



**NVIDIA**®

## **Performance Tools**

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# Performance Tools Agenda



- **Problem statement**
- **NVIDIA Solution:**
  - **NVPerfKit 2.0**
  - **NVShaderPerf**
- **NVPerfHUD 4.0 Demo**

# What's The Problem?



- Why is my app running at 13FPS after CPU tuning?
- How can I determine what is going on in that GPU?
- How come IHV engineers are able to figure it out?

# NVPerfKit 2.0 package



## ● Instrumented Driver

- Exposes Driver and GPU performance counters
- GLExpert, a debug runtime for OpenGL

## ● NVPerfSDK

- NVPerfAPI for accessing GPU signals in your applications
- Sample code for OpenGL(tm) and DirectX(tm) applications
- NVIDIA Developer Control Panel

## ● Tools

- NVPerfHUD 4
- NVIDIA Plug-in for Microsoft PIX for Windows
- gDEBbugger (30-day trial version)
- Any tool using Windows PDH (VTune,...)

# Old Architecture

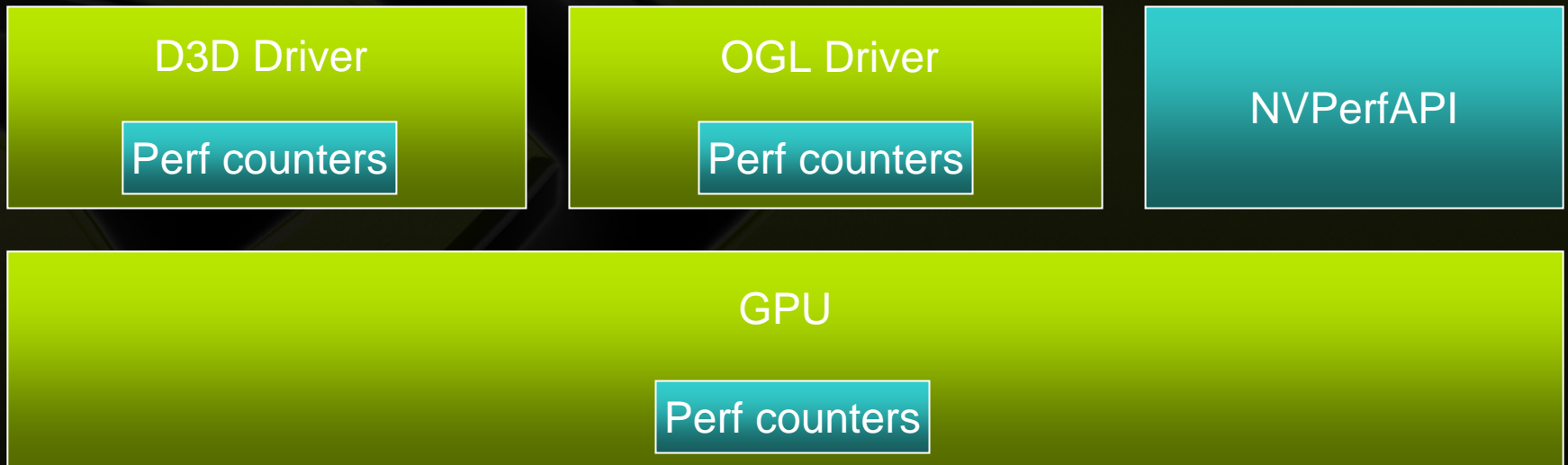


D3D Driver

OpenGL Driver

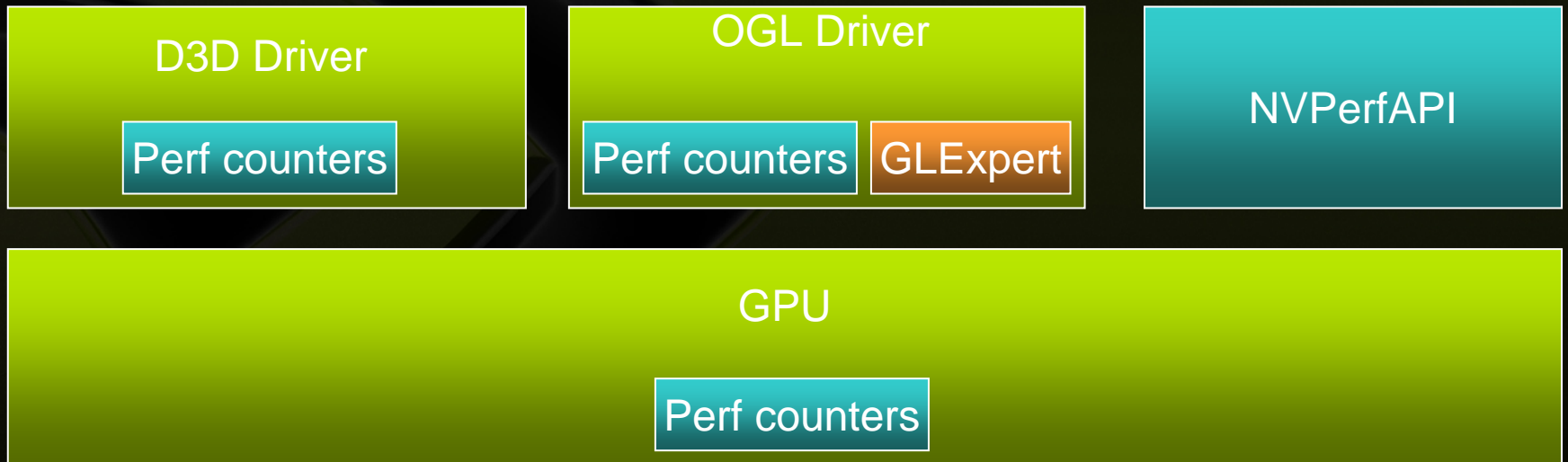
GPU

# NVPerfKIT 2.0 Architecture



- GPU counters available only in GeForce 6 and 7 series

# NVPerfKIT 2.0 Architecture

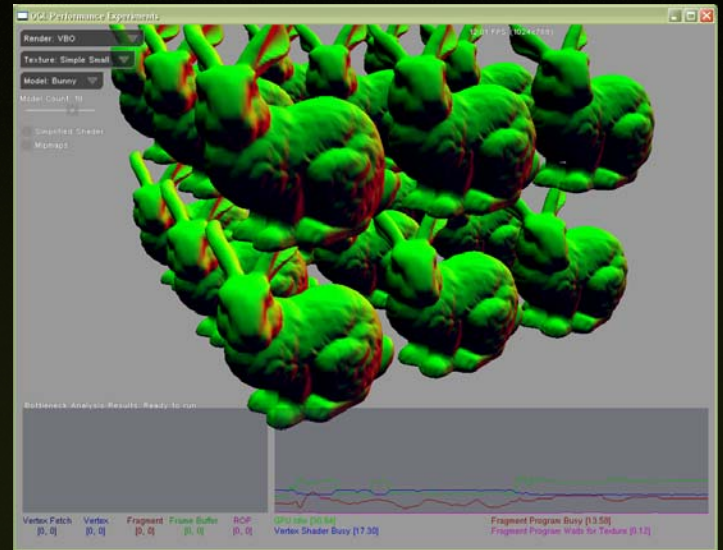


# NVPerfKIT 2.0 Architecture



NVPerfAPI

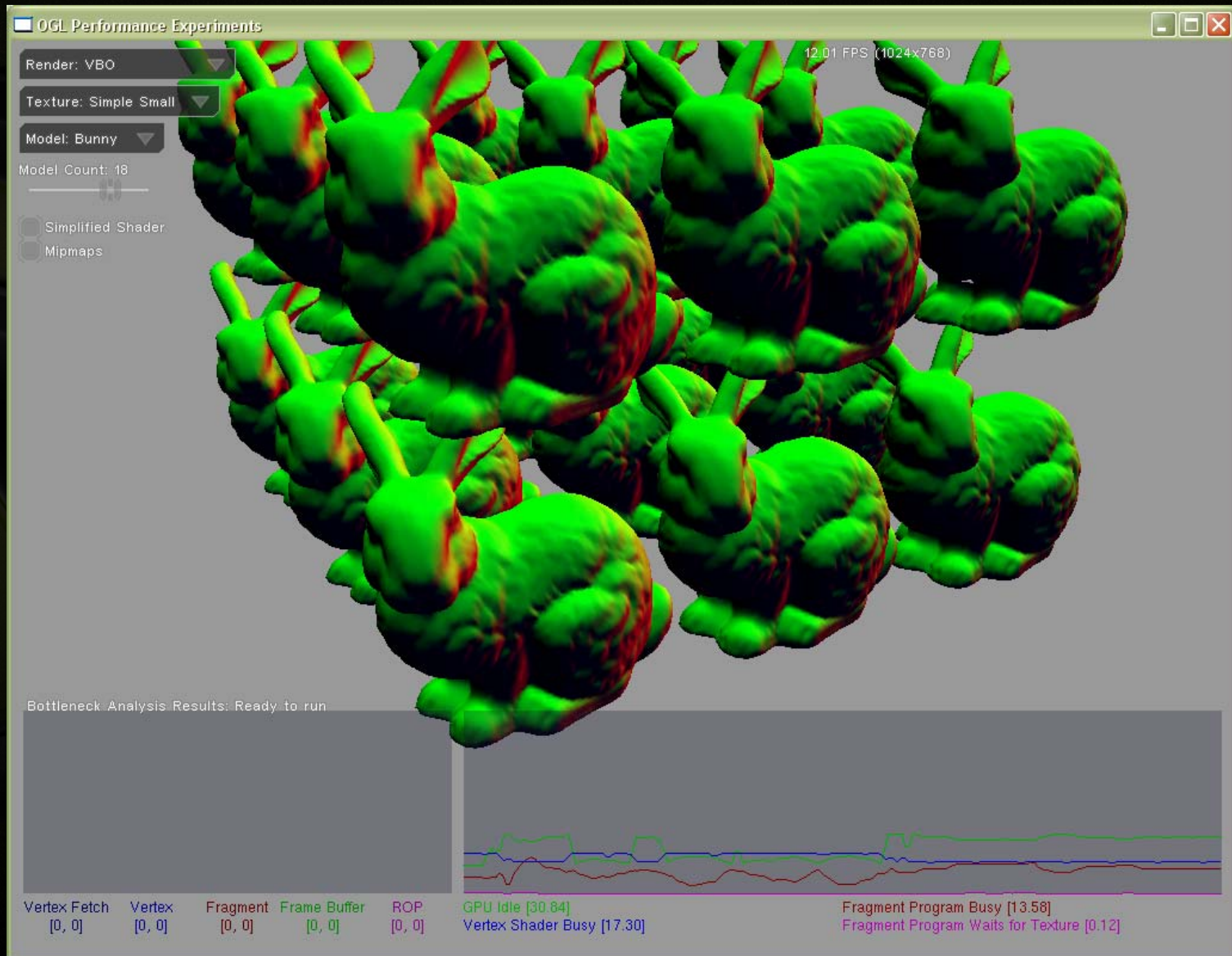
# NVPerfKIT 2.0 Architecture



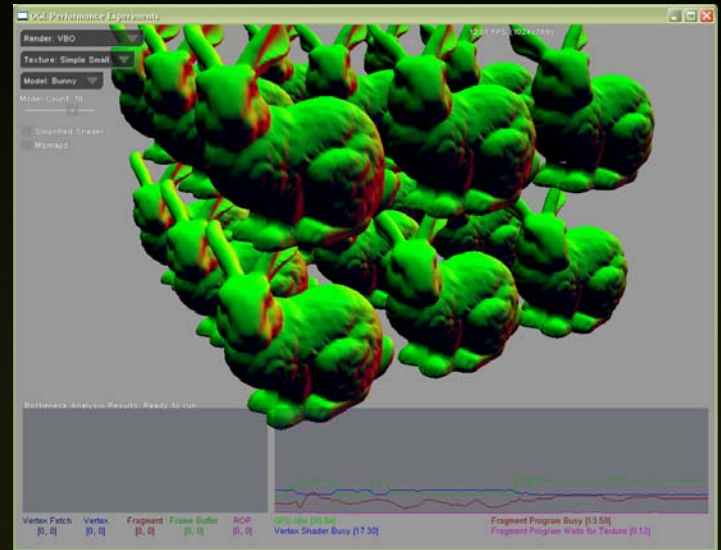
SDK /  
your  
application

NVPerfAPI

# NVPerfKIT 2.0 Architecture



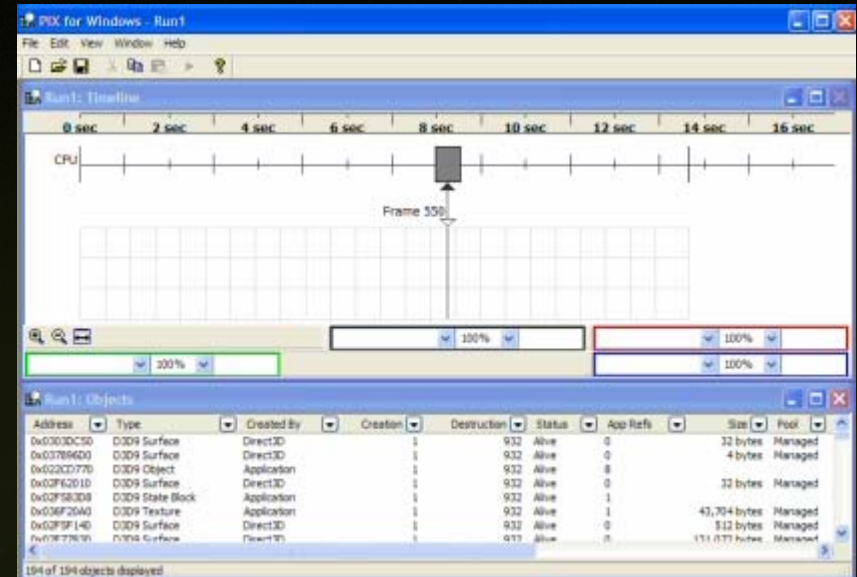
# NVPerfKIT 2.0 Architecture



SDK /  
your  
application

NVPerfAPI

# NVPerfKIT 2.0 Architecture



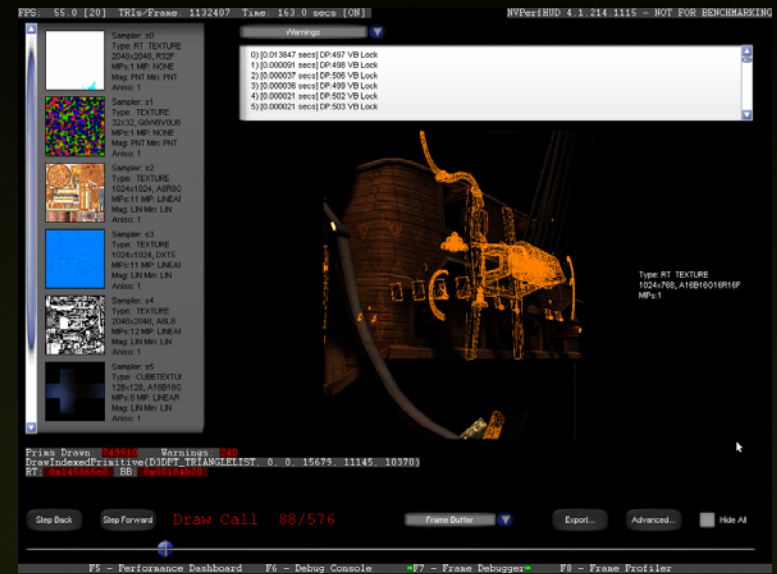
SDK /  
your  
application

Microsoft PIX  
for Windows

PIX Plug in

NVPerfAPI

# NVPerfKIT 2.0 Architecture



SDK /  
your  
application

Microsoft PIX  
for Windows

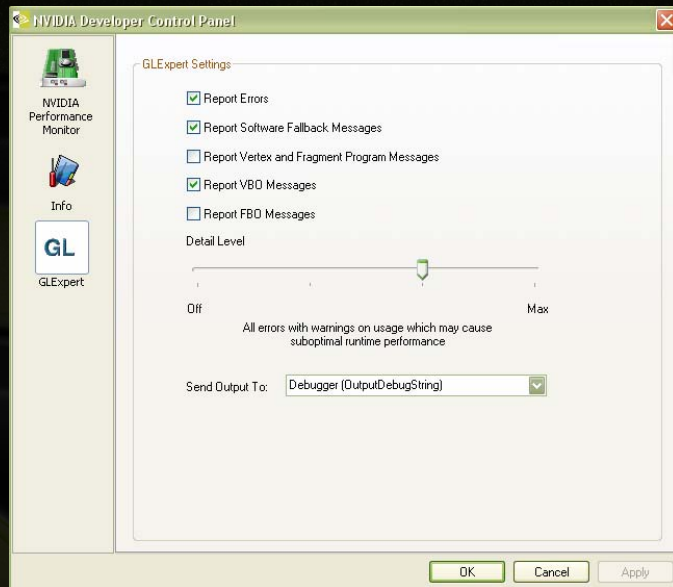
PIX Plug in

NVPerfHUD  
4.0

NVPerfAPI



