MIRROR'S EDGE™ CATALYST

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Senior Lighting Artist

LIGHTING THE CITY OF GLASS

GDC 2016

MIRROR'S EDGE (2008)

- Gorgeous futuristic office spaces and rooftops

- Lighting was a big part of the art direction

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MIRROR'S EDGE (2008)
LIGHTING TECH

- Lighting is Static

- Using Beast inside Unreal Engine 3

  - Baked Direct and Indirect Lighting

  - High Resolution lightmaps
    - 1 pixel per cm
    - Directional irradiance

  - 25 hours to render 1 level

MIRROR'S EDGE: CATALYST
GAME DESIGN

- Large city as a playground

  - Free roaming

  - Exploration

MIRROR'S EDGE: CATALYST
GAME DESIGN

- Living world

  - Day cycle

  - Vibrant world

  - Immersion

MIRROR'S EDGE: CATALYST
GAME DESIGN

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MIRROR'S EDGE: CATALYST
GAME DESIGN

- Strong narration

  - City of Glass history

  - Rise of Faith

MIRROR'S EDGE: CATALYST
CHALLENGES

- Creating a Time of Day system

- Can we even make Mirror's Edge with dynamic lighting?

- Making beliveable characters for cinematics

- Creating stylized images with Physically Based rendering

SHADING FUNDAMENTALS
PHYSICALLY BASED RENDERING

- Frostbite transitioned to PRR

http://www.frostbite.com/2014/11/moving-frostbite-to-pbr/

- Specular: Microfacet model with GGX normal distribution function
- Diffuse: Disney Diffuse with energy renormalization

- Now industry standard
  - Easier to author textures with other softwares
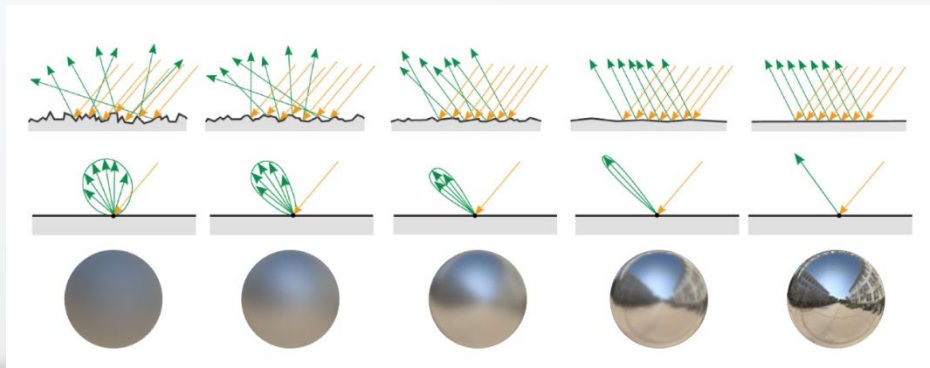
SHADING FUNDAMENTALS
PHYSICALLY BASED RENDERING

- Base Color
  - sRGB 40 – 230

- Smoothness
  - Artist driven

- Reflectance
  - Controls fresnel curve of reflections
  - Physically correct values to follow

- Metal mask
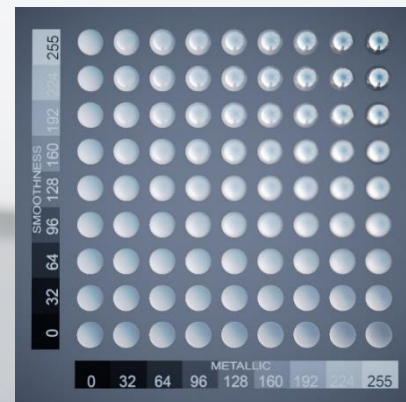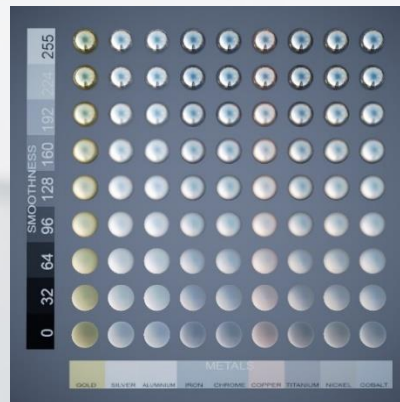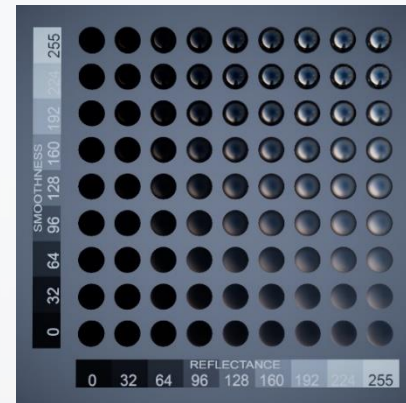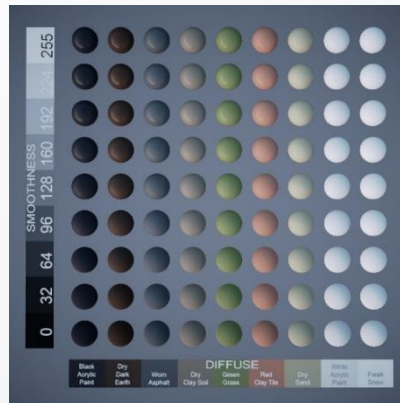
SHADING FUNDAMENTALS
PHYSICALLY BASED RENDERING

- Dynamic Time of Day loves PBR
  - Shading for every lighting conditions
  - Accurate reflections of the environment

- Game camera is a physical camera
  - Accurate Exposure values: Shutter Speed, Aperture, ISO
  - Realistic Depth of Field

GATHERING REFERENCES
BUILDINGS ARCHITECTURE

GATHERING REFERENCES
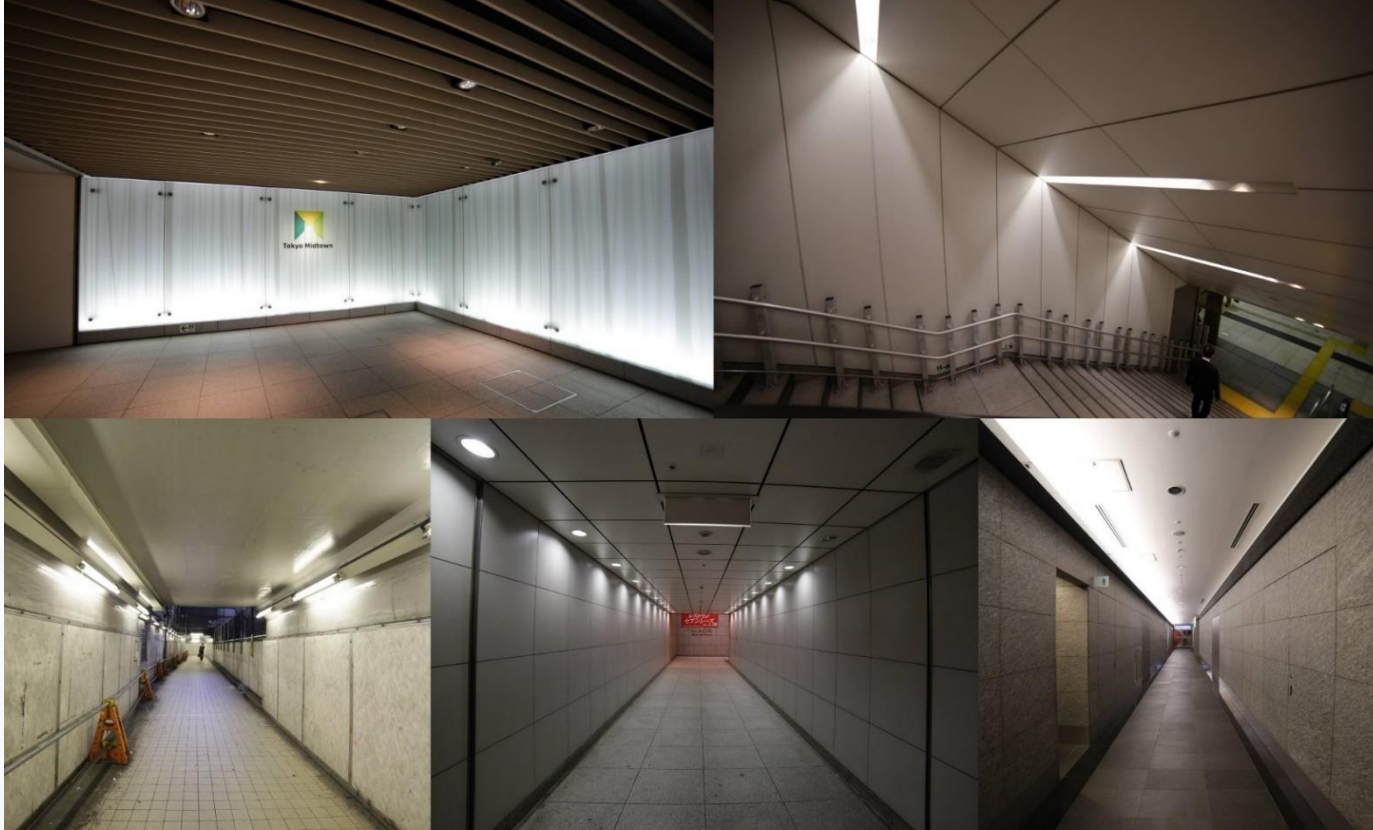## FACADE PROPS AND BILLBOARDS

GATHERING REFERENCES
ROOFTOPS

GATHERING REFERENCES
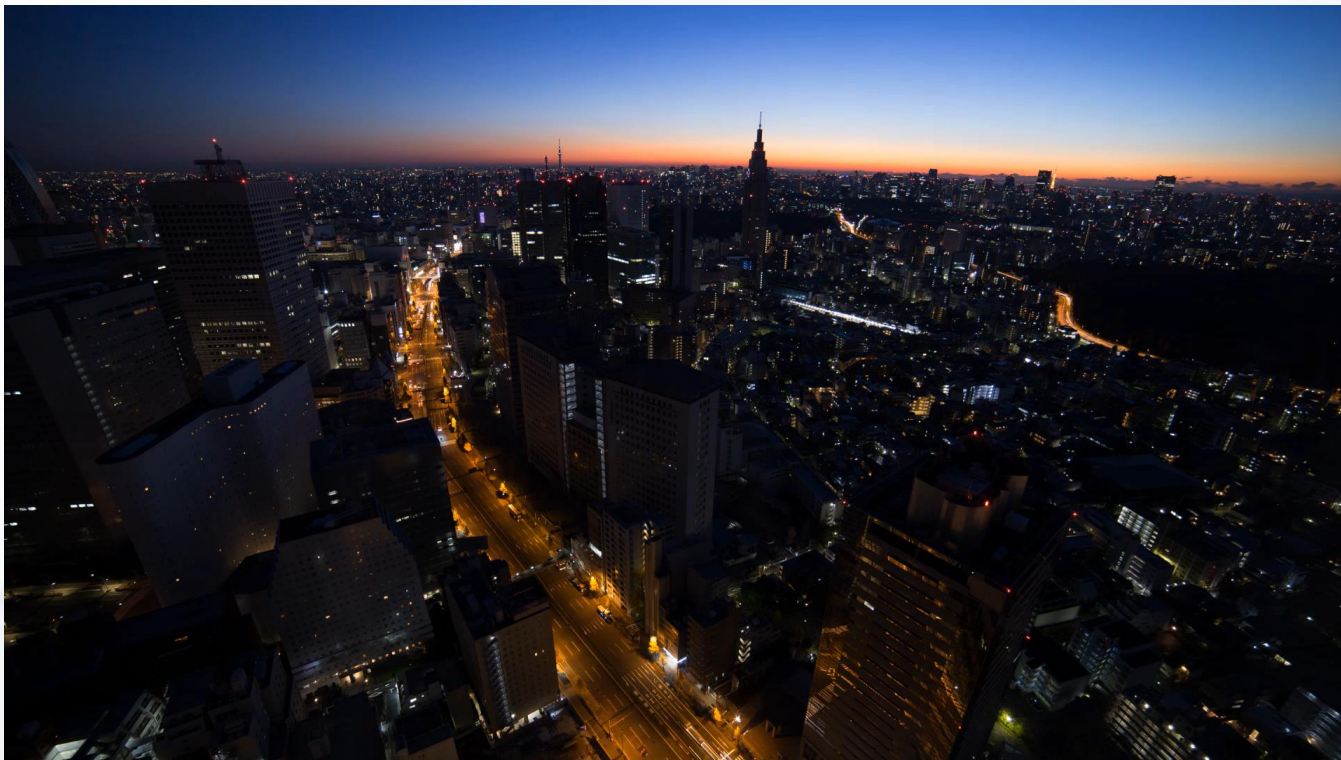## LIGHTING

GATHERING REFERENCES
TIMELAPSE

- Useful EXIF data

    - White Balance

    - Exposure

GATHERING REFERENCES
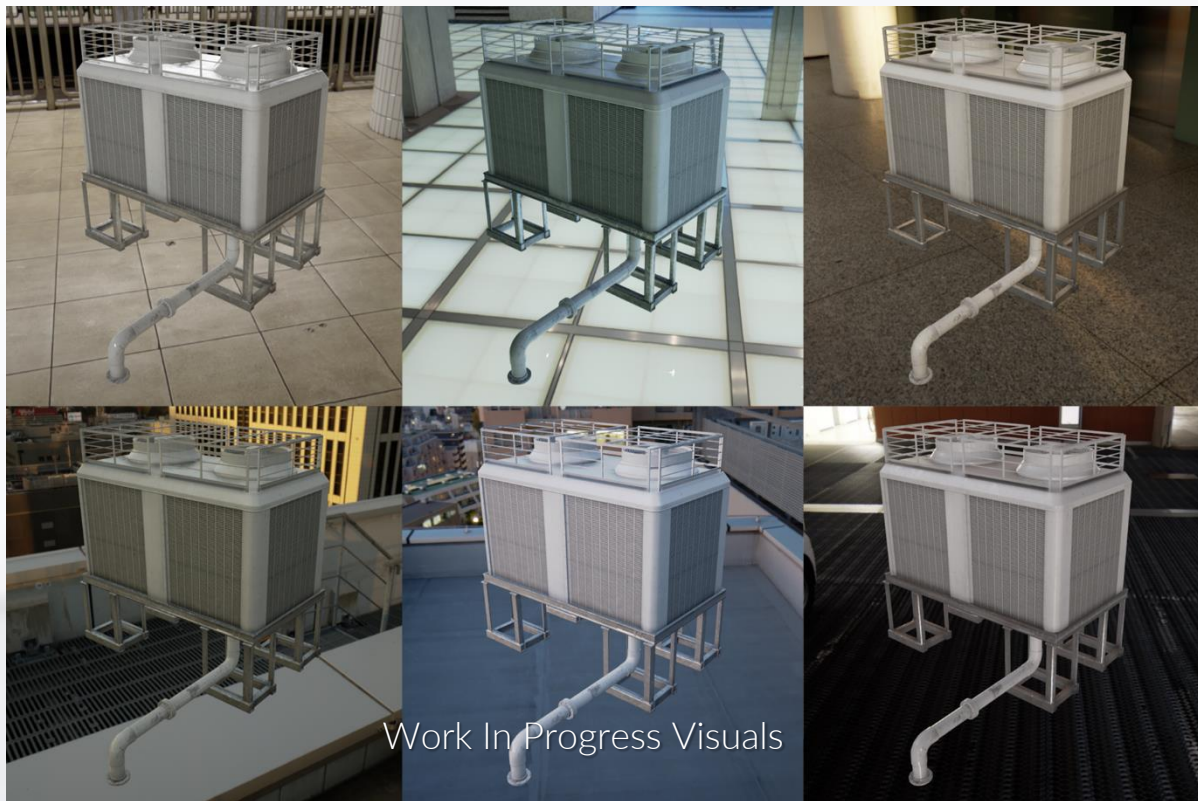## HDR PROBES

- Capturing HDR probes as references

  - 16k * 8k using a 14mm rectilinear lens
    - 14 camera positions

  - Up to 22 EV

  - Absolute HDR

  - HDR timelapses of sunrise and sunset

GATHERING REFERENCES
HDR PROBES

- Object previewing

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CREATING THE SKIES
## OBSTACLES

HDR skies couldn't be used in the game

- Dynamic time of day would require many skies

- Needs a lot of memory / fast streaming

- Blending between HDR skies was obvious

- Clouds requires high resolution

- Want to relight the clouds

PHYSICALLY BASED SKY
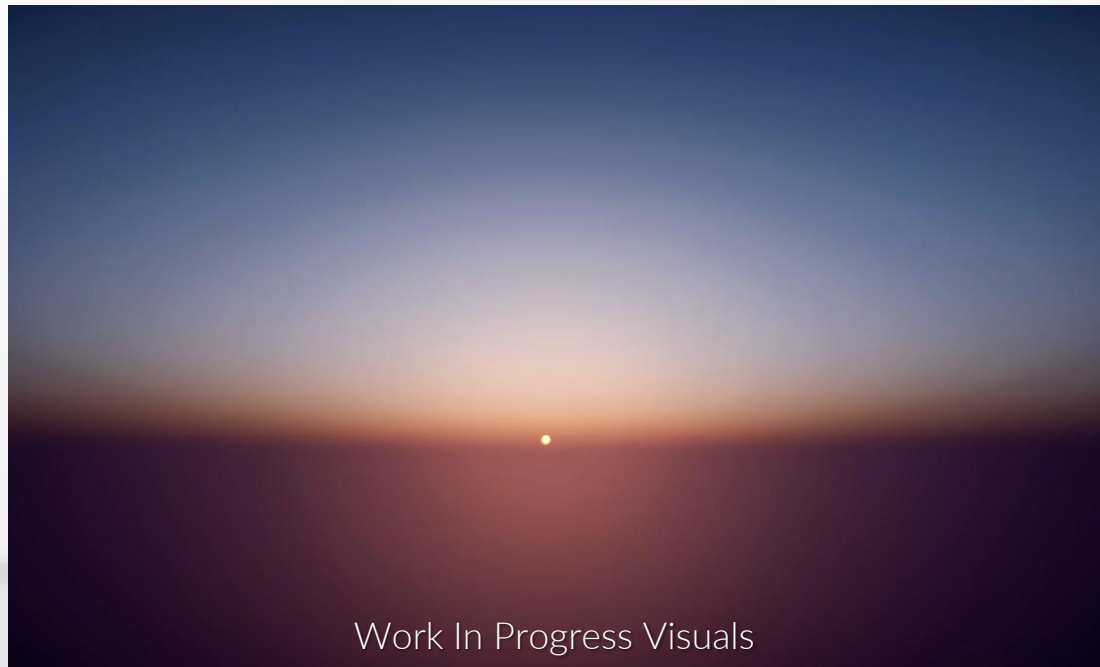
CREATING THE SKIES
PHYSICALLY BASED SKY

- Precomputed atmospheric scattering

  - Rayleigh coefficients multiplier
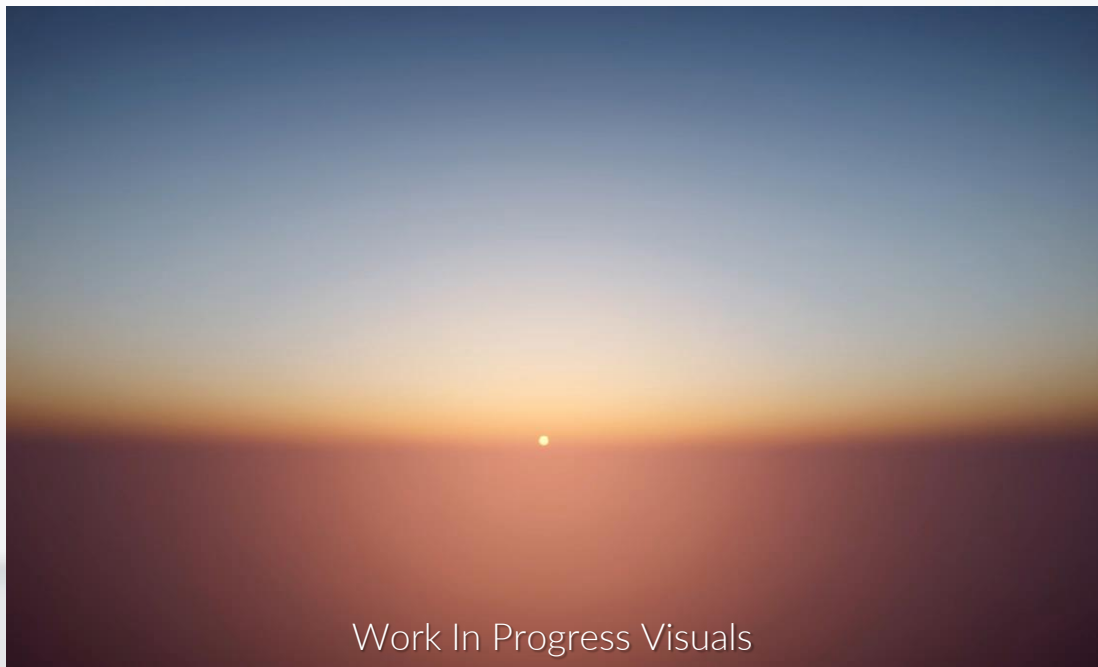
  - Rayleigh height

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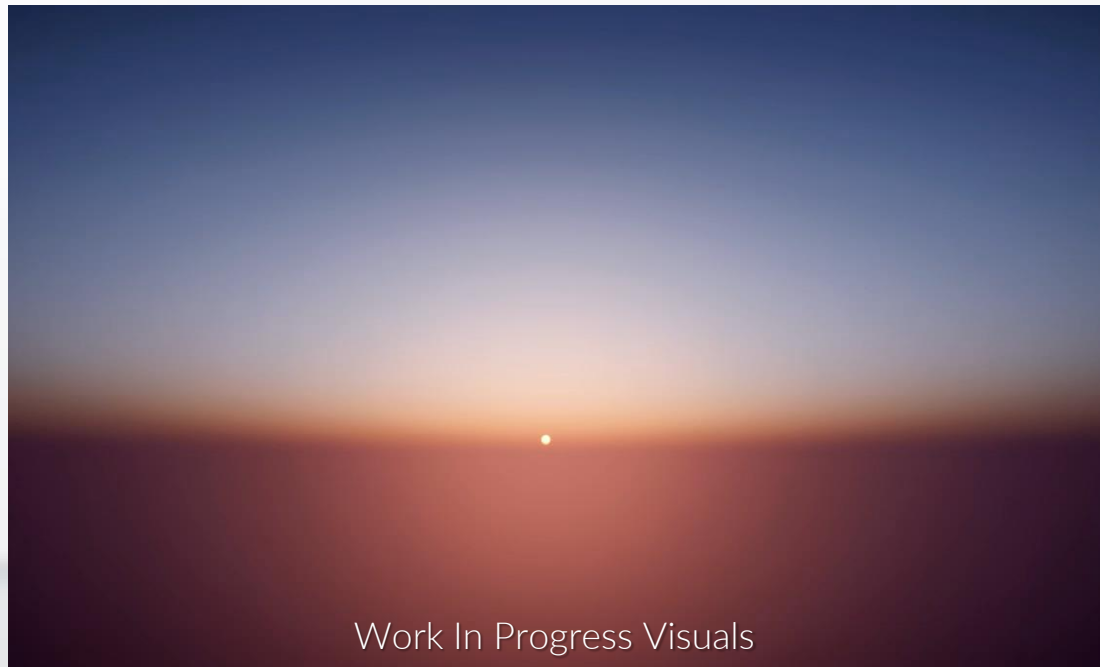
CREATING THE SKIES
PHYSICALLY BASED SKY

- Precomputed atmospheric scattering

  - Mie Scattering coefficients multiplier
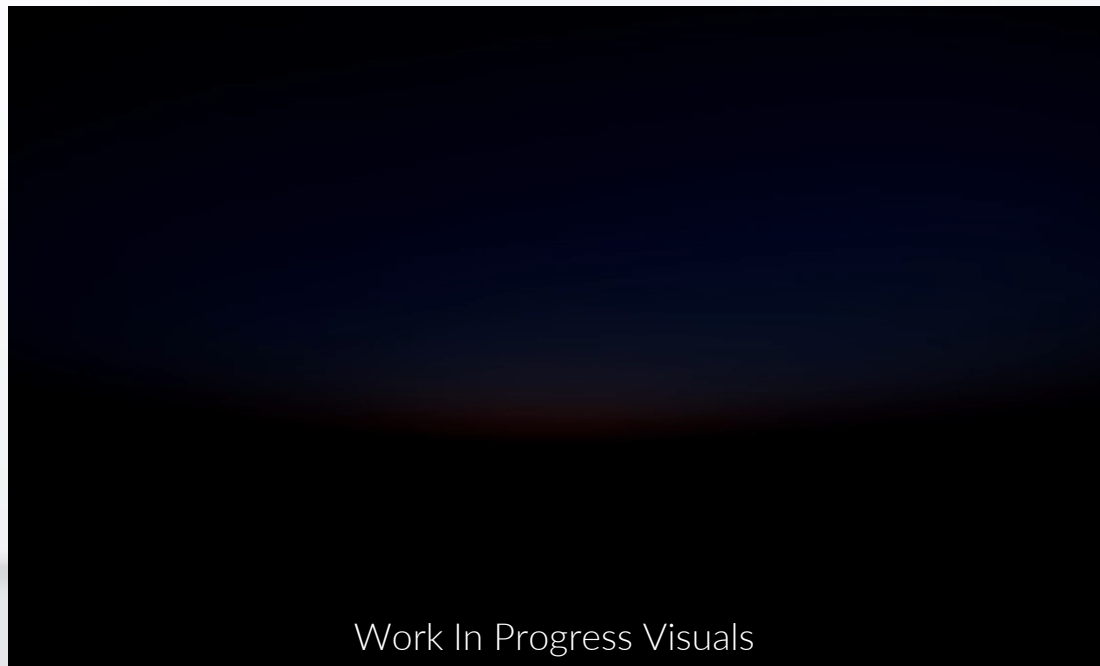
  - Mie Scattering height

