Profiling in Depth

Do you know where your code is?

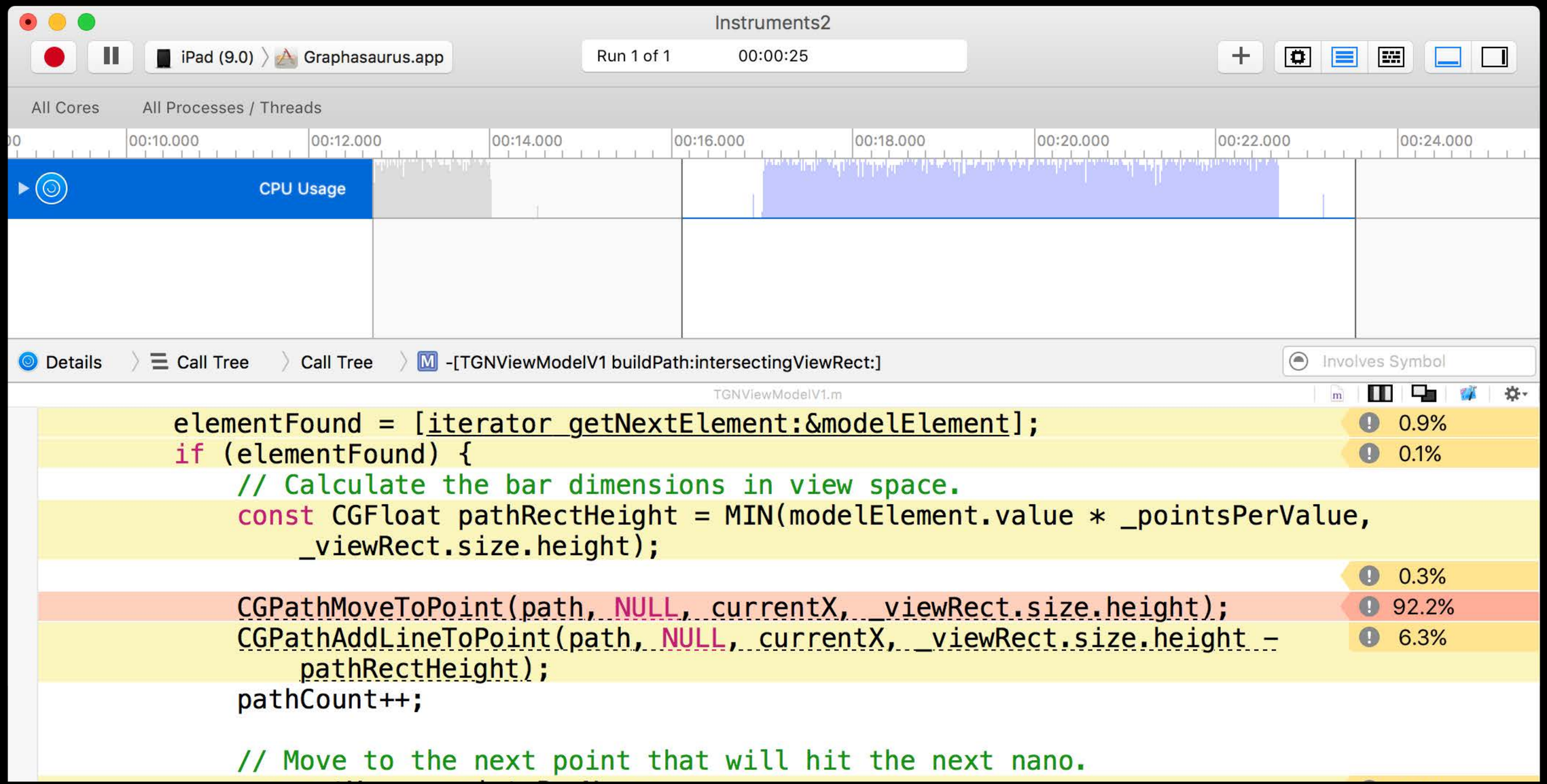
Session 412

Kris Markel Performance Tools Engineer
Chad Woolf Performance Tools Engineer

Time Profiler

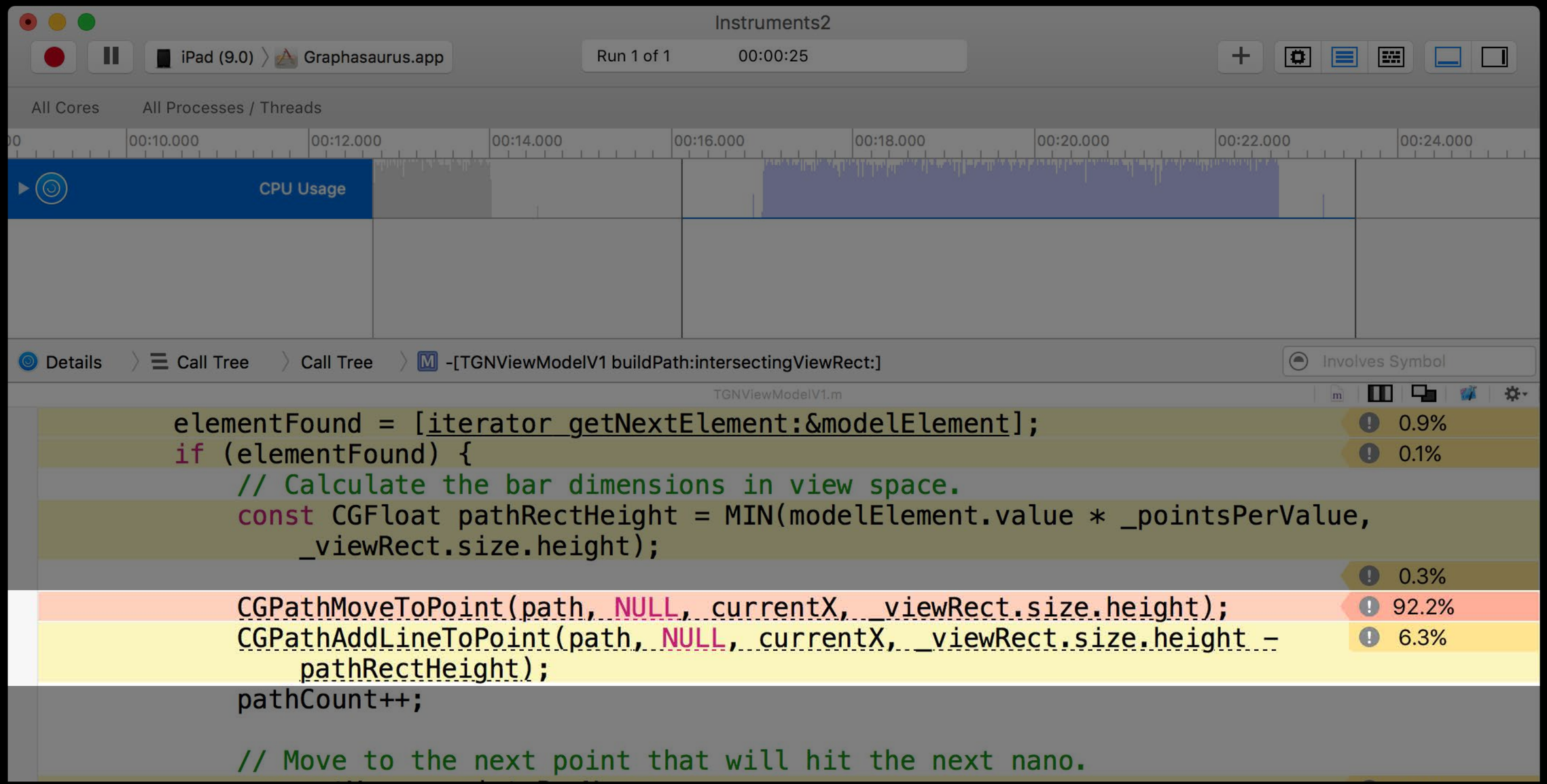
Time Profiler

Hotspots



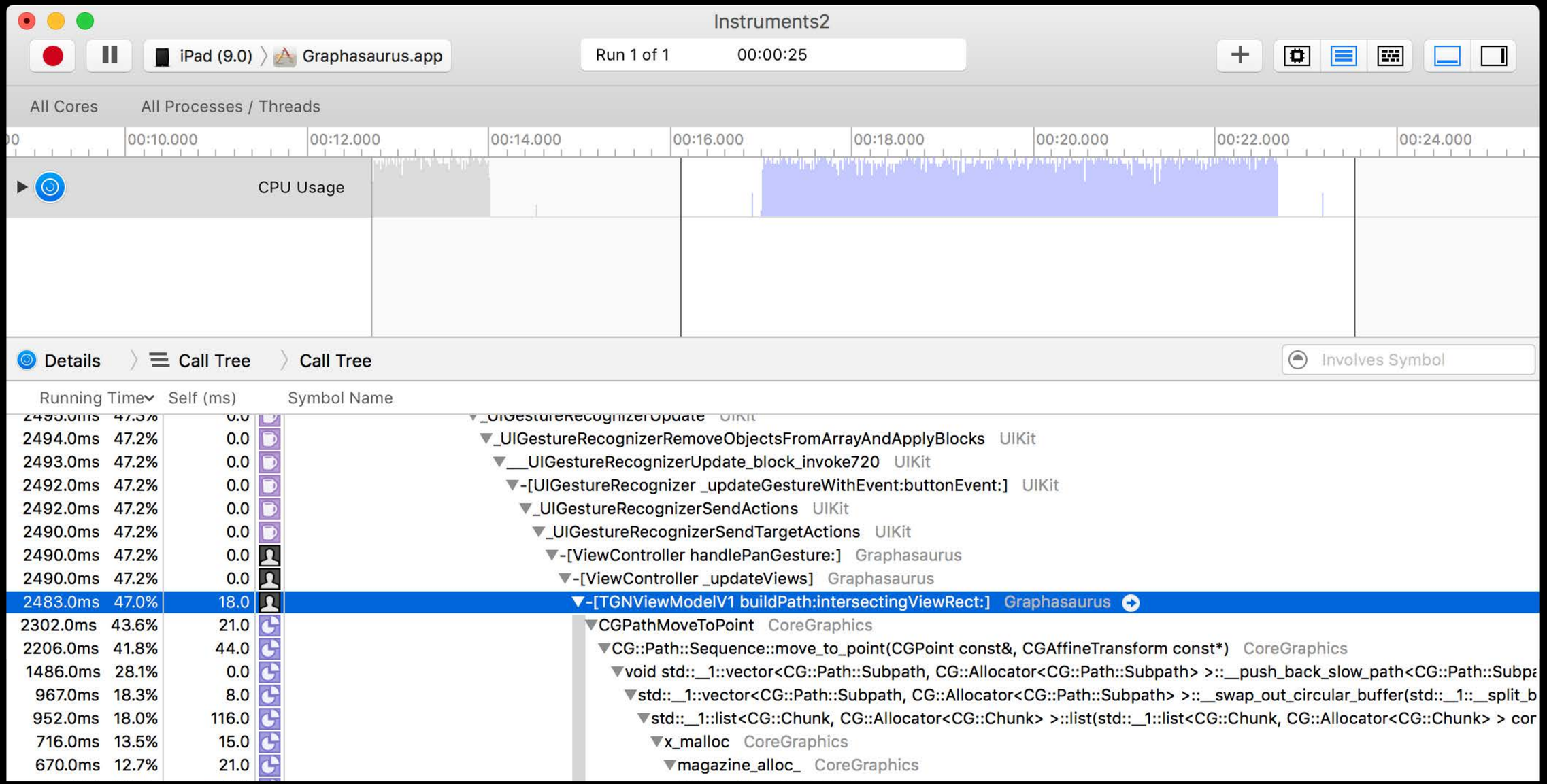
Time Profiler

Hotspots



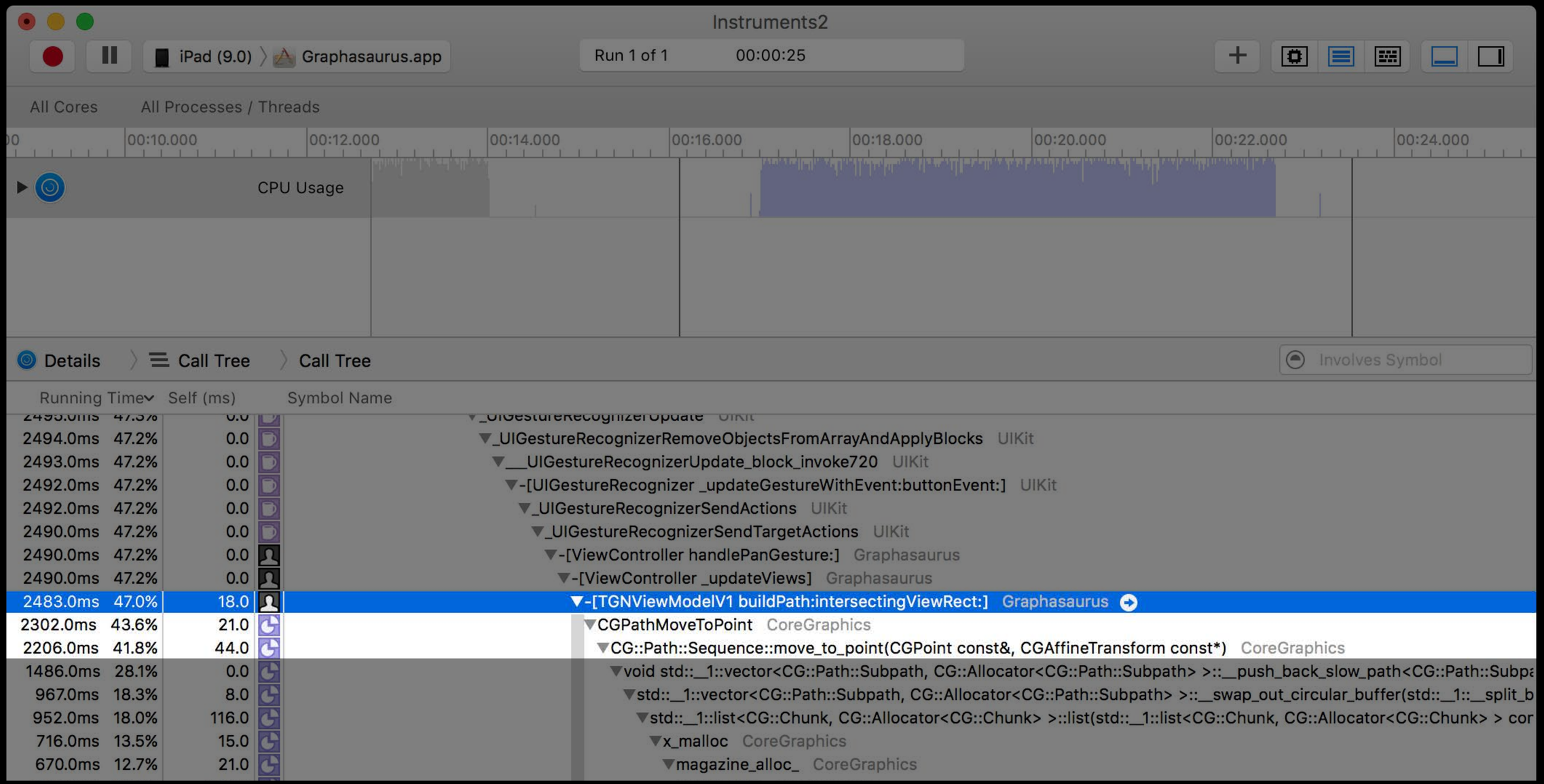
Time Profiler

Call Trees



Time Profiler

Call Trees



Session Overview

Time profiling in depth

Session Overview

Time profiling in depth

Motivation

Session Overview

Time profiling in depth

Motivation

Demonstrations/Insights

