Insert Title here

Gliederung

1)Allgemeines

2)Zugriffsmuster: Copy Kernel

3)Zugriffsmuster: Strided Access

4)Zugriffsmuster: Offset Access

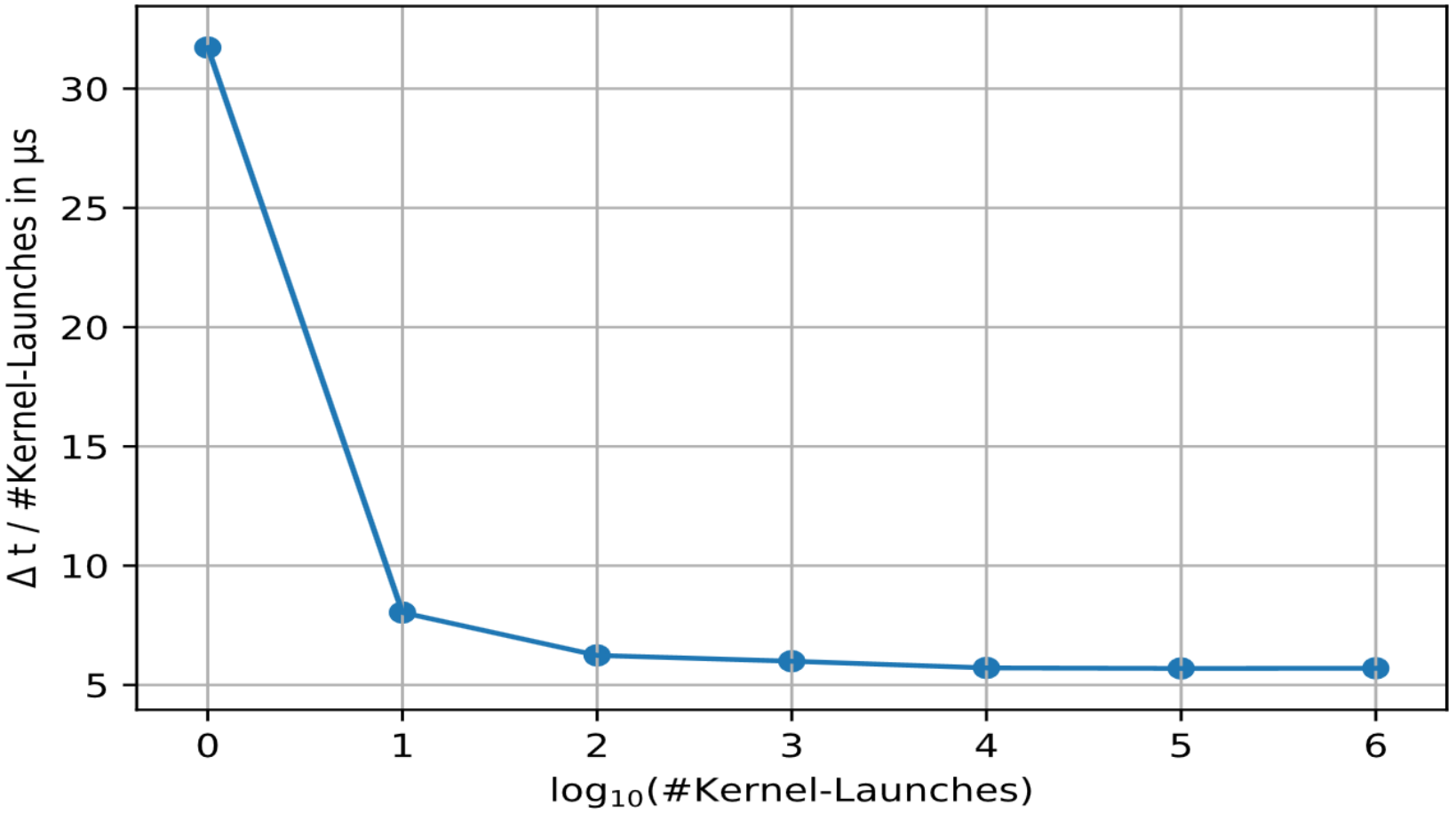
5)Allokation: Standard und UnifiedMemory

6)Kommunikation zwischen Threads

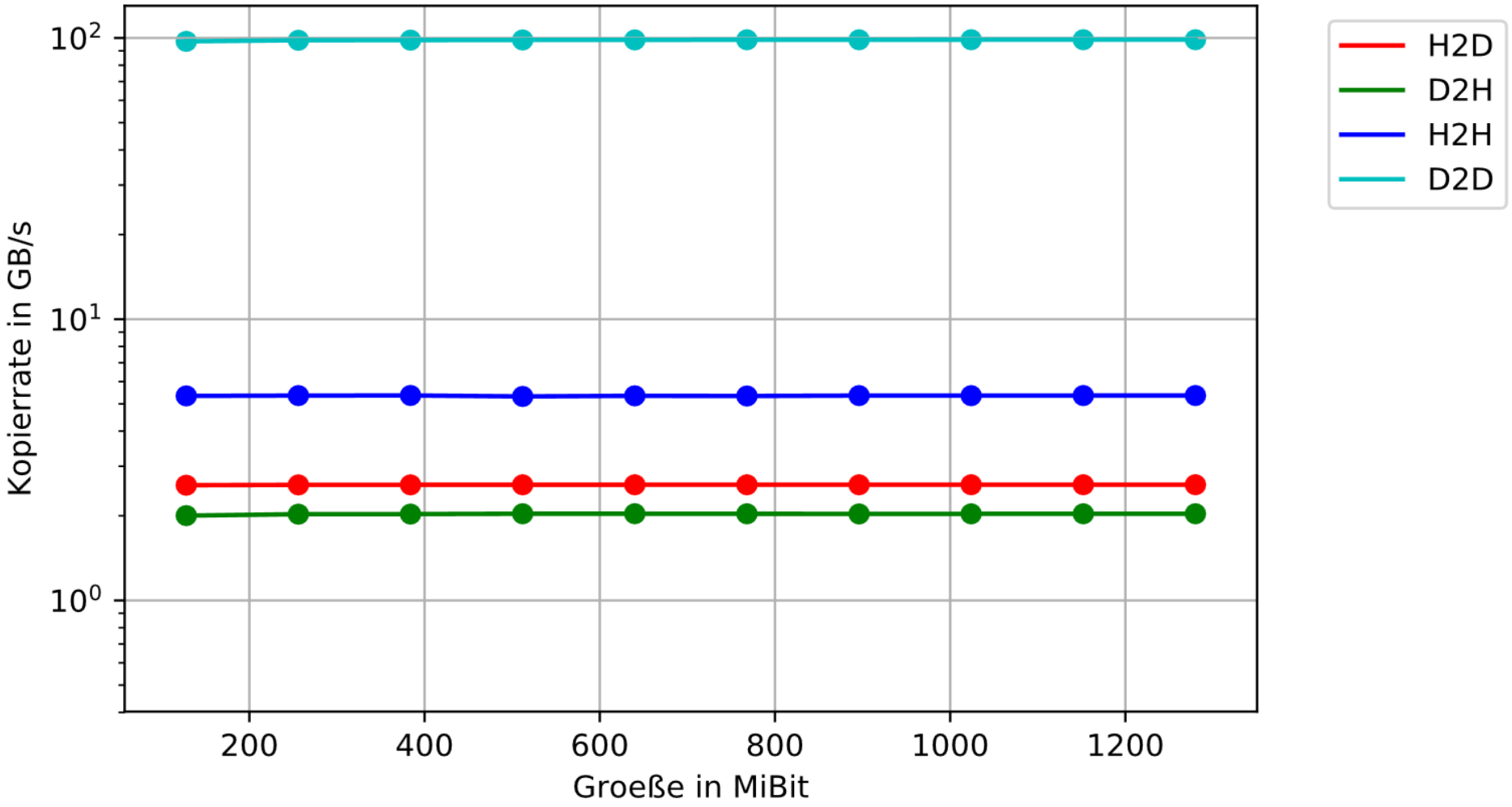
GTX 1070

- Cores 1920
- Basistaktung 1506 MHz
- Standard-Speicherkonfiguration 8 GB GDDR5
- Speicherbandbreite 256 GB/s

