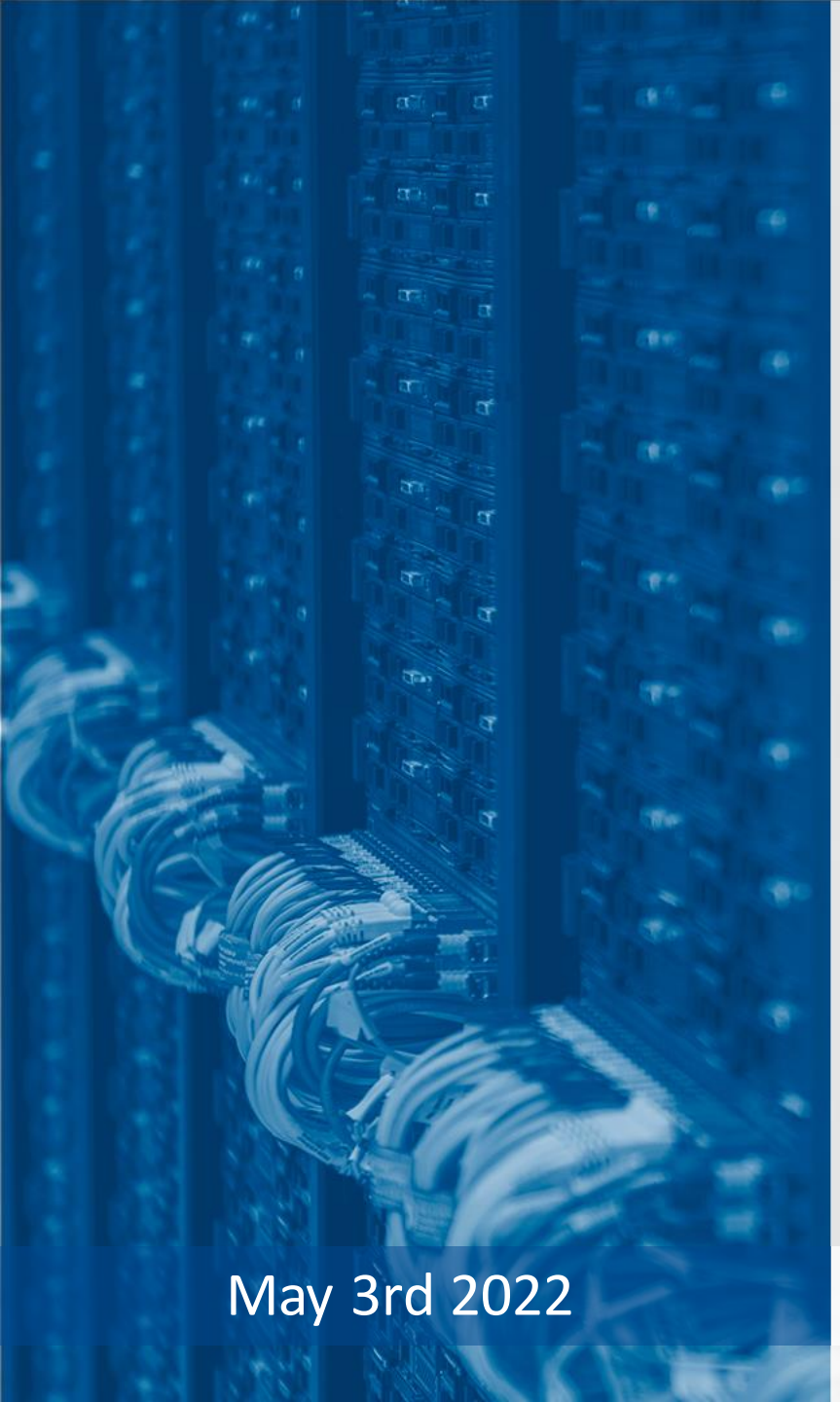


Barcelona Supercomputing Center
Centro Nacional de Supercomputación

SW Toolchain for RISC-V Vector Extensions

Roger Ferrer Ibáñez
roger.ferrer@bsc.es

May 3rd 2022

Spring 2022 – RISC-V Week - Paris

