

# PPPL multi-machine program on seeding of plasmas with powder droppers

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R. Maingi, on behalf of dropper team

**MAST-U collaboration discussion**  
**PPPL, Princeton NJ**  
**22 Nov 2017**



Max-Planck-Institut  
für Plasmaphysik

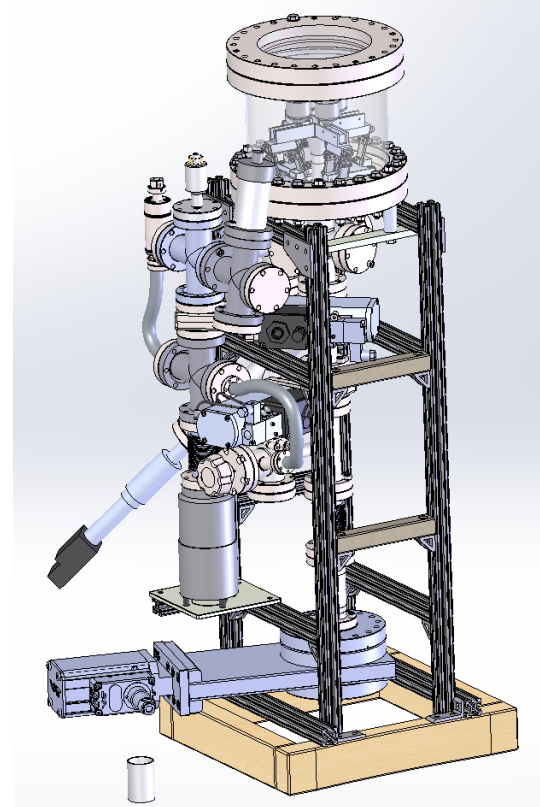
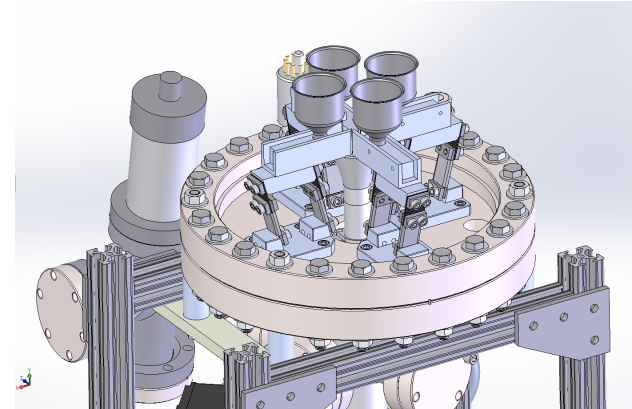


