x32-ABI Re-Evaluation

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x32-ABI

- Support 64bit instruction set but size of pointers is only 32bit
- A new ABI (different from x86 and x86_64), i.e. it constitutes a new platform and requires recompilation of the entire software stack
- Introduced in Linux kernel 3.4
- Evaluation done in 2012:
  - `https://indico.cern.ch/event/214319/`
  - `https://indico.cern.ch/event/217511/contribution/26`

Why Re-Evaluation

- Things might have changed since 2012
- Improved support
- Easier deployment (container technologies)

Support

- LLVM since 3.6
  `http://www.phoronix.com/scan.php?page=news_item&px=MTExNDE`
- Ubuntu since 13.04 and openSuSe since 13 (kernel only!)
- Debian (unofficial port): `https://wiki.debian.org/X32Port`
- Arch Linux (some unofficial packages):
  `https://github.com/fantix/ArchLinux-x32`

Comparison with 2012 results

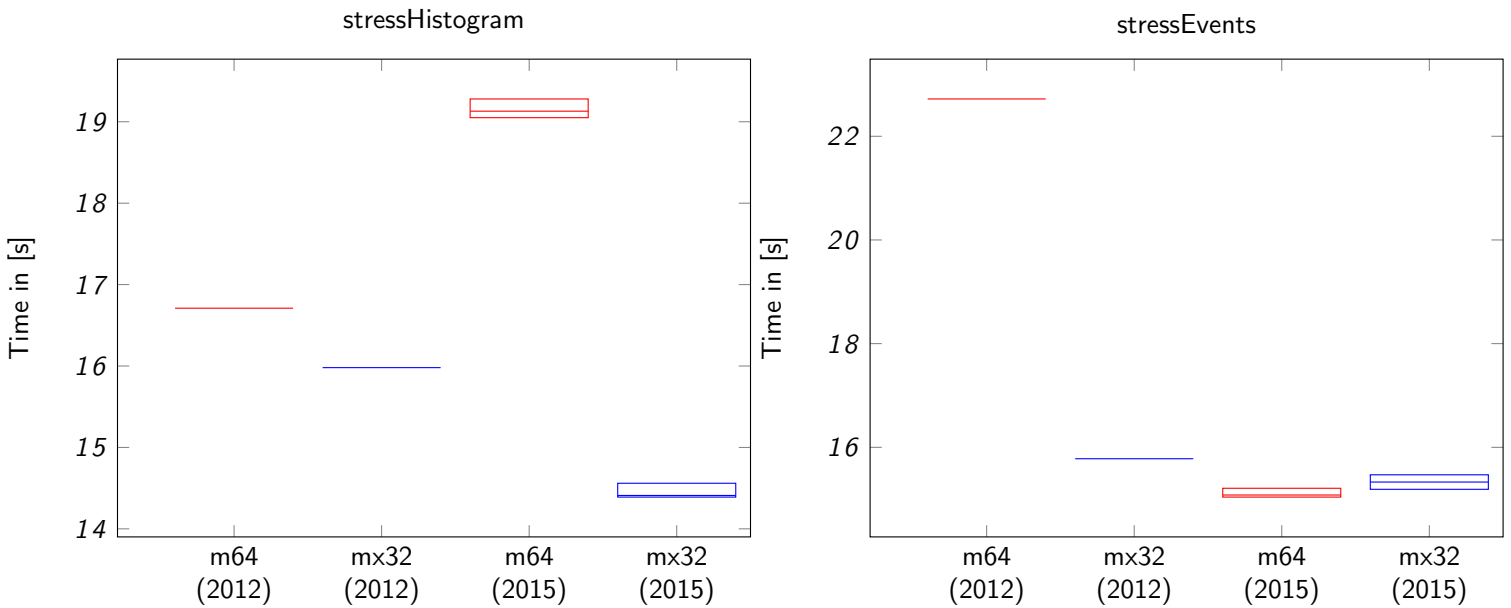
Test Setup 2012:

- Linux kernel 3.4
- Intel Core i7 3.4 GHz
- gcc 4.7
- Gentoo release

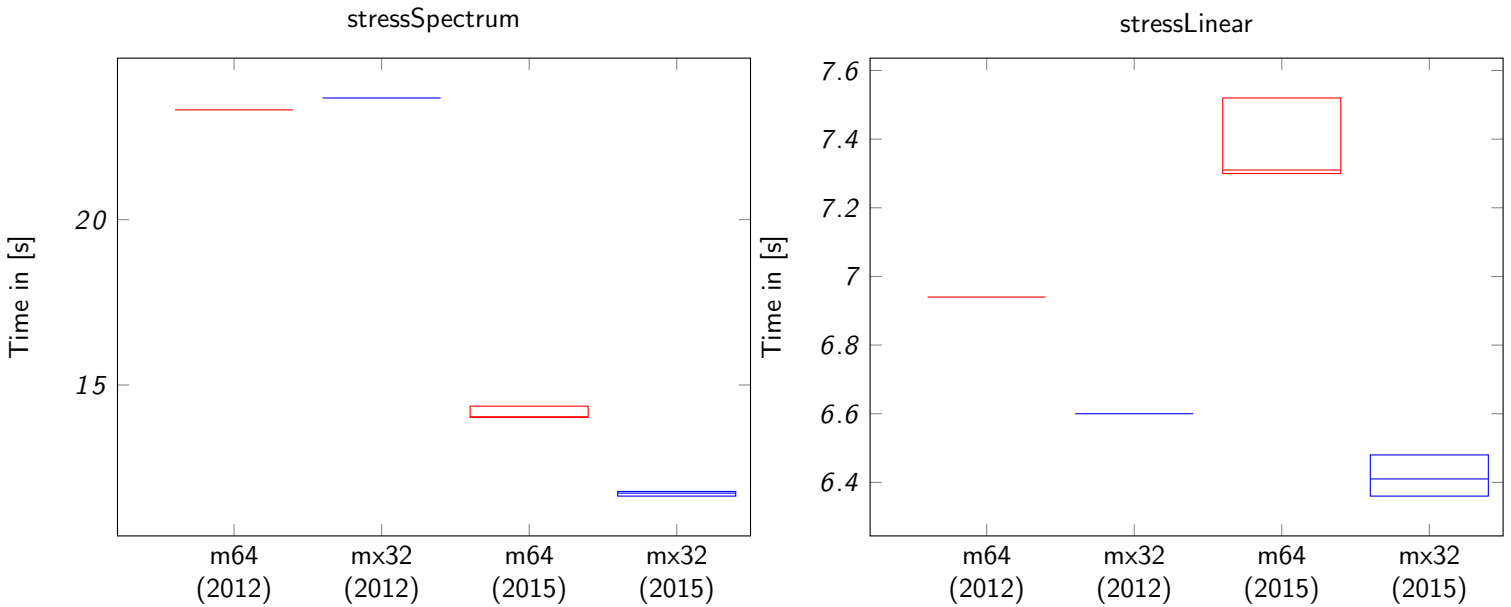
Test Setup 2015:

- Linux kernel 4.2.1
- Intel Core i7 3.4 GHz
- gcc 4.9
- Fedora 22
- ROOT 5.34.20
- Geant4 4.10.01.p02

