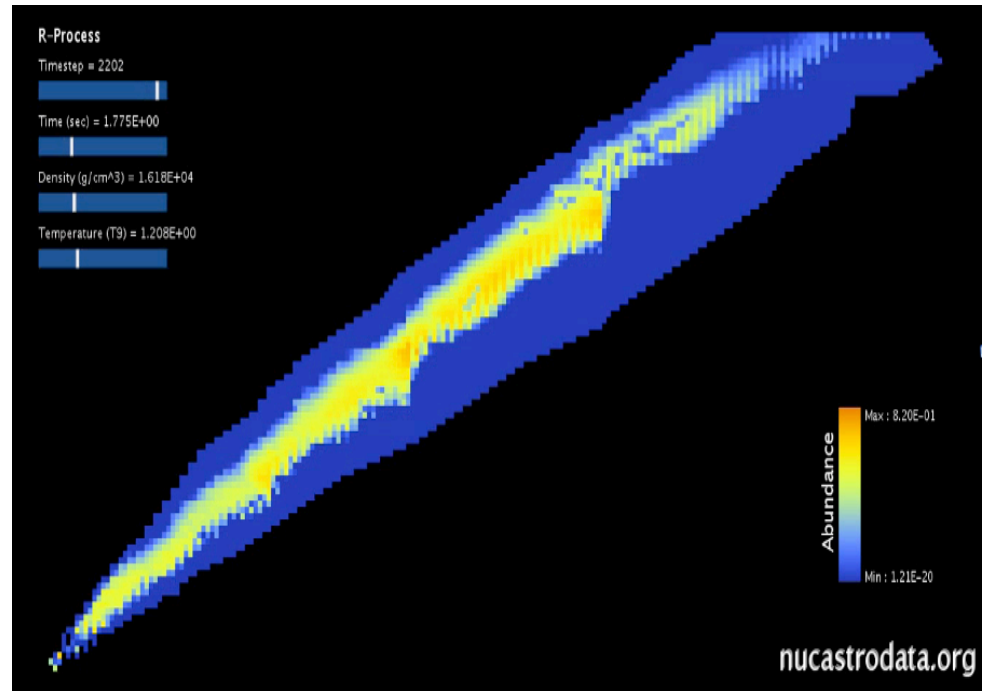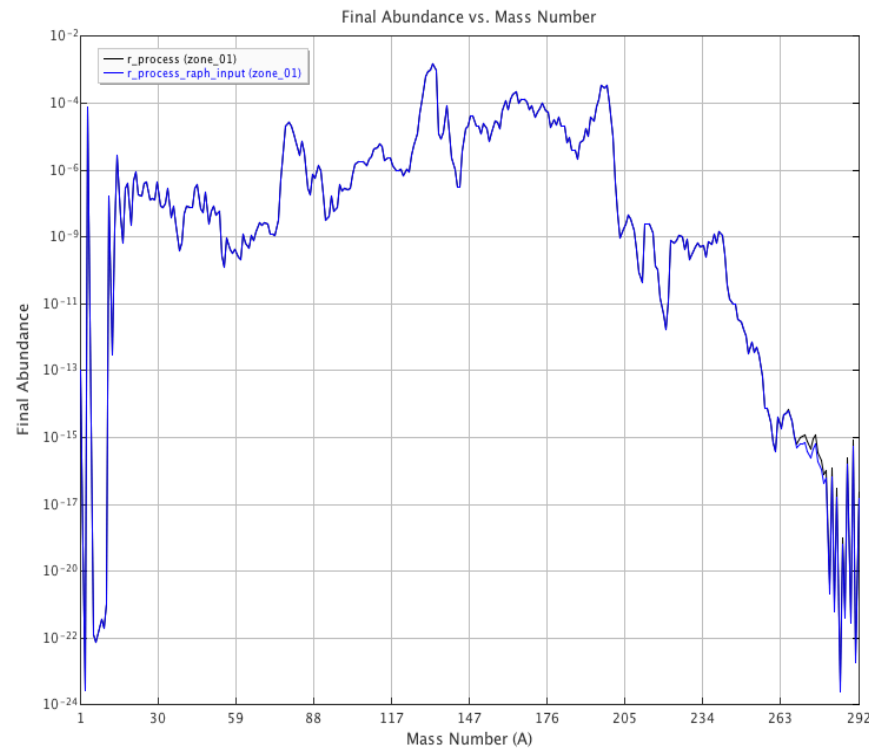# Element Synthesis Simulations with the Computational Infrastructure for Nuclear Astrophysics
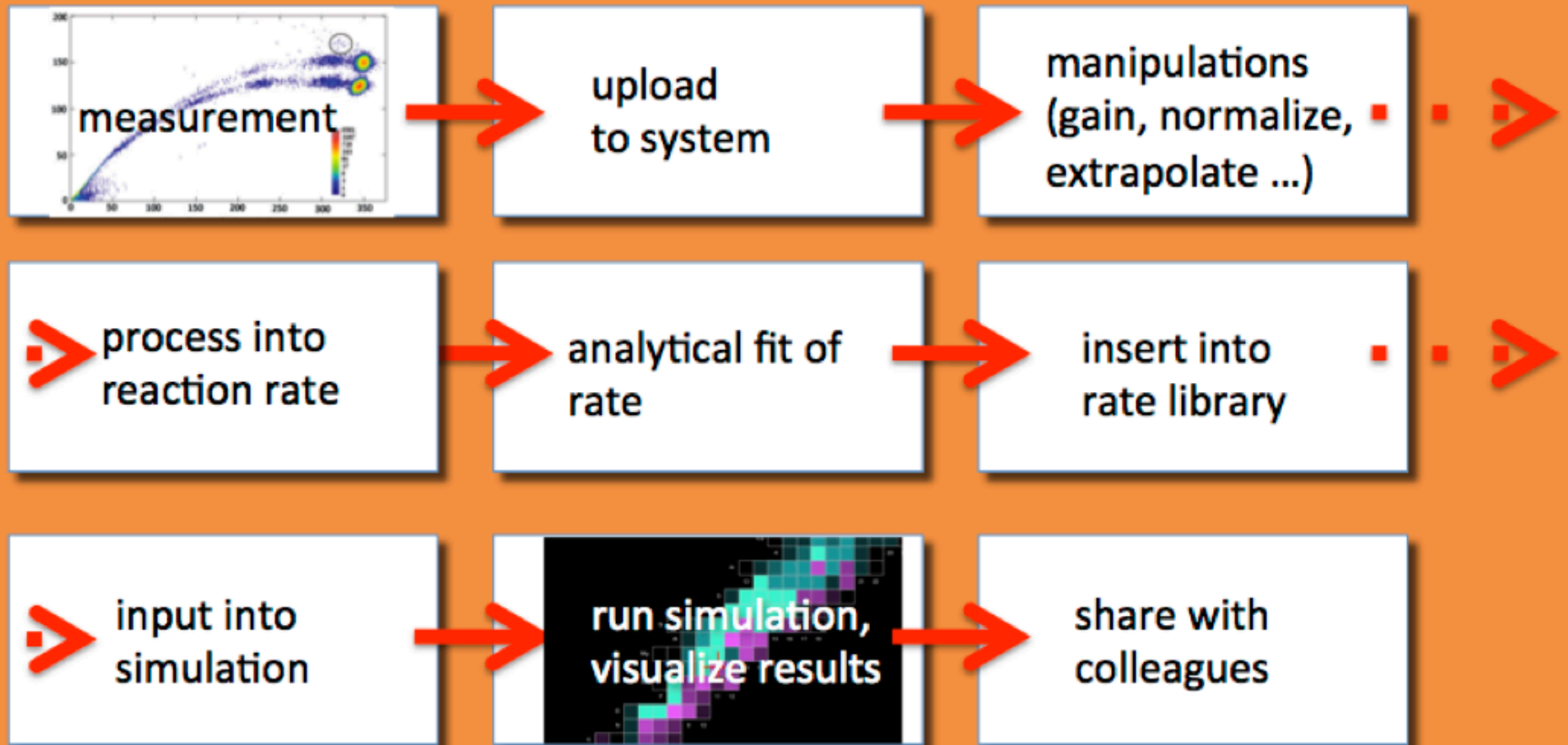

