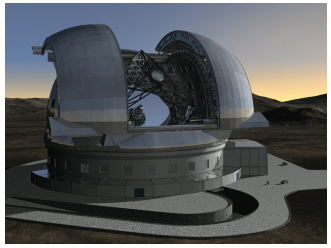

# Case for an E-ELT wide field imager to study resolved stellar populations

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**on behalf of**

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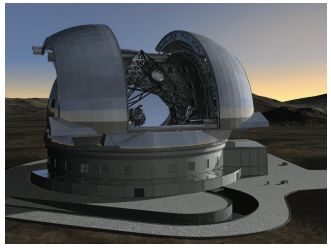
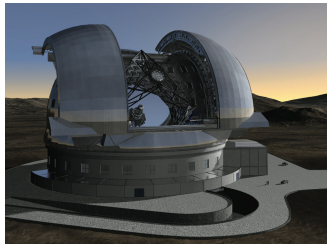


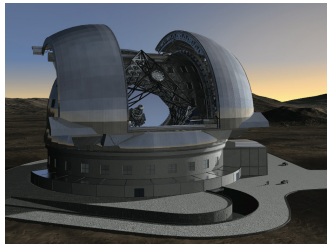
# Overview

- **E-ELT “wide” field imaging: pilot stellar population science**
- **Tentative instrument requirements**
- **Technical feasibility**
- **“Wide field” imaging capabilities of other ELTs**
- **Summary**
- **Next steps**



# Age-metallicity in the Galactic bulge

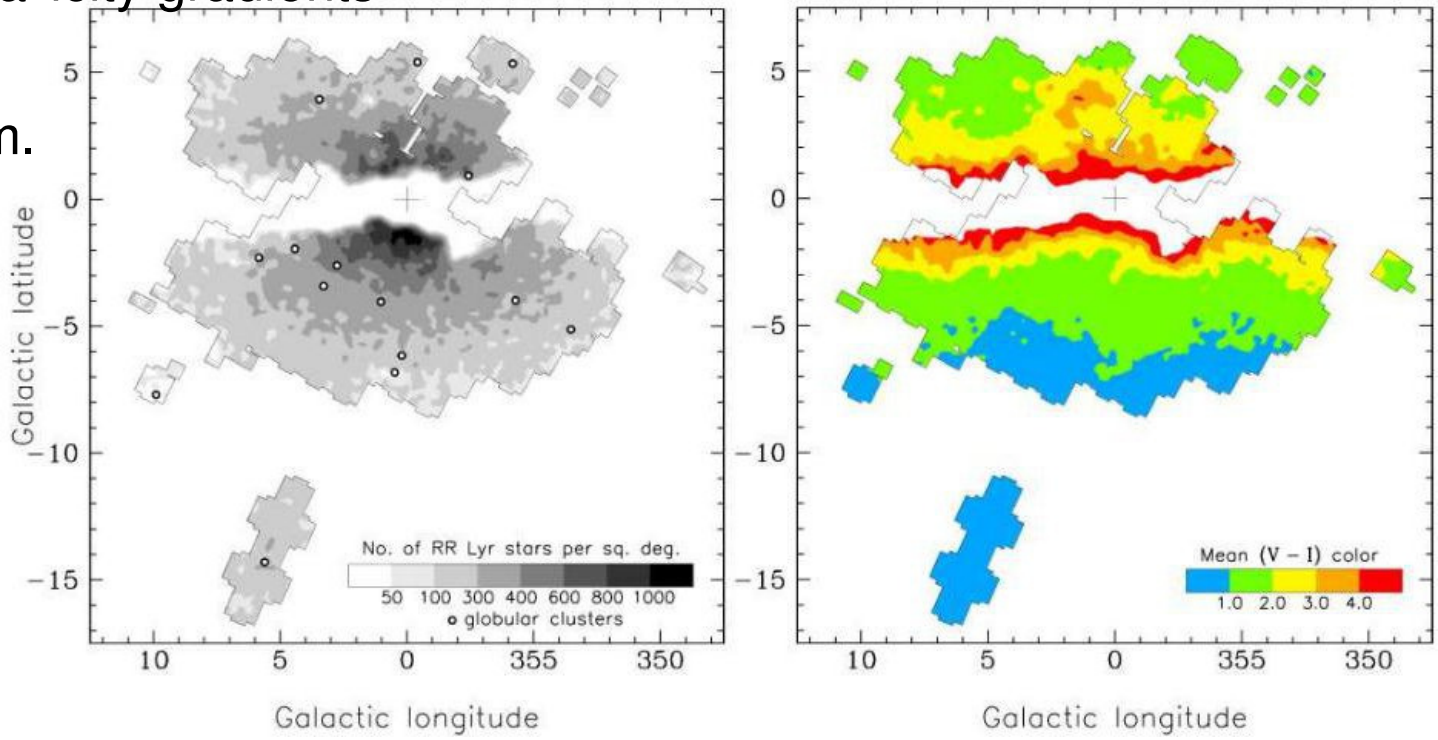
- **Signs that Galactic bulge kinematics depends on Z** (Babusiax+ 2010)
- **Z gradients in Galactic bulge** (Johnson+ 13, Ness+ 13, González+ 13)
- **But the need for disentangling age-Z distributions require:**
  - Accurate NIR photometry down to MSTO & MS knee (Bono+ 2011)
  - $\Rightarrow$ H 24-28 & K 22-26 AB mag
  - Mapping 10s-100s sq. deg.
  - But…
    - HST: not K band or large FoV
    - HAWK-I: too large exp. times ($10^4$h)