ASDEX Upgrade



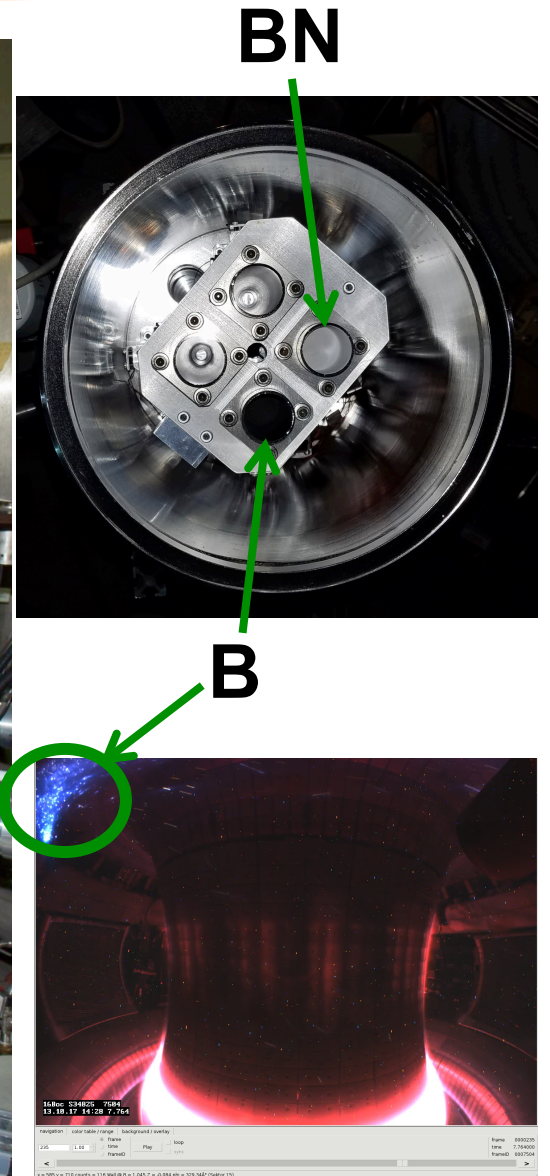
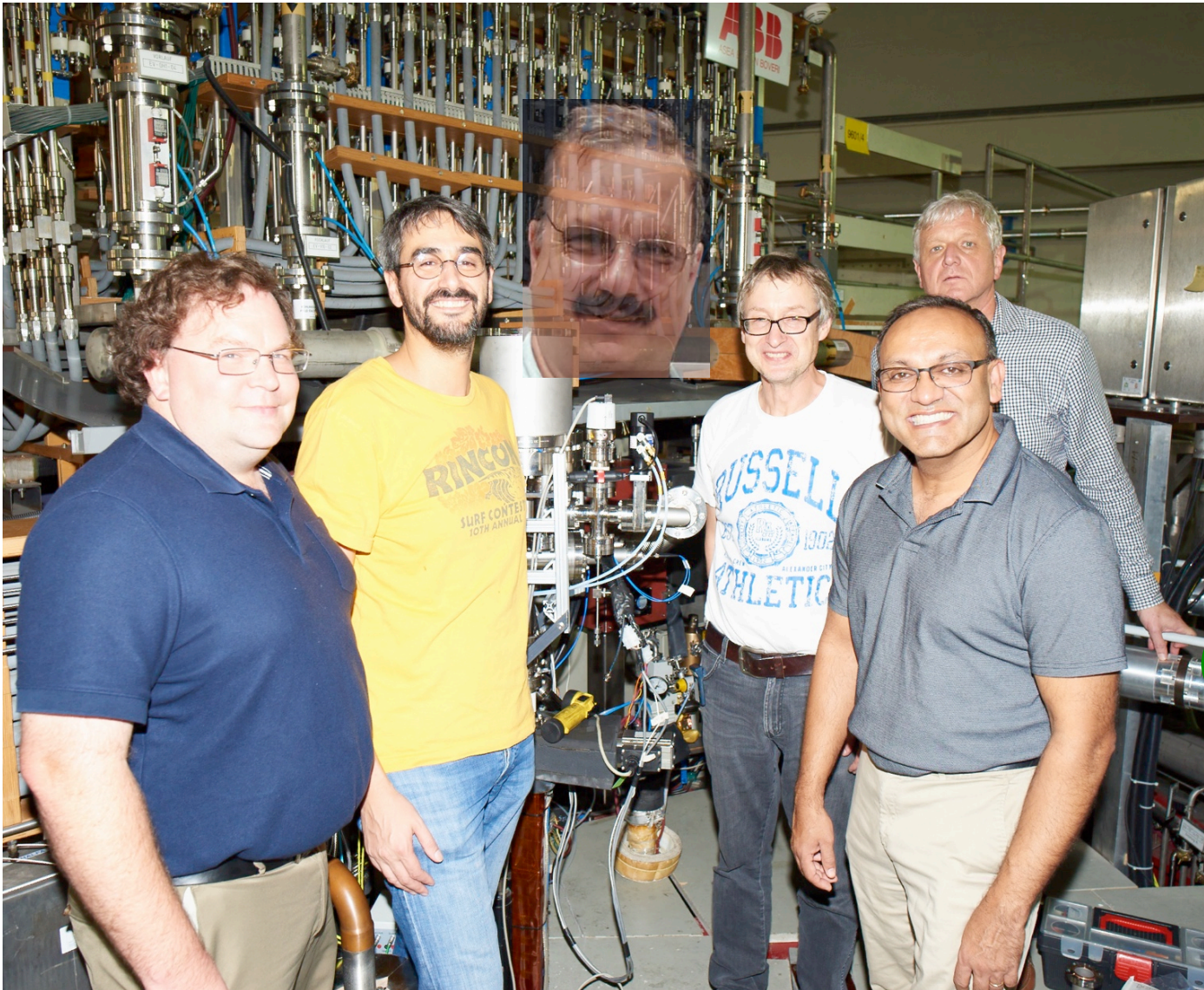
# New impurity powder dropper allows real-time impurity seeding and wall conditioning studies

