Galactic Archaeology

High resolution (40,000)
Reaching the faintest Gaia stars (G<20)
High-multiplex, large field of view

the ultimate Gaia follow-up

Else Starkenburg
on behalf of Carine Babusiaux
MSE will be the only instrument with $R=40,000$ planned allowing to go down to the faintest Gaia stars ($G<20$)

<table>
<thead>
<tr>
<th></th>
<th>HERMES</th>
<th>WEAVE (4\text{-MOST})</th>
<th>MOONS</th>
<th>MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>wav.</td>
<td>optical</td>
<td>optical</td>
<td>NIR</td>
<td>optical</td>
</tr>
<tr>
<td>mag. limit</td>
<td>$V&lt;14$</td>
<td>$V&lt;16$</td>
<td>$H&lt;15.5$</td>
<td>$V&lt;20$</td>
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<tr>
<td>Resolution</td>
<td>28,000</td>
<td>20,000</td>
<td>20,000</td>
<td>40,000</td>
</tr>
<tr>
<td>FoV (deg²)</td>
<td>3</td>
<td>3–4</td>
<td>0.14</td>
<td>1.5</td>
</tr>
</tbody>
</table>
## Why $R = 40000$?

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Output</th>
<th>Accuracy</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt;10,000$</td>
<td>$V_r, T, g, FeH, \alpha$?</td>
<td>0.2</td>
<td>chemo-dynamics</td>
</tr>
<tr>
<td>20,000</td>
<td>$V_r, T, g, FeH, \alpha$, 5-10 elements</td>
<td>0.1-0.15</td>
<td>chemical labelling</td>
</tr>
<tr>
<td>$&gt;40,000$</td>
<td>$V_r, T, g, FeH, \alpha$, 15+els</td>
<td>$&lt;0.05$</td>
<td>chemical tagging</td>
</tr>
</tbody>
</table>
sub-structures discovery need VHR

Fuhrmann 2011

Nissen & Schuster 2010

Lindegren & Feltzing (2013)
HR 4-m surveys / MSE

Distance (kpc) vs. G (mag) diagram showing different lines for RGB Tip, HB giant, and Turn-Off dwarf.
The Inter Stellar Matter

3D Galactic ISM map
using Gaia + spectroscopic distances

Potential carriers of the DIBs
through measurement of various DIBs in different environments

ISM multi-phase structure
molecular, diffuse and ionized phases in different environments

Linking the ISM and the stellar history
joint stellar and ISM observations, including kinematics

Puspitarini et al. (2012)
The Halo

The outer halo
- 50 kpc up to the virial radius

Discovering the faint streams – Near-field cosmology

In-situ versus accreted stars in the inner halo
through chemical tagging of a large number of stars

The first stars
The metal-weak tail of the halo Metallicity Distribution Function
Understanding their chemical signatures and origin in various environments
The Galactic disk(s)

Detailed chemical tagging
re-construct ancient star-forming aggregates

The outer disk
structure out to the far edges
ages beyond 12 kpc from the Galactic Center

The disc dynamics
3D detailed velocity map from the center to the outskirts
what kind of spiral galaxy do we live in?

De Silva et al. (2009)
The Bulge

The bulge star formation history
bulge turn-off ages from dwarfs

Inner / outer substructures links
uniform chemical tagging

Searching for primordial populations
the primordial bulge, the first stars

Bensby et al. 2013: Microlensed bulge dwarfs
High-resolution (40000) wavelength coverage?

Revisit the blue?
Summary
Disk

![Graph showing Distance (kpc) vs G (mag) with outer disk end and outer arm indications, and Av=2 lines for HB giant and Turn-Off dwarf markers.]
Bulge