Session Overview

Time profiling in depth

Motivation

Demonstrations/Insights

Final tips

Creating Instruments 7

Creating Instruments 7

Look and feel

Creating Instruments 7

Look and feel

New graphing styles

Creating Instruments 7

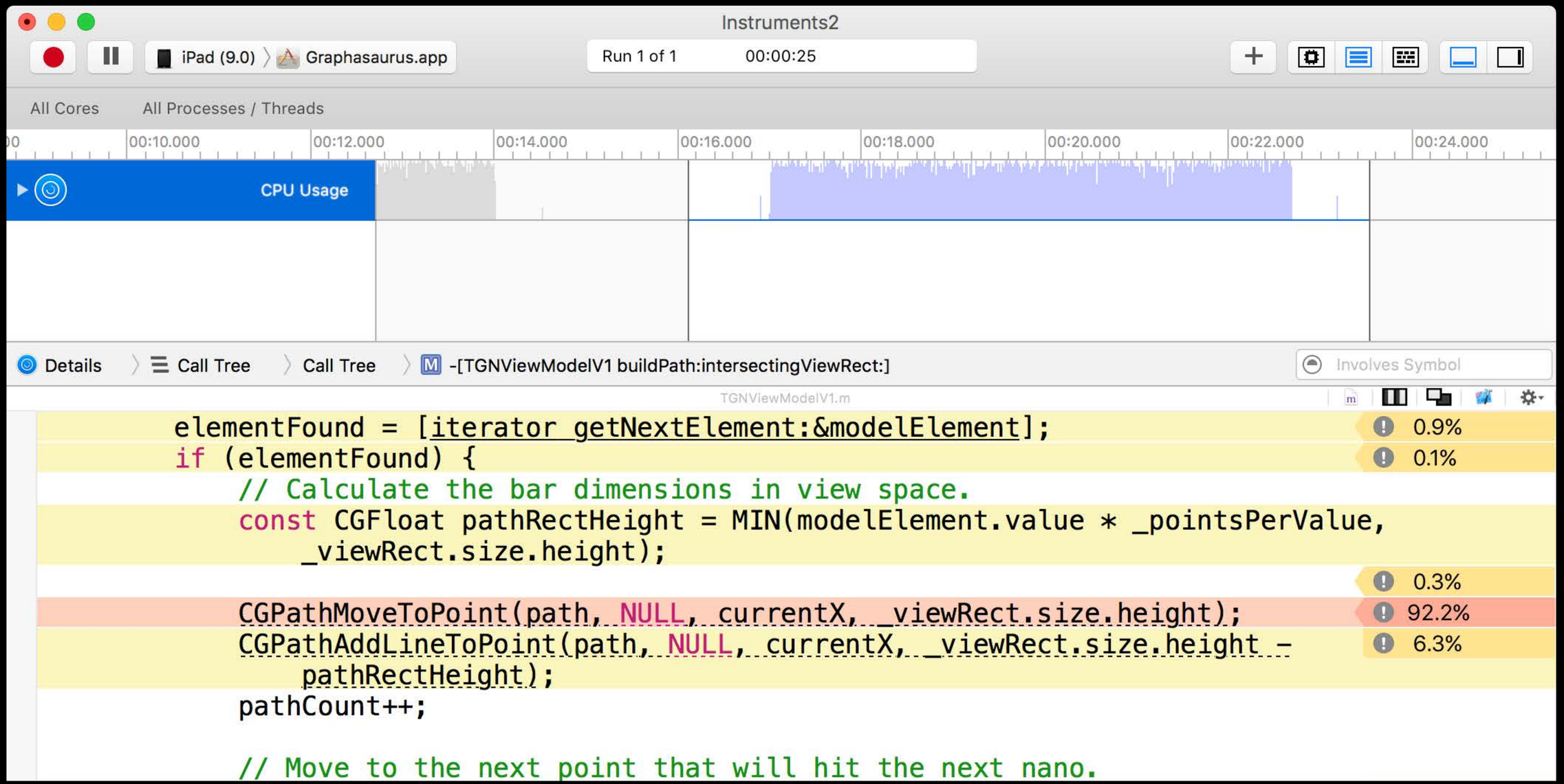
Look and feel

New graphing styles

Faster rendering

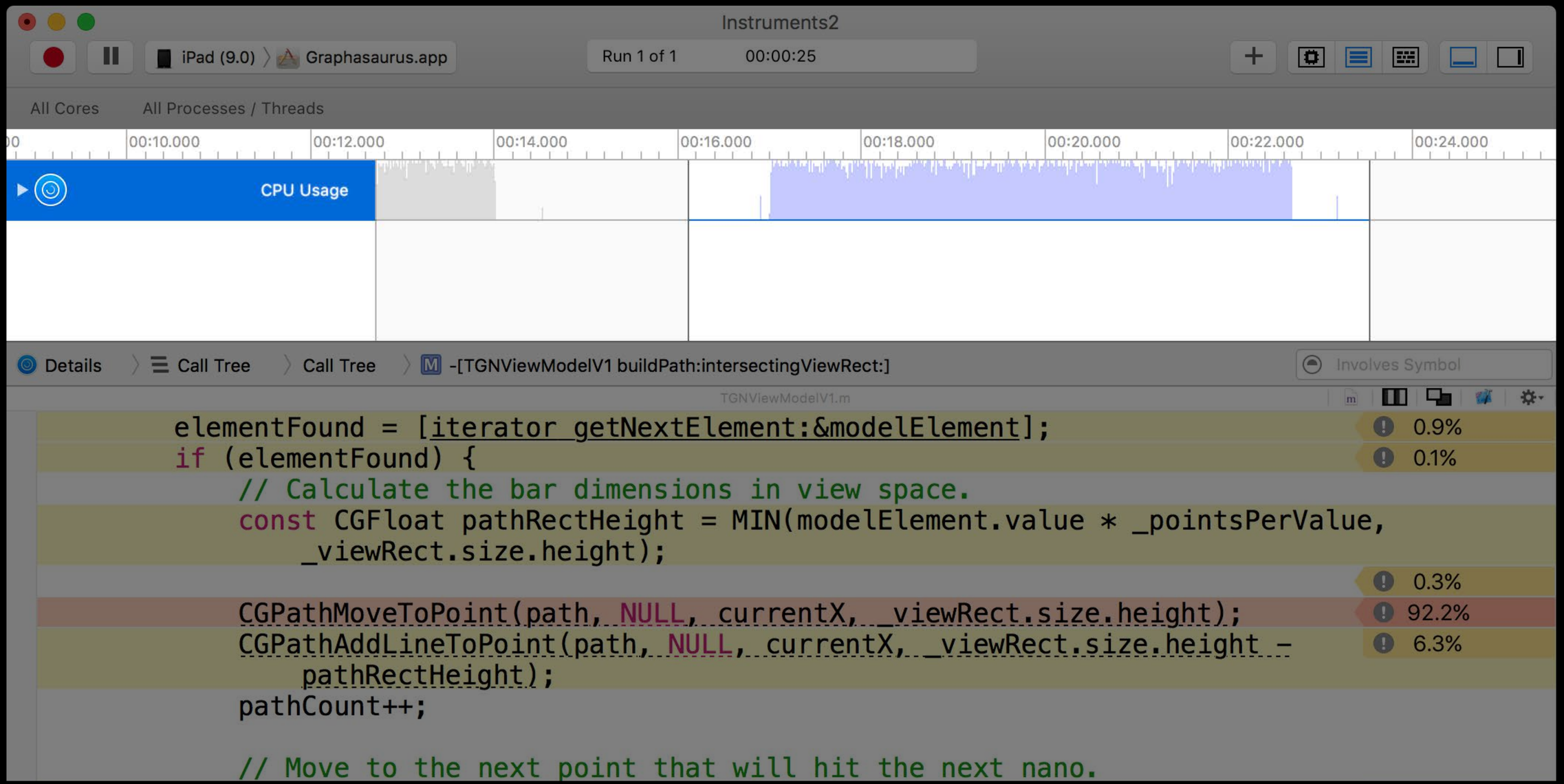
Creating Instruments 7

Track View



Creating Instruments 7

Track View

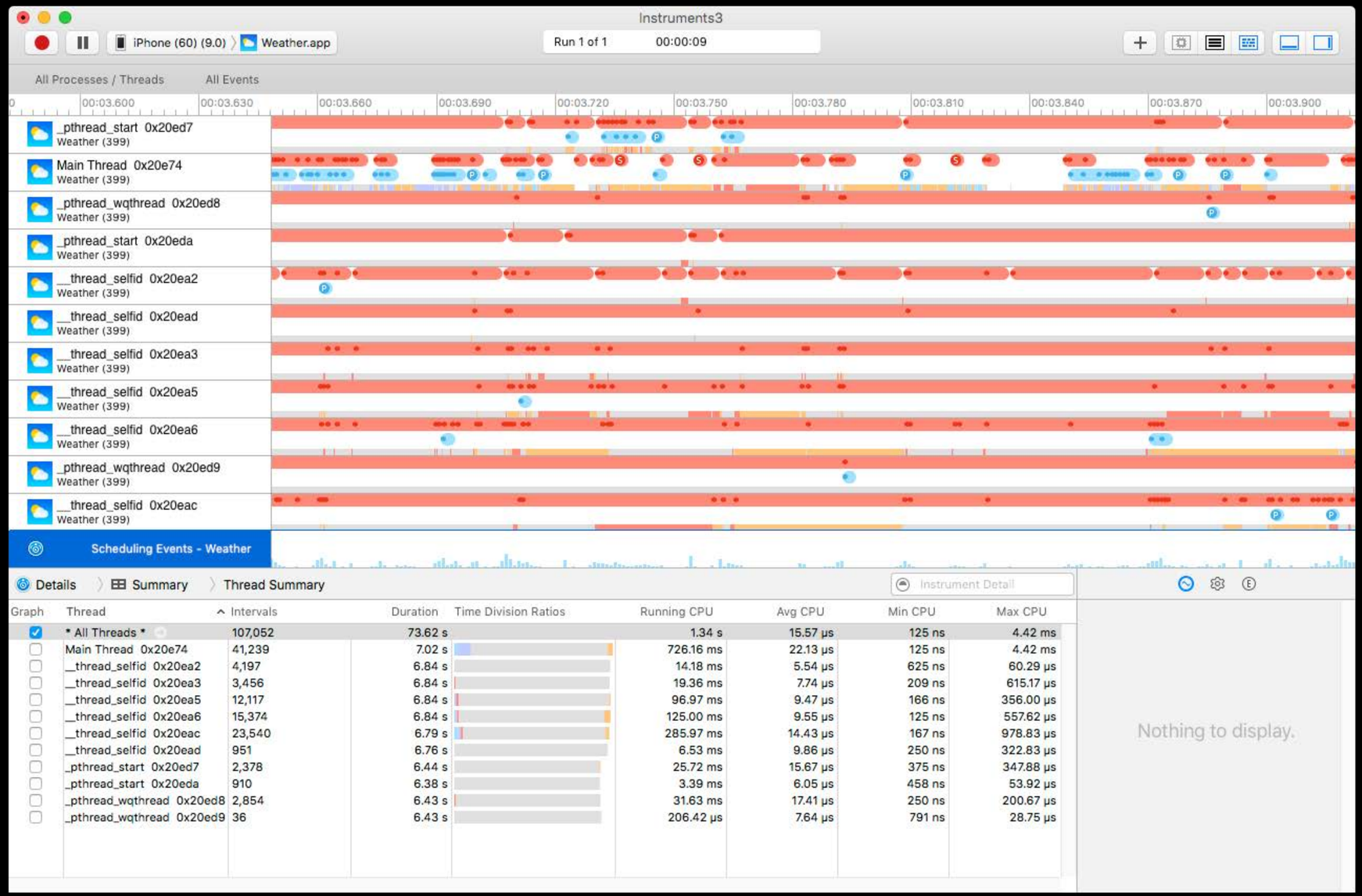


Creating Instruments 7

Prototyping

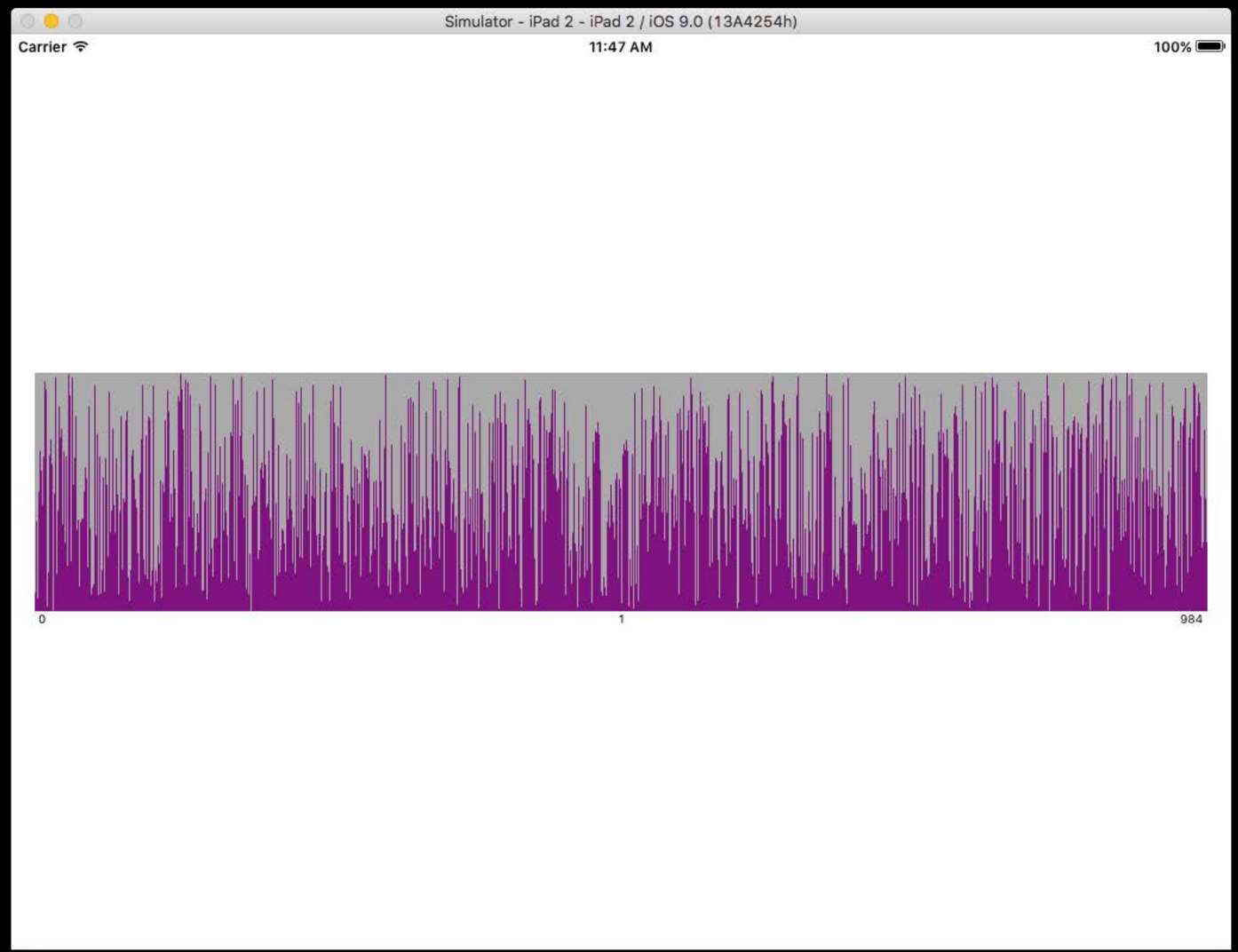
Creating Instruments 7

Integration