- **AUG (via LDRD): 10/9-10/13**
  - Goal: increase operational space (e.g. lower  $\nu^*$ ) with high-Z coated limiters
  - Injected B, BN powder into H-modes
  - Rapid wall re-conditioning successful!
- Unit being built for EAST – 1/18
- Unit being built for DIII-D – 4/18
  - Goal to compare Li, B, BN, C
- Plan to deploy at W7-X (2018,2020)
- *Request from KSTAR and MAST-U for collaboration with this capability*
- *Hope to deploy in JET with Be powder (R&D at JET) if JET is extended; eventually for ITER*



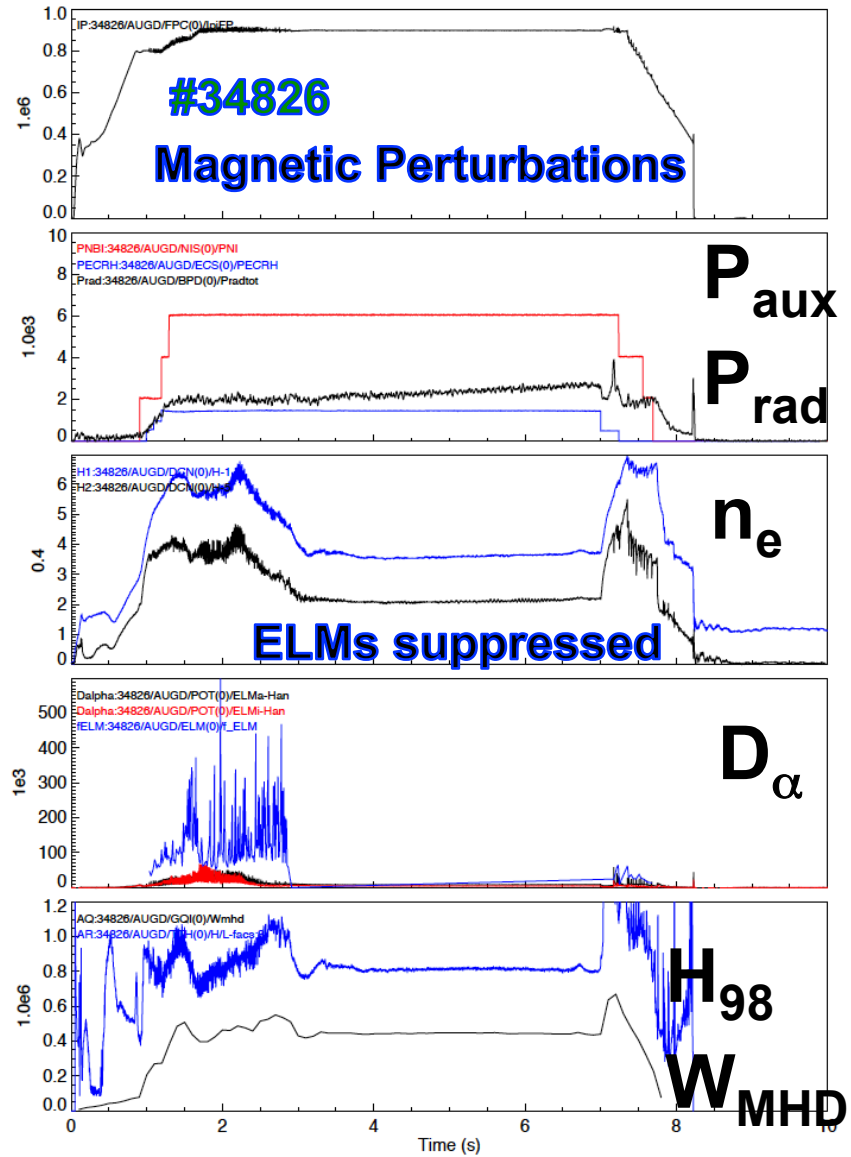
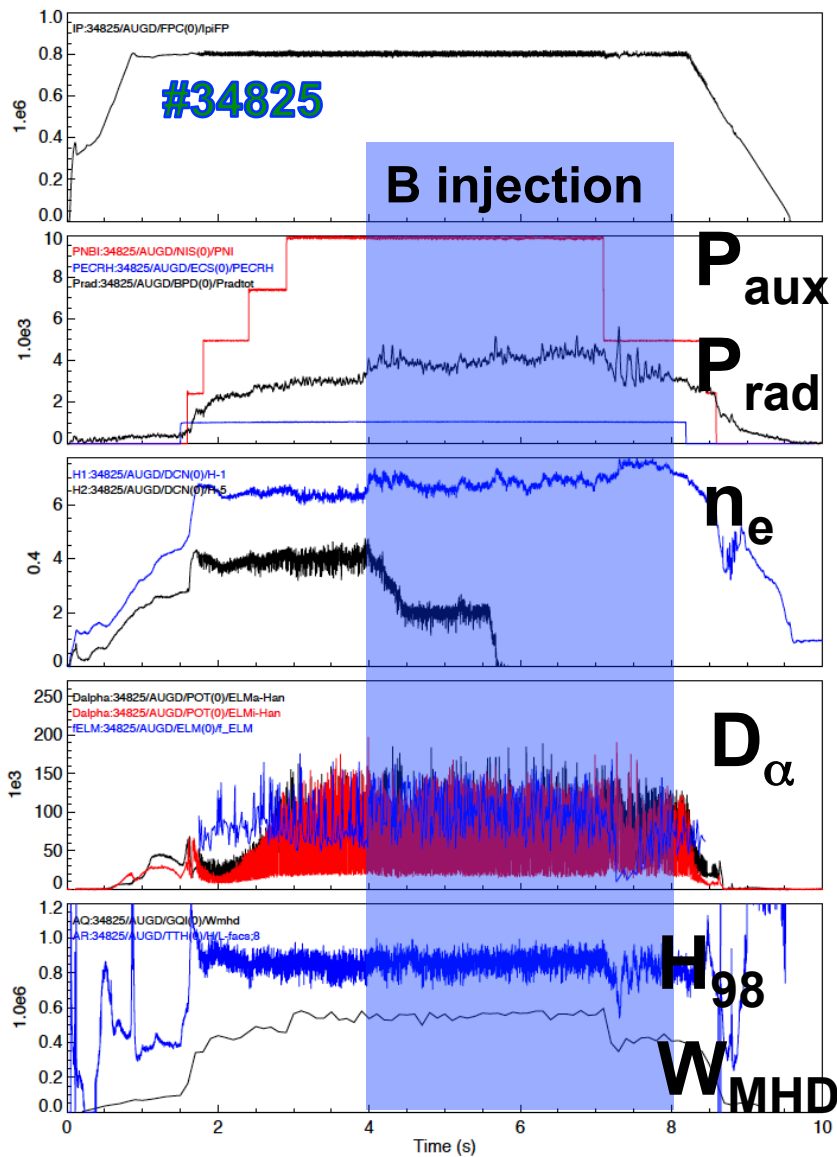


