!!! CAUTION !!!

Arguments: FLOYD/S dither with Floyd-Steinberg algorithm  
Description: Displays rendered pic on screen

## 1.17 objectpath

OBJECTPATH

Arguments: PATH/A pathname  
Description: Defines the path where to search Imagine objects.

## 1.18 pointlight

POINTLIGHT

Arguments: POSX, POSY, POSZ position  
COLR/N, COLG/N, COLB/N color  
SHADOW/S cast shadows if keyword given  
Description: Creates a point lightsource  
Default: POINTLIGHT 0 0 0 255 255 255

## 1.19 quit

QUIT

Arguments: none  
Description: Quits Raystorm

## 1.20 savepic

SAVEPIC

Arguments: NAME/A name of file to save  
Description: Saves rendered pic as IFF-ILBM-file

---



## 1.21 setcamera

SETCAMERA

Arguments:      POSX/A, POSY/A, POSZ/A    position  
                  VIEWX, VIEWY, VIEWZ    viewpoint  
                  VUPX, VUPY, VUPZ      viewupvector  
                  FOVX, FOVY            field of view (in degree)  
     (20 degree creates camera like Imagine default camera)  
                  FOCALDIST            distance from eye to focal plane  
                  APERTURE             aperture width (0 == pinhole)

Description:    Sets the parameters of the camera

Default:        SETCAMERA 0 0 -10 0 0 0 0 1 0 45 45 1. 0.

## 1.22 setscreen

SETSCREEN

Arguments:      RESX/N/A, RESY/N/A    resolution  
                  COLORS/N            number of colors (not yet implemented)

Description:    sets the screen parameters

Default:        SETSCREEN 128 128 32

## 1.23 setworld

SETWORLD

Arguments:      BACKR/N/A, BACKG/N/A, BACKB/N/A    backgroundcolor  
                  AMBR/N, AMBG/N, AMBB/N            ambientcolor

Description:    Sets world parameters

Default:        SETWORLD 0 0 0 0 0 0

## 1.24 spotlight

SPOTLIGHT

Arguments:      POSX, POSY, POSZ      position  
                  COLR/N, COLG/N, COLB/N      color  
                  DIRX, DIRY, DIRZ            direction  
                  COEFF                    coefficient  
                  SHADOW/S                cast shadows if keyword given

Description:    Creates a spot lightsource

Default:        SPOTLIGHT 0 0 0 255 255 255

## 1.25 startrender



## 1.30 sphere

SPHERE

Arguments: SURF/A surface name  
 POSX/A, POSY/A, POSZ/A position  
 RADIUS/A radius  
 Description: Creates a sphere

## 1.31 triangle

TRIANGLE

Arguments: SURF/A surface name  
 P1X/A, P1Y/A, P1Z/A first point  
 P2X/A, P2Y/A, P2Z/A second point  
 P3X/A, P3Y/A, P3Z/A third point  
 N1X, N1Y, N1Z first normal  
 N2X, N2Y, N2Z second normal  
 N3X, N3Y, N3Z third normal  
 Description: Creates a triangle

## 1.32 newsurface

NEWSURFACE

Arguments: NAME/A  
 Description: Creates a new surface with name 'NAME'

## 1.33 ambient

AMBIENT

Arguments: COLR/N/A, COLG/N/A, COLB/N/A color  
 Description: Sets the ambient color of surface  
 Default: AMBIENT 255 255 255

## 1.34 brush

BRUSH

Arguments: NAME/A name of brush file (IFF-ILBM)  
 TYPE/A Brush type: valid strings  
 COLOR, REFLECT, FILTER, ALTITUDE  
 WRAP/A Brush wrapping method: valid strings  
 FLAT, WRAPX, WRAPY, WRAPXY  
 PX/A, PY/A, PZ/A position

AX/A, AY/A, AZ/A      alignment  
 LX/A, LY/A, LZ/A      length of each axis  
 Description:      Adds a brush to surface (only 24Bit-IFF-ILBM images are supported)

### 1.35 difftrans

DIFFTRANS

Arguments:      COLR/N/A, COLG/N/A, COLB/N/A      color  
 Description:      Sets the diffuse transmission color of surface  
 Default:      DIFFTRANS 0 0 0

