WG 7 summary

^{3}He(α,γ)^{7}Be and ^{3}He(^{3}He,2p)^{4}He

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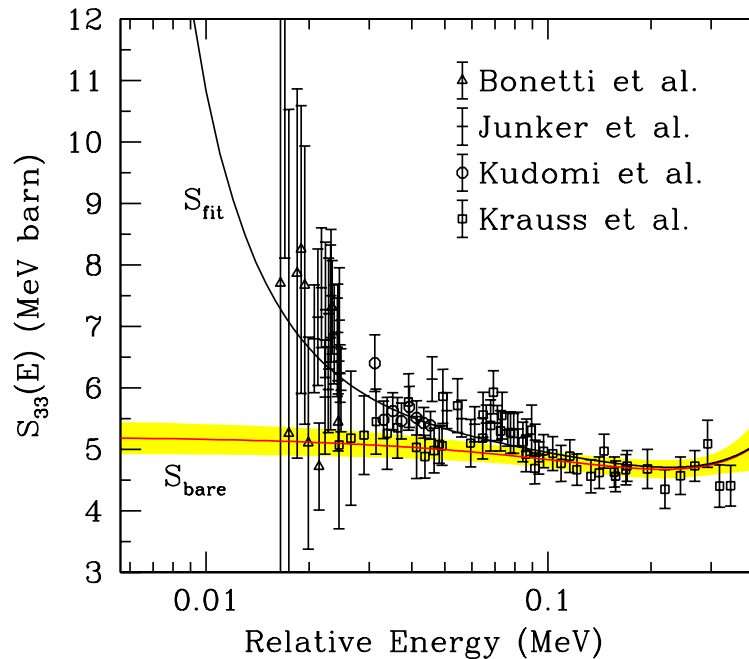Kostas Kravvaris
Daniel Odell
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Tamás Szücs
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^{3}He(^{3}He,2p)^{4}He state of the art and recommendations

- No new experimental cross section data post-SF II.
- We plan to recommend to maintain the SF-II exitation function (see figure).
- It will be noted in the text of the review that a recent Bayesian fit by Iliadis gives consistent results.

- There is an important caveat:

  The energy spectrum of the emitted protons from the reaction is significantly different from the spectrum assumed for the data analysis of most of the ^{3}He(^{3}He,2p)^{4}He cross section measurements, see Zylstra *et al.* 2017.

  This may actually increase the recommended uncertainty, which is 4.3% (SF-II).

- As a result, we may recommend further work on this energy spectrum.

