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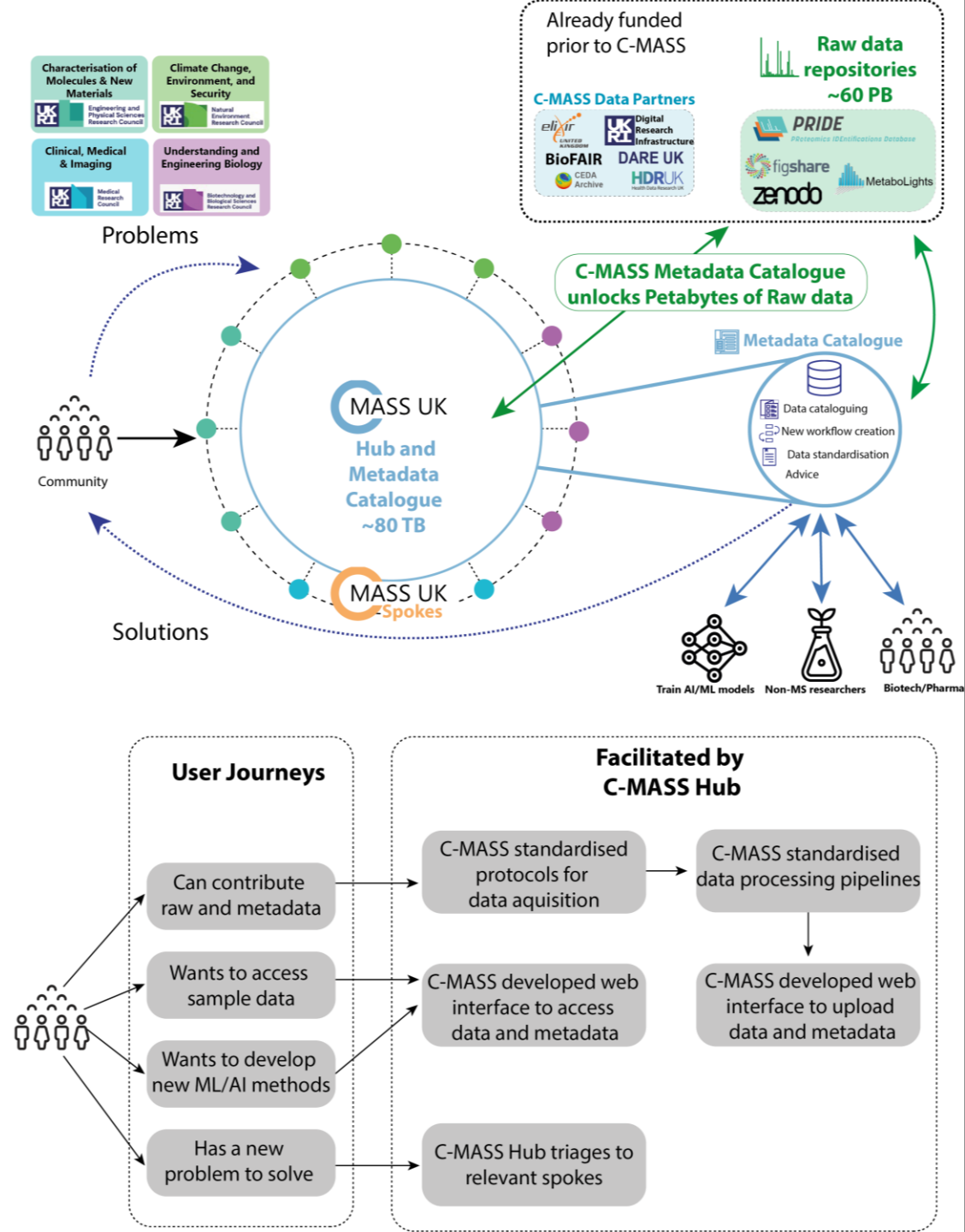
# UPDATE ON C-MASS BID TO THE UK INFRASTRUCTURE COMMITTEE

BMSS September 2023

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# A DISTRIBUTED INFRASTRUCTURE FOR HIGH THROUGHPUT AND HIGH PRECISION ANALYSIS OF MOLECULES AND MATRICES

CRITICAL MASS UK



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# WHAT IS INFRASTRUCTURE FUNDING?



UK Research  
and Innovation

- We will invest £2.9 billion over the three-year period in infrastructure funding.
  - This includes:
    - £48m for the Carbon Zero Fund
    - £129m for the Digital Research Infrastructure Programme
    - £482m **for the Infrastructure Fund**
    - £370m for existing infrastructure investments
    - £129m for the UK Research Partnership Investment Fund (UKRPIF), managed by Research England
    - £1,070m for World Class Labs delivering through the seven Research Councils
    - £145m for capital for international subscriptions
    - £679m for Research Capital Investment Fund (RCIF) England: Higher Education Research Capital (HERC) England and HEI Research Capital England.
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# KEY CRITERIA FOR INFRASTRUCTURE BIDS

