

ADAS/ADAS-EU/ Extended-ADAS

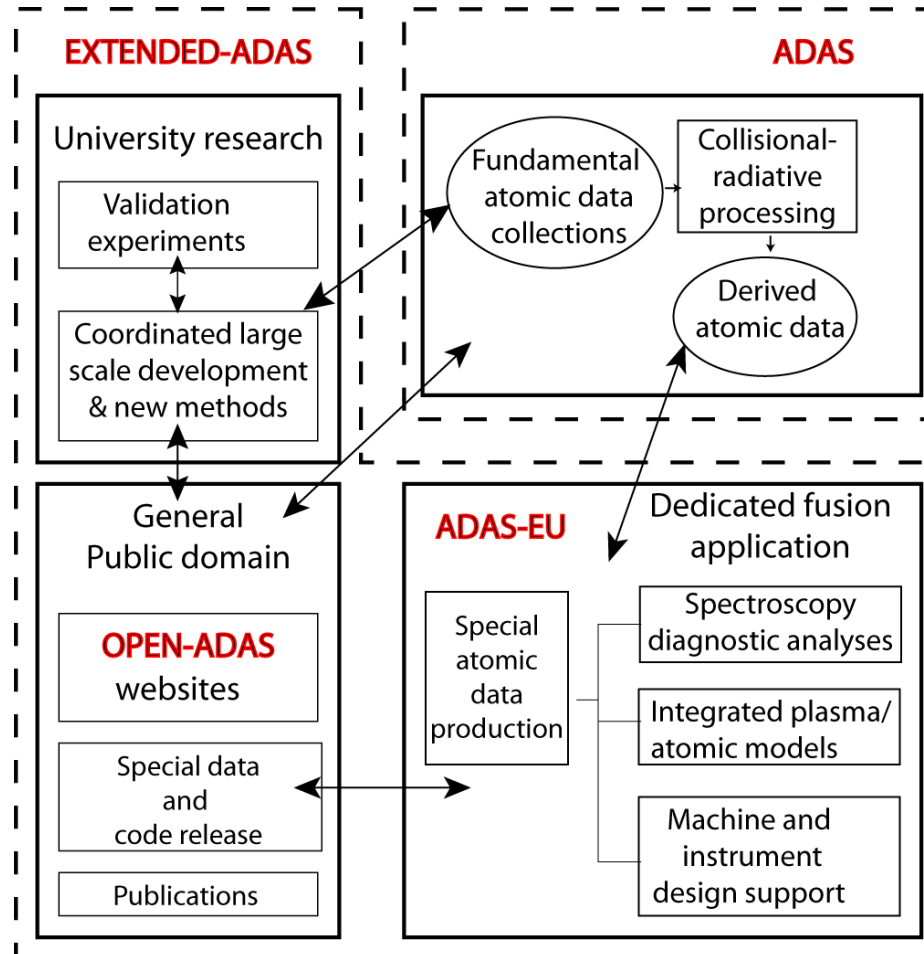
Discussion and Planning

Hugh Summers

University of Strathclyde
CCFE Culham/JET Facility

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Armagh

ADAS overview and connections



<http://www.adas.ac.uk>

<http://www.adas-fusion.eu>

Areas for attention

- Initiatives and collaborations to lift the ADAS database
 - fundamental data, applied data, ADAS population models.
 - Extending ADAS towards dedicated applications
 - close-coupled diagnostic application codes, spectral analysis codes.
 - Ensuring effective ADAS connection with plasma models
 - close-coupled diagnostic application codes, spectral analysis codes.
- Providing effective ADAS-EU support to Europe
 - visits , defined shared developments.
 - Providing effective ADAS support to outside Europe
 - visits , defined shared developments.