Michael Smith, Eric Lingerfelt, Raph Hix, Chris Smith   ORNL
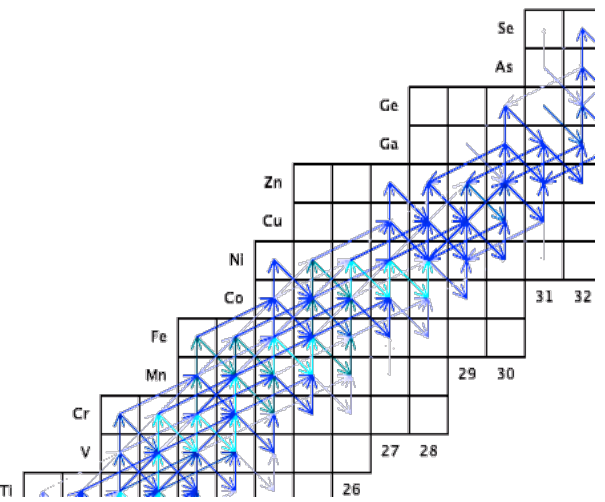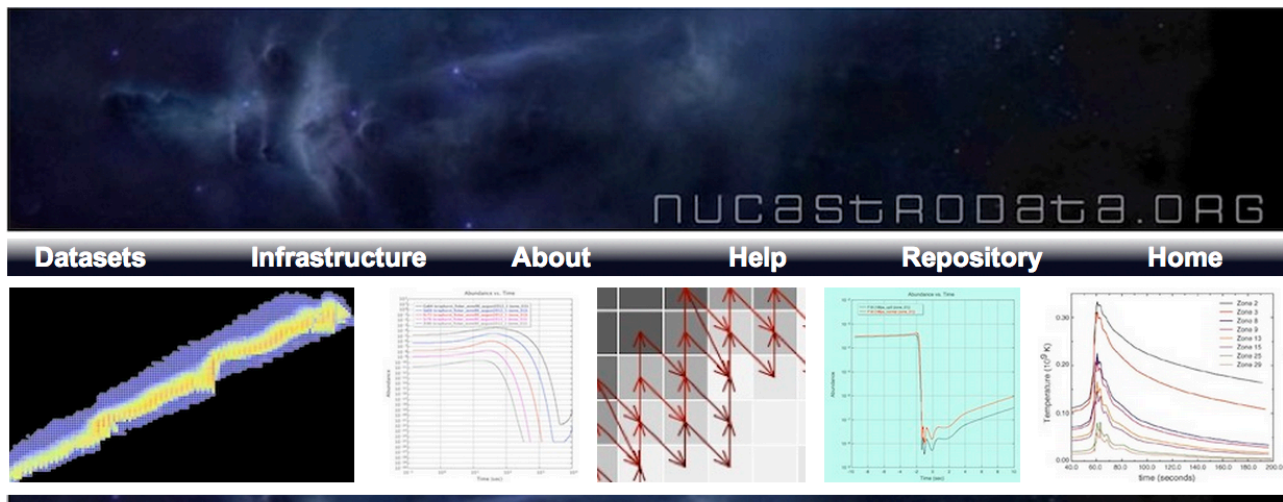
Computational Infrastructure