Graphasaurus

All the other cool names were taken



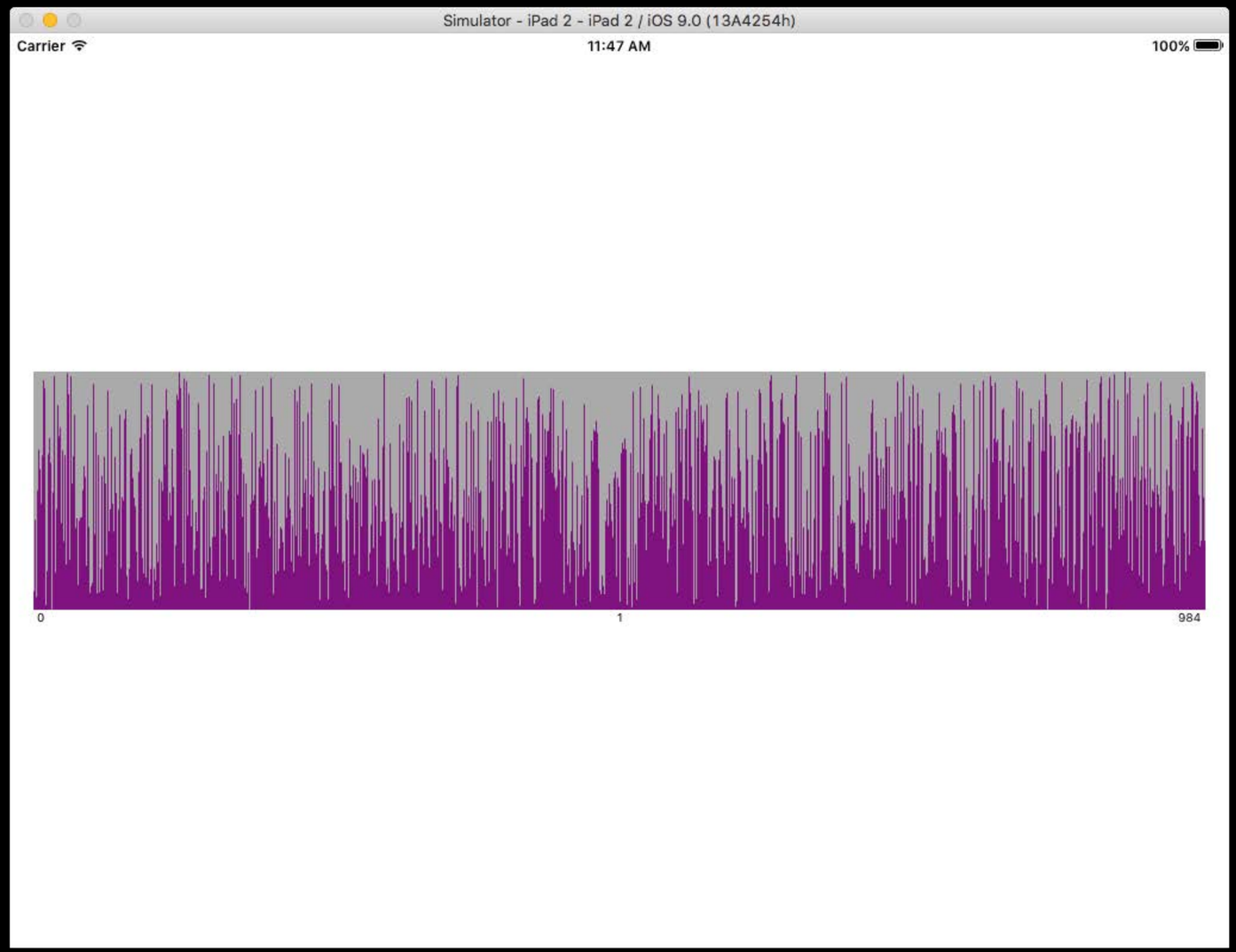
Graphasaurus

Requirements

100,000 data points

60 fps

iPad Mini 1st Generation

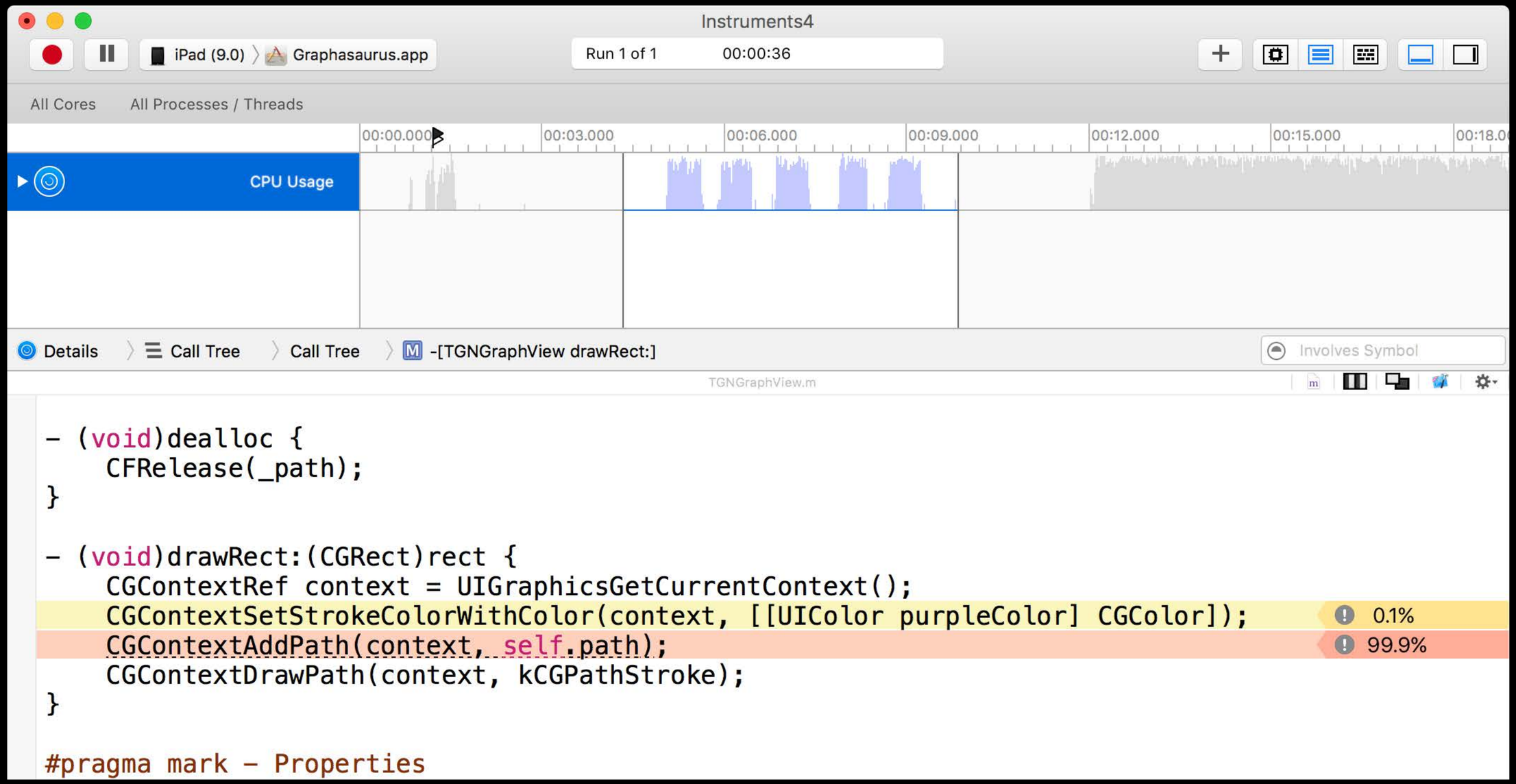


Demo

Getting started

Time Profiler

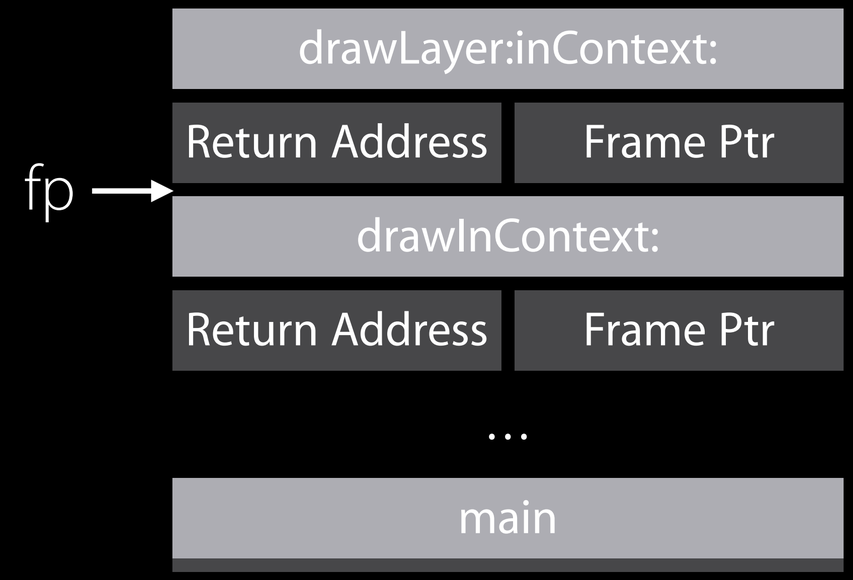
Missing stack frames



Backtrace Example

Normal case

```
- (void) drawRect: (NSRect) rect {
    // draw stuff
   ...
   CGContextDrawPath(_path, kCGStroke);
}
```



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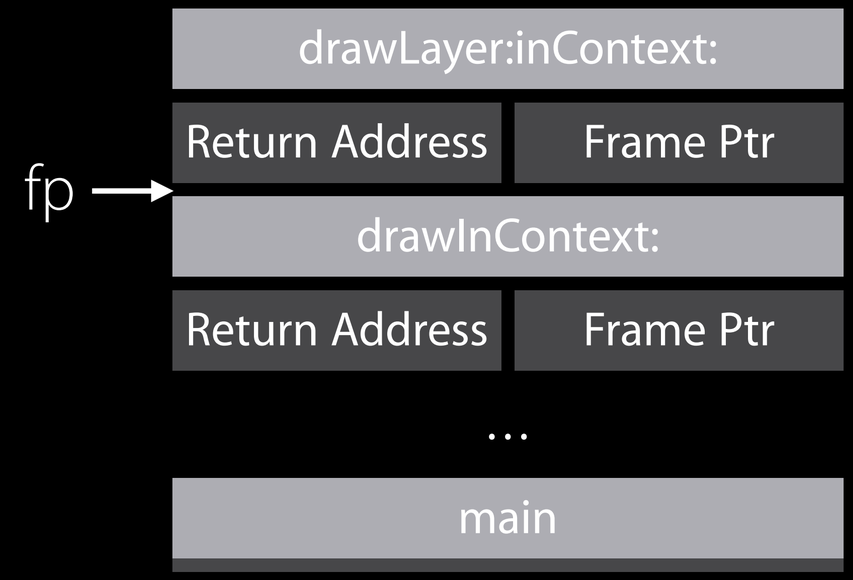

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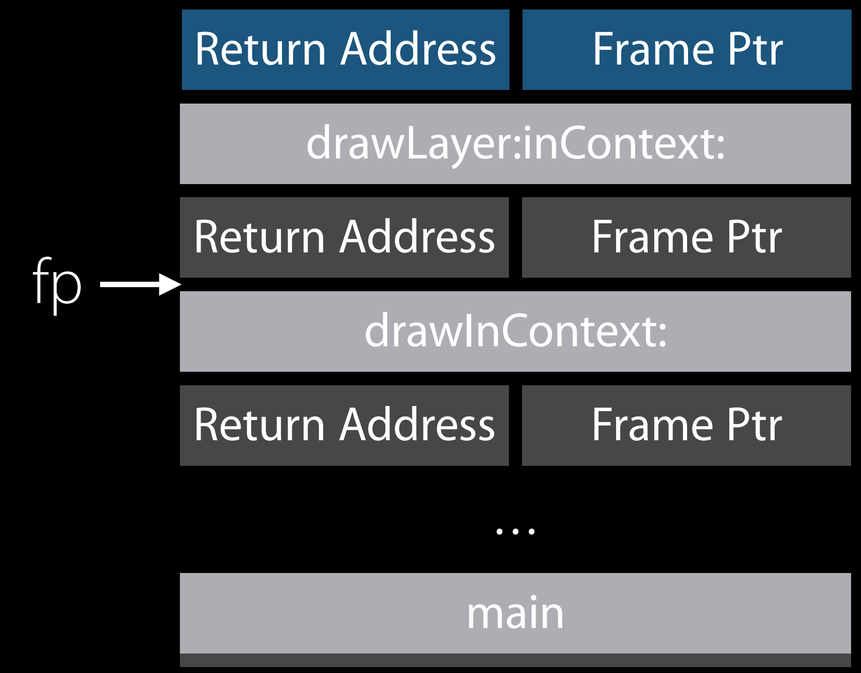


