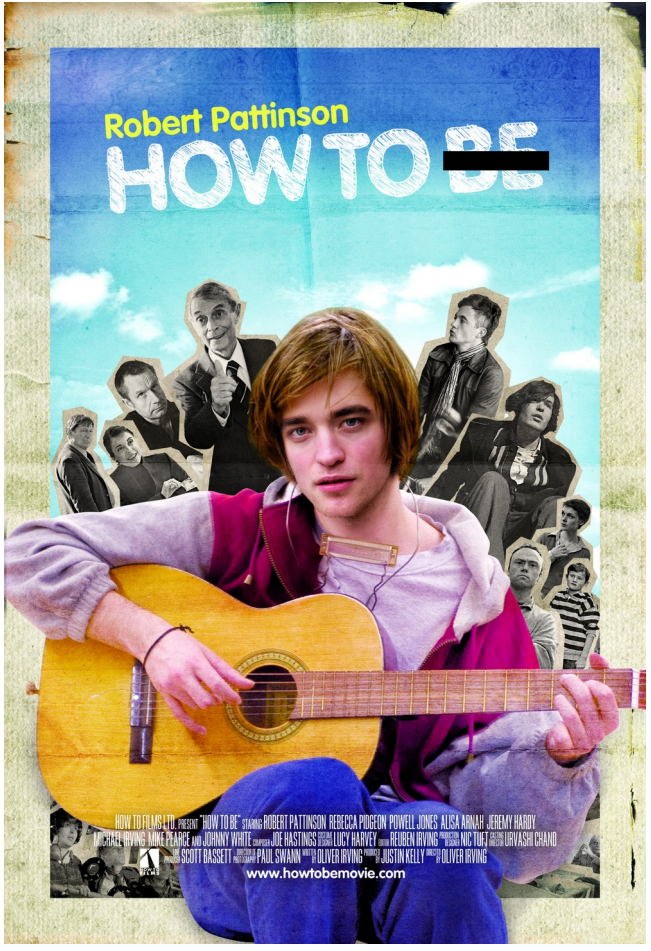
SII software school: Lesson 5



Contribute to *magic_spysii*

T. Hassan on behalf of
the magic_spysii dev team

European Research Council
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Ciemat
Centro de Investigaciones
Energéticas, Medioambientales
y Tecnológicas

IACT-SII: Lesson V summary

- Wrap up of the SII analysis we discussed about over the last weeks
  - Current software has many limitations… Many things to improve!
- How to contribute to the IACT-SII business?
  - Bug fixes
  - Analysis enhancements
  - List of proposed projects
- Next steps

IACT-SII: Analysis steps wrap up

- Data download and reduction should be possible now, using the sync script

- sii_production allows correlation channel-wise analyses

  - Checking each correlation signal is adviced, specially those that look “fishy” (sometimes correlation peaks are not clear, a wrong t0 is found, or the peak falls outside of your allowed delay range)

  - My advice is: always look at the correlation signal in each UV bin!

  - Not yet a clear way on how to validate an analysis… be aware! It will mostly be my opinion for now… but this needs to change!

IACT-SII: Analysis steps wrap up

- Data download and reduction should be possible now, using the sync script

- sii_production allows correlation channel-wise analyses

- sii_combine allows to simultaneously use **multiple sources and correlation channels** to determine ZBCs and diameters

  - I consider this to be the current best procedure to determine ZBCs

  - Until we have something better, you better understand how the combined analysis works! (why do we do it? How are samples statistically combined? Why do all ZBCs improve so much?)

IACT-SII: Analysis steps wrap up

- Data download and reduction should be possible now, using the sync script

- sii_production allows correlation channel-wise analyses

- sii_combine allows to simultaneously use **multiple sources and correlation channels** to determine ZBCs and diameters

- Once you have a decent determination of ZBCs with sii_combine, I would extract the ZBC calibration file and perform the source analysis you may need for your paper

    - Be aware of the current **limitations of the software**!