Empty Kernel – Startup Cost



Datenkopierrate CudaMemcpy



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Copy Kernel

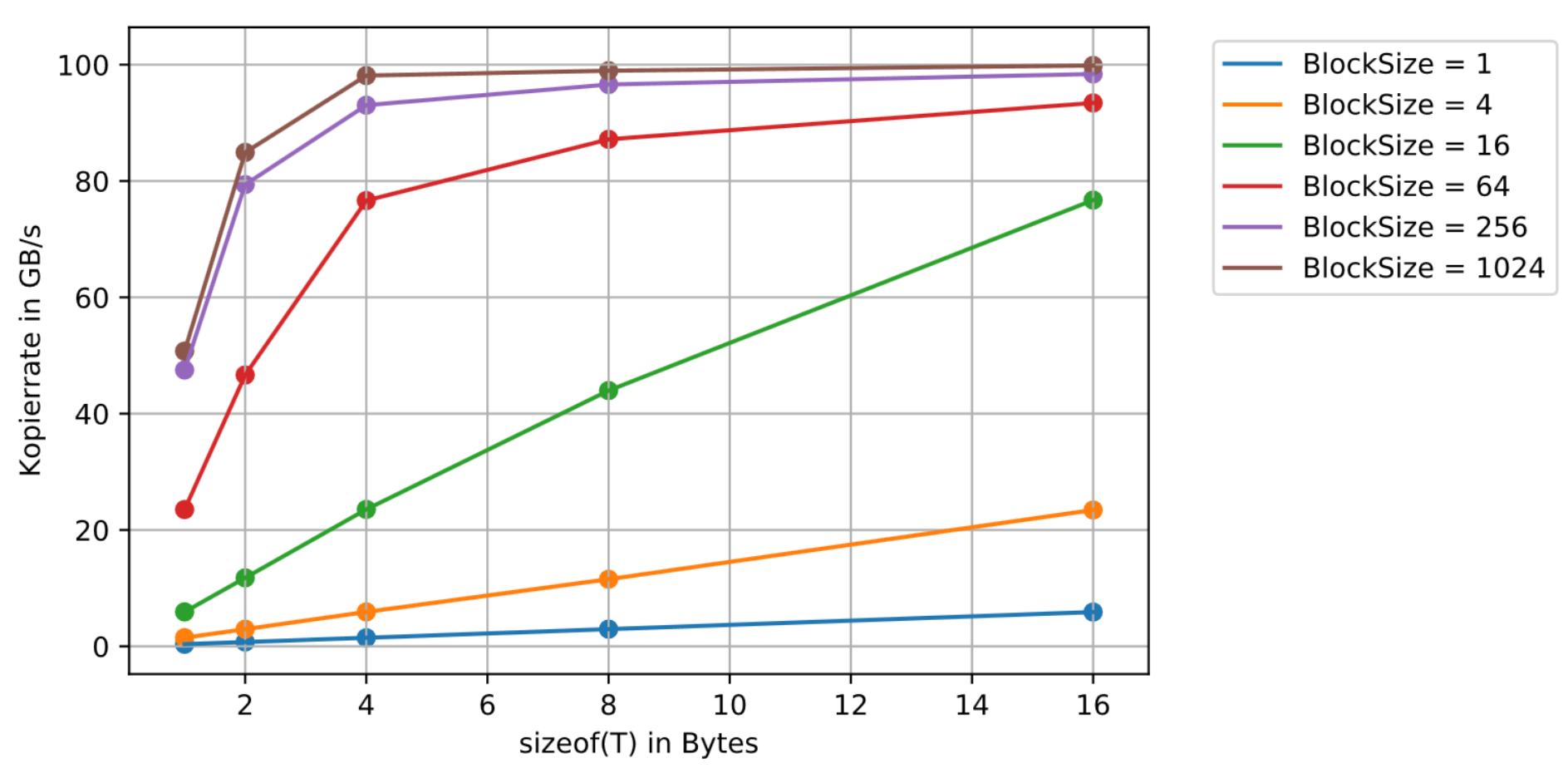
```
//Kernel definition
template<typename T>
__global__
void copyKernel(T* out, T* in) {
        unsigned id = threadIdx.x + blockIdx.x * blockDim.x;

        out[id] = in[id];
}
```

Parameter:

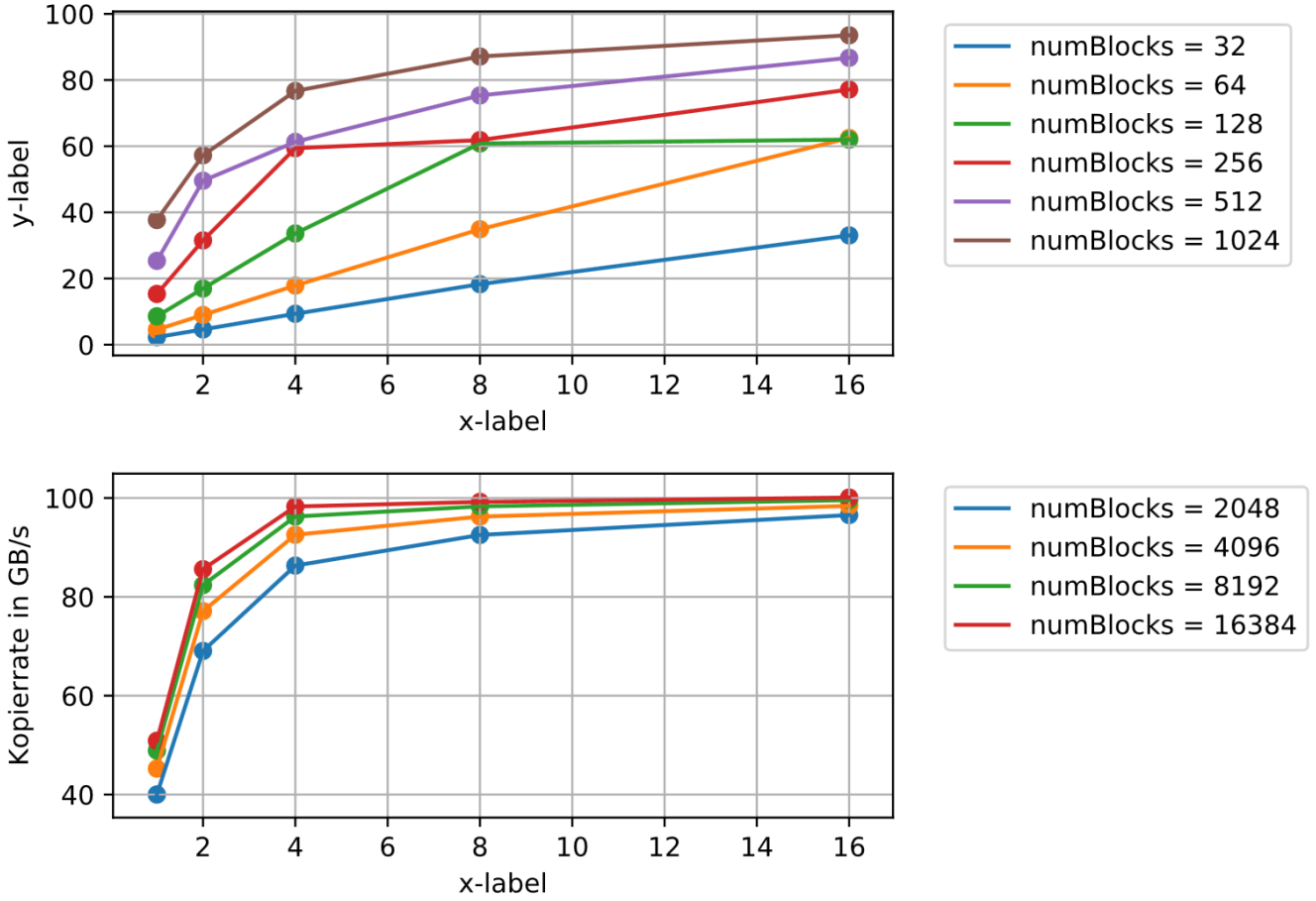
- Blockgröße
- Anzahl der Blöcke
- Zugriffstypen T (zB. char, int...)