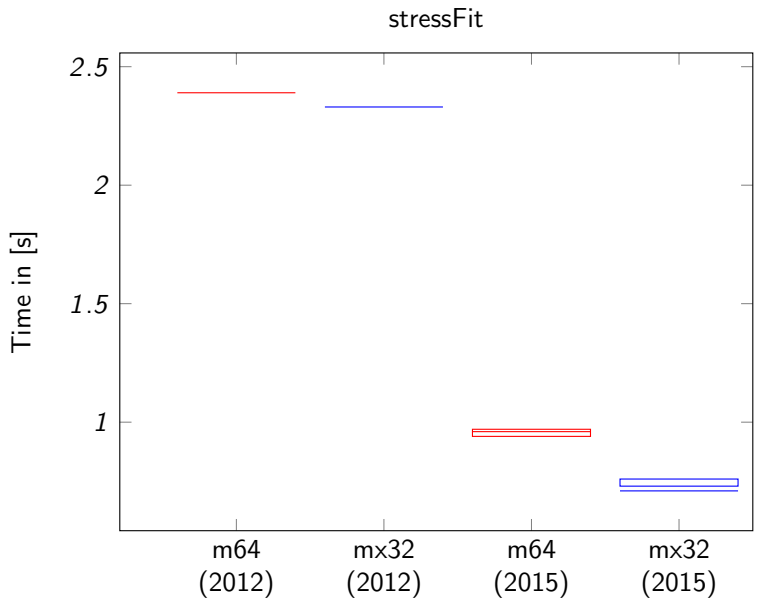
Comparison with 2012 results



Comparison with 2012 results

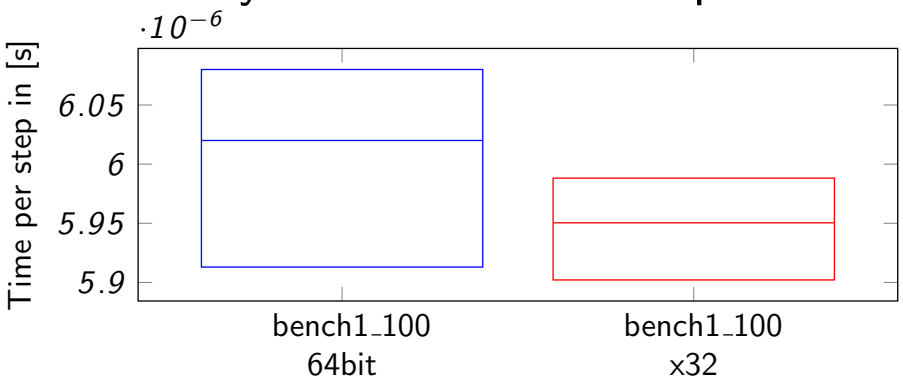


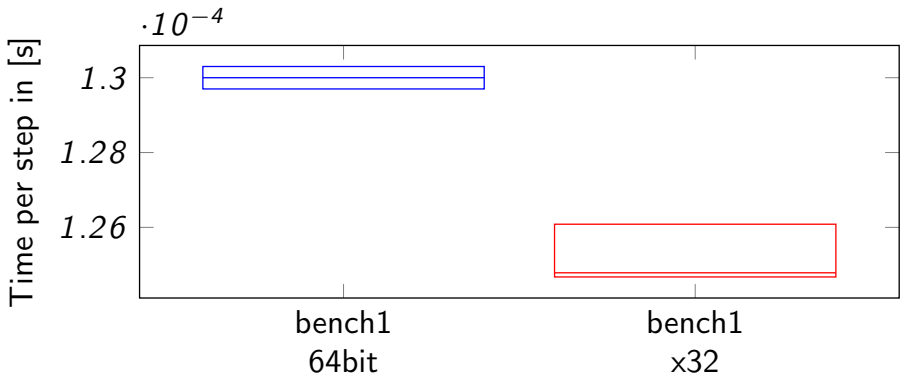
Comparison with 2012 results

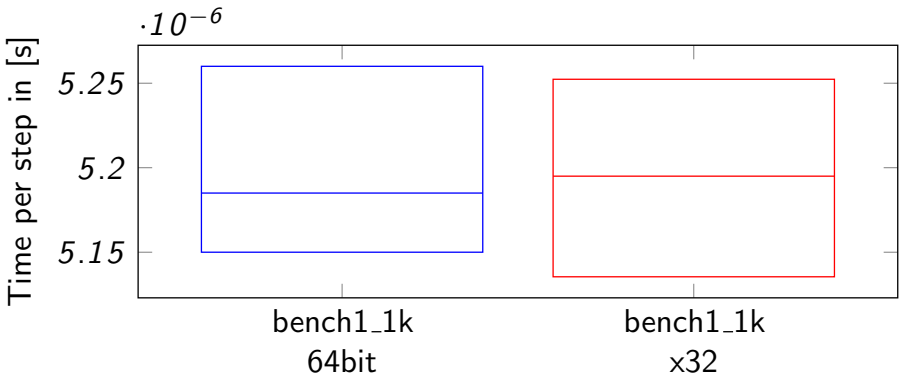


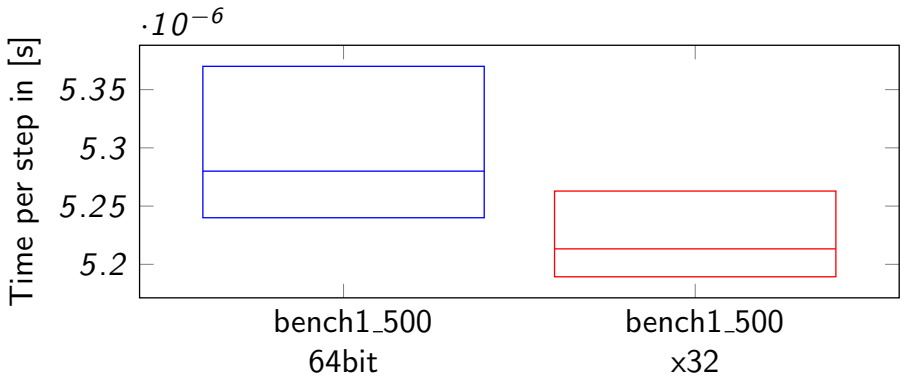
Results for Geant4.10-01.p02 (CPU benchmark based on full CMS detector)

Problem: x32 and 64-bit version might produce different random numbers. Need to divide by the number of steps.