Acknowledgements

European Processor Initiative

THE EUPILOT

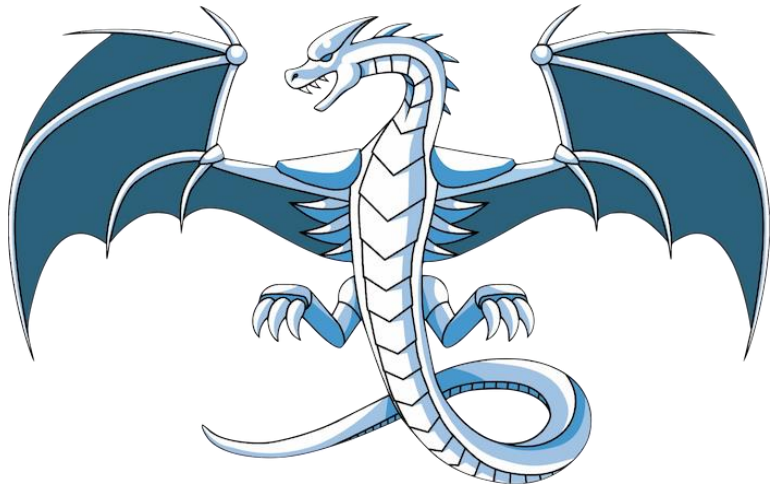
Pilot using Independent Local & Open Technologies

MEEP

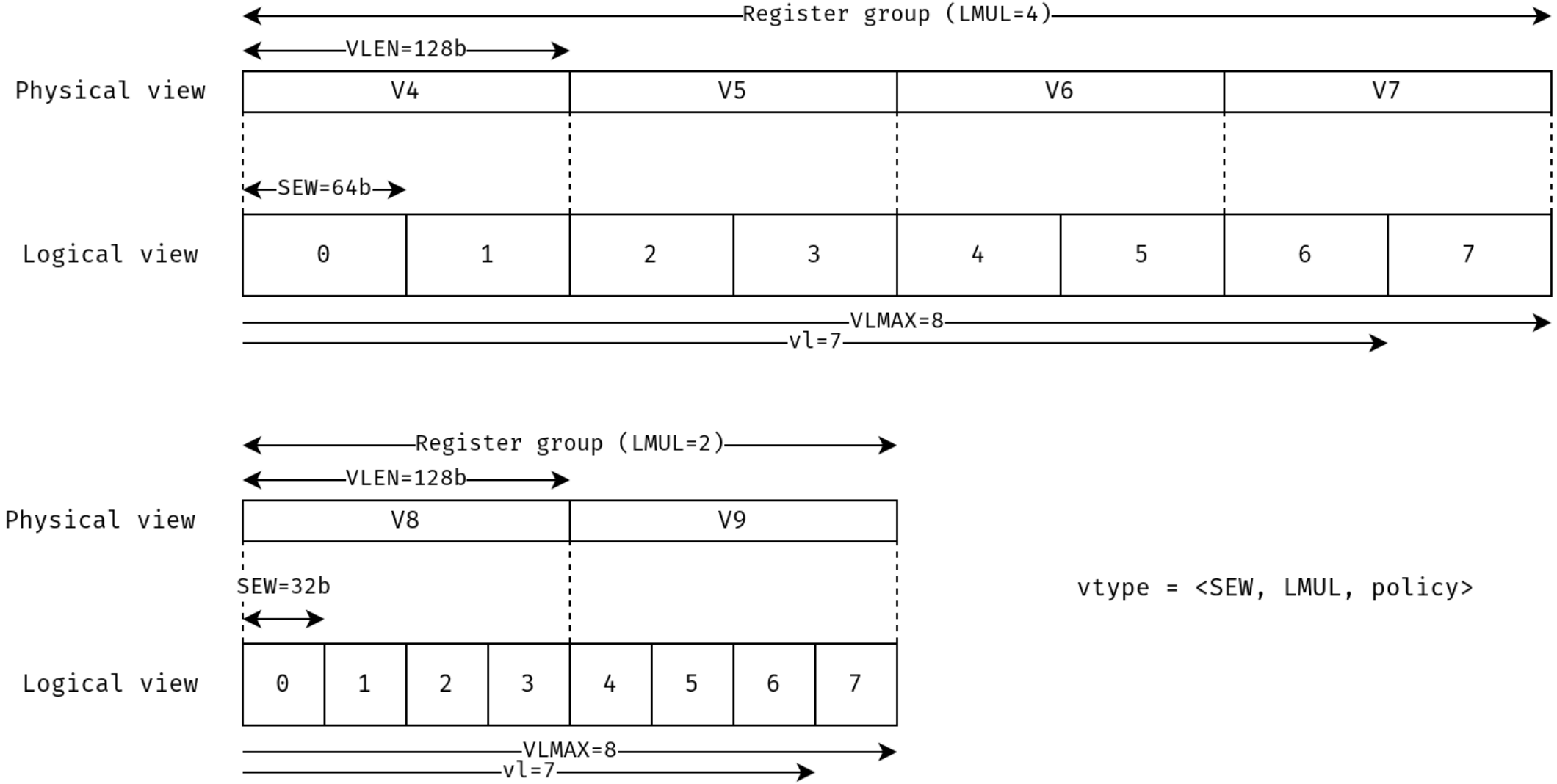
MareNostrum Experimental Exascale Platform