ADAS/ ADAS-EU: Science themes

Light element spectroscopy and models	Heavy element spectroscopy and models	Diatomic spectra and coll-rad models
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Database	Uncertainty and error propagation
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Charge exchange spectroscopy	Beam stopping beam emission spectroscopy	Special features
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Light element spectroscopy and models

	Completed in ADAS	Current development activity	Future activity
Lifting the ADAS database	H-Ne Gen. Coll. Rad. Li-B Gen. Coll. Rad.	Si, S Gen. Coll. Rad.	
Dedicated applications		Non-Maxwellian	
Connection with plasma models		ITM, JAMS	

Update of atomic data for light elements up to Si

Requirements

- Sophisticated ADAS approach (full GCR) has been applied to the light elements until Ne only
- Extension of GCR calculations until Si (plus S, Ar, Ca, Fe) is needed for both astrophysics and fusion
- Recommendation of atomic data with appropriate accuracy is important to avoid interpretation errors

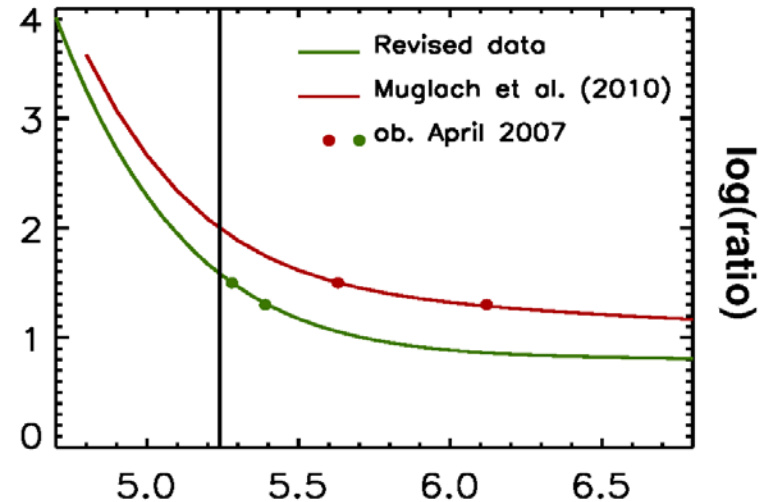
Current work

- The precision of the earlier calculations for the light elements have been re-examined and revised when necessary
- Computations have been performed to extend and top-up preferred data from literature
- New calculations for Si ionisation (*ground to ground and metastable resolved*) are nearly to be completed

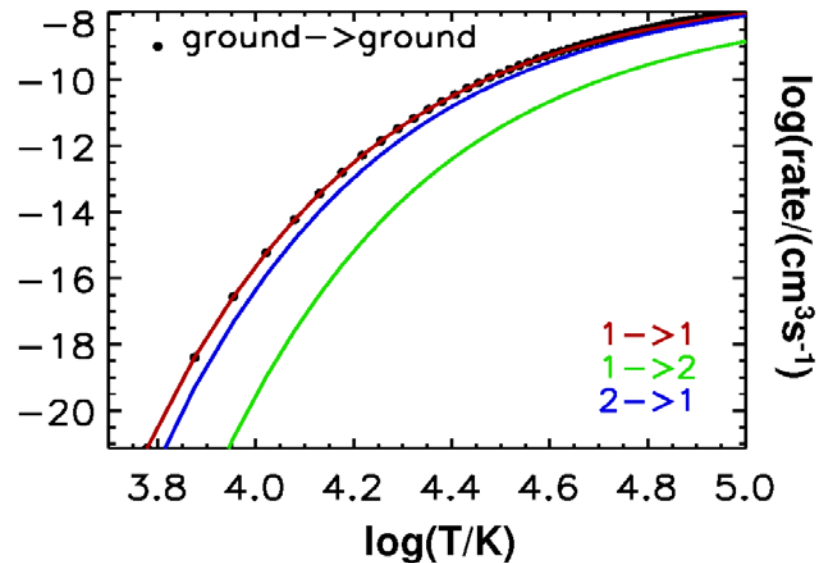
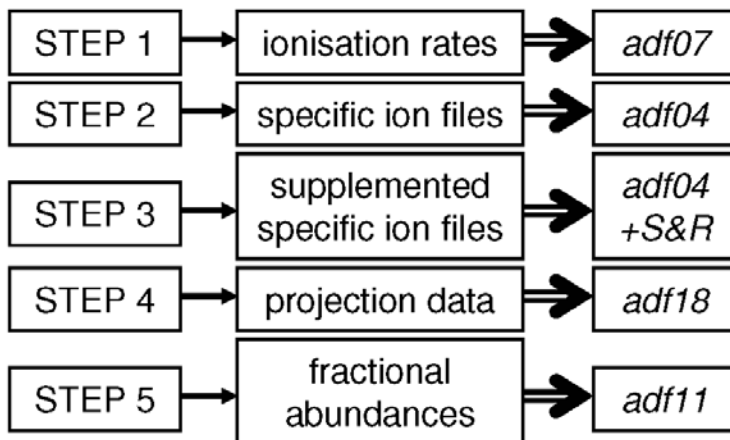
Results and future developments