Current model fitting

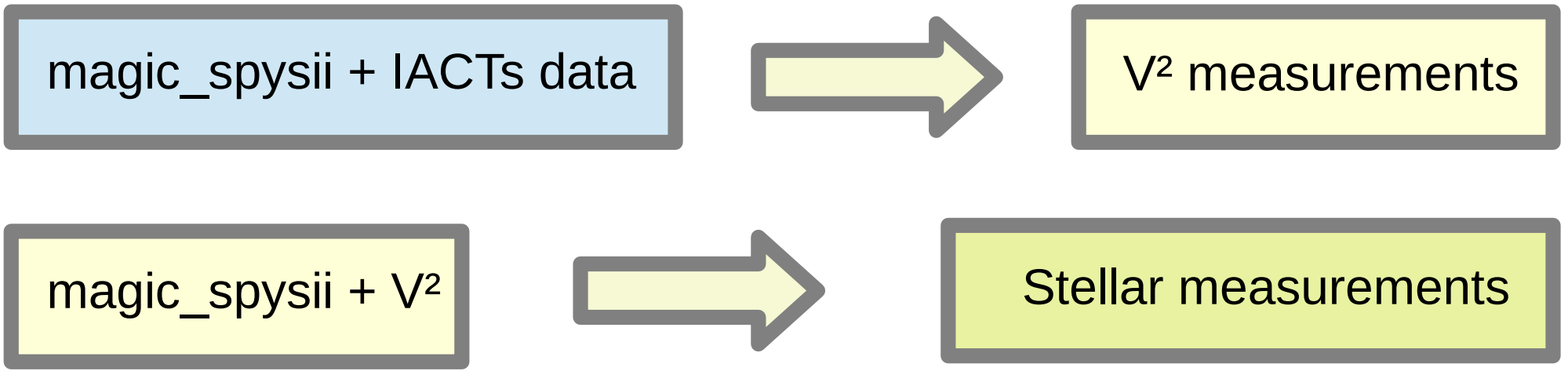
- magic_spysii never intended to have a broad model fitting library

- We can fit uniform disc, limb darkened and ellipse models (nothing else available for the time being)

- Its easy to add more models (probably least effort solution...), but this is not what I would like…

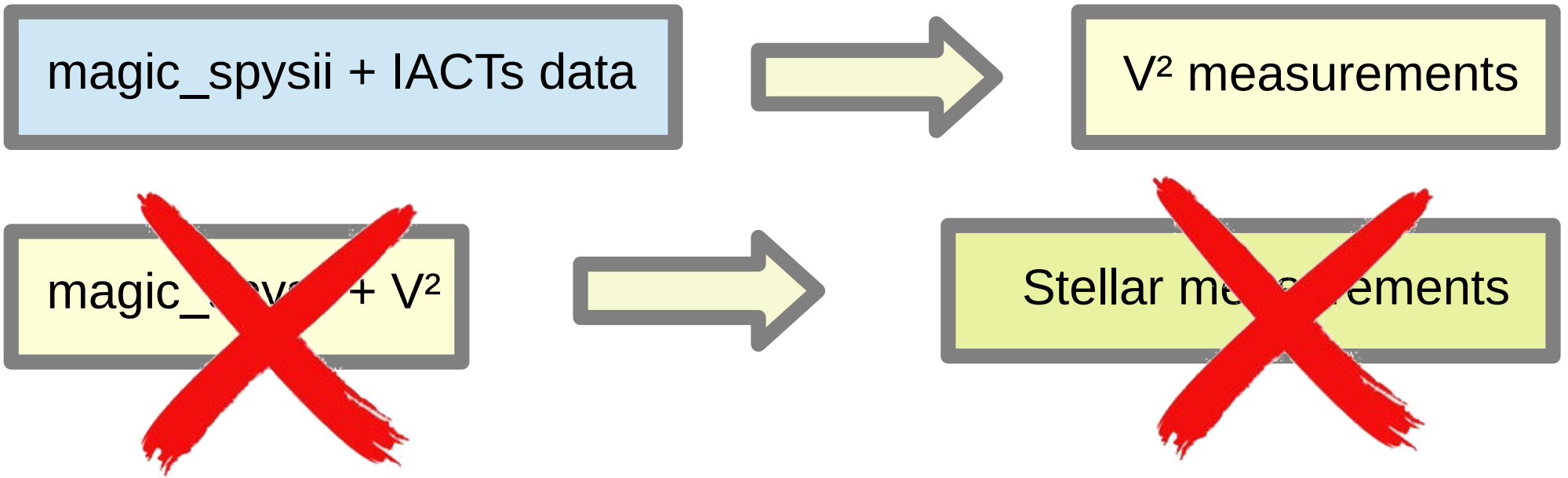
Current model fitting

- We currently do:



Current model fitting

- We currently do:



We should use standard optical interferometry software for that!