Barcelona Supercomputing Center

Centro Nacional de Supercomputación



RISC-V Vector Extension (RVV)



vtype = <SEW, LMUL, policy>

Flexibility

Photo by Benn McGuinness on Unsplash

Challenges in code generation

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

RVV Architectural State and Instructions

```
%dc  = fadd <2 x double> %da, %db
%sc  = fadd <4 x float> %sa, %sb
%sc2 = fadd <8 x float> %sa2,
%sb2
%sch = fadd <2 x float> %sah,
%sbh
```



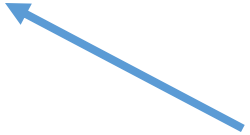
```
vfadd.vv
```

```
VLEN=128b
→ vl=2, sew=64, lmul=1
→ vl=4, sew=32, lmul=1
→ vl=8, sew=32, lmul=2
→ vl=2, sew=32, lmul=1/2
```

Current approach

```
%sc   = fadd <4 x float> %sa, %sb          VLEN=128b
```

```
%3:vr = nofpexcept PseudoVFADD_VV_M1 %0:vr, %1:vr, -1, 5, implicit $frm
```



vl=VLMAX vtype=<sew=32,lmul=1>

What about setting the context

```
%3:vr = nofpexcept PseudoVFADD_VV_M1 %0:vr, %1:vr, -1, 5, implicit $frm
```

```
dead %4:gpr = PseudoVSETVLIX0 $x0, 80, implicit-def $vl, implicit-def $vtype

%3:vr  = nofpexcept PseudoVFADD_VV_M1 %0:vr, %1:vr, -1, 5,
                    implicit $frm, implicit $vl, implicit $vtype
```