Copy Kernel – BlockSize & sizeof(T)



Copy Kernel – Number of Blocks

- BlockSize = 1024



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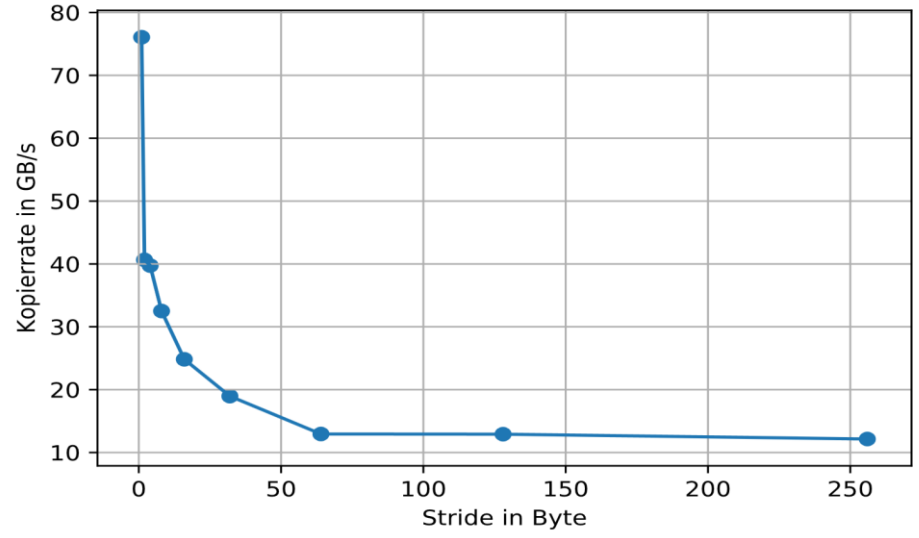
Strided Access

```
//Kernel definition
template<typename T>
__global__
void copyKernel(T* out, T* in, int stride) {
        unsigned id = threadIdx.x + blockIdx.x * blockDim.x;
        out[id*stride] = in[id*stride];
}
```

- Zugriff nicht mehr auf jedes Element konsekutiv hintereinander, sondern auf jedes N-te Element
- Bei elementarem Zugriff sollte sich die Kopierrate nicht ändern (Wenn übersprungene Elemente nicht mitgezählt werden)

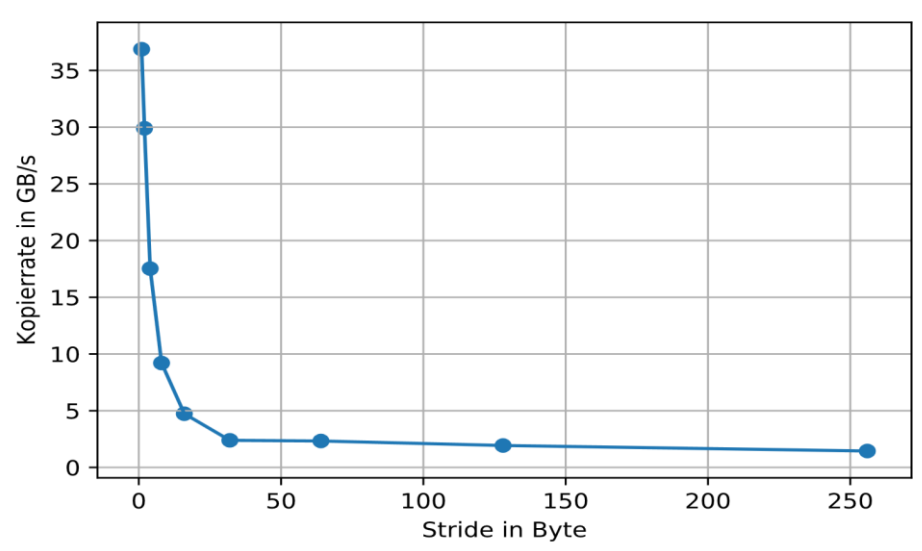
Strided Access

- Blockgröße = 128 Threads
- Blockanzahl = 2048
- Zugriffstyp: int4 (sizeof(int4) = 16)
- stride = 1,2,4,8,16,32,64,128,256



Strided Access II

- Blockgröße = 256 Threads
- Blockanzahl = 8192
- Zugriffstyp: char (sizeof(char) = 16)
- stride = 1,2,4,8,16,32,64,128,256



Strided Access: Beobachtungen

- Zwei fast gleiche Werte jeweils bei sizeof(T) * stride = 32 und 64
- Ab sizeof(T) * stride = 1024 wenn überhaupt nur noch vernachlässigbares Nachlassen der Kopierrate

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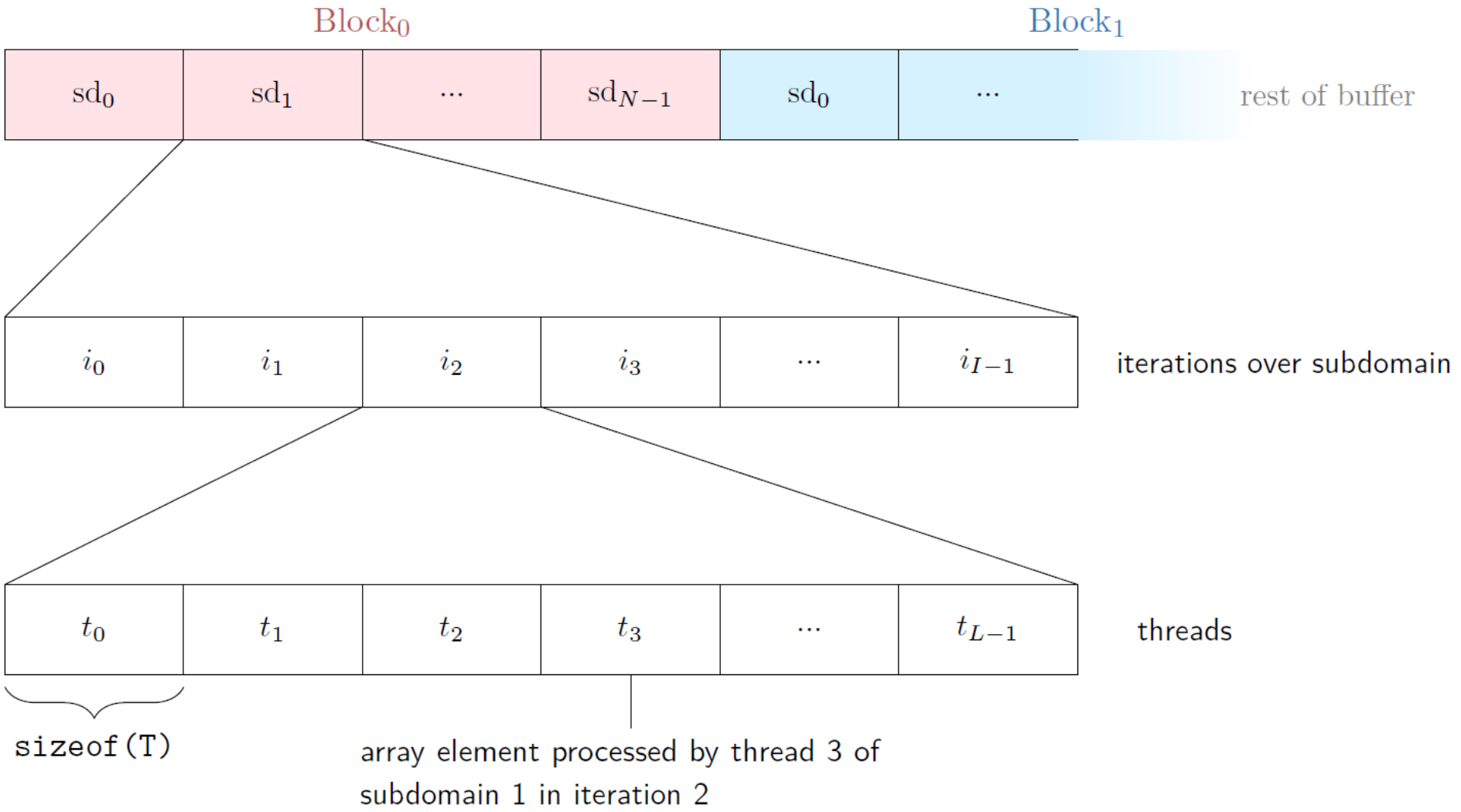
Offset Access – Zugriffsmuster