Available optical interferometry software

- Many tools have been in use by CHARA, VLTI and other optical interferometers

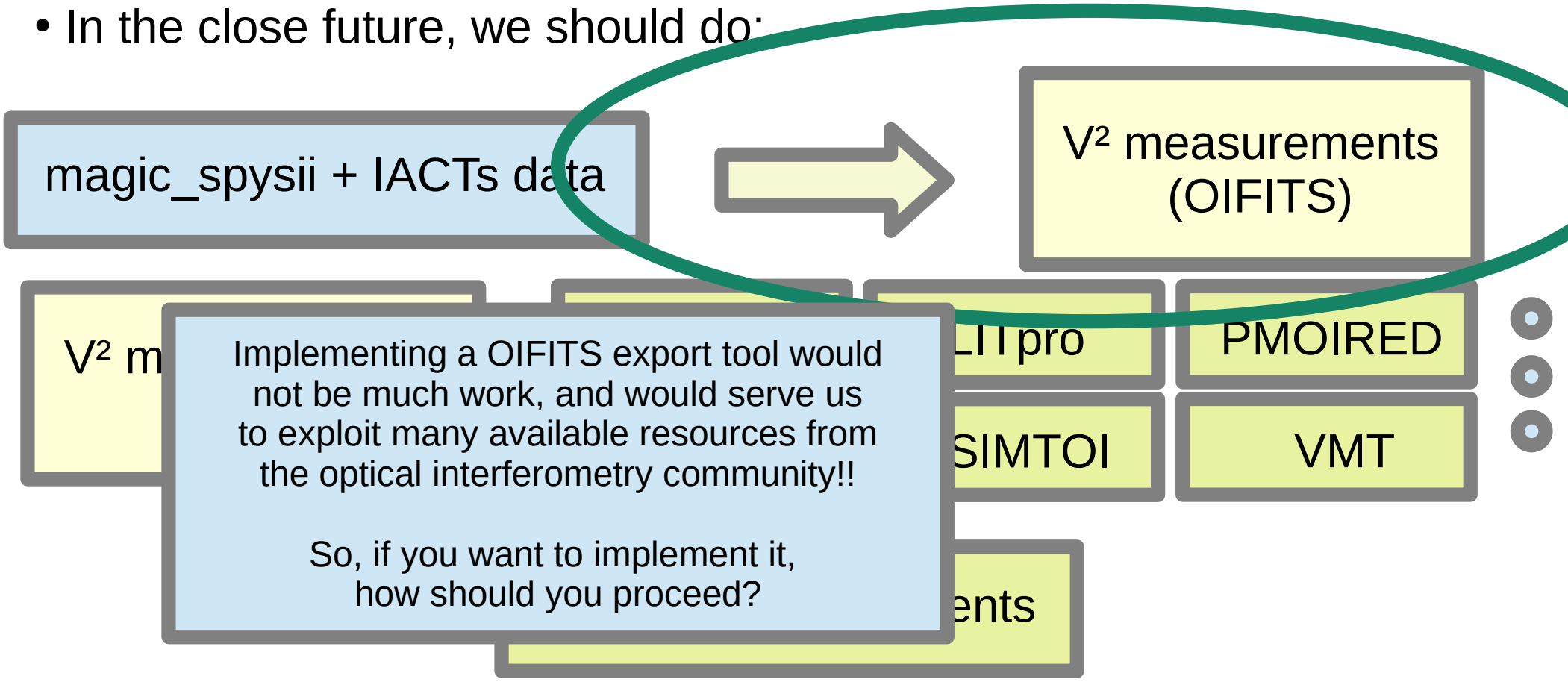
- Models created by the community are prepared to be used by these tools

- We should not reinvent the wheel: if something is available we should use it… And these tools were done by people that know way more about stellar astrophysics than us!

- Any way we can profit from these?

Ideal model fitting procedure

- In the close future, we should do:



magic_spysii: How to contribute

- I expect 2 main contributions:
  - Bug/issue reporting
    - “Tarek! XXX is giving me YYY error message, what do I do?”
  - Analysis improvement/enhancement
    - “I want to fit binaries with magic_spysii, how do I do it?”

