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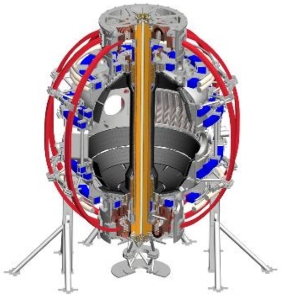
U.S. Department of Energy Office of Science
Fusion Energy Sciences

Linking Boundary Modeling Milestone Activities to Experimental Capabilities

M.L. Reinke

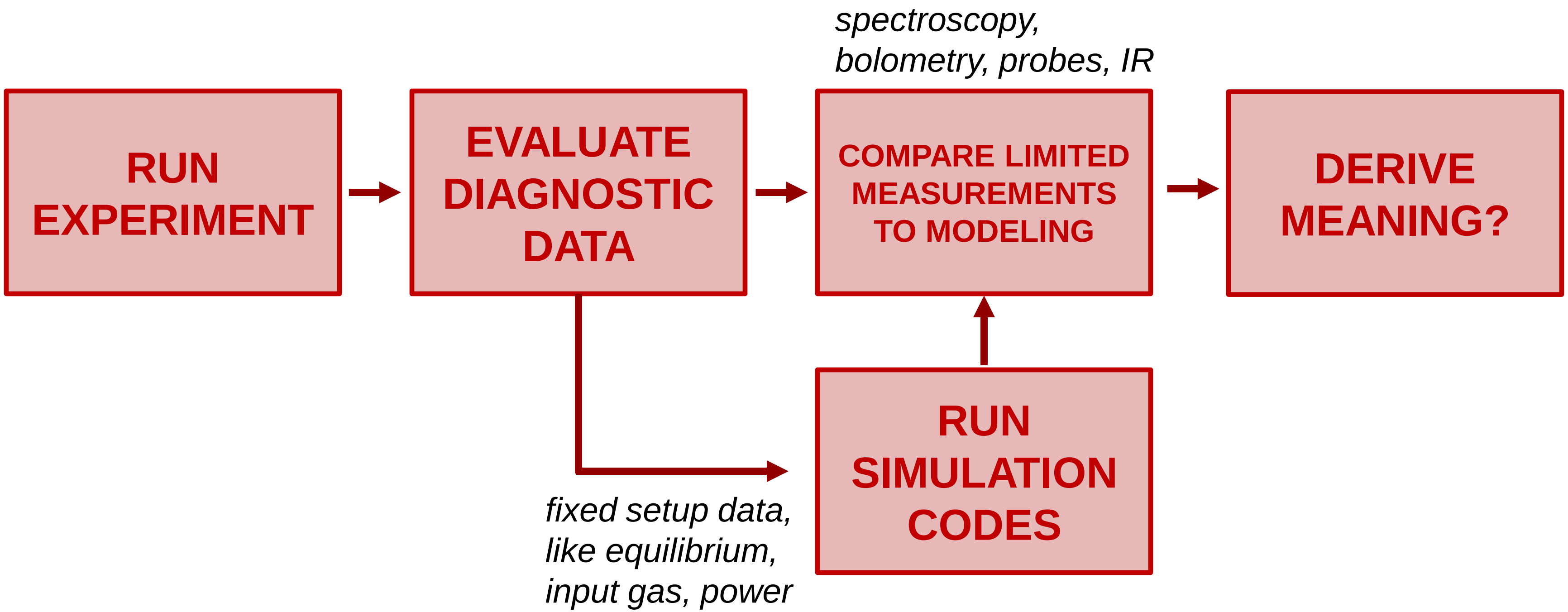
NSTX-U Milestone Update Meeting
B318
3/30/2017



Overview

- example workflow for boundary 'validation'
- how this can be improved given the outage timeline
  - inclusion of synthetic diagnostics to isolate observables
    - R(17-2): "Transport and radiation in these advanced divertor configurations will be modeled using SOLPS and UEDGE multi-fluid two-dimensional transport codes and will include studies of the effects of poloidal variation of transport coefficients
- examples of how this might work