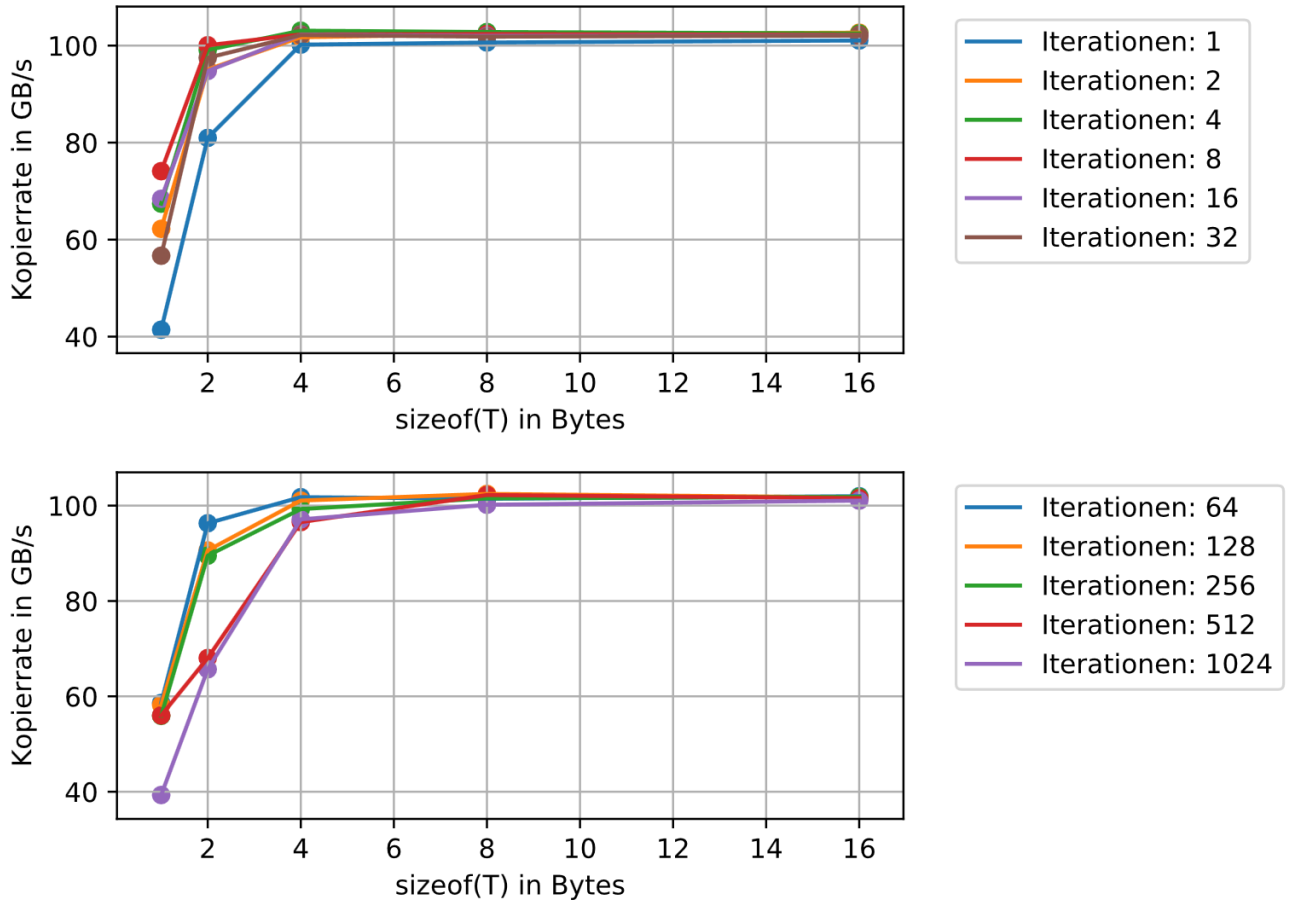


Offset Access

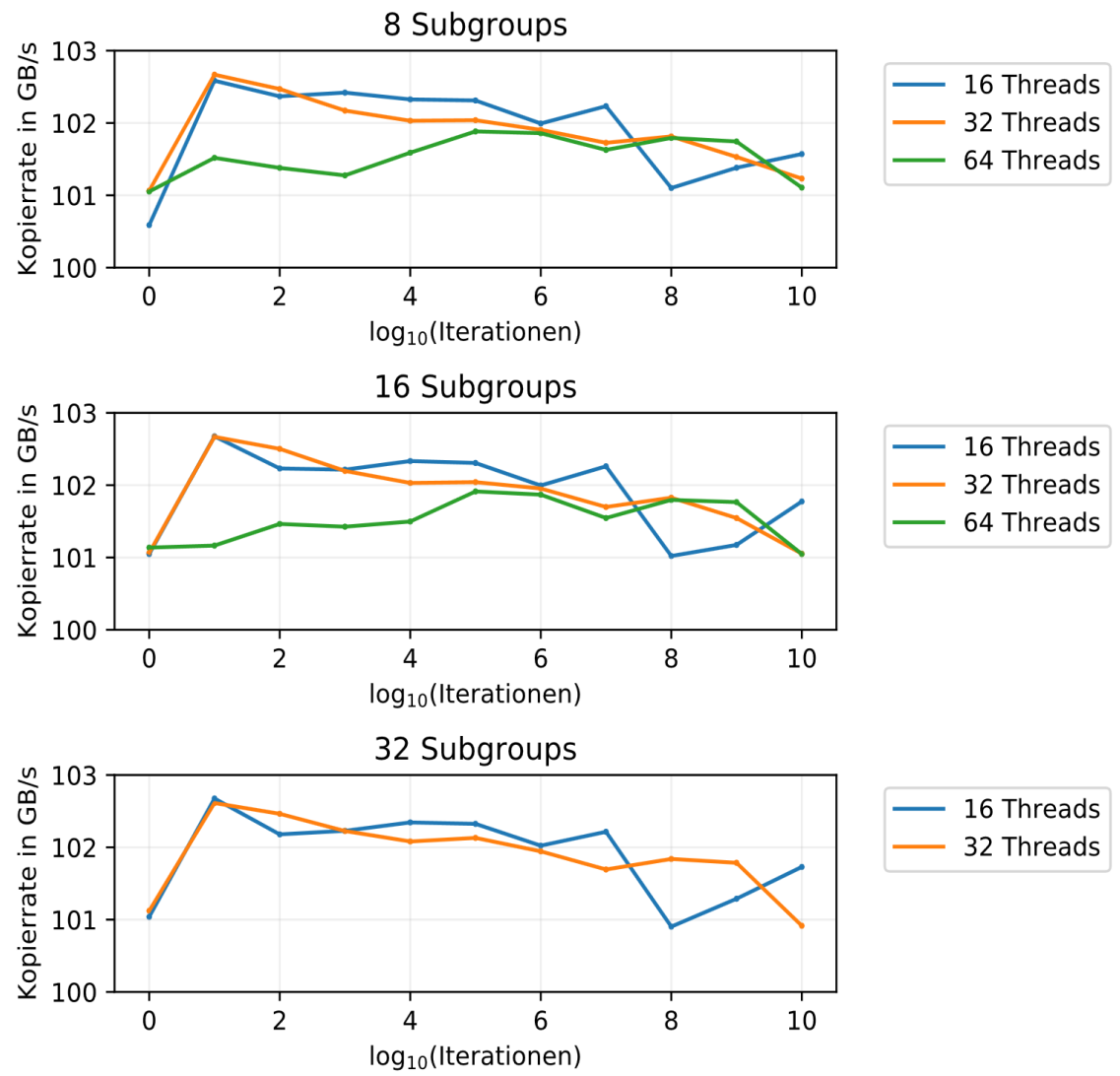
```
//Kernel definition
template<typename T>
__global__
void oftKernel (T* out,
                T* in,
                const unsigned int sd_size,
                const unsigned int block_size,
                const unsigned int I,
                const unsigned int L)
{
        const unsigned int sd_id = static_cast<int> (threadIdx.x / L); //automatically rounded down in int arithmetics
        const unsigned int id = threadIdx.x - sd_id * L;
        const unsigned int sd_start = blockIdx.x * blockDim.x * I + sd_id * L * I;

        for (unsigned int i = 0; i < I; i++)
        {
                const unsigned el_id = sd_start + i * L + id;
                ((T*) out)[el_id] = ((T*) in)[el_id];
        }
}
```