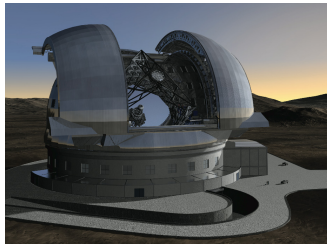


# RR-Lyr in the Galactic bulge

- **Steep density & reddening gradients towards the centre**
- **The detailed study of Galatic bulge RR-Lyr would allow**
  - Mapping 3D structures in the bulge
  - Examining early SFH of the Galaxy
  - Tracing metallicity gradients
- **& require**
  - Deep NIR im.
  - “Wide” FoV

**Soszynski+ 2014**





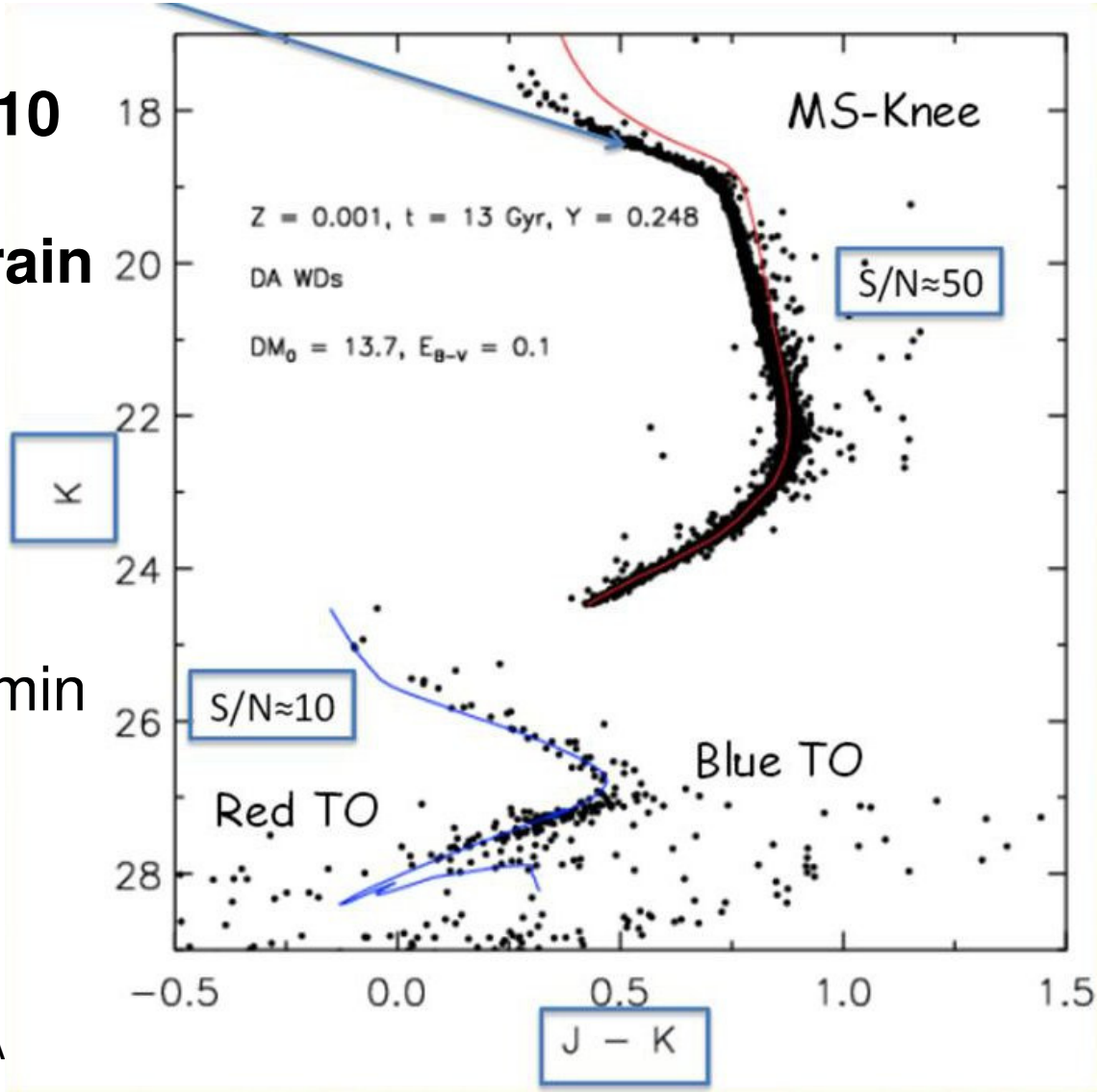
# Galactic GC ages

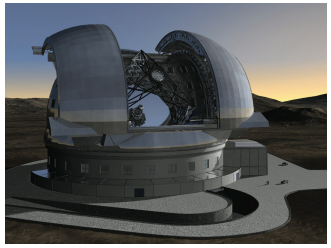
- **WDs blue TO at S/N >10 together with other indicators, can constrain GC distance and age**

Calamida+ 2014

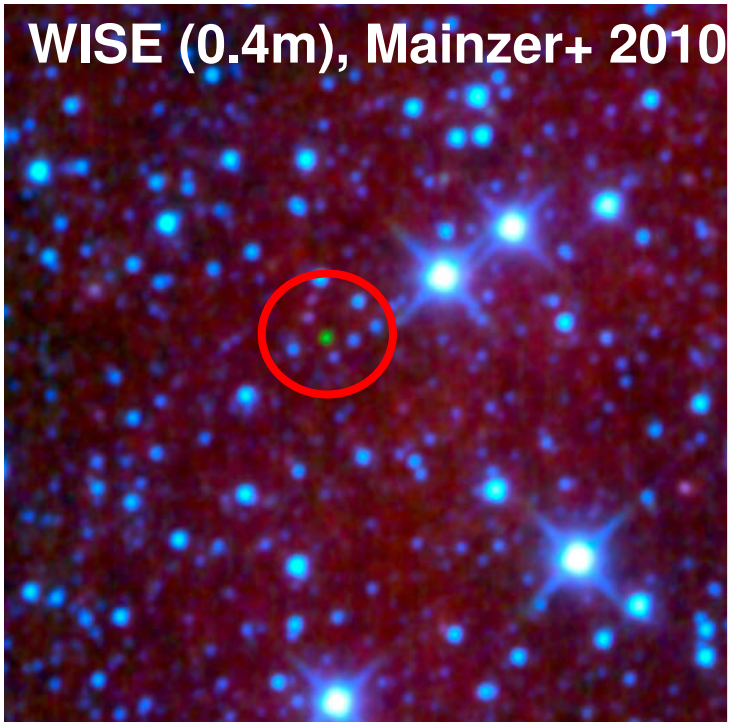
(& talk in this meeting)

