Updates on AIMS and on the SpaceINN hare-and-hounds exercise

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Update on AIMS

- AIMS is now publicly available:
  - September 2015: version 1.0
  - April 2016: version 1.1
- more and more users:
  - Birmingham, Meudon, Porto ...
  - solar-like stars, red giants?
  - discover bugs and improve the code

AIMS in a nutshell

Analytical priors & Observational constraints:
- seismic: ν_i, r_{02}, r_{01}, r_{10}, $\Delta\nu$
- classical: T_{eff}, L, [M/H], ...
- error bars and correlations

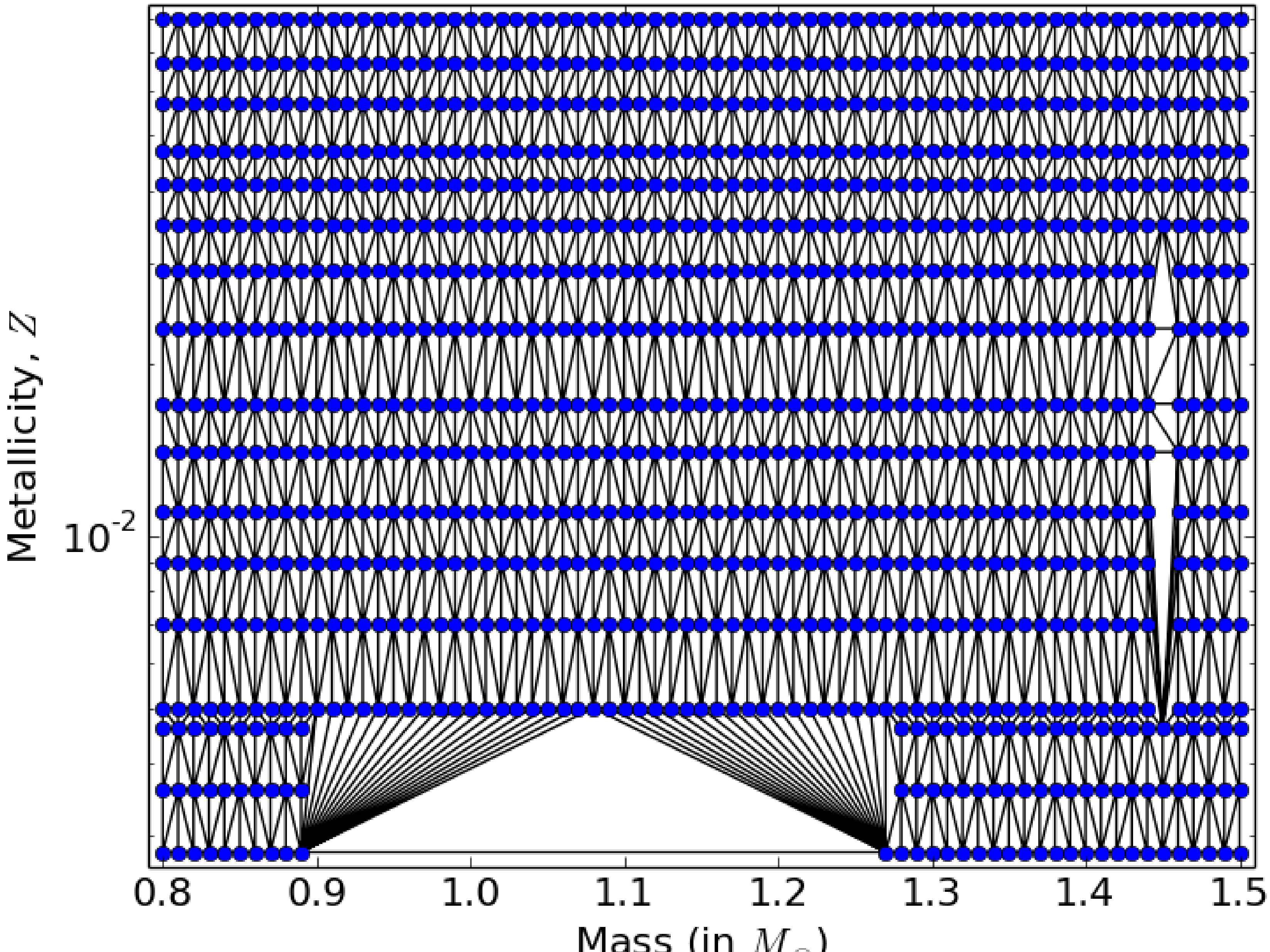
Grid of models
- n-dimensional (n ≥ 3)
- pre-computed pulsation frequencies
  - optional surface effects

AIMS = “Asteroseismic Inference on a Massive Scale”
- unstructured linear interpolation
- MCMC approach with parallel tempering (via the python EMCEE package, Foreman-Mackey et al. 2013)