Nuclear Astro Data Processing Pipeline

- measurement → upload to system → manipulations (gain, normalize, extrapolate ...)
- process into reaction rate → analytical fit of rate → insert into rate library
- input into simulation → run simulation, visualize results → share with colleagues

- Virtual Pipeline from Lab to Astro Simulations

Computational Infrastructure


- **Computational Infrastructure for Nuclear Astrophysics**
- Upload, manipulate, visualize, share
  - nuclear data (cross sections)
  - thermonuclear reaction rates
  - rate libraries
  - element synthesis calculations
- Cloud computing system – run cycles on our server
- Freely available at **nucastrodata.org**
- Simulations: r-process, novae, X-ray bursts, CNO, Hot CNO …
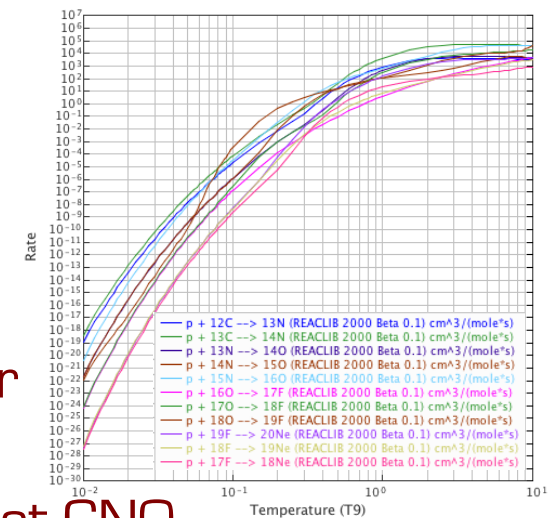
software tools
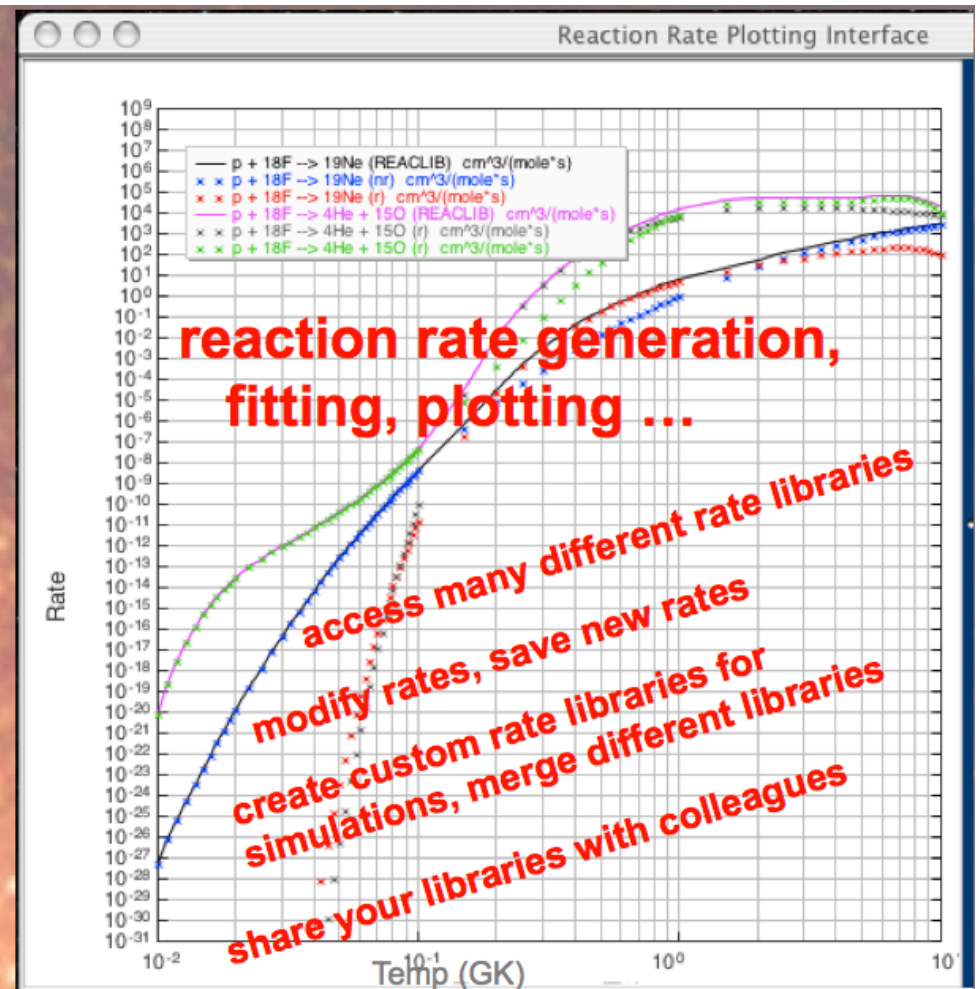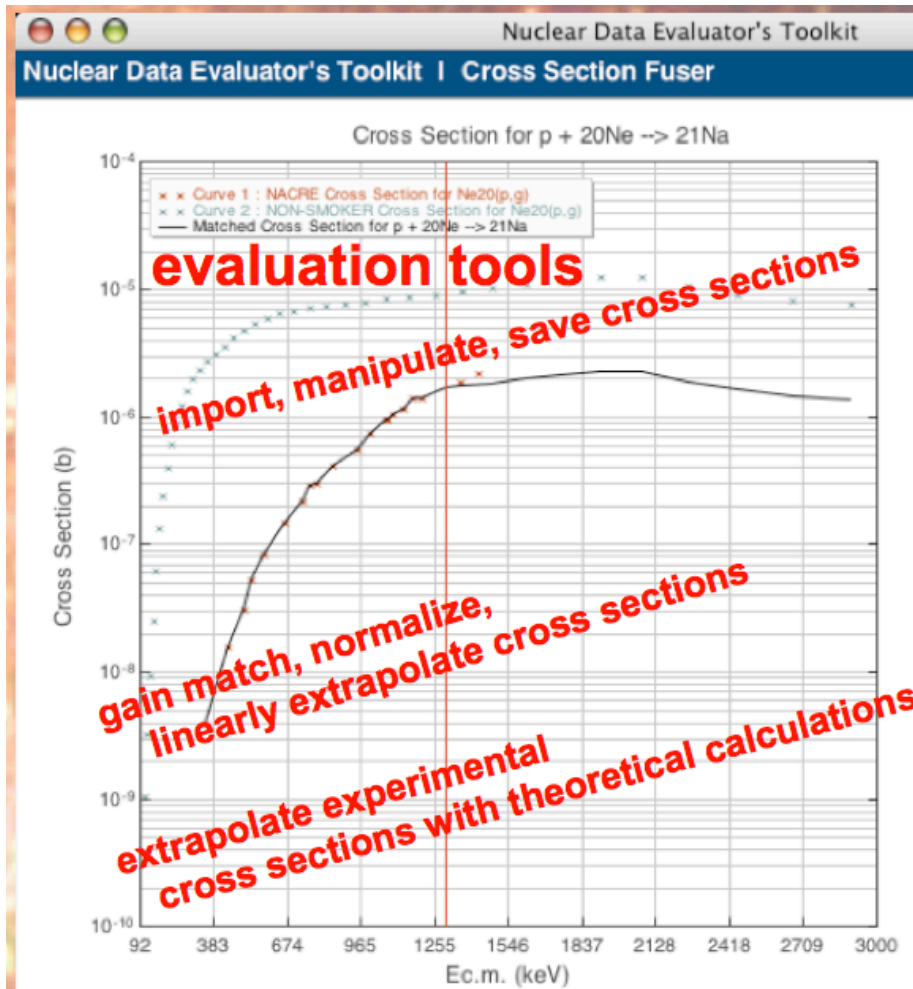
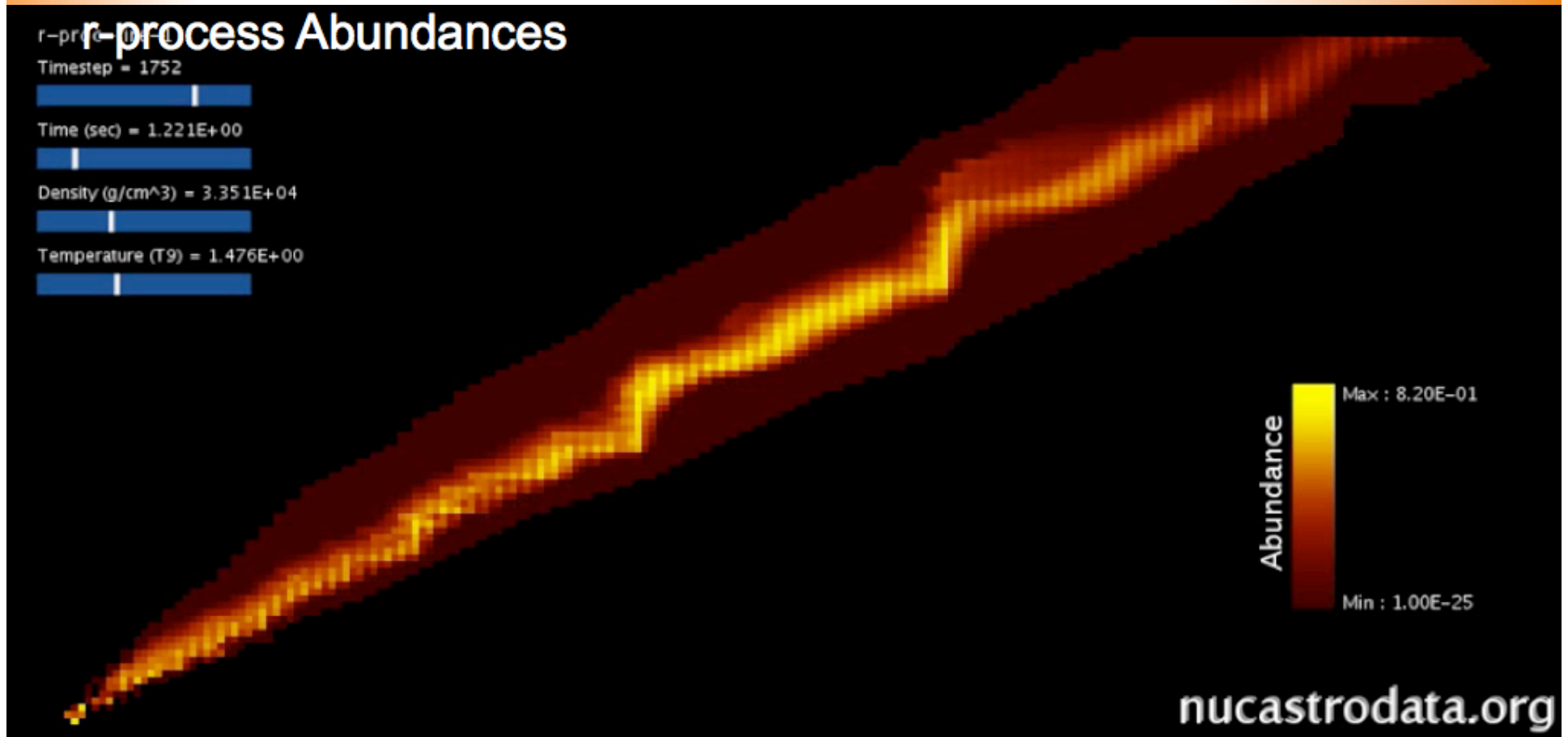# Computational Infrastructure
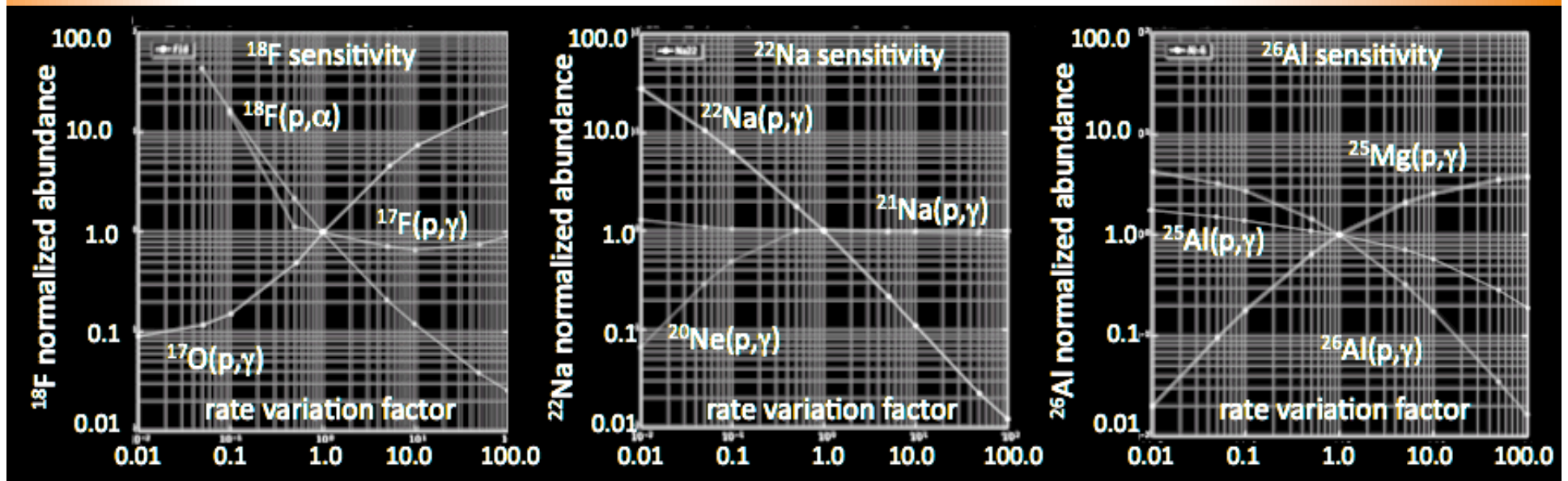
- ## Utilizations