# NVPerfKIT 2.0 GLExpert



NVPerfSDK / Your application

graphic REMEDY  
gDEDebugger

OpenGL Driver

GLExpert

# GLExpert: What is it?



- **Helps eliminate performance issues on the CPU**
- **OpenGL portion of the Instrumented Driver**
  - **Output information to console/stdout or debugger**
  - **Different groups and levels of information detail**
- **Controlled using tab in NVDevCPL**
- **What it can do (today)**
  - **GL Errors: print when they are raised**
  - **Software Fallbacks: indicate when the driver is in fall back**
  - **GPU Programs: errors during compile or link**
  - **VBOs: show where they reside, mapping details**
  - **FBOs: print reasons a configuration is unsupported**
- **Feature list to grow with future drivers**

# NVShaderPerf 1.8



- Run numbers and performance estimates without having the hardware or the driver

- **Inputs:**

- **Shader Code:**

- GLSL, HLSL, Cg, !FP1.0, ARBfp1.0, VSx.x, PSx.x

- **GPU Arch:**

- GeForce 7X00, GeForce 6X00, Geforce/Quadro FX series

- **Outputs:**

- Resulting assembly code
  - # of cycles
  - # of temporary registers
  - Pixel throughput
  - Test all fp16 and all fp32

# NVPerfAPI: D3D/OpenGL Perf Counters



## ● General

- FPS
- ms per frame

## ● Driver

- Driver frame time (total time spent in driver)
- Driver sleep time (waiting for GPU)

## ● Counts

- Triangles
- Instanced triangle
- Batches
- Locked render targets (only Direct3D)

## ● Memory

- AGP memory used in MB and bytes
- Video memory used and total in MB and bytes

# NVPerfKit: GPU Counters

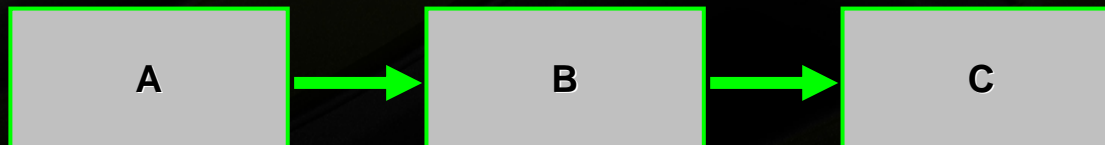


- **Raw counters**

- count vertices, pixels...

- **Simplified experiments**

- Unit bottleneck and utilization
- Require multiple passes



# NVPerfKit: GPU Counters



- **Raw counters**

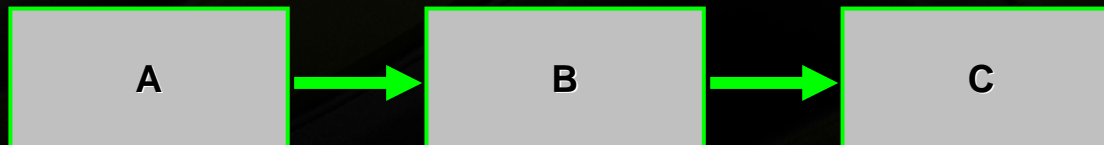
- Count vertices, pixels...