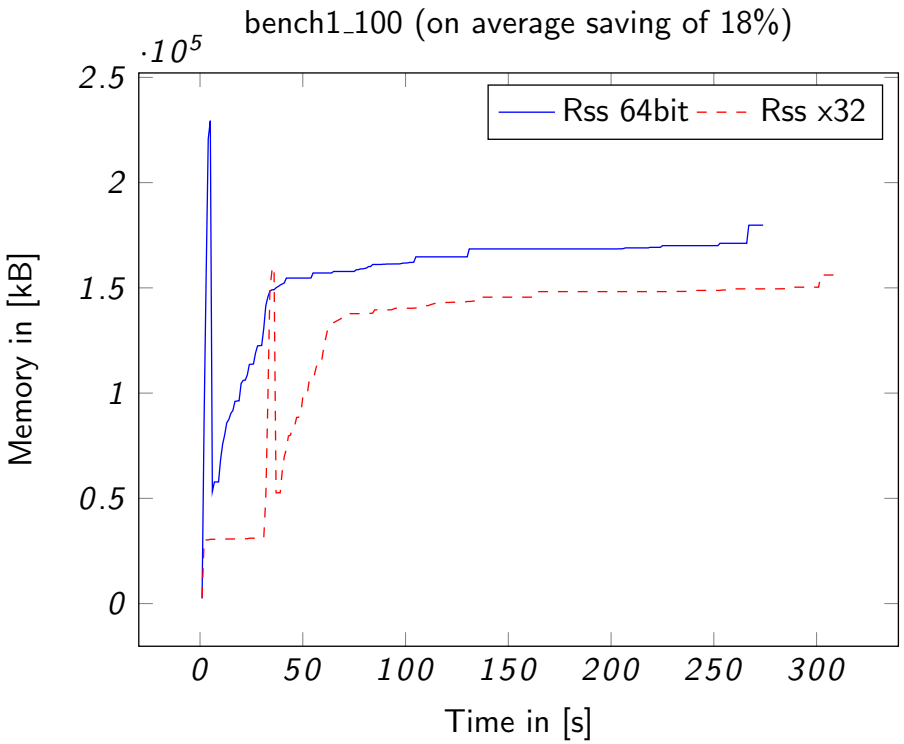


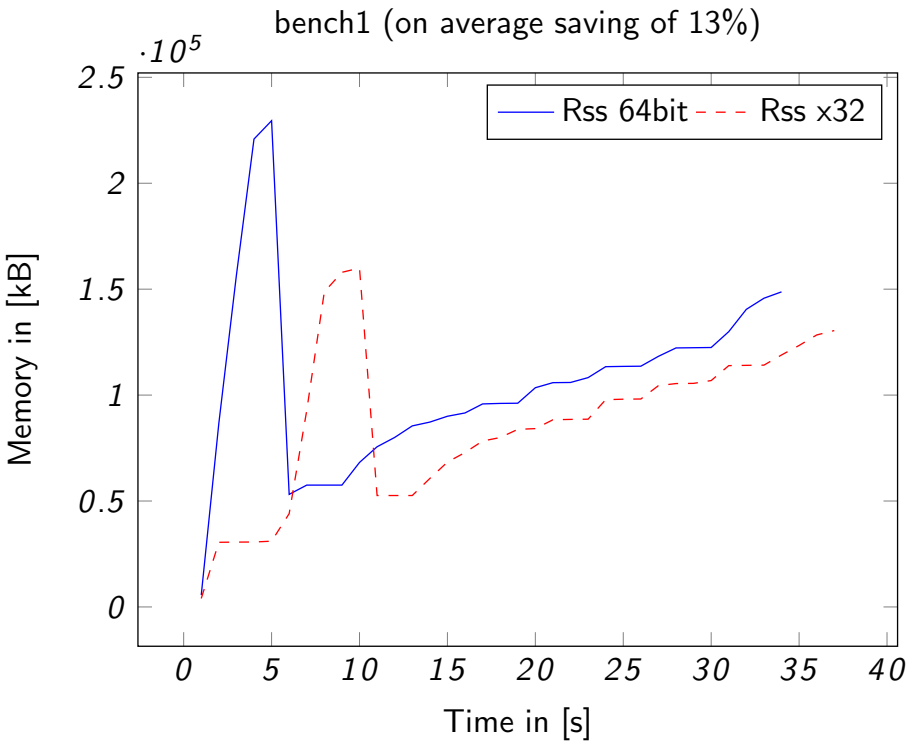






Results for Geant4.10-01.p02 (CPU benchmark based on full CMS detector)