### 1.36 diffuse

DIFFUSE

Arguments:      COLR/N/A, COLG/N/A, COLB/N/A      color  
 Description:      Sets the diffuse color of surface  
 Default:      DIFFUSE 255 255 255

### 1.37 imtexture

IMTEXTURE

Arguments:      NAME/A      name of Imagine texture file  
                   PX, PY, PZ      position  
                   AX, AY, AZ      alignment  
                   LX, LY, LZ      length of each axis  
                   P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13,  
                   P14, P15, P16      texture parameters  
 Description:      Adds a Imagine texture to surface  
 Default:      defaults are take from texture if not all paramters are given

### 1.38 refexp

REFEXP

Arguments:      VALUE/A      specular reflection exponent  
 Description:      Sets the specular reflection exponent of surface  
 Default:      REFEXP 12.

### 1.39 reflect

## REFLECT

Arguments: COLR/N/A, COLG/N/A, COLB/N/A color  
 Description: Sets the specular reflectivity of surface  
 Default: REFLECT 0 0 0

**1.40 refrindex**

## REFRINDEX

Arguments: VALUE/A index of refraction  
 Description: Sets the index of refraction of surface  
 Default: REFRINDEX 1.  
 Examples:

MATERIAL	Index
Vacuum .....	1.00000 (exactly)
Air (STP).....	1.00029
Acetone .....	1.36
Alcohol .....	1.329
Amorphous Selenium .....	2.92
Calspar1 .....	1.66
Calspar2 .....	1.486
Carbon Disulfide .....	1.63
Chromium Oxide .....	2.705
Copper Oxide .....	2.705
Crown Glass .....	1.52
Crystal .....	2.00
Diamond .....	2.417
Emerald .....	1.57
Ethyl Alcohol .....	1.36
Flourite .....	1.434
Fused Quartz .....	1.46
Heaviest Flint Glass .....	1.89
Heavy Flint Glass .....	1.65
Glass .....	1.5
Ice .....	1.309
Iodine Crystal .....	3.34
Lapis Lazuli .....	1.61
Light Flint Glass .....	1.575
Liquid Carbon Dioxide .....	1.20
Polystyrene .....	1.55
Quartz 1 .....	1.644
Quartz 2 .....	1.553
Ruby .....	1.77
Sapphire .....	1.77
Sodium Chloride (Salt) 1 ....	1.544
Sodium Chloride (Salt) 2 ....	1.644
Sugar Solution (30%) .....	1.38
Sugar Solution (80%) .....	1.49
Topaz .....	1.61
Water (20 C) .....	1.333
Zinc Crown Glass .....	1.517

---

## 1.41 spectrans

SPECTRANS

Arguments: COLR/N/A, COLG/N/A, COLB/N/A color  
Description: Sets the specular transmission color of surface  
Default: SETSPECTRANS 255 255 255

## 1.42 specular

SPECULAR

Arguments: COLR/N/A, COLG/N/A, COLB/N/A color  
Description: Sets the specular color of surface  
Default: SPECULAR 255 255 255

## 1.43 transattu

TRANSATTU

Arguments: VALUE/A specular transmission attenuation  
Description: Sets the specular transmission attenuation of surface  
Default: TRANSATTU 1.

## 1.44 transexp

TRANSEXP

Arguments: VALUE/A specular transmission exponent  
Description: Sets the specular transmission exponent of surface  
object  
Default: TRANSEXP 12.

## 1.45 transluc

TRANSLUC

Arguments: VALUE/A diffuse transmittance  
Description: Sets the specular transmittance of surface  
Default: TRANSLUC 0

## 1.46 transpar

---

## TRANSPAR

Arguments: COLR/N/A, COLG/N/A, COLB/N/A color  
Description: Sets the diffuse transmittance of surface  
Default: TRANS 0 0 0

## 1.47 alignment

## ALIGNMENT

!!! CAUTION !!!  
THIS COMMAND ISN'T RELEASED IN THIS VERSION YET  
!!! CAUTION !!!

Arguments: BEGIN/N,END/N begin and end of position  
ALIGNX/A, ALIGNY/A, ALIGNZ/A alignment  
Description: Sets the alignment of the object

## 1.48 maxframes

## MAXFRAMES

!!! CAUTION !!!  
THIS COMMAND ISN'T RELEASED IN THIS VERSION YET  
!!! CAUTION !!!