  - **Proposal writing**: find **sensitivity** of astrophysical observables to an input reaction rate

  - **Journal articles**: determine astrophysical predictions using OLD input data vs. your NEW input data

  - **Uncertainty analysis**: vary input according to its uncertainty, find uncertainty in astro predictions

r-process simulations
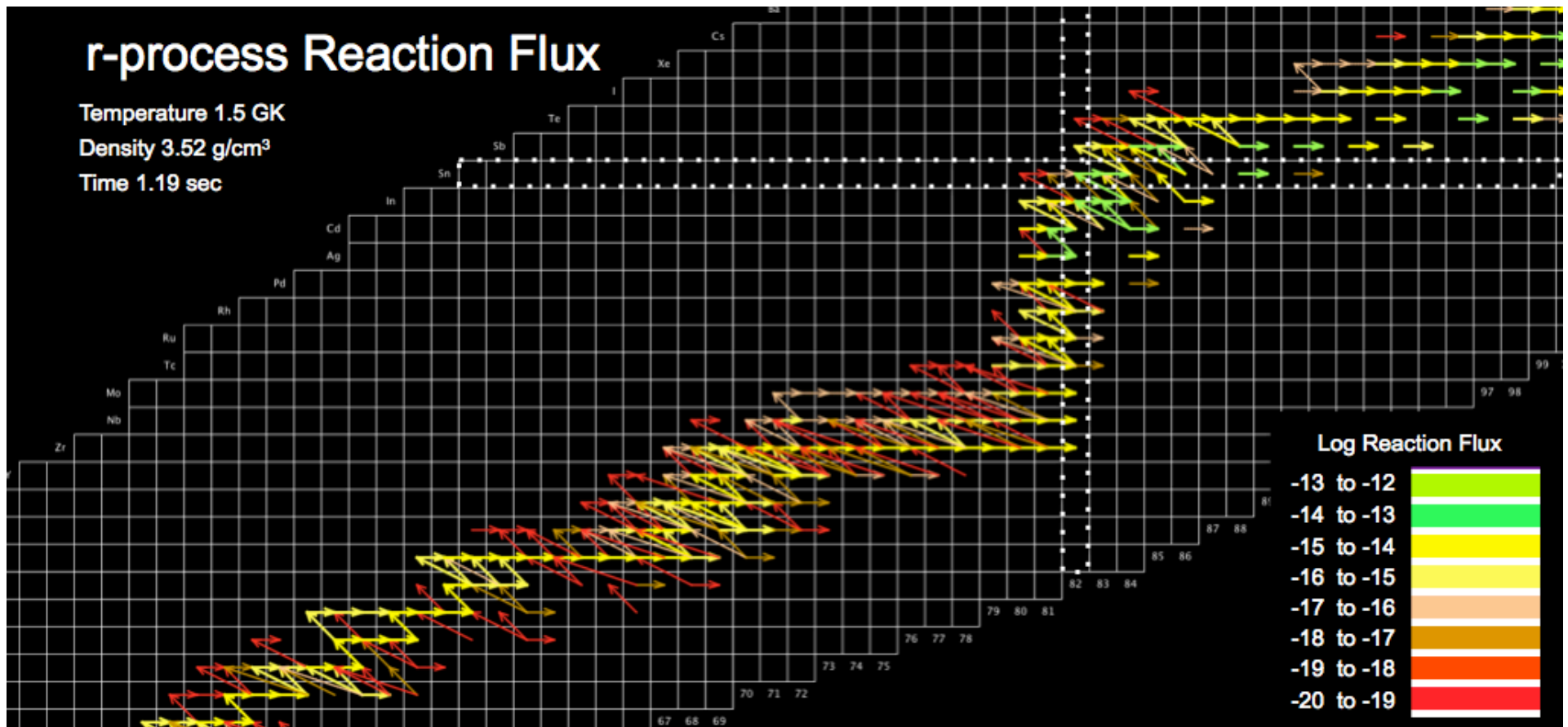
- brand new capability

