IceCube Analyses: Today and Future

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IceCube's discovery rate is accelerating...
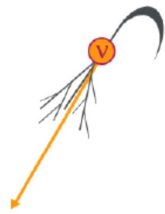

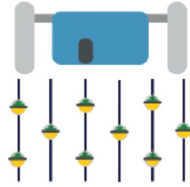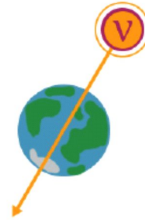| 1988	2000	2001	2011	2013	2018	2021	2022	2023
Telescope in the Ice Envisioned	AMANDA Completed	Atmospheric Neutrinos Detected	IceCube Completed	Astrophysical Neutrinos Discovered	First Source TXS 0506+056 Identified	Glashow Resonance Neutrino Identified	Second Source NGC 1068 Identified	Third Source Milky Way Identified

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New Simulation Technique (MuonGun)

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Implementation of Streamlined Realtime Alerts

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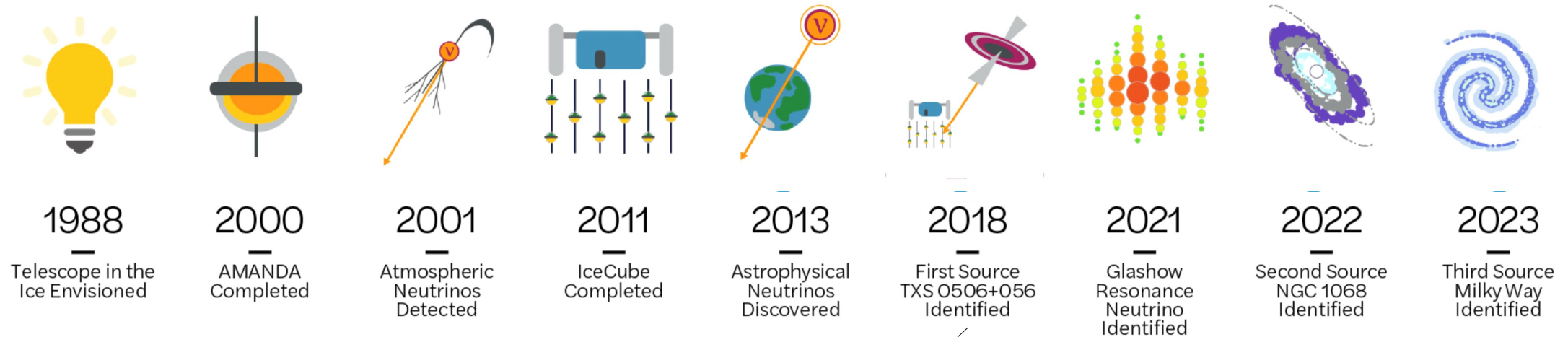
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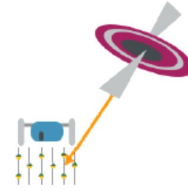2000 — AMANDA Completed
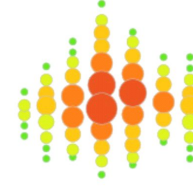2001 — Atmospheric Neutrinos Detected
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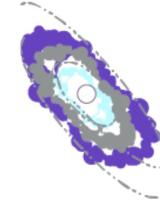2013 — Astrophysical Neutrinos Discovered
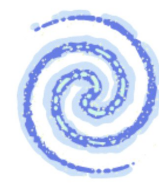2018 — First Source TXS 0506+056 Identified
2021 — Glashow Resonance Neutrino Identified
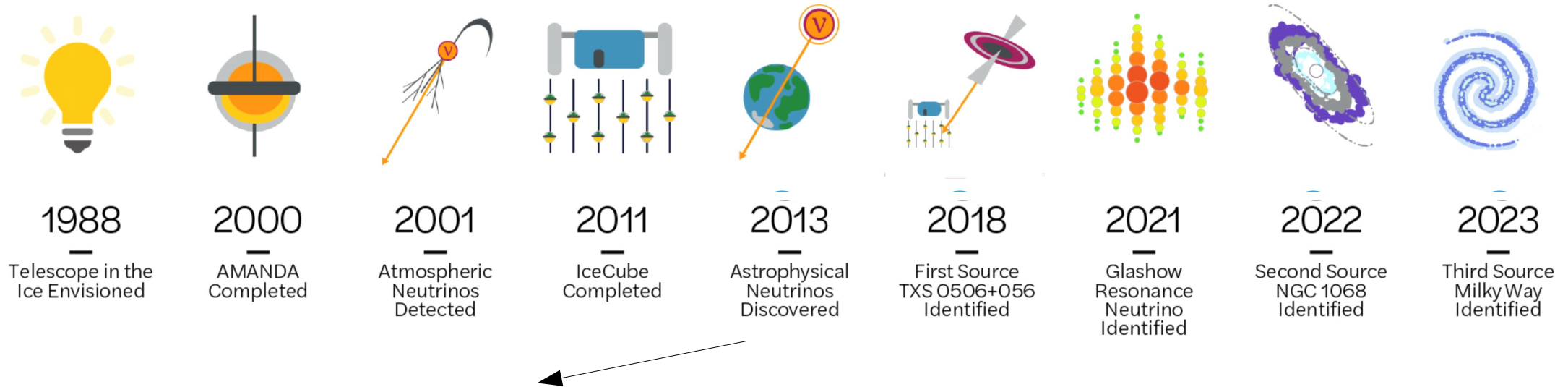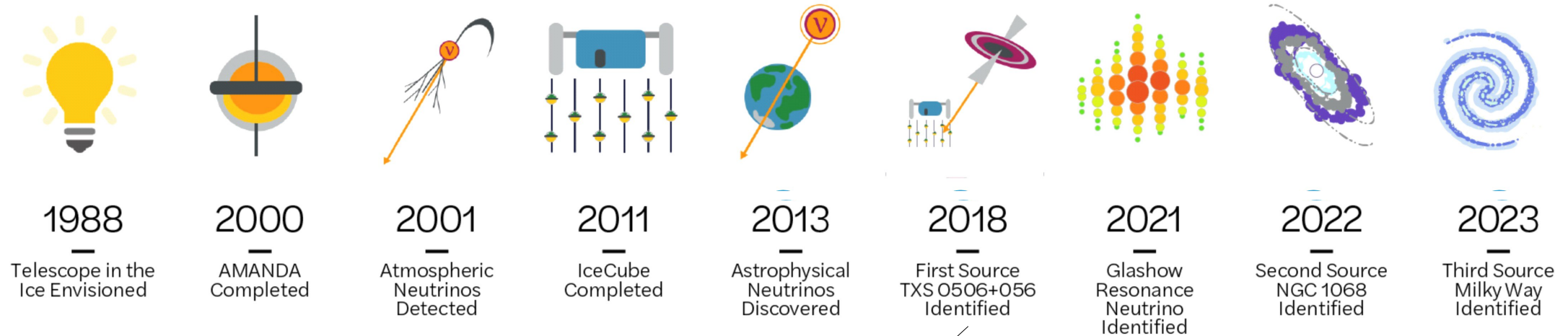2022 — Second Source NGC 1068 Identified
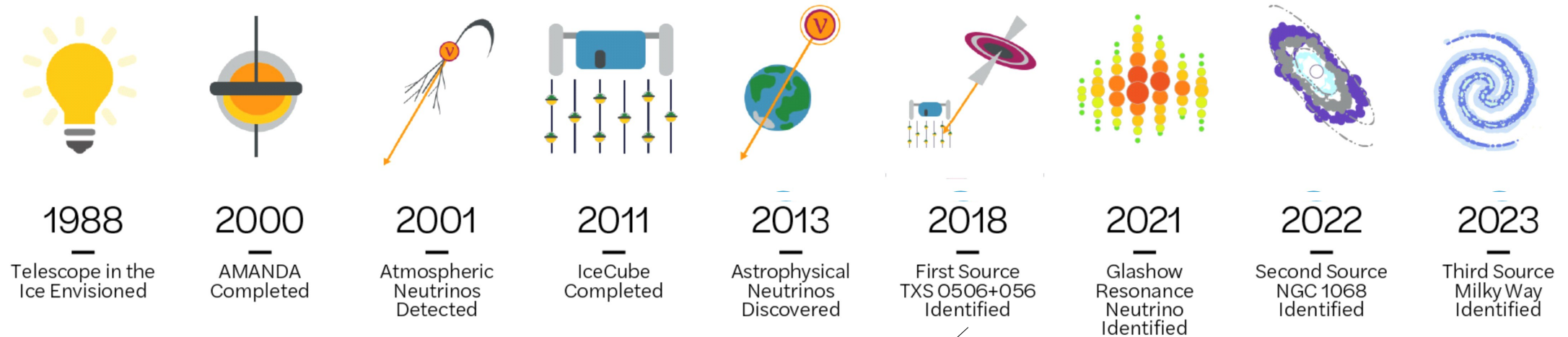2023 — Third Source Milky Way Identified