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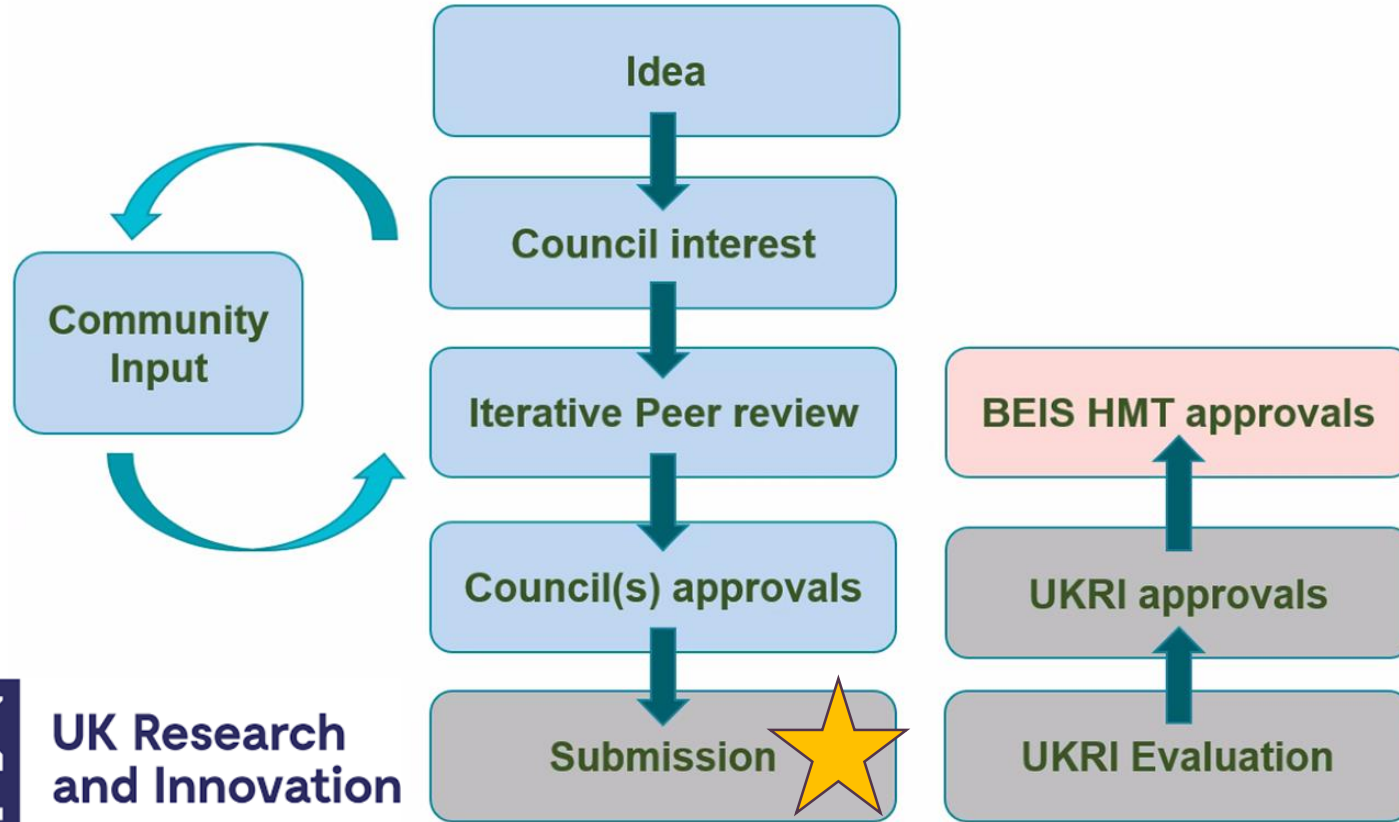
	Criterion
<b>Core criteria</b>	Excellent research and/or innovation
	High impact potential
	Step change in science/ innovation capability
	Accessibility
	Strategic driver
	Feasibility/ deliverability
<b>Optional criteria</b>	Leverage or creation of strategic partnerships outside public sector
	Fosters collaboration or creates strategic linkage and efficiency (UK)
	Fosters collaboration or creates strategic linkage and efficiency (international)
	Fosters multi or inter disciplinary working
	Efficiency gains through 'invest to save'

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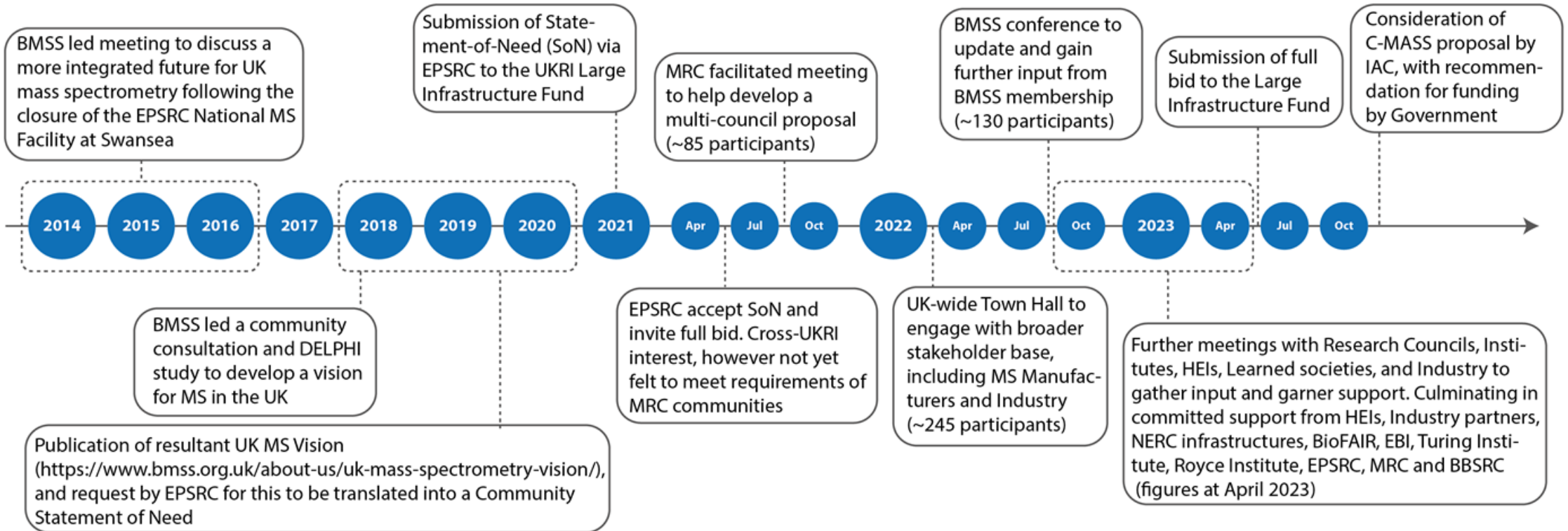


