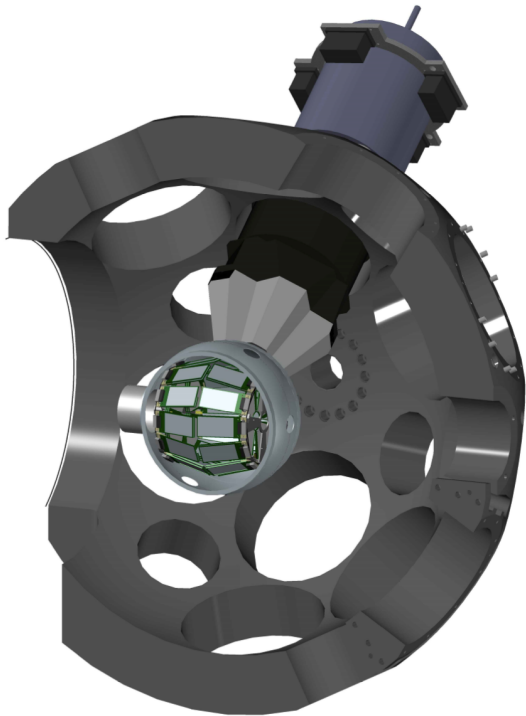


DRACULA

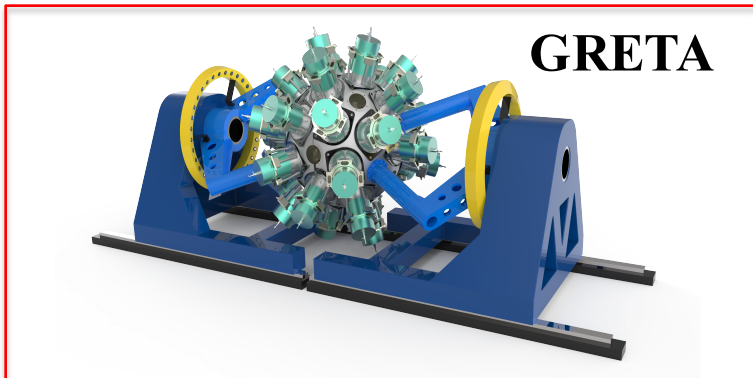
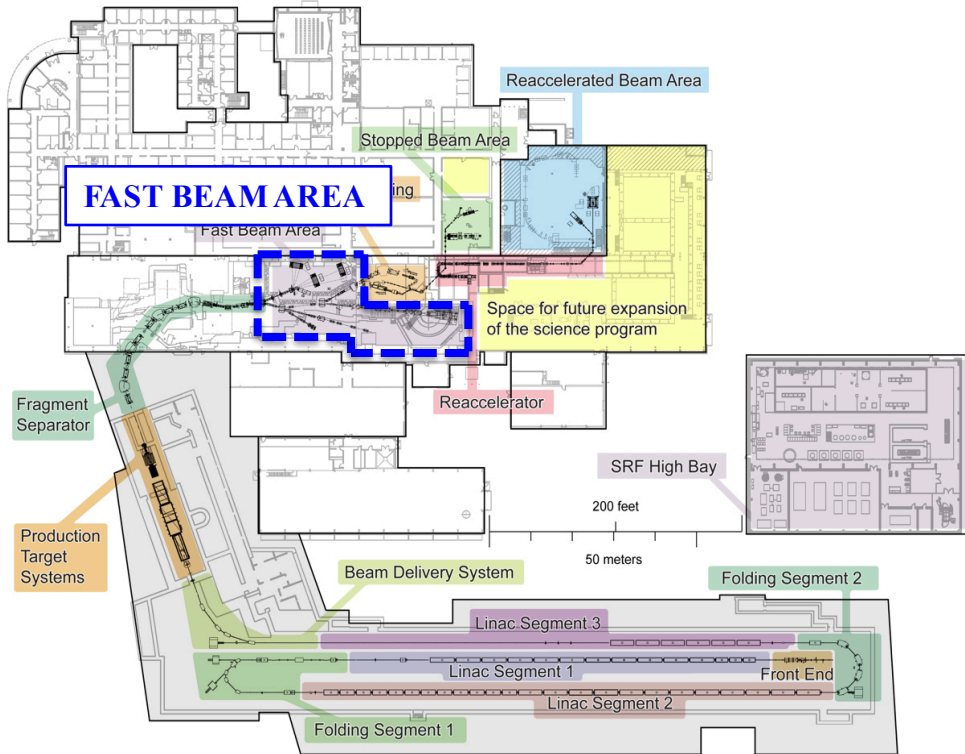
Direct **R**eaction **A**rray for the **C**ore
Understanding of **L**ight nuclei and
Astrophysics