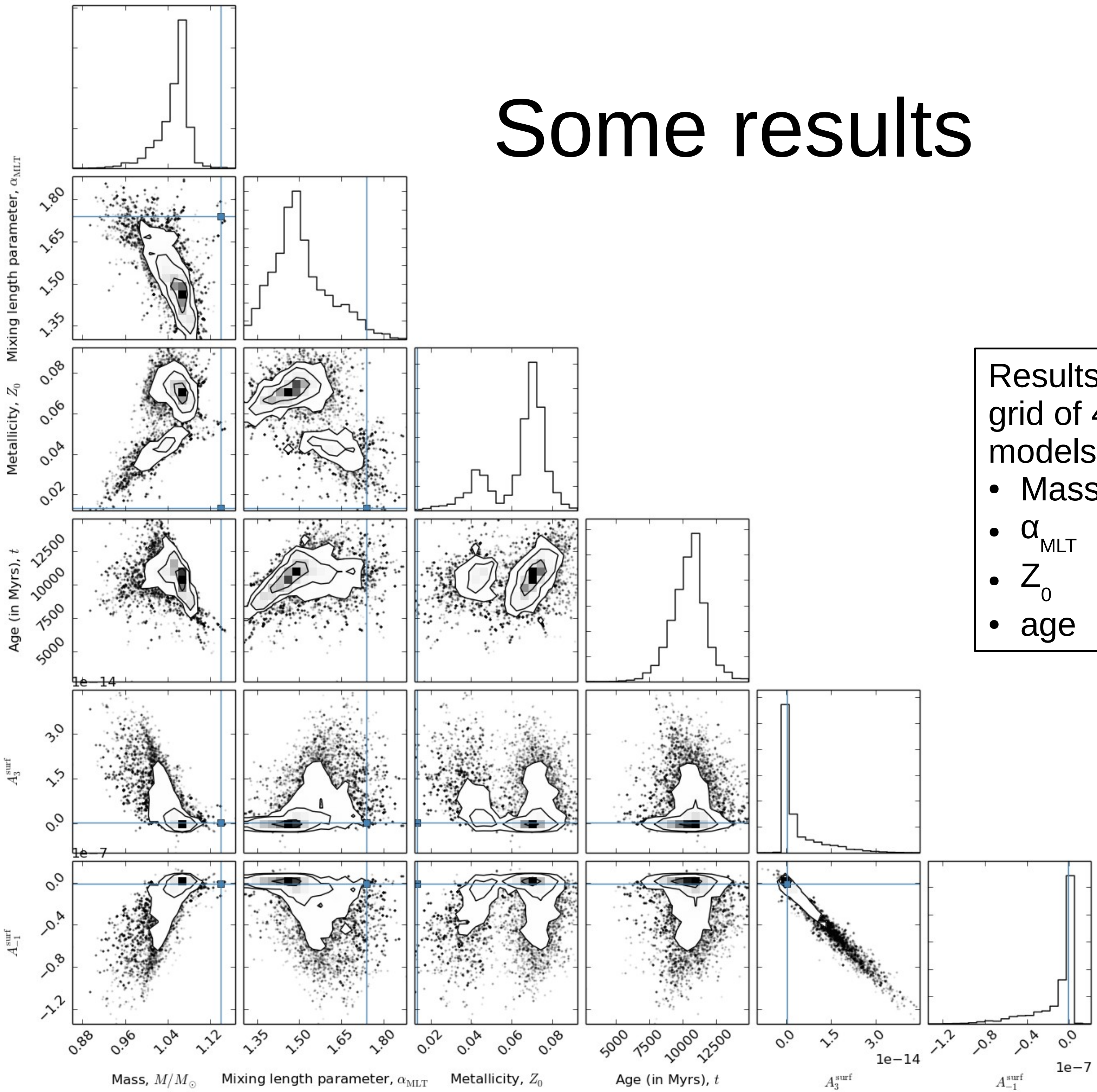
Estimated properties
- probability distribution functions for different parameters

Representative models
- provides coefficients for inter-polating acoustic structure
- allows inversions