**UK Research  
and Innovation**

# BID DEVELOPMENT

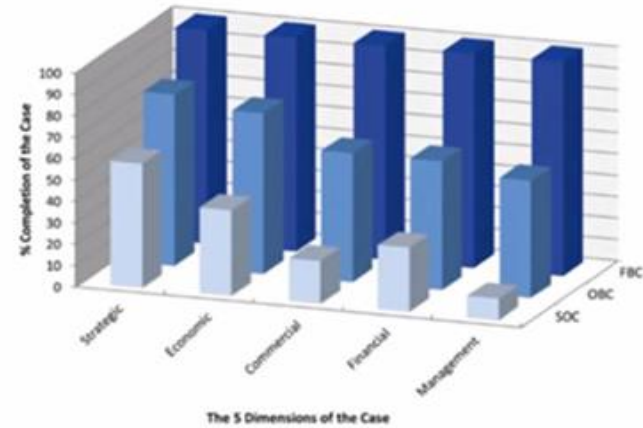
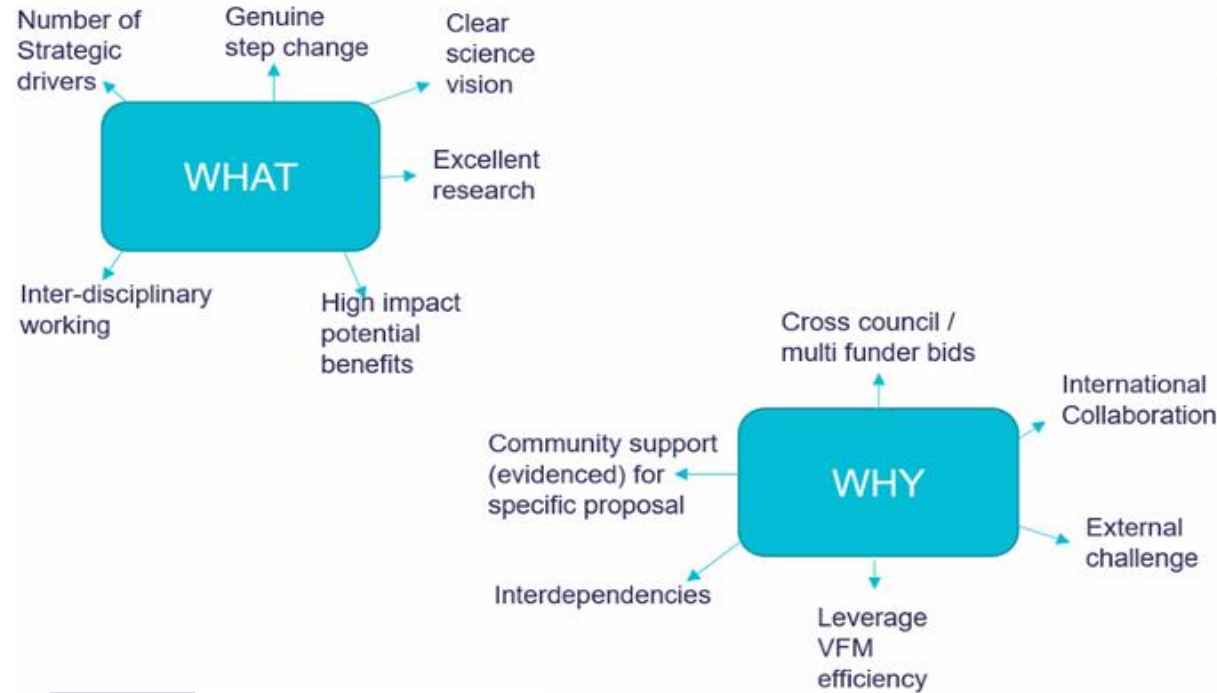


# TIMELINE TO SUBMISSION





# Readiness for IAC Bid



UK Research and Innovation

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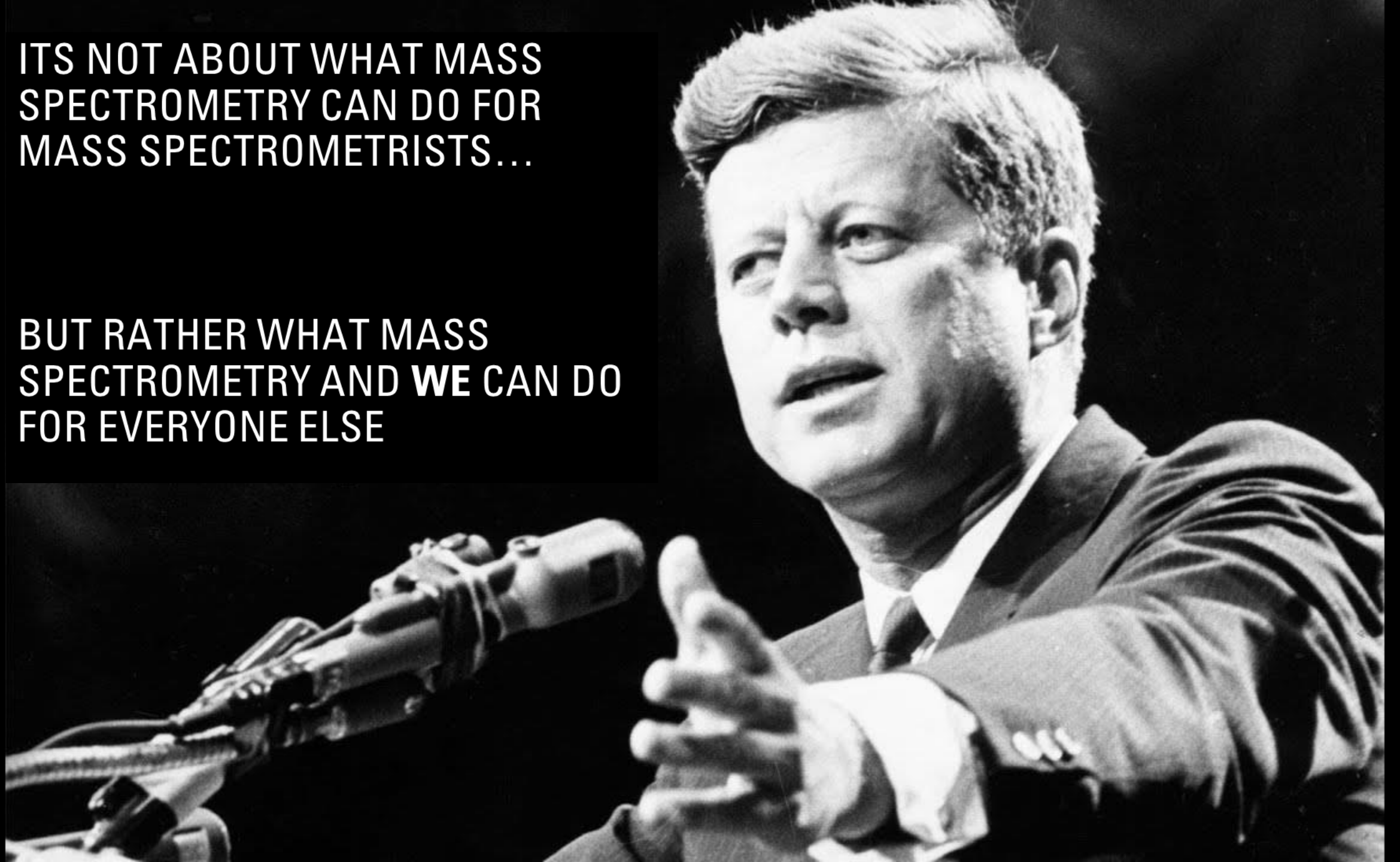
# WHERE ARE WE NOW?