- compute engine: XNET (Raph Hix et al.)

- post-processing calculations (nuclear burn)

- supernova temperature/density profiles from multi-d

r-process simulations

r-process Abundances
Timestep = 1752
Time (sec) = 1.221E+00
Density (g/cm^3) = 3.351E+04
Temperature (T9) = 1.476E+00

Abundance
Max : 8.20E-01
Min : 1.00E-25

nucastrodata.org

- brand new capability

- compute engine: XNET (Raph Hix et al.)

- post-processing calculations (nuclear burn)

- supernova temperature/density profiles from multi-d

Element Synthesis Simulations   Michael Smith   ORNL Physics

OAK RIDGE
National Laboratory

r-process simulations

Available Tracked Nuclei Lists and Associated Initial Abundances
R_Process: 4510 isotopes from neutron to Fm300: Free nucleons with Ye of 0.18

Element Synthesis Simulator | Simulation Results

Element Syn

Element Synthesis Simulation Type	Supernova
Number of Timesteps Before Exit	5000
Start Time (sec)	2.210000E-02
Stop Time (sec)	7.250000E+00
Include Weak Reactions	Y
Include Screening	Y
User Notes	N/A
Selected Zones	1
Initial Abundance Profile	R_Process_Abund
26Al State	only stable
Isotope List Selected By	Sunet File
Sunet File	R_Process
Reaction Rate Library	ReaclibV2.0