Arguments: FRAMES/N amount of frames  
Description: Sets the amount of objects

## 1.49 newactor

## NEWACTOR

!!! CAUTION !!!  
THIS COMMAND ISN'T RELEASED IN THIS VERSION YET  
!!! CAUTION !!!

Arguments: NAME name of new actor  
Description: creates a new actor

## 1.50 position

## POSITION

!!! CAUTION !!!  
THIS COMMAND ISN'T RELEASED IN THIS VERSION YET  
!!! CAUTION !!!

---

Arguments: BEGIN/N,END/N begin and end of position  
          POSX/A, POSY/A, POSZ/A position  
Description: Sets the position of the object

## 1.51 size

SIZE

!!! CAUTION !!!  
THIS COMMAND ISN'T RELEASED IN THIS VERSION YET  
!!! CAUTION !!!

Arguments: BEGIN/N,END/N begin and end of position  
          SIZE/A,SIZEY/A,SIZEZ/A position  
Description: Sets the size of the object

## 1.52 General ARexx-commands

GENERAL AREXX-COMMANDS

ANTIALIAS  
sets antialiasing parameters

BRUSHPATH  
sets brush path

CLEANUP  
cleanups scene

DISPLAY  
displays scene

OBJECTPATH  
sets object path

POINTLIGHT  
creates point lightsource

QUIT  
quits RayStorm

SAVEPIC  
saves scene as IFF-ILBM-file

SETCAMERA  
sets camera parameters

SETSCREEN  
sets screen parameters

---



```
SETWORLD
  sets world parameters

SPOTLIGHT
  creates spot lightsource

STARTRENDER
  starts rendering

TEXTUREPATH
  sets texture path

WINTOFRONT
  brings window to front
```

### 1.53 ARexx-commands for creating objects

AREXX-COMMANDS FOR CREATING OBJECTS

```
LOADOBJ
  loads an Imagine TDDD-file

PLANE
  creates a plane (ground in Imagine)

SPHERE
  creates a sphere

TRIANGLE
  creates a triangle
```

### 1.54 ARexx-commands for setting attributes

AREXX-COMMANDS FOR SETTING ATTRIBUTES

```
NEWSURFACE
  creates a new surface

AMBIENT
  sets ambient color

BRUSH
  adds a brush

DIFFTRANS
  sets diffuse transmission color

DIFFUSE
  sets diffuse color
```

---

IMTEXTURE  
adds a Imagine texture

REFEXP  
sets the specular reflection exponent

REFLECT  
sets the specular reflectivity

REFRINDEX  
sets the index of refraction

SPECTRANS  
sets the specular transmission

SPECULAR  
sets the specular color

TRANSATTU  
sets the specular transmission attenuation

TRANSEXP  
sets the specular transmission exponent

TRANSLUC  
sets the specular transmittance

TRANSPAR  
sets the diffuse transmittance

## 1.55 ARexx-commands for animation control

AREXX-COMMANDS FOR ANIMATION CONTROL

ALIGNMENT  
sets alignment

MAXFRAMES  
sets amount of frames

NEWACTOR creates a new actor

POSITION  
sets position

SIZE  
sets size

## 1.56 ARexx-errors

AREXX-ERRORS

---

10 Error in argumentstring  
11 Unknown command  
12 Error using Imagine texture  
13 Not enough memory for this command  
14 File not found  
15 Error reading IFF-ILBM file  
16 Error reading IFF-TDDD file  
17 Surface not defined

## 1.57 Examples

### EXAMPLES

There are several examples in the directories 'rexx' and 'examples'.

In the 'arexx' directory are examples scripts which show the usage of RayStorm with ARexx. Start them simply by typing 'rx ???ray' in a shell (???ray is the name of the script).

Attrtest.ray

Several examples for attributes.

Attrtest1.ray

Several examples for attributes.

Brush.ray

Demonstrates usage of brush mapping.

Bump.ray

Test of bump texture.

Chess.ray

Chess scene.

Dof.ray

Test of depth of field.

Eight.ray

Billard scene.

Im\_texture.ray

Example for usage of Imagine textures.