- Following community inputs and encompassing feedback from stakeholders across the wide science landscape including industrial, policy makers, HEIs and external experts, working to the IAC rules, a bid document was co-created.
  - This document has been submitted to the IAC on our behalf, jointly by MRC and EPSRC – technical focus on High Throughput and High Precision MS
  - BBSRC and NERC are in support – although not submitting councils
  - IAC will meet and decide on all bids this year in November
  - **If successful** it will provide capital infrastructure in a Hub and Spoke model, with a Metadata Catalogue to unlock the MS data lakes
  - Spokes will work collectively on Grand Challenges with sample swapping for exemplar datasets and processing pipelines
  - Hosts will be decided by competition with UKRI and external governance
  - It will NOT replace normal mode funding of capital
  - It WILL provide an opportunity for new ways of working for all
  - It WILL add to what we have and ALSO catalyse (but not fund explicitly) skills training
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ITS NOT ABOUT WHAT MASS  
SPECTROMETRY CAN DO FOR  
MASS SPECTROMETRISTS...

BUT RATHER WHAT MASS  
SPECTROMETRY AND **WE** CAN DO  
FOR EVERYONE ELSE





VISION AND IMPACT

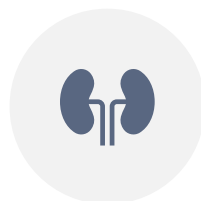
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# CAPITALISING ON HIGH THROUGHPUT AND HIGH PRECISION MASS SPECTROMETRY



Critical Mass UK (C-MASS) is a cross-UKRI remit, distributed infrastructure comprising of a hub and spoke architecture that will provide a step change in high throughput and high precision mass spectrometry for the UK.



Machines have been built that are capable of screening 500 patient biofluids per day, that can locate a drug interaction site in a tissue or organ, and unequivocally determining the structure of pathogens



C-MASS Spoke labs will be equipped with new mass spectrometers and work together to generate robust exemplary reference datasets and standard operating protocols, to measure and identify the molecules that make up our world



This capability, expertise and data will be catalogued and made accessible through the C-MASS management Hub and metadata catalogue which will complement new UK and international Digital research infrastructures



We request 49M from the IAC and have secured co-investment exceeding £20M from industry and project partners

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# UNLOCKING DATA LAKES

- Data is our new plastic – it is everywhere, used by everything, and we need to use it wisely, reducing, reusing and recycling where we can
- The UK MS OMICS community produces more data annually than CERN ever has, filling hard drives and data repositories often after only a single use
- C-MASS will work with existing data repositories to unlock these data silos, enabling multi-use and retrospective data mining through the provision of reference data sets and standardised data capture protocols in critical areas e.g. biofluid multi-omics; single and sub-cell omics; medical device materials, and environmental monitoring
- On-going collaborations with MS vendors will develop archetype reference data, vendor agnostic pipelines, and common reporting formats to democratise access to this valuable resource

Capital request: **Hub for data catalogue, compute for exemplar pipelines, capitalise reference data into robust protocols and pipelines**

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# DELIVERING PRECISION MEDICINE: FROM POPULATION SCREENING TO INDIVIDUAL HEALTH

- UK BioBank includes samples from 450,000 individuals, with a potential to determine health phenotypes and identify early stage disease biomarkers
- MS has unrivalled power to unlock proteomic, metabolomic and genomic information. C-MASS will analyse all UK BioBank samples, generate individual molecular fingerprints, resulting in the largest multi-omic investigation ever performed, and provide a comprehensive mechanistic understanding of the relationship between the genome and proteome at a population level
- Linking health data to metabolite information will allow us to define individual molecular phenotypes, necessary for the development of rapid diagnostic tests, transforming clinical medicine and individual health outcomes
- C-MASS technology and expertise will also be used to locate disease molecules in tissues accelerating medicine design and enabling precision delivery exactly where it is needed

**Capital request:** High performance, high throughput LC-MS instrumentation, capable of discovery and targeted screening of up to 450,000 samples, proteomics and metabolomics in three years.