Typ und Iterationen

- 32 Threads pro Subdomäne, 16 SD pro Block

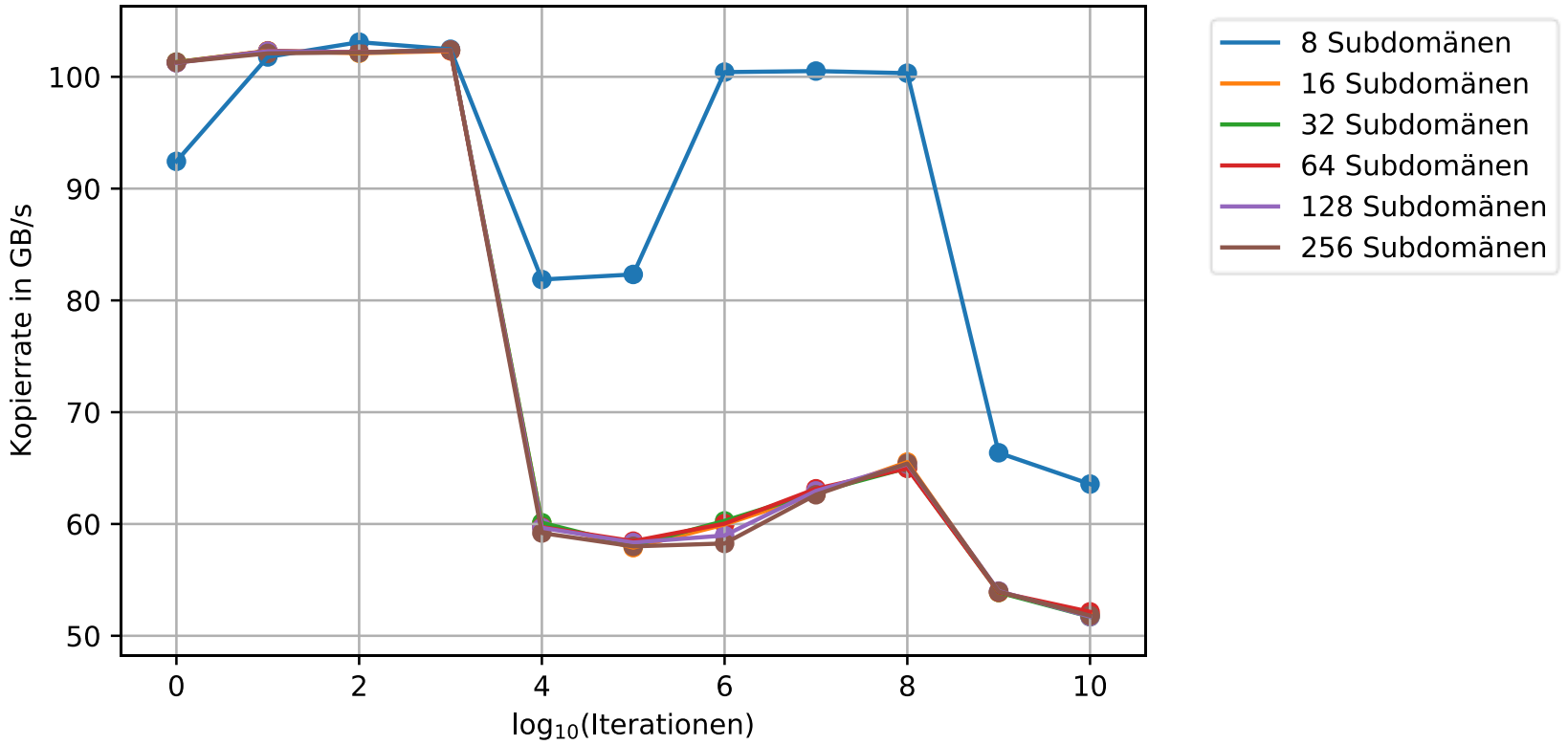


Subgroup Anzahl pro Block



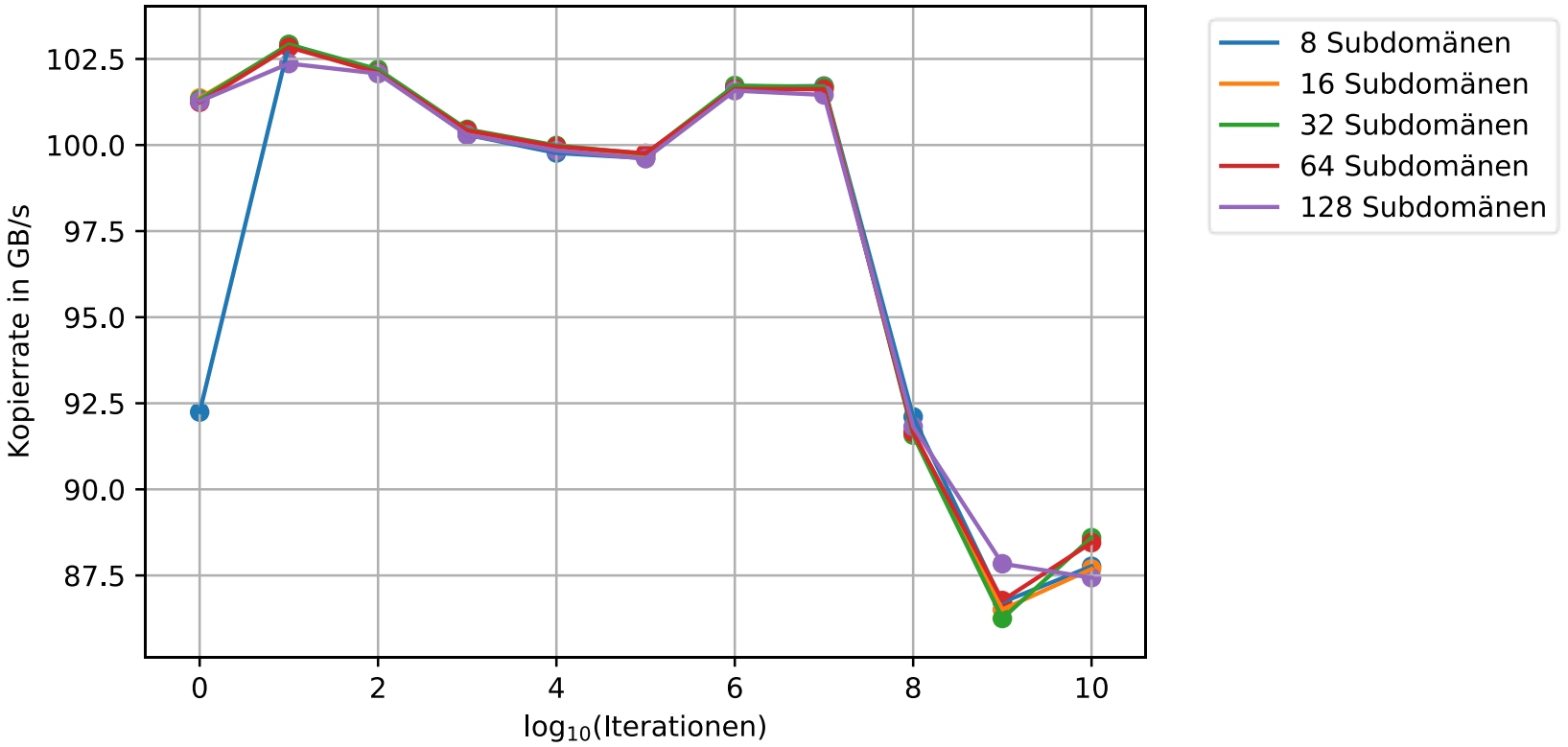
Variiere Subdomänen pro Block

4 Threads pro SD, sizeof(T) = 16



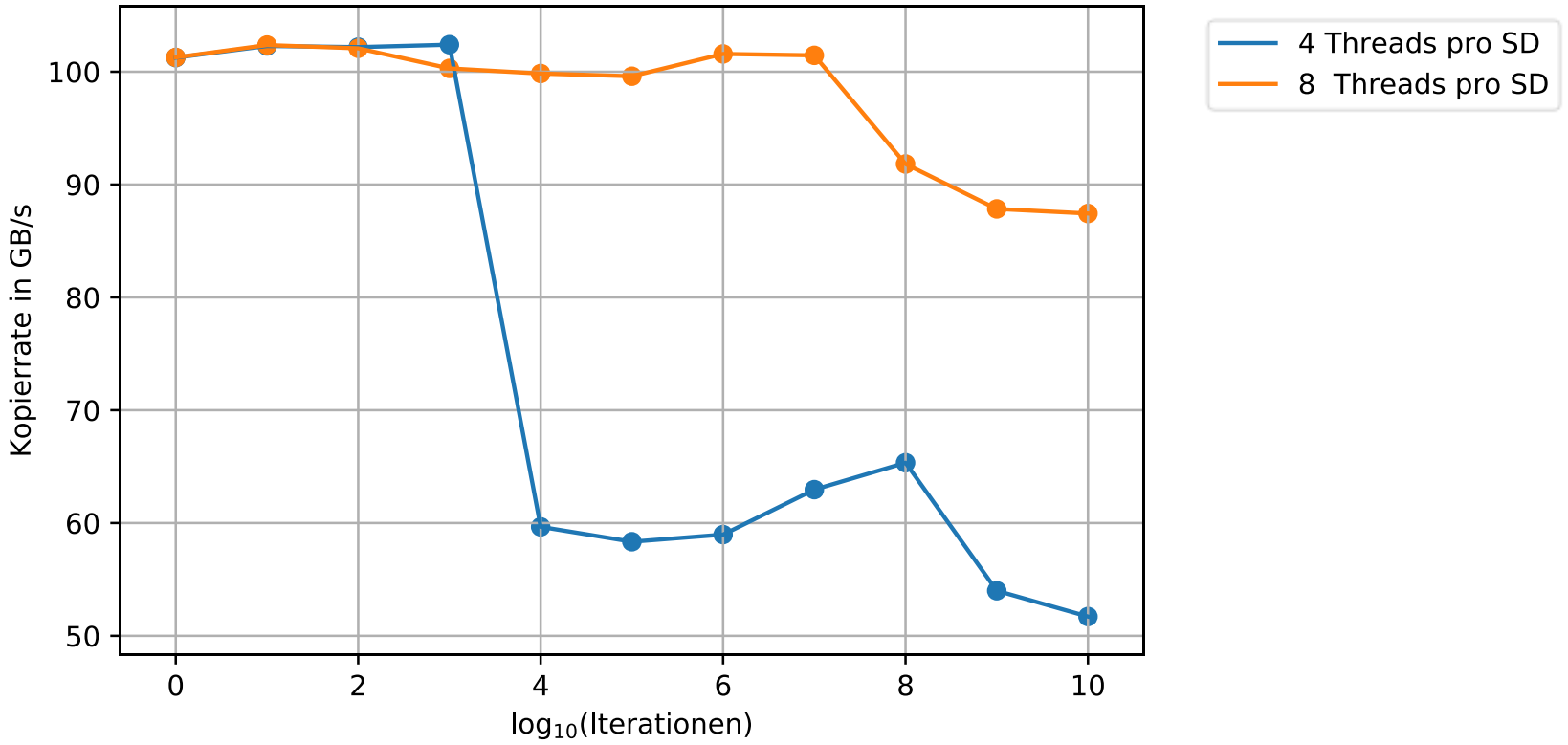
Variiere Subdomänen pro Block

8 Threads pro SD, sizeof(T) = 16



Direkter Vergleich

sizeof(T) = 16, 128 Subdomänen



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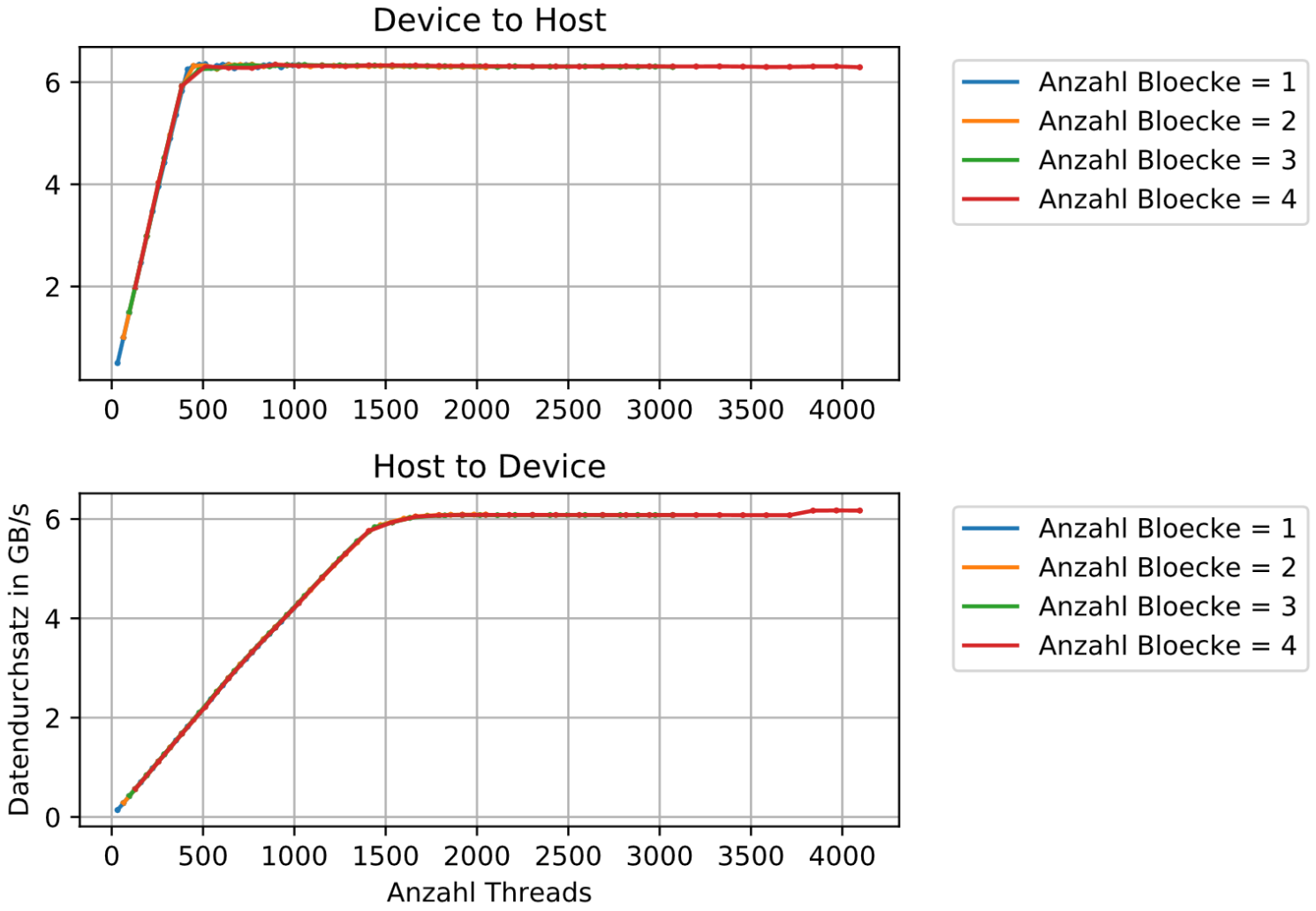