# Dropper with B & BN installed on AUG on 10/11/17



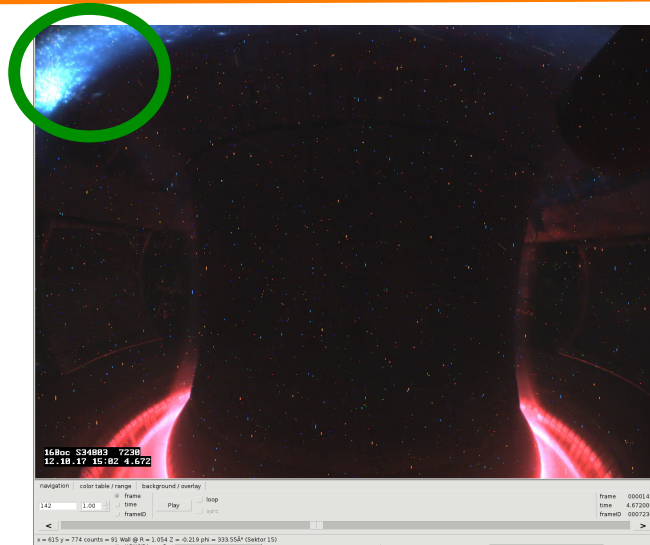
# ELM suppression with magnetic perturbations successfully (and surprisingly?) achieved after B injection discharge