Work In Progress Visuals

CREATING THE SKIES
PHYSICALLY BASED SKY

- Precomputed atmospheric scattering

  - Ozone percentage

Work In Progress Visuals

DICE

CREATING THE SKIES
PHYSICALLY BASED SKY

- Lights sources

  - Sun Intensity illuminates the sky
    On a sunny day: Sun = 100 000 lux

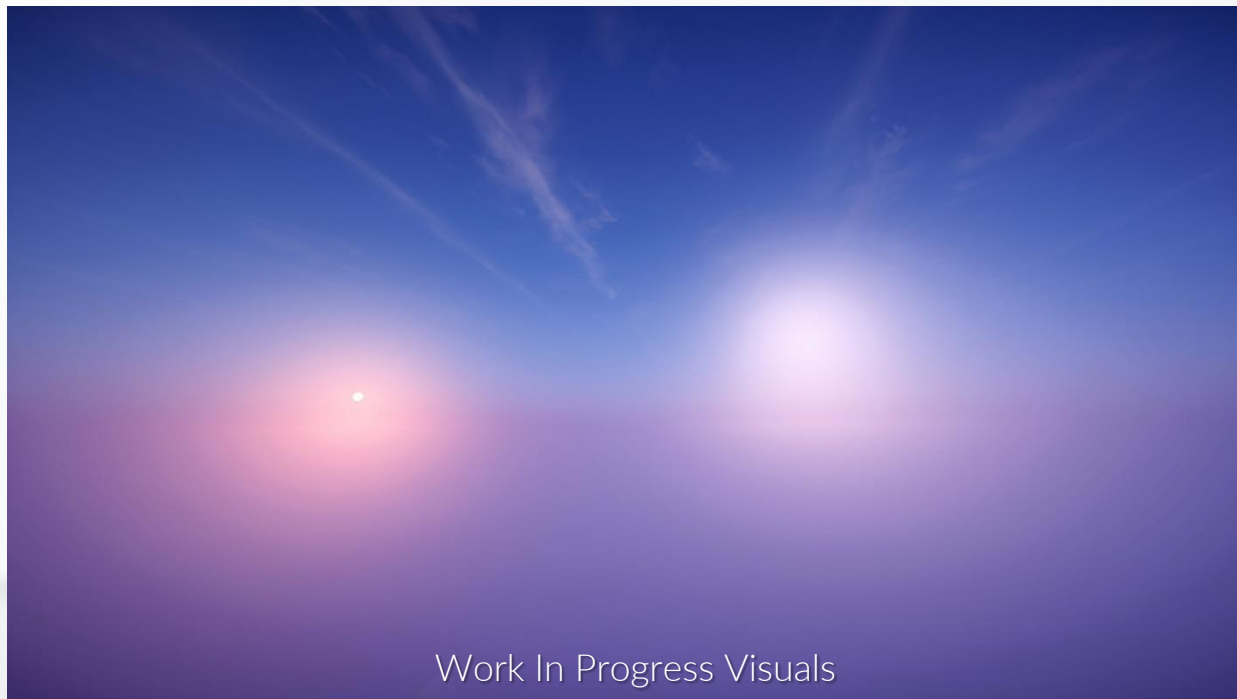 - Sun elevation does all the work

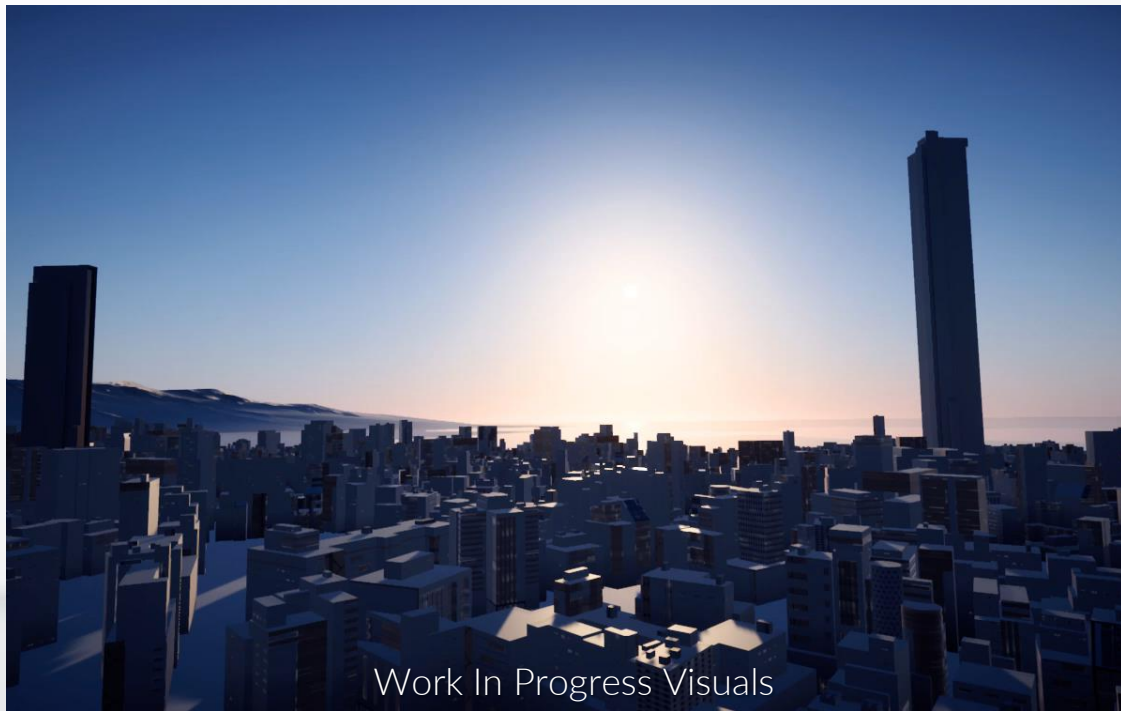Work In Progress Visuals

CREATING THE SKIES
PHYSICALLY BASED SKY

- Lights Sources

  - Using 2 light sources
    - Sun
    - Moon

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CREATING THE SKIES
PHYSICALLY BASED SKY

- Aerial Perspective

  - Scale and intensity controls

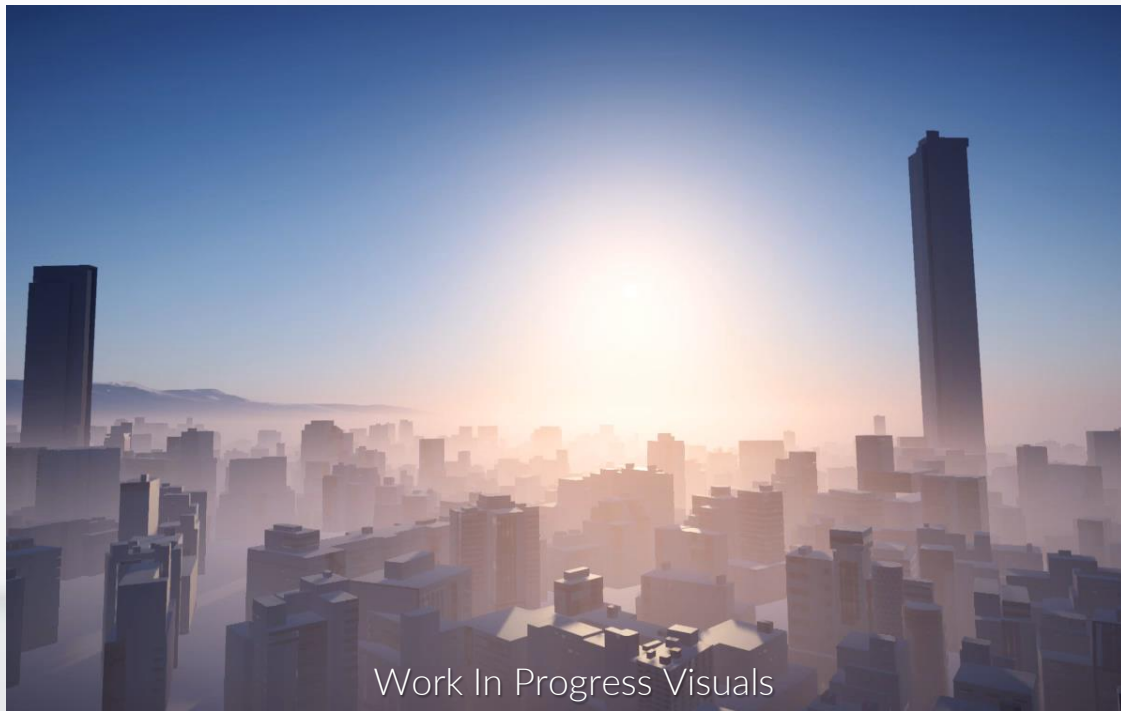Work In Progress Visuals

CREATING THE SKIES
PHYSICALLY BASED SKY

- Height fog

  - Altitude

  - Density

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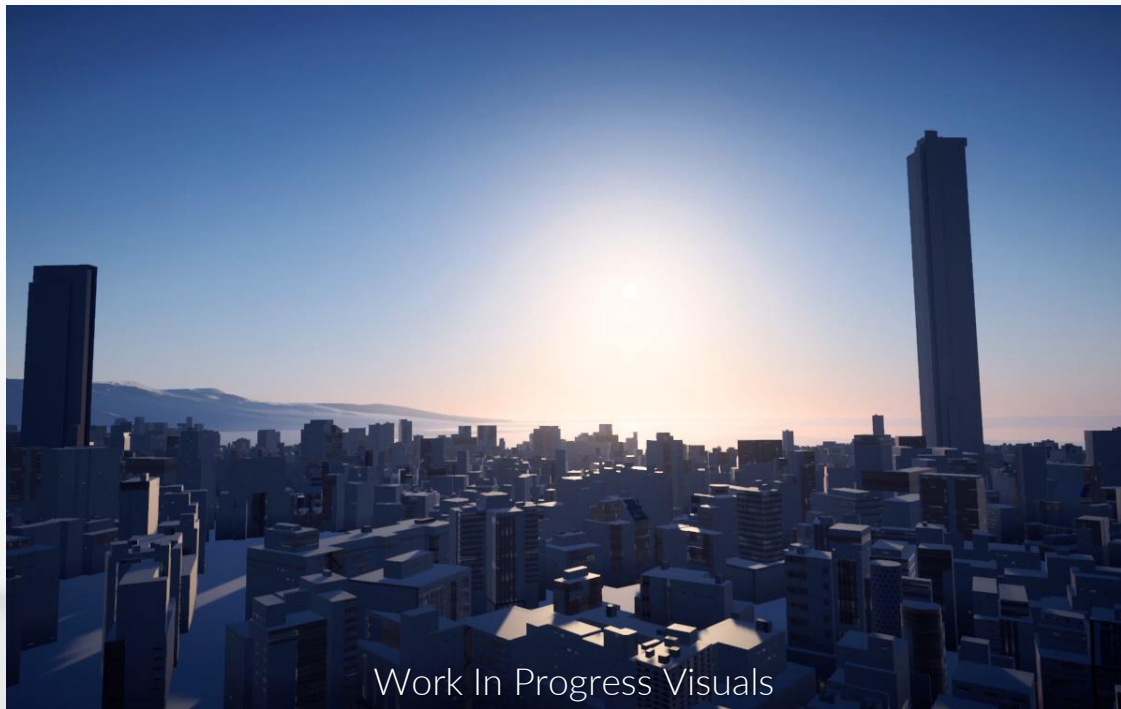
CREATING THE SKIES
PHYSICALLY BASED SKY

- Height fog

  - Clamp density

  - Color add or multiplier

Work In Progress Visuals

CREATING THE SKIES
PHYSICALLY BASED SKY
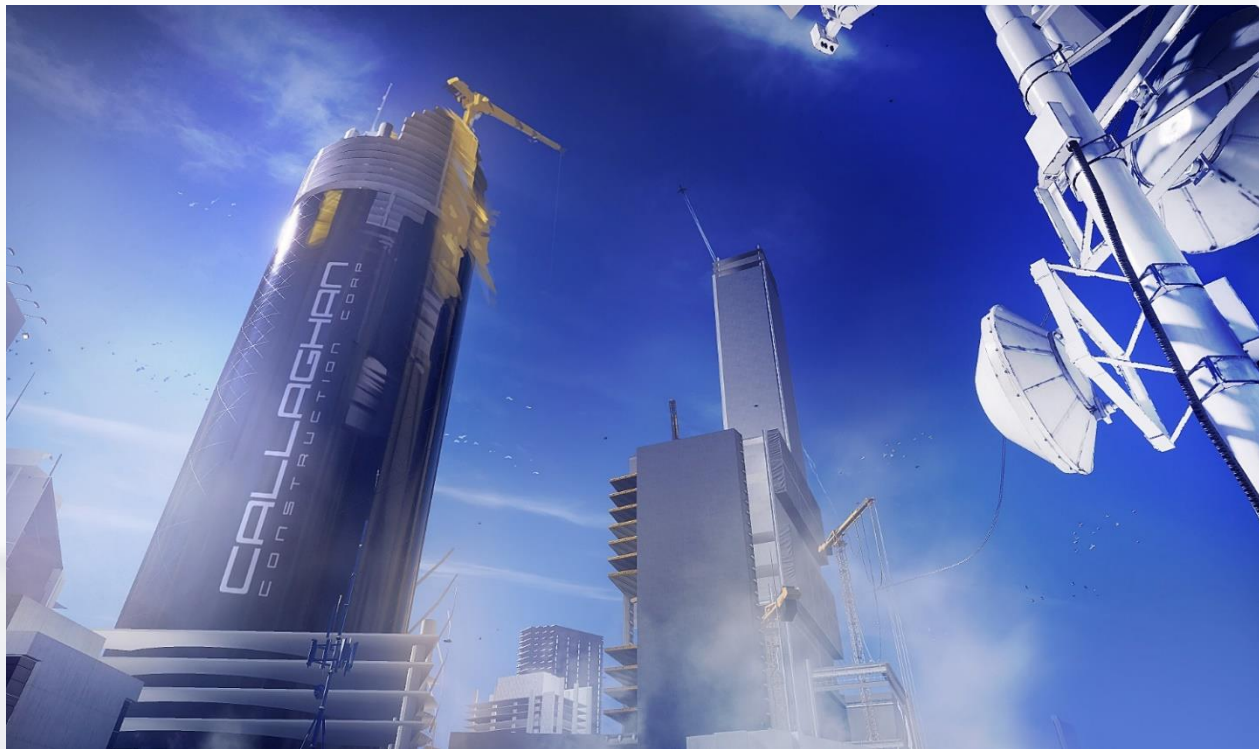
MIRROR'S EDGE
CATALYST

- 2 Cloud planes lit by the sky

  - Alpha texture
  - Absorbtion and thickness values

- Sky and Clouds cost:
  - Around 0.75 ms on consoles
    (+ 0.35 ms compared to static sky)

Work In Progress Visuals
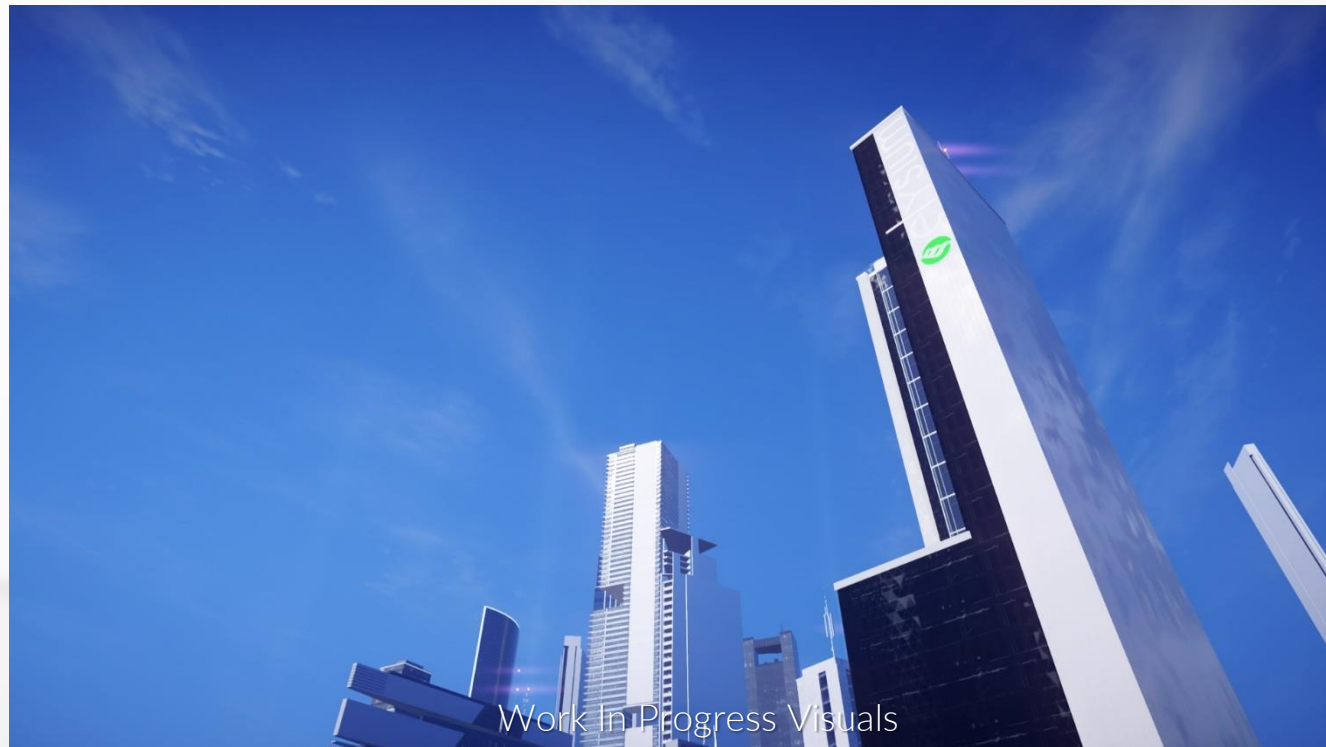
DICE
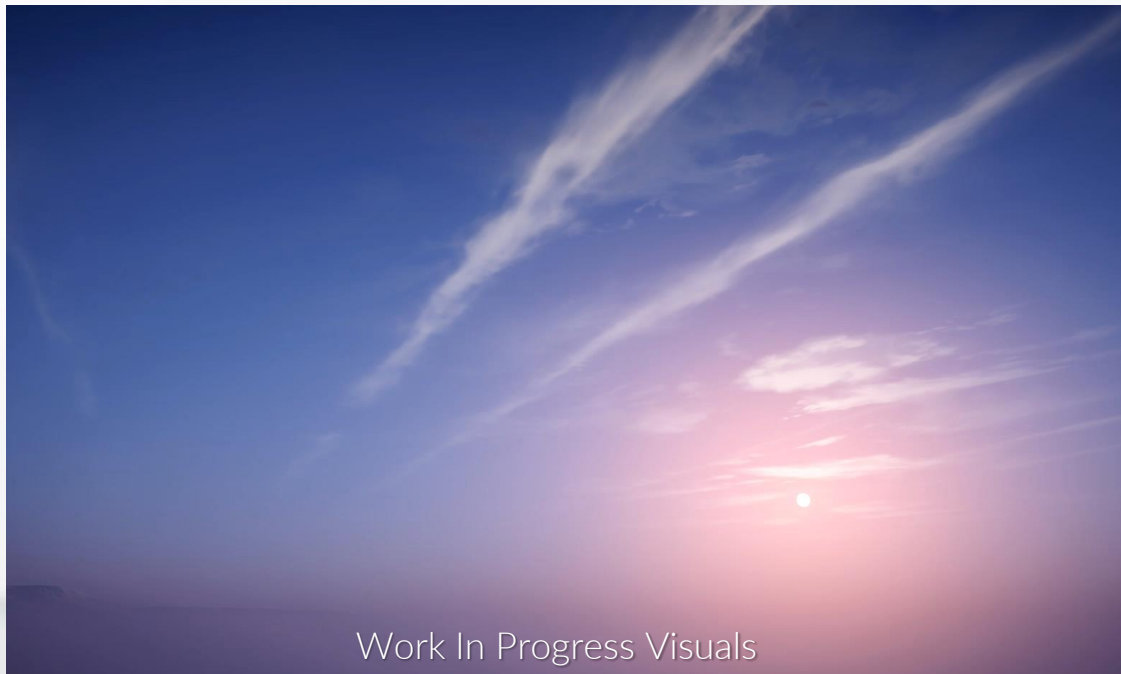
CREATING THE SKIES
PHYSICALLY BASED SKY

- Always want more control

  - Wanted deeper blues

CREATING THE SKIES
PHYSICALLY BASED SKY

- Physically correct

- But not deep enough

Work In Progress Visuals

CREATING THE SKIES
PHYSICALLY BASED SKY

- Circular Polarizing Filter OFF

CREATING THE SKIES
PHYSICALLY BASED SKY
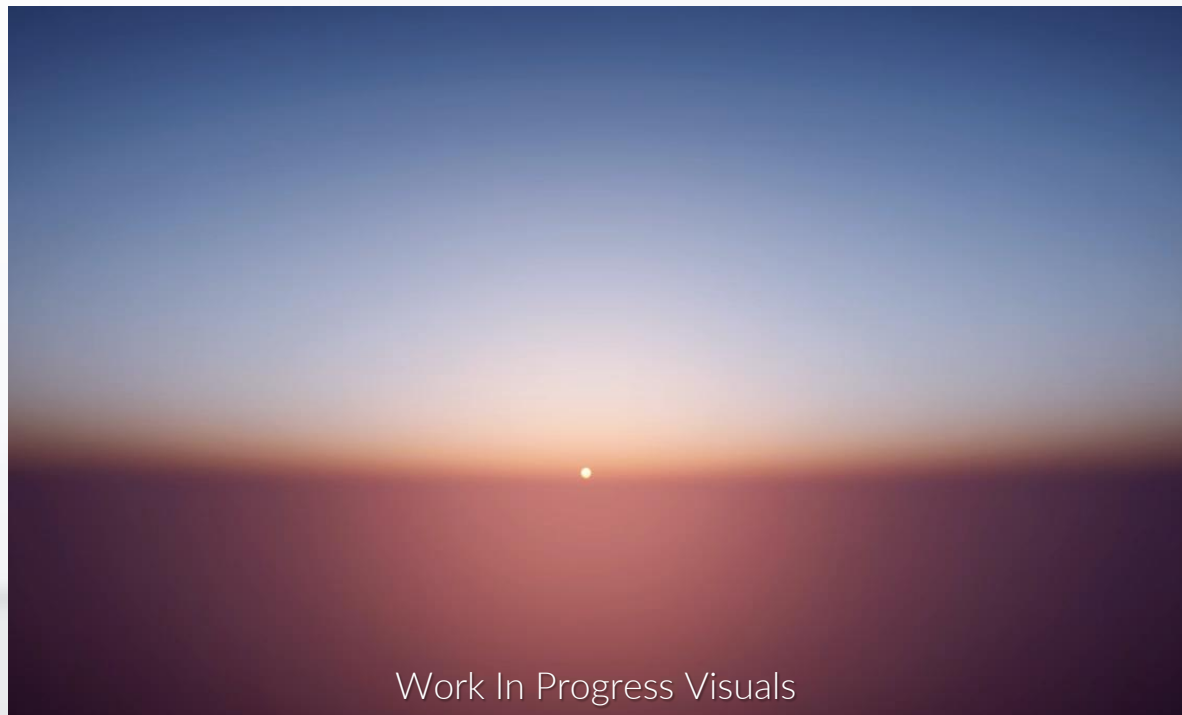
- Circular Polarizing Filter ON

CREATING THE SKIES
PHYSICALLY BASED SKY

- Solution

  - Add Rayleigh Scattering Multiplier

Work In Progress Visuals

CREATING THE SKIES
PHYSICALLY BASED SKY

- Not deep enough

CREATING THE SKIES
PHYSICALLY BASED SKY

- Rayleigh scattering / 2

- More dramatic

CREATING THE SKIES
PHYSICALLY BASED SKY
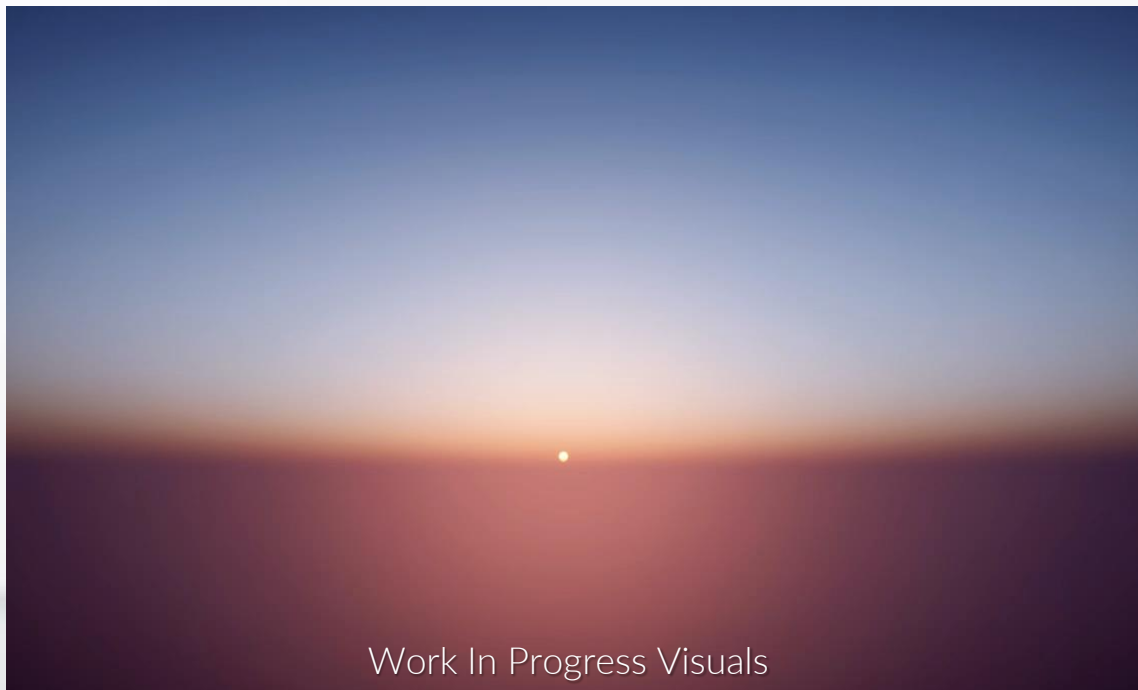
CREATING THE SKIES
PHYSICALLY BASED SKY

- Aerial perspective leaking through geometry

Work In Progress Visuals

CREATING THE SKIES
PHYSICALLY BASED SKY

- Solution

  - Added Mie Scattering multiplier

Work In Progress Visuals

CREATING THE SKIES

PHYSICALLY BASED SKY

- Solution

  - Replaced with Forward Scattering lightshafts

Work In Progress Visuals

CREATING THE SKIES
CREATING A DAY CYCLE

- Celestials rotation
  - Sun, moon and stars

- Time of Day Clock
  - 48 min cycle
  - Sunrise at 06:00 AM
  - Sunset at 06:00 PM
  - Curve to control the speed