- In both cases, the best approach is to start with a **github issue**

magic_spysii: How to contribute – Bug fixes

- For bug fixes, I usually know how to solve the issues relatively quickly, but devoting the time to solve the issue is not possible

- Create an issue so that I (and others!) may be able to fix the issue

    - Fix should be implemented in dev branch

    - “Issuer” should confirm the bug fix solves the issue

    - Dev branch will be merged with master frequently

- The more users we have, the more bugs we will find… Be vocal and report! (you are not bothering, **you are helping**!)

magic_spysii: How to contribute – Enhancement

- If you plan to improve magic_spysii, let me know!! I'll be able to help.
- Create an issue (and add a "Enhancement" label):
  - I will provide feedback on which way we should implement it
  - We will create a list of tests to ensure we are doing things ok
  - We should also ensure nothing breaks
  - All enhacements should be done in **their own branch**, and they should be merged via pull request

Want to contribute?

- There is a long list of topics in which you could contribute:

  - UV + timing analysis: we should not only bin in UV, also we should be able to add time to the bining (once we do, we could fit **ANY MODEL**)
  - Implementing a OIFITS export would open IACT-SII data to **an enormous library of available tools**
  - As proposed by Fernando: observation database to help scheduling
  - Improve MAGIC-LST1 implementation, and also start thinking about LST2-4
  - Improve source simulation tools (they exist, but not yet ideal)
  - Better tutorials explaining the content of each analysis pickle file
  - Create unit testing for most of the code
  - Maintain and improve siicheduler

  and many others!

Next steps

- One way things could proceed is:
  - You start analyzing more data, with specific papers in mind
  - You will soon need specific things from the analysis currently not implemented
  - This will push you to understand the internals and slowly improve it
  - Eventually submit these improvements and contribute

    (this is what Alejo did over the last couple of years)

Next steps

- **OR** we could be more organized and methodic:
  - Identify members of the group that want to implement a specific enhancement
    - Enhancements are clearly linked to scientific topics (examples):
      2D binning and fitting → fast rotators
      2D+time binning and fitting → binaries
  - Have periodic calls to show progress, and ask for support
  - Define best tests to confirm the enhancement works (and does not break things)

Next steps: Proposal

• As we don’t know yet the amount of people that will be interested/available to devote time to these tasks, I propose to follow this approach:

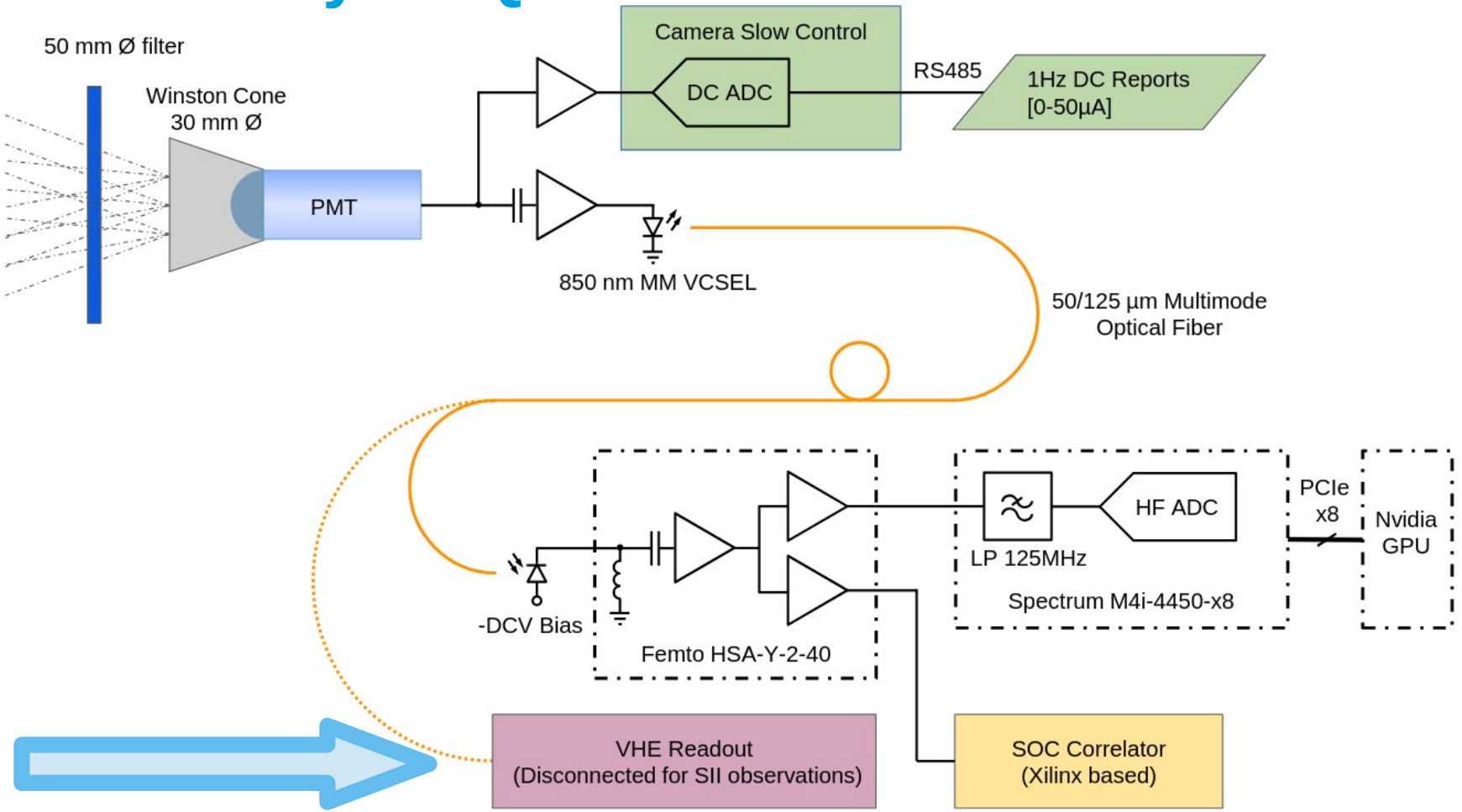
- Contact me and/or the #sii-analysis channel to express your interest of specific enhancements
- If we reach a critical mass, we will have periodic calls to report and discuss about these developments
- If no critical mass is reached, analysis calls will be organized when needed by specific topics (or even private calls between developers, directly)

