

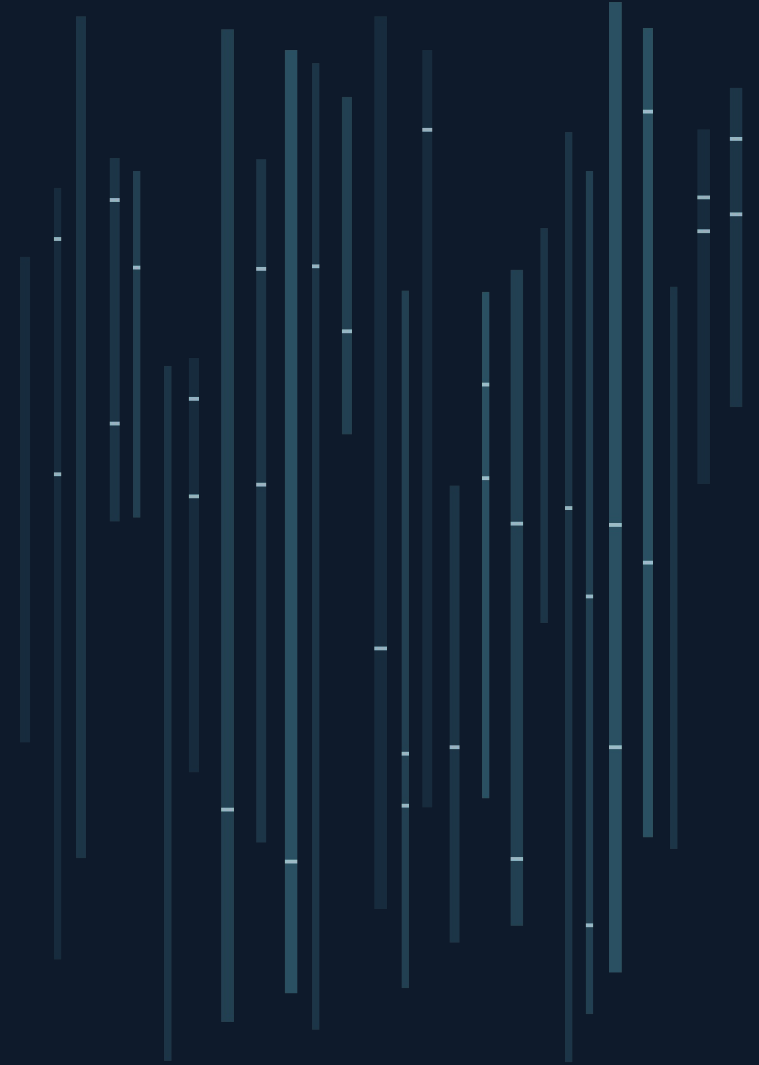
From VIMOS to 2030 and beyond

The COSMOS group's expertise in spectroscopic
software

Adriana Gargiulo

on behalf of the COSMOS group · INAF – IASF Milano

Susanna Bisogni, Paolo Franzetti, Marco Fumana, Chiara Mancini,
Marco Scodeggio, Giustina Vietri



Shaping the VLT beyond 2030: three actors

LEADS THE VISION

Science

Defines the open questions and sets the requirements.

FOLLOWS SCIENCE

Technology

Builds the instruments able to answer those questions.



Shaping the VLT beyond 2030: three actors

LEADS THE VISION

Science

Defines the open questions and sets the requirements.

FOLLOWS SCIENCE

Technology

Builds the instruments able to answer those questions.

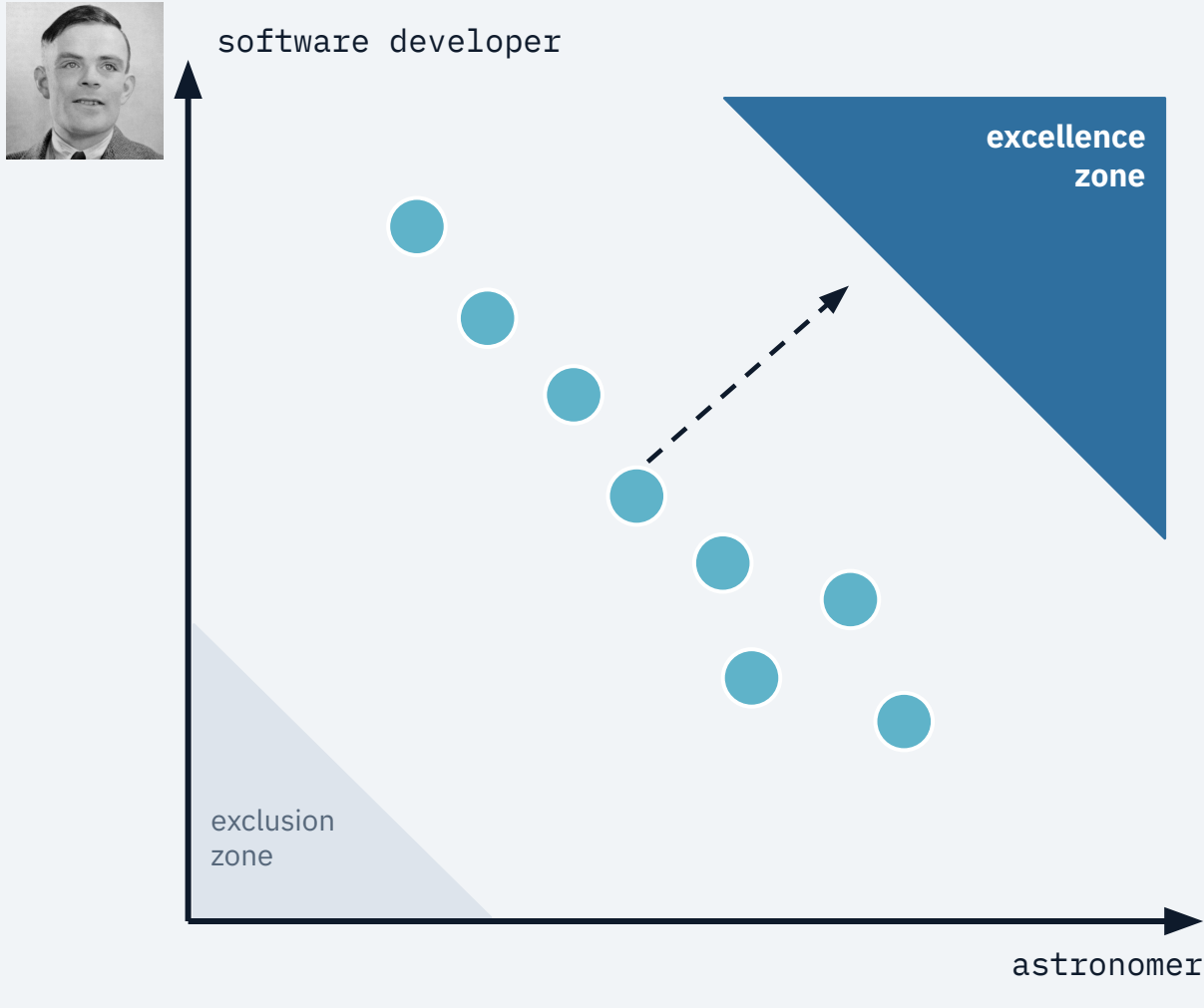
INCREASINGLY NEEDED

Software

Turns instrument complexity into scientific output.

