

# Fortran 2018 Parallelization of a Particle-Beam Physics Package

Damian Rouson\*

D. T. Abell\*\*, P. Moeller\*\*, R. Nagler\*\*, B. Nash\*\*, I. V. Pogorelov\*\*

F. Méot\*\*\*, I. B. Beekman\*\*\*\*



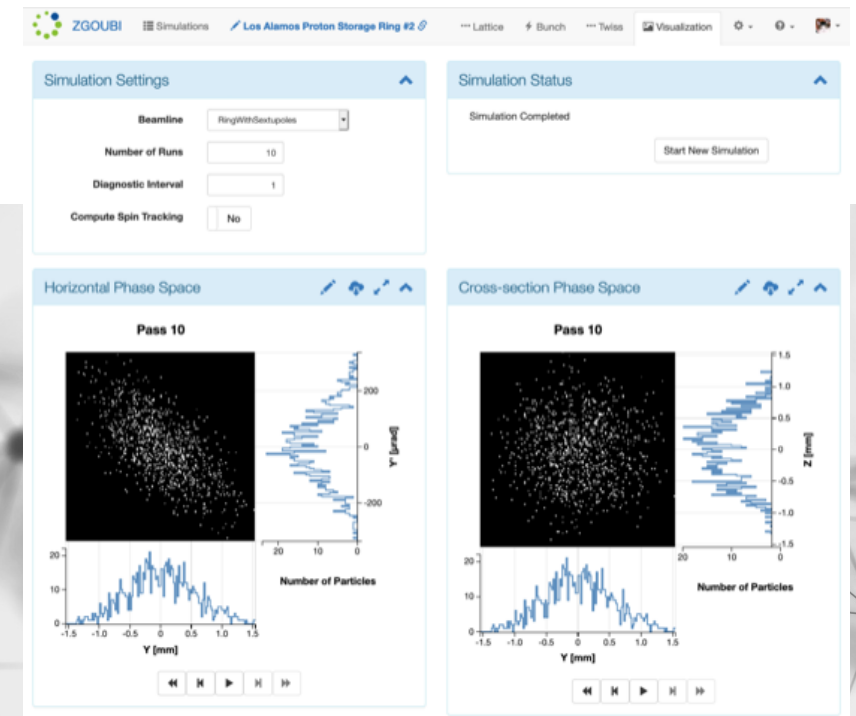
# Application: zgoubi

[github.com/radiasoft/zgoubi](https://github.com/radiasoft/zgoubi)

- 🧙 Particle accelerator beam design application.
- 🧙 Actively developed at Brookhaven for over 30 years.
- 🧙 Currently used for evaluating several proposed accelerator designs.
- 🧙 200K lines of serial Fortran 77 with extensive use of obsolescent features: COMMON, computed GOTO, ENTRY.
- 🧙 SBIR: users can now run zgoubi in a browser through RadiaSoft's open-source Sirepo cloud platform.



Beam line (LANL Proton Storage Ring)



Particle  $x/\theta$  phase space

# Approach



## Application characteristics

- Relativistic charged-particle tracking
- Dominant computation: particle update (~75% of runtime)
- Use case: independent particles without synchrotron radiation



## Fortran 2018 features employed

- Collective subroutine: **co\_sum**
- Asynchronous execution
- Synchronize only in test suite
- Image enumeration, error termination



## Strategy

- Partition particle ownership across executing images
- Progressive SPMD parallelization
- Gather for output: gather wraps **co\_sum**

Example: Image 1 of 3 owns particles 1-2

	1	2	3	4	5	6
PROCEDURE A	O	O	O	O	O	O
PROCEDURE B	O	O	O	O	O	O
TRANSF	O	O				
PROCEDURE D	O	O	X	X	X	X
GATHER	O	O	O	O	O	O

