BGSW 2008 SHRIMP Talk

Pioneering the Technique, Perfecting the Technology



ASI Presentation

Ed Roberts, CEO

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Presentation to BGSW-08

- Whats Happening with the SHRIMP
  - Technical updates
  - Automation
  - Remote access
  - SHRIMP SI
  - Double-dating
  - SQUID II
- Alphachron
- Collaboration & Developments
- Questions and Answers

SHRIMP IIe Instrument

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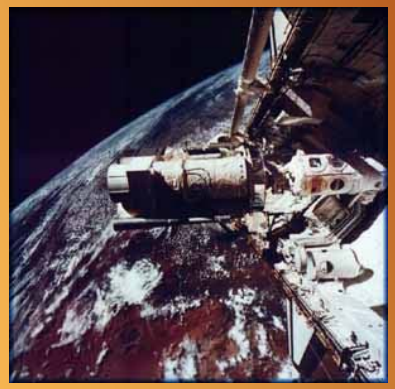
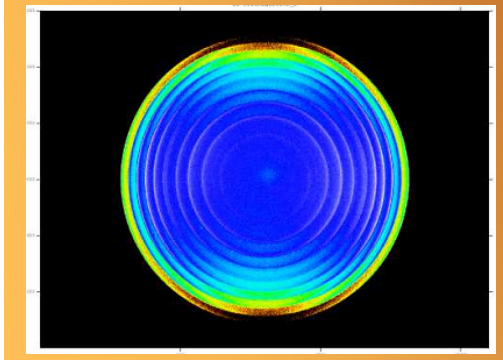
SHRIMP Technical Updates



Imaging detector (VUV) on Shuttle (top) and in Lab (e^-) (below 4k x 4k pixels)

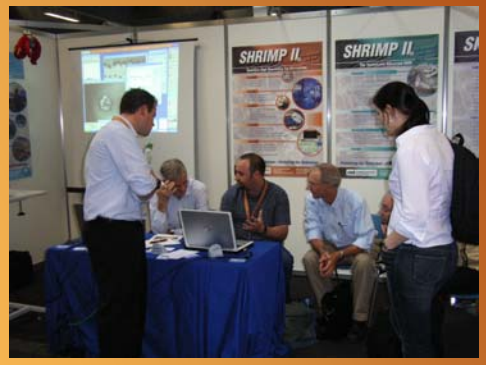


- Ongoing refinement of remote access capabilities – eg China, Goldschmidt
- Upgrades to optics manufacturability (with ANU Engineering / students)
- Upgrades to stages & encoders
- Deployment of advanced electrometers
- Use of dry-pumped systems
- Close-packed multi-collector heads for nuclear analysis, eg KBSI;
- Development of imaging detector capability – SIAS
- Labwindows now at version 8.5

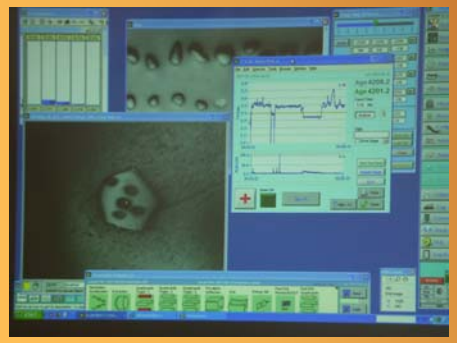
SHRIMP Automation

- Developed at ANU for surveying Jack Hills zircons on SHRIMP I, 400 zircons per night;
- Uses LabView imaging capability;
- User defines spots on a jpeg image, system uses pattern recognition to locate zircons and area of the zircon;
- Image can be visible light, CL, BSE or other jpeg set;
- Retrofittable to all SHRIMPs, eg NIPR
- Overcomes need for ‘night runners’

SHRIMP Remote Access

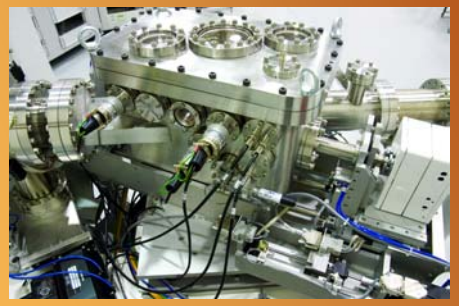


Conference attendees using SHRIMP IIe/MC in Canberra by remote access from Goldschmidt in Cologne



- All SHRIMPs can be run in remote access mode, with existing or tailored software;
- Tailored software reduces hand-shaking when operating with long ping-times;
- Allows use within a building, checking from home (eg when running automation software), sharing within a local consortium, or selling machine time to overseas users (as done by CAGS);
- Also allows remote support including fault diagnosis and tuning from ASI;
- No extra charge for this capability.