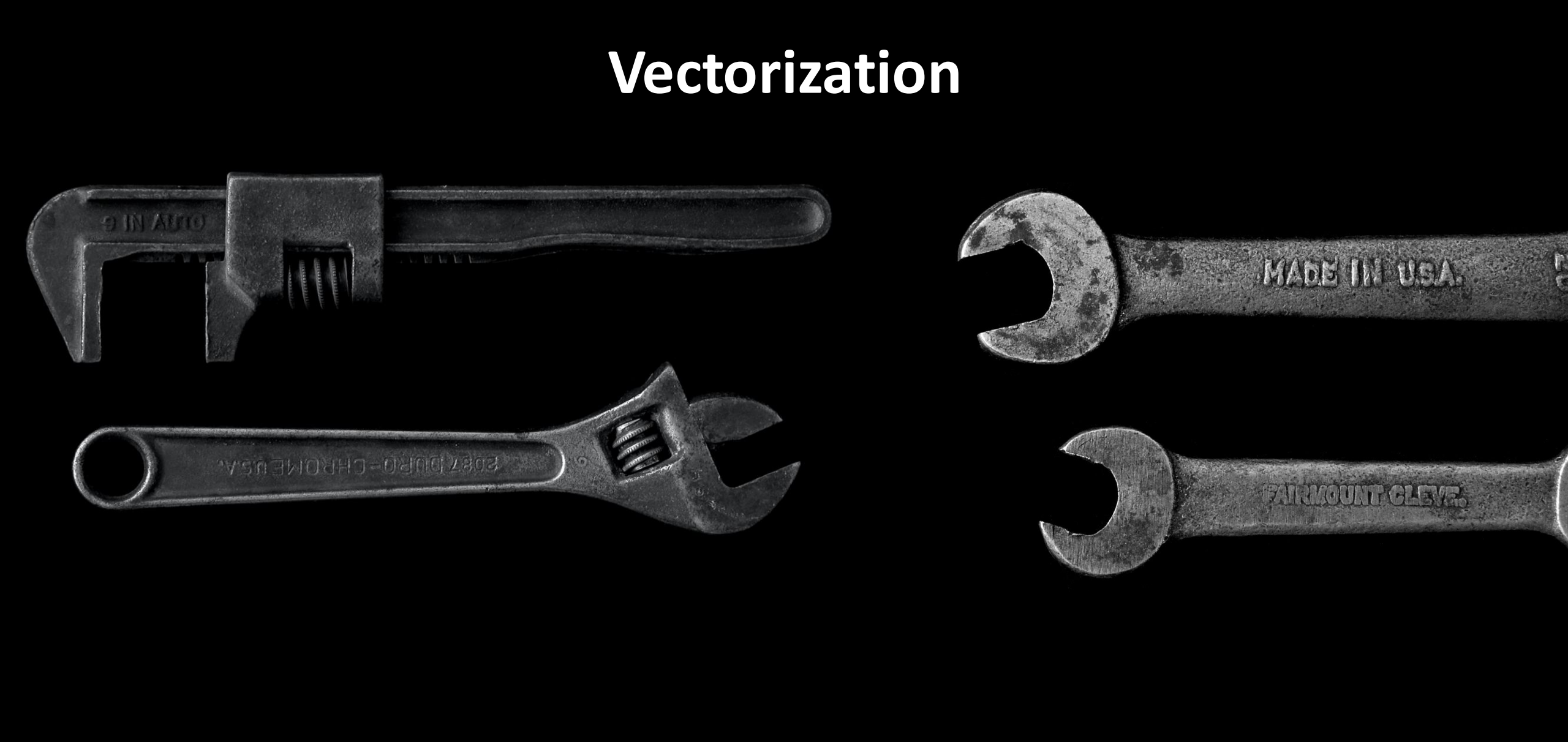
Challenges that impact the user of RVV

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Intrinsics

Photo by Annie Spratt on Unsplash

Vectorization



Photos by Matt Artz on Unsplash

LLVM and predication

Image by AxxLC from Pixabay

Vector Predication

Scalar operation (add two double precision values)

```
%sc = fadd double %sa, %sb
```

Element-wise extension to whole vectors (add two double precision vector values)