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Pass 2 Reprocessing

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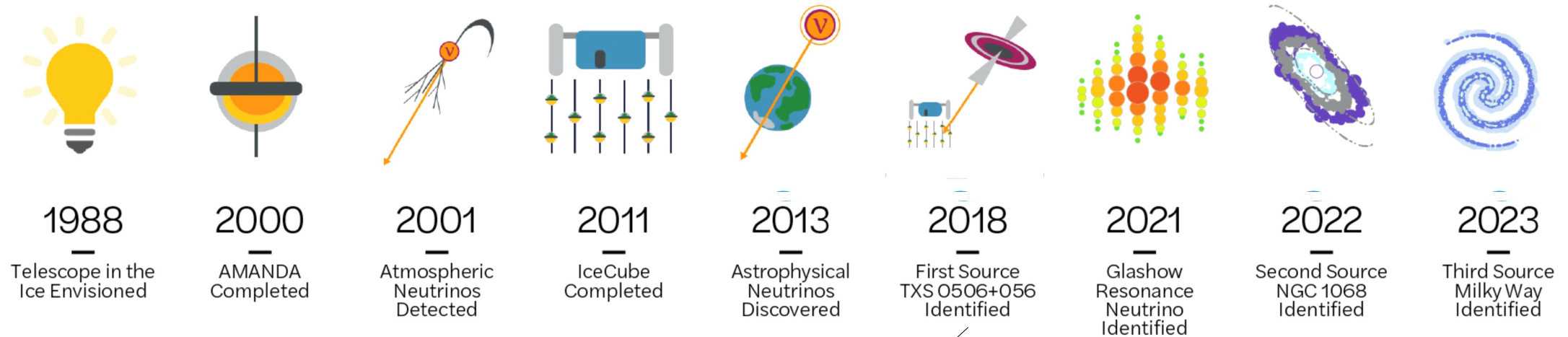
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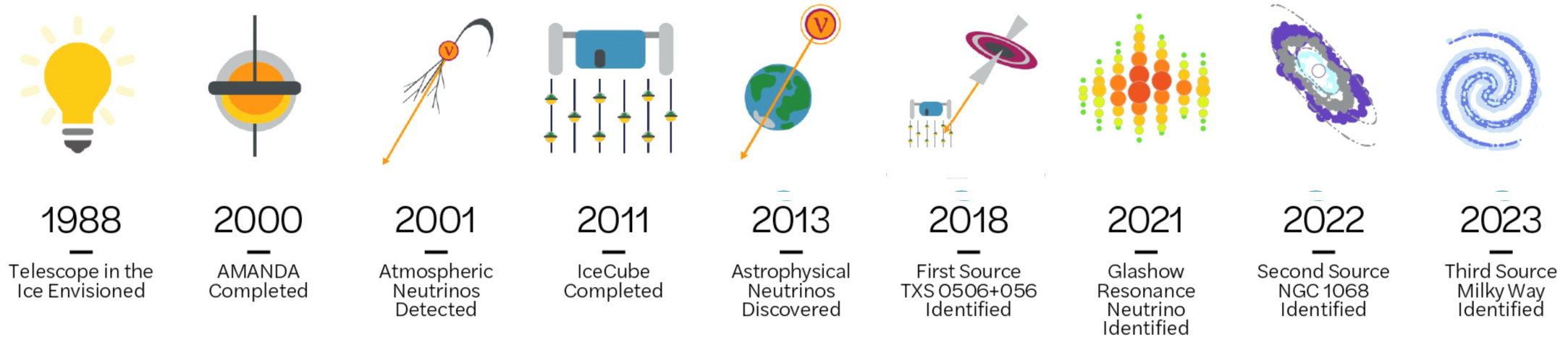
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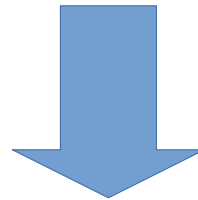
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Every discovery is connected to a new computing tool

New discoveries and expansion in to new science requires expansion of computing needs

Computation needs from analyzers keep diversifying...

Examples:

- AI/ML → no standardization, diverse implementations (neural networks, decision trees, etc) and diverse packages within each
- GPU vs CPU
- Grid computing support (experts vs novice)

Customized needs + support at all levels = high support load

Historical approach from analyzer side:

"Keep asking for what I need"

No down-selecting/organizing with bigger picture in mind

We have essentially relied on expanding computing resources to accommodate analyzers instead of pushing back to streamline needs

Examples

- "save all data" → instead of cutting down on what to keep we have kept the "OR" of every analyzers' wants/needs and bought more disk space

- Keep all software packages → instead of modernizing data processing/analysis software, we have kept adding new software and have had to support more

Some recent improvements though

- IceTray modernization project

- Offline processing modernization project

- Code review/reproducability review of analyses code by working groups

- "blessed" data sets cataloged and maintained by some working groups → encouraged to use the same standard data sets

What still needs work

- IceTray modernization project

- Offline processing modernization project

- More centralized data sets catalog to encourage inter-working group use cut down on duplicate effort/storage/maintenance

- More analyzers knowledgeable in data processing

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  - "too busy" doing final level analysis → victim of own success
  - No incentive to learn data processing
  - Software left in ad-hoc way that was tacked on as needs increased → very murky for new people to learn

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Gulf between people who know/"do" computing/data processing and people who know/"do" analysis

Even if some know both, very silo-ed – no good overview of both

Conclusions

Diversifying computing needs for expanding science, new needs need to be supported (ex: ML obvious one)

Diversification can and has caused lack of coordination on the analyzer side in terms of prioritizing computing needs

Coordinating/prioritizing needs experts who have a good overview of both computing and analysis, few in numbers – interface can become pressure points

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2021-7

2025-1

2025-2

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What does this mean for Upgrade/Gen2 Analyses?
- Pressure at bottle neck increasing...
- Need for more people to develop expertise to be able to interface (ie analyzers with broad view learning low level processing)