```
+0x00  push  {r4, r5, r6, fp, lr}
```

Backtrace Example

Normal case

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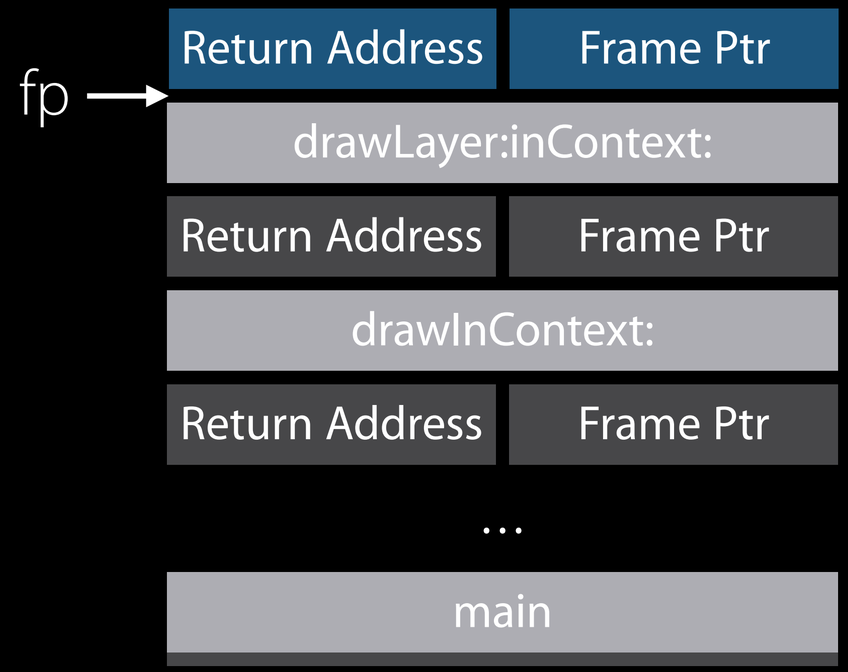


```
+0x00  push  {r4, r5, r6, fp, lr}
+0x02  add   fp, sp, #12
```

Backtrace Example

Normal case

```
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    // draw stuff
    ...
    CGContextDrawPath(_path, kCGStroke);
}
```
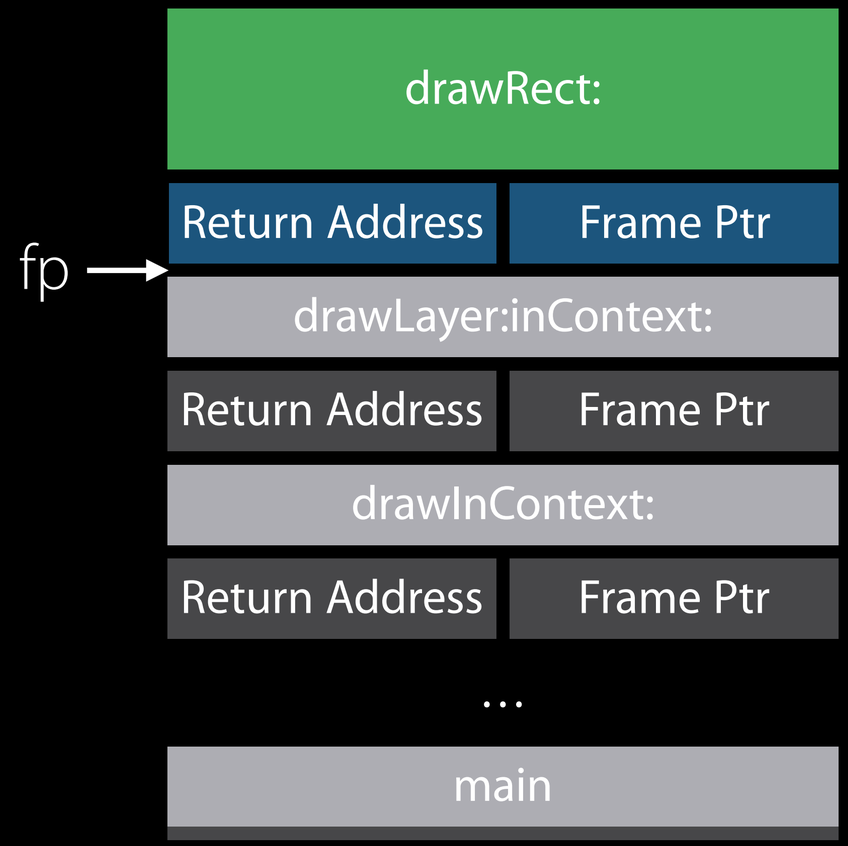
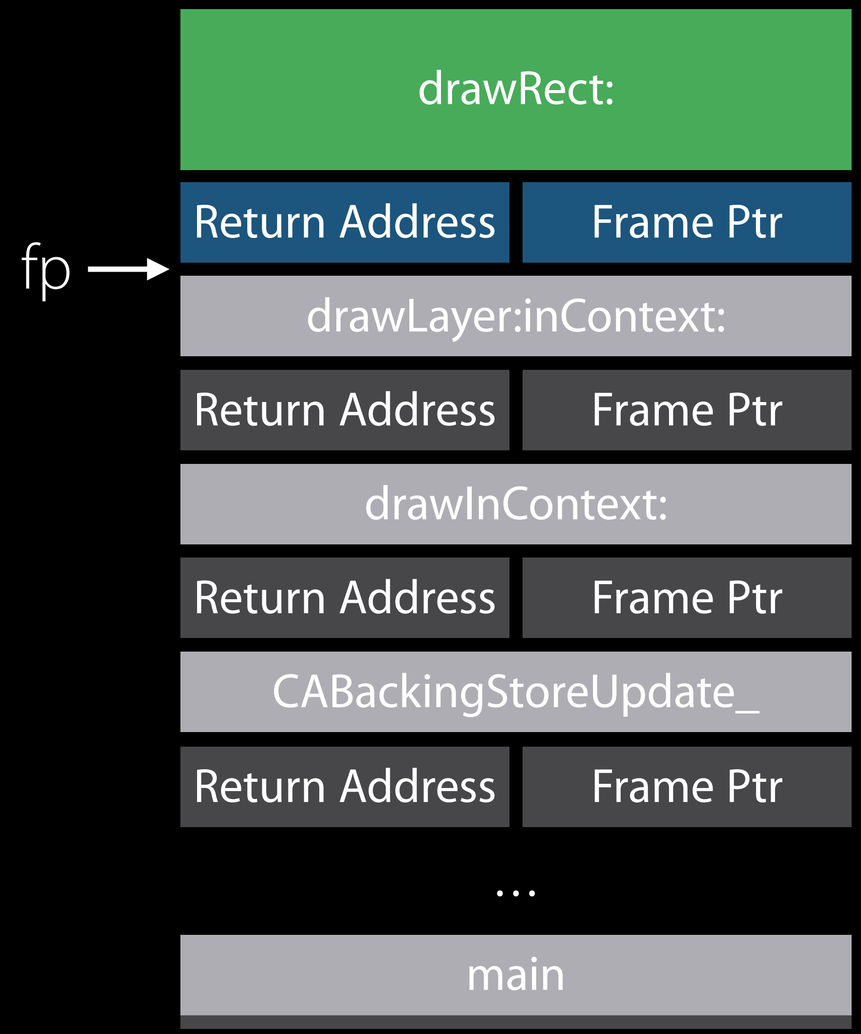




```
+0x00  push  {r4, r5, r6, fp, lr}
+0x02  add   fp, sp, #12
+0x04  sub   sp, #180
```