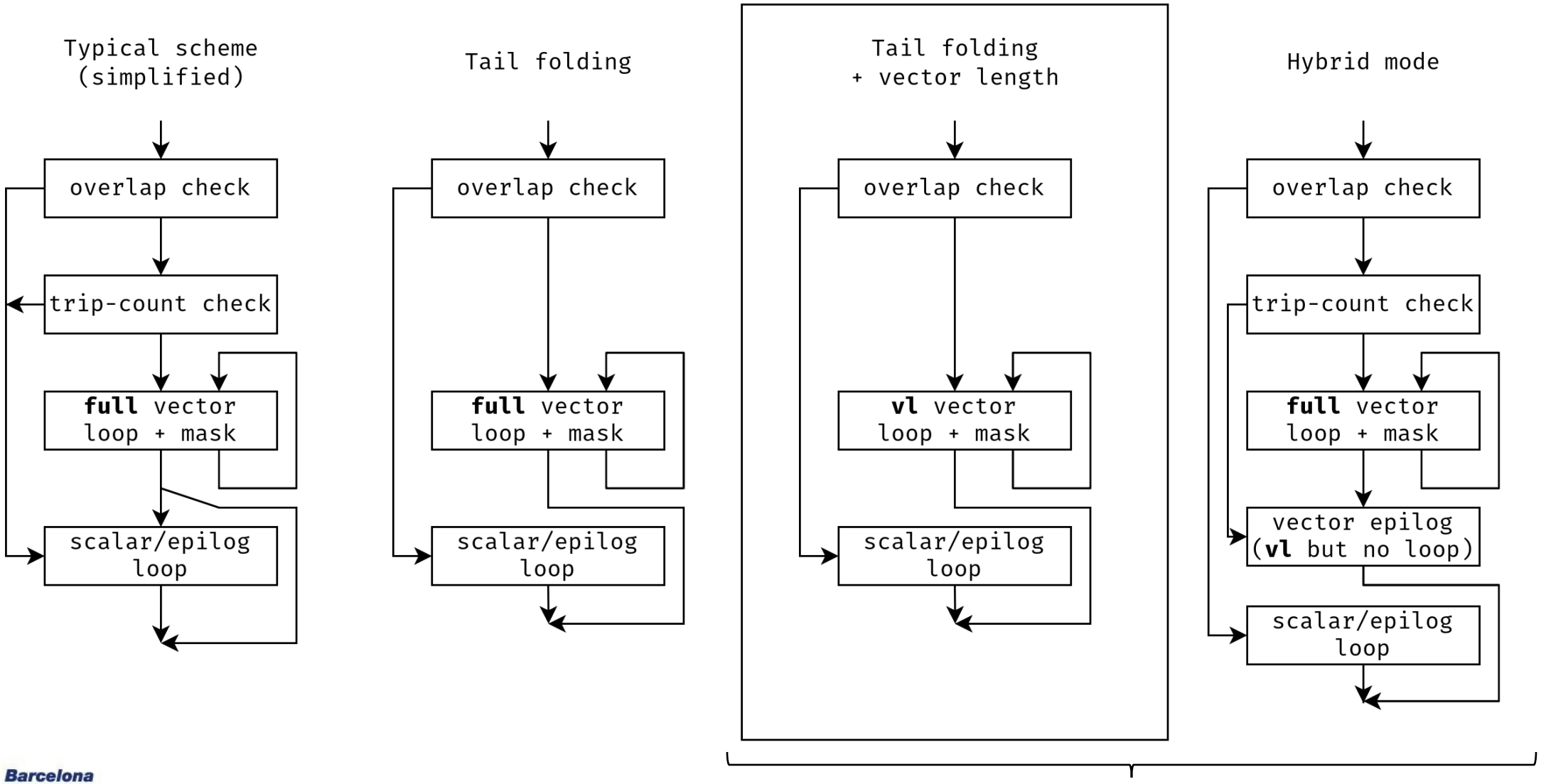
```
%vc = fadd <8 x double> %va, %vb
%vla.c = fadd <vscale x 1 x double> %vla.a, %vla.b
```