As instruments grow more complex, software contributes more and more *to what they can deliver*,
but to do so at its best, software must be **designed with the instrument**, not after it.

The COSMOS group: where astronomers meet developers



Born to join both worlds, with a focus on spectroscopy.

Astronomers and developers working side by side, aiming at the excellence zone: robust, reusable, scientifically sound spectroscopic software.

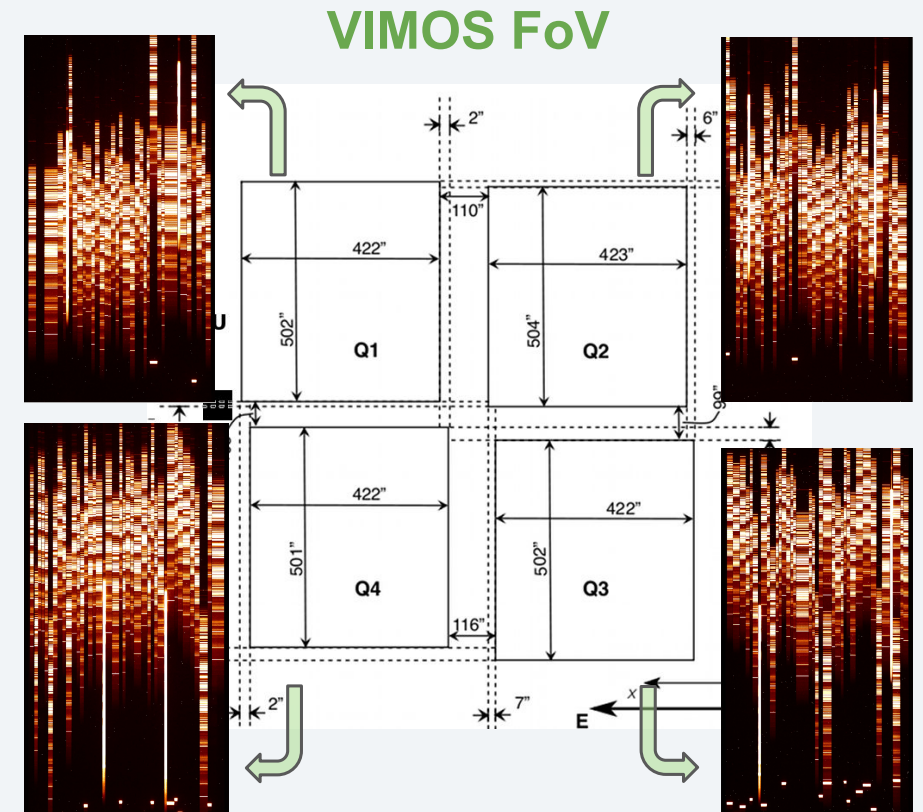
2002: our story starts with VIMOS

A multi-object optical spectrograph at VLT,
built for extragalactic spectroscopic surveys

~**600** optical spectra in a single exposure

~**30000** spectra for the VVDS alone

Goal: a reduction that is quick, but accurate.



VIMOS field of view: four quadrants, hundreds of slits each.

VIPGI: quick but accurate reduction, for thousands of spectra

Fast

C code, built-in quality control, instrument models,

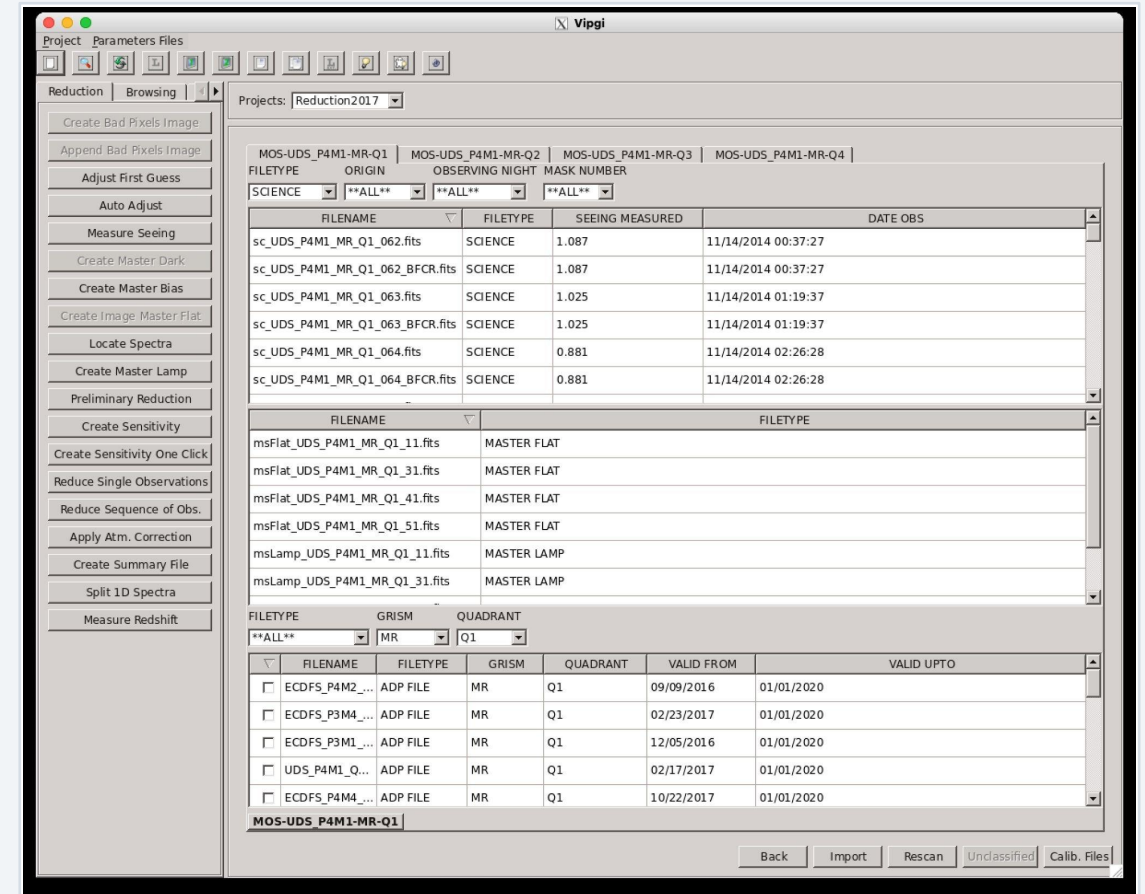
Easy

automatic data organiser, graphical interface, plotting tools

Modular

recipes separated from functions, minimal instrument dependence

Reduced spectra with same quality as by-hand IRAF reduction but produced in a fraction of time



Scodeggio et al. 2005

EZ: automatic redshift measurement tool

Growing numbers demanded not only faster reduction, but automatic measurements too.