Backtrace Example

Normal case

```
- (void) drawRect: (NSRect) rect {
    // draw stuff
    ...
    CGContextDrawPath(_path, kCGStroke);
}
```



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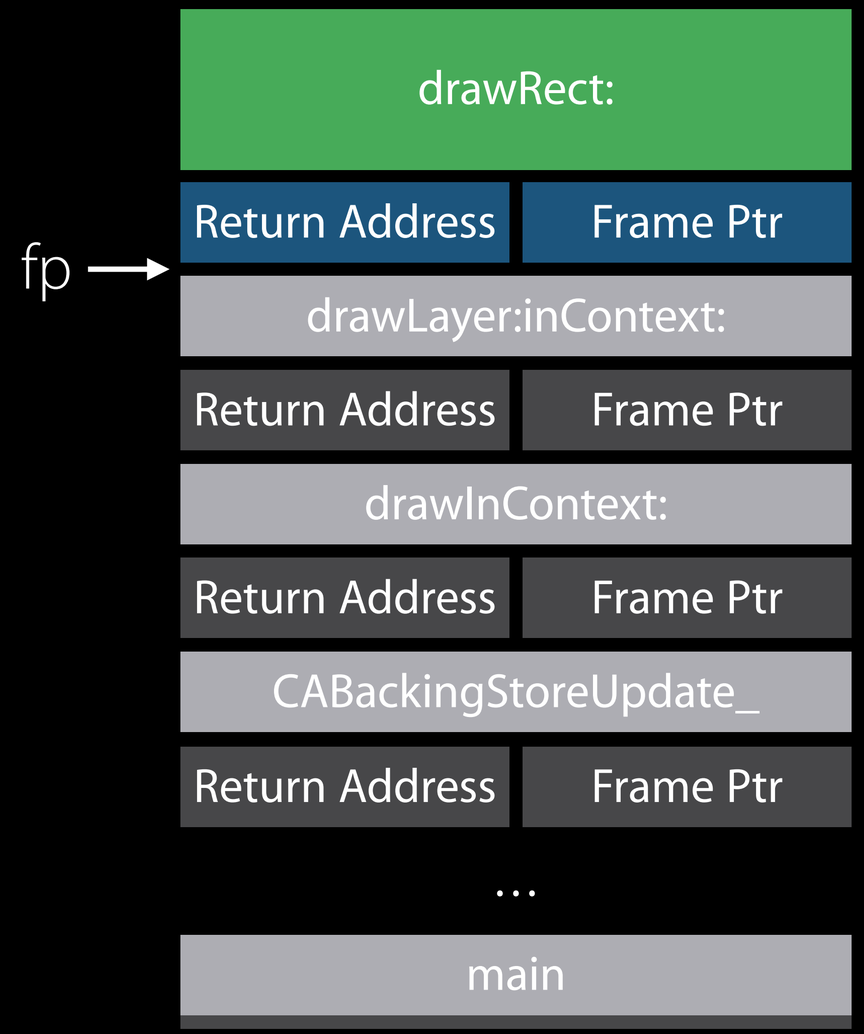

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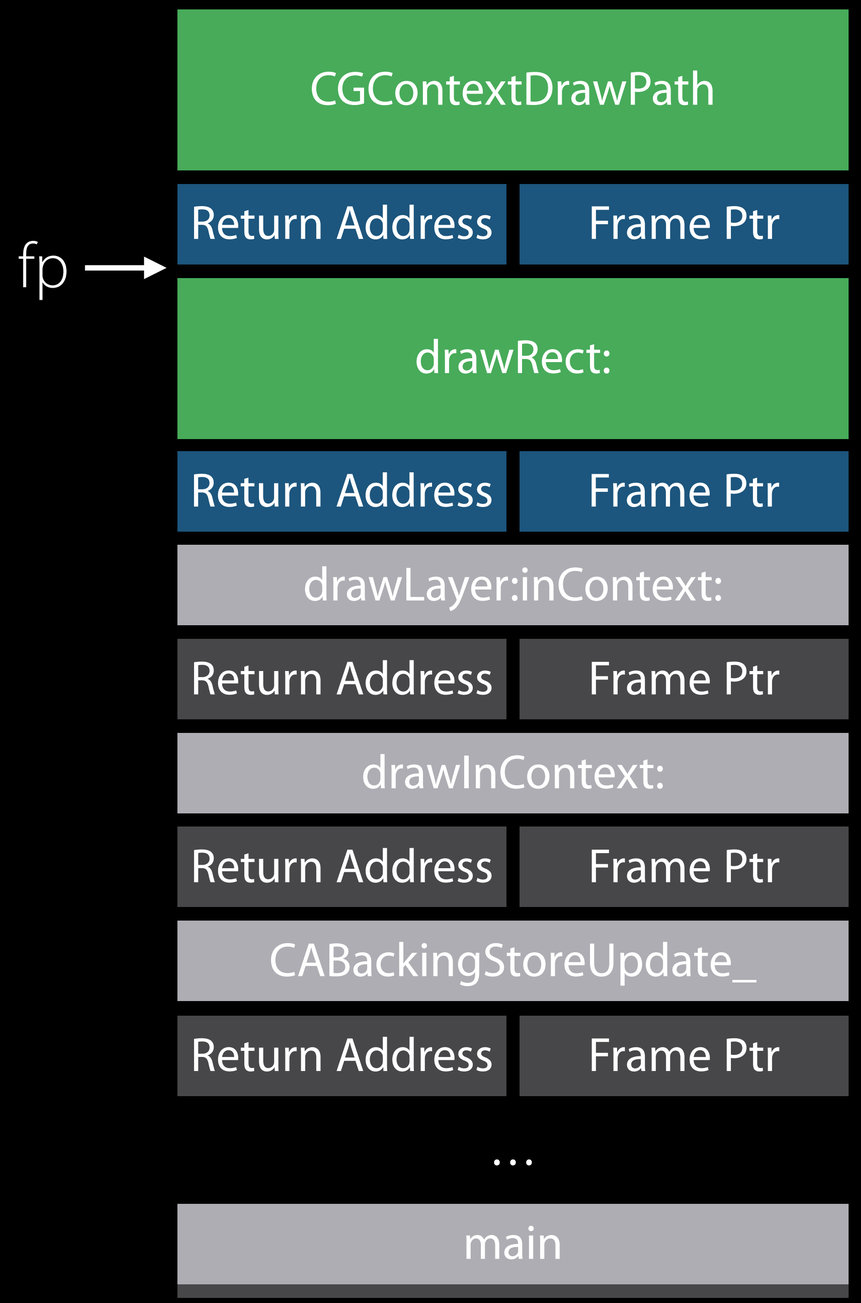
```



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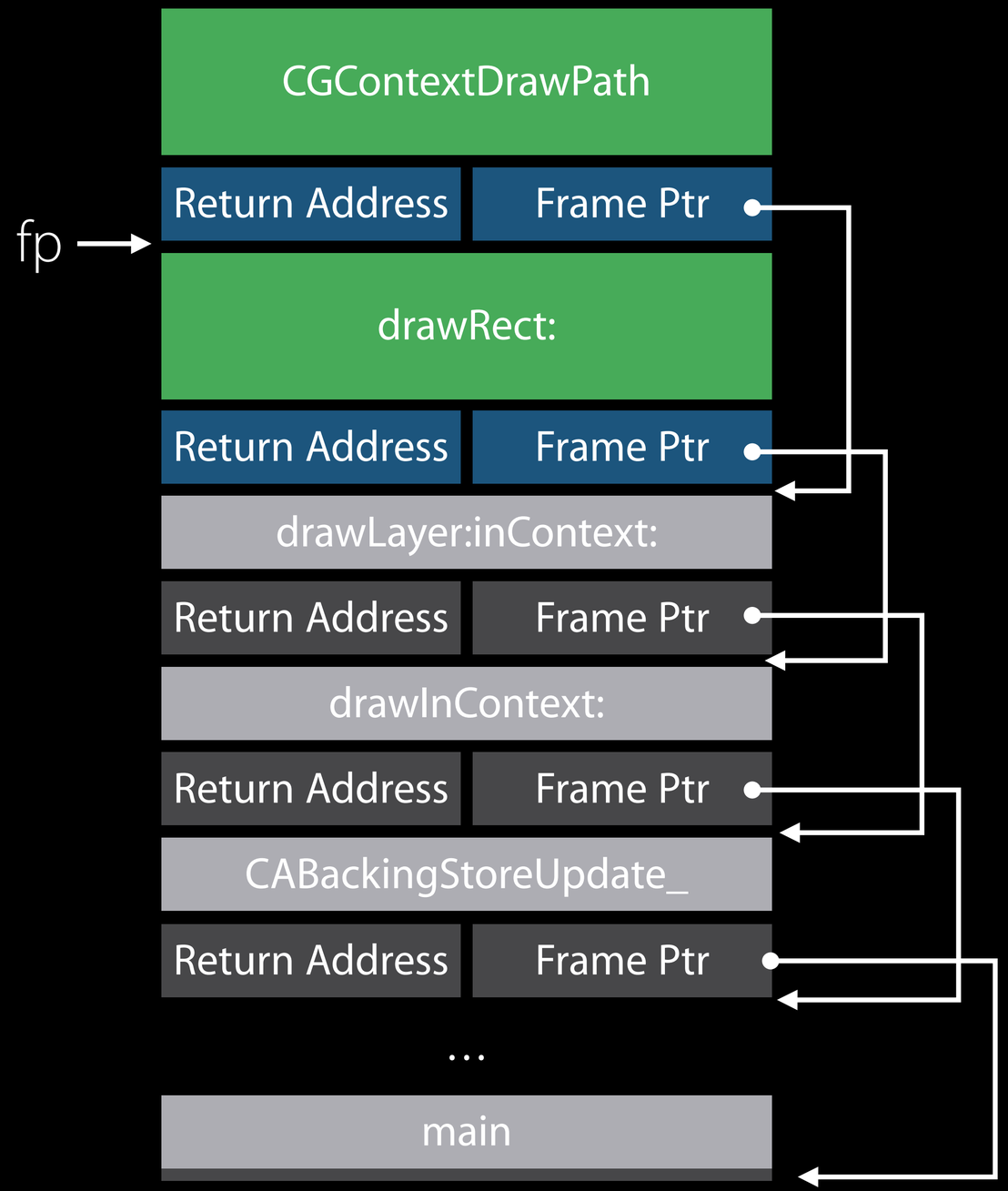
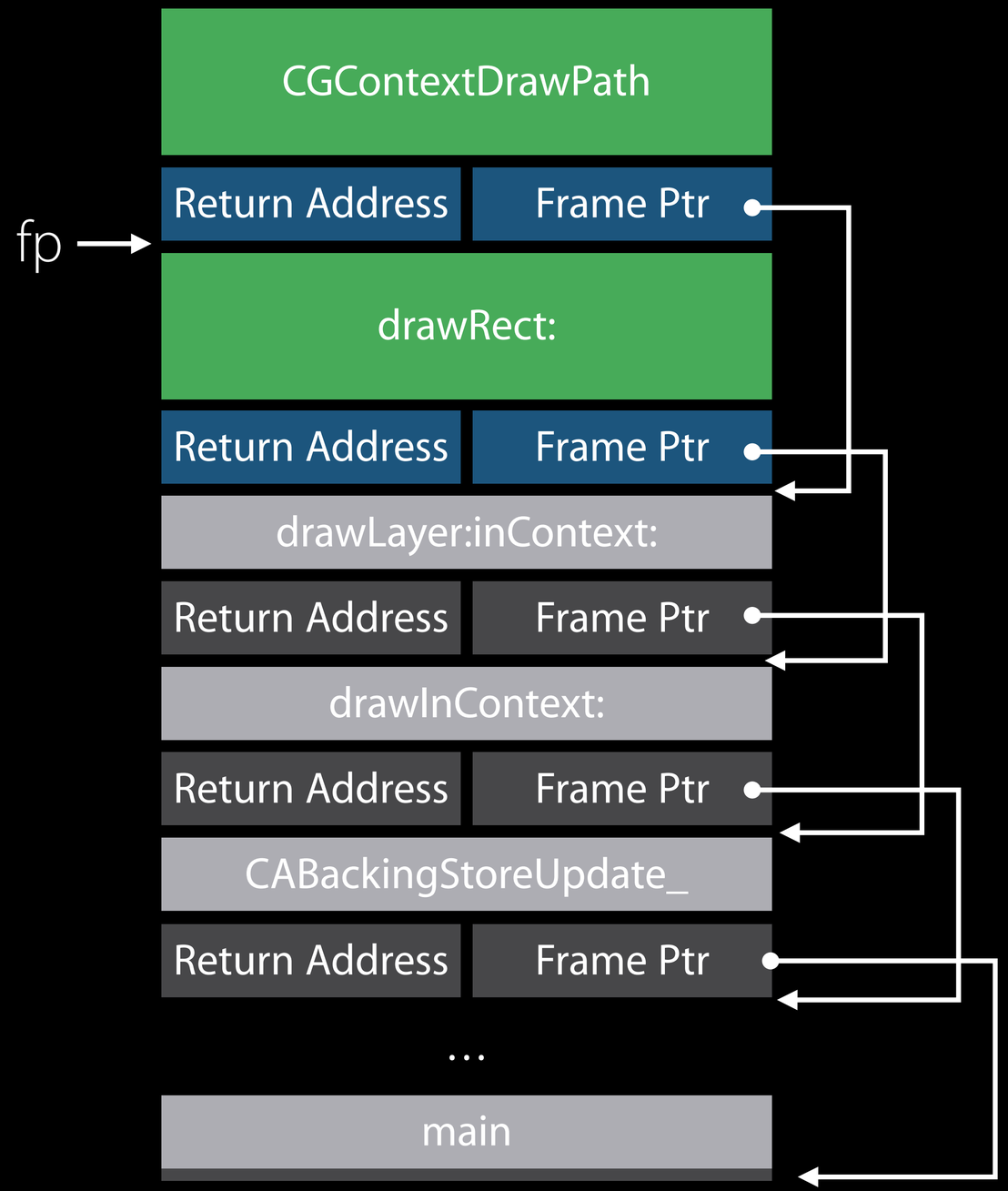


Backtrace Example

Normal case