- Revised *adf04* (e.g.: O^{+3} 787.7/279.9)

He ⁰ , He ¹	Mg ⁷ , Mg ⁹
C ⁰ to C ²	Si ⁰ to Si ¹³
N ¹	S ²
O ⁰ to O ⁵	Ar ⁶ , Ar ⁷
Ne ³ to Ne ⁷	Ca ⁷ , Ca ⁹
Na ⁷	Fe ⁶ to Fe ¹⁵



- Si ionisation (e.g.: $Si^{+1} \rightarrow Si^{+2}$)



Thermal He beams (nozzle or supersonic expansion)

At $T_e > 10\text{eV}$, CX with background Hydrogen plasma is an important depopulation mechanism for the triplet system

No high quality cross-section data exists $\text{He}^* + \text{p} \rightarrow \text{He}^+ + \text{H}$

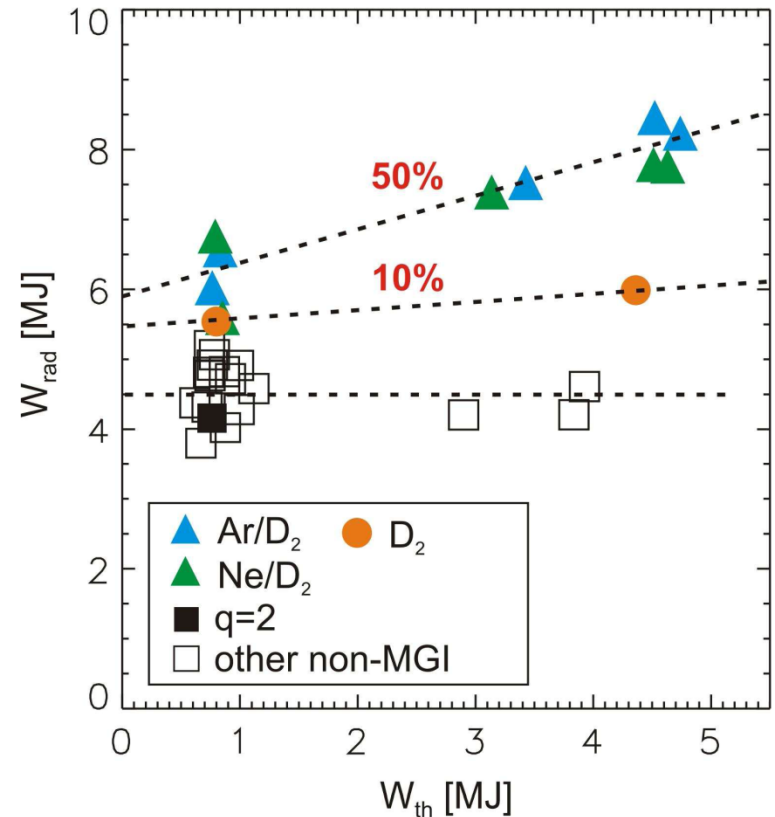
Can CX-cross sections be used ADAS208 ?

What about spin system breakdown (e.g. of $4^{1,3}\text{F}$ states)?

Hugh has some ideas / concepts...

This is important e.g. for the line intensity ratio technique for the measurement of T_e and n_e at TEXTOR and TJ-2....

- ▶ Necessity to account for the radiated power during Massive Gas Injection.
- ▶ ADAS CR models can be used to account for the Ar total radiated power.
- ▶ A timestep model of gas injection is under development in collaboration with M. Tokar and M. Koltunov.
Experimental side from A. Huber and M. Lehnen.