Automatic

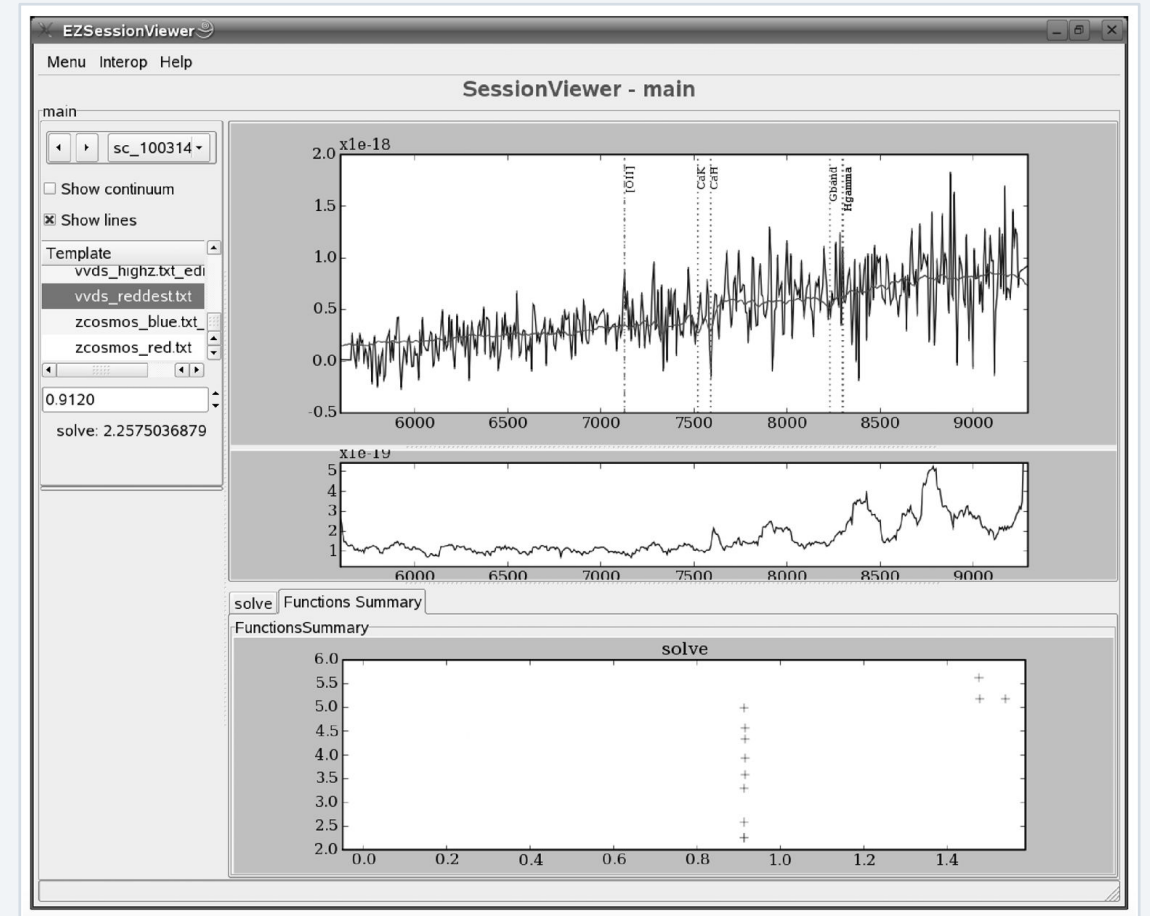
redshifts measured without supervision

Interactive

graphical interface to inspect and validate

Survey-ready

built for large samples



Garilli et al. 2010

The COSMOS-group history

2002 →

Facility

VLT · VIMOS

Reduction & measurement

VIPGI
optical MOS reduction

EZ
automatic redshifts

Data & survey management

Observation preparation

Spectroscopic surveys
VVDS · zCOSMOS · VUDS



Reduction & Measurement



Data & survey management



Observation preparation

VIPERS and EasyLife: managing a whole survey

~1000000 galaxies targeted by VIPERS: three times the VVDS, in a single survey

At that scale, reducing and measuring were not enough: we also had to manage the flow of data.

EASYLIFE

Reduce

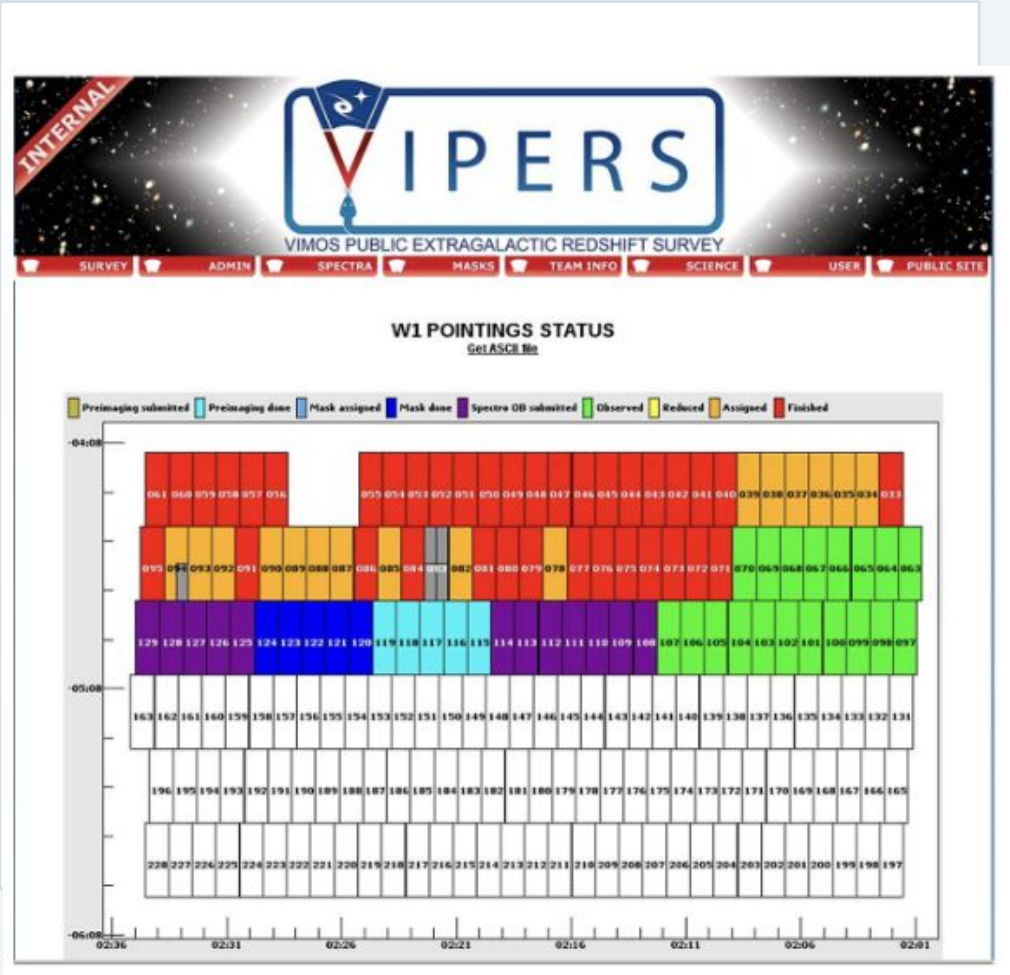
VIPGI-based, with semi-automatic quality monitoring