Zugriffsmuster: Copy Kernel

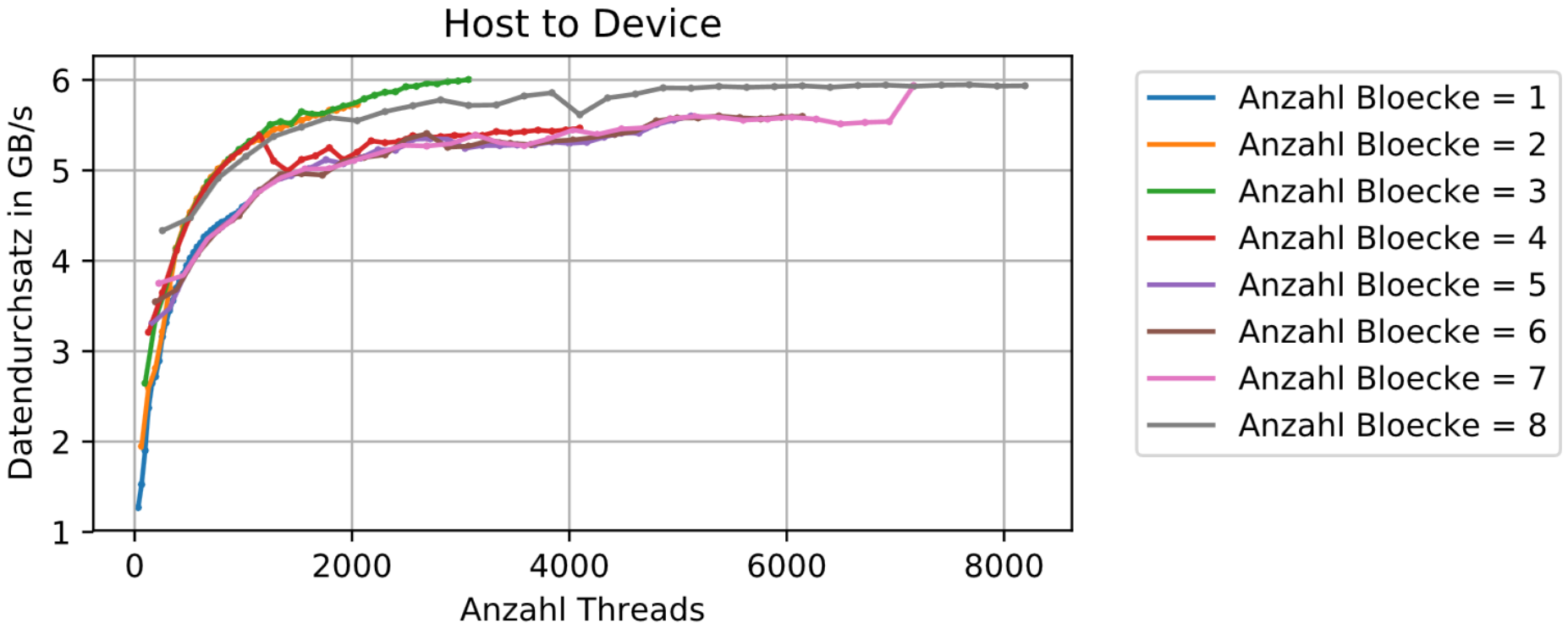
```
//Kernel definition
template<typename T>
__global__
void copyKernel (T* out,
                 T* in,
                 const unsigned int N)
{
        const unsigned int id = threadIdx.x + blockIdx.x * blockDim.x;
        for (unsigned int i= id; i < N; i = i + blockDim.x * gridDim.x)
        {
                const unsigned el_id = i;
                ((T*) out)[el_id] = ((T*) in)[el_id];
        }
}
```