  - Deep NIR imaging
  - Mapping 100 sq.arcmin

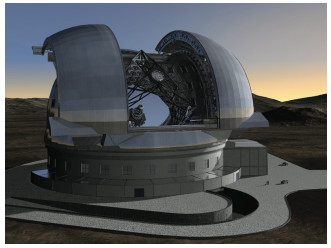




# Study of resolved stellar populations

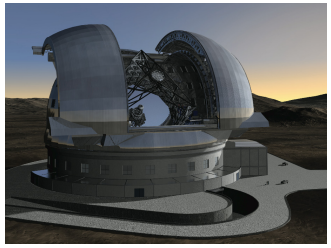



- **Some NIR diagnostics:**
  - $T_e$: Br$\gamma$ (2.17 $\mu$m) & Pa lines
  - g: NaI doublet (0.81-0.82 $\mu$m)
  - $\alpha$-el:FeII(1.64), Wing-Ford(0.99), CO(2.3)
  - L dwarfs: $H_2O$ absorption (1.49, 1.75 $\mu$m)
  - T dwarfs: $CH_4$ (1.66 $\mu$m)
  - Y dwarfs: $NH_3$ (1.53 $\mu$m)
- **NB competitive wrt spectroscopy for**
- **Crowded Galactic regions & Local Group**
  - Deep mapping/survey of extended regions required
- **But… (i.e.)**
  - ~2.600 hours with HAWK-I for $CH_4$
  - JWST NIRCam 2.2' FoV, 3 NB filters @ 1.64, 1.87, 2.12 $\mu$m R~100
- **Complementary study of unresolved populations using MICADO**



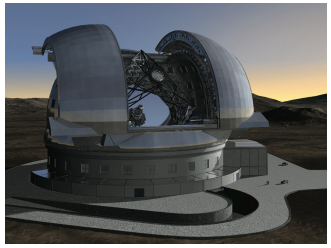
# Extragalactic NIR NB hints

- **SF & Metallicity of low L systems at 1.2 < z < 2.5**
  - Hα, Hβ & R23 indicators
- **Intracluster Light at high redshift**
  - [OIII] at 0.6 < z < 3.5
- **Galaxy clusters & protoclusters at 1.2 < z < 2.5**
  - Hα, Hβ, [OII], [OIII] ⇒ SFR, $A_V$, BPT, R23
- **Based on:**
  - Mapping/Survey capabilities (Cluster Virial radii: 2-4 arcmin)
  - Key optical spectral lines shifted to NIR
  - Too high exposure times required at other facilities
  - NB imaging competitive wrt MOS (crowded/surveys)