Pix for Windows  
gDebugger  
NVPerfSDK  
PDH

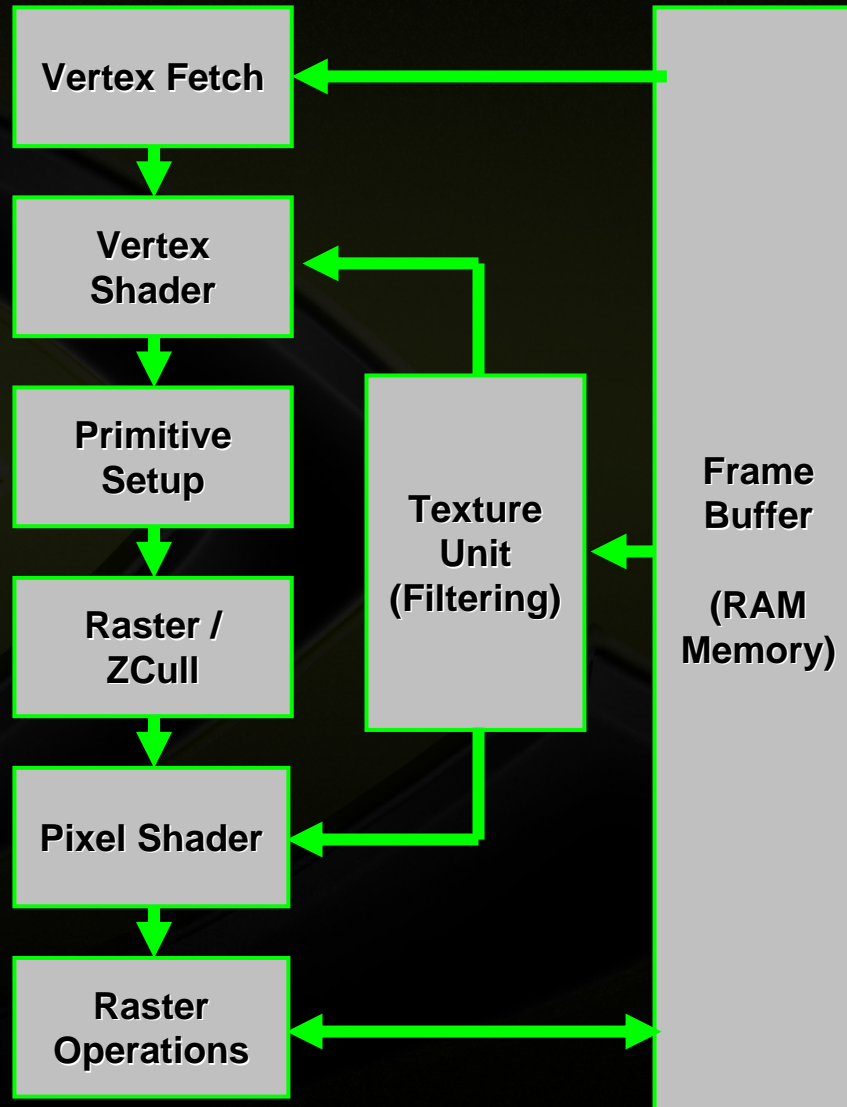
- **Simplified experiments**

- Unit bottleneck and utilization
- Require multiple passes

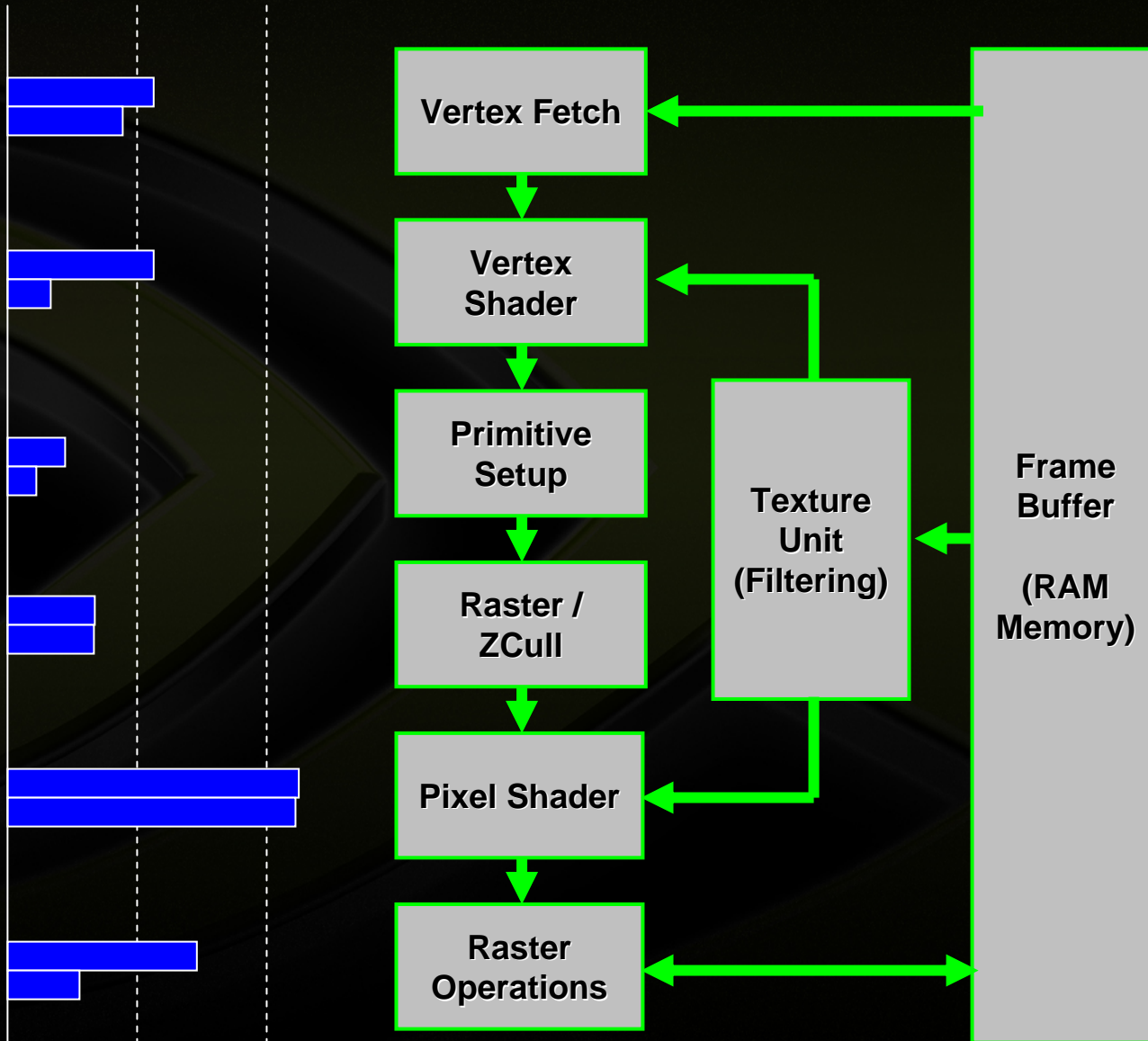
NVPerfHUD 4  
NVPerfSDK



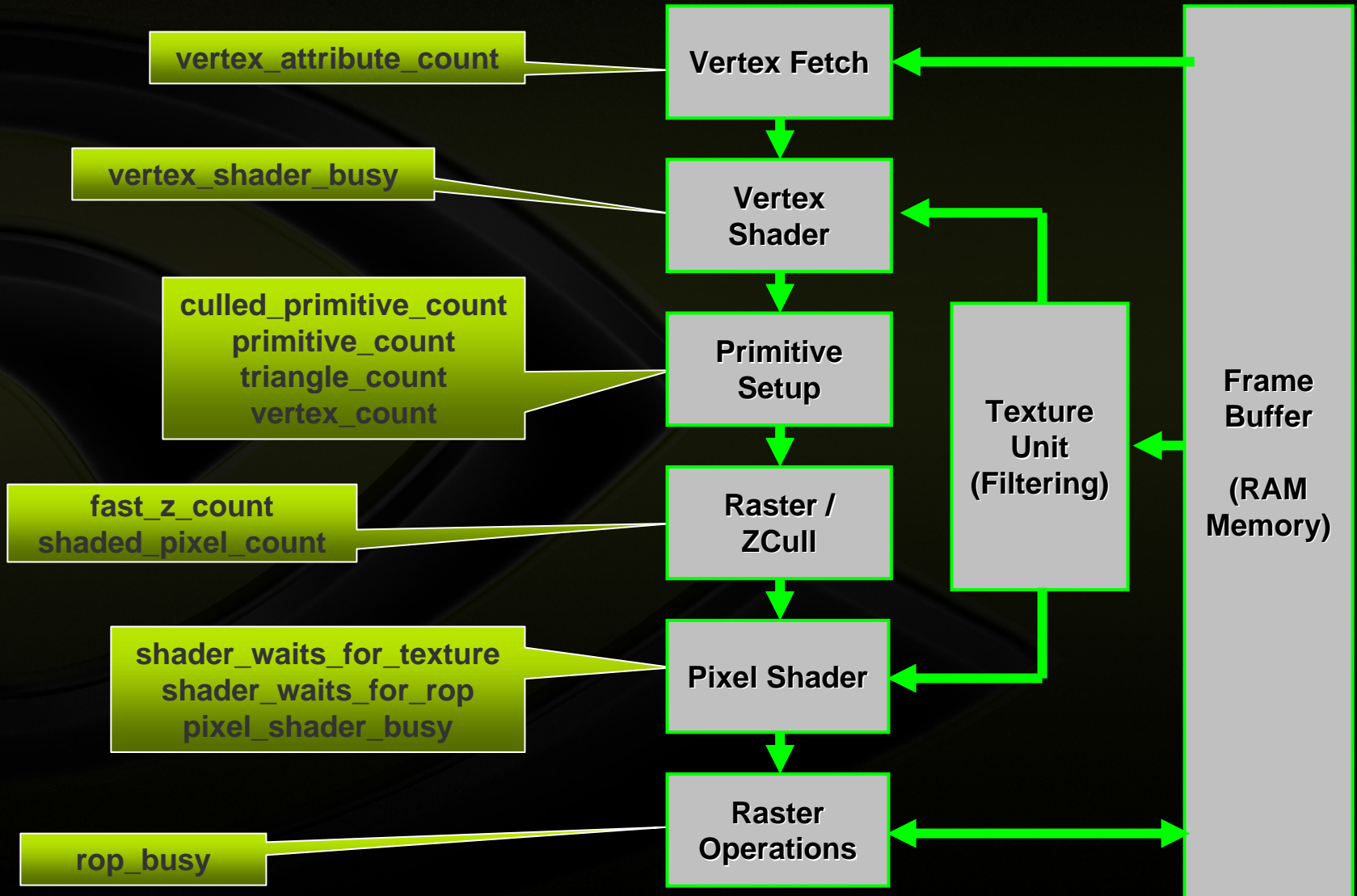
# NVPerfKit: GPU Counters



# NVPerfKit: GPU Counters



# NVPerfKit: GPU Raw Counters



# What is NVPerfHUD?



- **Direct3D PERFORMANCE Heads Up Display**
  - Overlay graphs and debugging tools on top of your application
  - Interactive tools for debugging and performance tuning
- **4 different HUDs**