- *Poor wall conditions before B & BN injection*

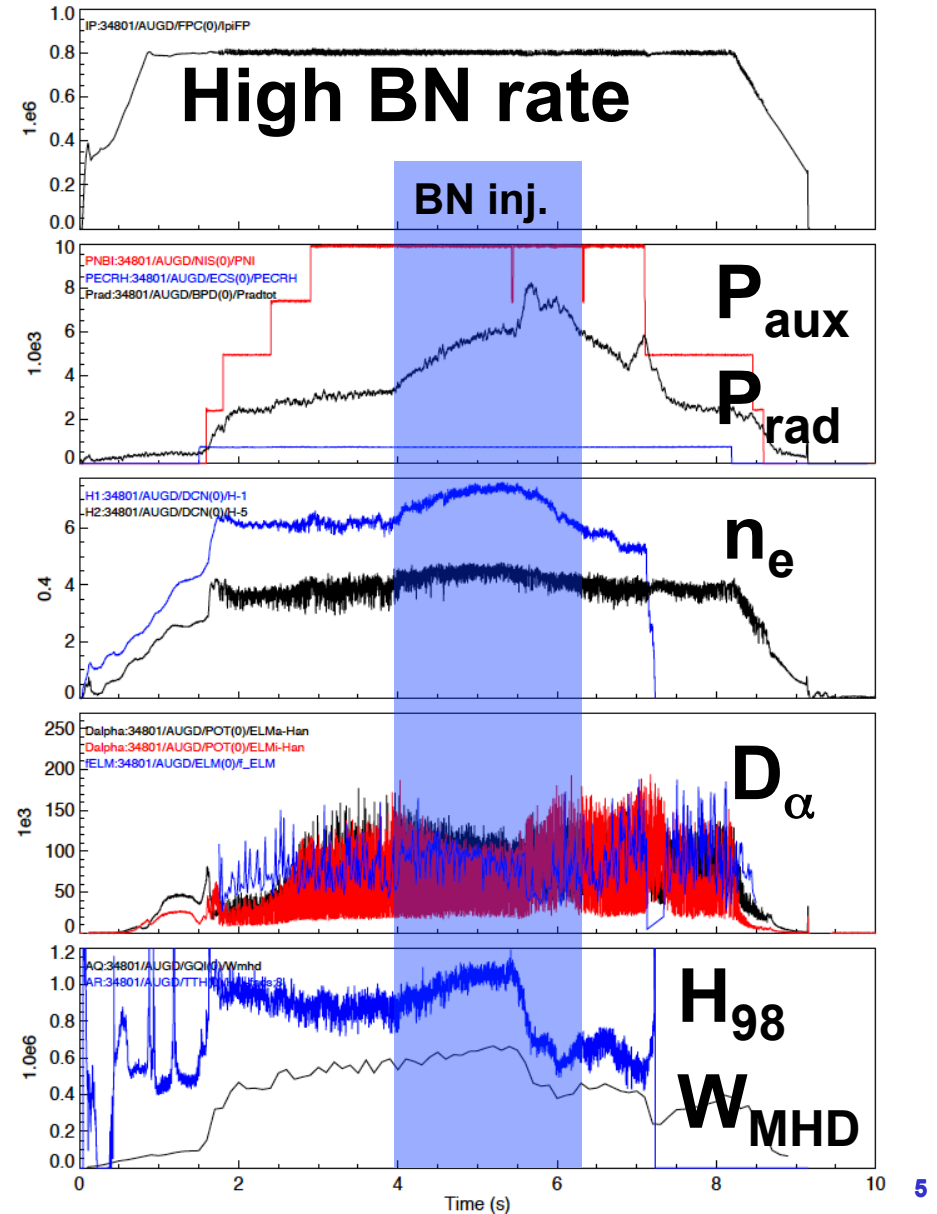




# Radiated power and confinement increased with high BN injection rate in AUG ELMy H-modes

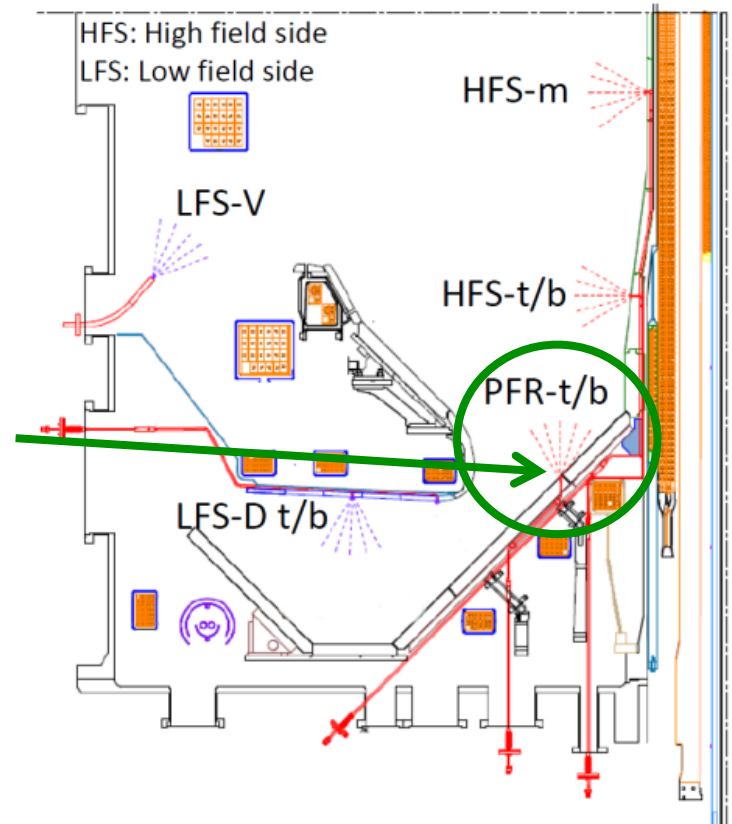


- Observed increased B & N flux from limiters & divertor
- $P_{\text{rad}}$  increased by  $> 100\%$  at highest rates
- At high injection rates, H98  $W_{\text{MHD}}$  increased by 20%, as observed with  $N_2$  puffing
- Crashed if  $\beta_N > 2.7$



## News of success at AUG sparked interest from many groups

- MAST-U interested in 2019 or maybe 2018 deployment
  - Present plan is to use Trimethyl-Boron, which puts 3 carbons per boron
  - Pure B injection superior
  - Considering either a divertor port (hard) or a midplane port (easy)
- KSTAR requested assessment and possible deployment in 2018
  - Long pulse conditioning
  - First videocon on 12/4/17
- W7-X reiterated interest
- We will offer a seminar at JET with AUG (+DIII-D, EAST) results in 2018