Daniel Doherty
University of Surrey

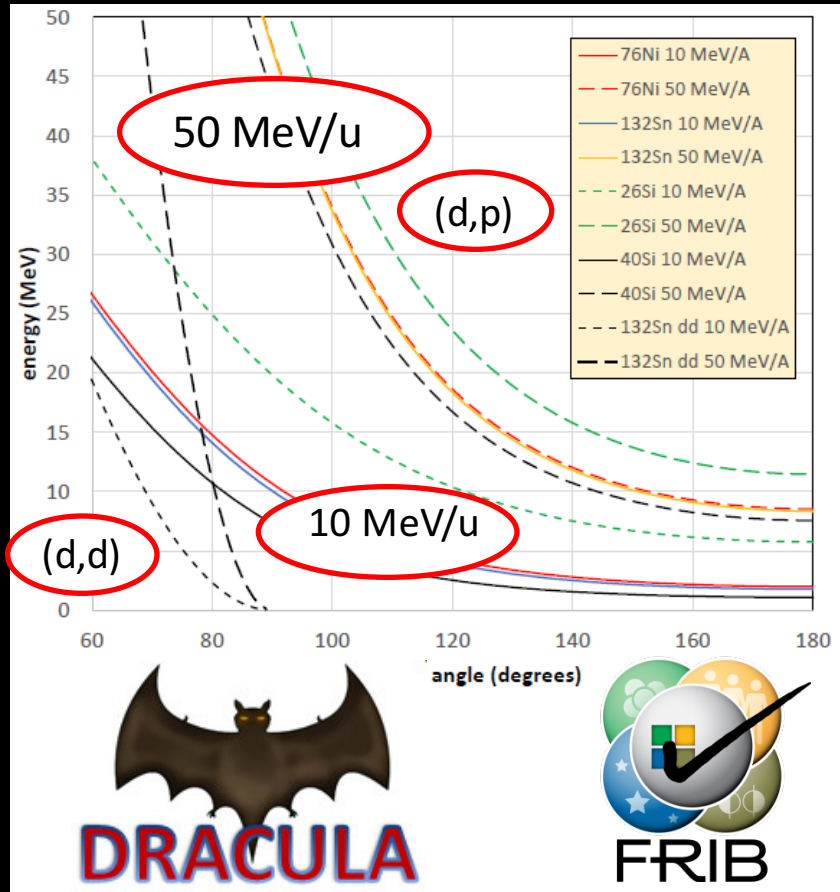


FRIB – Fast Beam Area



DRACULA – Surrey/UK Proposed Light-Particle Array for (d,p) and (⁶Li,d) (t,p) etc., at FRIB

G LOTAY, D T DOHERTY & W N CATFORD (Surrey UK)