# Mid Band imaging

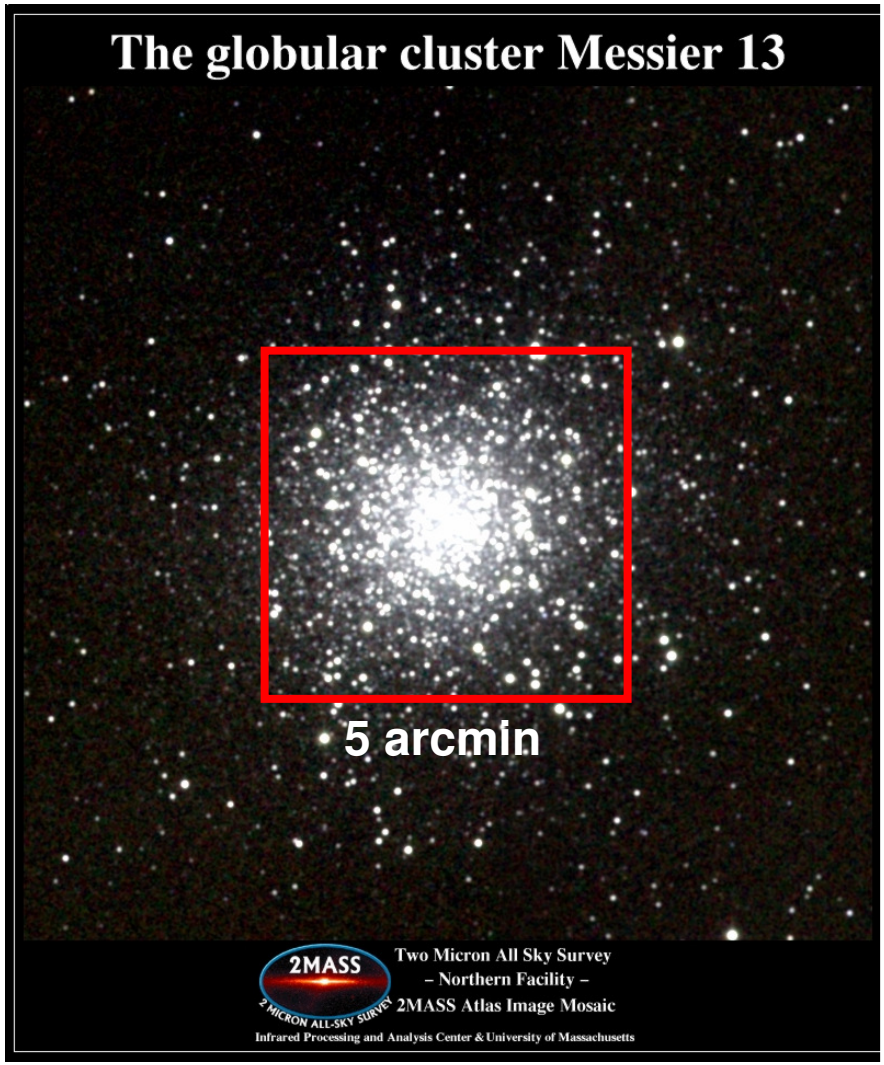
- **Imaging the FoV through a set of contiguous MB filters**
- **Equivalent to low R 3D spectroscopy of all targets in FoV**
- **Follow-up or definition of very faint spectroscopic targets**
- **Advantageous wrt MOS for crowded fields:**
  - Extragalactic fields for $AB_I \geq 24$, allowing $\Delta z/(1+z) \sim 0.006$
  - Galactic bulge
  - Galactic GC