M. Lehnen EPS 2009

Heavy element spectroscopy and models

	Completed in ADAS	Current development activity	Future activity
Lifting the ADAS database	Baseline Ionisation	Diel. Recomb.: BBGP ADAS-EU sub-contracts Badnell DW	Electron collision working party
Dedicated applications			
Connection with plasma models	Superstages		

X-ray Spectrometers at JET for W

-Installation of ITER-like wall with W and Be tiles

-New detectors for KX1 at JET

⇒ new x-ray W spectra at JET (from 2012)

Need: Line energies, intensities & line widths,
excitation, recombination rates and emission coefficients

W^{46+} ($W^{38+} \rightarrow W^{56+}$) as function of Te and ne at 2.38 keV.

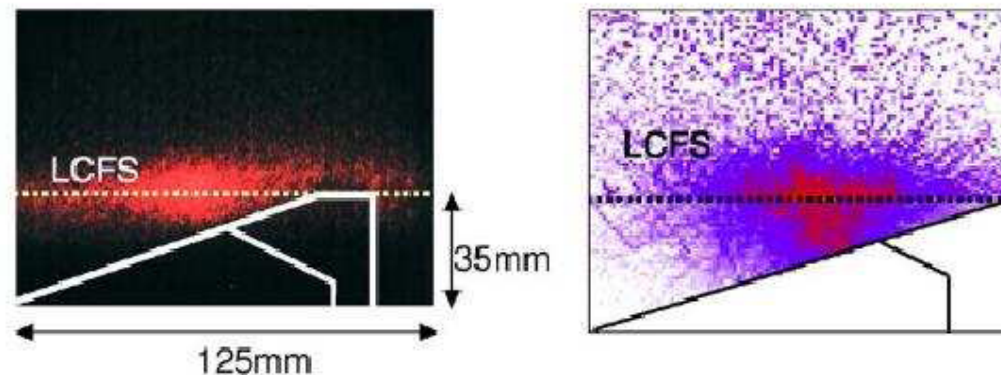


all possible W x-ray lines (2.33-2.46 keV) as a f (Te, ne)