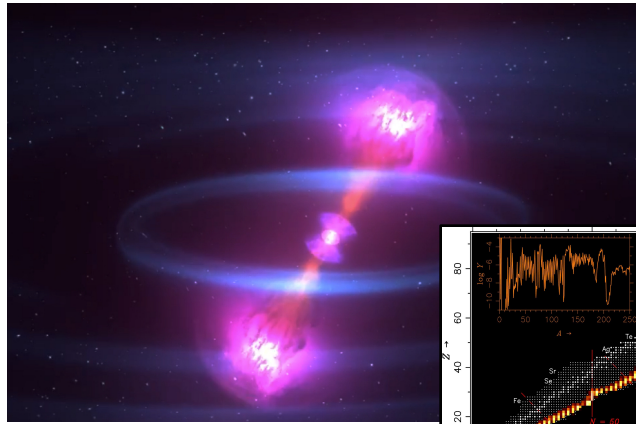


- existing arrays such as GODDESS at RIA3 are ideal for reaccelerated FRIB beams
- the **OPPORTUNITY** is for a dedicated array to exploit slower fast beams
- designed to mount in front of the S800
- designed to fit inside GRETA/GRETINA
- while 10 MeV/A is ideal for assigning $\ell_{transfer}$, 50 MeV/A still **works fine** for transfer
- there will be no untagged beam contaminant
- there will be no chemistry or breeding issues
- we can use **any of the beams** from FRIB
- we will need **higher stopping power**
- we will need low noise, especially to extend to (⁹Be, ⁸Be → αα) etc.
- we have costed **digital electronics** with 300 MHz sampling to allow Si-PSD with nTD silicon
- the electronics/DAQ would be designed to also be suitable to connect to GODDESS
- we foresee important extensions to study (t,p) and (p,t) with GRETA and in-flight beams
- Discussions and collaboration with SDP, AG, BMS

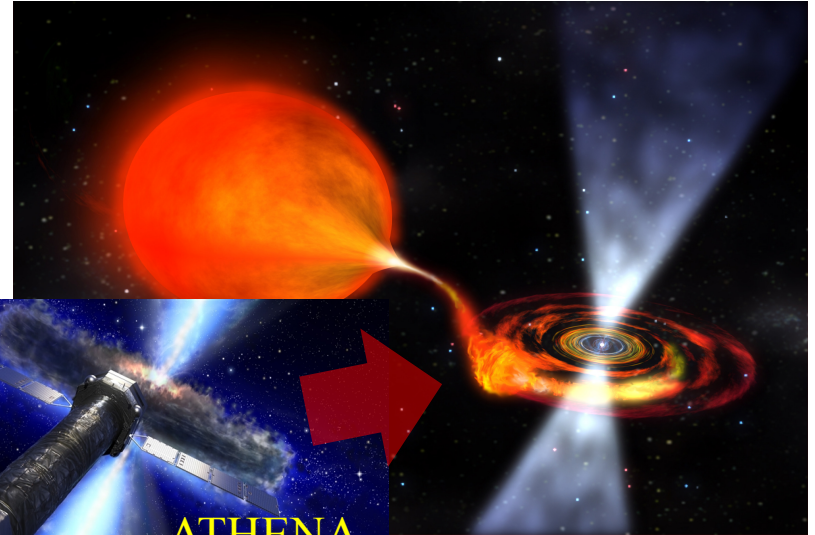
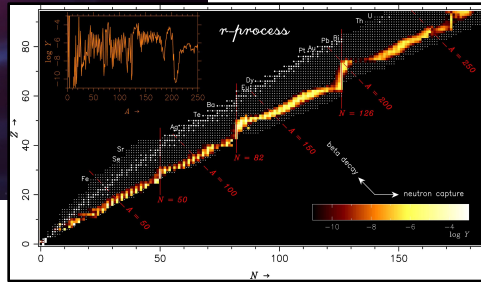
DIRECT REACTION ARRAY for the CORE UNDERSTANDING of LIGHT NUCLEI and ASTROPHYSICS