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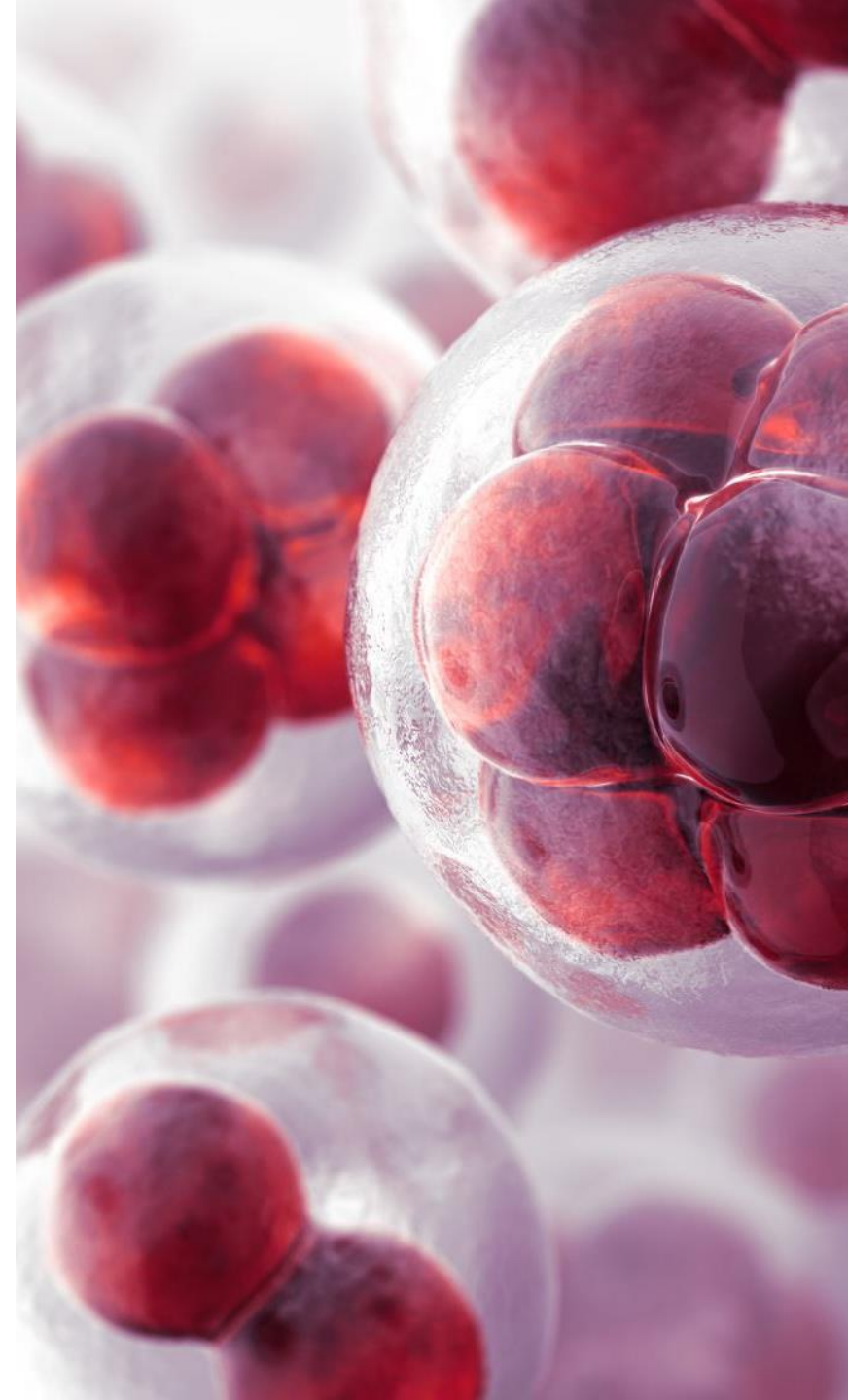
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# UNDERSTANDING OUR PROTEINS TO ACCELERATE ENGINEERING BIOLOGY

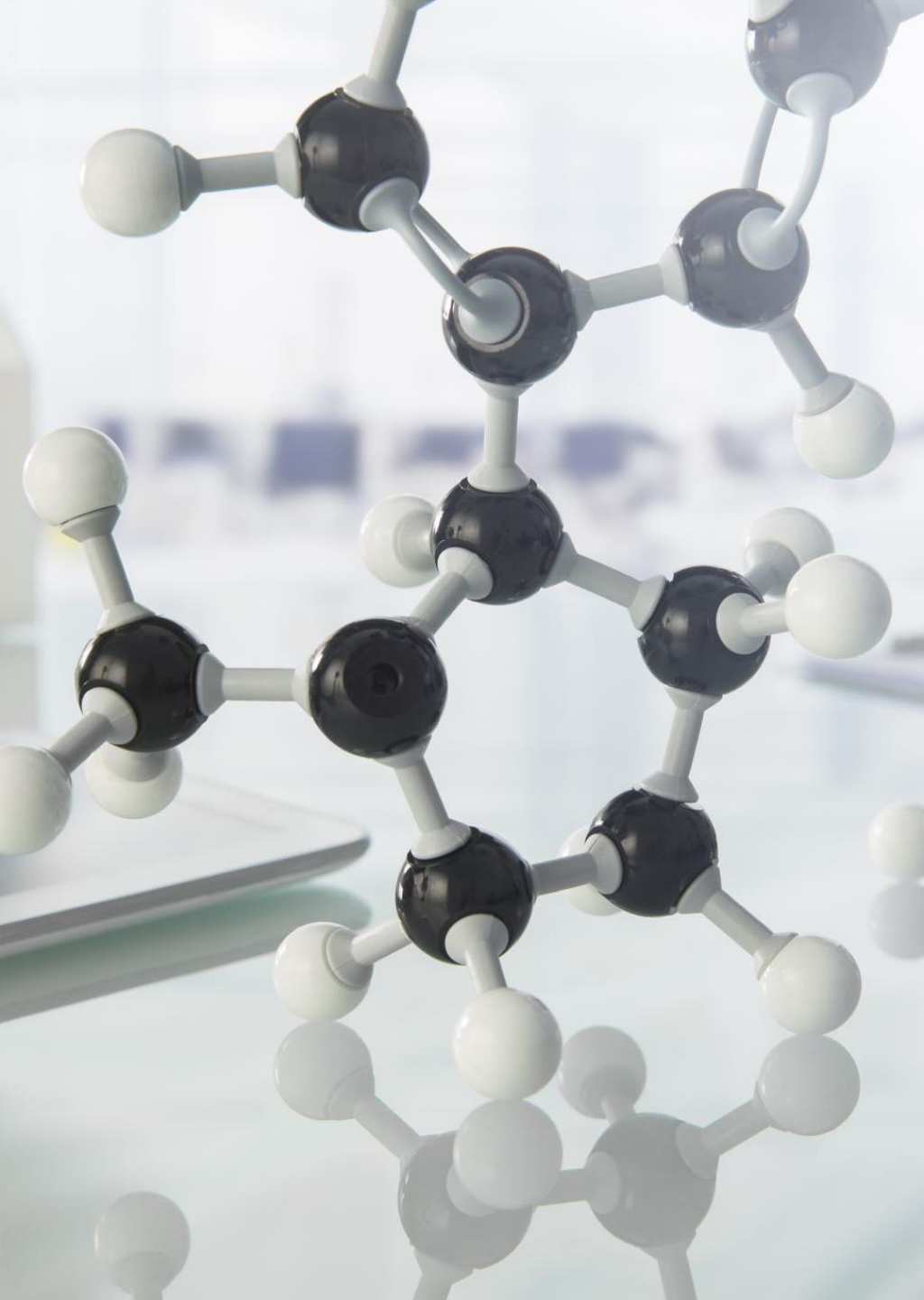
- To better exploit biological processes and engineer solutions we need an improved understanding of how cells function
- Proteins are the key architects of life. Understanding their location and shape within the cell will greatly help with an understanding of their roles
- We will determine protein:protein interactions in a cellular context, to enable the discovery and delivery of new medicine
- C-MASS will help develop new MS techniques and technology used to detect, locate and characterise proteins at this single cell level, unlocking the potential of biology and enabling prototyping at both lab and industrial scales