Grid tessellation



Some results

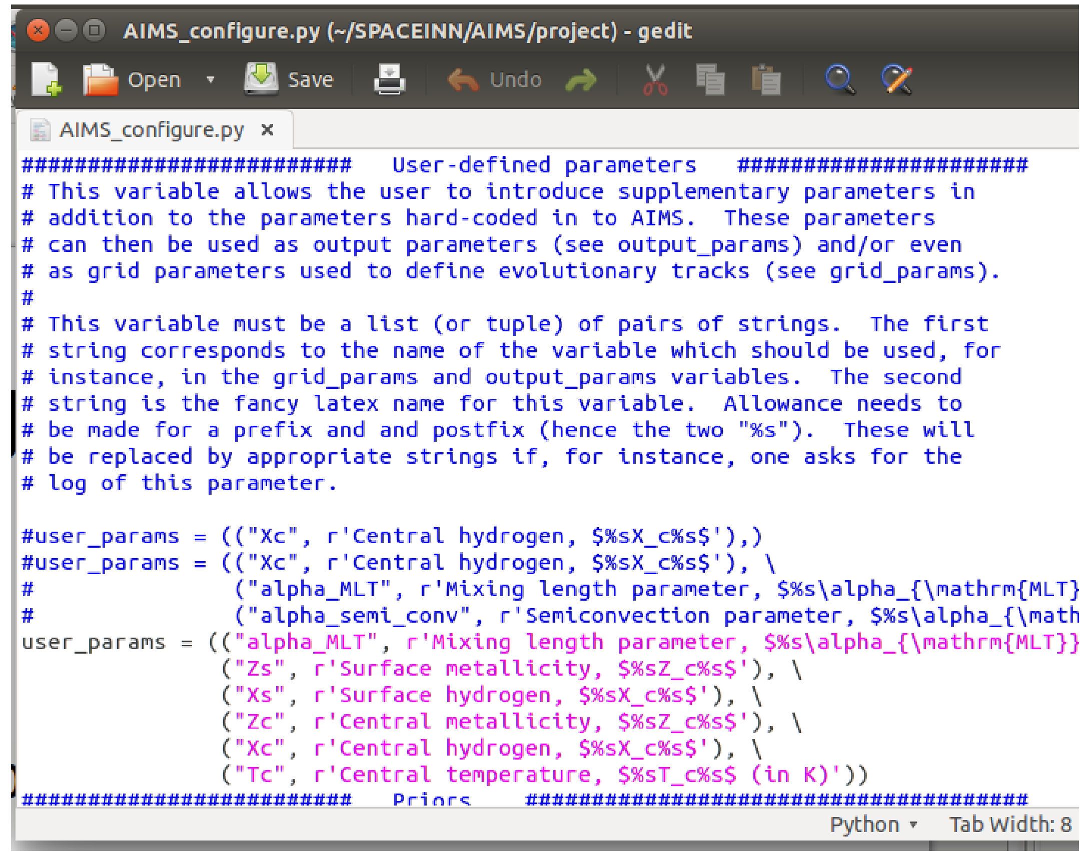


Results for Arthur using a grid of 400 000 CESTAM models

- Mass
- α_{MLT}
- Z_0
- age

What has changed in version 1.1?

- extrapolation beyond the edge of the grid is now possible
  - this can cause other problems, as recently discovered
- the user can easily introduce new grid parameters



Ongoing and future improvements

- inputs/outputs:
  - read binary frequency files from ADIPLS
  - write XML files to be used with OSM (Master's work by B. Herbert)
- numerical aspects
  - speed up various parts using fortran or c?