Measure

first-guess redshifts, ready for validation

Manage

survey monitoring, data distribution, public releases



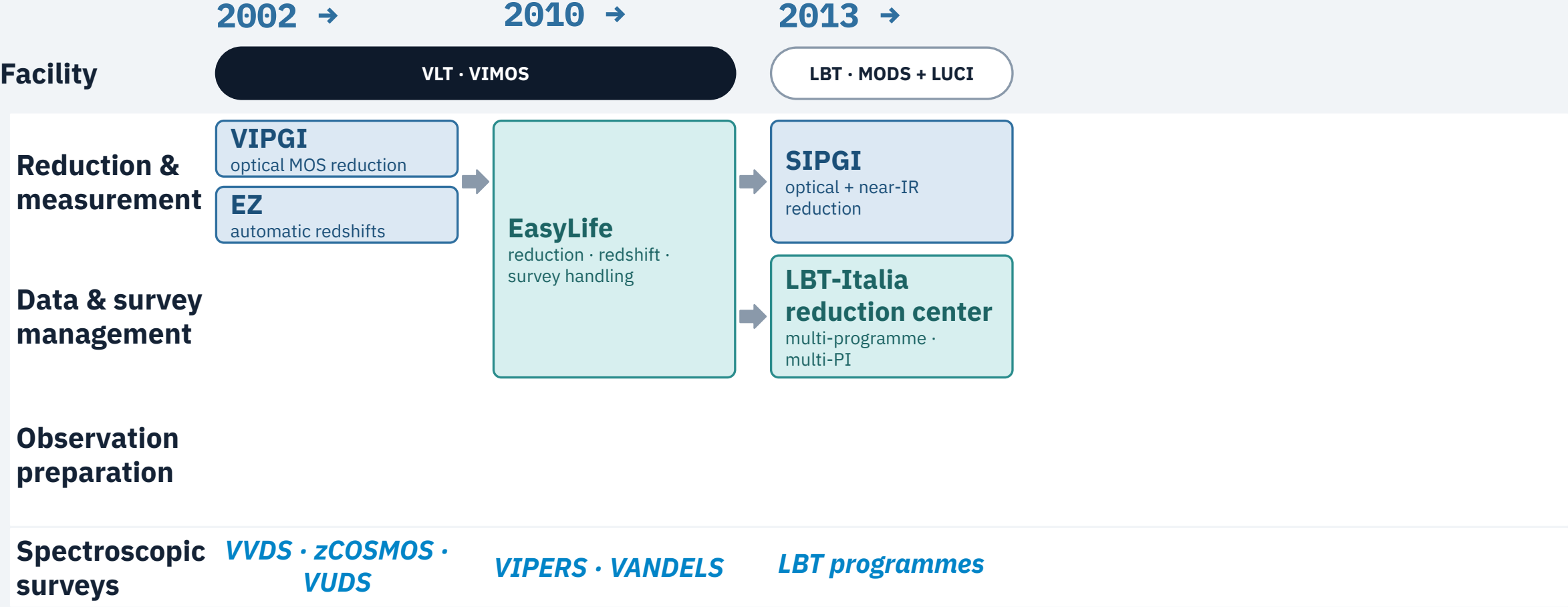
EasyLife survey monitor: VIPERS W1 pointings

The COSMOS-group history



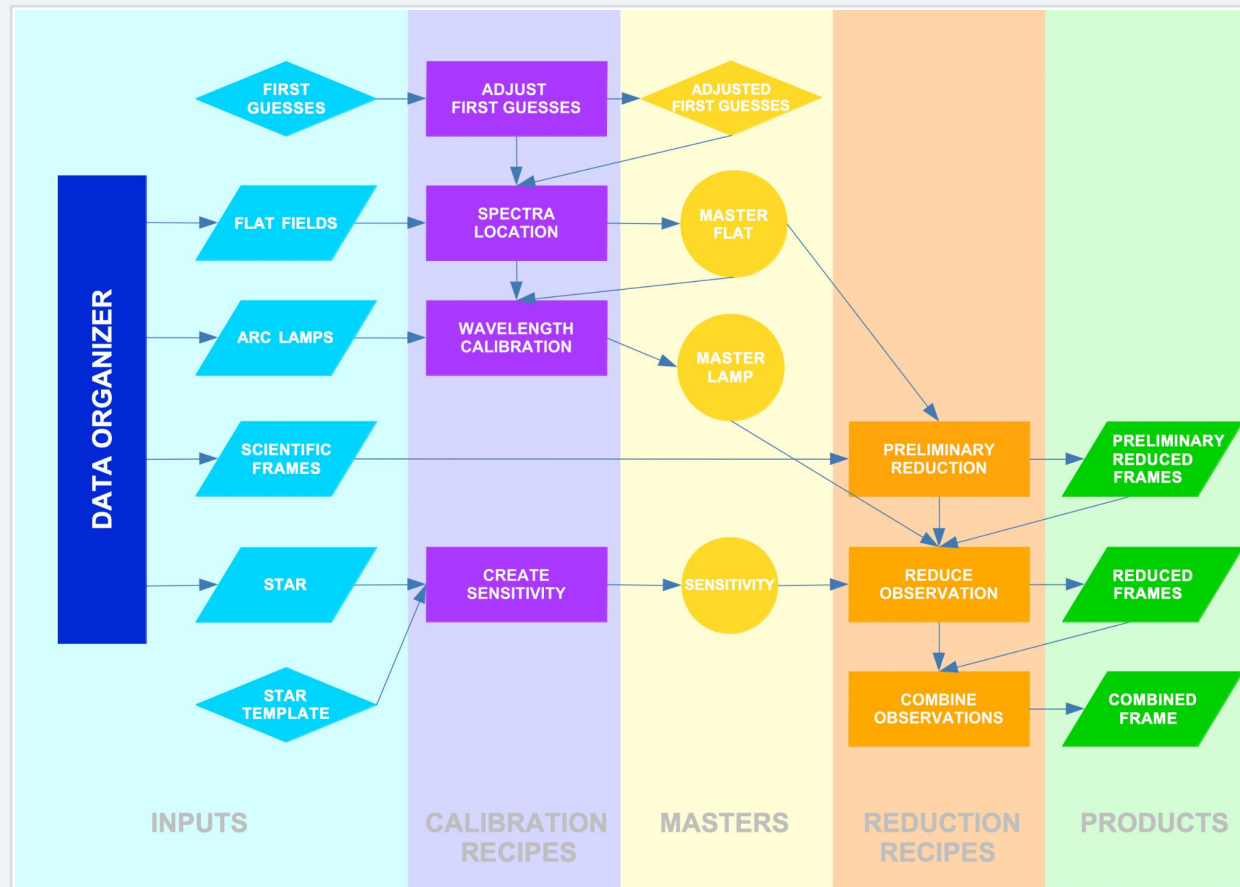
☐ Reduction & Measurement ☐ Data & survey management ☐ Observation preparation