BUILDING ON OUR SUCCESSES AND PREVIOUS SILICON COLLABORATION

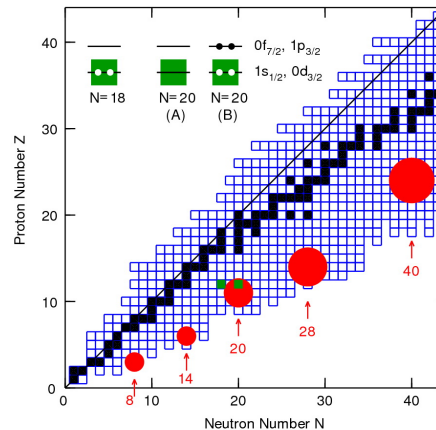
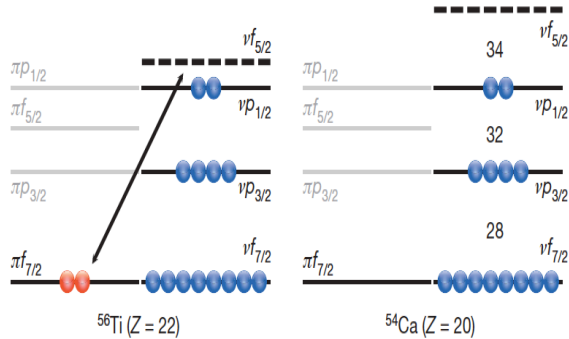




- Direct investigation of r process reactions and insight into neutron star mergers [e.g. $^{76}\text{Ni}(d,p)^{77}\text{Ni}$ as a surrogate for (n,γ) reactions around ^{78}Ni]



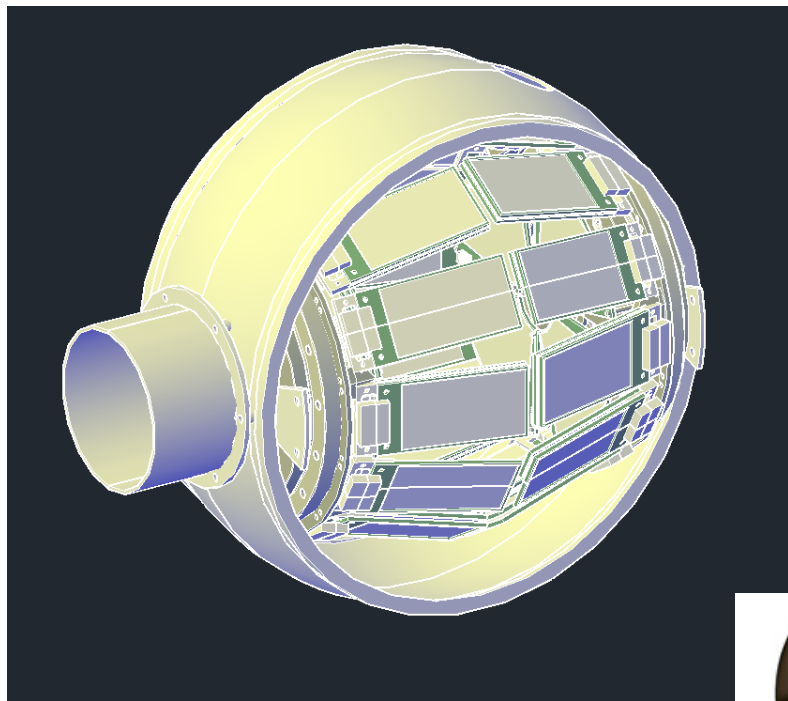
- Study of proton-rich nuclei involved in the rp process and their influence on X-ray bursts – targets of the ESA's ATHENA satellite [e.g. resonance strengths in the $^{56}\text{Ni}(\alpha,p)$ reaction via $^{56}\text{Ni}(^6\text{Li},d)$]