**Capital request:** High performance, high throughput LC-MS and MS imaging instrumentation, capable of single and few cell analysis.

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## DESIGNING NEW ADVANCED MATERIALS FOR OUR EVOLVING NEEDS

- New functionality requires development of ever more complex materials e.g. biocompatible materials for medical and drug delivery devices, and metal-insulator-metal sandwiches used in quantum computers
- Development of these new advanced materials requires comprehensive characterisation of molecular structures and material compositions throughout the design process, as well as quality assurance of any final products
- C-MASS will develop the mass spectrometry infrastructure to analyse these complex material samples across length scales, and develop reference data sets and protocols to enable the combining of data from different techniques to maximise understanding during the discovery phase, as well as facilitate simple quality monitoring during scale up and manufacturing

Capital request: High throughput high precision lab based architecture

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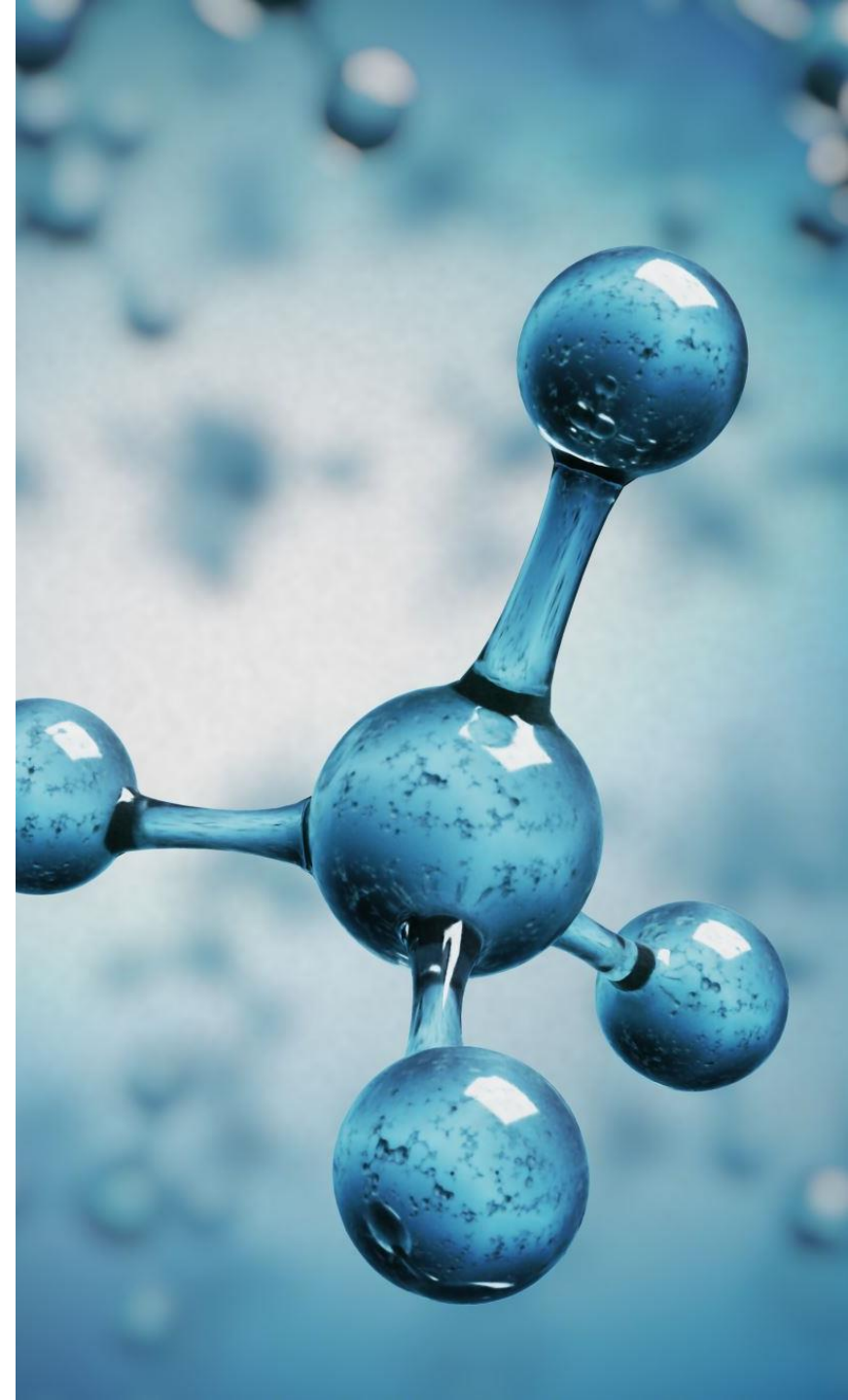
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# SECURING OUR ENVIRONMENT AND BEING PREPARED FOR FUTURE THREATS