- Sun Flare

- Animated values
  - Camera exposure
  - Bloom
  - Sun disk size
  - …

Work In Progress Visuals

CREATING THE SKIES
CREATING A DAY CYCLE

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Work In Progress Visuals
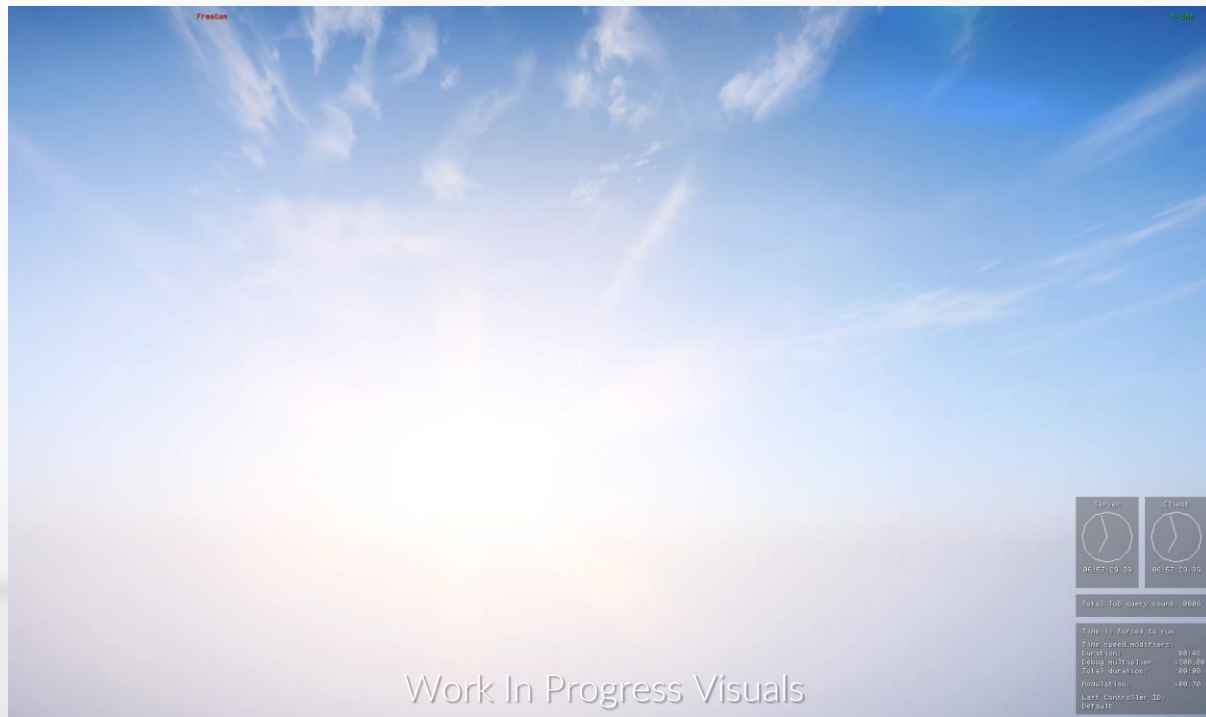
CREATING THE SKIES
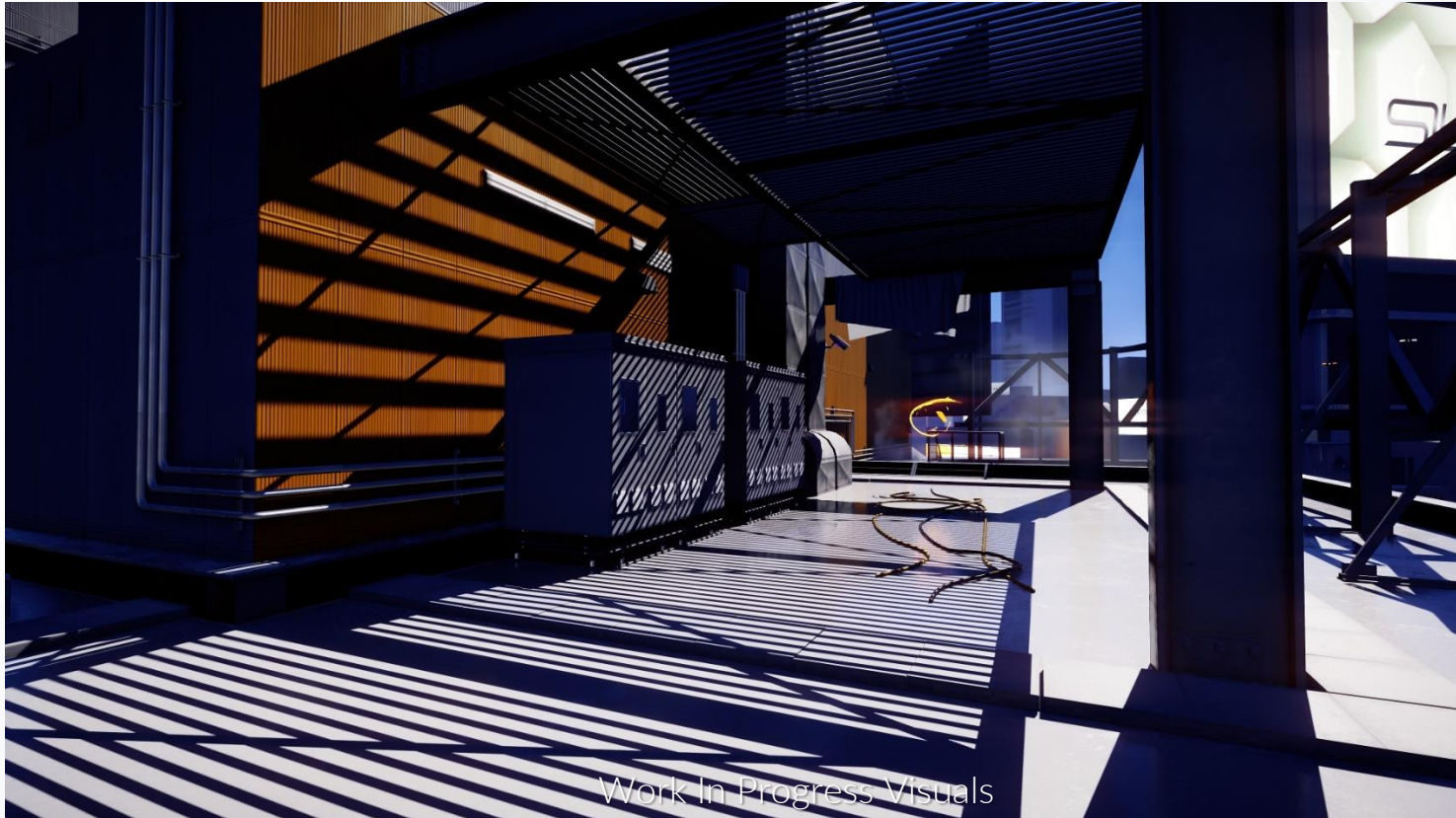## CREATING A DAY CYCLE

CREATING THE SKIES
CONTROLLING THE CLOCK

- Constrain the Time Of Day for Critical Path missions

  - Want to follow a color script

- Sun shadows

  - Connected to the player movement to hide jittery shadows

GLOBAL ILLUMINATION

Work In Progress Visuals

Work In Progress Visuals

GLOBAL ILLUMINATION
ENLIGHTEN

- Real-time indirect lighting solution by Geomerics

- Used in Frostbite since Battlefield 3

  - However only static lightmaps
  - Only used dynamically in Need for Speed Rivals

GLOBAL ILLUMINATION
ENLIGHTEN

- Rather fast precompute
  - 7 hours for the whole city

- Interactive relighting
  - Gives a lot of creative freedom

Work In Progress Visuals
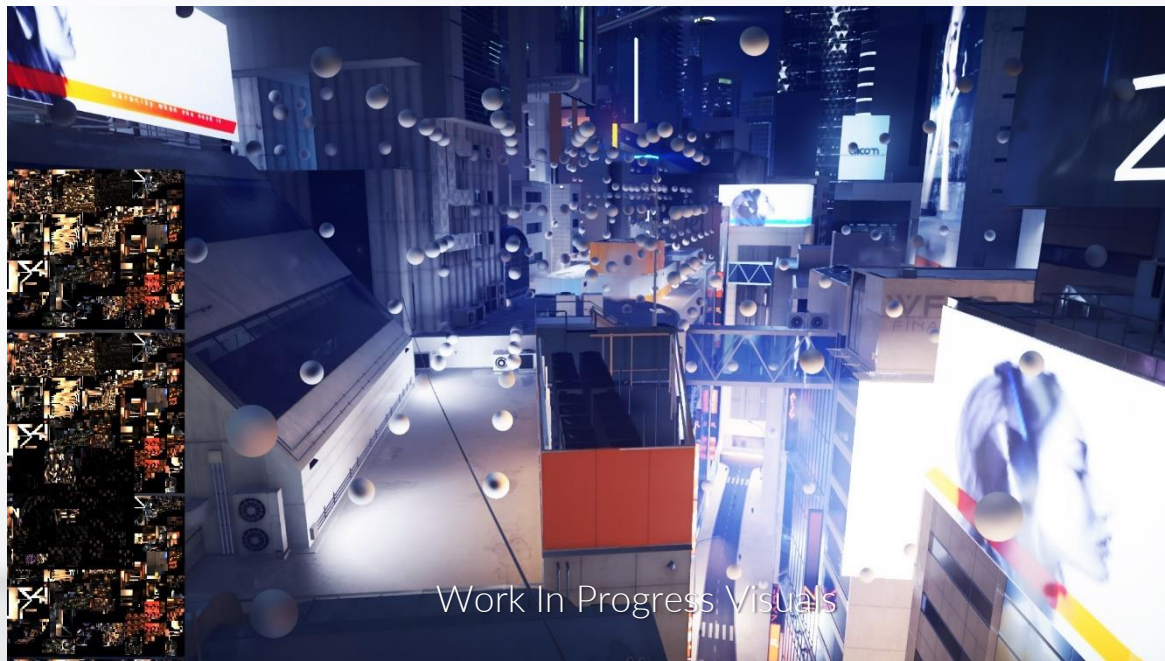
GLOBAL ILLUMINATION
ENLIGHTEN

- City divided in hierarchized zones for streaming

  - 17 Ground level zones

  - 83 Buildings zones

  - 391 Props zones

GLOBAL ILLUMINATION
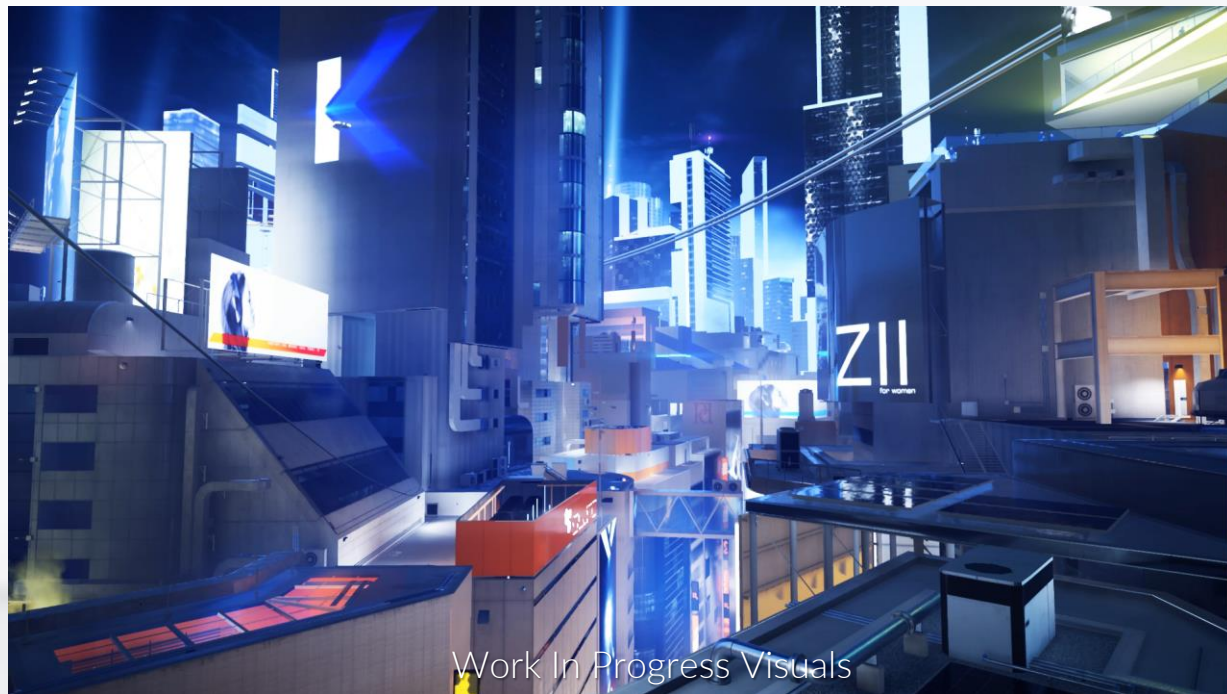## ENLIGHTEN

MIRROR'S EDGE™ CATALYST

- Each streaming zone has it own Enlighten database

  - 1 Lightmap (Atlas up to 2048*2048)
    - For large static objects

  - Lightprobes (L2 spherical harmonics)
    - For dynamic and small objects

  - GI data for relighting

  - Between 5 and 15 MB

- Around 30 databases loaded simultaneously

Work In Progress Visuals

DICE

GLOBAL ILLUMINATION
ENLIGHTEN

- Runtime update on CPU

  - Budget of 3 ms per frame

  - Small visual pop when
    Time Of Day progresses

Work In Progress Visuals
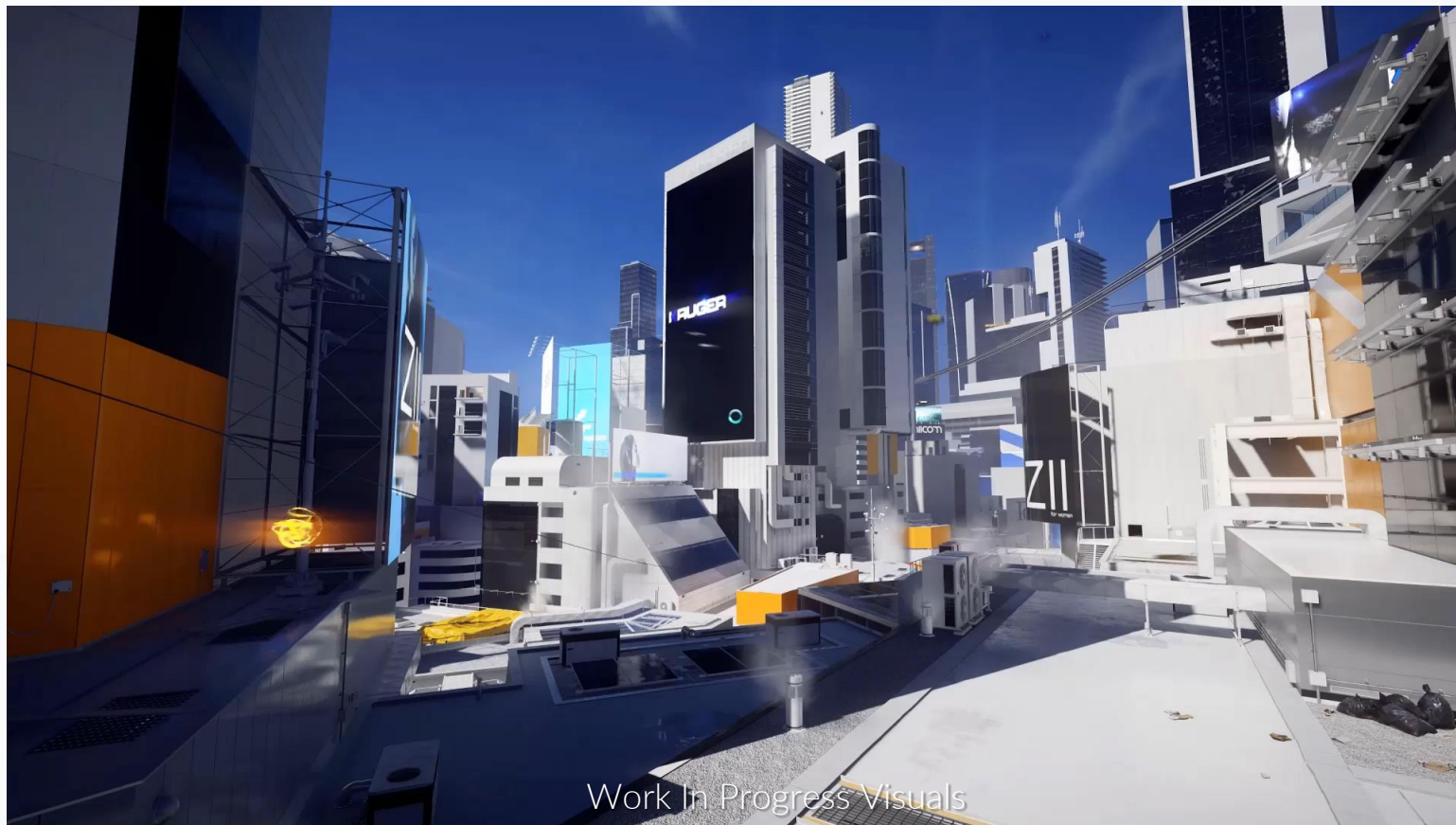
GLOBAL ILLUMINATION
BLENDING UPDATES

- Always render Enlighten 4 minutes ahead of TimeOfDay time (8 seconds in real life)

- 3 lightmaps for each database
  - Current one
  - Next one ready to blend
  - Next one getting solved

- Possibility to switch back to instant update

GLOBAL ILLUMINATION
BLENDING UPDATES

Work In Progress Visuals

GLOBAL ILLUMINATION
ARTISTIC CONTROLS

- Enlighten uses sky convolution to a 32*32 cubemap

  - Overall intensity slider

  - Multiply / Add colors
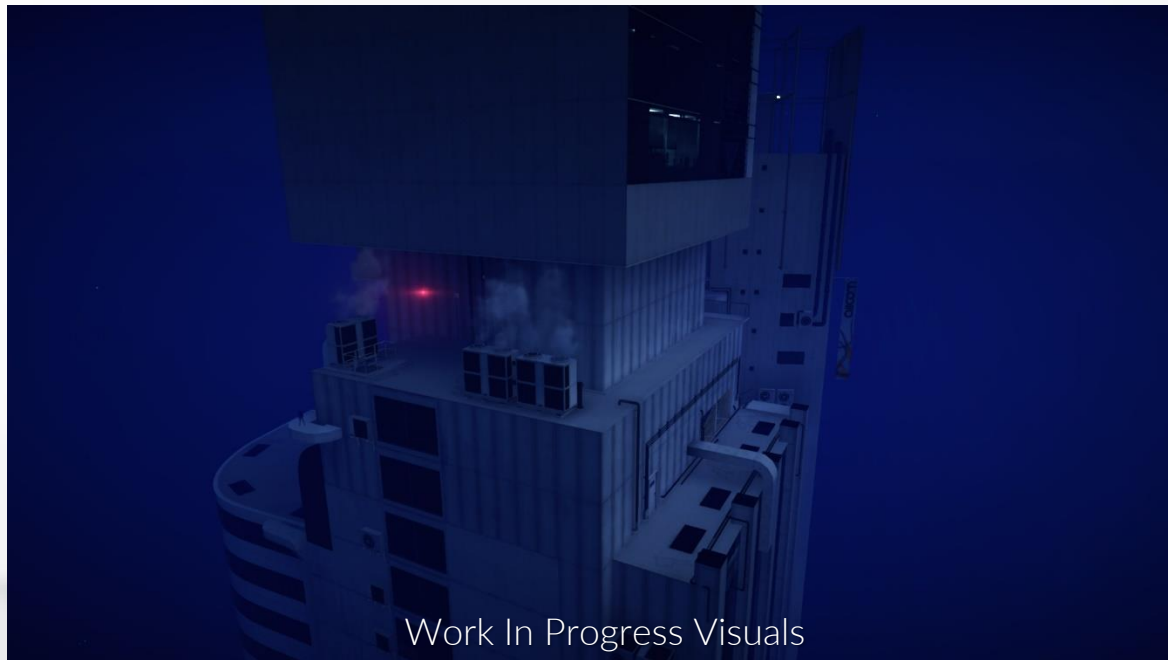

Enlighten sky

GLOBAL ILLUMINATION
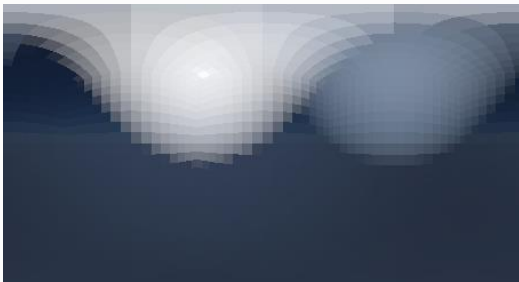## ARTISTIC CONTROLS

- Default sky from Physical Sky

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GLOBAL ILLUMINATION
MORE ARTISTIC CONTROLS

- Sun bounces
  - Intensity set to 75%

Work In Progress Visuals

DICE

GLOBAL ILLUMINATION
MORE ARTISTIC CONTROLS

- Sun bounces
  - Intensity set to 75%

Work In Progress Visuals

GLOBAL ILLUMINATION
ARTISTIC CONTROLS

MIRROR'S EDGE™
CATALYST

Work In Progress Visuals

DICE™

GLOBAL ILLUMINATION
ARTISTIC CONTROLS

MIRROR'S EDGE CATALYST

Work In Progress Visuals

DICE
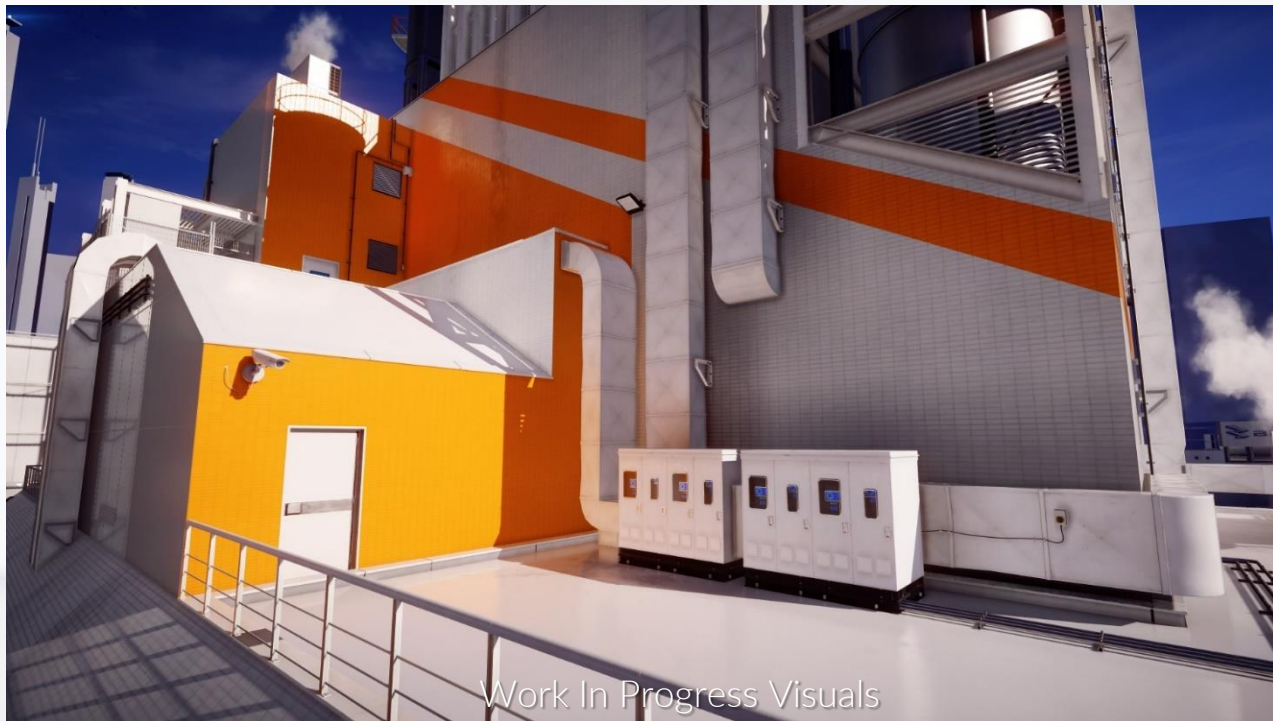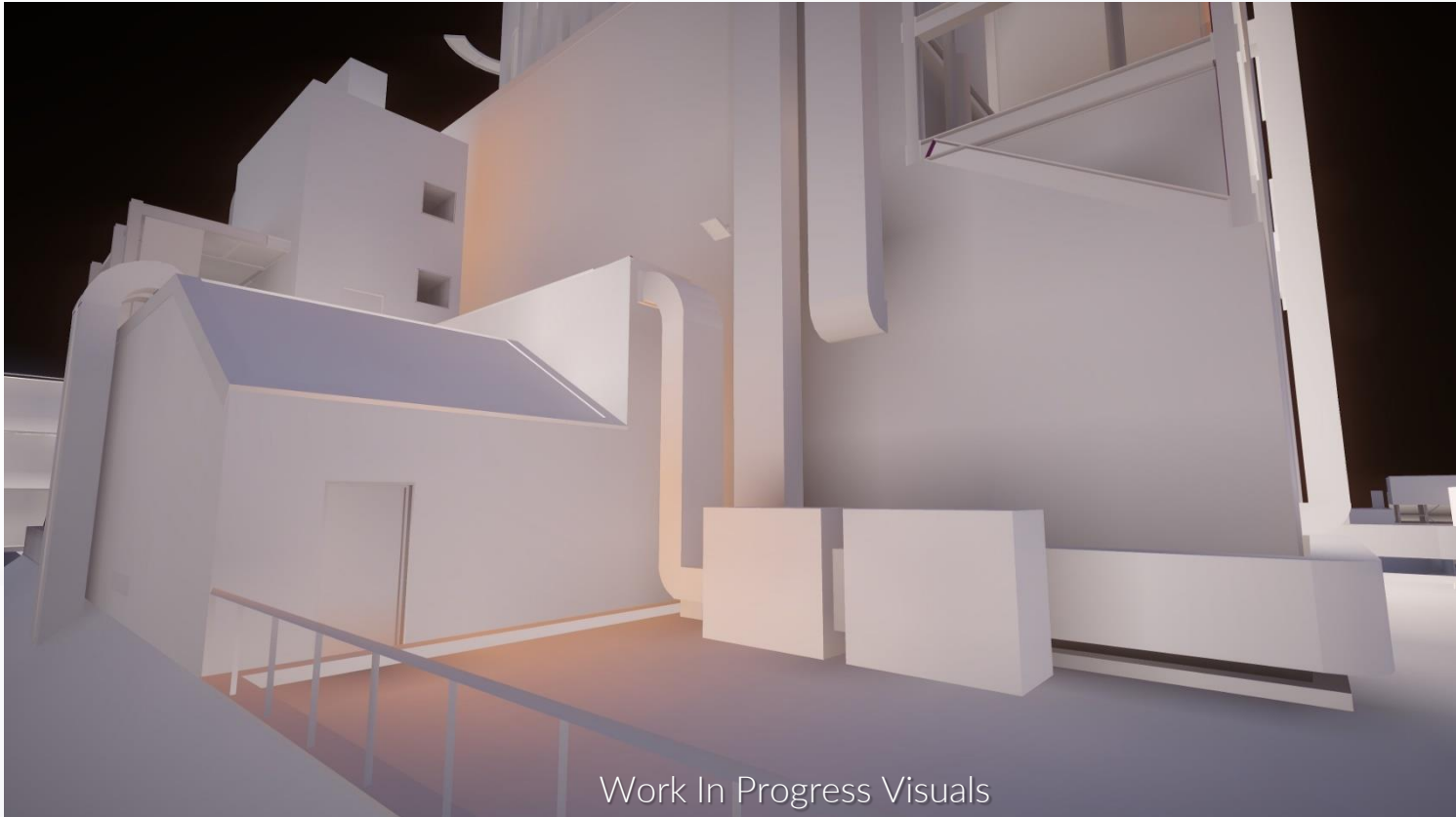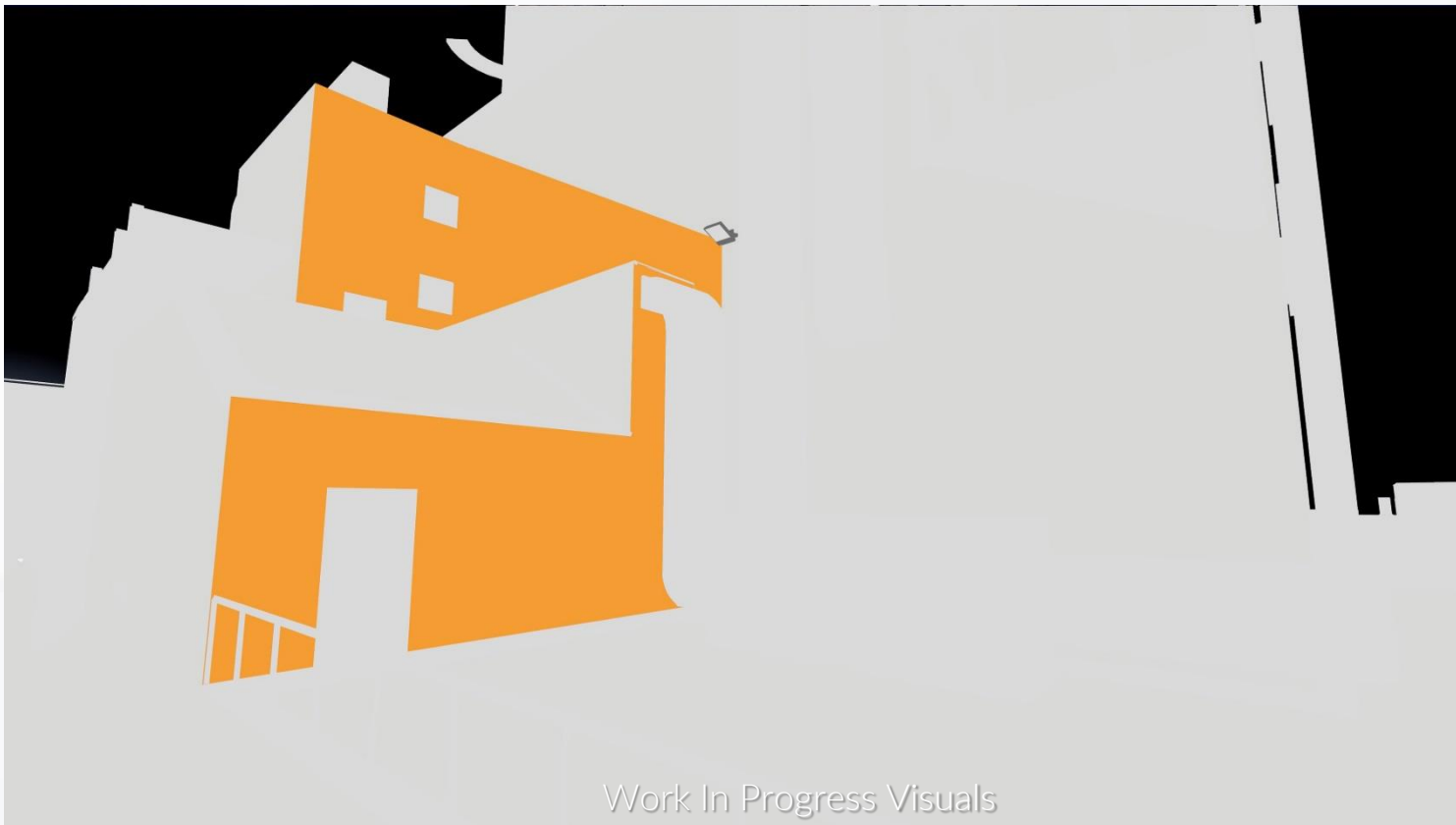
GLOBAL ILLUMINATION
ARTISTIC CONTROLS