```
- (void) drawRect: (NSRect) rect {
    // draw stuff
    ...
    CGContextDrawPath(_path, kCGStroke);
}
```

-fomit-frame-pointer



Backtrace Example

Normal case

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    // draw stuff
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    CGContextDrawPath(_path, kCGStroke);
}
```

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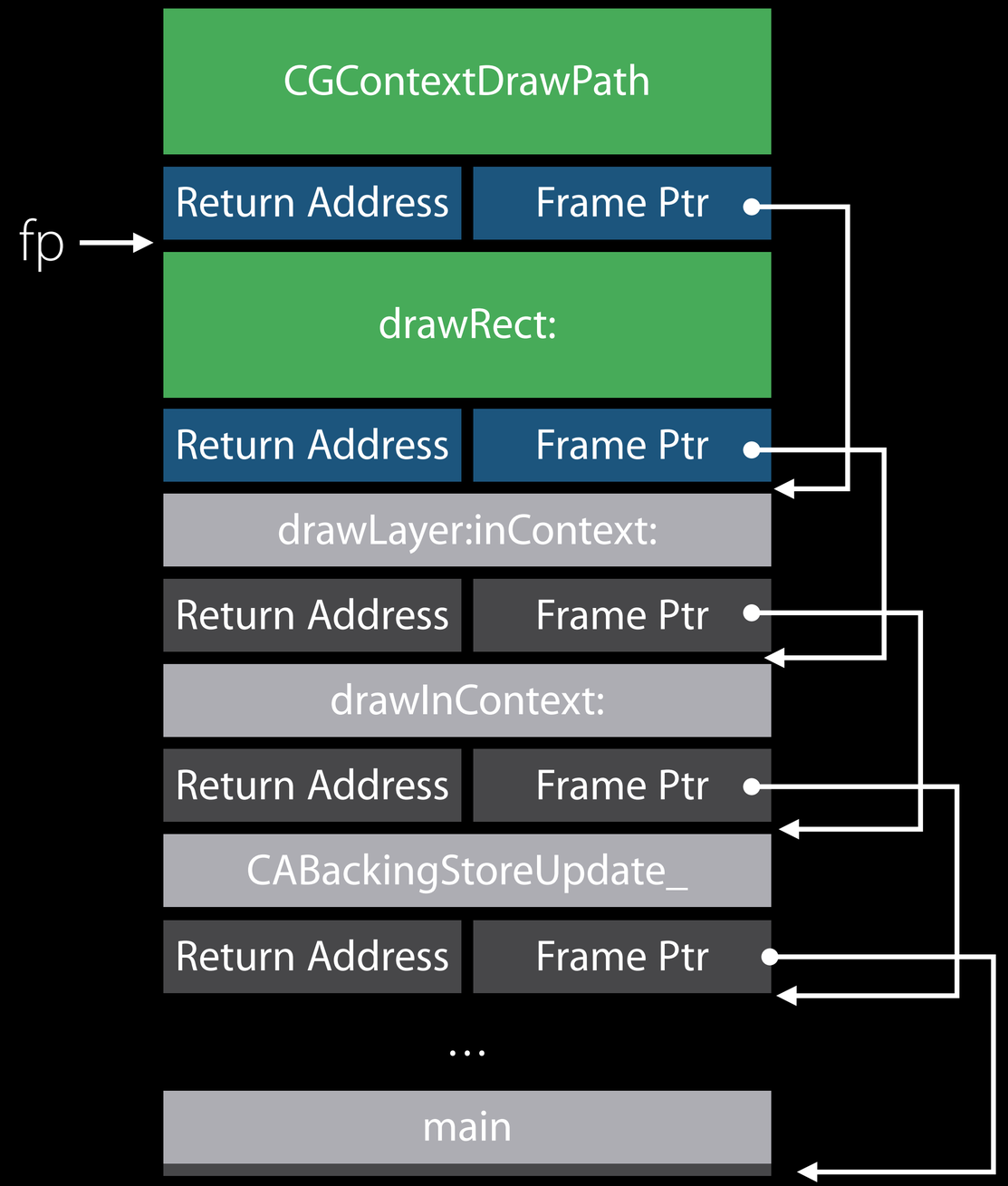
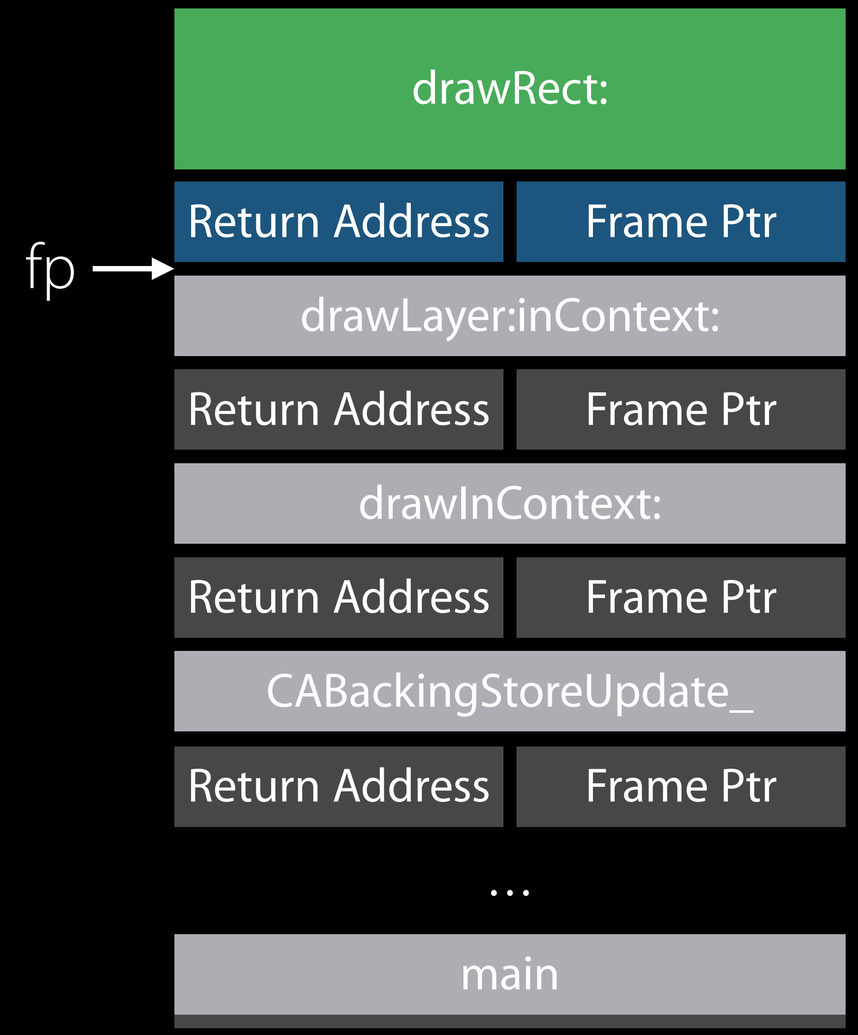


Backtrace Example

Optimized case

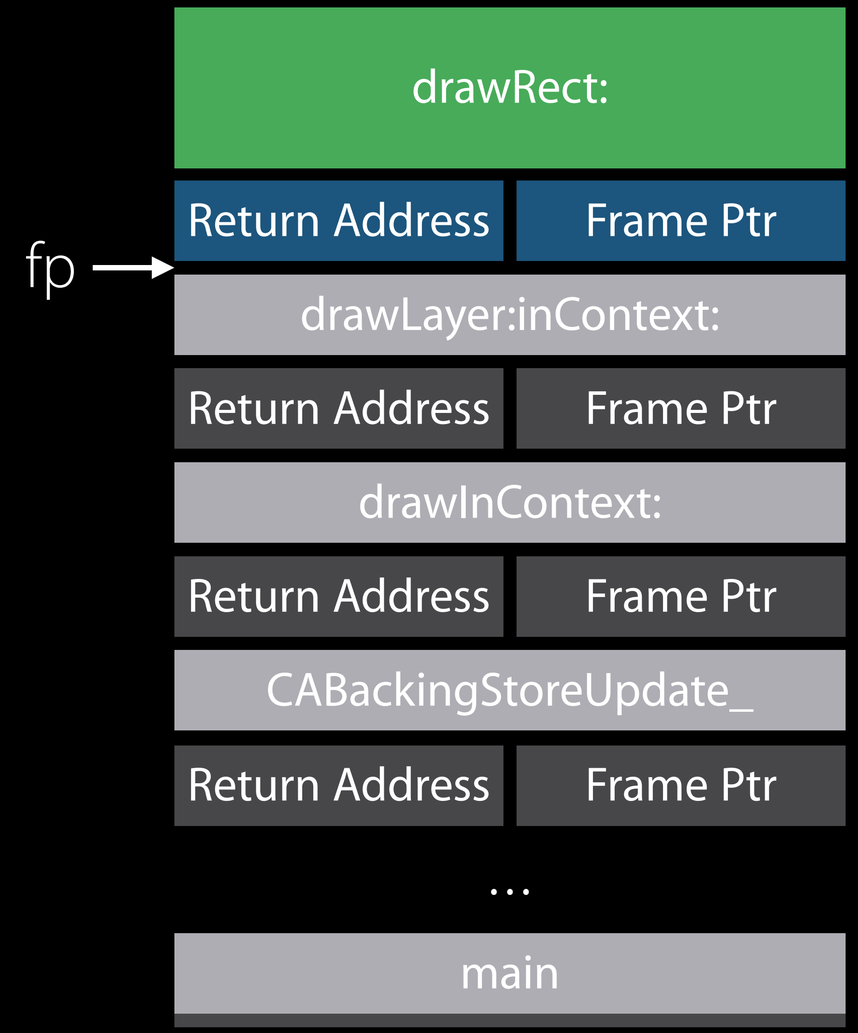
```
- (void) drawRect: (NSRect) rect {
    // draw stuff
    ...
    CGContextDrawPath(_path, kCGStroke);
}
```