XML file produced by AIMS

KIC8394589_seismic.xml (~) - gedit


```xml
<config>
  <parameter name="agemax">
    <value> 4.27178656e+03</value>
    <step> 2.00000000e+01</step>
    <rate> 5.00000000e+00</rate>
    <bounds> 2.00000000e+01 ,  1.00000000e+04</bounds>
  </parameter>
  <parameter name="mtot">
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    <step> 3.00000000e-02</step>
    <rate> 3.00000000e+00</rate>
    <bounds> 5.00000000e-01 ,  5.00000000e+00</bounds>
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  <parameter name="zsx0">
    <value> 1.17213649e-02</value>
    <step> 1.00000000e-02</step>
    <rate> 5.00000000e+00</rate>
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  </parameter>
  <parameter name="alpha">
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```
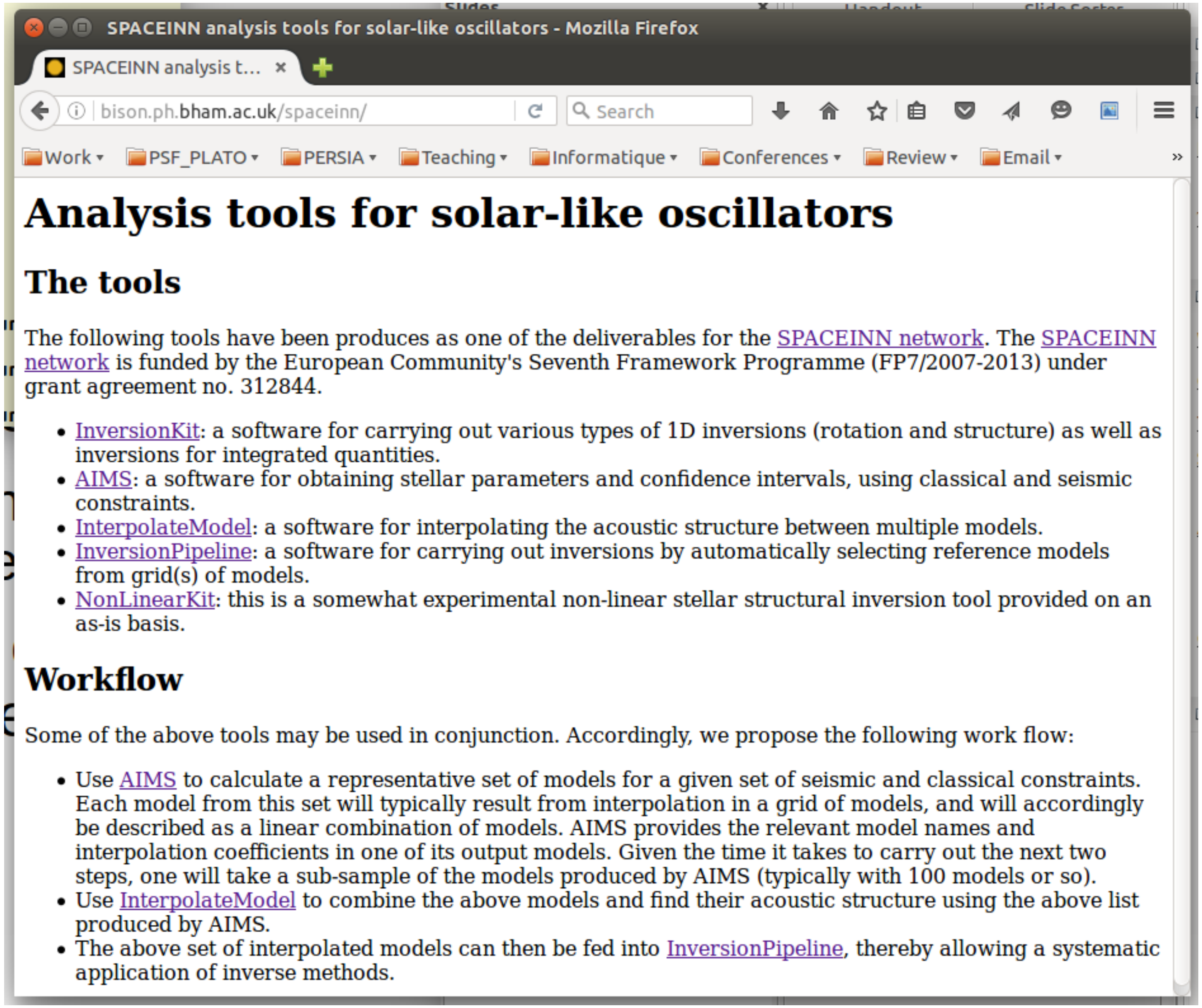


XML ▾ Tab Width: 8 ▾ Ln 1, Col 1 INS

B. Herbert (M1 master's project)

Other SpaceINN tools



SPACEINN analysis tools for solar-like oscillators - Mozilla Firefox

bison.ph.bham.ac.uk/spaceinn/

Analysis tools for solar-like oscillators

The tools

The following tools have been produces as one of the deliverables for the SPACEINN network. The SPACEINN network is funded by the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 312844.

- InversionKit: a software for carrying out various types of 1D inversions (rotation and structure) as well as inversions for integrated quantities.
- AIMS: a software for obtaining stellar parameters and confidence intervals, using classical and seismic constraints.
- InterpolateModel: a software for interpolating the acoustic structure between multiple models.