SHRIMP SI Development



- Development headed by ANU, with funding and input from ASI (as part of a larger team);
- SHRIMP SI provides a development platform for a range of technologies & techniques, as described by Trevor;
- These will flow into SHRIMP IIe ongoing development;
- SHRIMP SI may be offered as a product in its own right, depending on user needs & interest.
- SHRIMP SI can undertake conventional Pb/U measurements, using duoplasmatron

ASI-CSIRO Collaboration

Alphachron Helium thermochronology Spectrometer, manufactured by ASI under Licence from the CSIRO

- Commonwealth Scientific and Industrial Research Organisation (CSIRO) is the national research body, with research in;
  - Division of Mineral Exploration and Mining (DEM)
  - Computation and Robotics
- ASI and CSIRO (DEM) delivering He-Th Thermochronology instruments (Alphachron);
- ASI and CSIRO cooperating on automated software for remote operation of instruments, based on NASA-sponsored research for lunar and Martian mining;

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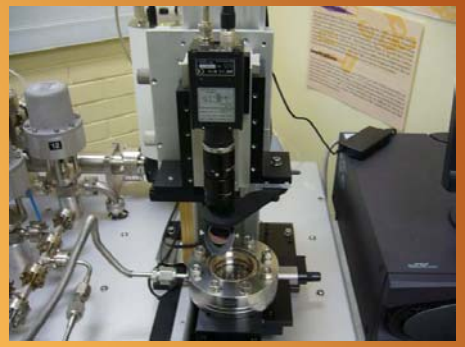
Alphachron



- Automated helium themochronology instrument
- Uses diode laser to heat individual grains, guided by optical microscope and image recognition software
- Helium content determined with QMS, with ^{3}He and ^{4}He spike tanks
- Typically has 25 samples, processed overnight;
- Option of Quartz-Halogen step-heating of sample over days or weeks to determine closure temperature;
- Option of sampling bulk samples in vacuum furnace
- Software and some subsystem commonality with SHRIMP
- Recent installation at ASU

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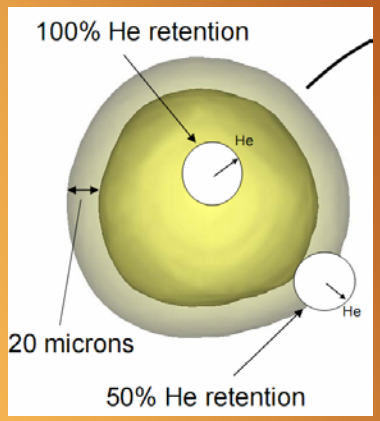
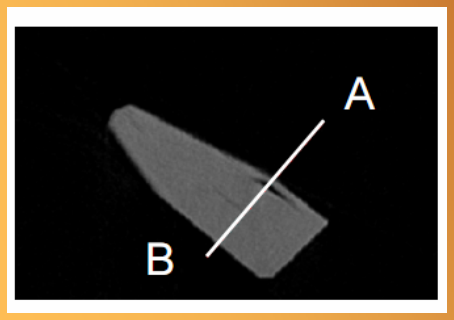
SHRIMP / Alphachron Double Dating





- Development of SHRIMP & Alphachron capabilities by CSIRO DEM (Brent McInnes) with Curtin SHRIMPs
- Measure U/Pb/Th with SHRIMP, then He with Alphachron – SHRIMPing has no impact on He measurement;
- Refinement of thermochronology measurement with X-Ray CAT Scan characterisation of mineral grain shape.
- This also allows detection of inclusions, fractures and voids.

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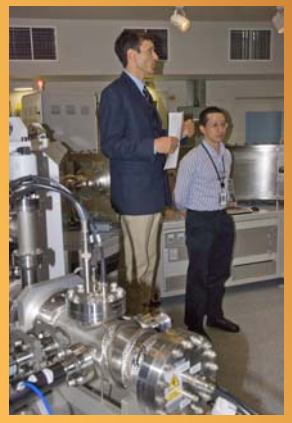
ASI-GA Collaboration

GA SHRIMP Lab, with Federal Minister, Departmental Secretary, and Keith Sircombe.