A Cynical Look at Boundary Simulation Workflows



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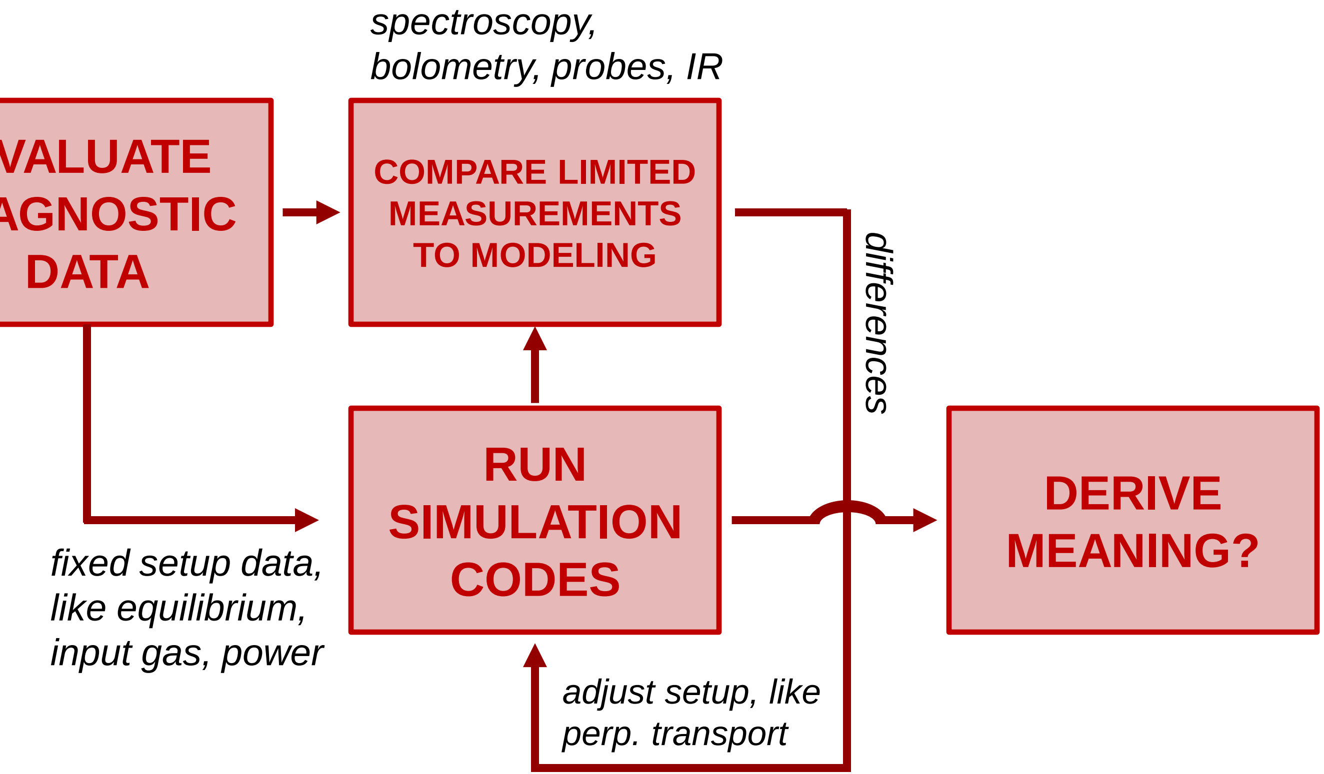
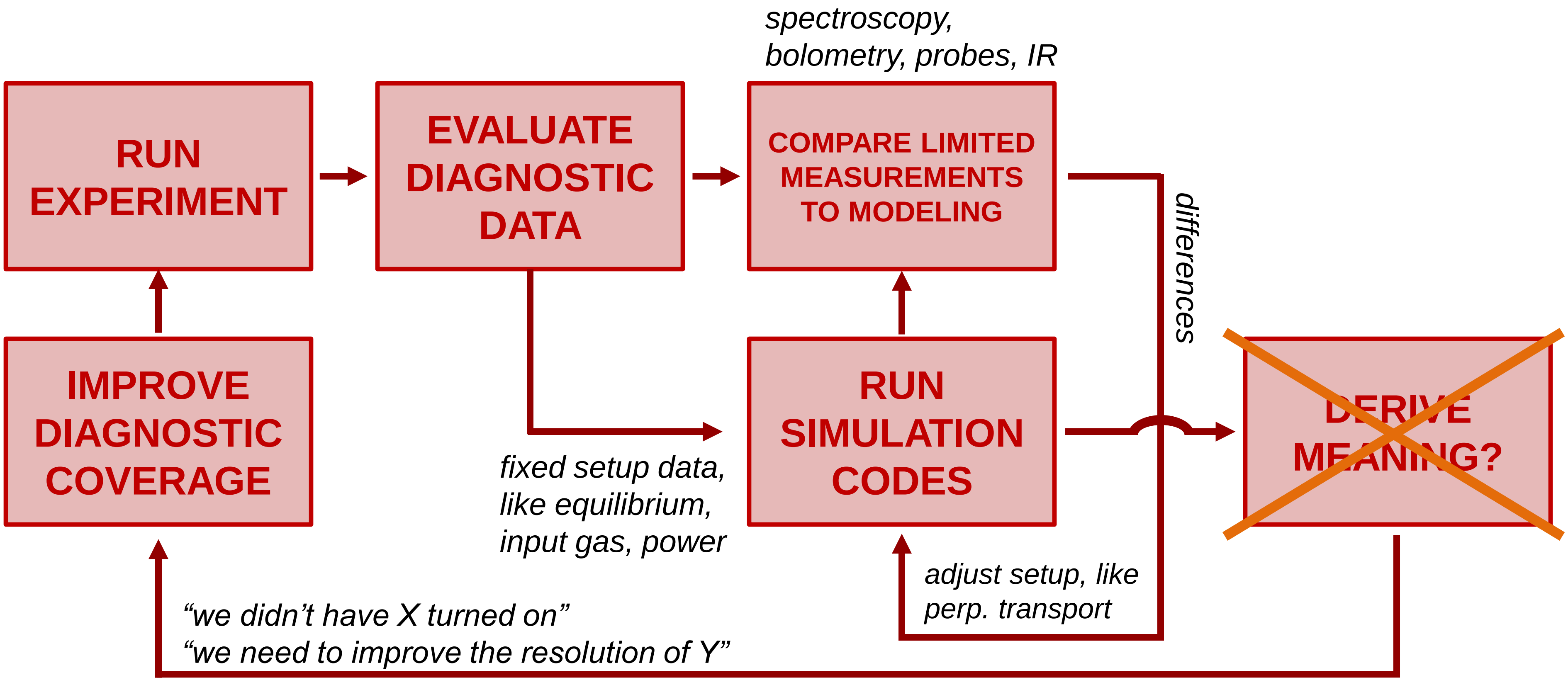