  - Performance Dashboard
  - Debug Console
  - Frame Debugger
  - Frame Profiler (New in 4.0)

# NVPerfHUD 4.0 Demo

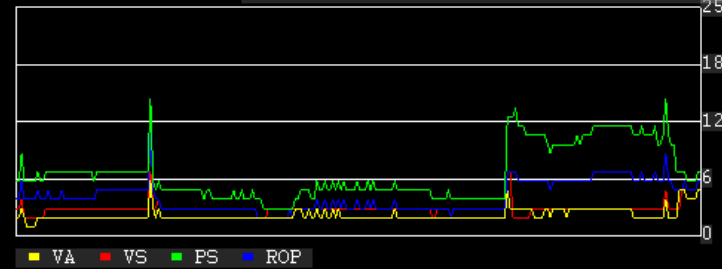


FPS: 52.3 TRIs/Frame: 339400 Time: 28.7 secs  
Speed: ▶ 1.000

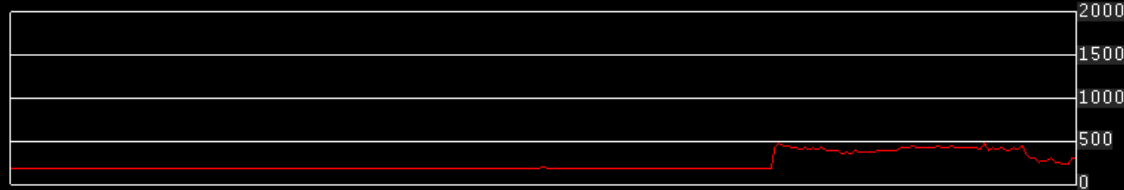
Press F1 for help

NVPerfHUD version: 4.0.321.1500  
NVIDIA driver version: 6.14.10.7772  
App name: C:\Program Files\Futuremark\3DMark03.exe  
■ Handshake with application OK.  
■ WARNING: Forcing NON PURE device  
■ DirectX \*RETAIL\* runtime detected  
■ : NVPMAPI found, enabling extended functionality.