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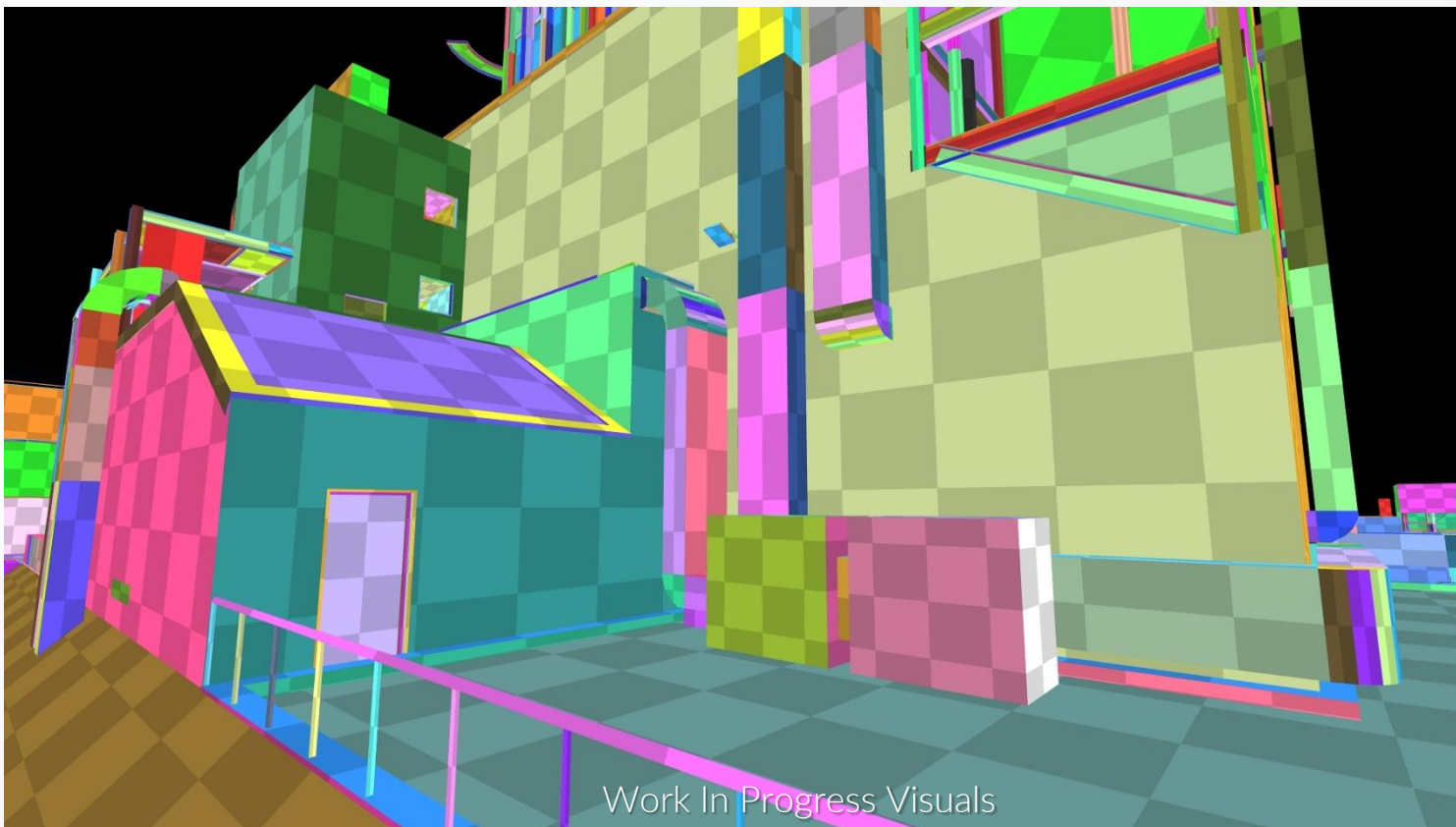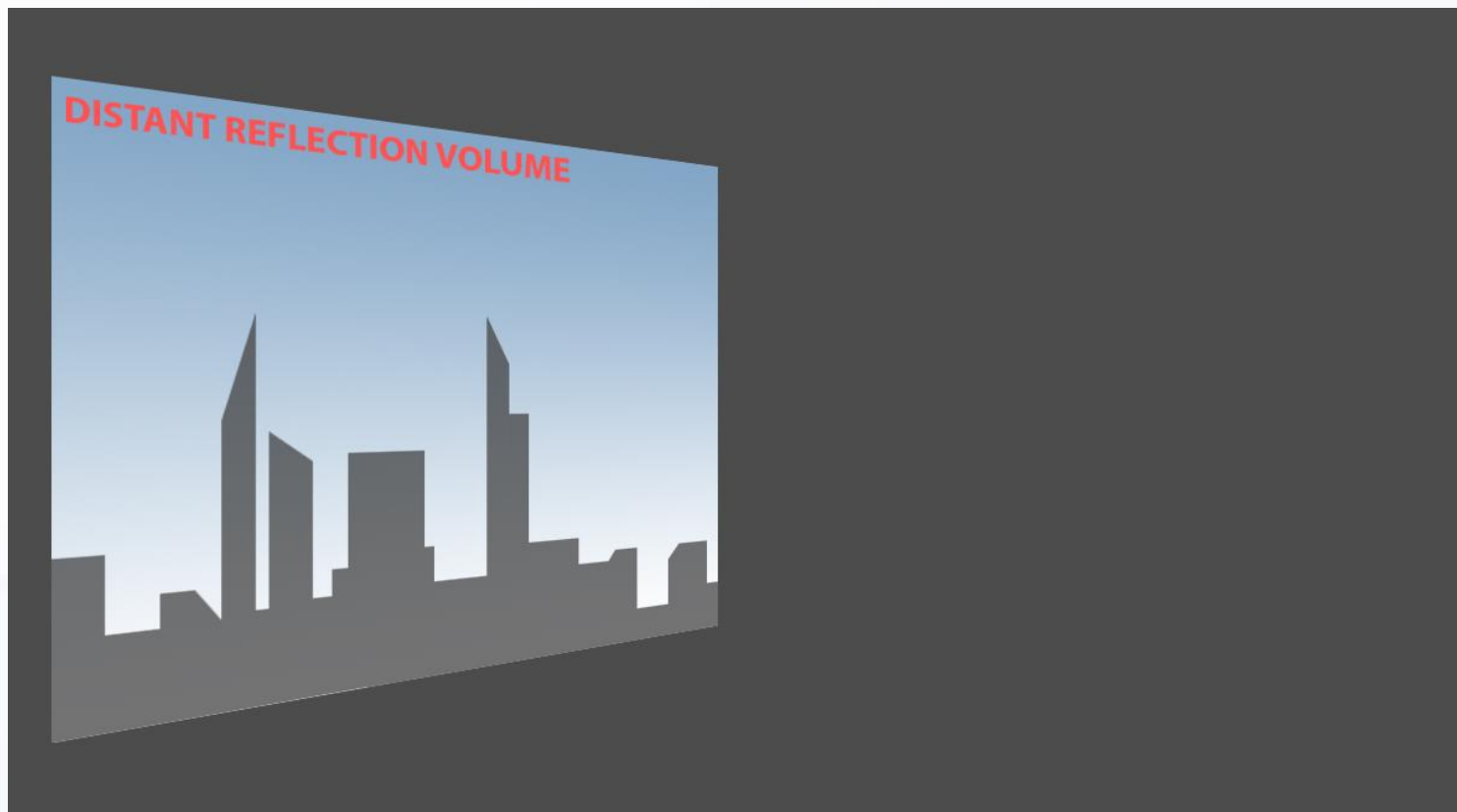
GLOBAL ILLUMINATION
LIMITATIONS

- Indirect lighting solution only
  - Not really made for baking direct lighting

- Low frequency radiosity
  - Low resolution lightmaps
  - Missing accurate ambient occlusion from objects

- Inaccurate lightprobe lighting
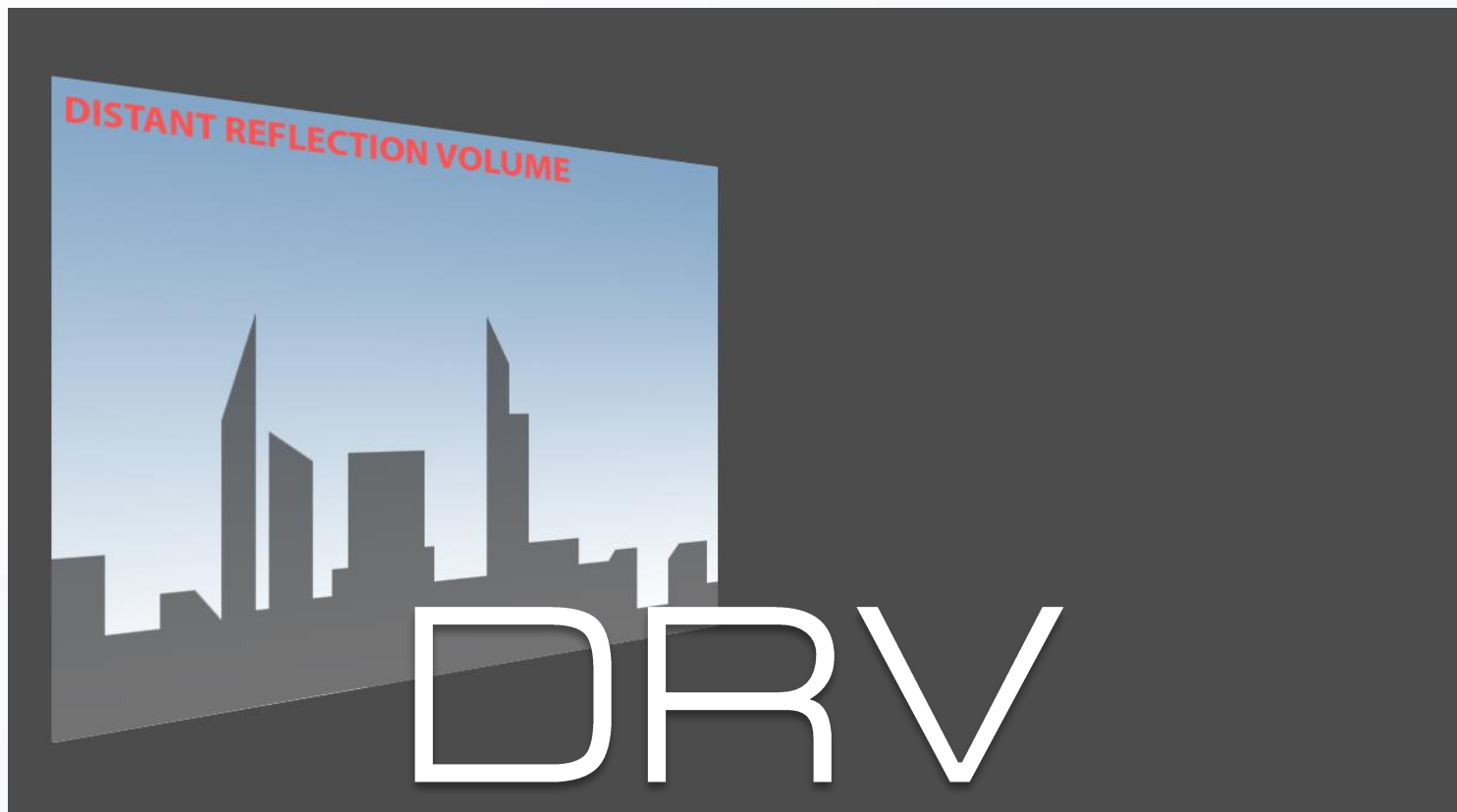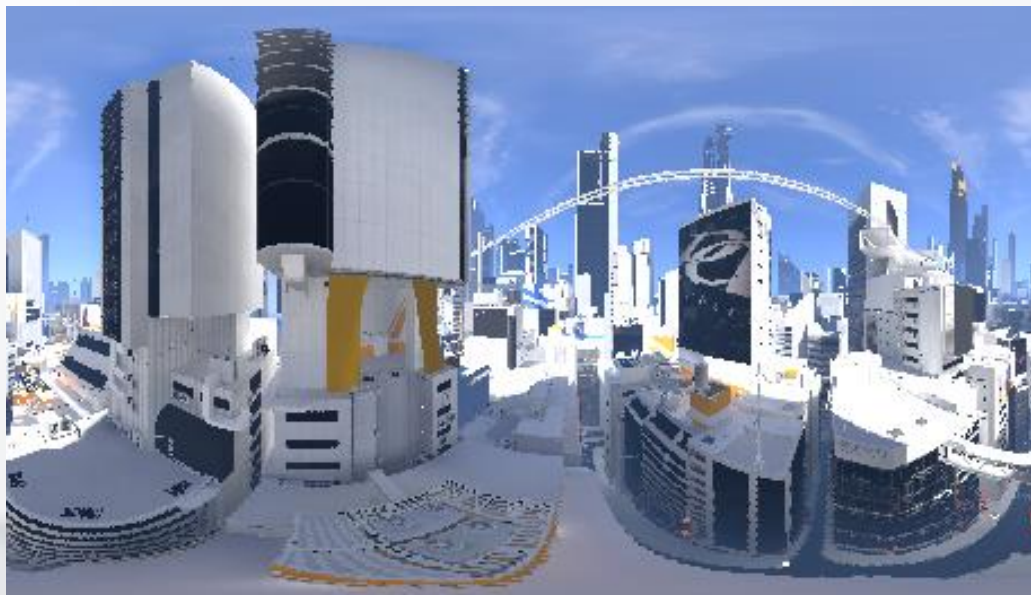 - Per-object lighting, not per-pixel

REFLECTIONS
DISTANT REFLECTION VOLUME

REFLECTIONS
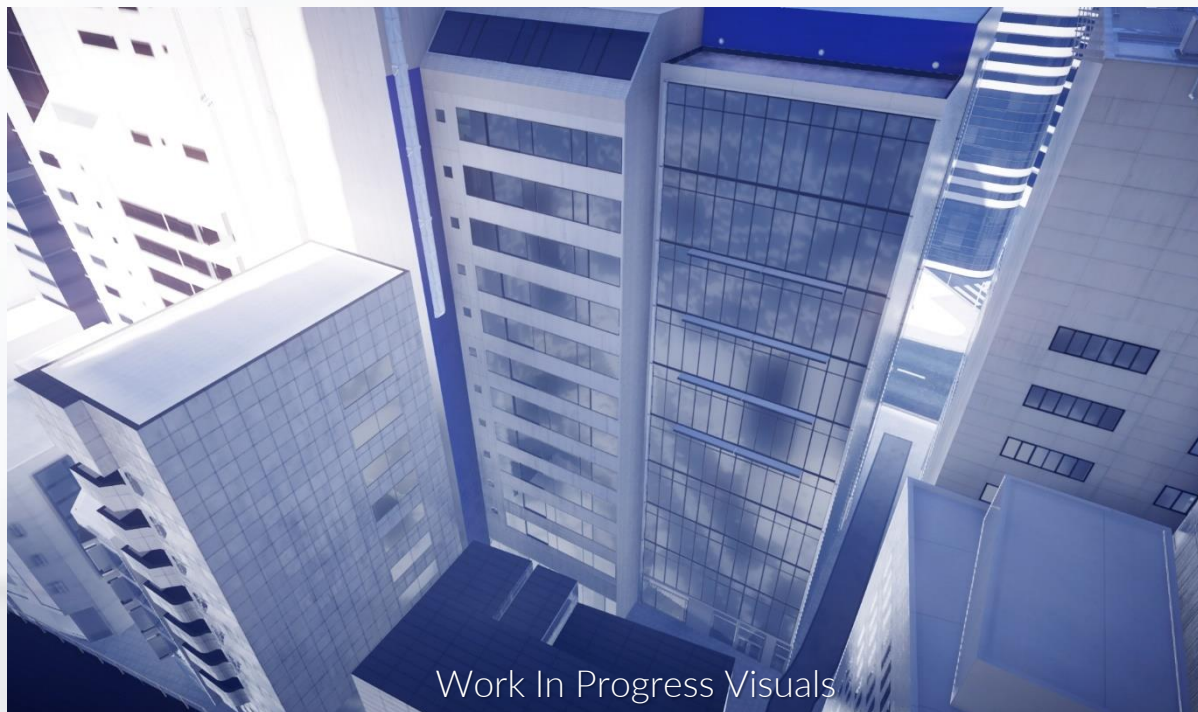## DISTANT REFLECTION VOLUME

- Old-style cubemap

  - Moving with the player

  - 256*256*6

  - Updated with the Time of Day

  - Cheap

REFLECTIONS
DISTANT REFLECTION VOLUME

- But not accurate

  - Reflections of the cityscape where there shouldn't be any

Work In Progress Visuals

REFLECTIONS
DISTANT REFLECTION VOLUME

- Sky Visibility mask from Enlighten

  - Occludes reflections in small streets and interiors

  - Works for the day

  - Lowered contrasts at night

Work In Progress Visuals

REFLECTIONS
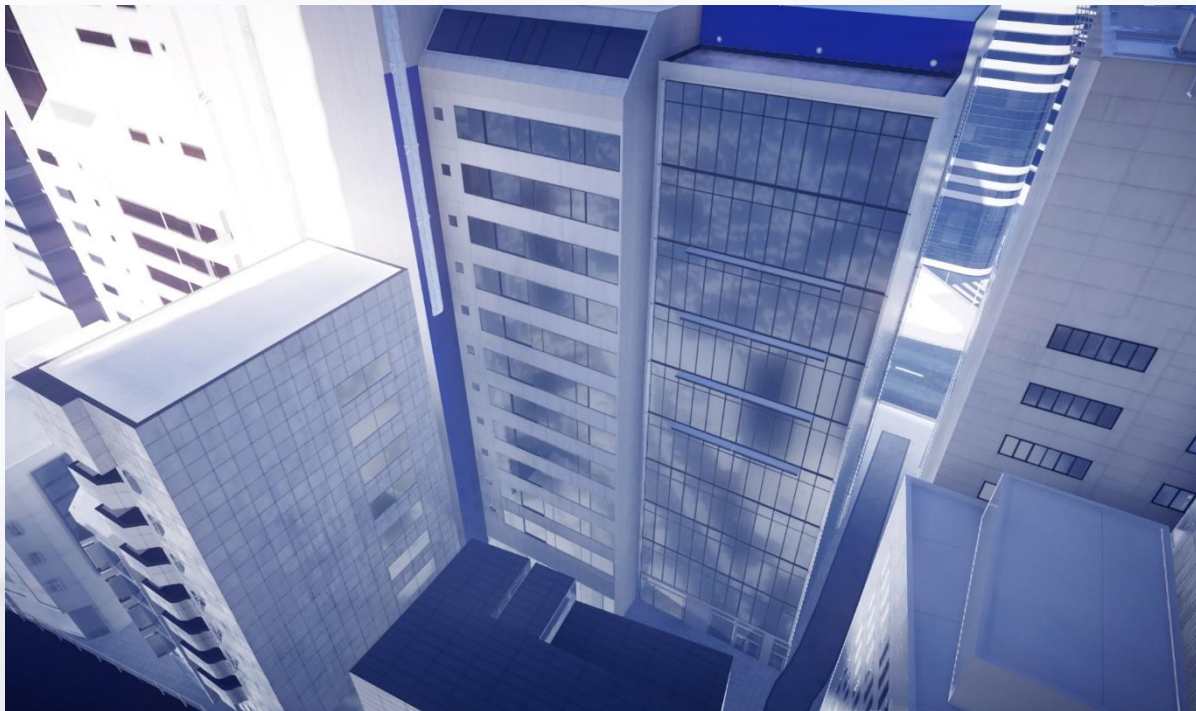## DISTANT REFLECTION VOLUME

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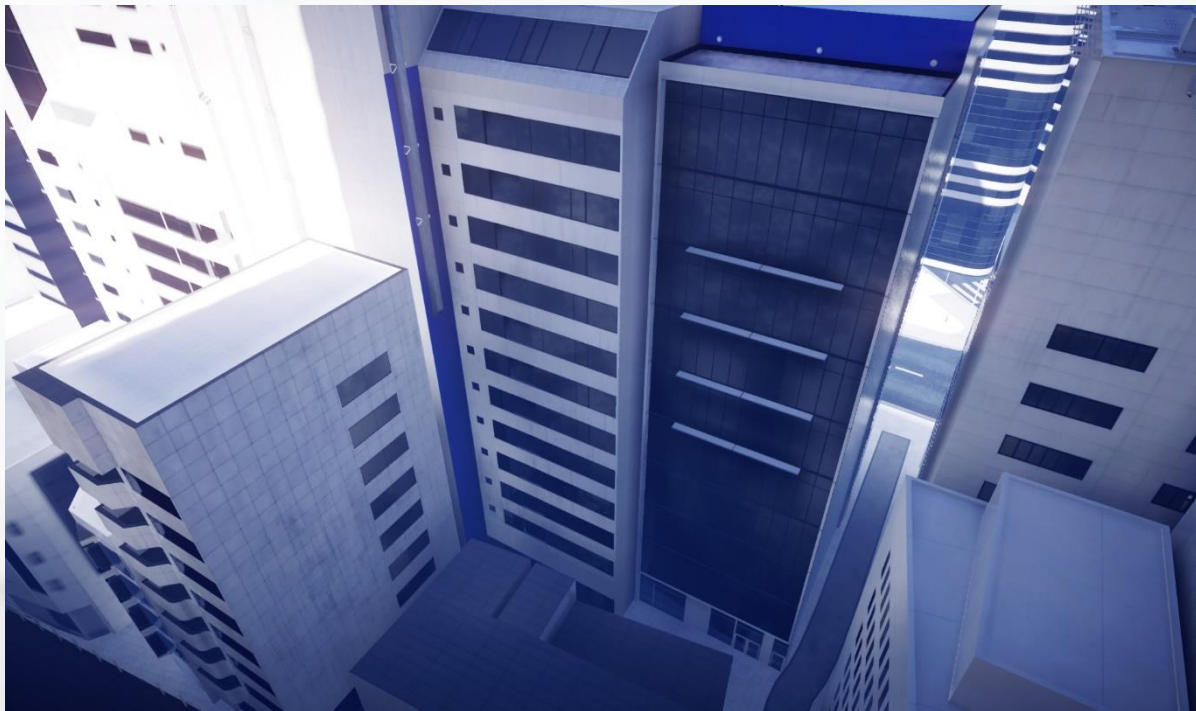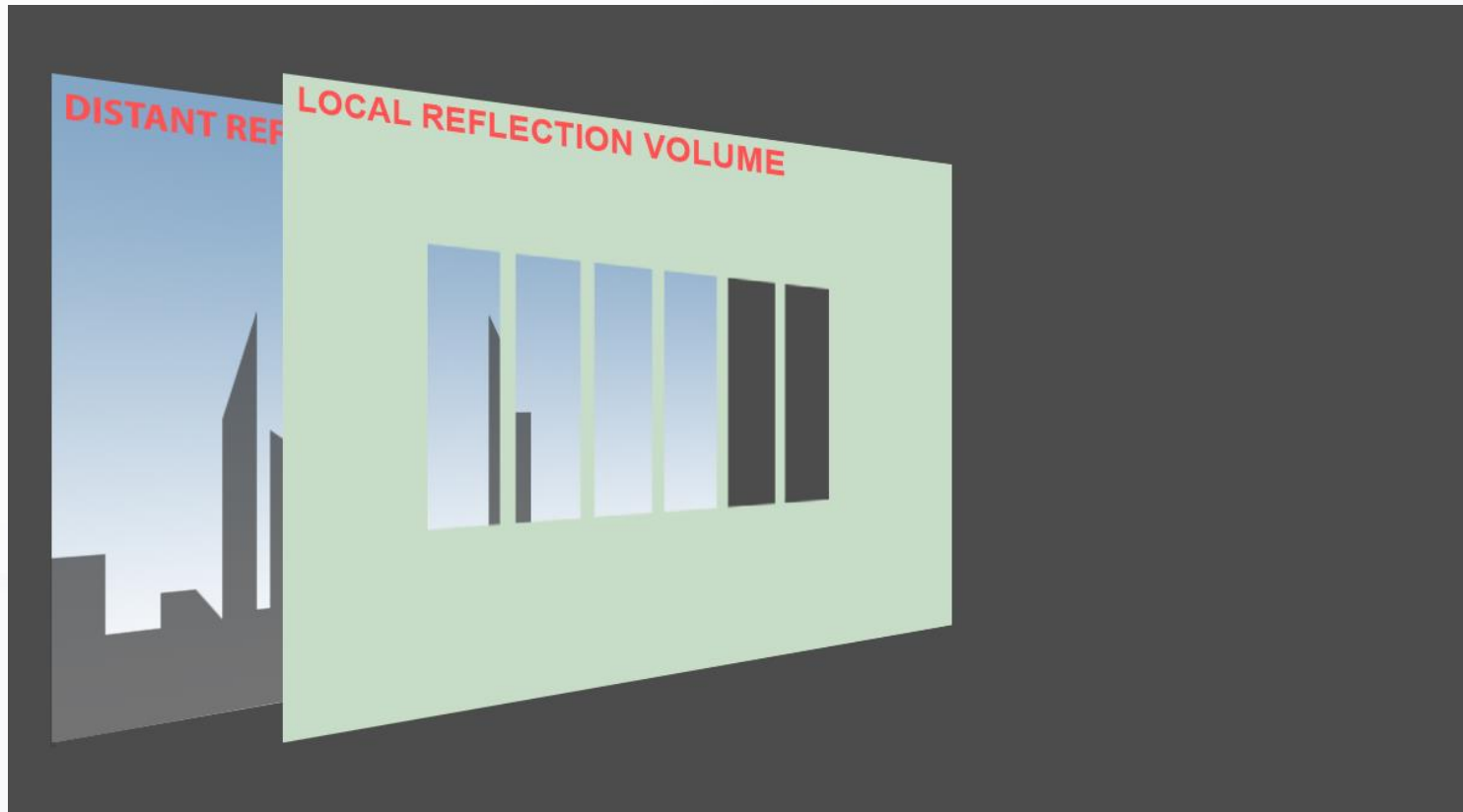## DISTANT REFLECTION VOLUME