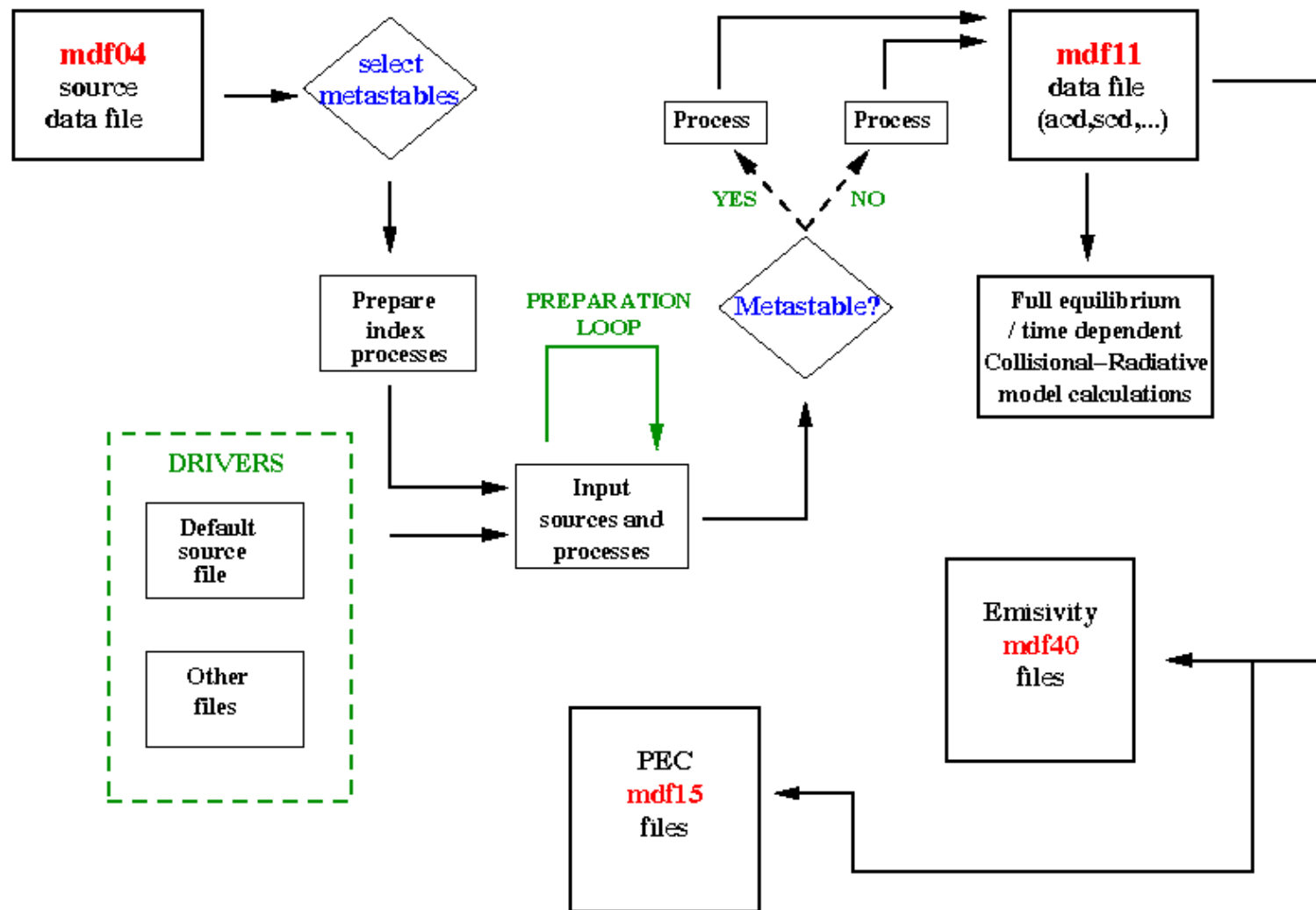
Diatomic spectra and coll-rad models

	Completed in ADAS	Current development activity	Future activity
Lifting the ADAS database		ADAS-EU Theme – H ₂	
Dedicated applications			
Connection with plasma models		ADAS-EU Theme – H ₂	

- ▶ Molecular ADAS structure will help to deal with the contribution to emission from the products from molecule dissociation.
- ▶ CR coefficients as PEC or DXB will be obtained.
- ▶ The actual work in H2 will be the basis of new molecular models as hydrocarbons. Collaboration with ERO group in Jülich (D. Borodin) is on that.



A. Kirschner et al., J. Nucl. Mat. **328** (2004) 62



Charge exchange spectroscopy

	Completed in ADAS	Current development activity	Future activity
Lifting the ADAS database	$B^{+5} + H$ Guzman Universal CXS $Ar^{+16}, Ar^{+17}, Ar^{+18} + H$ UAM	$N^{+7} + H$ Igenbergs $Ar^{+16}, Ar^{+17}, Ar^{+18} + H$ Schultz	
Dedicated applications	CXSFIT		NEW-CHEAP
Connection with plasma models		Radial transport	

Beam stopping and beam emission spectroscopy

	Completed in ADAS	Current development activity	Future activity
Lifting the ADAS database	Delabie corrections	H/ion impact excit. - Guzman	
Dedicated applications		Advanced CR model	
Connection with plasma models		NUBEAM/TRANSP	

He or He doped beams

$(E_{He} = 10 \dots 70 \text{ keV/amu})$

No quality heavy particle cross sections exist for excited states (CX, ionisation, excitation)...

We need a beam cr-model calculating beam emission,...

Who works in this area?

What is the diagnostic application?

Is this important for fusion α particle spectroscopy?

Is there synergy with the Li and Na beam models?