- Our world is under threat from physical, chemical and biological threats, including climate change, pollution, antimicrobial resistance etc.
- C-MASS will coordinate and support a nationwide deployment of mass spectrometry technology coupled with big data and AI/machine learning approaches to allow us to monitor our environment, secure our food supply, and maintain our health
- Lab based mass spectrometers will help us combat these threats through sensitive detection of counterfeits, and the development of climate resistant crops, new antidotes to chemical poisons, and new antibiotics to secure our water, agriculture and health
- Field deployable instrumentation monitor the effect of extreme weather events on our environment and detect emerging markers of disease in our waste water enabling timely responses and interventions. The CMASS meta catalogue will complement the NERC CEDA Archive such that results taken in field can be considered in concert with high throughput high precision analysis

**Capital request:** High throughput lab based architecture

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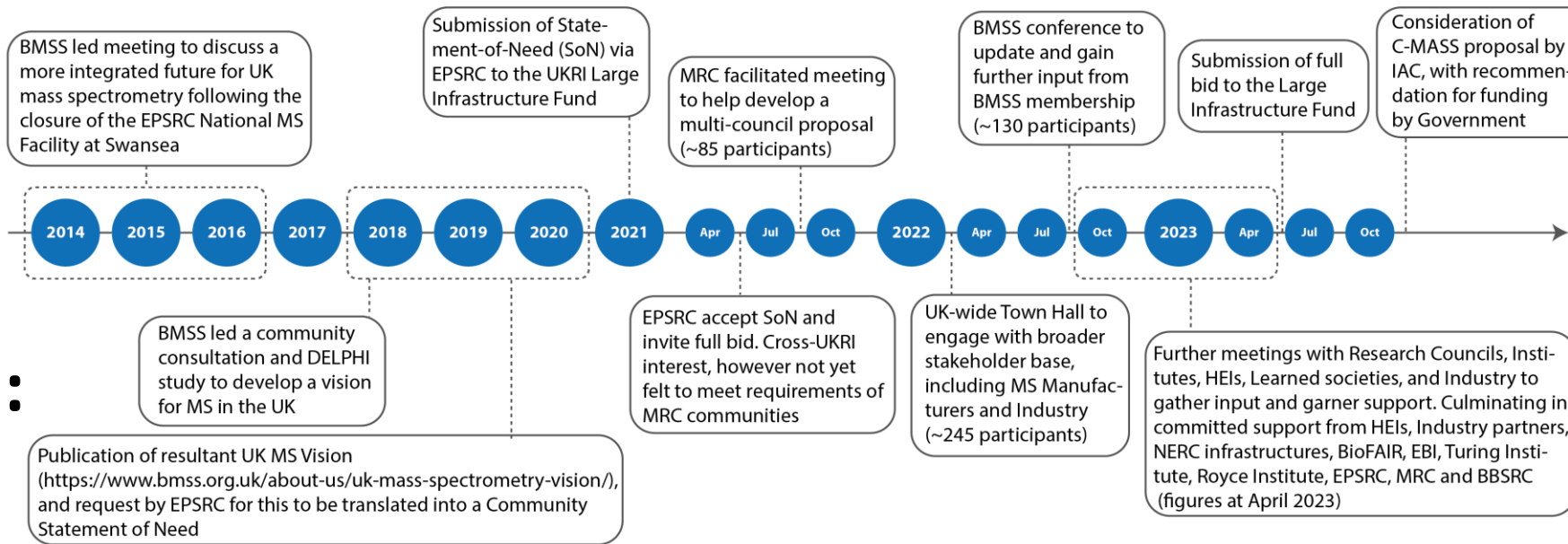