Final Abundance vs. Mass Number
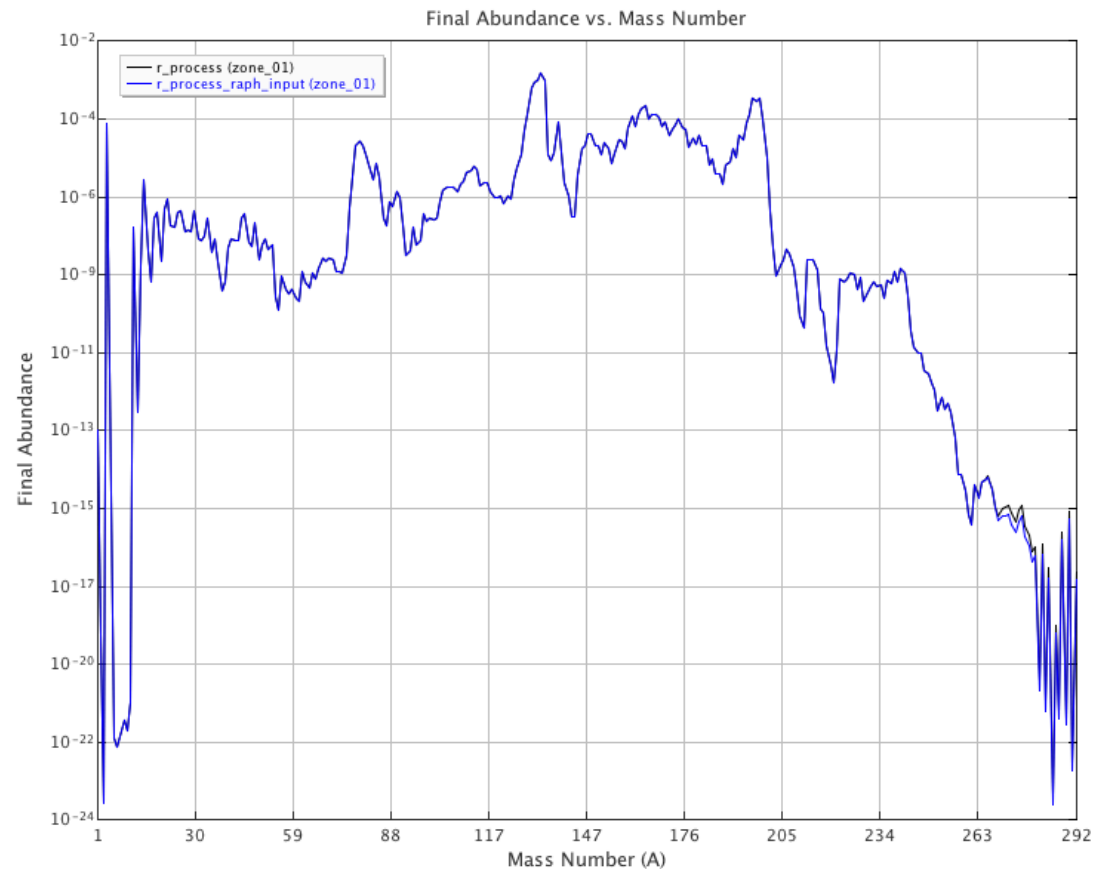
- 9 simple steps to set up & run – easy user interface
- register anytime [free] & try it at nucastrodata.org
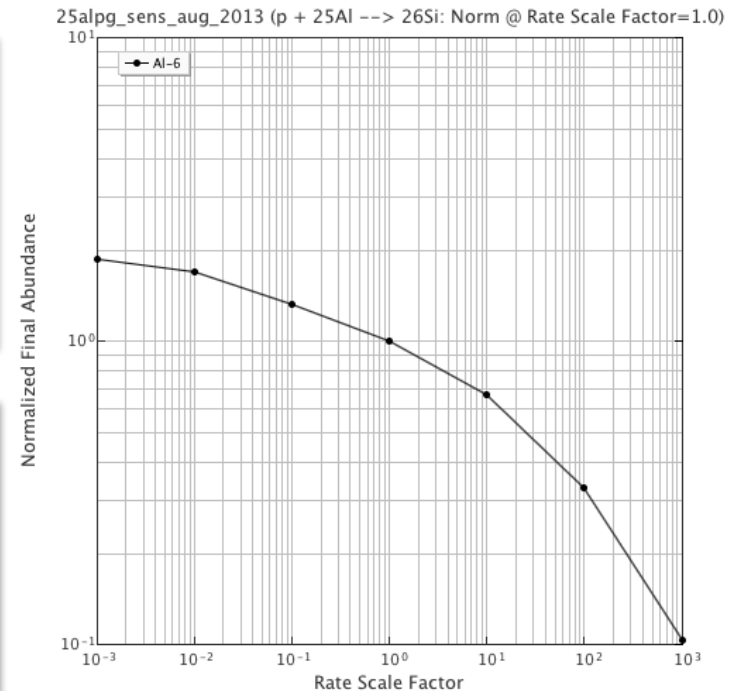- The only r-process calculations online in the world !

sensitivity studies

- choose simulation, input rate, rate variations
- system runs series of simulations
- visualization tools quickly show results
- speeds up "manual" sensitivity studies by factor of 20
- try it out to check your favorite reactions !

data harvesting
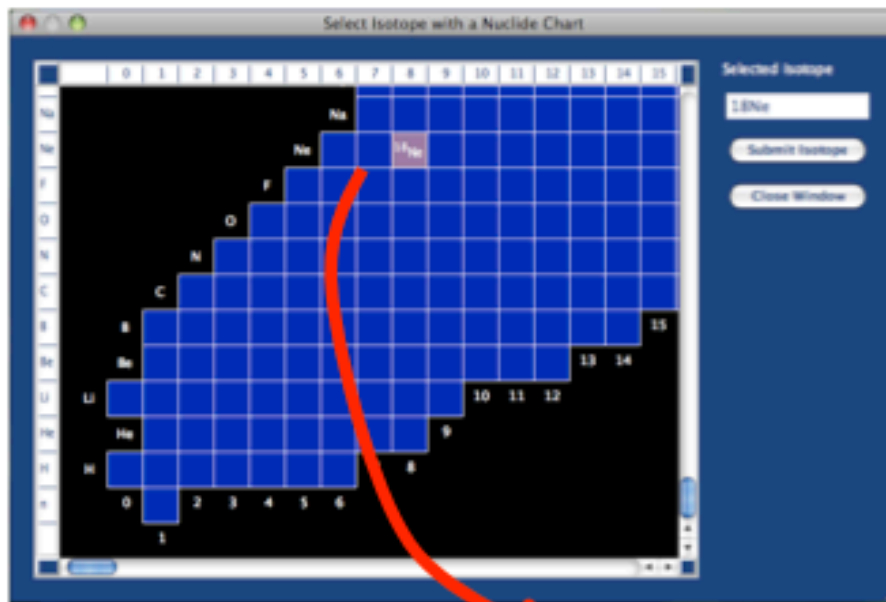
- get information from international databases with just one click !

other cloud computing systems

- specialized software systems running in the cloud for nuclear and astrophysics research

safety

exploding stars on your computer

- computer simulation work – please be careful