The COSMOS-group history



Reduction & Measurement Data & survey management Observation preparation

SIPGI: modular and adaptable by design



SIPGI reduction flow · Gargiulo et al. 2022

VIPGI's modular blocks, adapted to MODS (optical) and LUCI (near-IR).

UNTIL 2021A

We reduced all the spectroscopic data of the Italian LBT time: ~500 complete reductions in 2021.



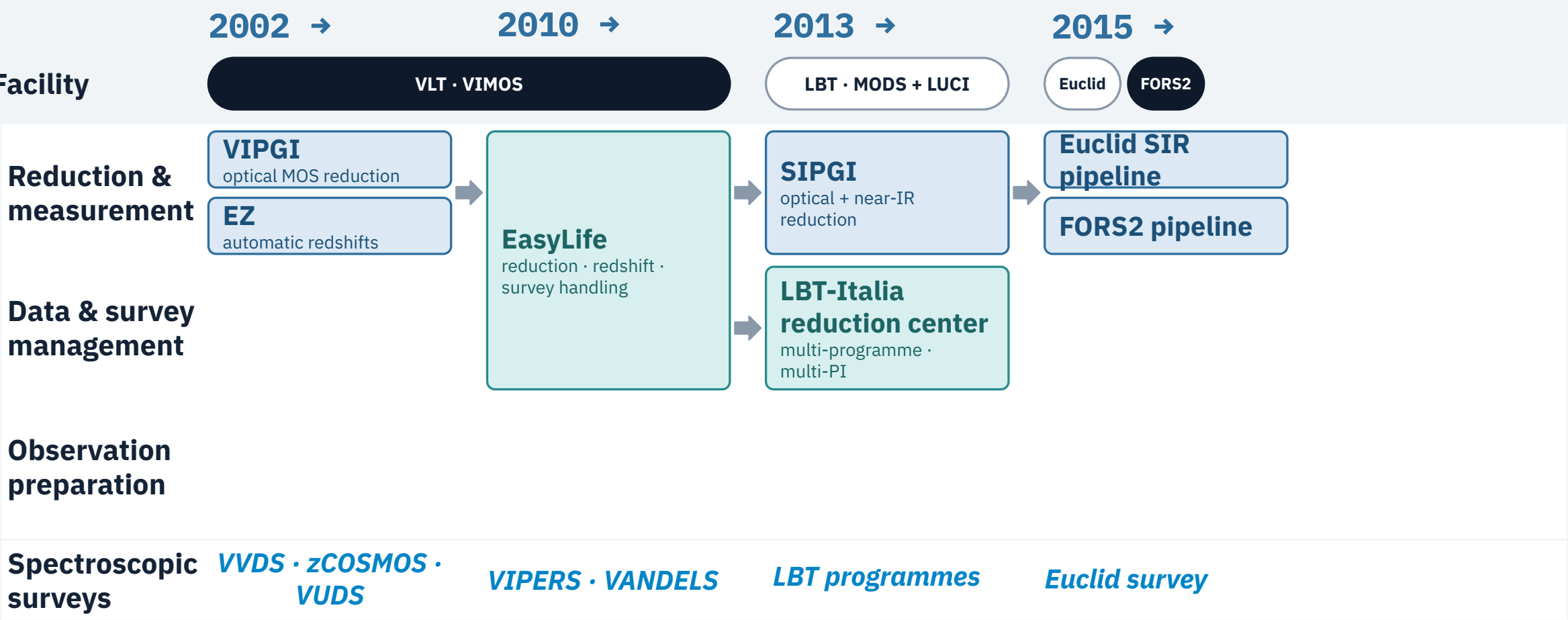
SINCE 2021B

SIPGI released to the community: documentation, video tutorials, help desk

NEXT, AT THE VLT

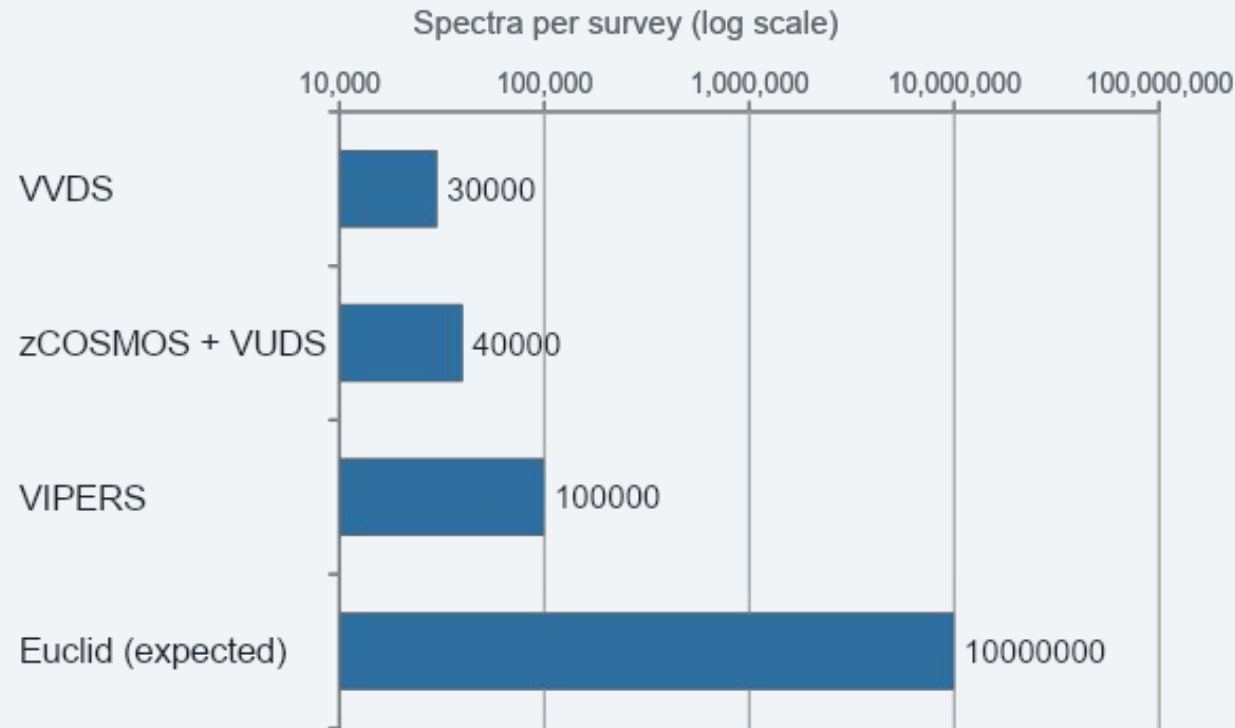