DEVELOPMENT, GOVERNANCE AND DELIVERY

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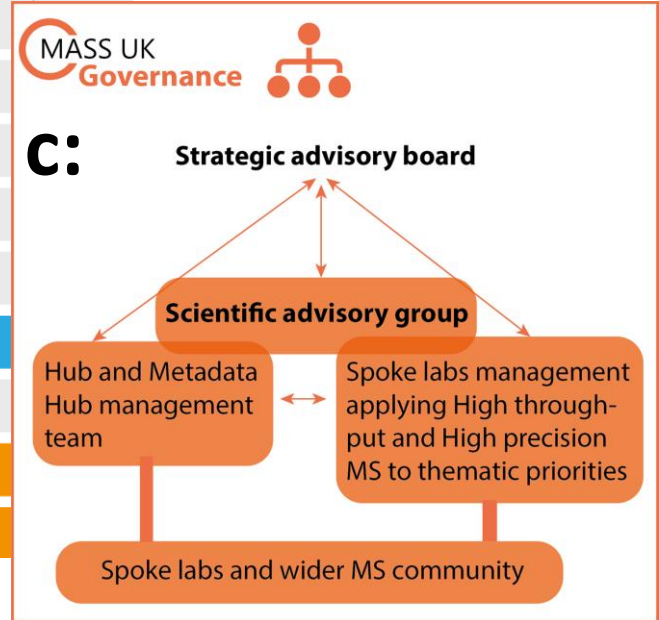
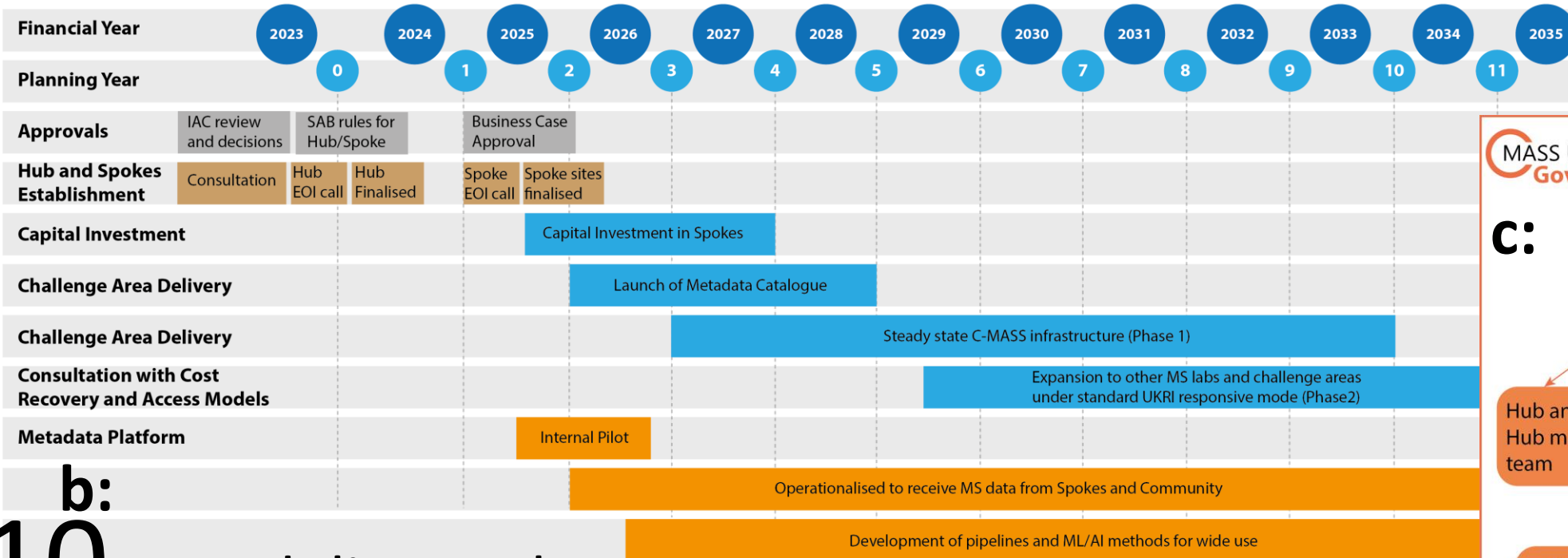
**a:**



**10**  
years  
in the  
making

**b:**

**10** year delivery plan



# Expressions of interest in nationally distributed C-MASS delivery

Institution	Hosting the Hub	Hosting an Expert Lab	Community Engagement Data Catalogue and Hub
British Geological Survey	X	X	X
Cardiff University			X
CRUK Beatson Institute		X	X
Durham University	X	X	X
Institute of Cancer Reseach		X	X
Keele University		X	X
King's College London	X	X	X
Loughborough University			X
Sheffield Hallam University		X	X
Swansea University	X	X	X
The Francis Crick Institute		X	X
The University of Surrey	X	X	X
UCL	X	X	X
University of Bath		X	X
University of Birmingham	X	X	X
University of Bristol		X	X
University of Cambridge		X	X
University of Dundee		X	X

Institution	Hosting the Hub	Hosting an Expert Lab	Community Engagement Data Catalogue and Hub
University of Edinburgh	X	X	X
University of Glasgow		X	X
University of Huddersfield			X
University of Leeds		X	X
University of Leicester	X	X	X
University of Liverpool	X	X	X
University of Manchester	X	X	X
University of Nottingham		X	X
University of Oxford		X	X
University of Plymouth		X	X
University of Sheffield		X	X
University of Southampton		X	X
University of St Andrews		X	X
University of Strathclyde		X	X
University of Surrey	X	X	X
University of Warwick	X	X	X
University of York	X	X	X



# Modes of Engagement Model

If you are ...	Mode of Access	What will you do?	What might you obtain?
An MS service lab in an HEI or UKRI institute	<ul style="list-style-type: none"> <li>• Opt-in to be a <i>Spoke Lab</i></li> <li>• Your capability will be signposted by the hub</li> <li>• Common TRAC-costed cost recovery model for researcher access</li> </ul>	<ul style="list-style-type: none"> <li>• Provide routine MS access and training to researchers in one or more specialist areas</li> <li>• Undertake to provide metadata for cataloguing back to the hub</li> <li>• Take part in generation of SOPs for common MS analyses</li> <li>• Take part in thematic strategic Challenges</li> </ul>	<ul style="list-style-type: none"> <li>• Increased capacity in terms of equipment</li> <li>• Enhance capabilities if shown to benefit user base</li> <li>• Increase in the expertise required to support your lab.</li> <li>• Better signposting of your capability through the Hub.</li> <li>• Ability to focus on activities that you have strengths in and pass to others when you do not.</li> </ul>
An MS research group in an HEI or UKRI institute	<ul style="list-style-type: none"> <li>• Be a member of a thematic metrology network</li> <li>• Help direct, run, or lead one of the Themes or Hub</li> </ul>	<ul style="list-style-type: none"> <li>• Work on strategic challenge</li> <li>• Undertake to provide metadata for cataloguing back to the hub</li> </ul>	<ul style="list-style-type: none"> <li>• Membership of network and hub to enable work that cannot be done just by your lab</li> <li>• Increased capability to solve the strategic challenge</li> </ul>
A research group from HEI or UKRI institute dependent on routine MS OR Industrial user	<ul style="list-style-type: none"> <li>• Apply through hub for access to Theme/<i>Spoke labs</i></li> <li>• TRAC-costed fee for service access to routine services</li> </ul>	<ul style="list-style-type: none"> <li>• Undertake to provide metadata (when possible) for cataloguing back to the hub.</li> </ul>	<ul style="list-style-type: none"> <li>• Targeted access to expert laboratories</li> <li>• Opportunity for collaboration on strategic challenges</li> </ul>