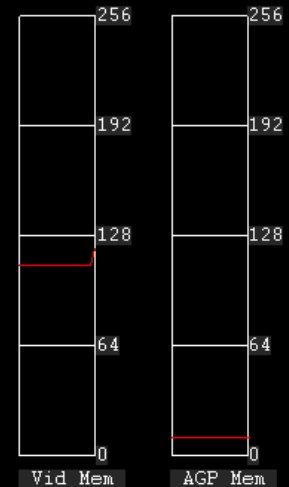
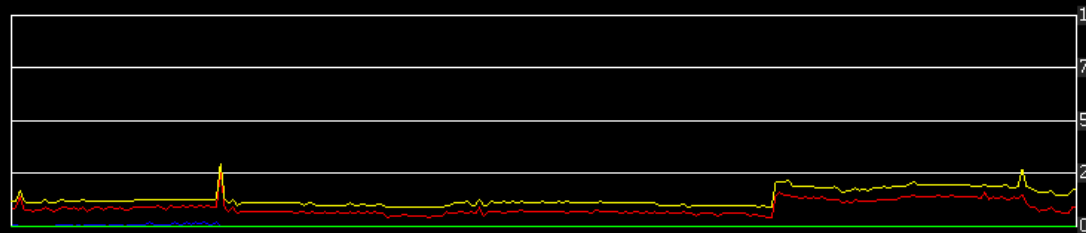
NVPerfHUD 4.0.321.1500 - NOT FOR BENCHMARKING