EXTRA CYNICISM:

non-first principles fluid simulations have more free parameters than measurements, so if you don't have complete agreement, you didn't try hard enough

A Cynical Look at Boundary Simulation Workflows



Learning From Experience

- as new initiatives in boundary physics are identified, working through this loop takes multiple years and multiple attempts
  - Alcator C-Mod: (Reinke/Lore) MP 747 (2014), MP 770 (2015)
  - JET: M13-17 (Aug 2013), M15-20 (Nov. 2016)
  - ASDEX-U: see years of publications, new FY17 experiments underway
- workflows tend to *start* with experiments and then see if modeling can reproduce something interesting in empirical scans
  - many lack a clear demonstration if uncertainties in the modeling are resolvable with existing diagnostic set
  - many lack a clear statement of what testable hypothesis is going to be able to be confirmed other than 'is the model accurate?'
- pushing through the workflow can be exhausting if that's when the linkages with diagnostics begin, thus the paper/poster timeline limits what you end up including in comparisons
  - this work is repeated as multiple codes are applied to similar experiments
- I'm totally guilty of exploiting this validation cycle for run time…

Suggested Way to Start Workflow w/o NSTX-U

R(17-2) "include studies of the effects of poloidal variation of transport coefficients"

fixed setup data,
varying $D_{\perp,div}$

SIMULATION-A

SIMULATION-B

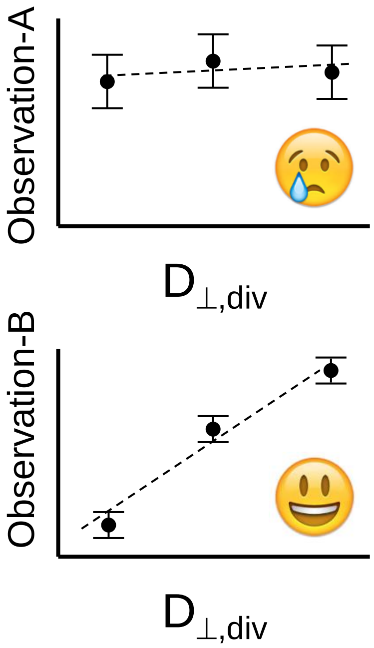
⋮

SIMULATION-Z

→ **SYNTHETIC DIAGNOSTIC DATA** → **COMPARE SYNTHETIC DATA BETWEEN SIMULATIONS**

spectroscopy, bolometry, probes, IR

no differences, improve resolution/coverage



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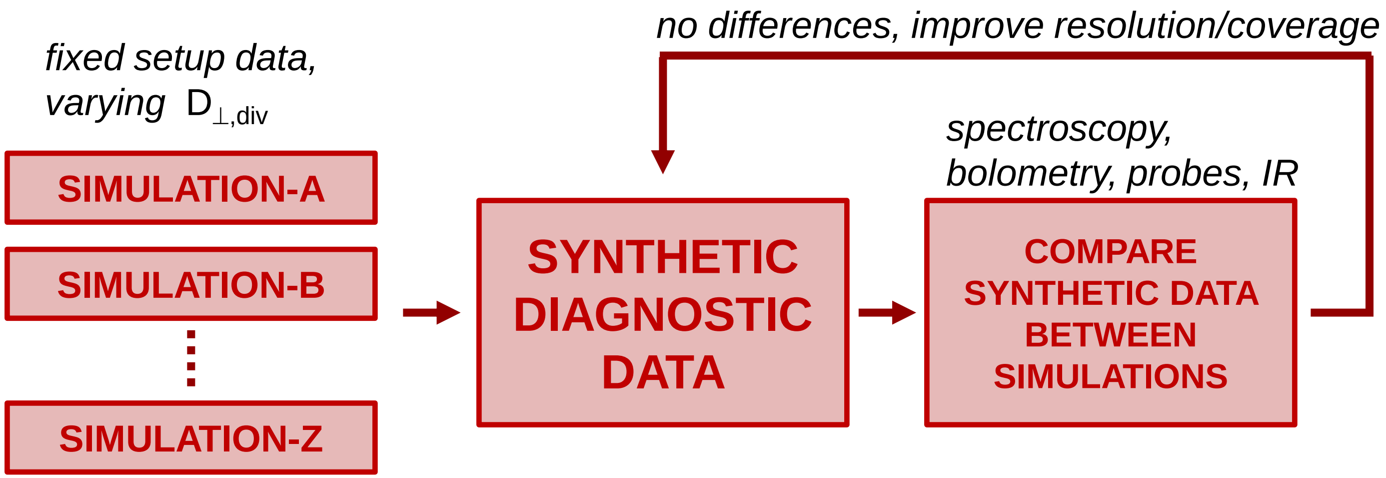
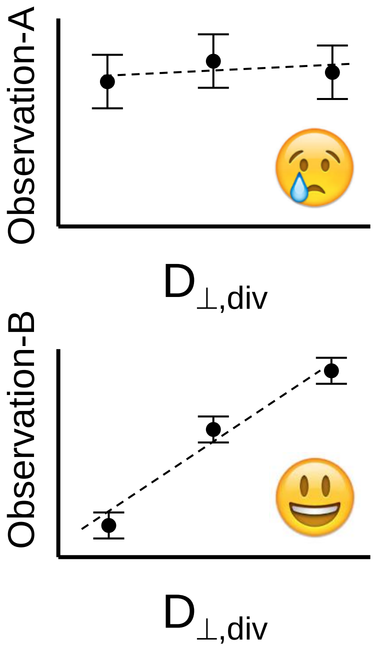
R(17-2) "include studies of the effects of poloidal variation of transport coefficients"





- establishes a workflow that links modelers and the diagnostic responsible officers RO's *(this needs to be done anyway)*
- demonstrates which diagnostics are critical for running experiments, helps to prioritize bringing up machine capabilities, improve run coordination
- motivates changes/upgrades to diagnostic set which can be done now, need to be done during the run and need future development