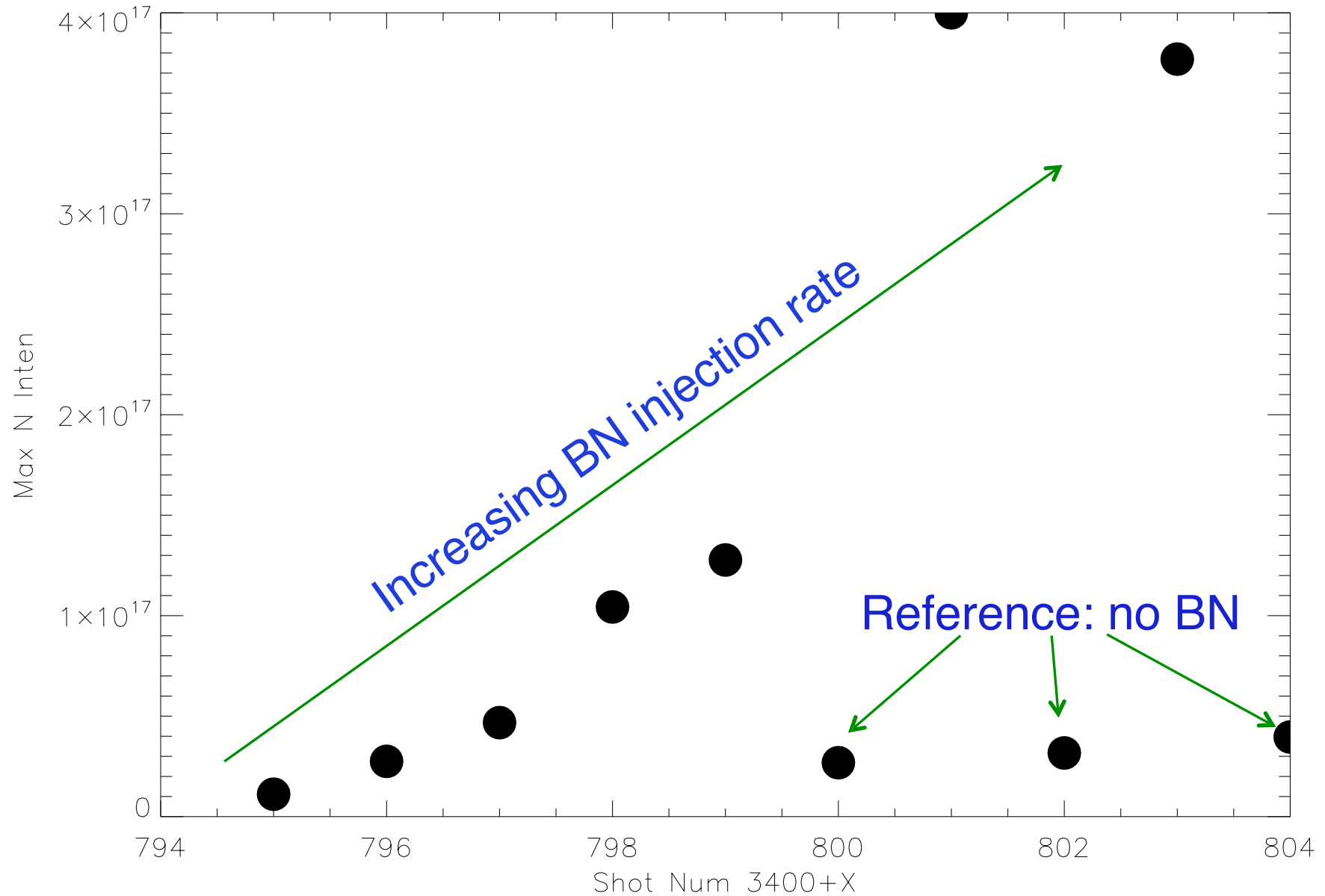


# Backup

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# N emission intensity on CER increased with increasing BN injection rates



# B emission intensity on CER increased with increasing B injection rates