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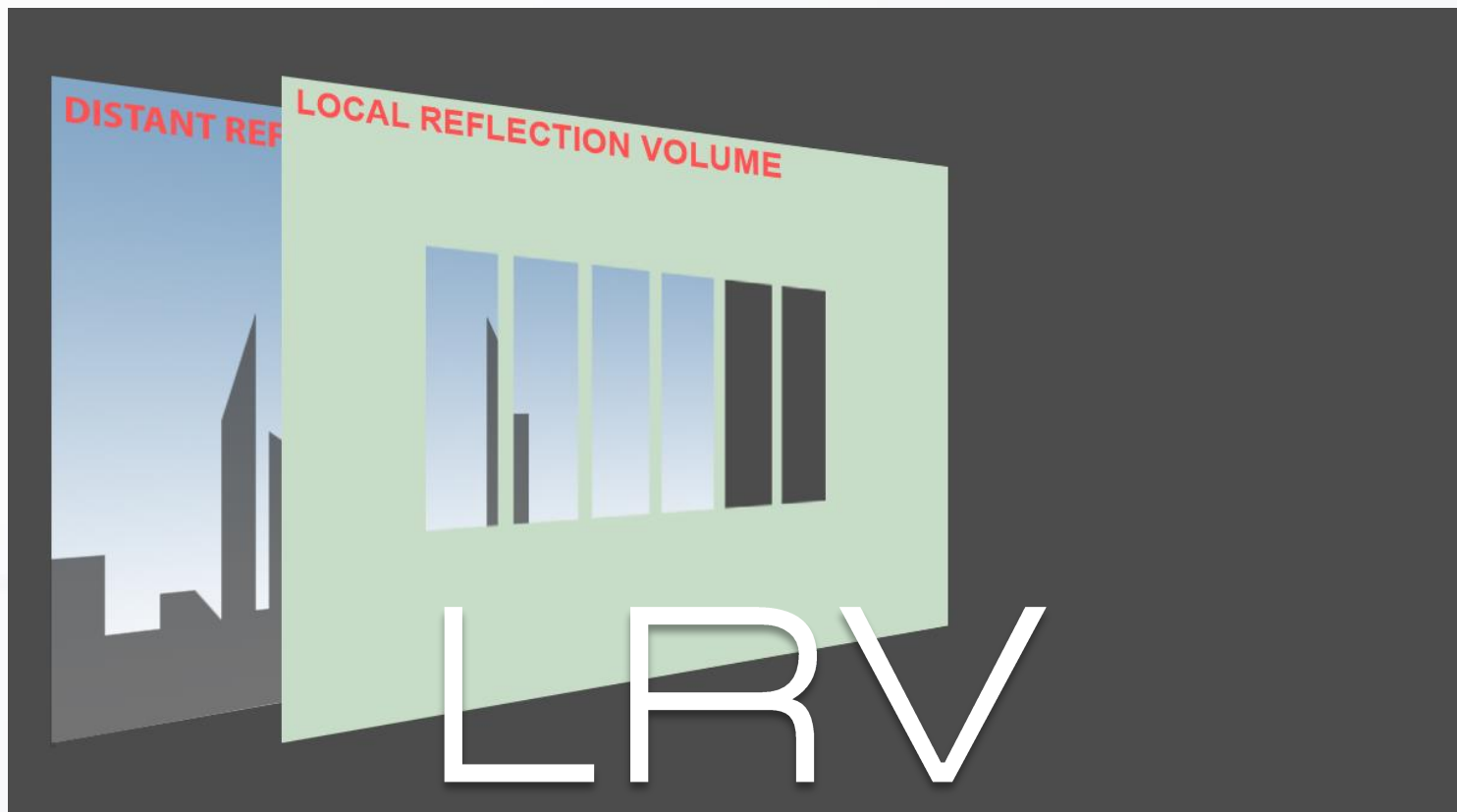
REFLECTIONS
LOCAL REFLECTION VOLUME

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REFLECTIONS
LOCAL REFLECTION VOLUME

- Parallax-corrected cubemap
  - Box or Sphere
  - 256*256*6

- Capture point can be moved

Work In Progress Visuals

REFLECTIONS
LOCAL REFLECTION VOLUME

Work In Progress Visuals

- Parallax-corrected cubemap
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- Tricky to place them
  - Normal fade
  - Faces fade
  - Expanded influences

- Cost of 1 light on the surface

REFLECTIONS
LOCAL REFLECTION VOLUME

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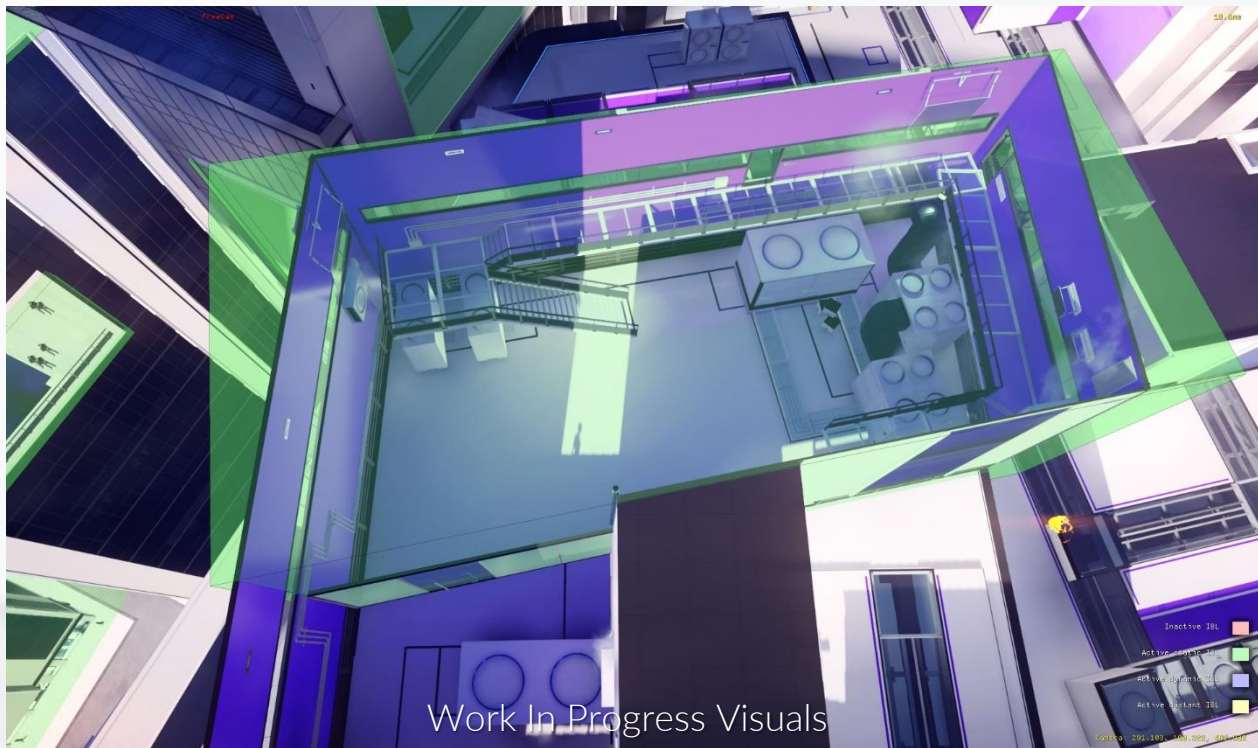
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Work In Progress Visuals
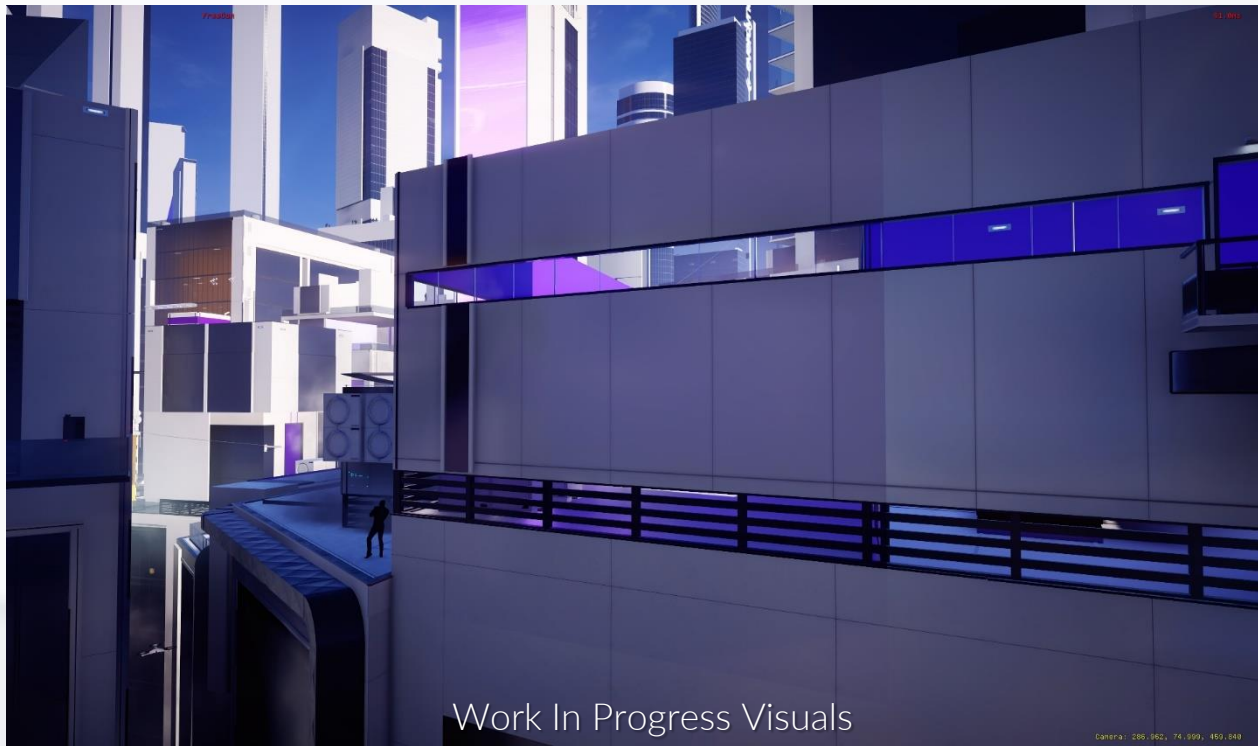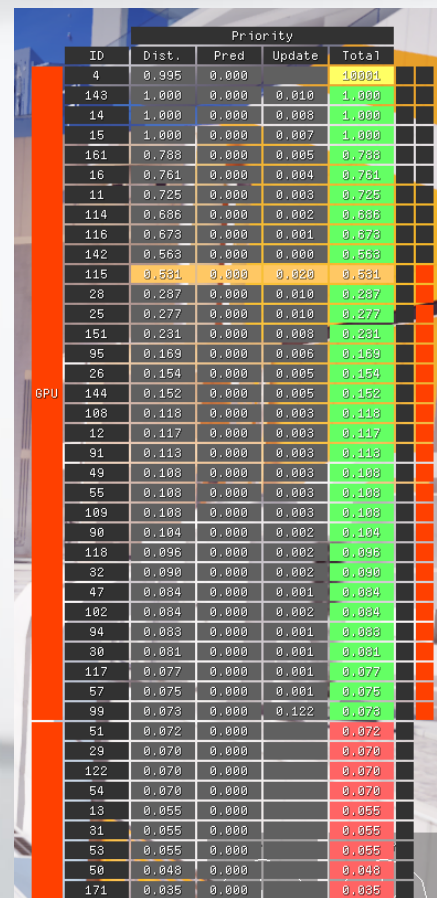
DICE

REFLECTIONS
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Work In Progress Visuals

DICE

REFLECTIONS
## LOCAL REFLECTION VOLUME

- Updated with the Time of Day

  - Pool of 32 LRVs active

  - Priority system based on distance and camera frustum

  - Update 1 face per frame

ID	Dist.	Pred	Update	Total
4	0.995	0.000		10001
143	1.000	0.000	0.010	1.000
14	1.000	0.000	0.008	1.000
15	1.000	0.000	0.007	1.000
161	0.788	0.000	0.005	0.788
16	0.761	0.000	0.004	0.761
11	0.725	0.000	0.003	0.725
114	0.686	0.000	0.002	0.686
116	0.673	0.000	0.001	0.673
142	0.563	0.000	0.000	0.563
115	0.531	0.000	0.020	0.531
28	0.287	0.000	0.010	0.287
25	0.277	0.000	0.010	0.277
151	0.231	0.000	0.008	0.231
95	0.169	0.000	0.006	0.169
26	0.154	0.000	0.005	0.154
144	0.152	0.000	0.005	0.152
108	0.118	0.000	0.003	0.118
12	0.117	0.000	0.003	0.117
91	0.113	0.000	0.003	0.113
49	0.108	0.000	0.003	0.108
55	0.108	0.000	0.003	0.108
109	0.108	0.000	0.003	0.108
90	0.104	0.000	0.002	0.104
118	0.096	0.000	0.002	0.096
32	0.090	0.000	0.002	0.090
47	0.084	0.000	0.001	0.084
102	0.084	0.000	0.002	0.084
94	0.083	0.000	0.001	0.083
30	0.081	0.000	0.001	0.081
117	0.077	0.000	0.001	0.077
57	0.075	0.000	0.001	0.075
99	0.073	0.000	0.122	0.073
51	0.072	0.000		0.072
29	0.070	0.000		0.070
122	0.070	0.000		0.070
54	0.070	0.000		0.070
13	0.055	0.000		0.055
31	0.055	0.000		0.055
53	0.055	0.000		0.055
50	0.048	0.000		0.048
171	0.035	0.000		0.035

GPU
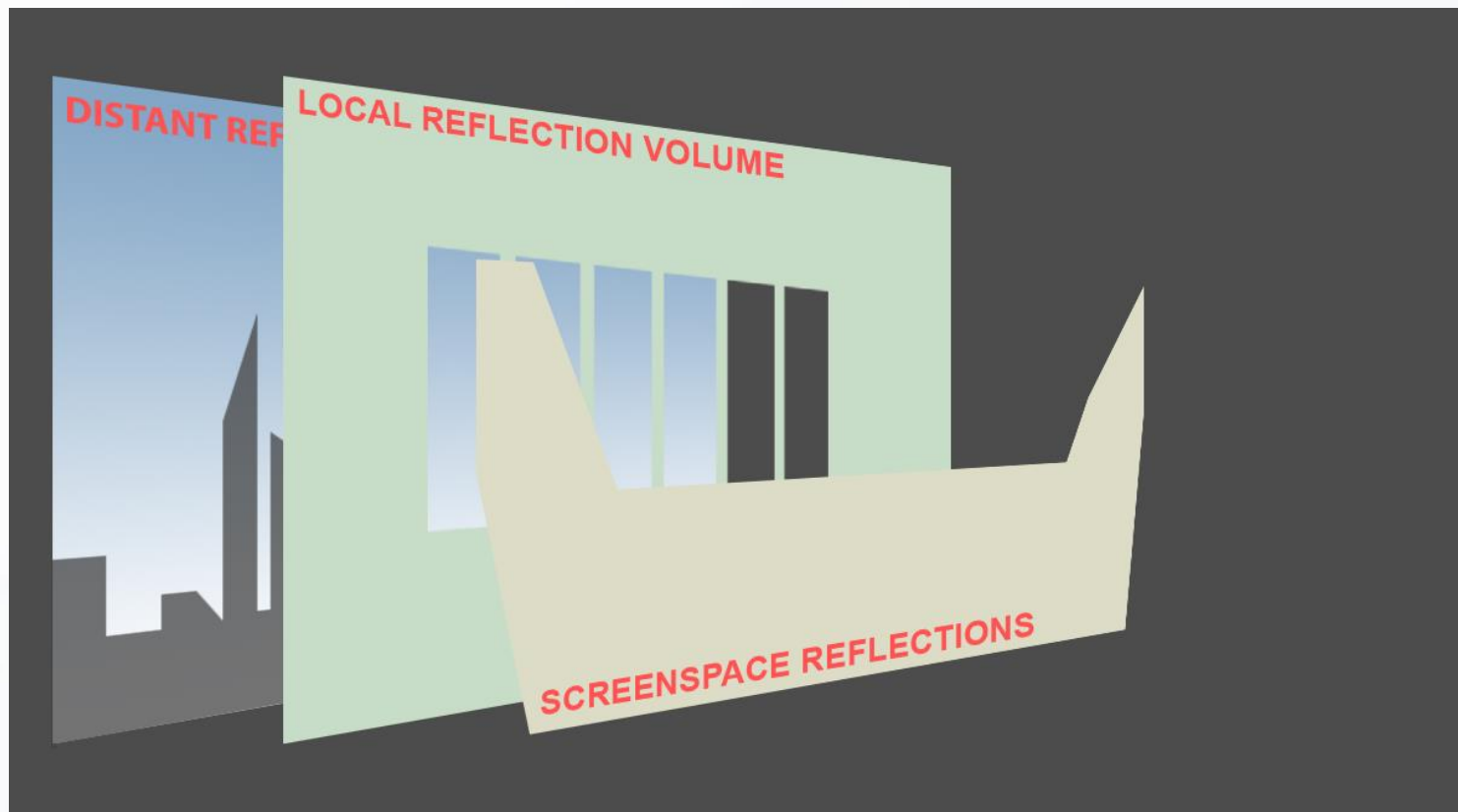
REFLECTIONS
SCREEN SPACE REFLECTIONS

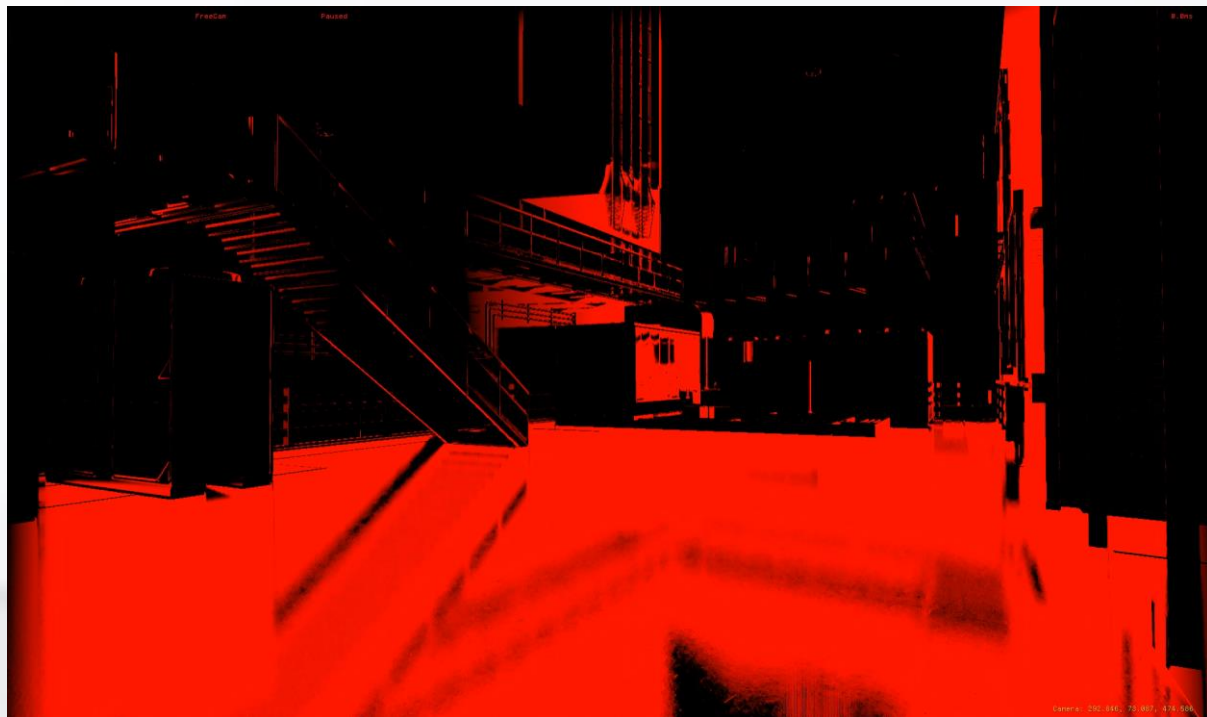# REFLECTIONS
SCREEN SPACE REFLECTIONS
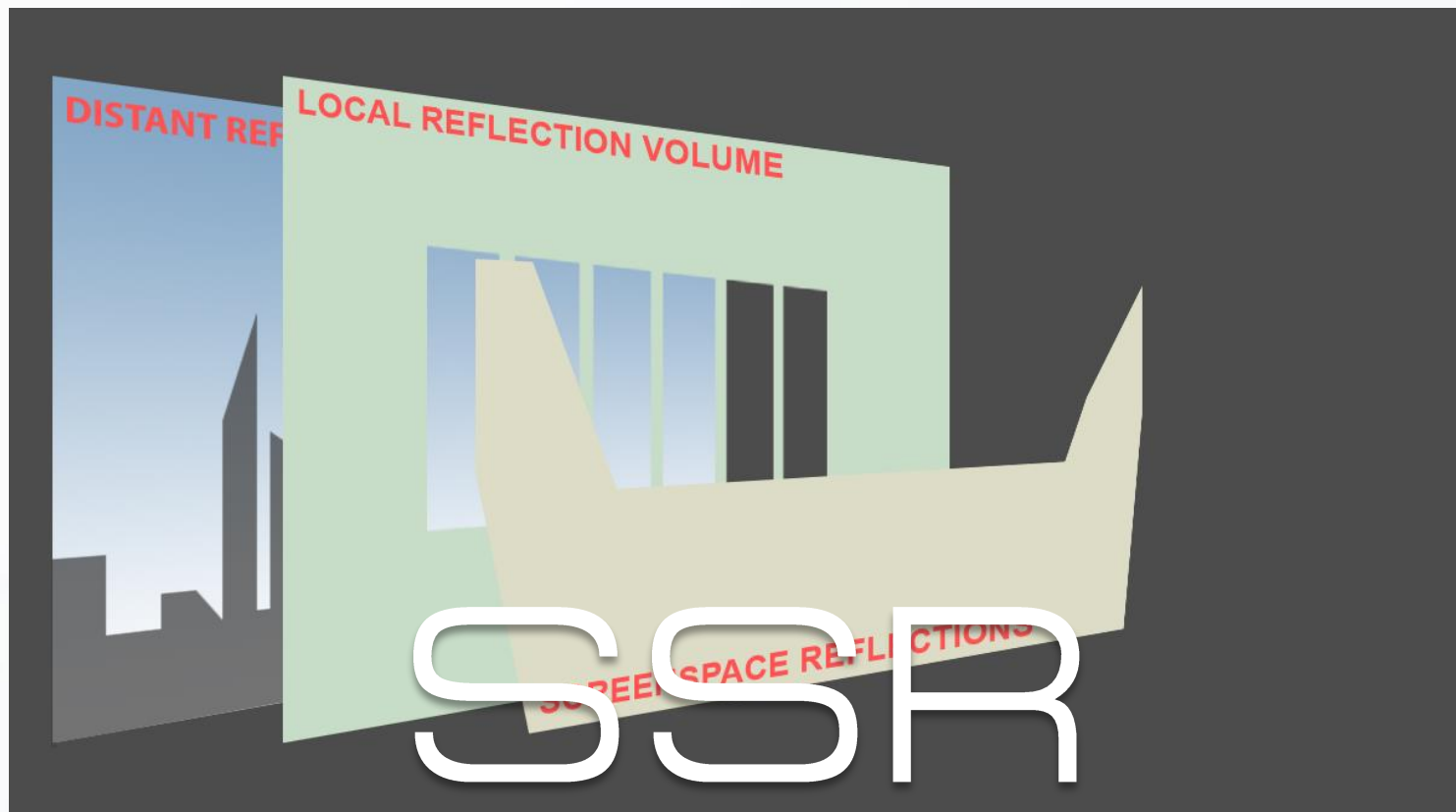
- Raytrace reflections of what is visible on screen, using the depth buffer