Suggested Way to Start this Process

- as written R(17-2) and R(18-1) lack a means for substantive contribution from experimentalists [note: R(18-1) overlap w/ PFCR-WG]
- if desired for those participating in modeling & diagnosticians, work through a synthetic diagnostic workflow
  - start w/ RO's giving basic description of diagnostic layouts & data (extend website)
  - modelers identify key measurements and link to participating diagnostic RO's

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Diagnostics > Ion Diagnostics >

Bolometry on NSTX-U

http://nstx-u.pppl.gov/diagnostics/ion-diagnostics/bolometry

Contents

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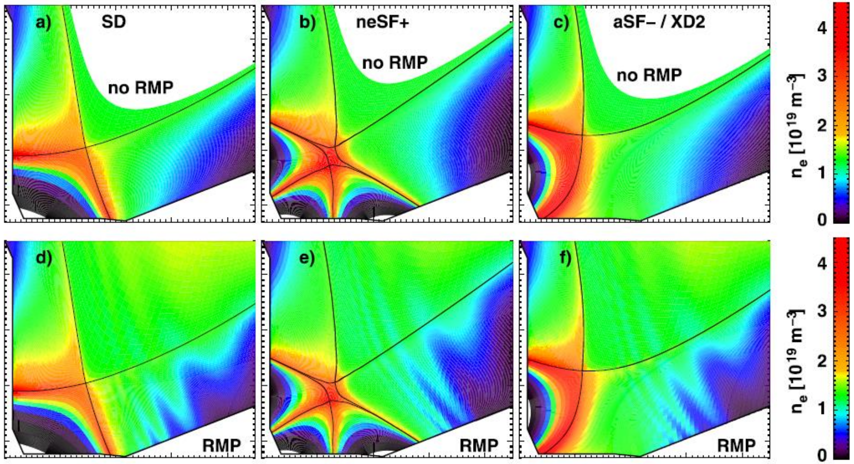
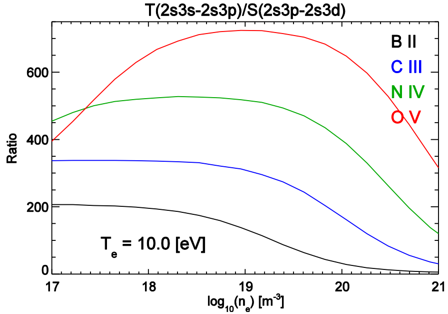
- if desired for those participating in modeling & diagnosticians, work through a synthetic diagnostic workflow
  - start w/ RO's giving basic description of diagnostic layouts & data (extend website)
  - modelers identify key measurements and link to participating diagnostic RO's
- develop means of providing synthetic measurements and error
  - bolometry this is straightforward; codes generally predict MW/m^3, have view chords, can provide line-of-sight integrated brightness profiles
  - divertor spectroscopy; a bit more difficult, simulate and fit spectra?
  - IR cameras; can actually work towards expected signal, explore issues w/ α, ε
    - help modelers understand some of the uncertainty in providing heat flux vs. integrated energy (TCs)
- try to establish basic service of interfacing exp. w/ multiple codes

Examples from Recent Work

H. Frerichs, et al PoP v23 062517 (2016)



- 2D density predictions from snowflake vs. standard div. from EMC3-EIRENE, do we have sufficient diagnostics?
  - Stark broadening
  - impurity line ratios
  - specifics of probe layouts



- <u>Canal, APS-DPP 2016:</u> M3D-C1 shows vacuum vs. plasma response of 'lobes', can imaging systems resolve these, SNR, FOV?
  - Z_{eff} induced differences may lead to correlated changes in surface heat flux
- <u>Izacard, APS-DPP 2016</u>: are non-maxwellian distributions observable within VUV line ratios (basis from Lawson work on JET)

Summary

- outage gives us the opportunity to develop boundary simulation workflows, using milestones as motivation
  - perform the work that would be data-driven ahead of time
- identify modelers/diagnosticians interested in linking to experimental data (SG or milestone driven activity?)
- if nothing official, people can contact me, and we can do this for bolometry
  - welcome the opportunity to use time to optimize planned resistive bolometry sight lines (if needed) and to motivate R&D on 2D imaging bolometry (IRVB)
  - in general ORNL experimental and modeling activities will try to push improved workflow internally