- InversionPipeline: a software for carrying out inversions by automatically selecting reference models from grid(s) of models.
- NonLinearKit: this is a somewhat experimental non-linear stellar structural inversion tool provided on an as-is basis.

Workflow

Some of the above tools may be used in conjunction. Accordingly, we propose the following work flow:

- Use AIMS to calculate a representative set of models for a given set of seismic and classical constraints. Each model from this set will typically result from interpolation in a grid of models, and will accordingly be described as a linear combination of models. AIMS provides the relevant model names and interpolation coefficients in one of its output models. Given the time it takes to carry out the next two steps, one will take a sub-sample of the models produced by AIMS (typically with 100 models or so).
- Use InterpolateModel to combine the above models and find their acoustic structure using the above list produced by AIMS.
- The above set of interpolated models can then be fed into InversionPipeline, thereby allowing a systematic application of inverse methods.

http://bison.ph.bham.ac.uk/spaceinn/

Inversion workflow

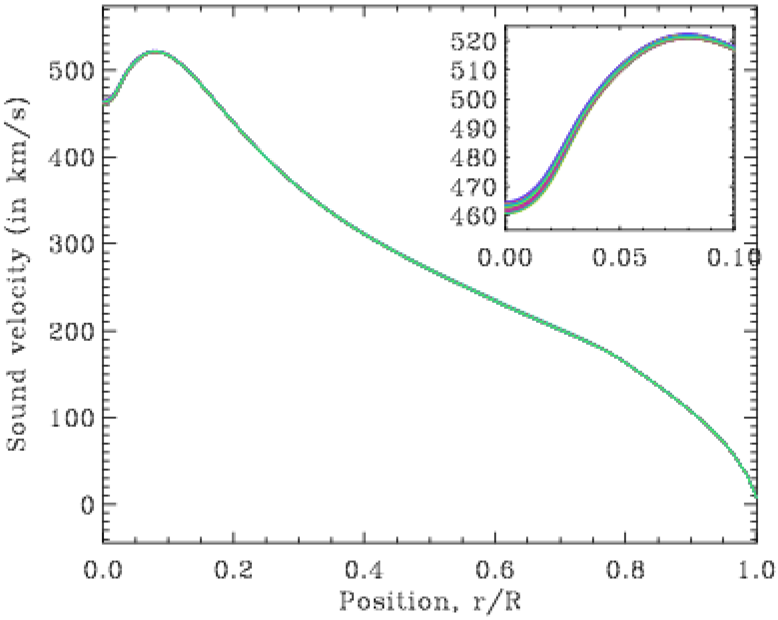
AIMS

Interpolate Model

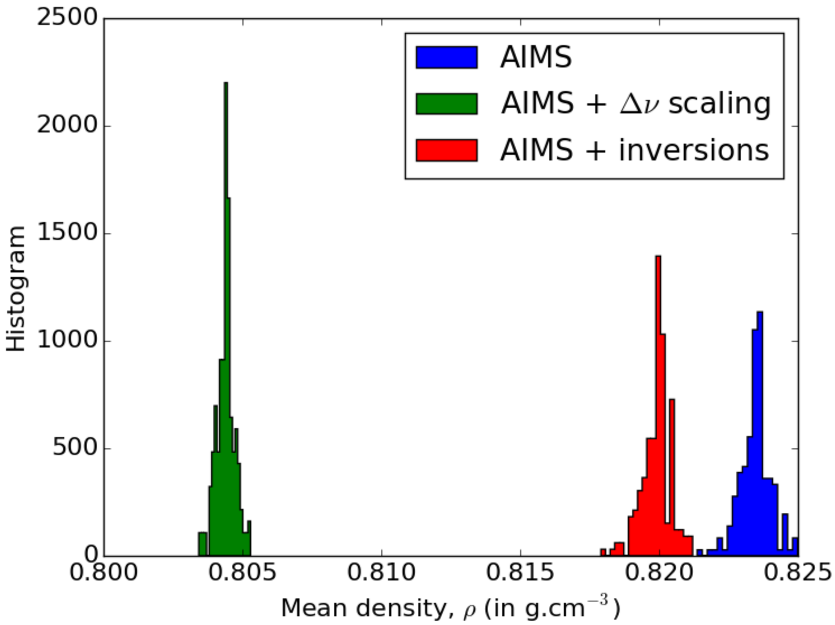
Inversion Pipeline

Stellar properties

Interpolated models



Stellar properties

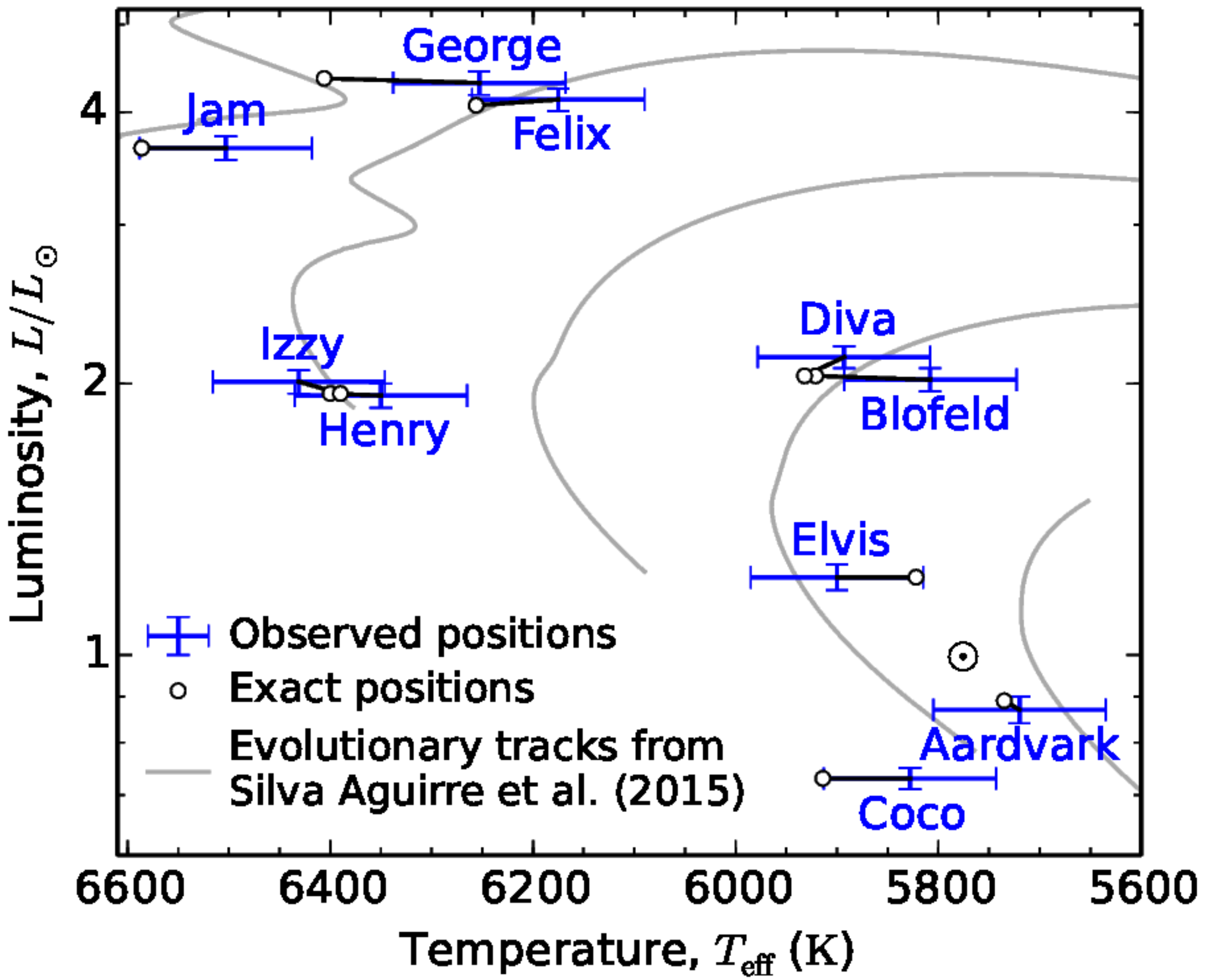


See poster from KASC/TASC conference (Aarhus, 2015)

SpaceINN hare-and-hounds article

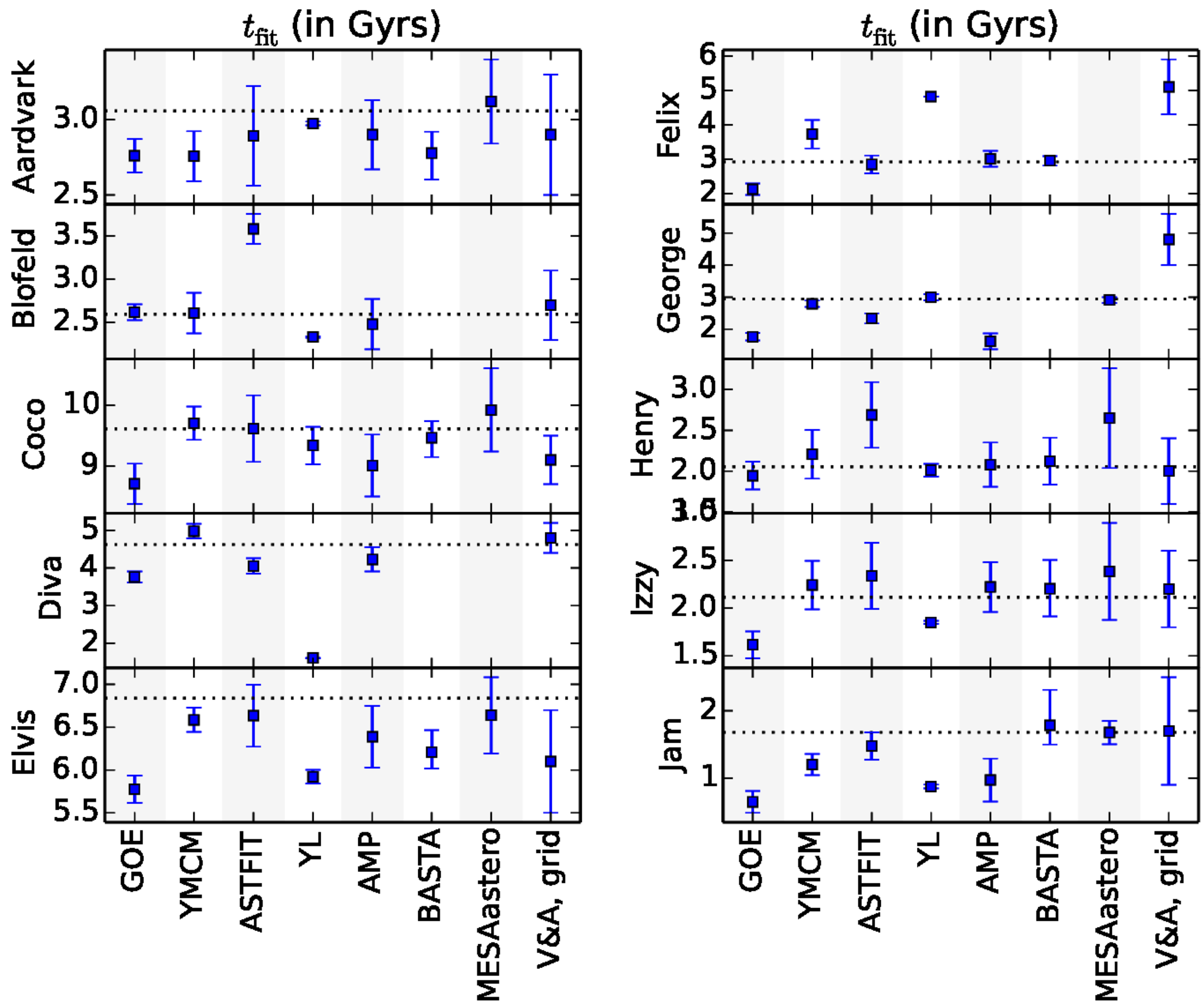
- number of participants: 4 hares + 14 hounds
- various methods applied by the hounds:
  - grid (or forward) modelling
  - glitch fitting
  - misc.: inversions, scaling laws
- accepted for publication in A&A
  - arXiv: astro-ph.SR/1604.08404

The stellar targets



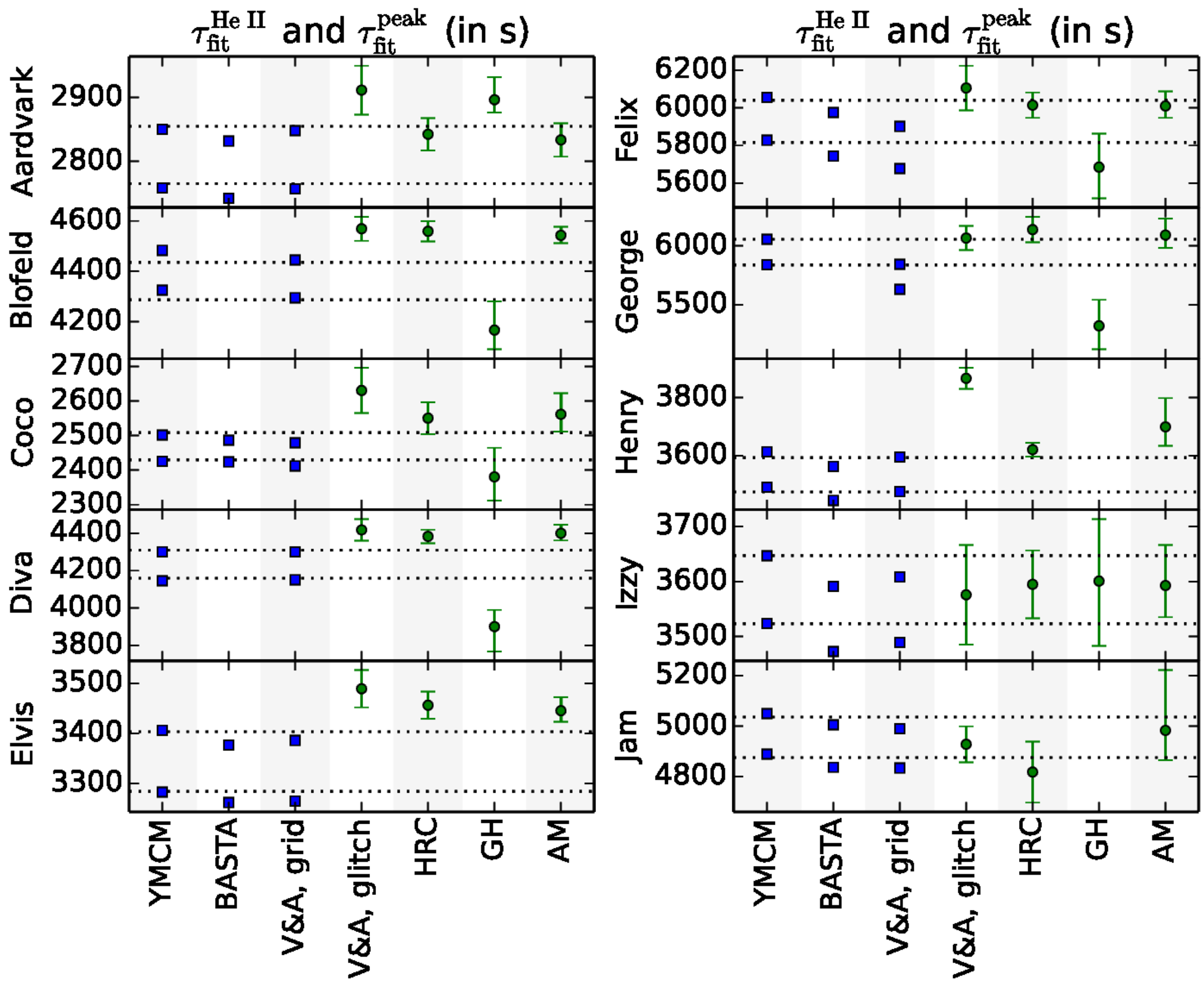
0.78 – 1.33 $M_\odot$; 0.82 – 1.72 $R_\odot$, 1.7 – 9.6 Gyrs

Some results



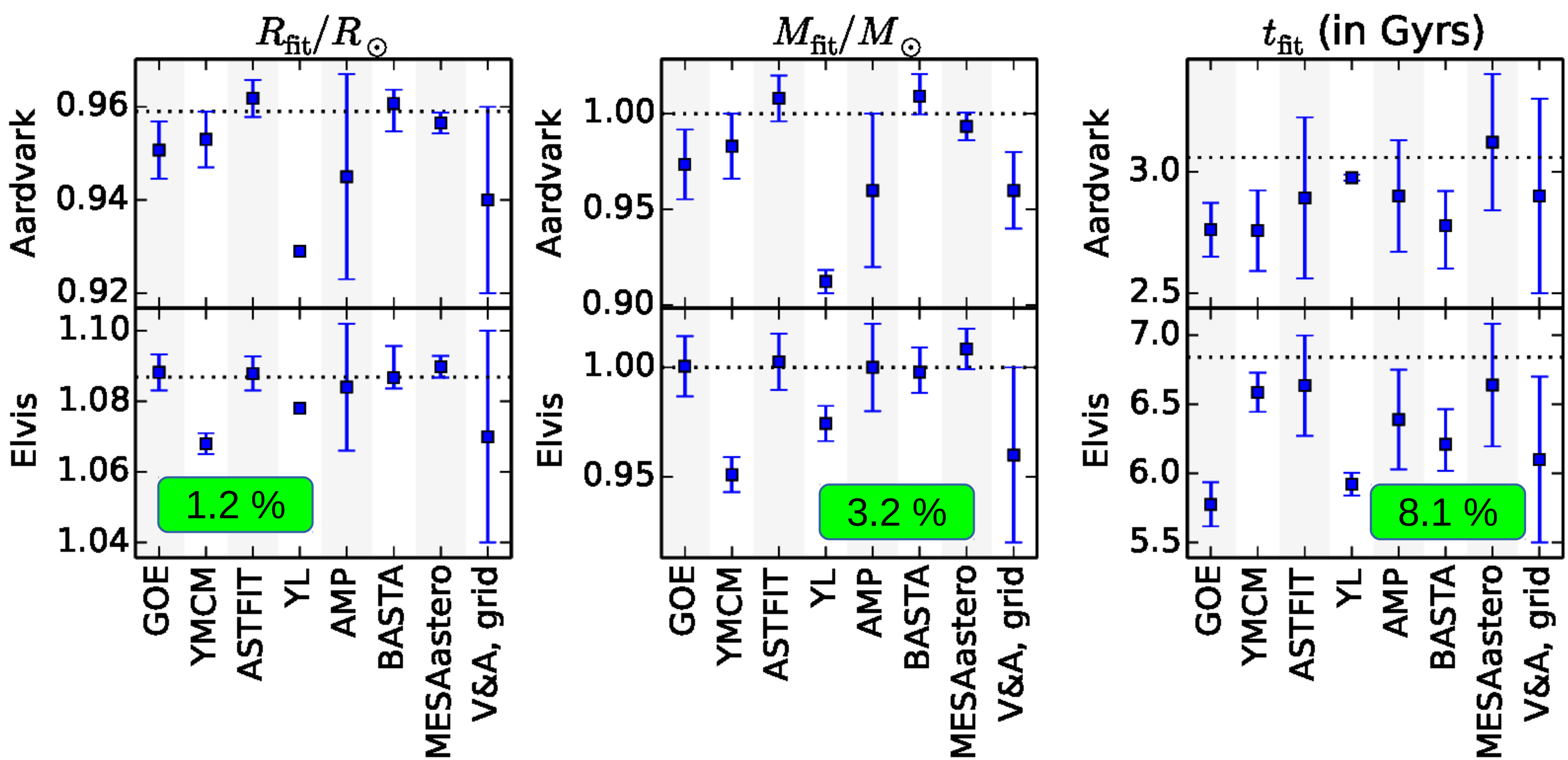
23 % overall accuracy

Some results



~ 2 % overall accuracy

Results for the 1.0 $M_\odot$ stars



Compliant with PLATO 2.0 requirements

Main conclusions

- forward modelling
  - most accurate
  - very model dependant
- glitch analysis
  - more model independent
  - complement forward modelling
- error bars
  - global methods (grid, bayesian, genetic algorithms ...) more robust than local methods (Levenberg-Marquardt)
- limitations of the exercise (based on models only)