FORS* pipeline, tailored to the Italian community. Being finalised.

The COSMOS-group history



Reduction & Measurement Data & survey management Observation preparation

From thousands to tens of millions of spectra



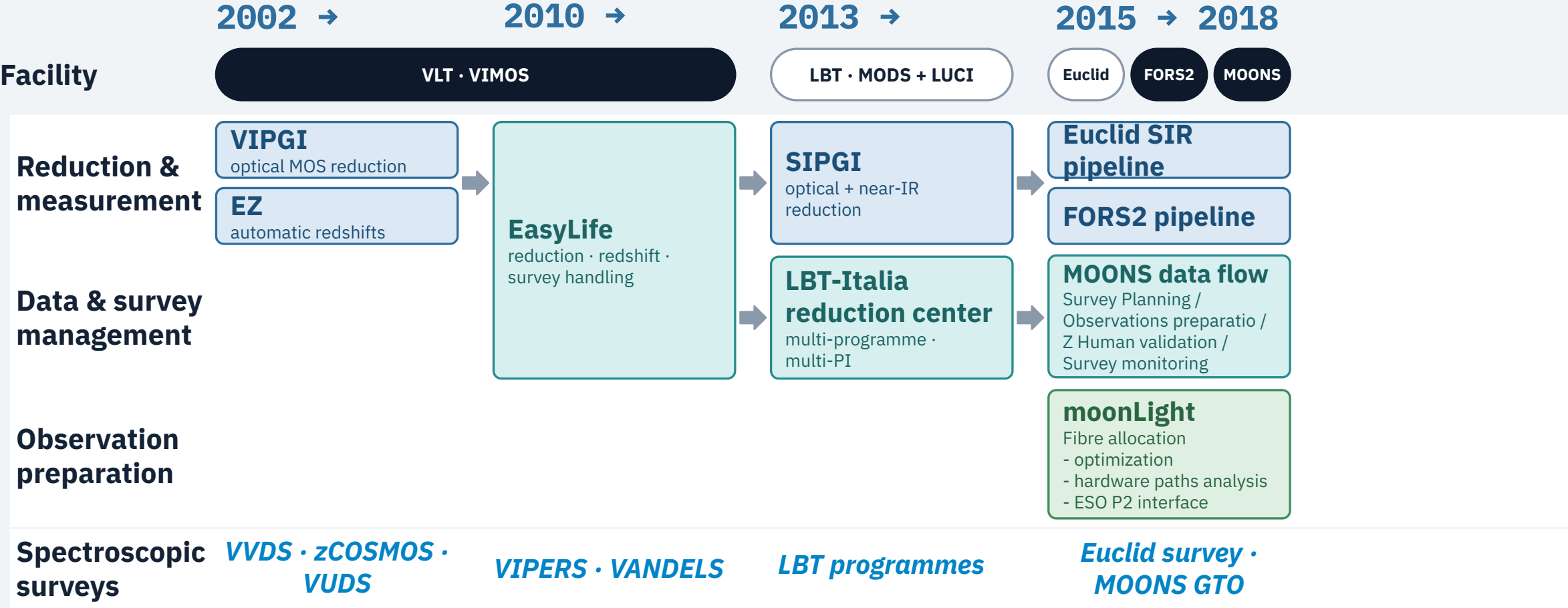
Euclid: we lead the development of the mission's spectroscopic (SIR) pipeline.

**NOT ONLY SOFTWARE:
DATA RELEASES THAT CARRY INAF NAME**

Building the software put us deep inside the collaborations: our group led the survey data-release papers.

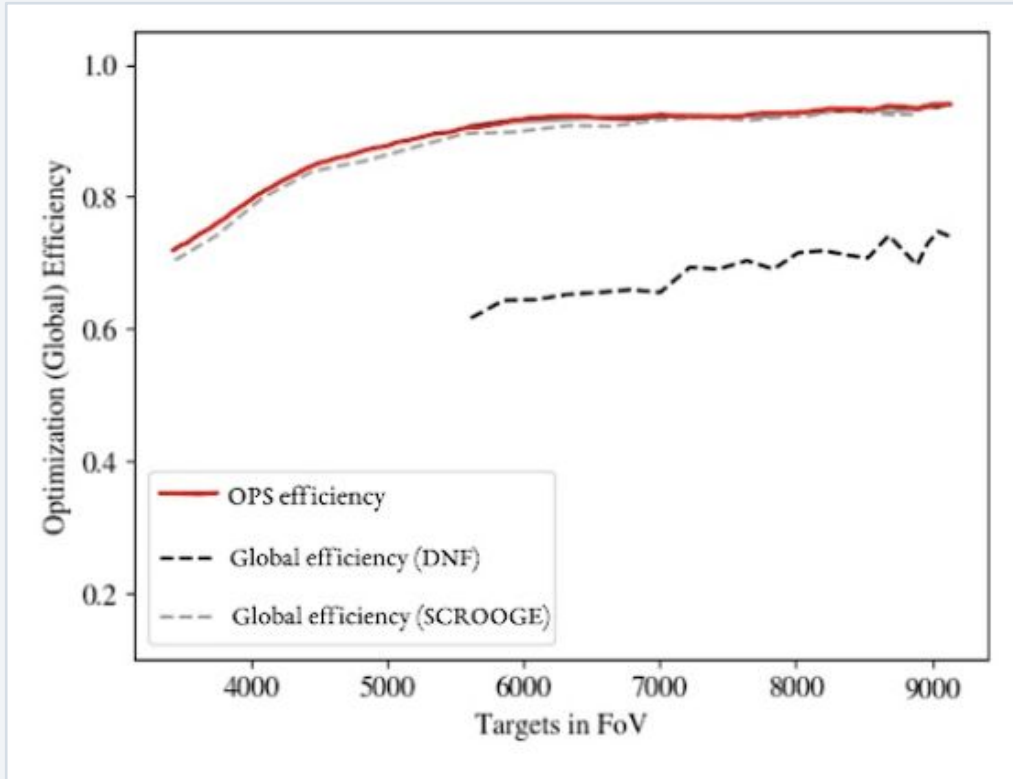
E.g.: VVDS-Wide, VIPERS PDR-1, VIPERS PDR-2, VANDELS final DR,