Marble.ray

Test of marble texture.

---

Randomsphere.ray

Randomly colored sphere.

Supersample.ray

Demonstrates adaptptive supersampling.

Title.ray

Renders the RayStorm title.

Title1.ray

Renders the RayStorm title.

Wood.ray

Test of wood texture.

In the 'examples' directory are C-programms which show the usage of RayStorm directly with a program. They can only be run from a shell. These programs are producing a couple of pictures no animation, which must be glued together with a utility like MainActor.

Sphanim

Animation of several spheres which jump over a checker board. Camera follows them.

Worldanim

Rotating world.

## 1.58 Textures

### TEXTURES

Textures are mathematical generated patterns which can be applied to the surface of a object.

There are several textures in the directory 'textures'.

Bump

Checker

Linear

Marble

Wood

---

## 1.59 Bump

BUMP

This texture applies a bumps to the surface.  
Size of texture determines size of bumps.

Parameters:

X bump size - Y bump size - Z bump size  
Sets the 'depth' of the bumps.

## 1.60 Checker

CHECKER

This texture applies a normal checks pattern to the surface.

Parameters:

Color Red - Color Green - Color Blue  
Color of the checks, other color is taken from object.

Reflect Red - Reflect Green - Reflect Blue  
Reflect color of the checks.

Filter Red - Filter Green - Filter Blue  
Filter color of the checks.

## 1.61 Linear

LINEAR

This texture varies the color of the object in the y-direction of the texture.

Parameters:

Color Red - Color Green - Color Blue  
Color to inerpolate to.

Reflect Red - Reflect Green - Reflect Blue  
Reflect to inerpolate to.

Filter Red - Filter Green - Filter Blue  
Filter to inerpolate to.

## 1.62 Wood

---

## WOOD

This texture applies a wood like texture to the surface.  
Size of texture determines size of wood.

Parameters:

Color Red - Color Green - Color Blue  
Color. Other color is taken from object.

Reflect Red - Reflect Green - Reflect Blue  
Reflect color.

Filter Red - Filter Green - Filter Blue  
Filter color.

Octave  
Than higher the octave than noisier are the wood rings.

Frequency  
Than higher the frequency than smaller the wood rings.

## 1.63 Marble

### Marble

This texture applies a marble like texture to the surface.  
Size of texture determines size of bumps.

Parameters:

Color Red - Color Green - Color Blue  
Color. Other color is taken from object.

Reflect Red - Reflect Green - Reflect Blue  
Reflect color.

Filter Red - Filter Green - Filter Blue  
Filter color.

Octave  
Than higher the octave than noisier is the texture.

## 1.64 Legal Stuff

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#### MUI

## 1.65 MUI

This application uses

MUI - MagicUserInterface

(c) Copyright 1993/94 by Stefan Stuntz

MUI is a system to generate and maintain graphical user interfaces. With the aid of a preferences program, the user of an application has the ability to customize the outfit according to his personal taste.

MUI is distributed as shareware. To obtain a complete package containing lots of examples and more information about registration please look for a file called "muiXXusr.lha" (XX means the latest version number) on your local bulletin boards or on public domain disks.

If you want to register directly, feel free to send

DM 30.- or US\$ 20.-

---

to

Stefan Stuntz  
Eduard-Spranger-Straße 7  
80935 München  
GERMANY

## 1.66 Credits

CREDITS

I want to thank the following person:

- Stephan Dorenkamp - for testing

## 1.67 Register

REGISTER

If you like RayStorm send me 20 DM or 15 US \$ and a empty disk and you get the full version of RayStorm.

## 1.68 Author

AUTHORS

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## 1.69 History of Changes

### HISTORY

version 1.0 (09-July-95)

- first release.

## 1.70 PC-version

### PC-VERSION

There is also a PC-version of RayStorm under development, but unfortunately it's not finished yet.

## 1.71 Future

### FUTURE ADDITIONS

- more objects (torus, cylinder, ...)
  - real motion blur
  - JPEG-saver (use datatypes to load and save pics)
  - use Imagine staging files (animation possibility)
  - fog
  - bright flag for objects
  - backdrop picture
  - global reflection map
  - TeX documentation
  - animation language
  - shadow caching
-