Vector Predication allows us to specify mask and vector length operands

```
%vc = call <8 x double> @llvm.vp.fadd.nxv1f64(
             <8 x double> %vla.a,
             <8 x double> %vla.b,
             <8 x i1> %mask, i32 %vl)

%vla.c = call <vscale x 1 x double> @llvm.vp.fadd.nxv1f64(
               <vscale x 1 x double> %vla.a,
               <vscale x 1 x double> %vla.b,
               <vscale x 1 x i1> %mask, i32 %vl)
```

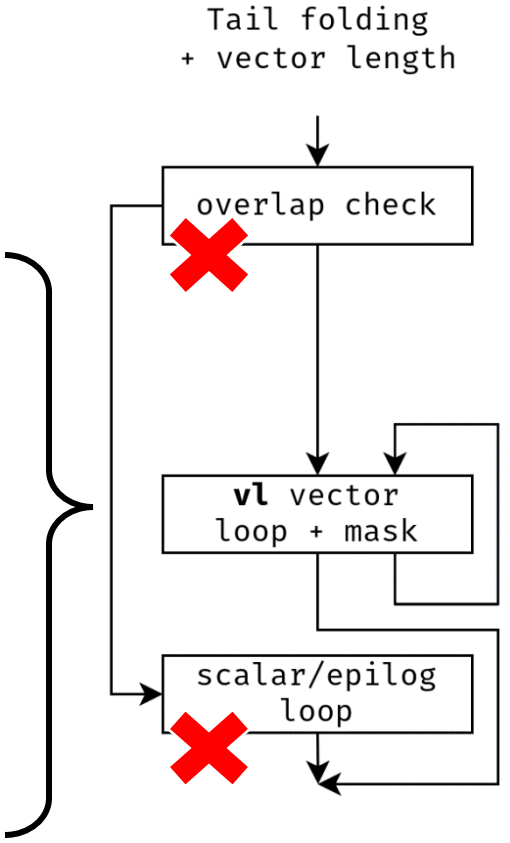
Loop Vectorisation at EPI



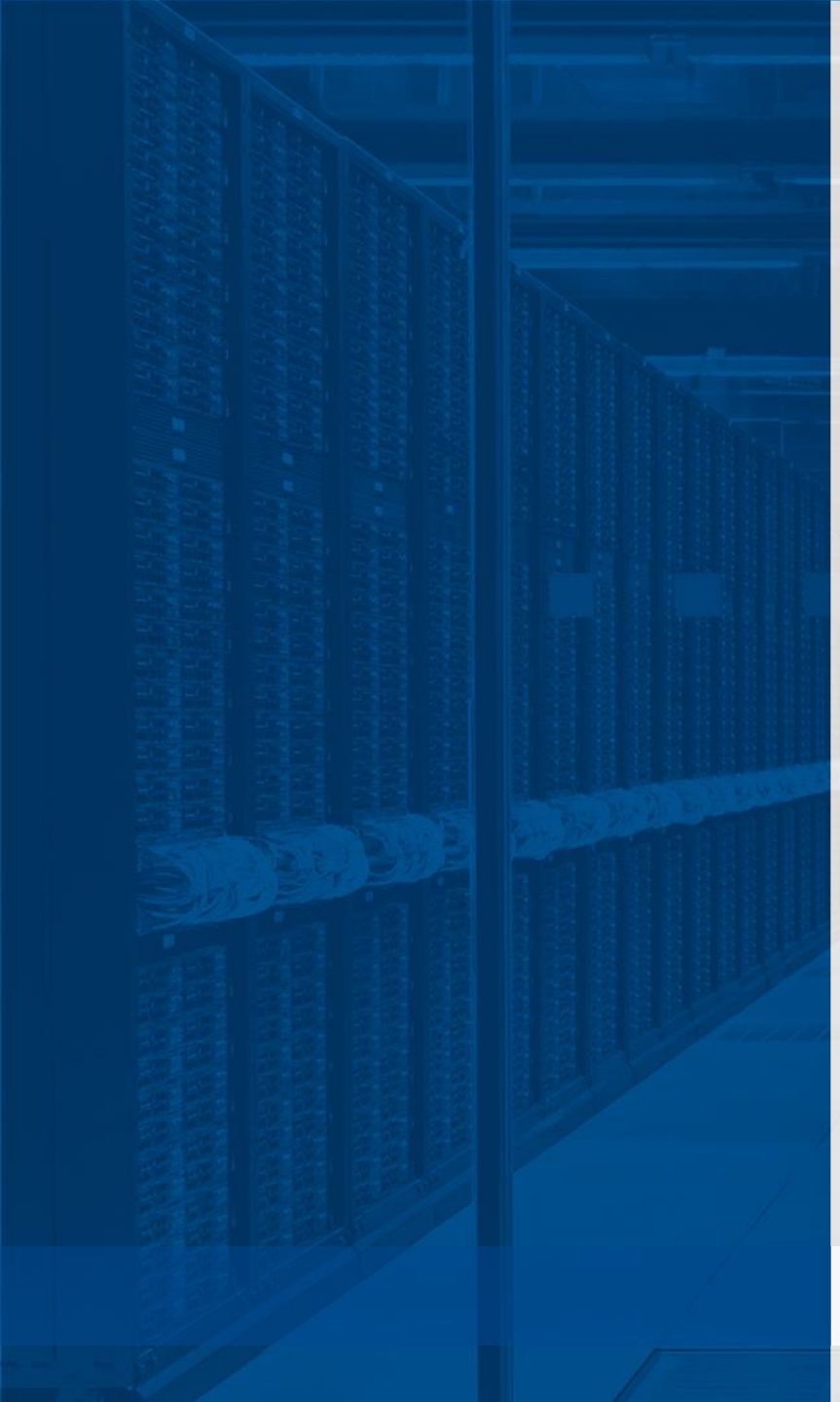
Example DAXPY kernel

```
void daxpy(double a,
           double * restrict dx,
           double * restrict dy,
           int n) {
  for (int i = 0; i < n; i++) {
    dy[i] += a * dx[i];
  }
}
```

```
daxpy:
        blez    a2, .LBB0_3
        li      a3, 0
        slli    a2, a2, 32
        srli    a6, a2, 32
.LBB0_2:
        slli    a4, a3, 3
        add     a5, a0, a4
        sub     a2, a6, a3
        vsetvli a2, a2, e64, m1, ta,
mu
        vle64.v v8, (a5)
        add     a4, a4, a1
        vle64.v v9, (a4)
        vfmacc.vf       v9, fa0, v8
        add     a3, a3, a2
        vse64.v v9, (a4)
        bne     a3, a6, .LBB0_2
.LBB0_3:
        ret
```



You can try it at
https://repo.hca.bsc.es/epic/z/iBdt4p



Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Thank you!

The European Processor Initiative (EPI) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement EPI-SGA1: 826647 and under EPI-SGA2: 101036168. Please see http://www.european-processor-initiative.eu for more information.

The EPI-SGA2 project, PCI2022-132935 is also co-funded by MCIN/AEI /10.13039/501100011033 and by the UE NextGenerationEU/PRTR.

The European PILOT project has received funding from the European High-Performance Computing Joint Undertaking (JU) under grant agreement No.101034126. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Spain, Italy, Switzerland, Germany, France, Greece, Sweden, Croatia and Turkey.

The MEEP project has received funding from the European High-Performance Computing Joint Undertaking (JU) under grant agreement No 946002. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Spain, Croatia, Turkey

roger.ferrer@bsc.es