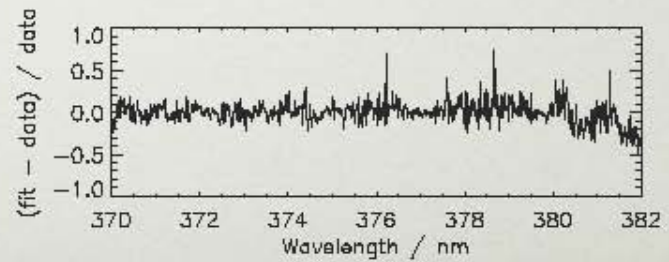
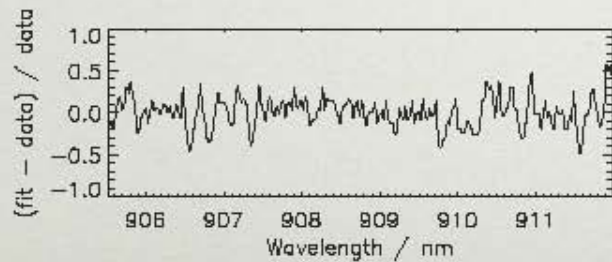
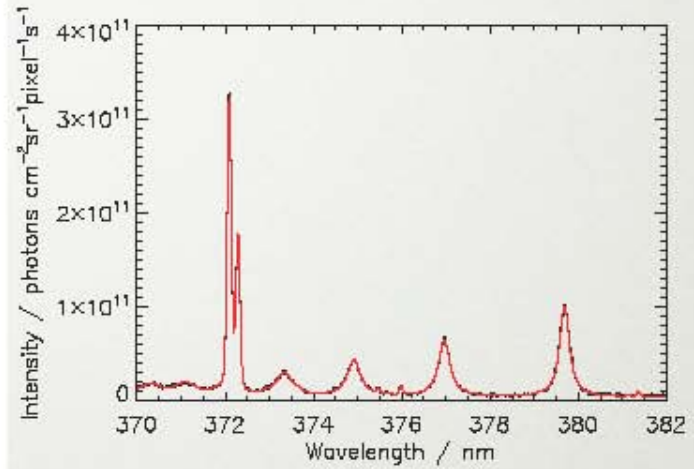
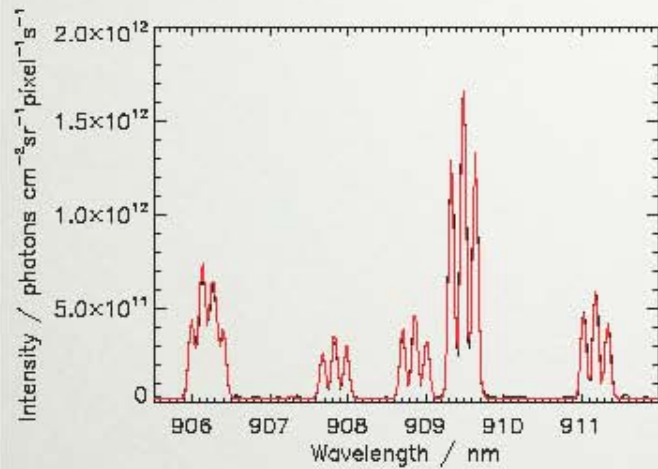
Special features

	Completed in ADAS	Current development activity	Future activity
Lifting the ADAS database		He-like/Li-like extended CR model	
Dedicated applications		AFG - AFS	
Connection with plasma models			

MODULAR SPECTRAL FITTING

- Two main software components:
 - ADAS Feature Generator (AFG)
 - Already included in ADAS.
 - Interactive code 605 makes use of this.
 - AFG provides easy, common interface to ADAS special feature models.
 - Framework for Feature Synthesis (FFS)
 - Flexible, modular system for spectral model definition and fitting.
 - Uses AFG to draw on special feature models.

EXAMPLE FITS WITH FFS



FFS

- Custom model definition language
 - model construct.
 - parameter values / constraints.
 - arbitrary coupling (allows for ad-hoc feature specification).
- Model optimisation.
- Batch fitting operation.

Line emission features in the visible

- More lines in X-Paschen / ADAS603
 - J Hey's Pascal codes should be ported to ?...
- Zeemann effect for Li beam ?
 - Try some measurements (A Korotkov)
- MSE with Hydrogen beams
 - Beam into gas calibration / measure in plasma
 - Mixing of levels not perfect [Gu2008]