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```
#BSUB [options]
command [arguments]
```

□□□□ `#BSUB` □□□□□□ `bsub` □□□□□□□□□□□□□□□

> “□□□□□□□□□ e5v3ib □□□□□ 48□□□□□□□□□□□□□□□ MgSiO3 □□□□□□□□□ `out` □□□□□□□□□□□ `err` □ Intel MPI □□□□□ 0
>
> ```
> $ cat job.lsf
> #BSUB -q e5v3ib
> #BSUB -n 48
> #BSUB -J MgSiO3
> #BSUB -o out
> #BSUB -e err
> module load ips/2018u4
> mpirun ./app
>
> $ bsub < job.lsf
> Job <3207099> is submitted to queue <e5v3ib>.
> ```
>
> □□□□□□□□□
>
> ```
> $ bsub -q e5v3ib -n 48 -J MgSiO3 -o out -e err "module load ips/2018u4;mpirun ./app"
> Job <3207099> is submitted to queue <e5v3ib>.
> ```

bsub □□□□

- `-J job_name` □□□□□

□□□□

- `-n min_tasks[,max_tasks]` □□□□□ CPU□□□□□□□□□ `-n 4` □□□ 4~8□□□ `-n 4,8`
- `-m` □□□□□□□□□□□□□□□□

[illegible] `+[num]` [illegible] c04n01 [illegible] c04n02 [illegible] `-m "c04n01 c04n02"` [illegible] f01n01~n03 [illegible] f01n01 [illegible] f01n02 `-m "f01n01+2 f01n02+1 f01n03"` [illegible]

- `-R "res_req"`

  [illegible] -R largemem

- `-R "select[hname!=host_name]"` [illegible] host_name [illegible] && [illegible] `-R "select[hname!=x001 && hname!=x002]"` [illegible] x001 [illegible] x002 [illegible]
- `-x` [illegible]
- `-W [hour:]minute` [illegible] kill

CPU[illegible]

- `-R affinity[core:cpubind=core:membind=localprefer:distribute=pack]` [illegible] CPU [illegible] MPI [illegible]

[illegible]

- `-r` [illegible]
- `-Q "exit_code [exit_code ...]"` [illegible] all [illegible] `~` [illegible]

[illegible]

- `-I`

  [illegible]

  [illegible]

- `-K` [illegible]
- `-i input_file` [illegible]
- `-o output_file` [illegible]
- `-e error_file` [illegible]

- [illegible] `%J` [illegible] JOBID[illegible] `-o` [illegible] `-oo` [illegible] `output_%J` [illegible] `-o /dev/null`

[illegible] [illegible]

GPU [illegible]

[illegible] `-gpu` [illegible] GPU [illegible] GPU[illegible] CPU [illegible] GPU [illegible] 8[illegible] GPU [illegible] 40[illegible] CPU [illegible] 2[illegible] GPU [illegible] 10[illegible] CPU [illegible]

`-gpu` [illegible] :[illegible] `num=1:mode=shared:mps=no:j_exclusive=yes` [illegible]

- `num=number` [illegible] GPU[illegible]
- `mode=shared | exclusive_process` [illegible] GPU[illegible] `shared` [illegible] Nvidia/AMD DEFAULT compute mode[illegible] `exclusive_process` [illegible] Nvidia EXCLUSIVE_PROCESS
- `mps=yes | no` [illegible] Nvidia Multi-Process Service (MPS)[illegible] MPS [illegible] GPU[illegible] MPS[illegible] CUDA Context [illegible] GPU[illegible]
- `aff=yes | no` [illegible] GPU-CPU [illegible] `-R affinity[core:cpubind=core:membind=localprefer:distribute=pack]` [illegible] GPU-CPU[illegible]

[illegible]

[illegible]

[illegible] bsub [illegible] -w 'dependency_expression'

[illegible]

- `-w 'done(job_ID | "job_name")'` [illegible] job_ID [illegible] job_name [illegible] DONE[illegible] 0

- `-w 'ended(job_ID | "job_name")'`[illegible] job_ID [illegible] job_name [illegible] EXIT [illegible] DONE
- [illegible] && (AND)[illegible] || (OR)[illegible] ! (NOT)
- [illegible] 1[illegible]

[illegible] [illegible]

MPI/OpenMP [illegible]

OpenMP (Open Multi-Processing) [illegible] MPI (Message Passing Interface) [illegible] OpenMP [illegible] MPI [illegible]

[illegible] OpenMP [illegible] MPI [illegible] NUMA[illegible] OpenMP [illegible] NUMA[illegible] MPI [illegible] MPI[illegible] NUMA [illegible]

mpirun[illegible] LSB_MCPU_HOSTS[illegible] MPI [illegible] CPU[illegible] MPI/OpenMP[illegible] MPI [illegible]

1. `#BSUB -n` [illegible] CPU[illegible]
2. [illegible]

   ```
   source /fs00/software/lsf/misc/ompthreads.sh [N]
   ```

3. [illegible] MPI [illegible] OpenMP [illegible] `OMP_NUM_THREADS` [illegible] CPU [illegible]

□□□□□

□□□□

- LSB_JOBID□□□ ID
- LSB_QUEUE□□□□
- LSB_JOBNAME□□□□
- LSB_DJOB_NUMPROC□□□ CPU□□□
- LSB_DJOB_HOSTFILE□□□□□□□□□□□□□□
- LSB_HOSTS□□□□□□□□□□□ CPU□□□□□□□□□□□□
- LSB_MCPU_HOSTS□□□□□□□□□□□□□□□□□□ CPU□□□□□