Backtrace Example

Optimized case

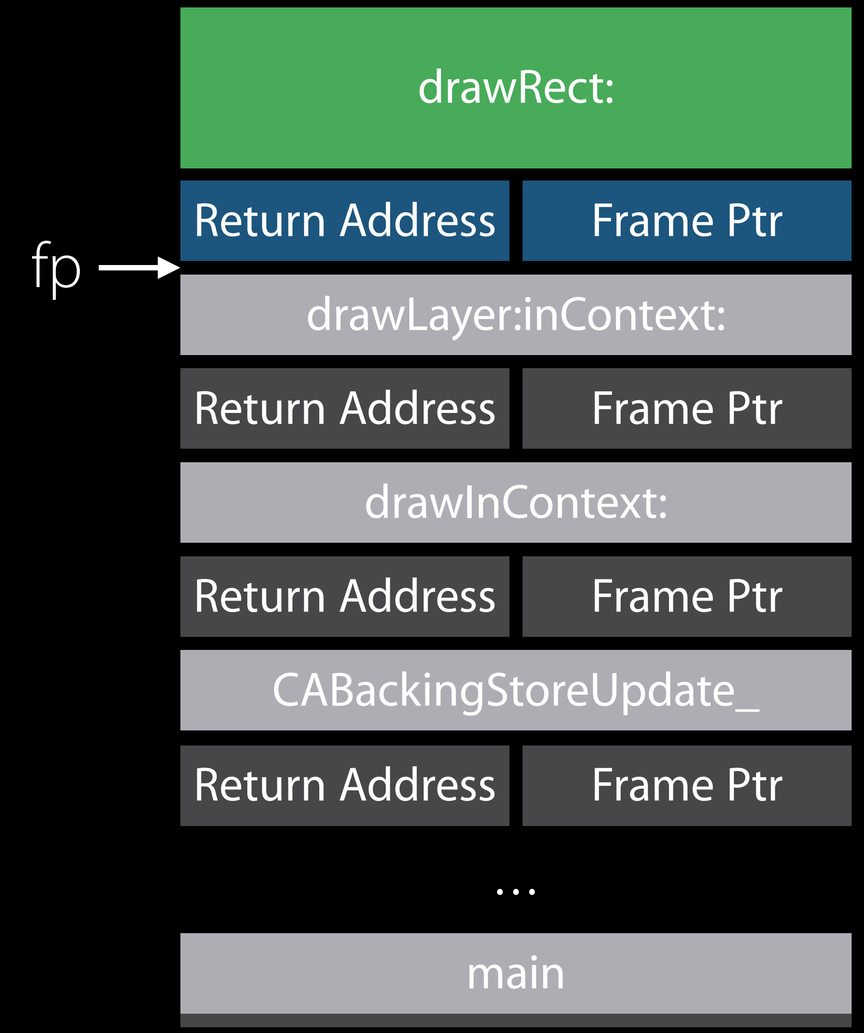
```
- (void) drawRect: (NSRect) rect {
    // draw stuff
    ...
    CGContextDrawPath(_path, kCGStroke);
    pop stack frame
    restore fp
    jump back to caller
}
```



Backtrace Example

Optimized case

```
- (void) drawRect: (NSRect) rect {
    // draw stuff
    ...
    pop stack frame
    restore fp
    CGContextDrawPath(_path, kCGStroke);
    jump back to caller
}
```



Backtrace Example

Optimized case

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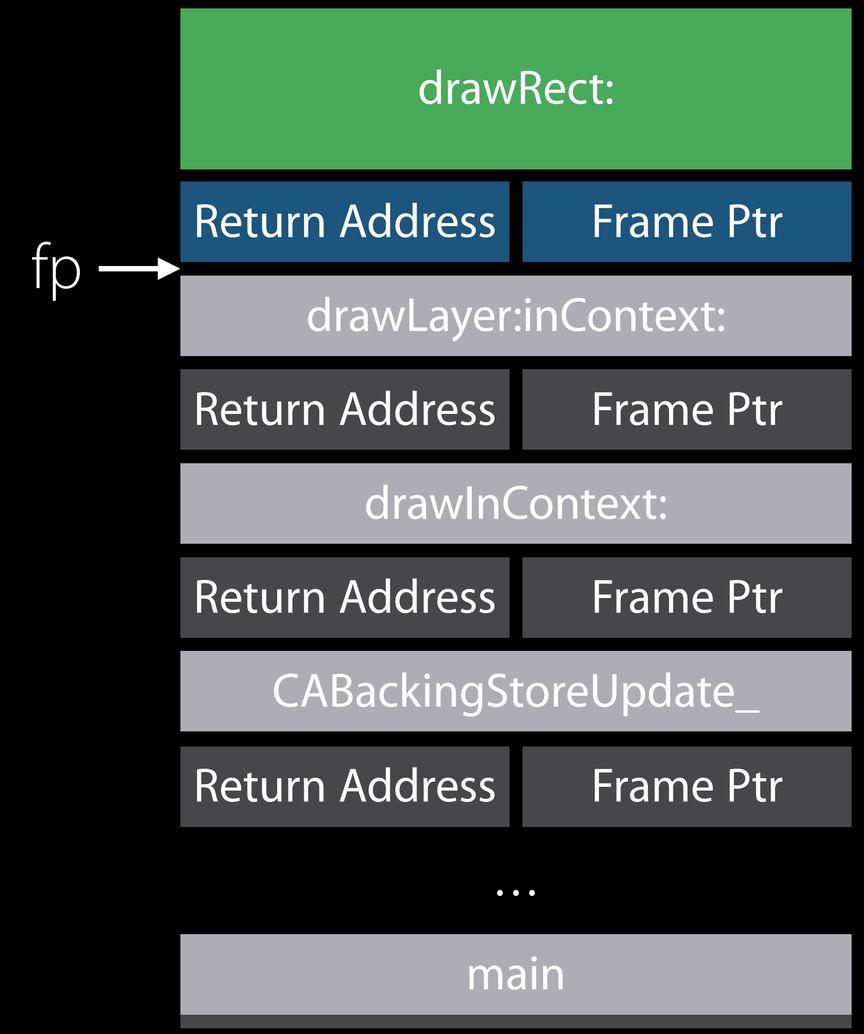
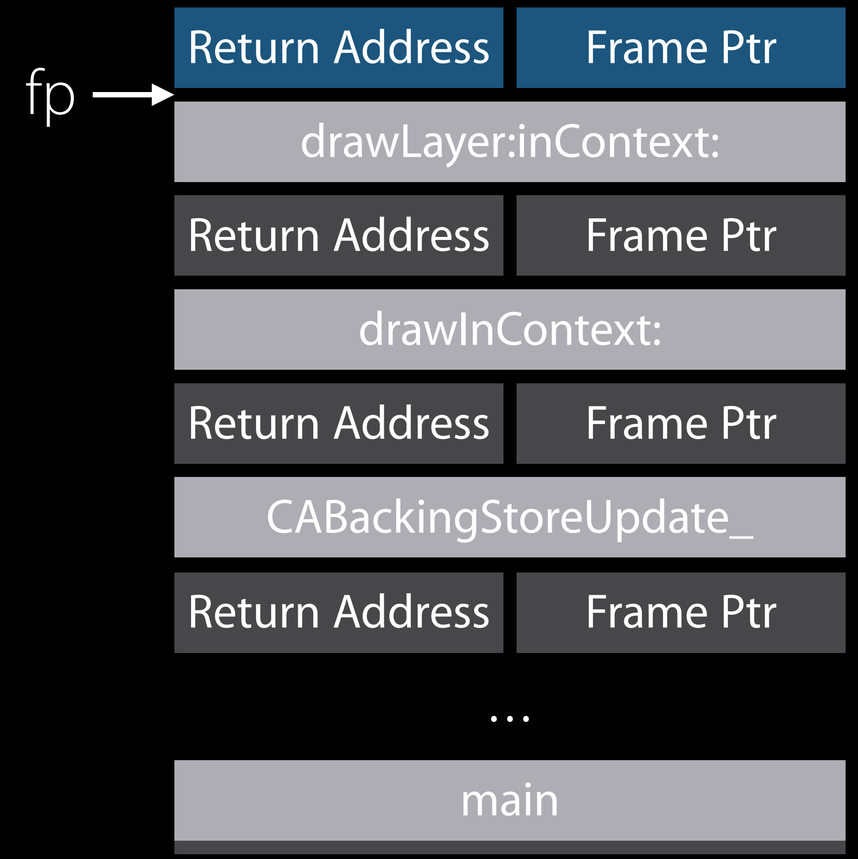


Backtrace Example

Optimized case

```
- (void) drawRect: (NSRect) rect {
    // draw stuff
   ...
   pop stack frame
   restore fp
   CGContextDrawPath(_path, kCGStroke);

}
```



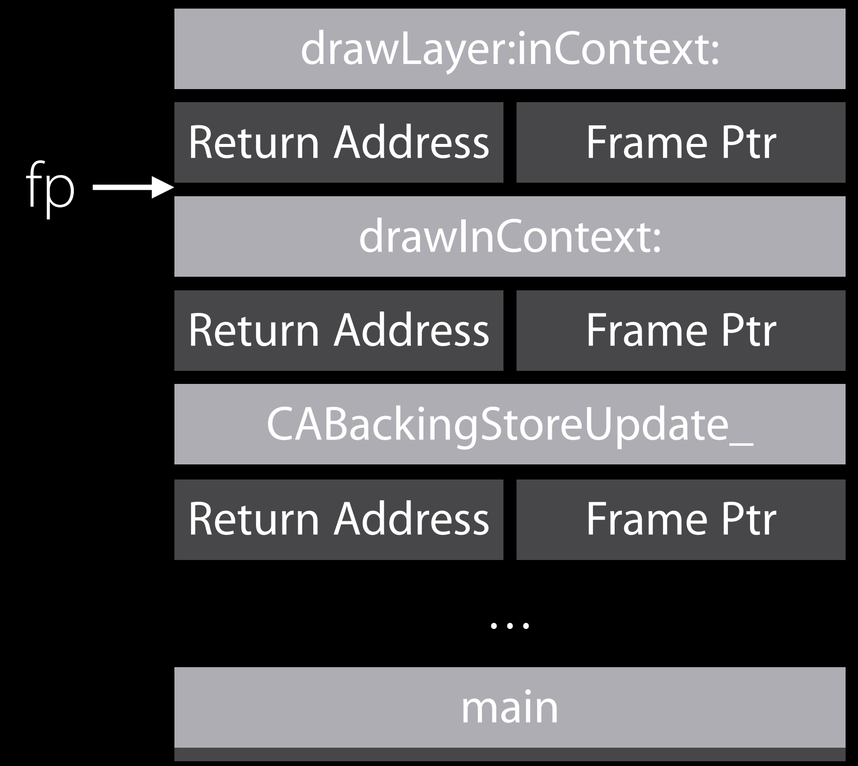

```
+0x68  add     sp, #180
```

Backtrace Example

Optimized case

```
– (void) drawRect: (NSRect) rect {
    // draw stuff
   ...
   pop stack frame
   restore fp
→  CGContextDrawPath(_path, kCGStroke);

}
```



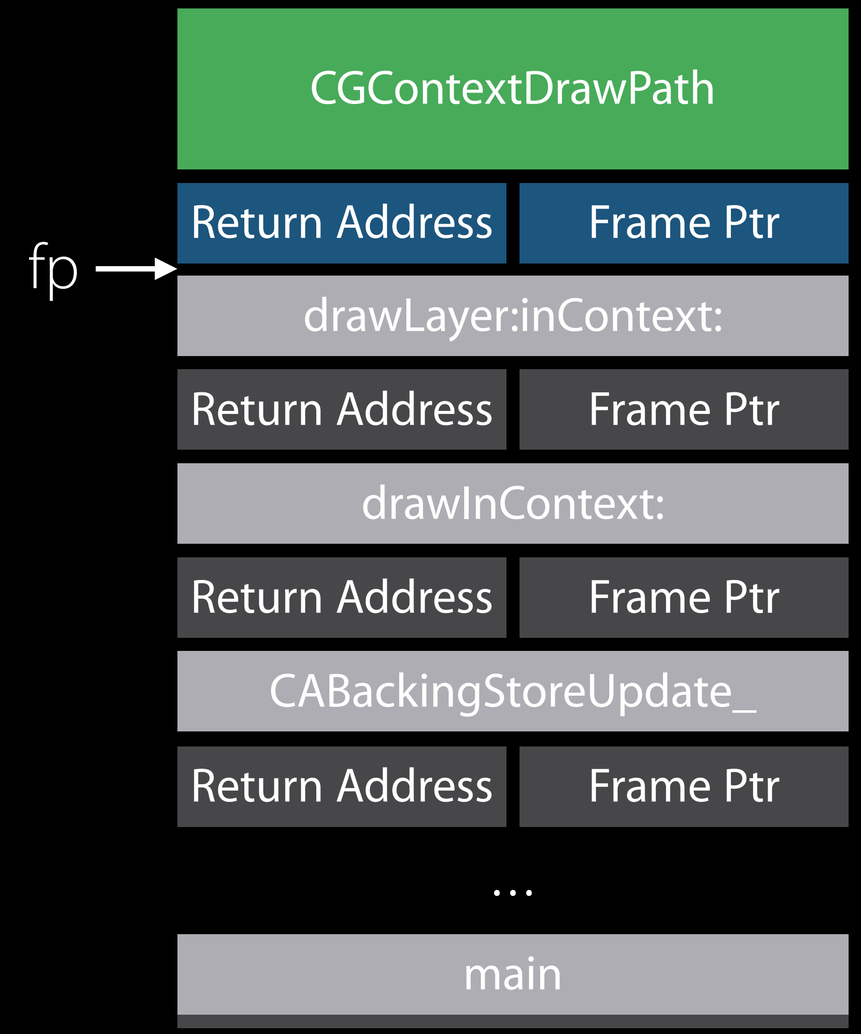

```
+0x68  add     sp, #180
+0x72  pop.w   {r4, r5, r6, fp, lr}
```

Backtrace Example

Optimized case

```
- (void) drawRect: (NSRect) rect {
    // draw stuff
   ...
   pop stack frame
   restore fp
→  CGContextDrawPath(_path, kCGStroke);

}
```