CudaMalloc und CudaMallocHost



Unified Memory

- CudaMallogManaged + memset + CudaMemset



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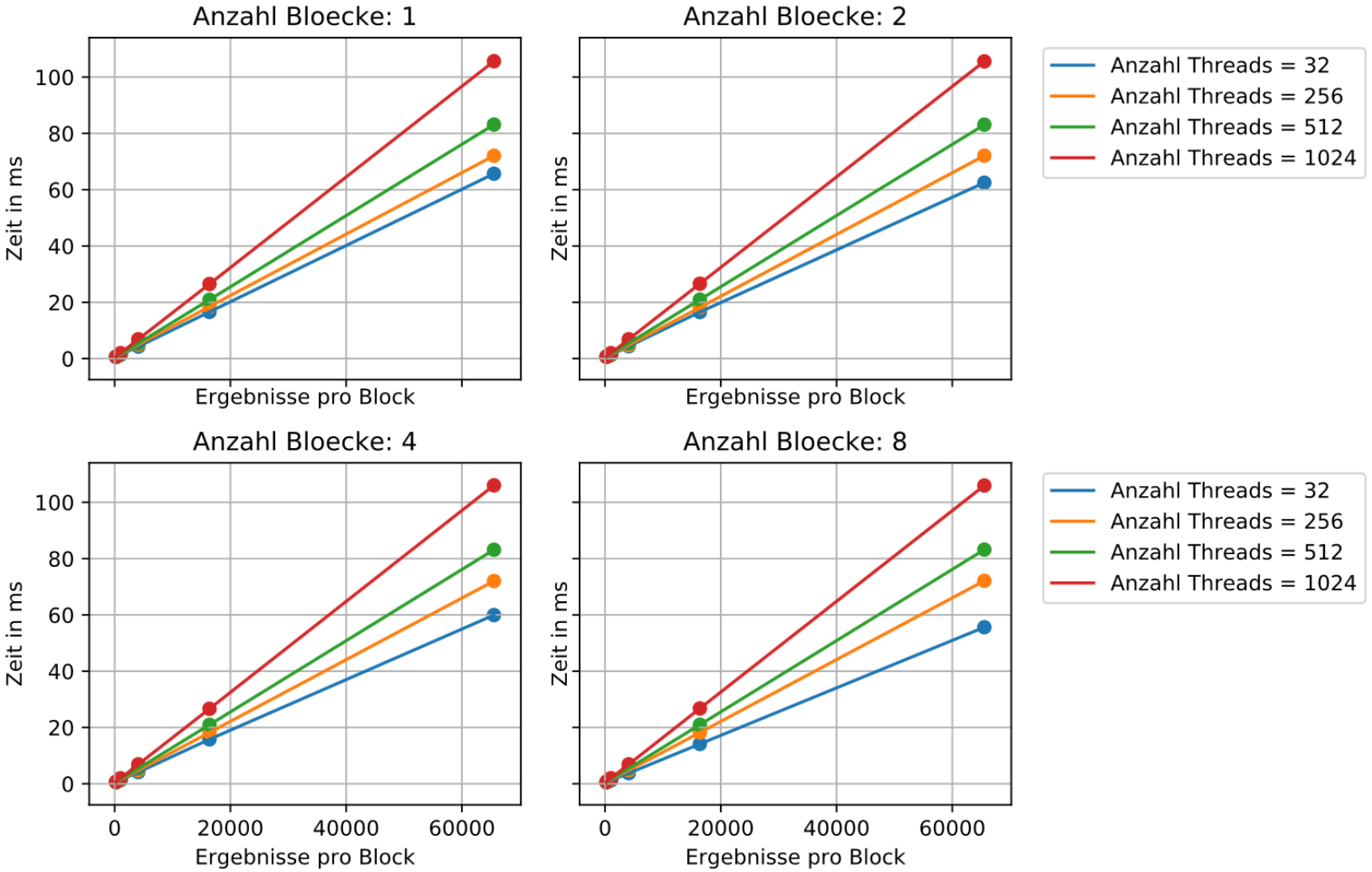
Kommunikation -Aufgabenstellung

- Was genau tat dein Code nochmal? Kann man das überhaupt in einem Satz zusammenfassen?
- Kurz gesagt ist ja die Idee darauf hinzuweisen, dass natürlich Effizienz verloren geht, wenn die Kernel aufeinander warten müssen statt einfach vor sich hin zu arbeiten

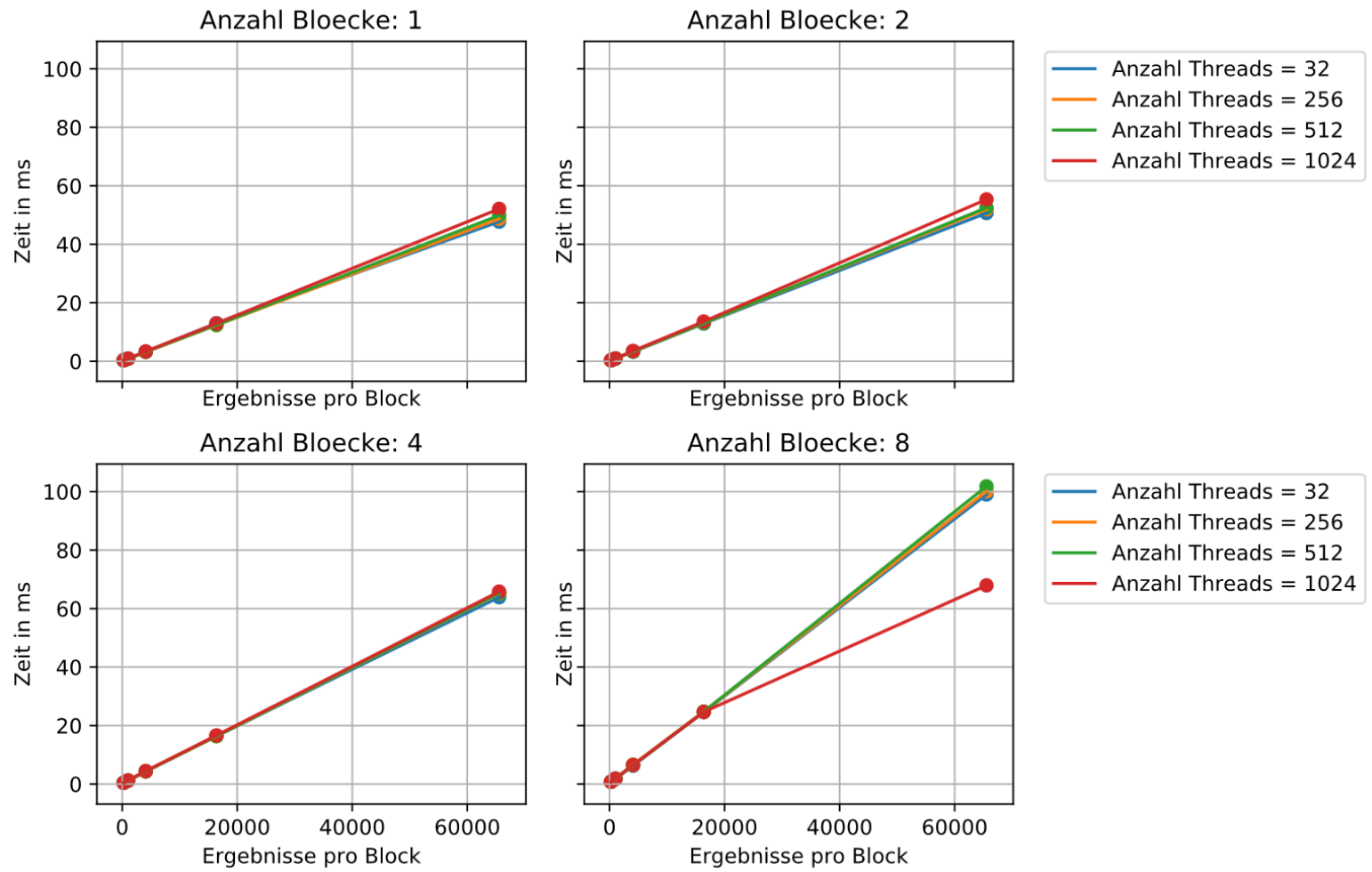
Kommunikationsmessung: Laufzeit ohne Kommunikation