```
LSB_DJOB_NUMPROC=6
LSB_HOSTS="node1 node1 node1 node2 node2 node2"
LSB_MCPU_HOSTS="node1 3 node2 3"
```

```
$ cat $LSB_DJOB_HOSTFILE
node1
node1
node1
node2
node2
node2
```

> “ LSB_HOSTS □ LSB_MCPU_HOSTS □□□□□□□□□□□□□□ LSB_MCPU_HOSTS □ LSB_HOSTS □□□□□□□□ LSB_HOSTS □□ 4096 □□□□□□ LSB_MCPU_HOSTS□

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□□□□□□□□□ e52660 □□□□□□□□□□□□□□□□□

```
$ bsub -q e52660 ./app
Job <3279929> is submitted to queue <e52660>.
$ cat job.lsf
#BSUB -q e52660
./app
```

```
$ bsub < job.lsf
Job <3279930> is submitted to queue <e52660>.
```

MPI □□□□

MPI□□□□□□ `mpirun` □□

□□□□□□ 48□□ Intel MPI □□□□□ e5v3ib□□□□□□□□

```
$ bsub -q e5v3ib -n 48 "module load ips/2018u4;mpirun ./app"
Job <3280120> is submitted to queue <e5v3ib>.
```

□□□□□□ 48□□ Open MPI □□□□□ e5v3ib□□□□□□□

```
$ cat job.lsf
#BSUB -q e5v3ib
#BSUB -n 48
module load iccifort/15.0.3 imkl/11.2.3 openmpi/1.10.0-iccifort-15.0.3
mpirun ./app

$ bsub < job.lsf
Job <3280122> is submitted to queue <e5v3ib>.
```

OpenMP □□□□

OpenMP □□□□□□□□ `-n` □□□□□□□□□□□ **CPU□□**

□□□□□□ 64□□ OpenMP □□□□□ e7v4ib□□□□□□□ -nt □□□□□□□□□□□□□□

```
$ bsub -q e7v4ib -n 64 "./app-nt \$LSB_DJOB_NUMPROC"
Job <3348175> is submitted to queue <e7v4ib>.
```

□□□□□□ 64□□ OpenMP □□□□□ e7v4ib□□□□□□□ `OMP_NUM_THREADS` □□□□□□□□□□□□□

```
$ cat job.lsf
#BSUB -q e7v4ib
#BSUB -n 64
OMP_NUM_THREADS="$LSB_DJOB_NUMPROC"
./app

$ bsub < job.lsf
Job <3348182> is submitted to queue <e7v4ib>.
```

MPI/OpenMP □□□□

□□ MPI□□□ 6□ OpenMP□□

□□□□□□ `OMP_NUM_THREADS` □□

```
#BSUB -q 6140ib
#BSUB -n 72
export OMP_NUM_THREADS=6
source /fs00/software/lsf/misc/ompthreads.sh
module load ips/2018u4
mpirun ./run
```

□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

```
#BSUB -q 6140ib
#BSUB -n 72
source /fs00/software/lsf/misc/ompthreads.sh 6
module load ips/2018u4
mpirun ./openmx -nt 6
```

GPU □□

□□□□□□ 1□ GPU □□□□ e5v4p100ib □□

```
bsub -q e5v4p100ib -gpu num=1 ./gpu_app
```

□□□□□□ 4□ GPU □□□□ 62v100ib □□□□□ GPU-CPU □□

```
bsub -q 62v100ib -gpu "num=4:aff=yes" ./gpu_app
```

Revision #41
Created 9 May 2021 16:38:05 by Yao Ge
Updated 23 June 2024 16:06:54 by Yao Ge