^{3}He(α,γ)^{7}Be updated experimental situation

New experimental data

- New capture data at high energy (Carmona+ 2012, Bordeanu+ 2013, Szücs+ 2019).
- One data set spanning a wide energy range but not quite reaching the LUNA data (Kontos+ 2013).
- One ANC measurement (Kiss+ 2020) but there may be some theory uncertainty, also there are new d+α calculations
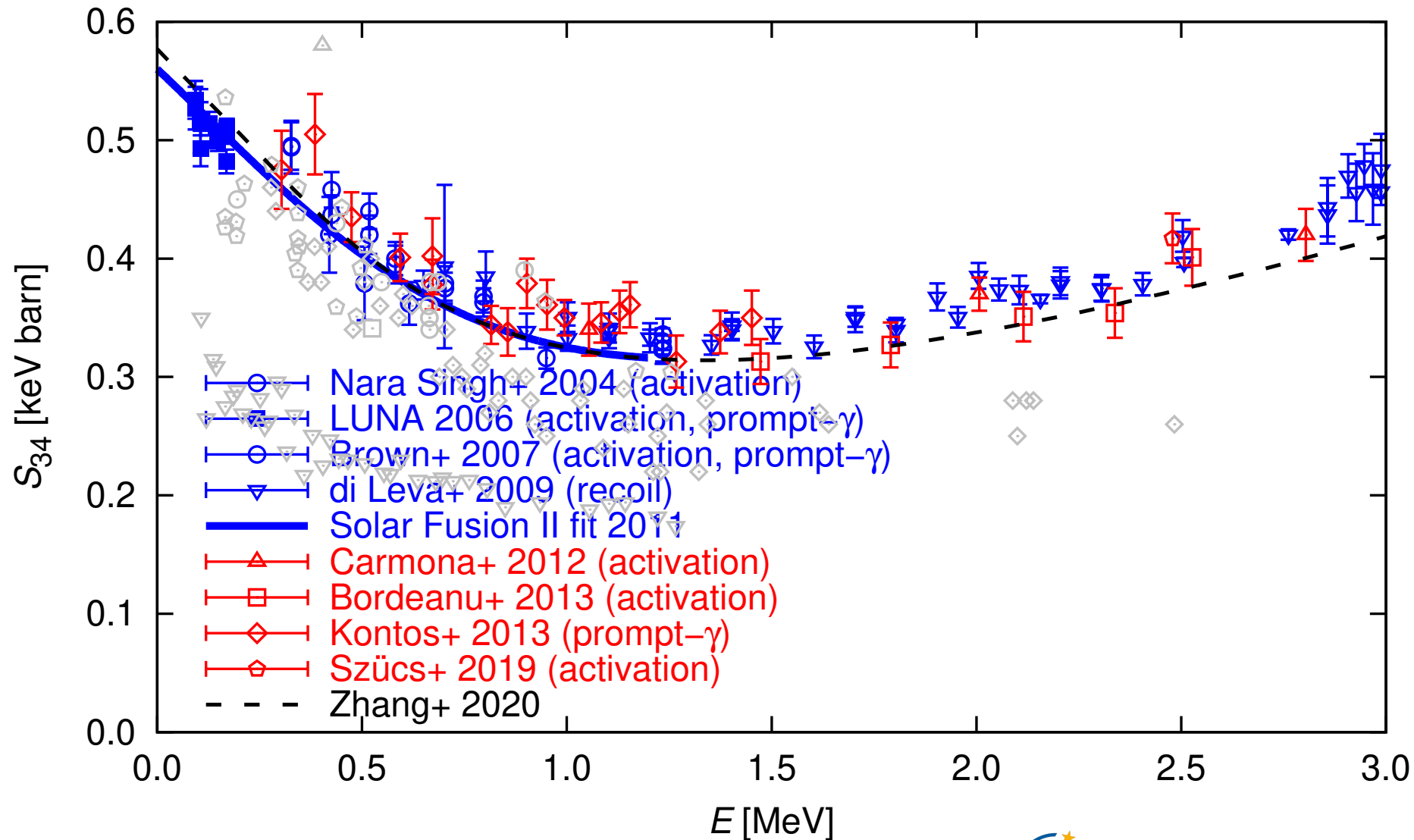
New treatment of archival experimental data

- In SF-II, we dismissed all pre-2000 data due to the generally lower level of documentation.
- For SF-III, we plan to check each of the archival papers whether it indeed is insufficiently documented, and decide case by case which ones to adopt for the final fit
- No large change in the recommended values is expected due to the re-inclusion of some archival data.

Ongoing work that we are aware of and that may be included if published by the cutoff date

- Elastic scattering at low energy (SONIK @ TRIUMF)
- γ-ray angular distribution (Felsenkeller)

^{3}He$(\alpha,\gamma)^7$Be data situation

S$_{34}$ [keV barn] vs E [MeV]

- Nara Singh+ 2004 (activation)
- LUNA 2006 (activation, prompt–γ)
- Brown+ 2007 (activation, prompt–γ)
- di Leva+ 2009 (recoil)
- Solar Fusion II fit 2011
- Carmona+ 2012 (activation)
- Bordeanu+ 2013 (activation)
- Kontos+ 2013 (prompt–γ)
- Szücs+ 2019 (activation)
- Zhang+ 2020

^{3}He(α,γ)^{7}Be planned approach for new recommended S_{34} value

- Fit upper limit will be higher than 1 MeV (SF-II) but below the 7/2$^-$ resonance

- Do several fits using existing code by WG7 members:
  halo EFT (Nollett, Rupak), tradional theory with Bayesian statistics (Iliadis)

- Frequentist fit will also be performed.

- Feasibility of doing an R-matrix fit with BRICK/AZURE on S_{34} will be explored

- Fitting will be done with floating norms, using the documented systematic errors of each experiment

- It is hoped that the final results will not depend much on fit algorithms used.

- Model choice error will be treated.

- Fits should take into account capture data, but also other data wherever possible (elastic scattering, etc.)

- Recommended S_{34}(E) curve should be tabulated (using maybe 5-10 points) in the review.

- Fuller information should be made available as a supplement to the review, and also on ChETEC-INFRA web-based cross section database (under construction now)

^{3}He(α,γ)^{7}Be probable recommendations for future work

1. New capture data spanning the range between LUNA (0.1 MeV) and the bulk of the other data (1 MeV).

2. New elastic scattering experiments also at high energy (low-energy ongoing at SONIK - TRIUMF)

3. New angular distribution measurements (ongoing at Felsenkeller).

4. New measurement of the γ-ray branching ratio.