- Adaptive Sampling based on surface roughness

  - Rough: 3 samples
  - Smooth: 1 sample

- Clamped to avoid fireflies

No SSR

Work In Progress Visuals

REFLECTIONS
SCREEN SPACE REFLECTIONS

- Raytrace reflections of what is visible on screen, using the depth buffer

- Adaptive Sampling based on surface roughness

  - Rough: 3 samples
  - Smooth: 1 sample

- Clamped to avoid fireflies

SSR

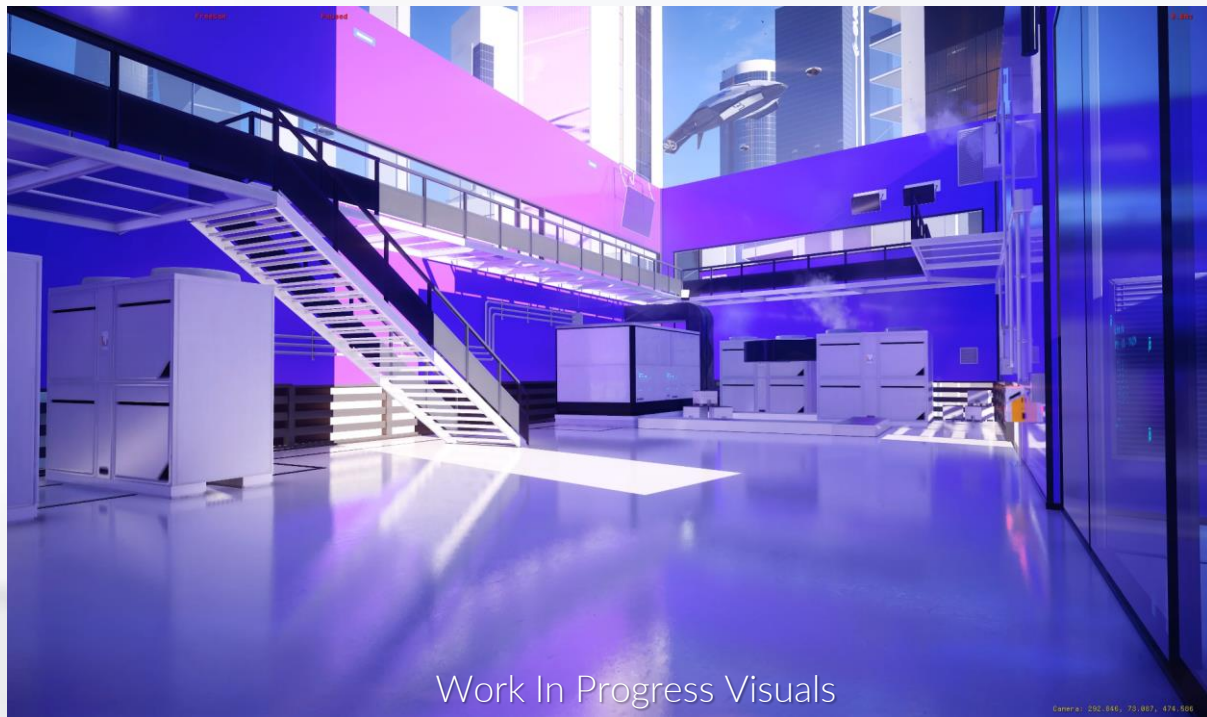Work In Progress Visuals

REFLECTIONS
SCREEN SPACE REFLECTIONS

- Optimization by roughness threshold

- Optimization by world normals
  - No reflections on ceilings

- Asynchronous SSR render with shadows
  - Budget of 4.2 ms for both

- Refined by Temporal Anti Aliasing

REFLECTIONS
SCREEN SPACE REFLECTIONS LIMITATIONS

- Only reflects what is on screen
  - Fallback to LRVs

- Opaque lines cut the SSR rays
  - Fix issues by turning off depth writing when possible
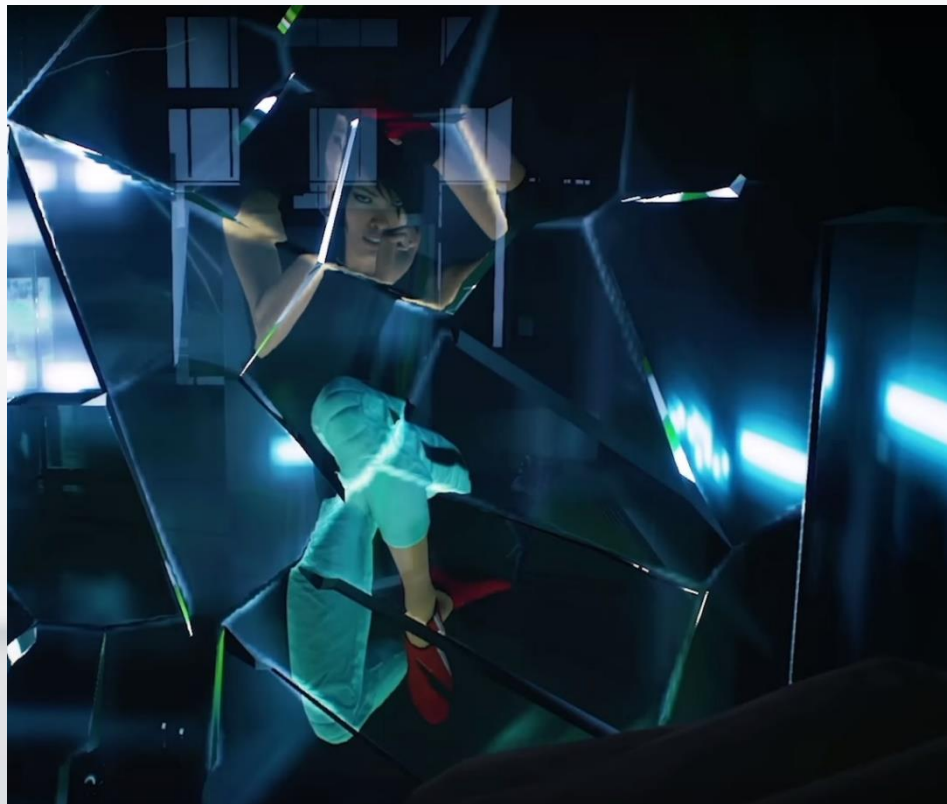
- Doesn't apply on Transparent objects

Work In Progress Visuals

REFLECTIONS
SCREEN SPACE REFLECTIONS LIMITATIONS

- Only reflects what is on screen
  - Fallback to LRVs

- Opaque lines cut the SSR rays
  - Fix issues by turning off depth writing when possible

- Doesn't apply on Transparent objects

Work In Progress Visuals

DICE

REFLECTIONS
LOCAL PLANAR REFLECTIONS

MIRROR'S EDGE™ CATALYST

DISTANT REF...

LOCAL REFLECTION VOLUME

LOCAL PLANAR REFLECTION

SCREENSPACE REFLECTIONS

DICE

REFLECTIONS
LOCAL PLANAR REFLECTIONS

- Mirror reflections for characters

- Forward Rendering
  - Light probe lighting
  - Directionnal Light without shadows

- Override lighting intensity and direction

GETTING THE RIGHT WHITE
CAMERA EXPOSURE

- Sun: 100 000 lux

- 00:00

- EV -0.35
  - Overexposed by 1.5 EV
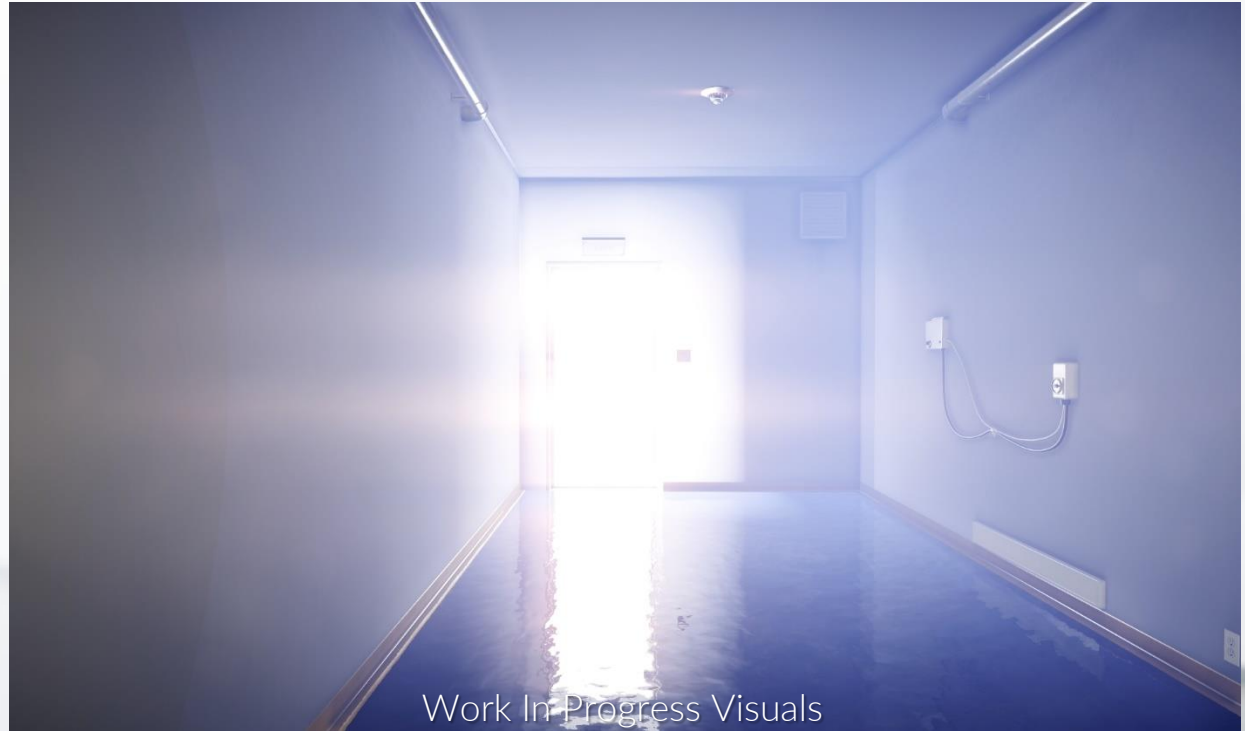
GETTING THE RIGHT WHITE
CAMERA EXPOSURE

- Sun: 100 000 lux

- 18:00

- EV 5.7
  - Overexposed by 1.8 EV

- Local lights contribution is very low around sunset

Work In Progress Visuals

GETTING THE RIGHT WHITE
CAMERA EXPOSURE

- Sun: 1000 lux

- 18:00

- EV 0.45
  - Overexposed by 1.8 EV

- Better ratio between local lights and sky

Work In Progress Visuals
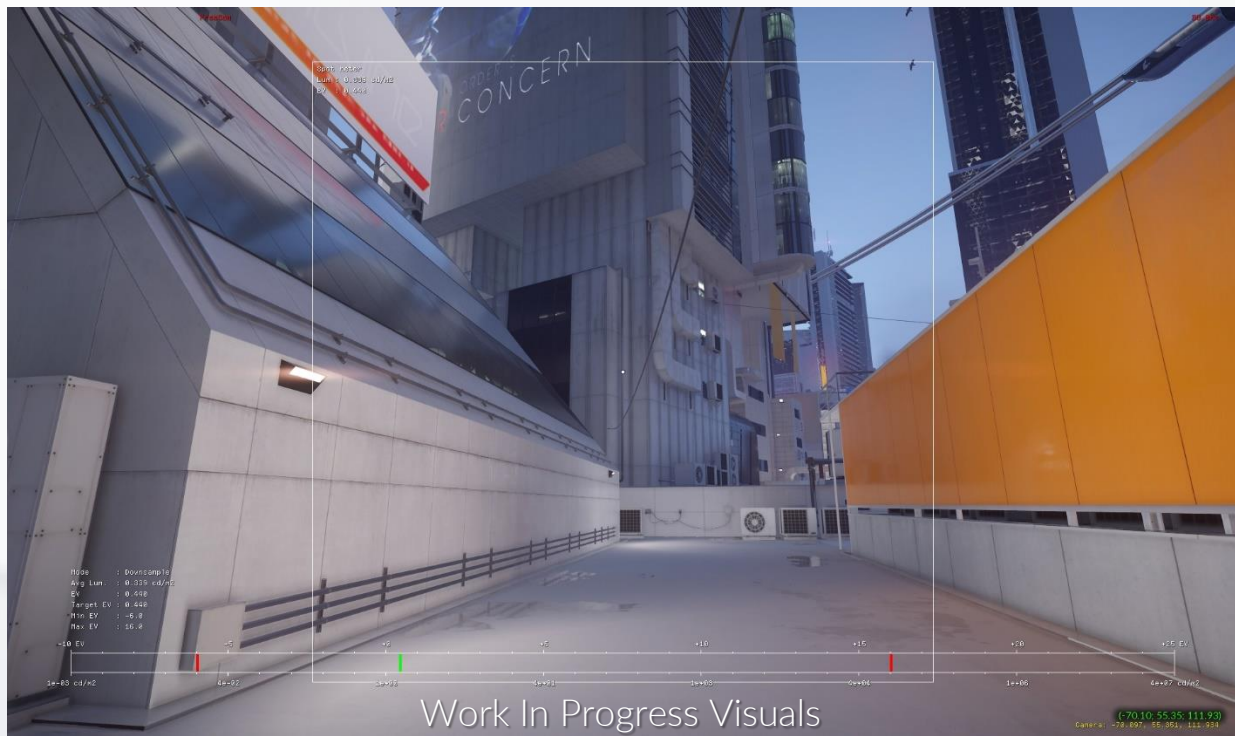
GETTING THE RIGHT WHITE
CAMERA EXPOSURE

- Sun: 1000 lux

- 11:00

- EV 6
  - Overexposed by 1.8 EV

Work In Progress Visuals

GETTING THE RIGHT WHITE
CAMERA EXPOSURE

- Sun: 100 000 lux

- 11:00

- EV 12.6
  - Overexposed by 1.8 EV

- No visual difference between 100 000 lux and 1 000 lux during the day

GETTING THE RIGHT WHITE
CAMERA EXPOSURE

- Sun: 100 000 lux

- Overblown exteriors

- Enlighten light leaks

Work In Progress Visuals

GETTING THE RIGHT WHITE
CAMERA EXPOSURE

- Sun: 1 000 lux

- Prefer Eye dynamic range
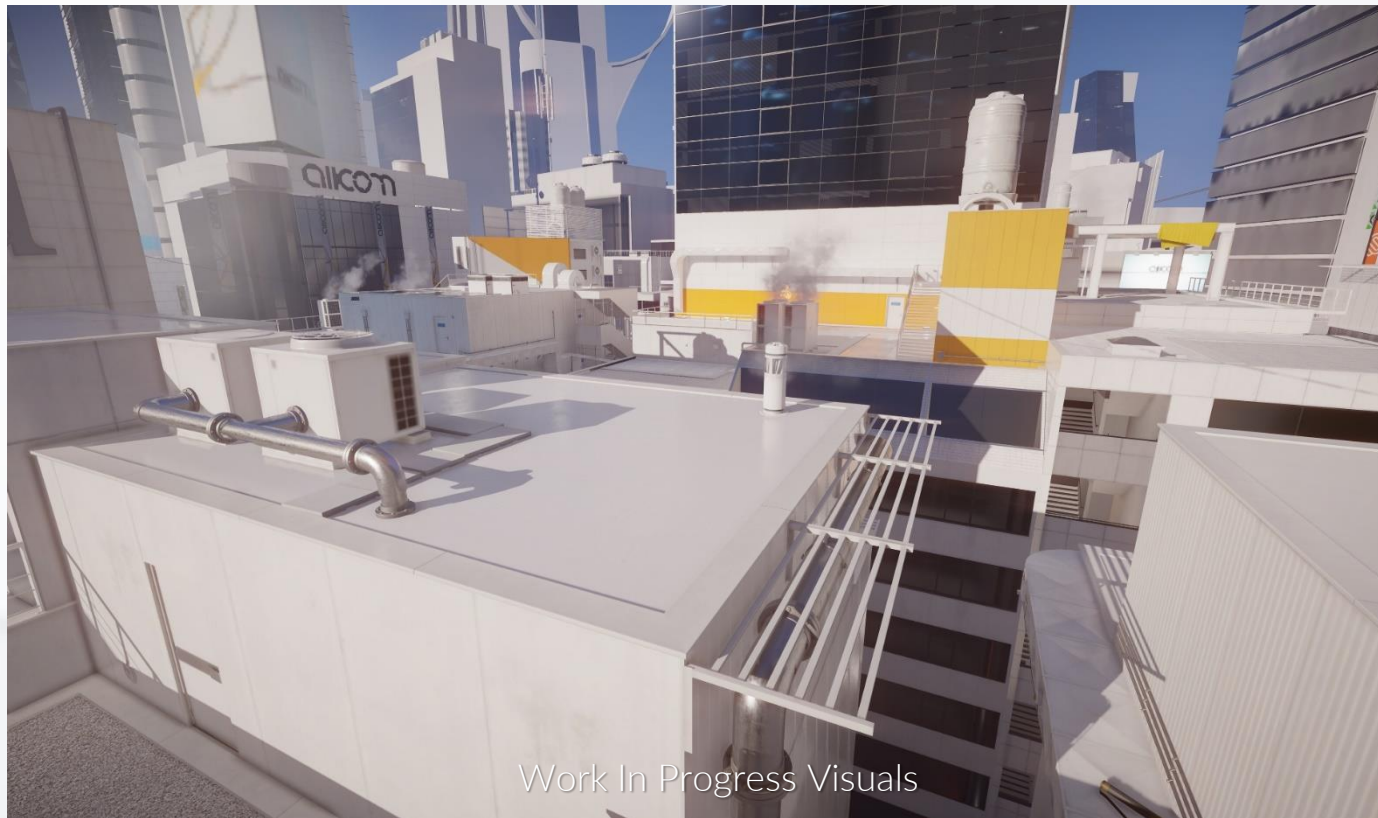 to camera dynamic range

So we divided sun intensity
by 100
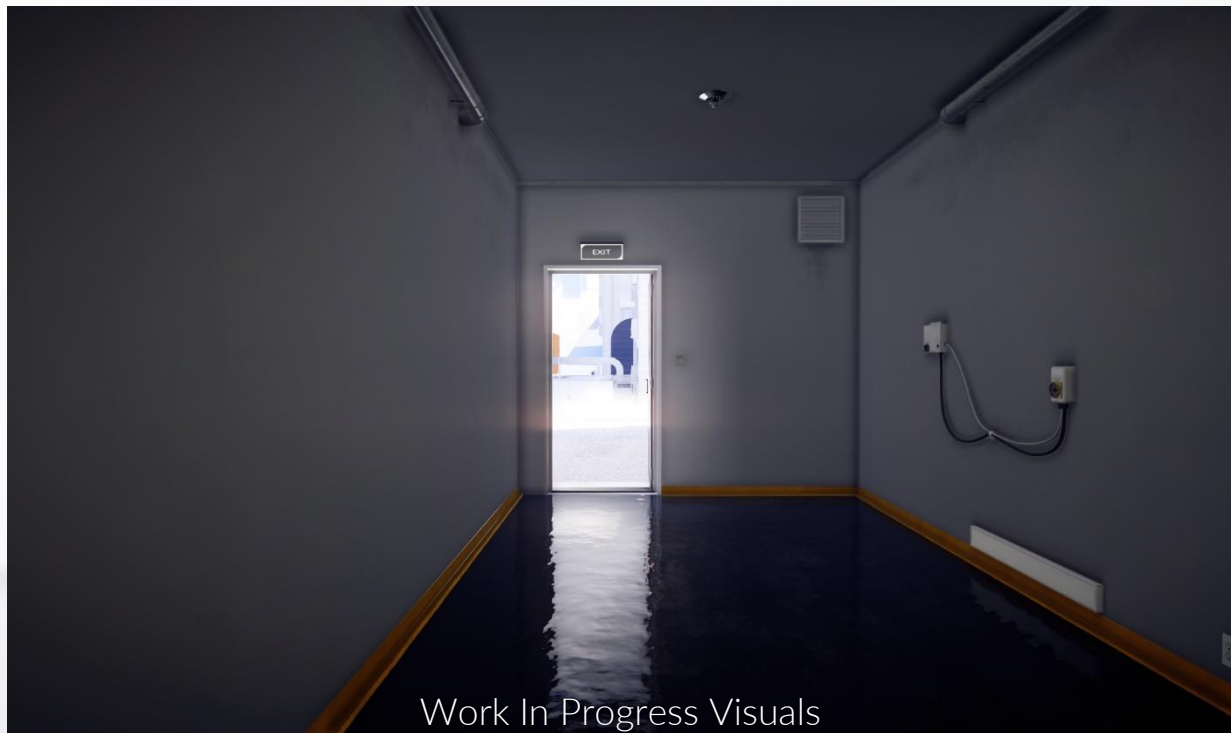
Work In Progress Visuals

DICE

GETTING THE RIGHT WHITE
TONEMAPPING CURVE

- Linear > sRGB

Work In Progress Visuals
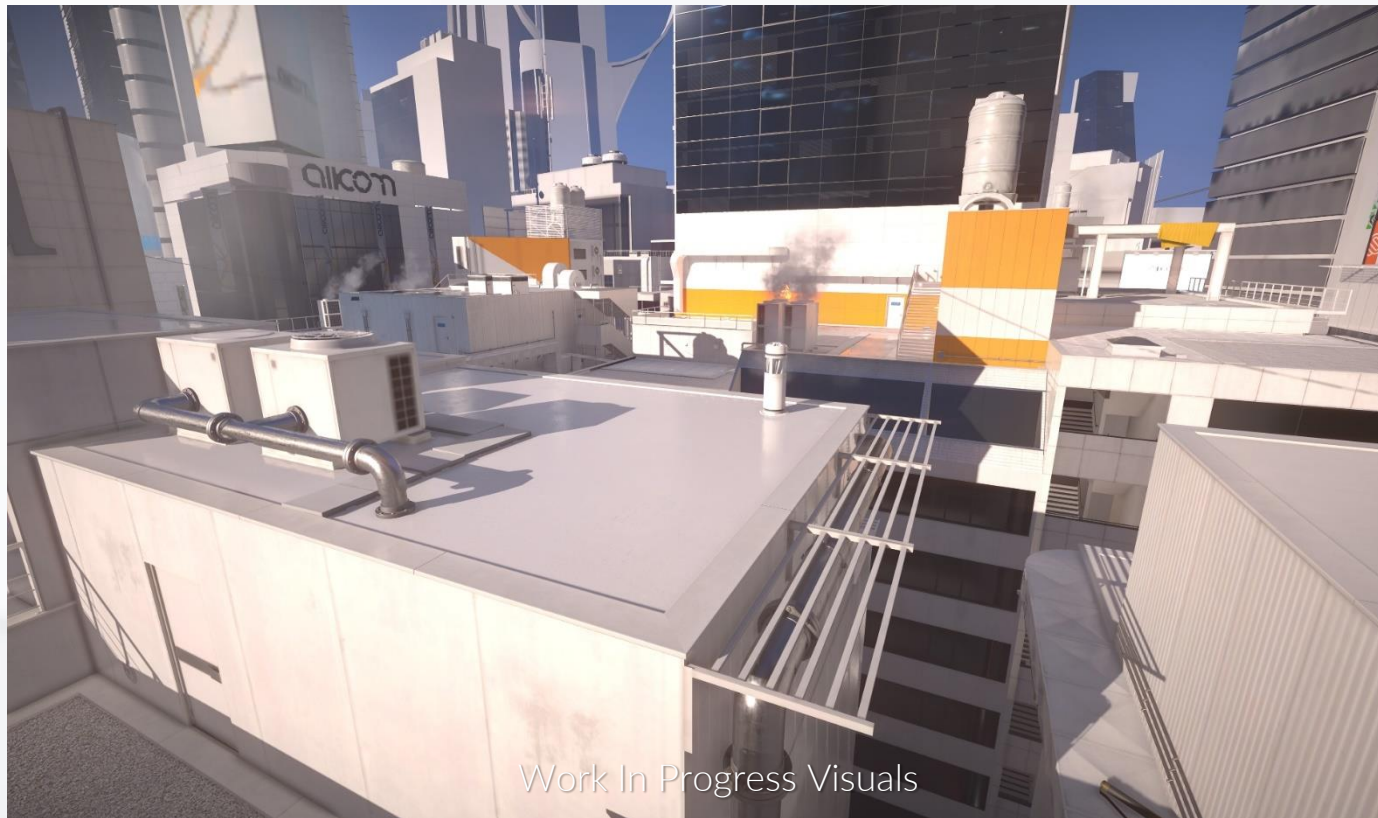
GETTING THE RIGHT WHITE
TONEMAPPING CURVE

- Linear > Filmic

Work In Progress Visuals

GETTING THE RIGHT WHITE
TONEMAPPING CURVE

- Filmic

Work In Progress Visuals

GETTING THE RIGHT WHITE
TONEMAPPING CURVE

- Filmic modified

  - White clipping

  - Adjusted toe

Work In Progress Visuals

DICE

GETTING THE RIGHT WHITE
TONEMAPPING CURVE

- Filmic modified

  - White clipping

  - Adjusted toe

Work In Progress Visuals

GETTING THE RIGHT WHITE
TONEMAPPING CURVE
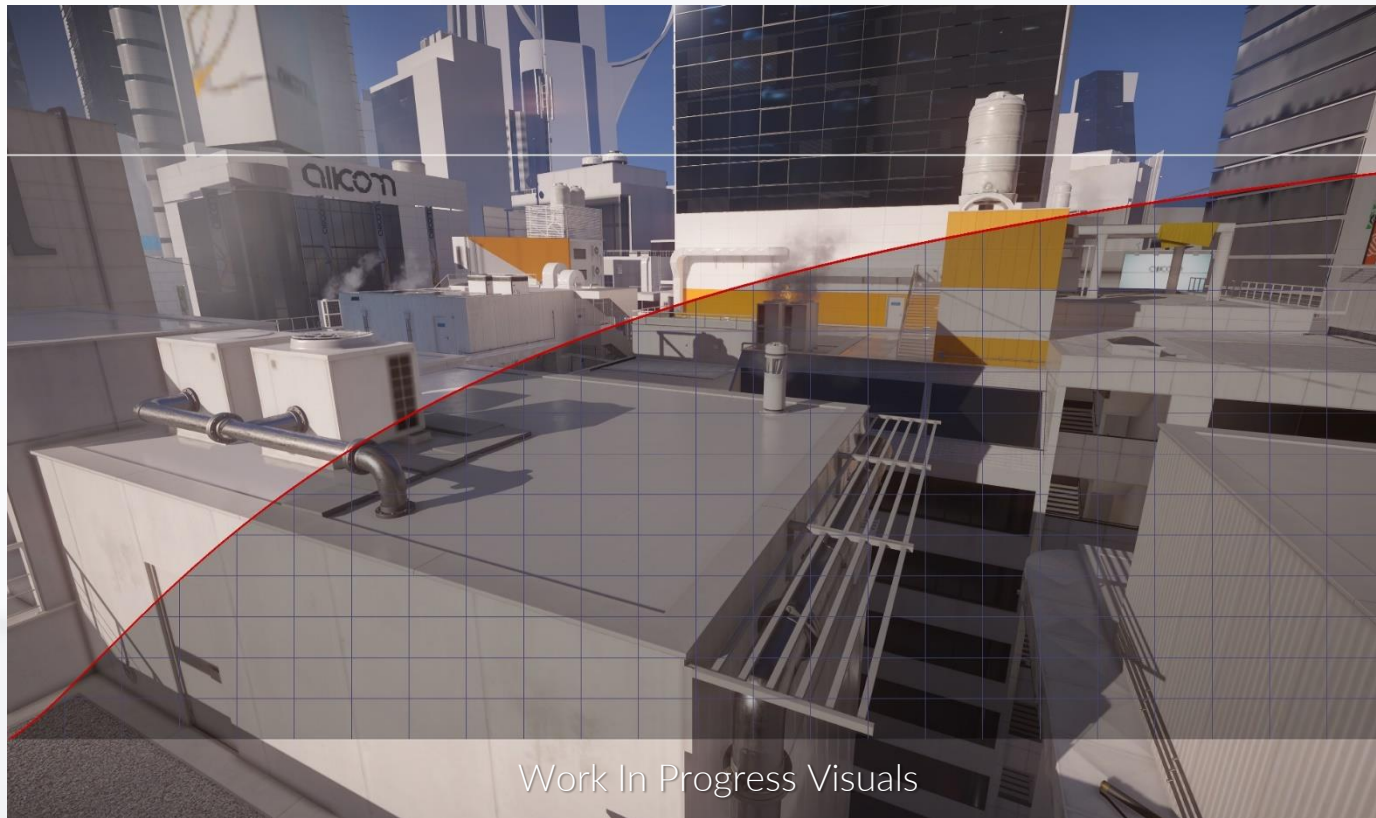
- Filmic modified