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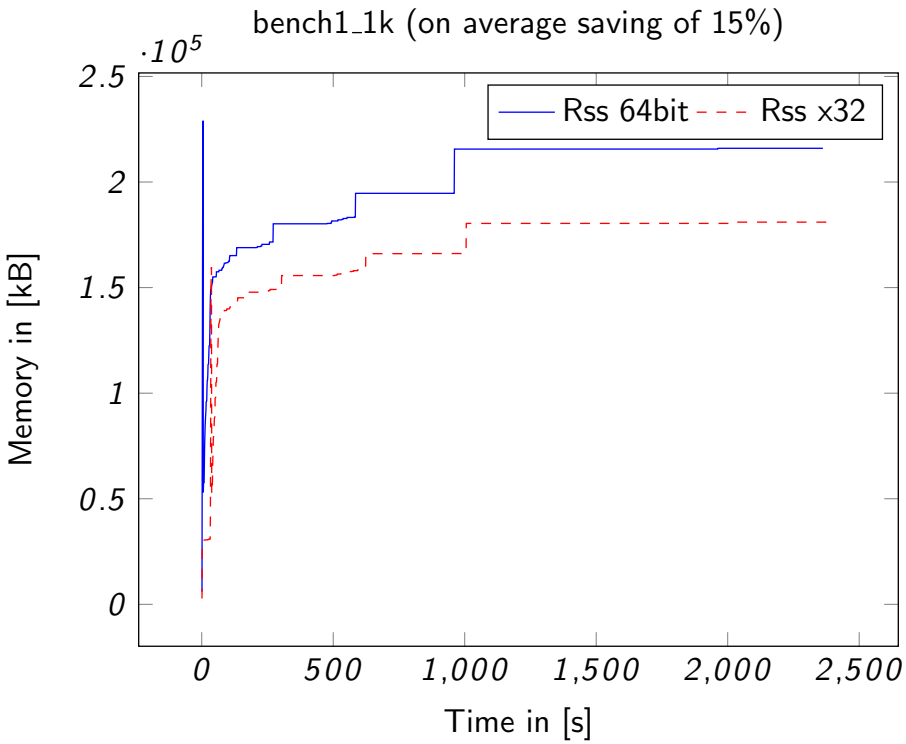