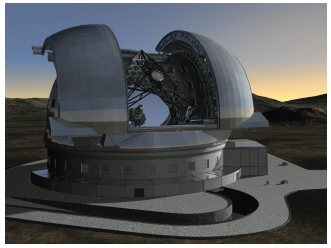


# Tentative top level requirements

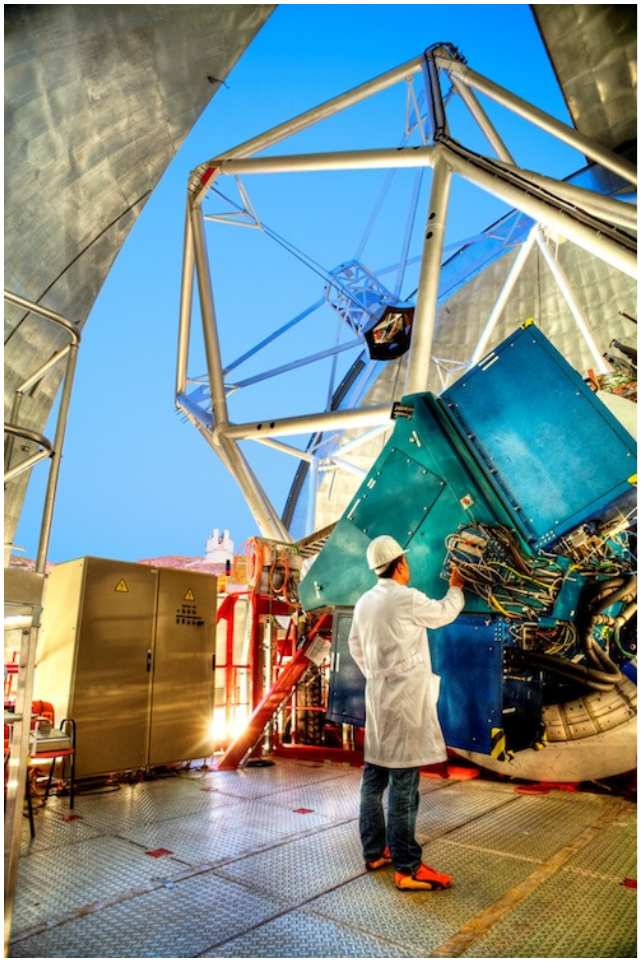
| | |
|---|---|
| **FoV** | **>25 (40) sq. arcmin** |
| **λ range** | **0.8-2.3 (0.3-2.3) (μm)** |
| **Filters** | **BB, MB & NB** |
| **Plate scale** | **0.05 ⇐ 0.1 (“/pix)** |
| **AO** | **GLAO (M4)** |