Lesson V – Conclusions

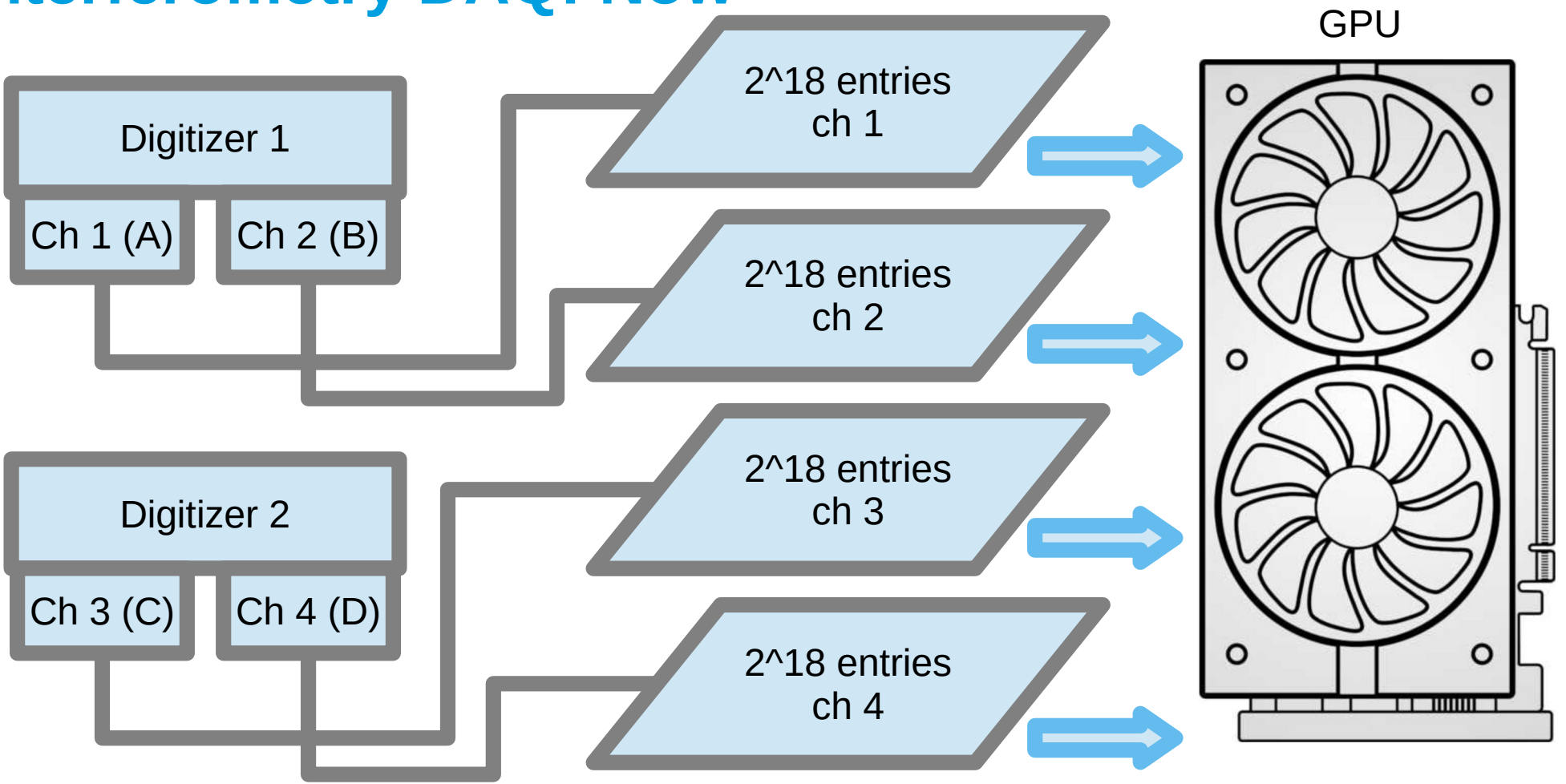
- I honestly hope most of you had a first contact with SII data analysis, and feel encouraged to continue working on the topic
    - Get involved in the observing proposals! Many cool targets are waiting!
- Due to my lack of availability, I'm sure many things were not 100% clear:
    - Tutorials to play around with the different kinds of pickle files I'm sure would be very useful… Sorry I did not have the time!
- If some of you want to continue working on interferometry analysis, the best way to learn is to pick your favourite enhancement and start working on it! (don't stay in the confort of the already-implemented analyses!)