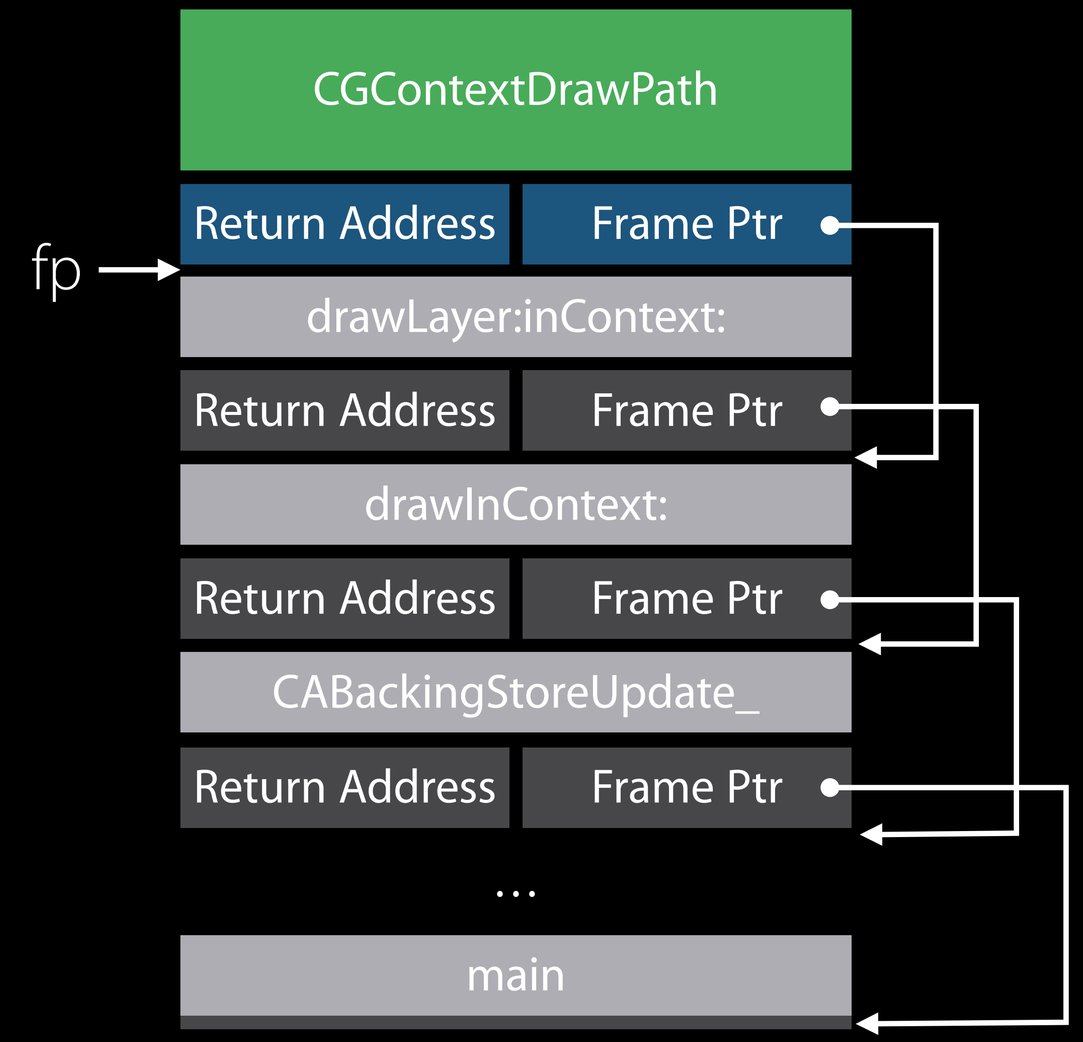

```
+0x68  add     sp, #180
+0x72  pop.w   {r4, r5, r6, fp, lr}
+0x76  b.w     "CGContextDrawPath$shim"
```

Backtrace Example

Optimized case

```
- (void) drawRect: (NSRect) rect {
    // draw stuff
    ...
    pop stack frame
    restore fp
    CGContextDrawPath(_path, kCGStroke);

}
```

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+0x68  add     sp, #180
+0x72  pop.w   {r4, r5, r6, fp, lr}
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```

Tail Call Elimination

Benefits

Tail Call Elimination

Benefits

Saves stack memory

Tail Call Elimination

Benefits

Saves stack memory

Keeps caches hot

Tail Call Elimination

Benefits

Saves stack memory

Keeps caches hot

Best for recursive function tail calls

Tail Call Elimination

Disabling

```
CFLAGS=“-fno-optimize-sibling-calls"
```

Call Semantics

ARM (32-bit)

- Branch and Link instruction (**`bl`**)
  - Sets "**`lr`**" to next address and jumps
- Tail Calls use simple branches (**`b`**)

```
Caller:
+0x174 blx    "CGContextDrawPath $shim”
```

```
Caller:
+0x174 b.w    "CGContextDrawPath $shim”
```

Demo

Going further

Objective-C Runtime

`objc_msgSend`

Objective-C Runtime

objc_msgSend

```
NSString *string = @"Hello";
NSUInteger len = [string length];  // or string.length
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Looks up the method implementation for a selector

Objective-C Runtime

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Looks up the method implementation for a selector

Invokes the method

Objective-C Runtime

objc_msgSend

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NSString *string = @"Hello";
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Looks up the method implementation for a selector

Invokes the method

Fast and highly optimized

Objective-C Runtime

objc_msgSend

```
NSString *string = @"Hello";
NSUInteger len = [string length];  // or string.length
```

Looks up the method implementation for a selector

Invokes the method

Fast and highly optimized

Does not push a stack frame

Objective-C Runtime

`objc_msgSend`

Objective-C Runtime

`objc_msgSend`

Required when

- Invoking methods on classes and objects
- Accessing properties

Objective-C Runtime

`objc_msgSend`

Required when

- Invoking methods on classes and objects
- Accessing properties

Method caching not as fast as inlining

Objective-C Runtime

`objc_msgSend`

Required when

- Invoking methods on classes and objects
- Accessing properties

Method caching not as fast as inlining

Alternatives

- C functions
- Objective-C++ (including STL)

Swift

Performance

Swift

Performance

Only dynamic when it needs to be

Swift

Performance

Only dynamic when it needs to be

Classes can be internal

Swift

Performance

Only dynamic when it needs to be

Classes can be internal

Whole module optimization

Demo

Going further

Time Profiler

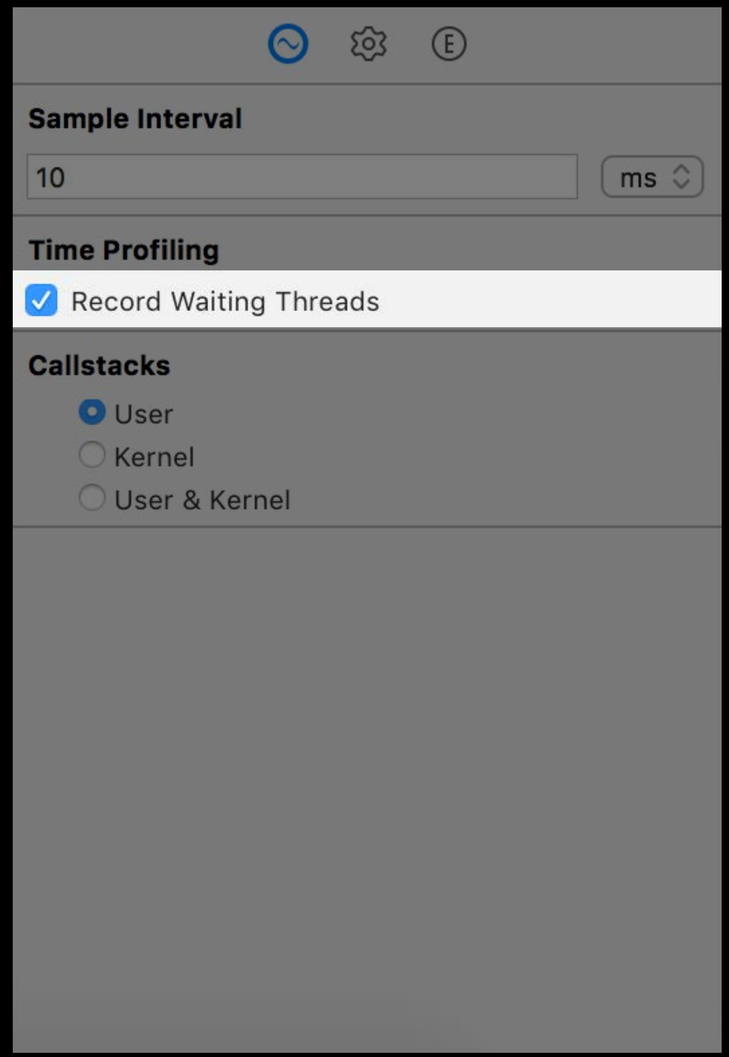
Going further

Time Profiler

Going further

More options to explore

- Record Waiting Threads

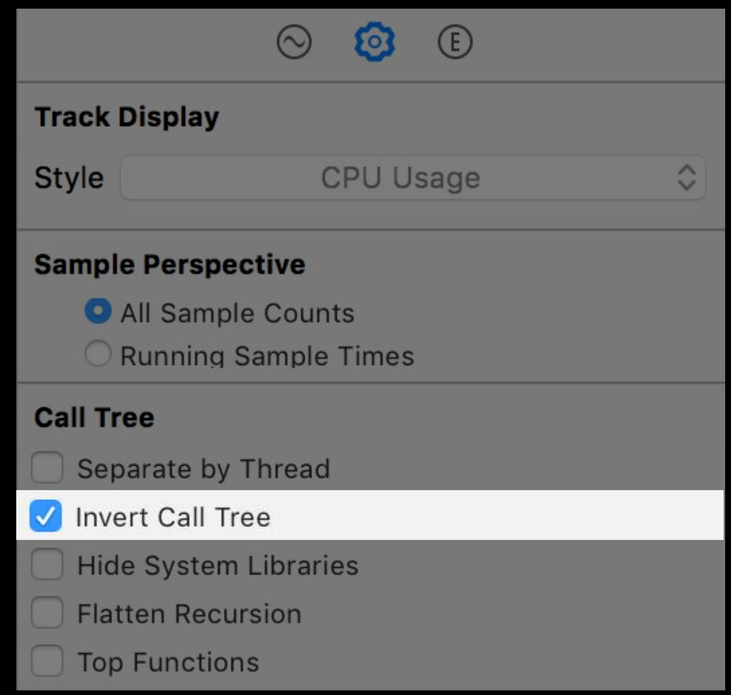


Time Profiler

Going further

More options to explore

- Record Waiting Threads
- Invert Call Tree

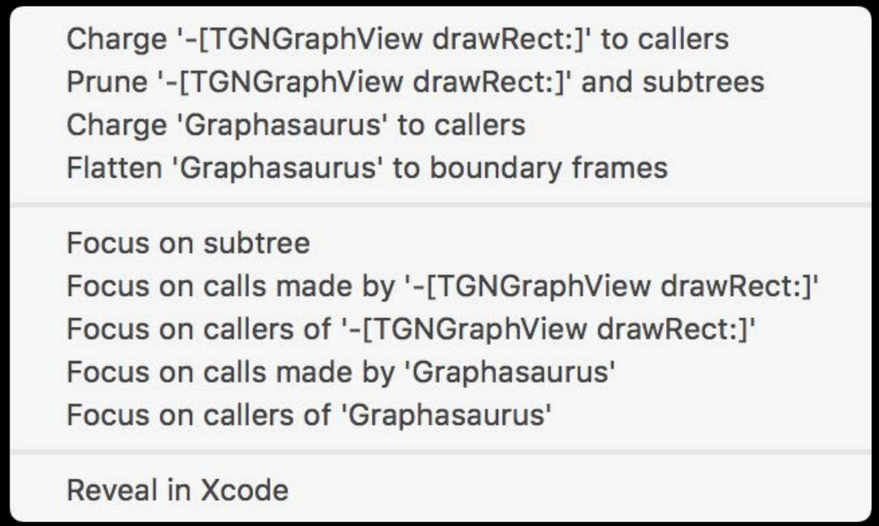


Time Profiler

Going further

More options to explore

- Record Waiting Threads
- Invert Call Tree
- Data Mining



Time Profiling in Depth

Lessons learned

Time Profiling in Depth

Lessons learned

Incorporate performance targets early

Time Profiling in Depth

Lessons learned

Incorporate performance targets early

Always measure

Time Profiling in Depth

Lessons learned

Incorporate performance targets early

Always measure

Keep digging

More Information

Swift Language Documentation
http://developer.apple.com/swift

Apple Developer Forums
http://developer.apple.com/forums

Stefan Lesser
Developer Tools Evangelist
slesser@apple.com

Related Sessions

Debugging Energy Issues	Nob Hill	Wednesday 10:00AM
Performance on iOS and watchOS	Presidio	Friday 11:00AM

Related Labs

Instruments and Debugging Lab	Developer Tools Lab B	Friday 9:00AM

WWDC15