Variation Ergebnisse pro Block: 256,1024,4096,16384,65536



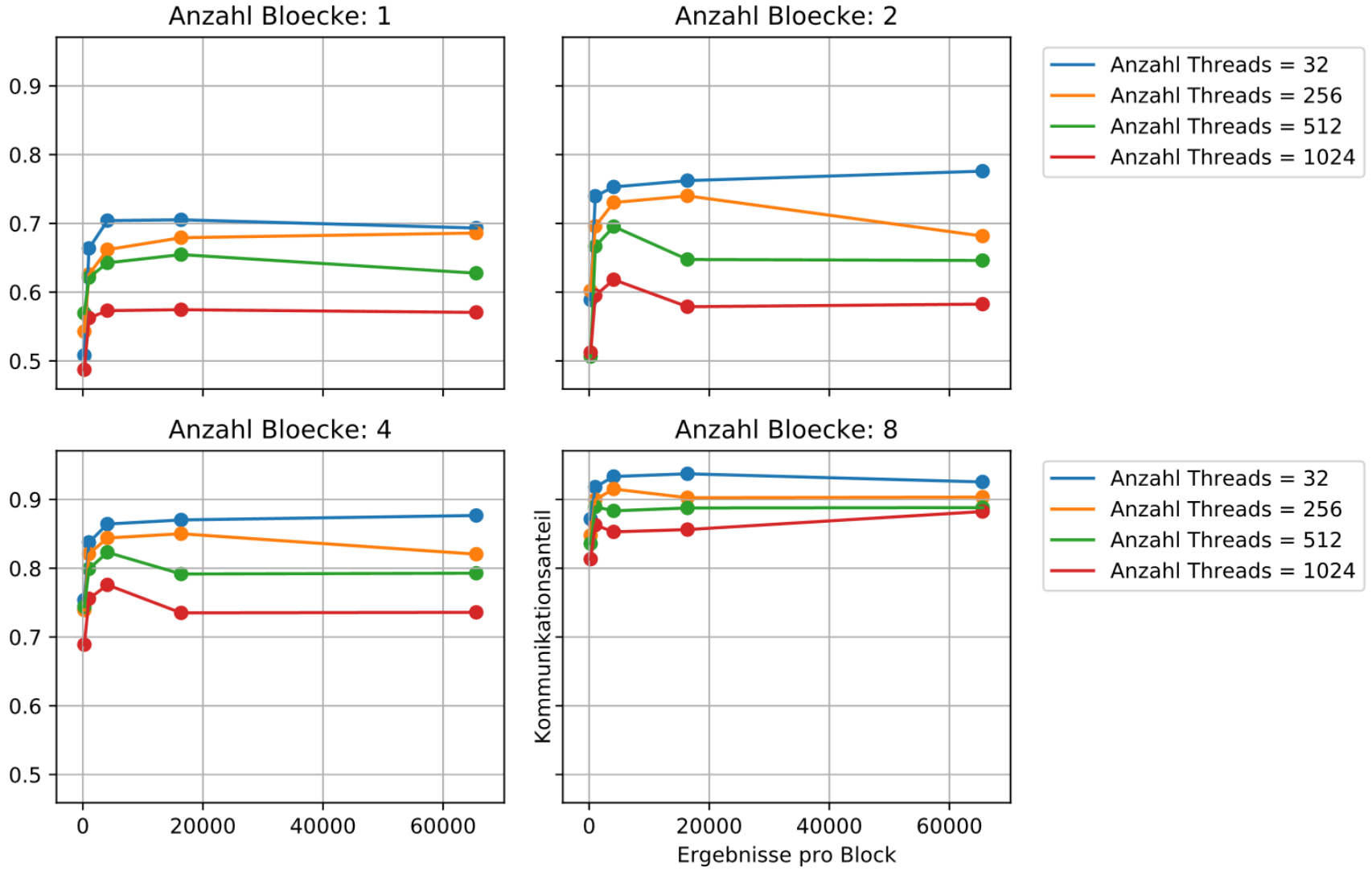
Kommunikationsmessung: Laufzeit mit Kommunikation

Variation Ergebnisse pro Block: 256,1024,4096,16384,65536



Anteil der Kommunikation an der Gesamtzeitdauer

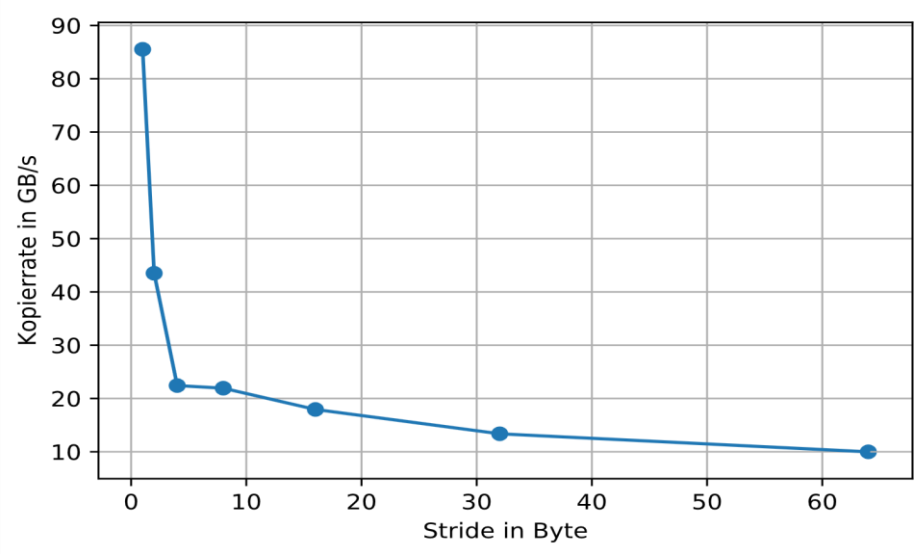
Variation Ergebnisse pro Block: 256,1024,4096,16384,65536



Ende der Präsentation – Fragen?

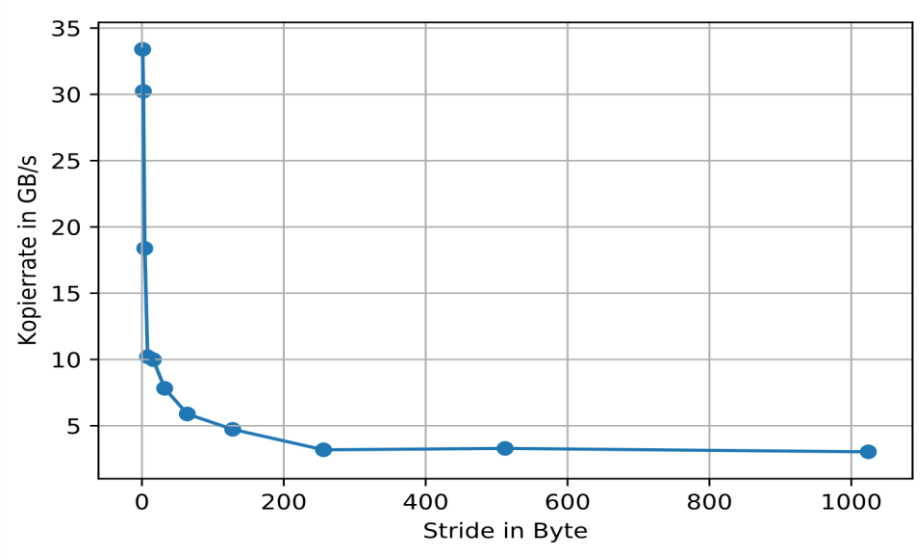
Zusatz - Strided Access III

- Blockgröße = 256 Threads
- Blockanzahl = 4096
- Zugriffstyp: int2 (sizeof(int2) = 8)
- Stride = 1,2,4,8,16,32,64



Zusatz - Strided Access IV

- Blockgröße = 128 Threads
- Blockanzahl = 2048
- Zugriffstyp: int (sizeof(int) = 4)
- Stride = 1,2,4,8,16,32,64,128,256,512,1024



Quellen

Bild GTX 1070: https://upload.wikimedia.org/wikipedia/commons/6/62/NVIDIA-GTX-1070-FoundersEdition-FL.jpg
Spezifizikationen GTX 1070: https://www.nvidia.com/de-de/geforce/products/10series/geforce-gtx-1070/