■ Tex VolTex CubTex ■ VB ■ IB RT DSS

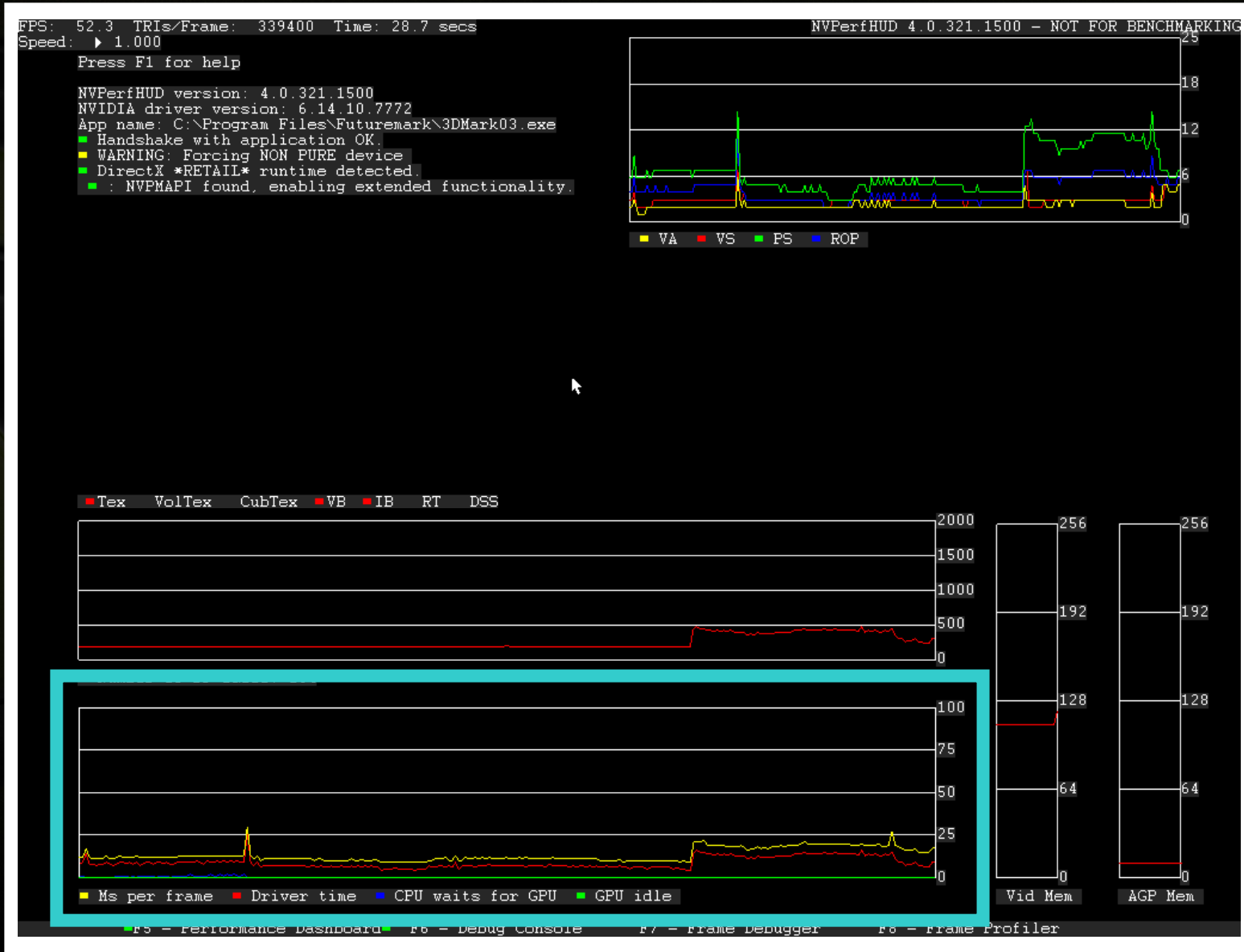


■ Number of DP calls: 184

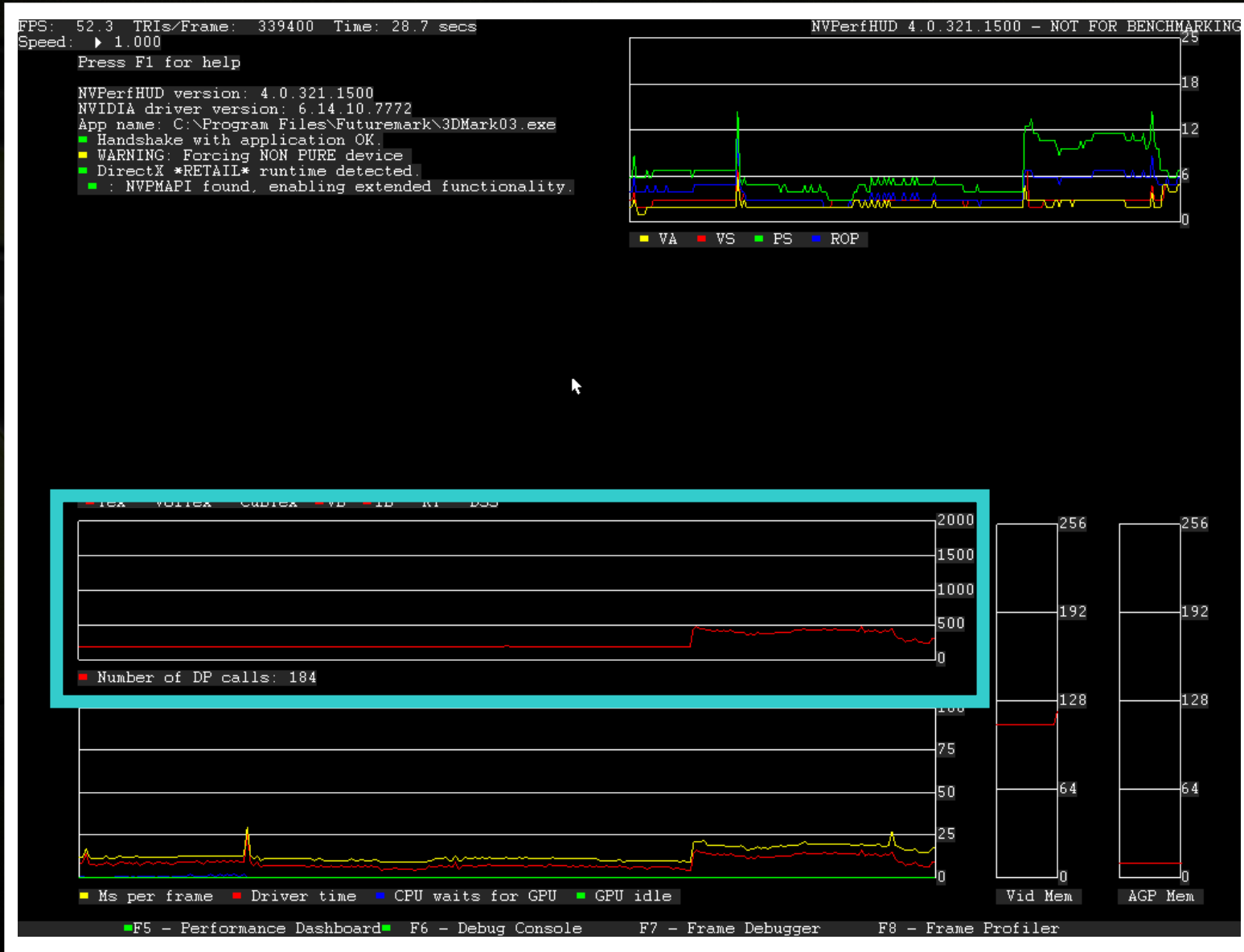


■ F5 - Performance Dashboard ■ F6 - Debug Console F7 - Frame Debugger F8 - Frame Profiler