  - White clipping

  - Adjusted toe

Work In Progress Visuals

GETTING THE RIGHT WHITE
GRADING

- Graded
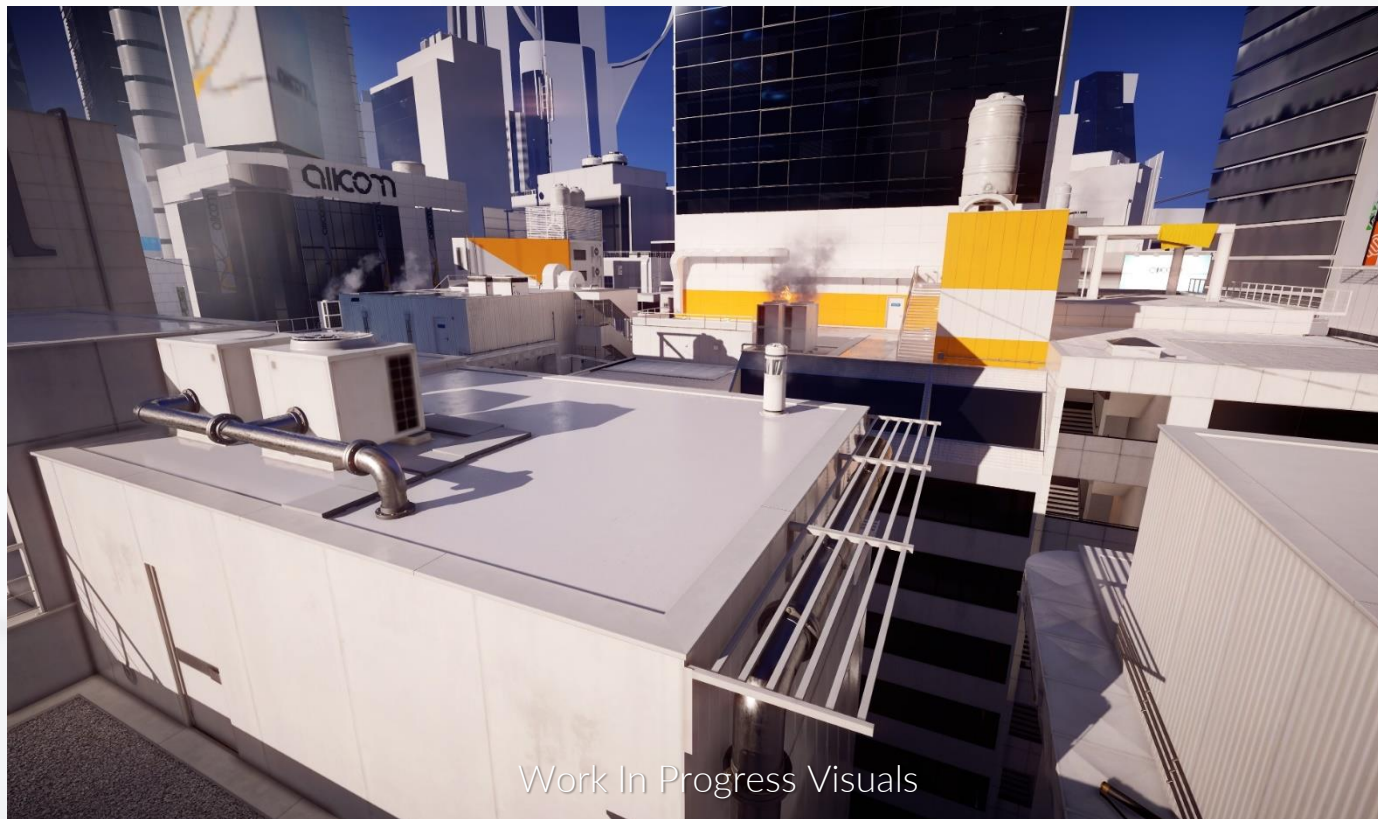
Work In Progress Visuals

GETTING THE RIGHT WHITE
WHITE BALANCING

GETTING THE RIGHT WHITE
WHITE BALANCING

Ungraded

Work In Progress Visuals

GETTING THE RIGHT WHITE
WHITE BALANCING

Graded

Work In Progress Visuals

GETTING THE RIGHT WHITE
WHITE BALANCING

LOCAL LIGHTING

LOCAL LIGHTING
PHYSICALLY BASED

- Physically based
  - Units in Lumens or Candelas
  - Realistic decay rate

- Color temperature in Kelvin, or RGB

- IES photometric
  - Real intensities or as masks

- Area lights
  - Rectangular
  - Disk
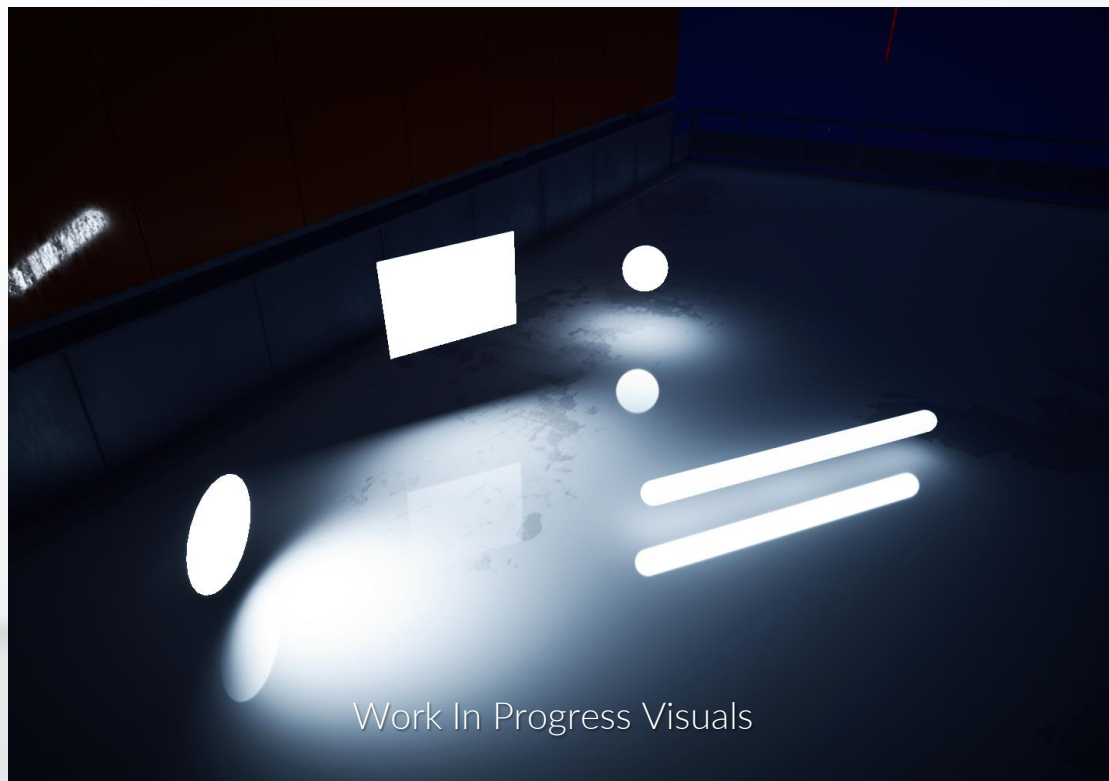 - Sphere
  - Tube

LOCAL LIGHTING
PHYSICALLY BASED

- Physically based
  - Units in Lumens or Candelas
  - Realistic decay

- Color temperature in Kelvin, or RGB

- IES photometric
  - Real intensities or as masks

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  - Rectangular
  - Disk
  - Sphere
  - Tube

LOCAL LIGHTING
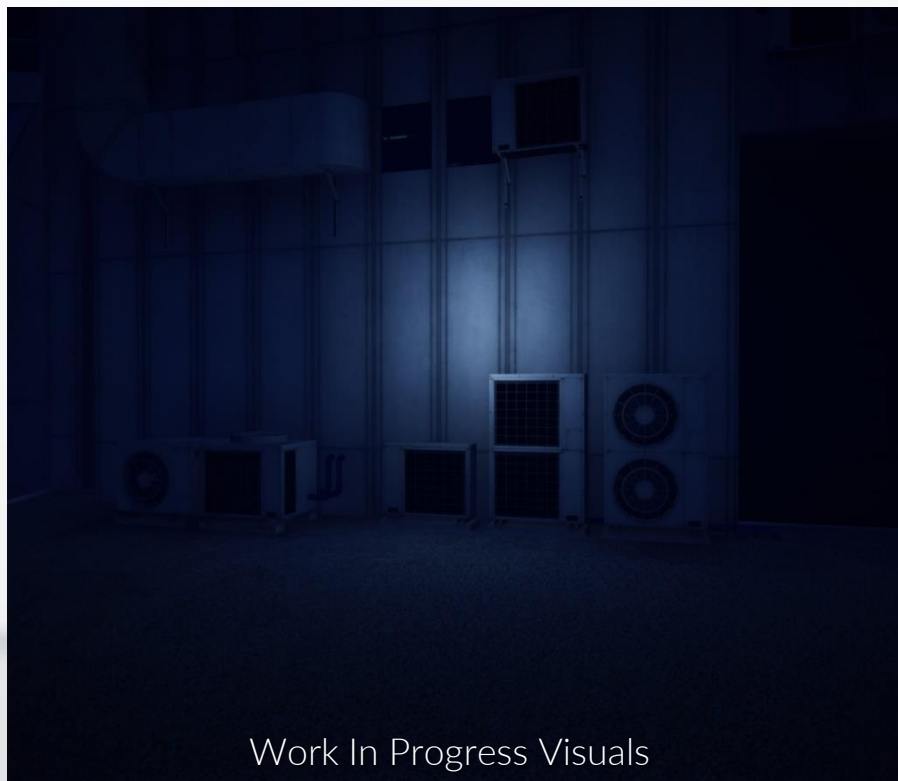## PHYSICALLY BASED

- Physically based
  - Units in Lumens or Candelas
  - Realistic decay

- Color temperature in Kelvin or RGB

- IES photometric
  - Real intensities or as masks

- Area lights
  - Rectangular
  - Disk
  - Sphere
  - Tube

Work In Progress Visuals

LOCAL LIGHTING
PHYSICALLY BASED

- Physically based
  - Units in Lumens or Candelas
  - Realistic decay

- Color temperature in Kelvin or RGB

- IES photometric
  - Real intensities or as masks

- Area lights
  - Rectangular
  - Disk
  - Sphere
  - Tube

Work In Progress Visuals

LOCAL LIGHTING
INTENSITIES ISSUES

- Hard to use real light intensities
  - Only works for point lights
  - Realtime lights are not infinite,
    have small cones, miss bounce lighting...

- First set up your camera exposure,
  then adjust intensities so it looks good

LOCAL LIGHTING
MORE ARTISTIC CONTROLS

- Attenuation Offset

  - Lighting more ambient

  - Avoid blown out surfaces

Work In Progress Visuals

LOCAL LIGHTING
MORE ARTISTIC CONTROLS

- Attenuation Offset

    - Lighting more ambient

    - Avoid blown out surfaces

Work In Progress Visuals

LOCAL LIGHTING
MORE ARTISTIC CONTROLS

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Work In Progress Visuals

LOCAL LIGHTING
MORE ARTISTIC CONTROLS

- Attenuation Offset

  - Lighting more ambient

  - Avoid blown out surfaces

Work In Progress Visuals

LOCAL LIGHTING
RADIOSITY

- Placement can be tricky as sampling is sparse

  - Make lights biggers
  - Use radiosity-only lights

- Radiosity Color ScaleScale
  - RGB for color shift

Work In Progress Visuals

LOCAL LIGHTING
RADIOSITY

- Placement can be tricky as sampling is sparse

  - Make lights biggers
  - Use radiosity-only lights

- Radiosity Color Scale
  - RGB for color shift
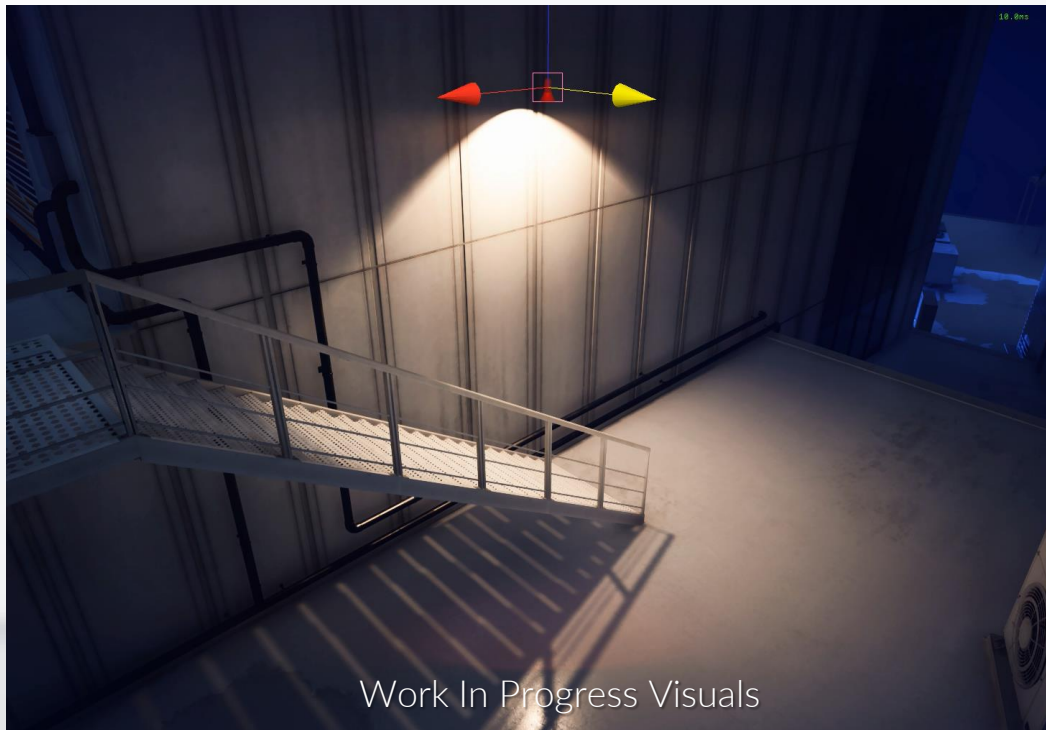
Work In Progress Visuals

LOCAL LIGHTING
PERFORMANCE

- Tiled Deferred Lighting

  - 8*8 tiles

  - Can afford many lights
    if they don't overlap

- Budget of 3.3 ms

LOCAL LIGHTING
PERFORMANCE
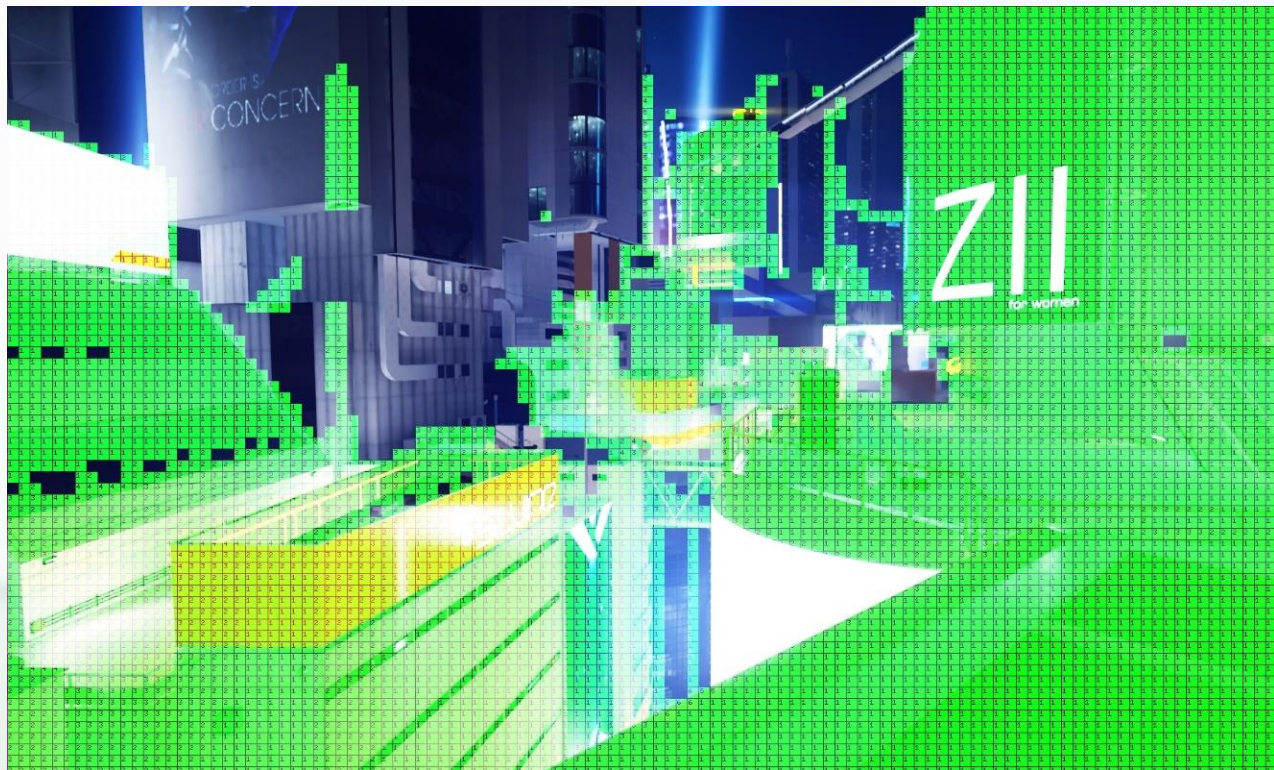
- Tiled Deferred Lighting

  - 8*8 tiles

  - Can afford many lights if they don't overlap

- Budget of 3.5 ms

Work in Progress Visuals
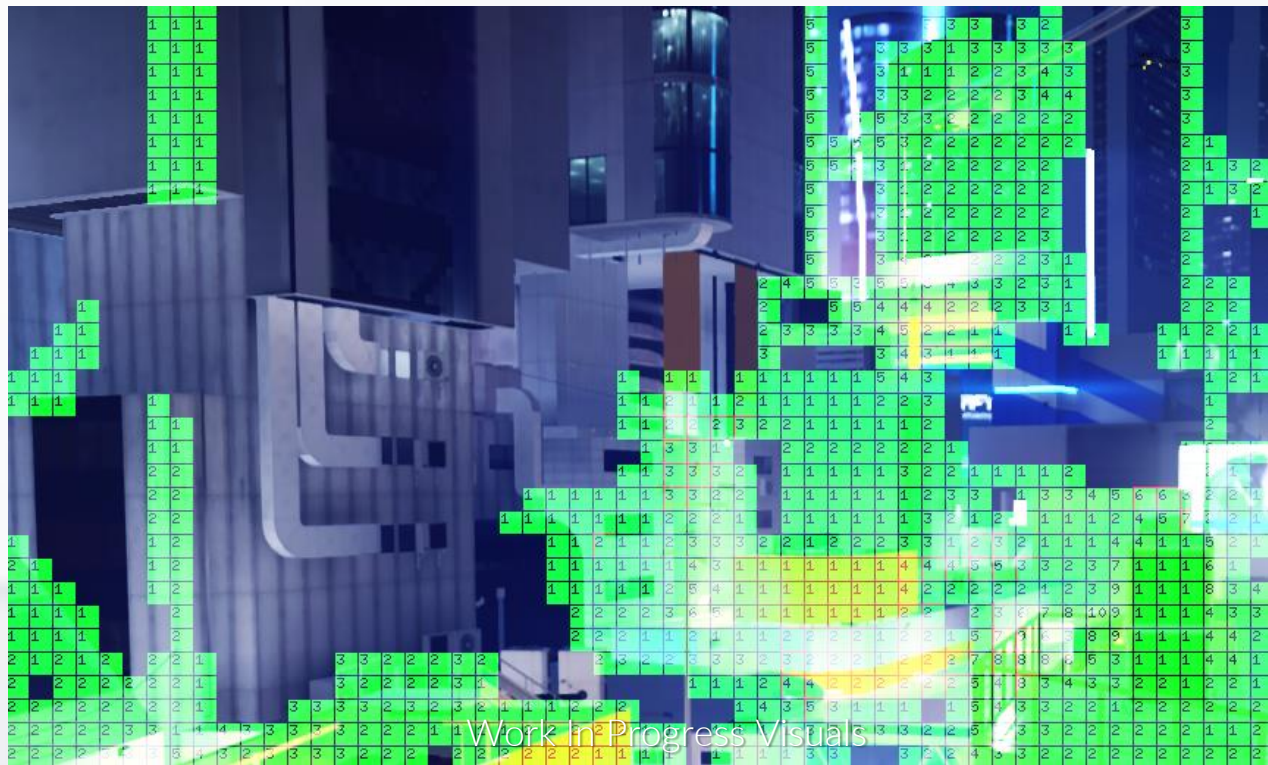
LOCAL LIGHTING
SHADOWS

- 8 shadow casting lights simultaneously

- Budget shared with SSR: 4.2 ms

- Cached shadows
  - Only update them when a character enters the light bounding box

- Fade distance setting
  - Manually tweaked for each light

Work In Progress Visuals
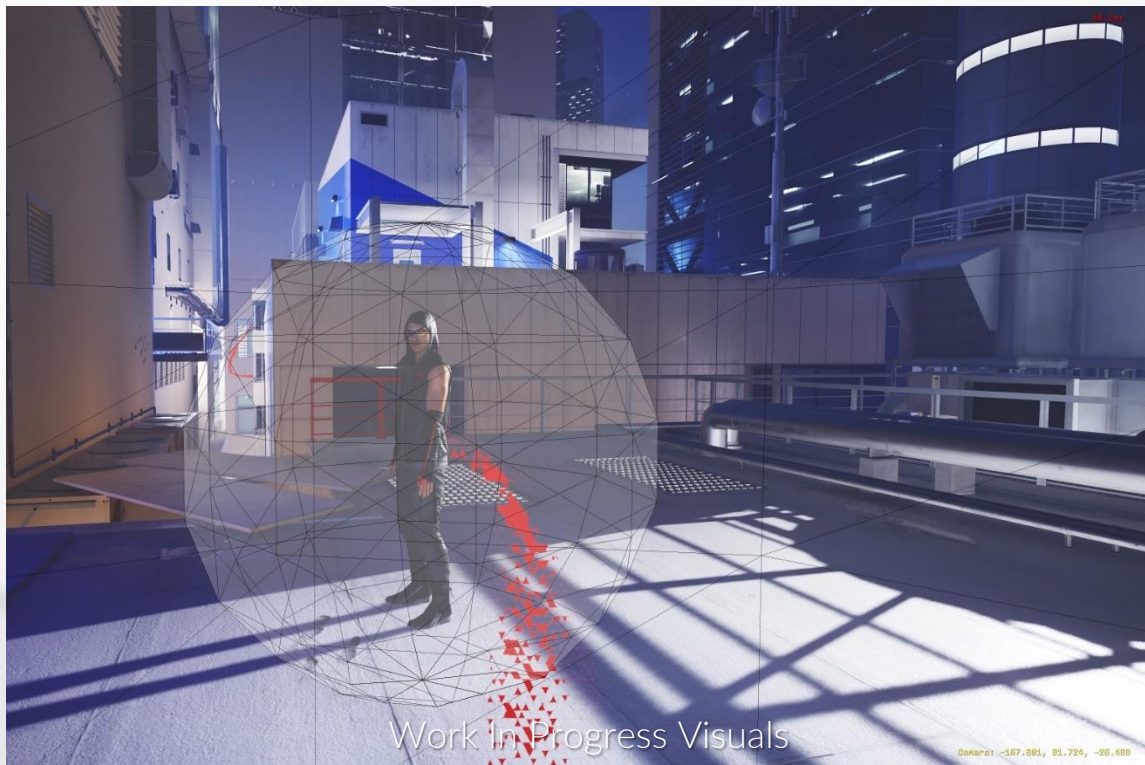
IMAGE STYLIZATION

IMAGE STYLIZATION
POST EFFECTS

- "Raw" image

Work In Progress Visuals

IMAGE STYLIZATION
POST EFFECTS

- Gaussian Bloom
  - Custom color for each pyramid level

Gaussian1Color	0.214/0.429/0.497 linear
Gaussian1Weight	0.681
Gaussian2Color	0.964/0.947/0.991 linear
Gaussian2Weight	0.801
Gaussian3Color	0.982/0.542/0.542 linear
Gaussian3Weight	1
Gaussian4Color	0.301/0.493/1 linear
Gaussian4Weight	0.555
Gaussian5Color	0.456/0.209/0.167 linear
Gaussian5Weight	1

  - Vertical /Horizontal stretch
  - Multiplied by a lens dirt texture

- Lens reflection
  - Transposed and distorted bloom

Work In Progress Visuals

IMAGE STYLIZATION
POST EFFECTS

- Gaussian Bloom
  - Custom color for each pyramid level

Gaussian1Color	0.214/0.429/0.497 linear
Gaussian1Weight	0.681
Gaussian2Color	0.964/0.947/0.991 linear
Gaussian2Weight	0.801
Gaussian3Color	0.982/0.542/0.542 linear
Gaussian3Weight	1
Gaussian4Color	0.301/0.493/1 linear
Gaussian4Weight	0.555
Gaussian5Color	0.456/0.209/0.167 linear
Gaussian5Weight	1