**Galactic Bulge: 5’ = 12 pc, 0.3” = 0.01 pc**

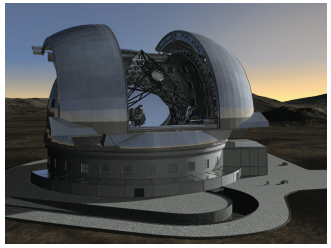




# Technical feasibility

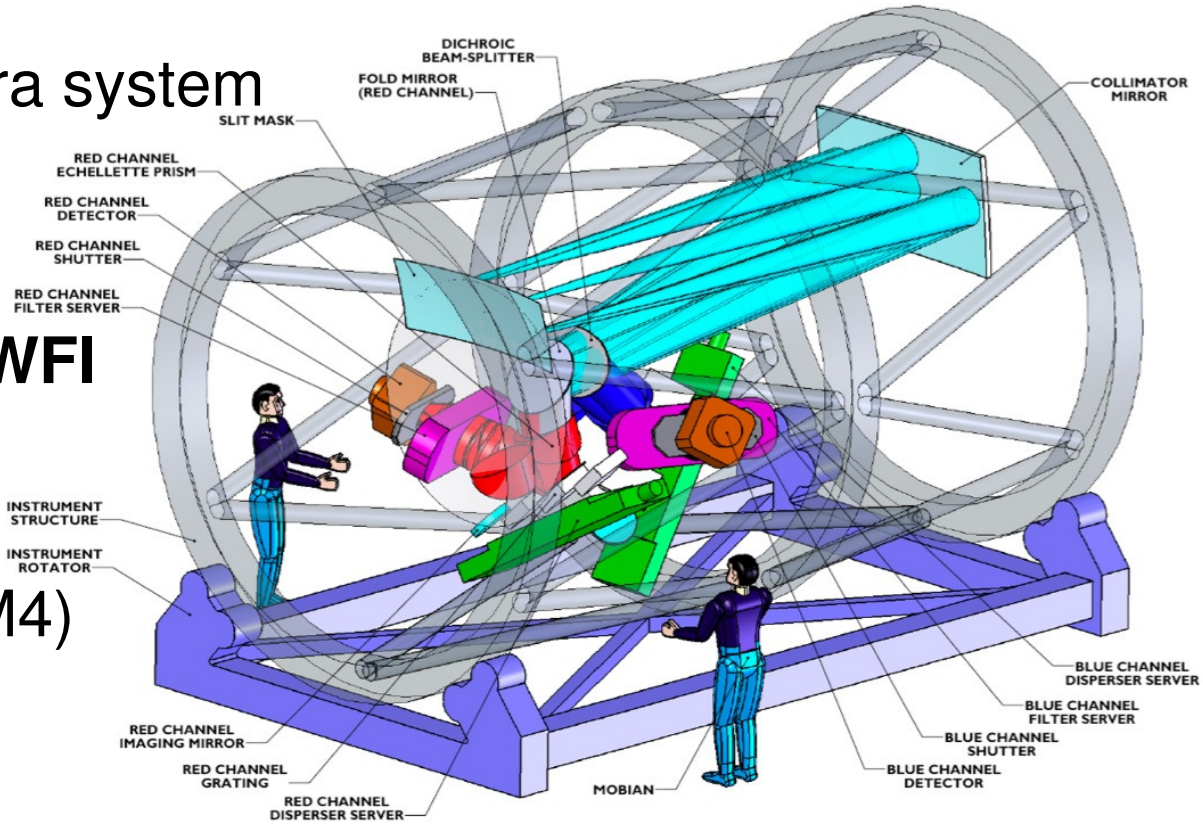


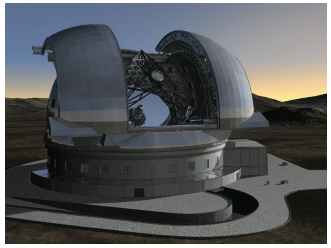
- **Preliminary hints**
  - Focal reducer: Collimator plus camera
    - Warm (0.8-1.7 μm) + cold (1.7-2.3 μm) arms?
    - Optical arm?
    - Field segmentation?
  - Relaxed OSIRIS/GTC-like design as trial
  - Trade-off: field size vs. plate scale
  - Crowding is a limit
    - Asymmetric Moffat functions (Fiorentino+14)
    - To be studied in NB (less severe)
- **Requirements TBD**
  - FoV & plate scale
  - Image quality stability across the FoV (Telescope+Instrument)
  - Wavelength range 0.8 μm < λ < 2.3 μm (warm+cold? optical extension?)
  - Filter strategy (number, FWHM, wavelength coverage)



# ELTs WFI context

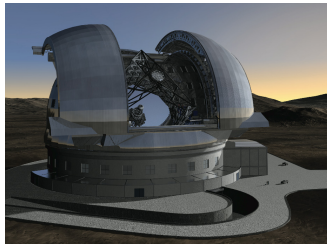
- **MOBIE @ TMT (f/15) "Workhorse"** (Bigelow+ SPIE 2014)
  - FoV: 25 sq. arcmin, at 0.05"/pix (15 μm pixel)
  - λ: 0.3 - 1.0 μm
  - Collimator + camera system
  - 37cm ϕ filters
  - Natural seeing
- **Competitive E-ELT WFI**
  - NIR
  - NB – MB filters
  - GLAO available (M4)





# Summary

- **There are interesting stellar population science cases that require**
  - NIR
  - Mapping/survey capabilities (i.e. relatively “wide field”)
  - Narrow band
- **& not feasible at VLT, but complementing E-ELT instrument suite**
- **Other add-ons: MB imaging covering spectral range**
  - Equivalent to low R spectroscopy >2mag fainter than spectroscopy
  - Advantageous in crowded fields wrt. MOS
  - Allow high photo-z accuracy & detection of emission lines
  - More accurate SED fitting
  - Follow-up or definition of faint spectroscopic targets
- **Competitive features wrt TMT (NB, K)**
- **Feasible technical solutions to be explored exists**



# Next steps: work to be done

- **Build up consortium gathering researchers & engineers**
- **Define/Refine Science Cases**
- **Derive Top Level Requirements from above**
- **Parallel viability study**
- **Preparing for ESO LoI for the "Instrument #6"**

**Interested? Please contact us: jcn@iac.es**