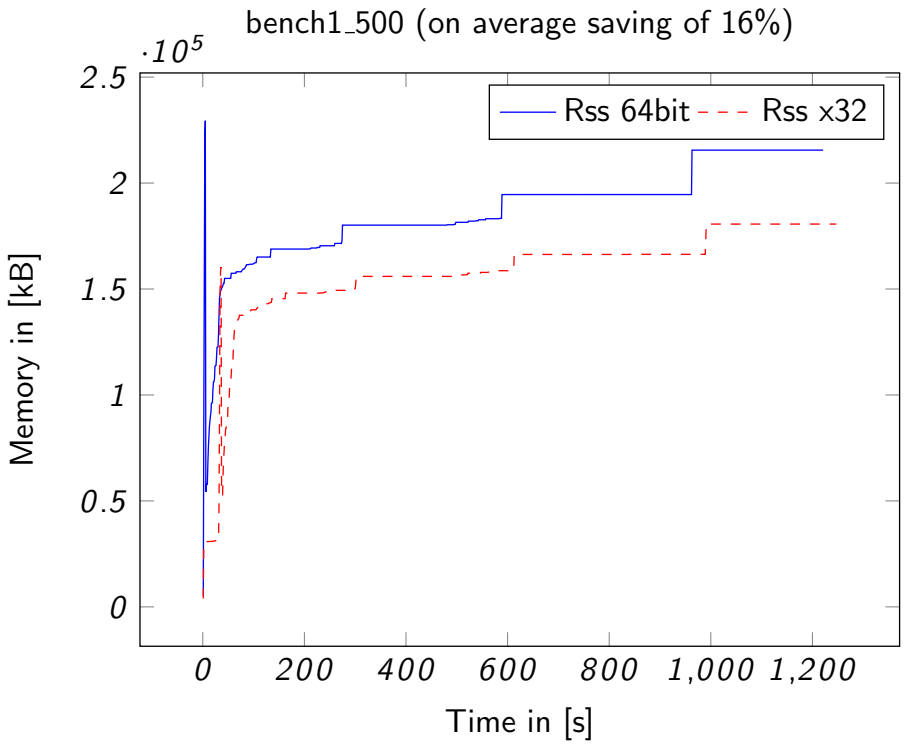
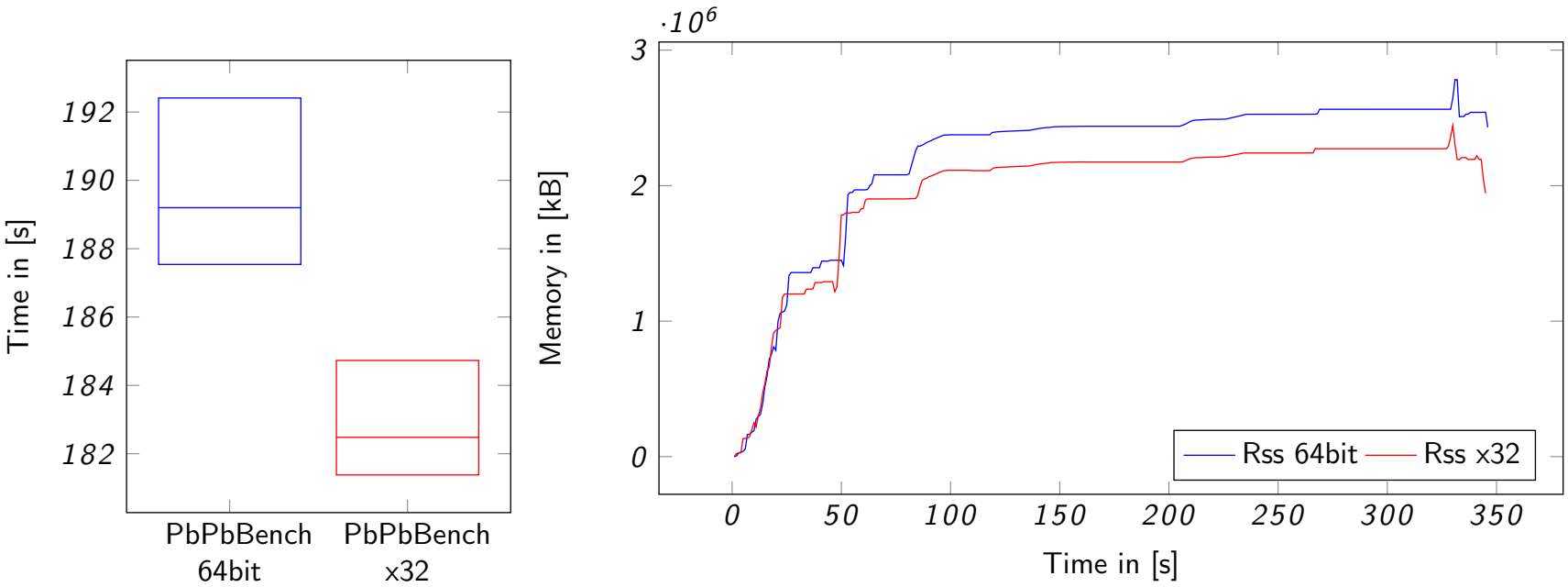