The COSMOS-group history

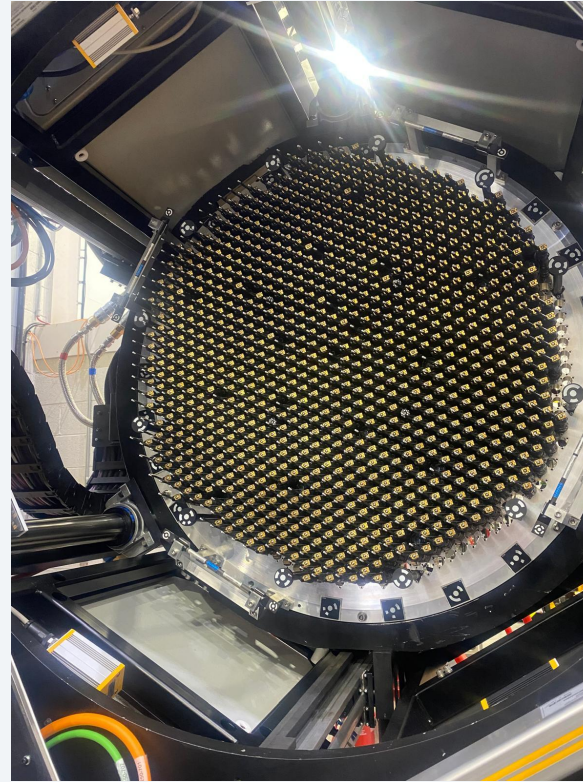


□ Reduction & Measurement □ Data & survey management □ Observation preparation

moonLight: allocating the ~1000 fibres of MOONS



Franzetti, Gargiulo et al., in prep.



MOONS focal plate

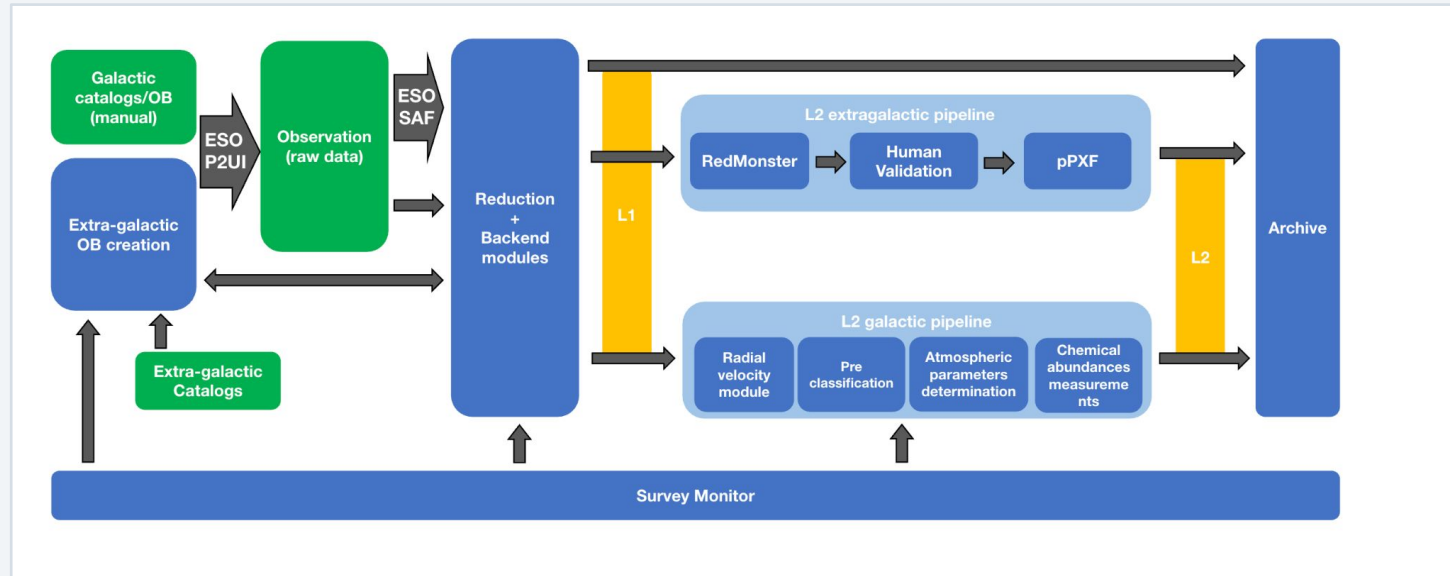
~70% → >90%

Global allocation efficiency, thanks to our software

FOR THE COMMUNITY

Know-how we already offer Italian colleagues planning MOONS observations.

Managing the whole MOONS data flow



WITH CASU

Design, implementation and management of the complete MOONS GTO data flow.

300

GTO nights of data

From the target catalogue to validated data products.

Plan

Extragalactic GTO strategy, optimised and tested with simulations.



Prepare & manage

Automated, fully interactive creation and submission of GTO OBs.