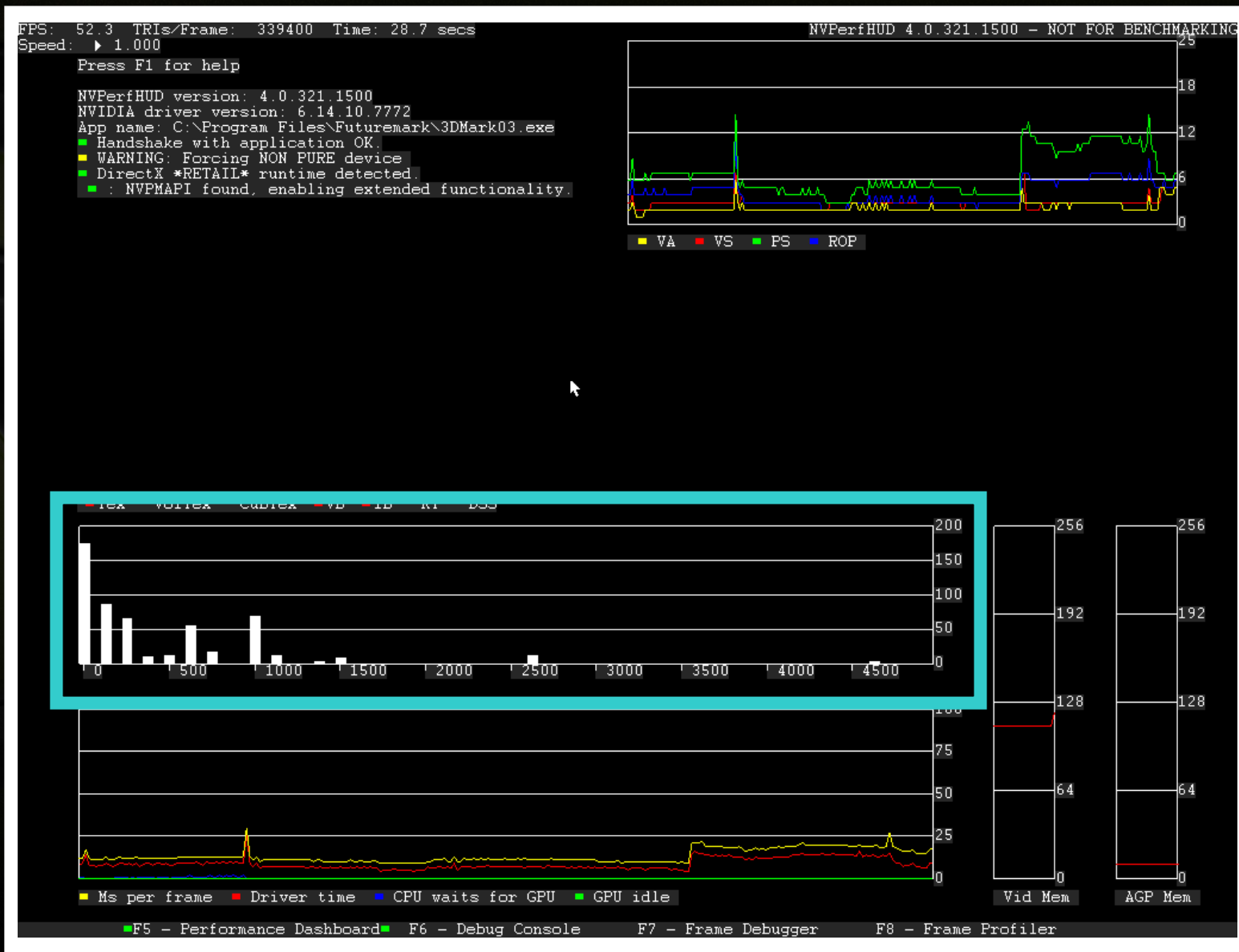
# Demo: Performance Dashboard



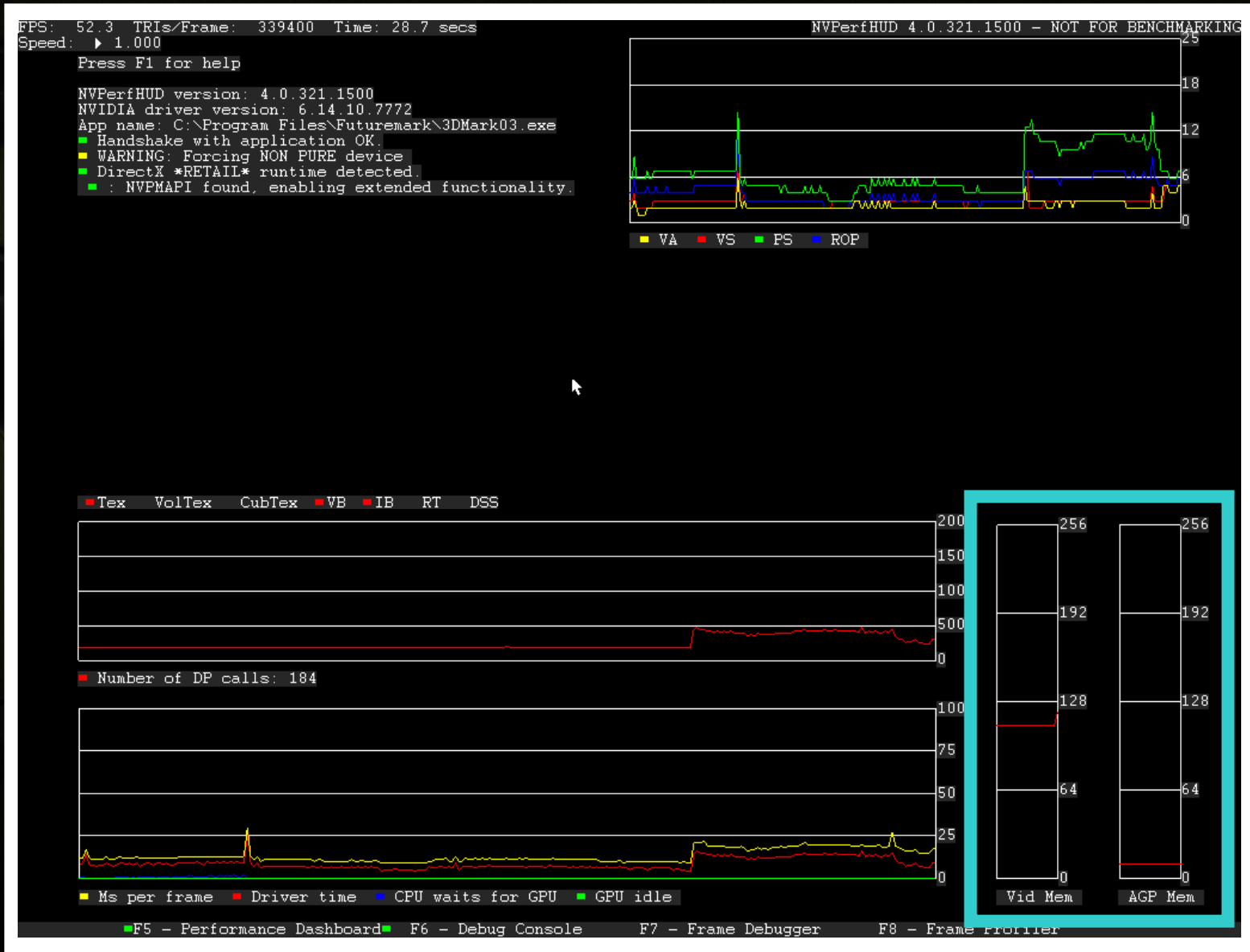
# Demo: Performance Dashboard



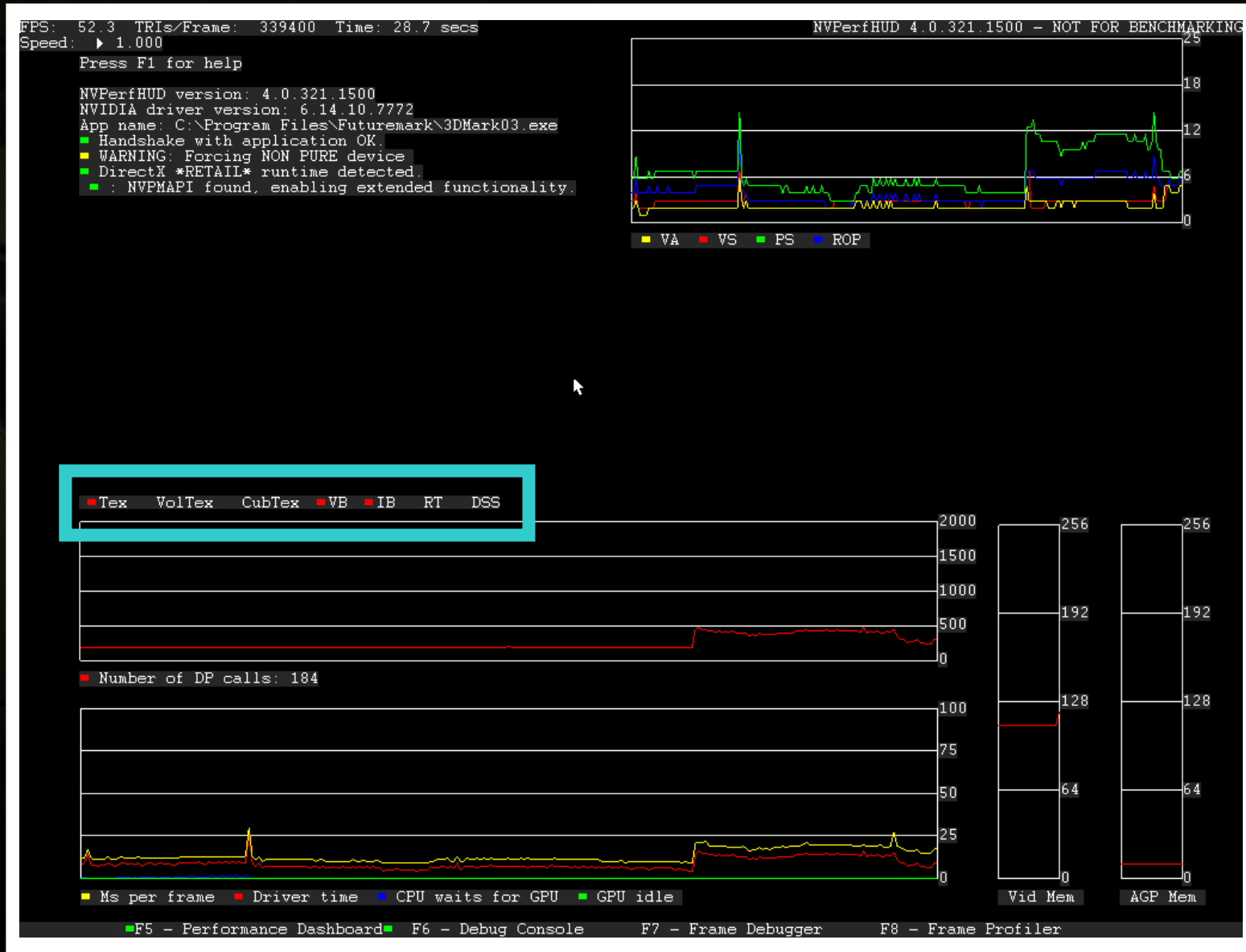
# Demo: Performance Dashboard



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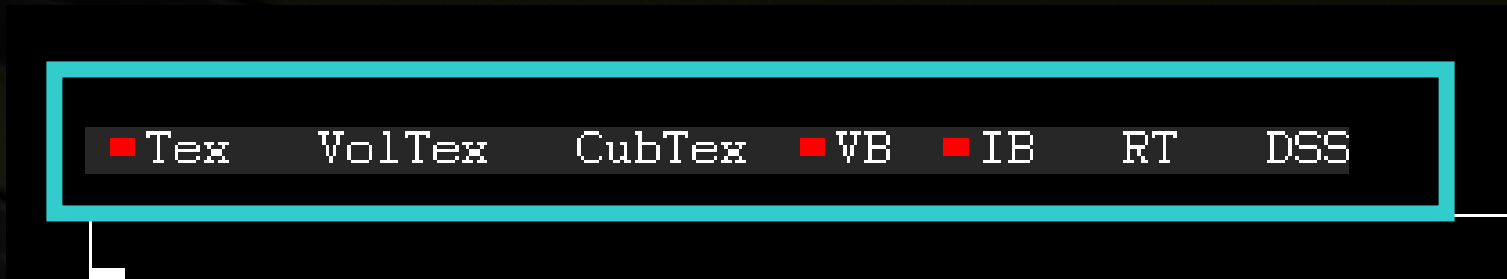
# Demo: Performance Dashboard