BACKUP

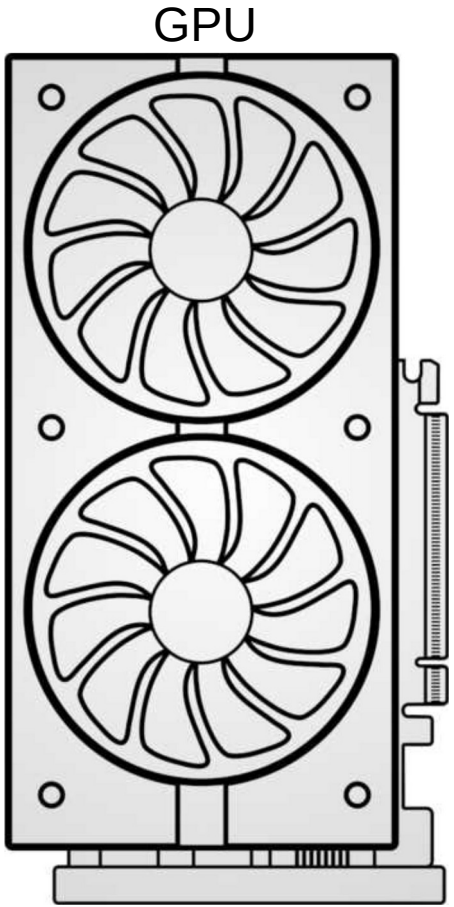
Interferometry DAQ



Interferometry DAQ: Now



Interferometry DAQ: Now



- Current DAQ computes:
  - Cross-correlation between each channel pair (via FFTs)
  - Auto-correlation of each channel
  - Certain useful parameters (mean and std dev of each channel)
- Current DAQ “accumulates” these, and writes the average correlation/mean/std dev every 500 cycles

ZBC: The constant of our system

- From HB&T, we know that the expected correlation:

$$\overline{c(d)} = \langle \Delta i_1(t) \Delta i_2(t) \rangle = e^2 A^2 \alpha^2 n^2 |\gamma_d(0)|^2 \Delta\nu \Delta f \qquad (4.28)$$

- After dividing by the flux, the remaining correlation should be:

$$\frac{\overline{c(d)}}{flux} \propto \frac{|\gamma_d(0)|^2}{\Delta\nu \Delta f}$$

- But as with our setup, our “flux” is the DCs (different gain than the correlation):

$$\frac{\overline{c(d)}}{\sqrt{DC^1 DC^2}} \propto \frac{|\gamma_d(0)|^2}{\sqrt{G^1{}_{DC} G^2{}_{DC}}\, \Delta\nu \Delta f}$$

Any time evolution in the DC gain will be a **systematic**