Results for Alice PbPbBench (Reconstruction only)



2012 Results: LHCb stripping (saving around 25%)

Deployment in CernVM-FS

- Available from within CernVM (part of next production release)
  `http://cernvm.cern.ch/releases/ucernvm-images.2.3-0.cernvm.x86_64/`

```
mount --bind /dev /opt/x32-v02/dev
mount --bind /proc /opt/x32-v02/proc
mount --bind /sys /opt/x32-v02/sys
mount --bind /etc/resolv.conf /opt/x32-v02/etc/resolv.conf
chroot /opt/x32-v02 bash
```

- Export from CernVM as a Docker Container (runs on latest Ubuntu and OpenSuSE)

```
cd /opt/x32-v02
mv etc/resolv.conf etc/resolv.conf.buildstage
tar cfz lfs-x32.tar.gz \
bin etc home lib libx32 media mnt opt root sbin srv tmp usr var
cat lfs-x32.tar.gz | docker import - <IMAGE NAME>
```

- Reasonably new (glibc 2.21, gcc 4.9, Python 2.9), enough prerequisites to compile ROOT 5, Geant 4, AliRoot can be used to bootstrap a new x32 environment

Pitfalls

- 4 GB memory limit per process
- sizeof(long) == 4 [Satisfying sizeof(long) == sizeof(void *)]
  - Random number generators might produce sequence different from x86_64
- Assembler usually not source code compatible
- Linux core packages trouble indicator: From about 120 packages (bash, grep, gcc, coreutils, gmp, ...)
  - Patches necessary for libffi, findutils, openssl
  - Special build options to disable assembler: boost, libjpeg
  - Some test cases fail: elfutils
  - A few percent of packages require inspection and special treatment
- Simple fixes necessary to ROOT 5 build system
- ZEBRA memory manager crashes, impact on event generators

Summary

- Some gain in memory footprint (reasonably to expect between 10 and 20 %)
- Small gain in CPU time
- ROOT6: x32 target available, but currently untested (dependent on latest LLVM version)
- Container technology
  - requires recompilation of software stack
  - allows for deployment at scale
- Experimental x32 available in CernVM