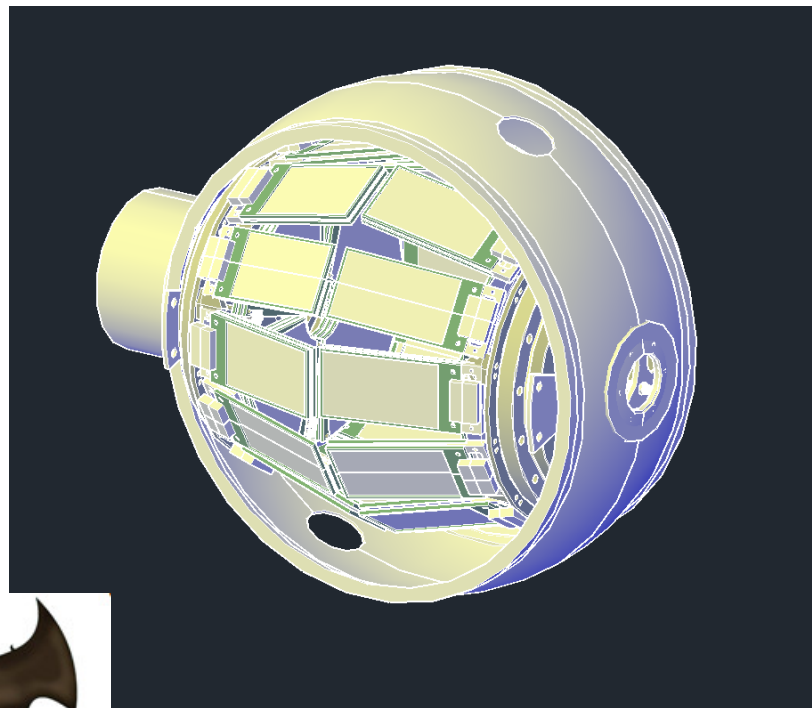
- Study of the evolution of magic numbers away from stability via single nucleon transfer reactions [e.g. $^{54}\text{Ca}(d,p)$] and the 2nd island of inversion [e.g. $^{64}\text{Cr}(d,p)$]

DRACULA – Surrey/UK Proposed Light-Particle Array for (d,p) and (⁶Li,d) (t,p) etc., at FRIB

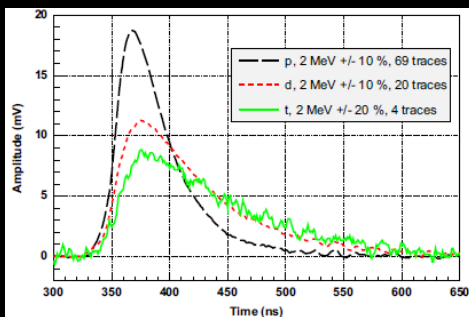
VIEW TOWARDS BEAM-ENTRY PORT



VIEW FROM BEAM-LEFT SIDE



VOLTAGE TRACES FOR 2 MeV
SIGNALS FOR p, d, t; 50ns/div
[Data: Orsay NIM A732, 87 (2013)]



PRESENT STATUS of PROJECT: PRIORITY
PROJECT proposal with UKRI.

PRELIMINARY DESIGN FOR COSTINGS (£3.7m/4years incl. manpower)

Telescopes of 4" Si DSSD 1mm + 2 x SiPAD 1.5mm + CsI/SiPM 3mm
Initial instrumentation for (d,p) at up to 50 MeV/u & elastic normalization
Feedthroughs to air for each channel, fast ASIC preamps in air
New custom digital electronics/DAQ; liaison with FRIB for compatibility
1500 channels, 250 or 500 MHz sampling, 14-bit; PSD with nTD Si possible

The UKRI (STFC's parent) HAS ALSO REQUESTED a bid for an EXTENDED PROJECT that will include A FULL S800 UPGRADE.

DRACULA Collaboration Meeting/ Workshop

- October 2019 with **follow-up** planned in 2020.
- A strong focus on establishing and building **UK-US collaboration**.
- Work on hardware specifications, electronics, and key science cases/ goals.
 - Geometry considerations
 - Choice of scintillators
 - Required sampling rate
- Arrived at a clear version of the optimised design (implemented in Geant4).