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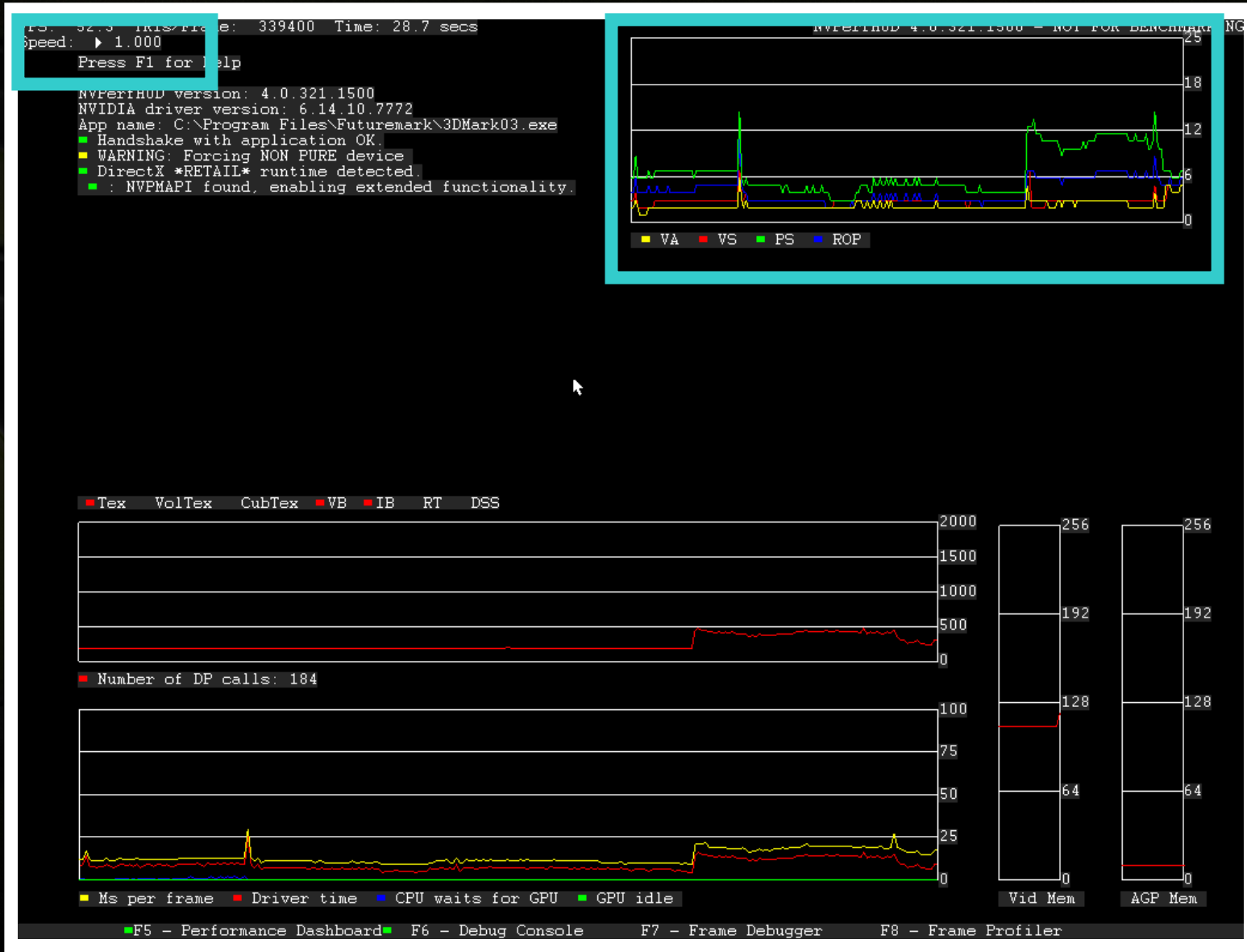


Resource creation monitor



- **Resources monitored**
  - Textures
  - Volume Textures
  - Cube textures
  - Vertex Buffers
  - Index buffers
  - Stencil and depth surfaces

# Demo: Performance Dashboard



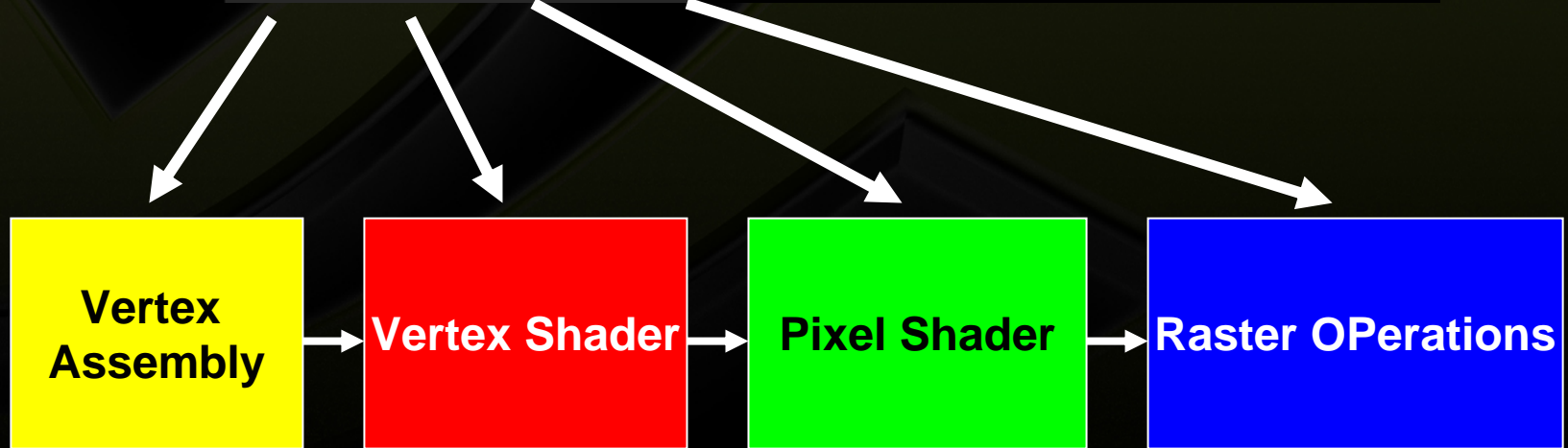
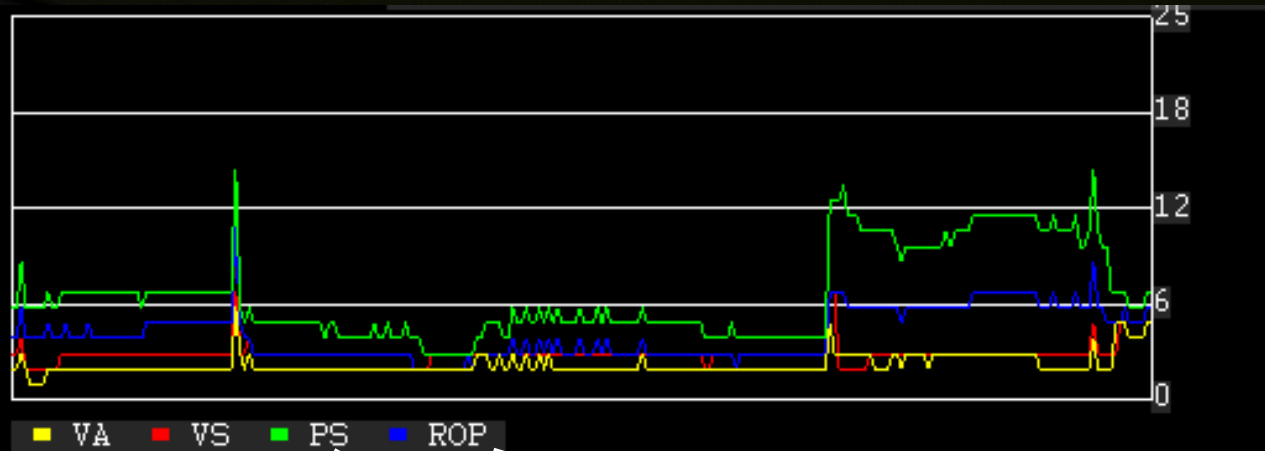
# Demo: Performance Dashboard



Speed control

```
FPS: 52.5 TRIS/Frame: 339400 Time: 28.7  
Speed: ▶ 1.000  
Press F1 for help  
  
NVPerfHUD version: 4.0.321.1500  
NVIDIA driver version: 6.14.10.7772  
App name: C:\Program Files\Futuremark\
```

# Demo: The simplified graphics pipeline



# Freezing the application



- Only possible if the application uses time-based animation
- $Pos += V * DeltaTime$
- Stop the clock
  - Intercept: `QueryPerformanceCounter()`, `timeGetTime()`
  - NO RDTSC!!

# Project Status



- **NVPerfKit 2.0 available NOW!**
  - Take it now from: <http://developer.nvidia.com/NVPerfKit>
  - Windows XP (Rel 85), Linux (beta)
- **NVPerfKit 2.1, available SIGGRAPH06**
  - Next generation drivers (Rel 95)
  - Windows XP and Linux (32bit and 64bit)
- **What types of things are interesting?**

[NVPerfKit@nvidia.com](mailto:NVPerfKit@nvidia.com)

# Questions?



## ● Online:

- <http://developer.nvidia.com/NVPerfKit>
- <http://developer.nvidia.com/NVPerfHUD>

[NVPerfKIT@nvidia.com](mailto:NVPerfKIT@nvidia.com)

[NVPerfHUD@nvidia.com](mailto:NVPerfHUD@nvidia.com)

[NVShaderPerf@nvidia.com](mailto:NVShaderPerf@nvidia.com)

[FXComposer@nvidia.com](mailto:FXComposer@nvidia.com)