  - **Vertical** / Horizontal **stretch**
  - Multiplied by a lens dirt texture
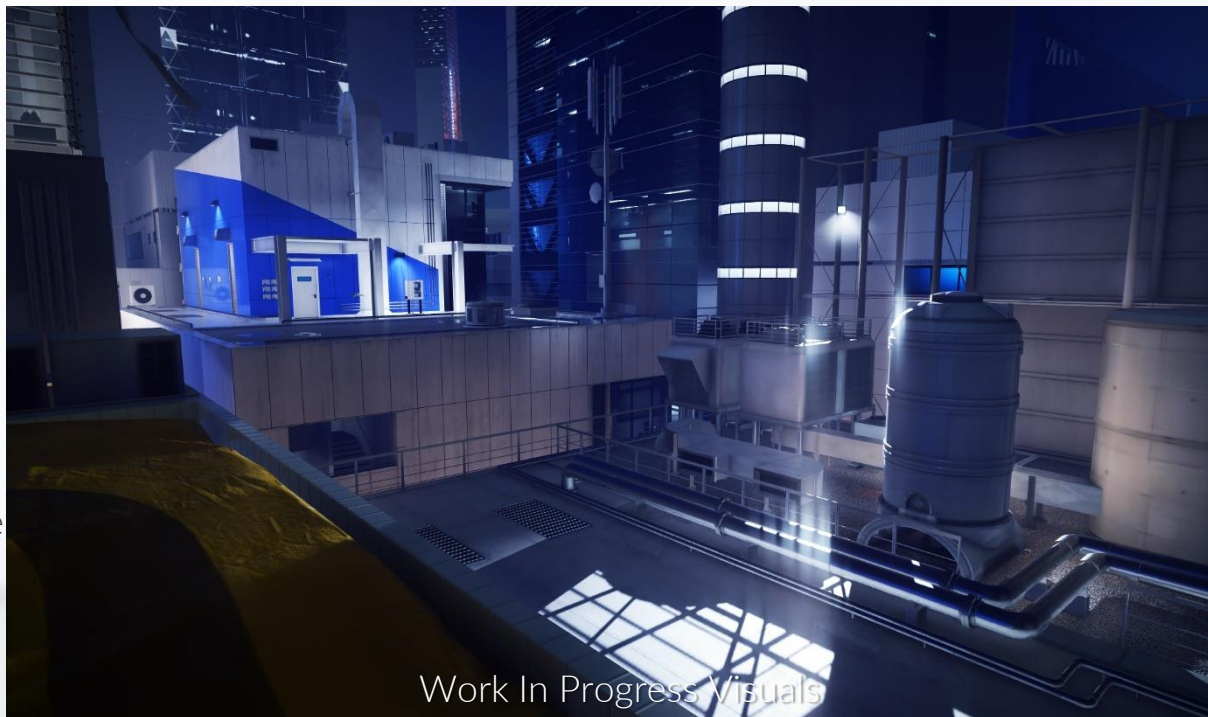
- Lens reflection
  - Transposed and distorted bloom

Work In Progress Visuals

DICE™

IMAGE STYLIZATION
POST EFFECTS

- Gaussian Bloom
  - Custom color for each pyramid level

Gaussian1Color	0.214/0.429/0.497 linear
Gaussian1Weight	0.681
Gaussian2Color	0.964/0.947/0.991 linear
Gaussian2Weight	0.801
Gaussian3Color	0.982/0.542/0.542 linear
Gaussian3Weight	1
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Gaussian4Weight	0.555
Gaussian5Color	0.456/0.209/0.167 linear
Gaussian5Weight	1

  - Vertical / **Horizontal stretch**
  - Multiplied by a lens dirt texture

- Lens reflection
  - Transposed and distorted bloom

Work In Progress Visuals

IMAGE STYLIZATION
POST EFFECTS

MIRROR'S EDGE CATALYST

- Gaussian Bloom
  - Custom color for each pyramid level

Gaussian1Color	0.214/0.429/0.497 linear
Gaussian1Weight	0.681
Gaussian2Color	0.964/0.947/0.991 linear
Gaussian2Weight	0.801
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Gaussian4Weight	0.555
Gaussian5Color	0.456/0.209/0.167 linear
Gaussian5Weight	1

  - Vertical / Horizontal stretch
  - Multiplied by a lens dirt texture
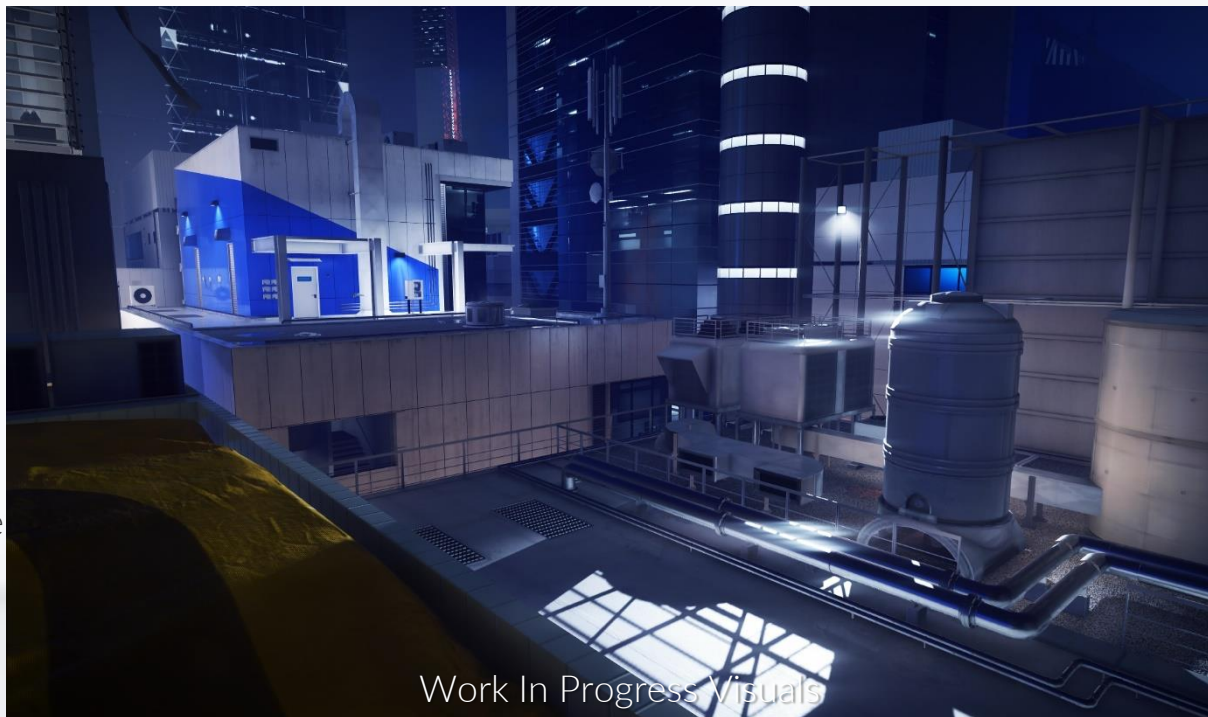
- Lens reflection
  - Transposed and distorted bloom

Work In Progress Visuals

DICE

IMAGE STYLIZATION
POST EFFECTS

- Simple Volumetrics

  - Additive Spheres

  - Adds depth separation

  - Creates color shift

Work In Progress Visuals

POST EFFECTS

Before

Work In Progress Visuals

POST EFFECTS

After
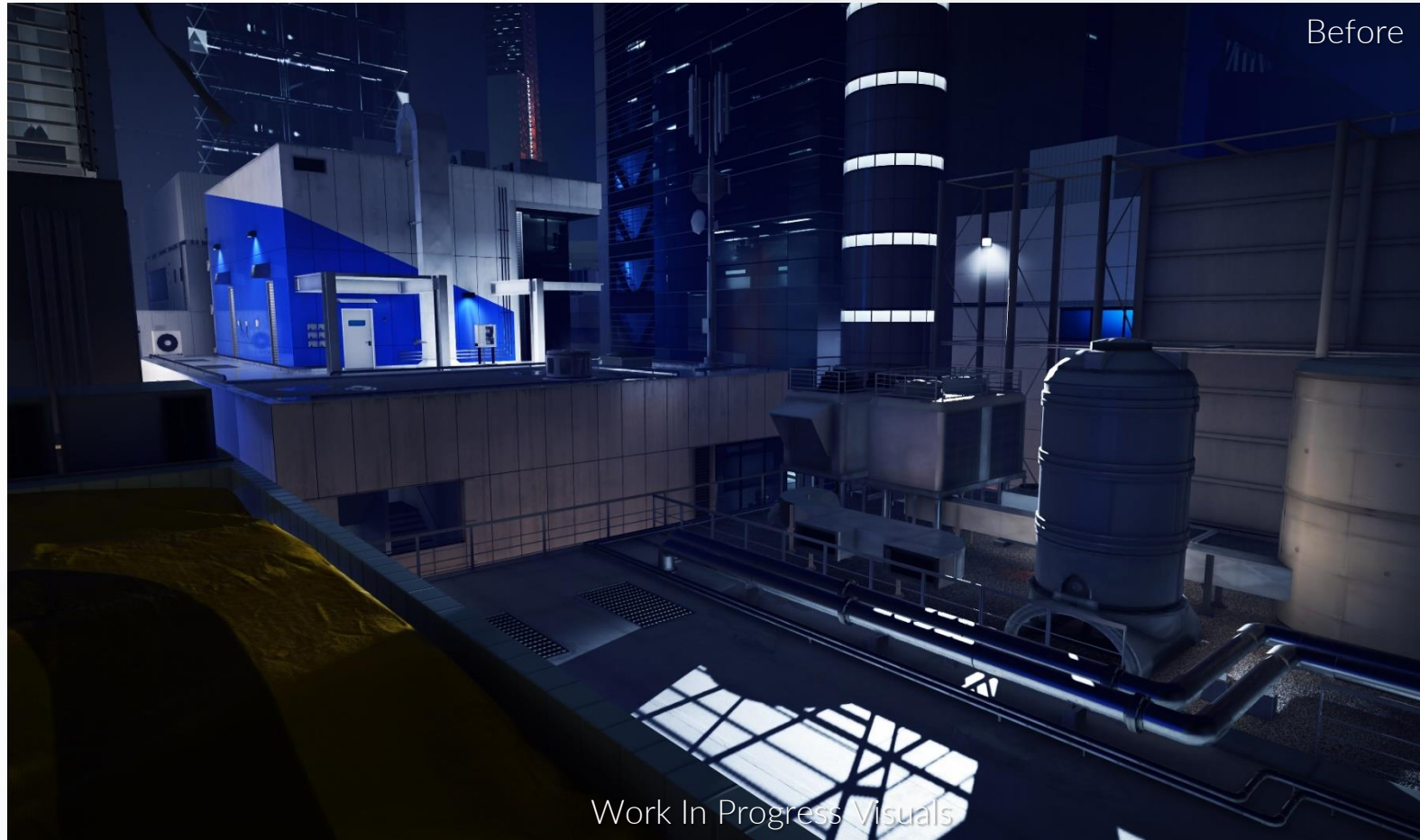
Work In Progress Visuals

LIVING WORLDS
LINEAR MEDIA STREAMING

- Commercial billboards

- Newscasts

- Average color output
  - Drive Simple Volumetrics and Light color

- Exposure Compensated

Work In Progress Visuals

CINEMATICS
BELIEVABLE CHARACTERS
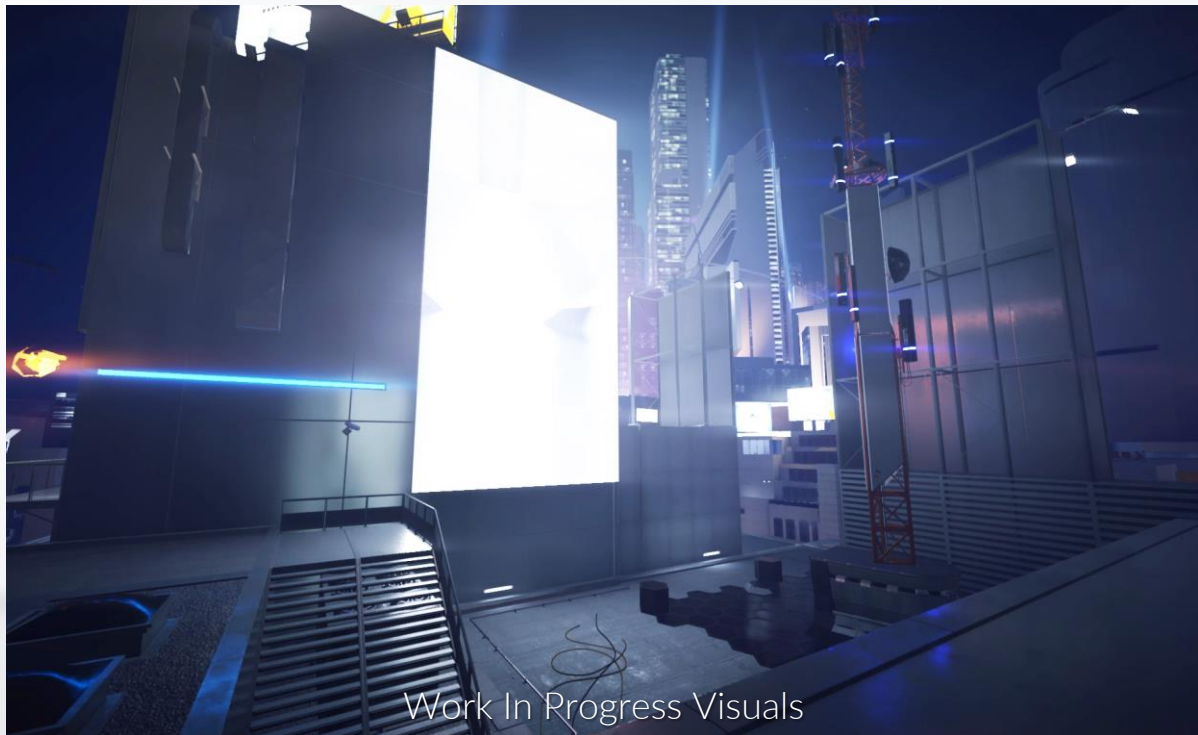
- Model face scan

  - Extract mesh and diffuse texture

  - Different face poses scanned for wrinkle maps

- But we modified all the faces

  - Stylized Characters

- Missing reflection information from capture

- Studio lighting test

- Recreate scene inside Frostbite
  - HDR capture
  - Identical lights
  - Lights rotating around subject

CINEMATICS
BELIEVABLE CHARACTERS

- Compare reference pictures to imported face scan

- Findings:

  - Skin Saturation was too high
  - Reflectance was too high
    - Skin reflectance = 2.8 %
  - Smoothness was too high

  - Emissive intensities of some light fixtures were too strong

CINEMATICS
BELIEVABLE CHARACTERS

MIRROR'S EDGE™ CATALYST

Lit · Base Color · AO · Smoothness · Reflectance · Normals

DICE

CINEMATICS
CHARACTERS

- Subsurface scattering

SSS Off

Work In Progress Visuals

CINEMATICS
CHARACTERS

- Subsurface scattering

SSS On

Work In Progress Visuals

CINEMATICS
BELIEVABLE CHARACTERS
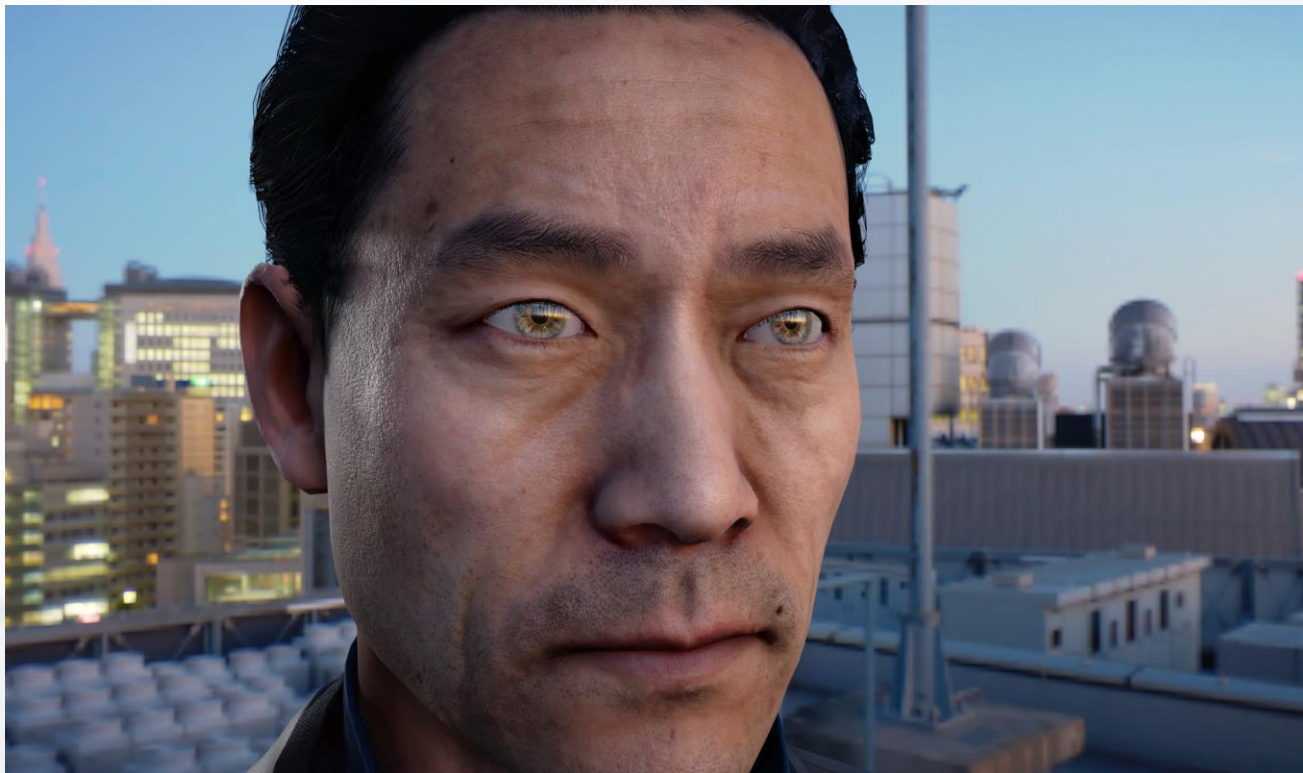
- Eye shader

    - Parallax for refraction
    - Normal map for iris concavity

- Anisotropic Hair Shader

CINEMATICS
BELIEVABLE CHARACTERS

- Eye shader

  - Parallax for refraction
  - Normal map for iris concavity

- **Anisotropic Hair Shader**

Work In Progress Visuals
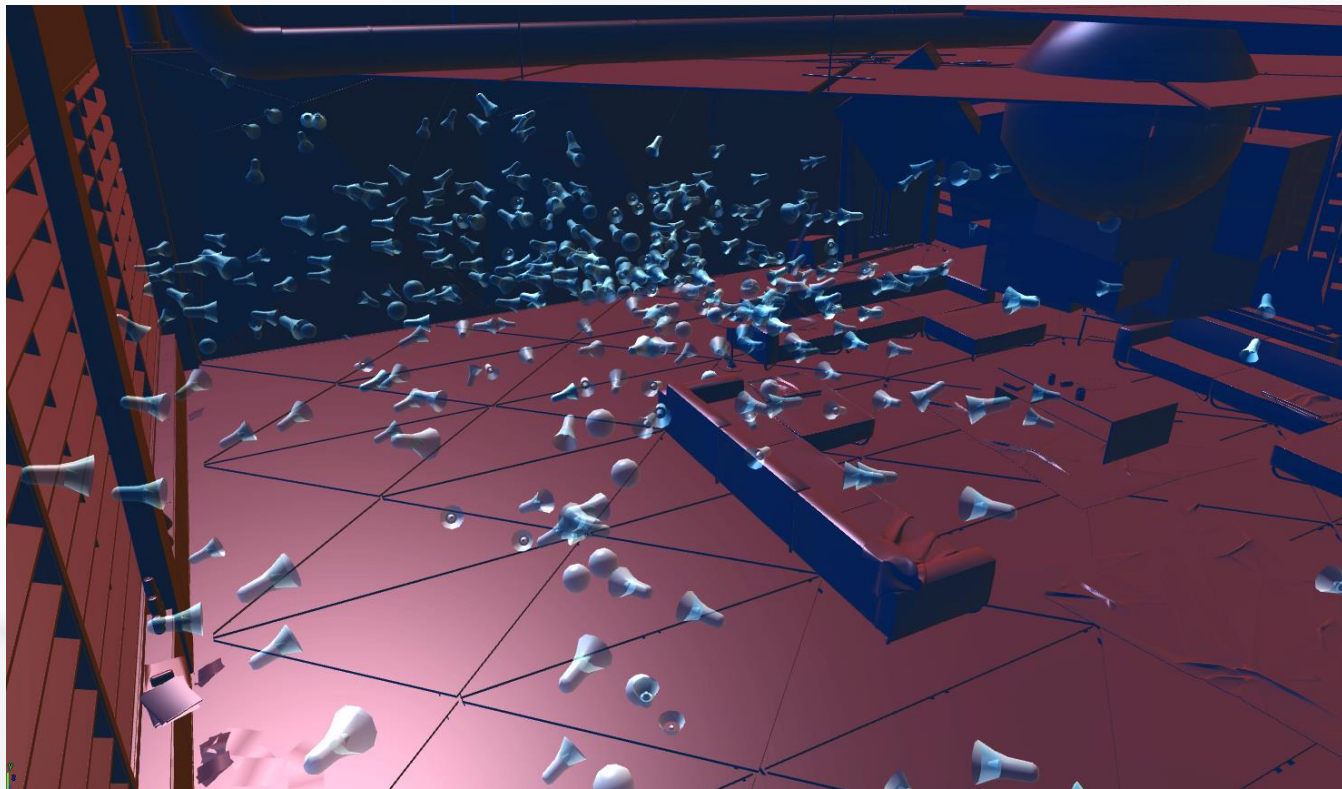
CINEMATICS
LIGHTING

- Used a lot of lights

CINEMATICS
LIGHTING

- Used a lot of lights

  - 472 for this scene

CINEMATICS
LIGHTING

- Attached lights to camera track

Key light

Work In Progress Visuals

CINEMATICS
LIGHTING

Background light

Work In Progress Visuals

CINEMATICS
LIGHTING

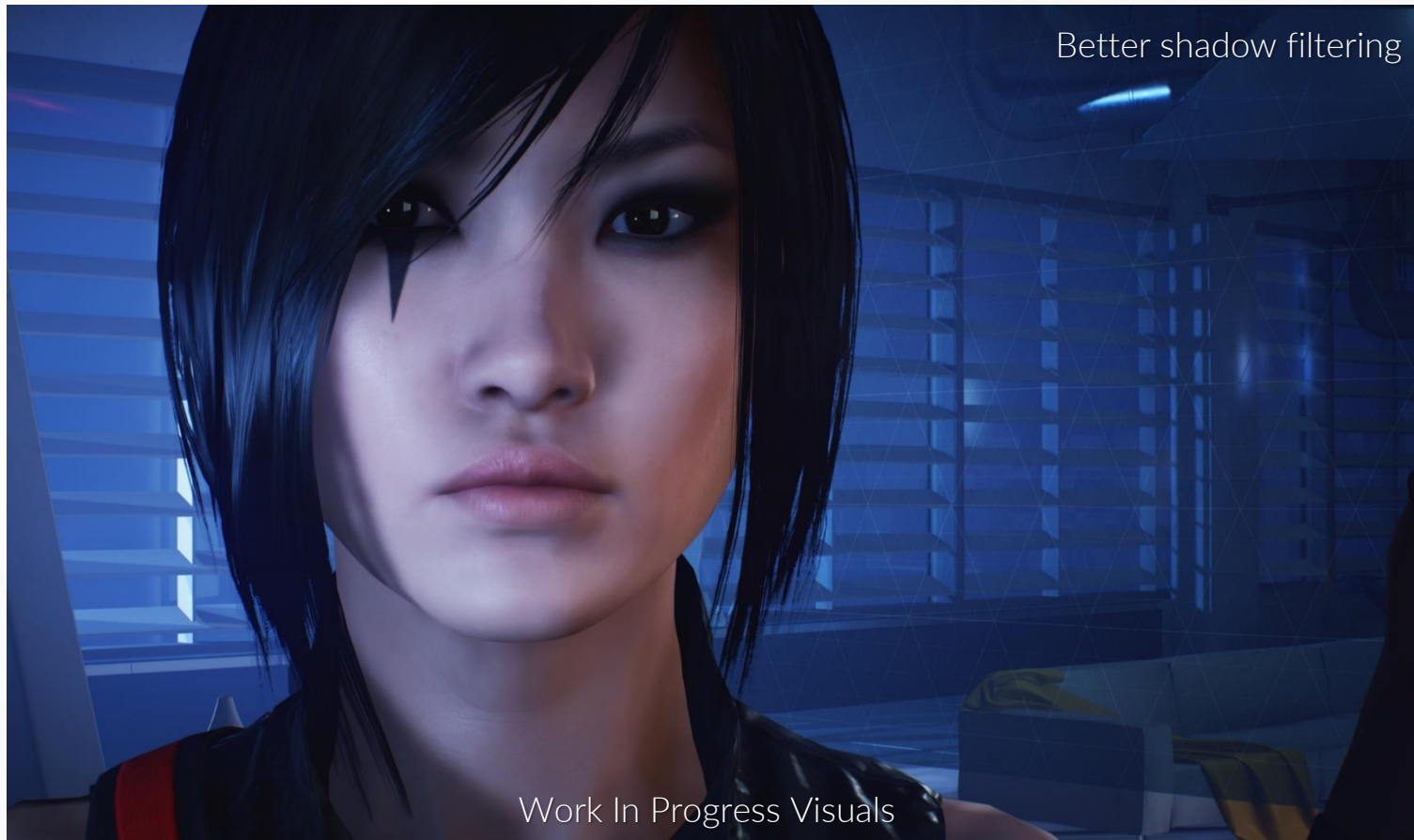Top Fill light

Work In Progress Visuals

CINEMATICS
LIGHTING

Rim light

Work In Progress Visuals

CINEMATICS
LIGHTING

Better shadow filtering

Work In Progress Visuals

CINEMATICS
LIGHTING

Emissive shapes for bokeh

Work In Progress Visuals

CONCLUSION

- Know your PBR
  - Work with references
  - Respect the ground rules: Dynamic Lighting doesn't forgive

- Break your PBR
  - Make up for inaccuracies
  - Enhance the visuals

- Stay in control!
  - Do not use the wrong fix for the wrong problem

- The result is what matters

THANKS

- The entire Mirror's Edge team

  - Anton Palmqvist / Lighting Artist
  - Karl Stjernberg / Lighting Artist
  - Ben Hutchings / Cutscene Lighting Artist
  - Hus Zekayi / Cutscene Lighting Artist

  - Jhony Ljungstedt / Art Director
  - Mikael Linderholm / Technical Art Director

  - Yasin Uludag / Graphics Programmer
  - Mikael Uddholm / Graphics Programmer
  - Mark Scheurwater / Software Engineer
  - Michael Lidgren / Software Engineer

- Frostbite Rendering team

- Gustav Bodare and Edvard Sandberg for the Physical Sky

QUESTIONS?

fabien.christin@dice.se