Validate

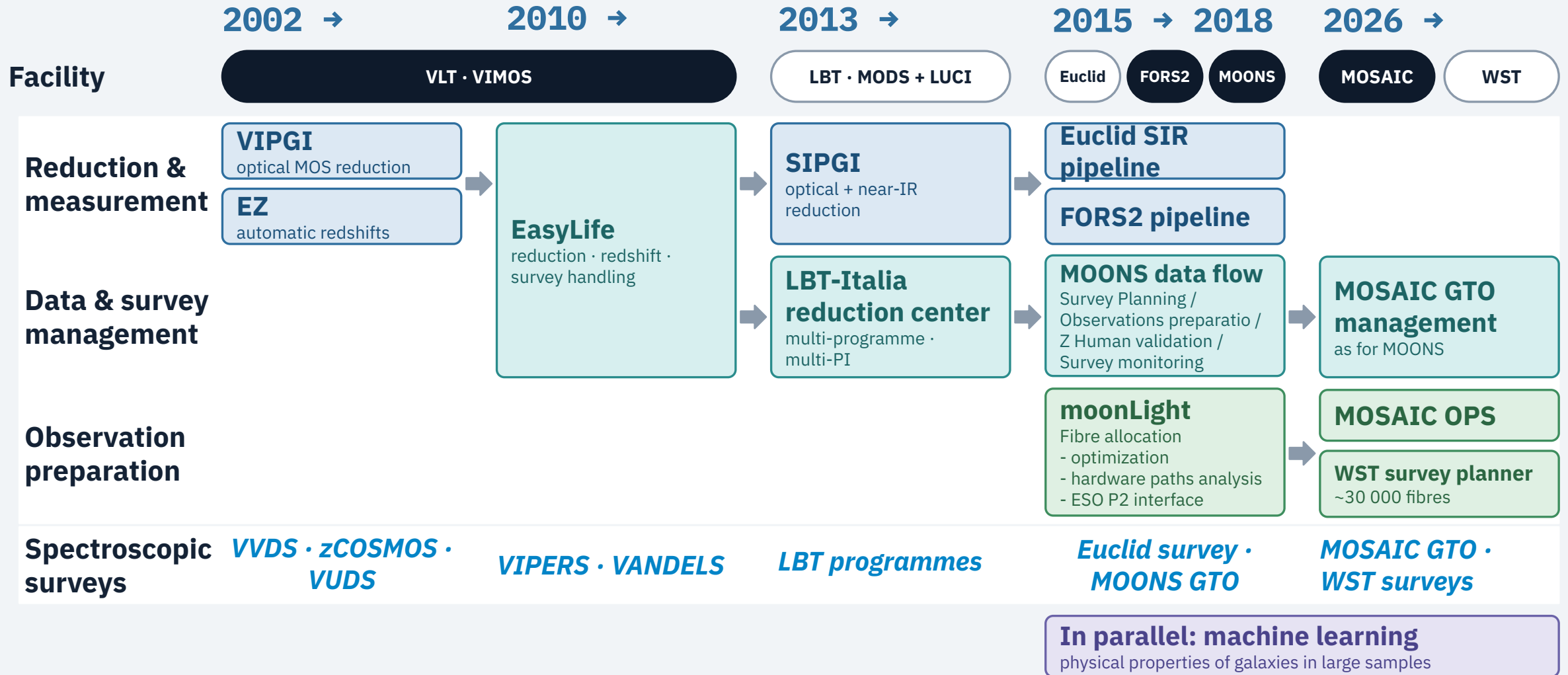
Human validation of the redshift measurements.



Monitor

GTO survey progress, with plots and statistics.

The COSMOS-group history



The lessons we learned

Reusable design pays off for decades

VIPGI → SIPGI, FORS2

MOONS OPS → MOSAIC OPS

MOONS scheduler → MOSAIC scheduler,
WST planner

Software contributes to the instrument's output

Software: a different way to be at the heart of collaborations

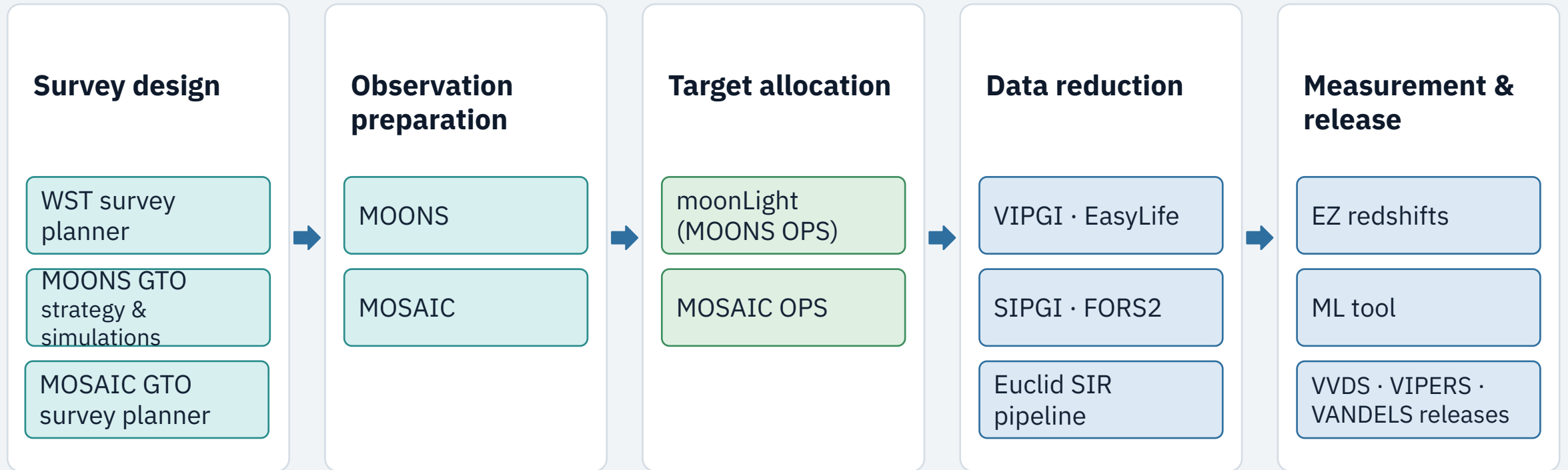
We know ESO from the inside

Twenty years of iterations with ESO, from VIMOS to MOONS.

NOW · MOONS commissioning at Paranal

Covering the whole observational workflow

One group across the whole chain: each step designed knowing what the others need.



Software development combined with a detailed understanding of the scientific and operational requirements of highly multiplexed spectrographs.

A “hub” for spectroscopic software

We are preparing to turn this experience into a hub:
a reference team at the service of the next VLT instruments

Share

Twenty years of tools, open to INAF teams: OPS, fibre allocation, simulators, pipelines.

Develop

New software for new instruments, designed with the consortia from day one.

Operate

Host, run and maintain data flows for INAF projects, including software developed by others

Discussed many times in INAF: now it is more relevant than ever



A Bianca

STRENGTHENING INAF'S ROLE

Science drives. Technology follows. Software delivers.

Twenty years of spectroscopic software,
ready for the next generation of VLT instruments.

✉ cosmos.iasfmi@inaf.it

Thank you