- Geoscience Australia is the Australian Government national agency for geoscience research
- ASI and GA entered an agreement to share a SHRIMP IIe
- To facilitate further development of equipment, techniques and standards, with a key SHRIMP laboratory
- 4th SHRIMP in the ACT, with a 5th under construction (SHRIMP SI)
- Disassembly, transport, reassembly and pumping undertaken in one week
- In routine, 24-hour use for GA, ASI and visitors.
- Good source of design ideas for SHRIMP laboratory layout

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SQUID II Software

Oxygen analysis of Neanderthal teeth (above) and conodonts (below)

- Developed in a consortium headed by Geoscience Australia
- Algorithms from Ken Ludwig (Berkley) via SQUID 1.
- Funding from SHRIMP Labs, GA, ASI
- Contributing labs have feedback into development, and early access to the code

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Why Change SQUID 1?

- SQUID-1 is **inflexible:**
  – Restricted minerals (Zrn-Bdl, Mnz, Ttn only)
  – Run tables entirely predetermined (e.g. Zrn can't use UO_2; Mnz must have ThO)

- SQUID-1 is **autocratic:**
  – User input into processing limited/peripheral
  – Output largely predetermined: additional calculations must be manual, sheet-by-sheet

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SQUID-2 = SQUID-1 + *flexibility*

- Can parse any SHRIMP-generated .PD file; any mineral, any run table (user-defined)
- Customised data processing via user-defined equations using any Excel or Isoplot function:
  – Perform highly specialised calculations
  – Automate routine post-processing of data
- "Live" Excel charts with user-chosen axes

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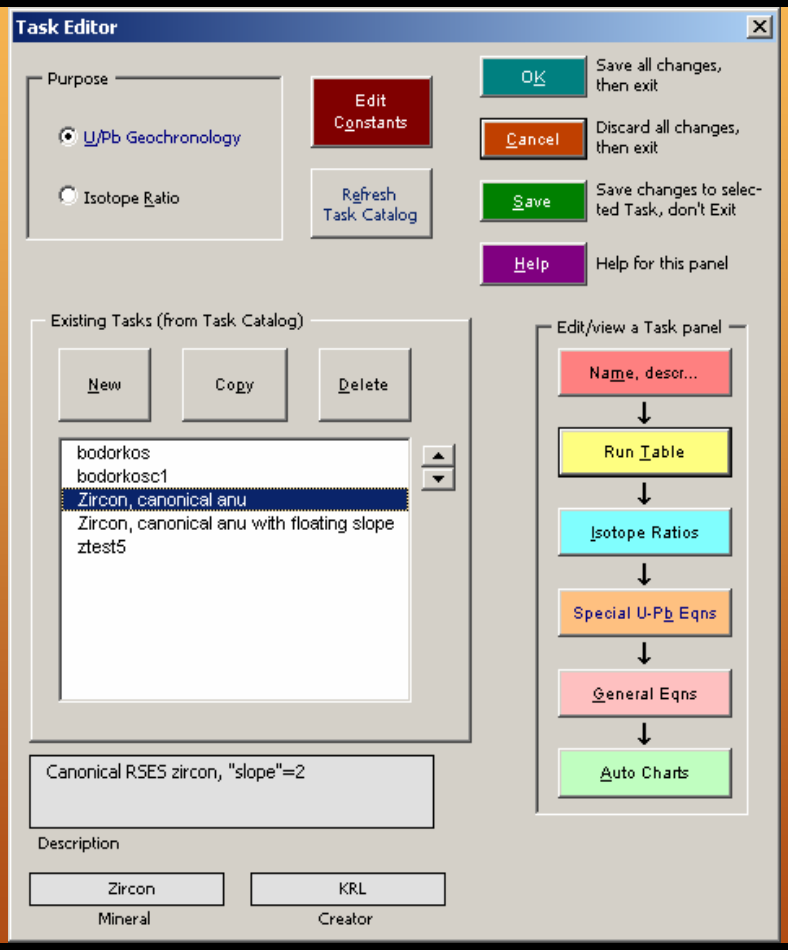
SQUID-2's "engine": the Task Editor



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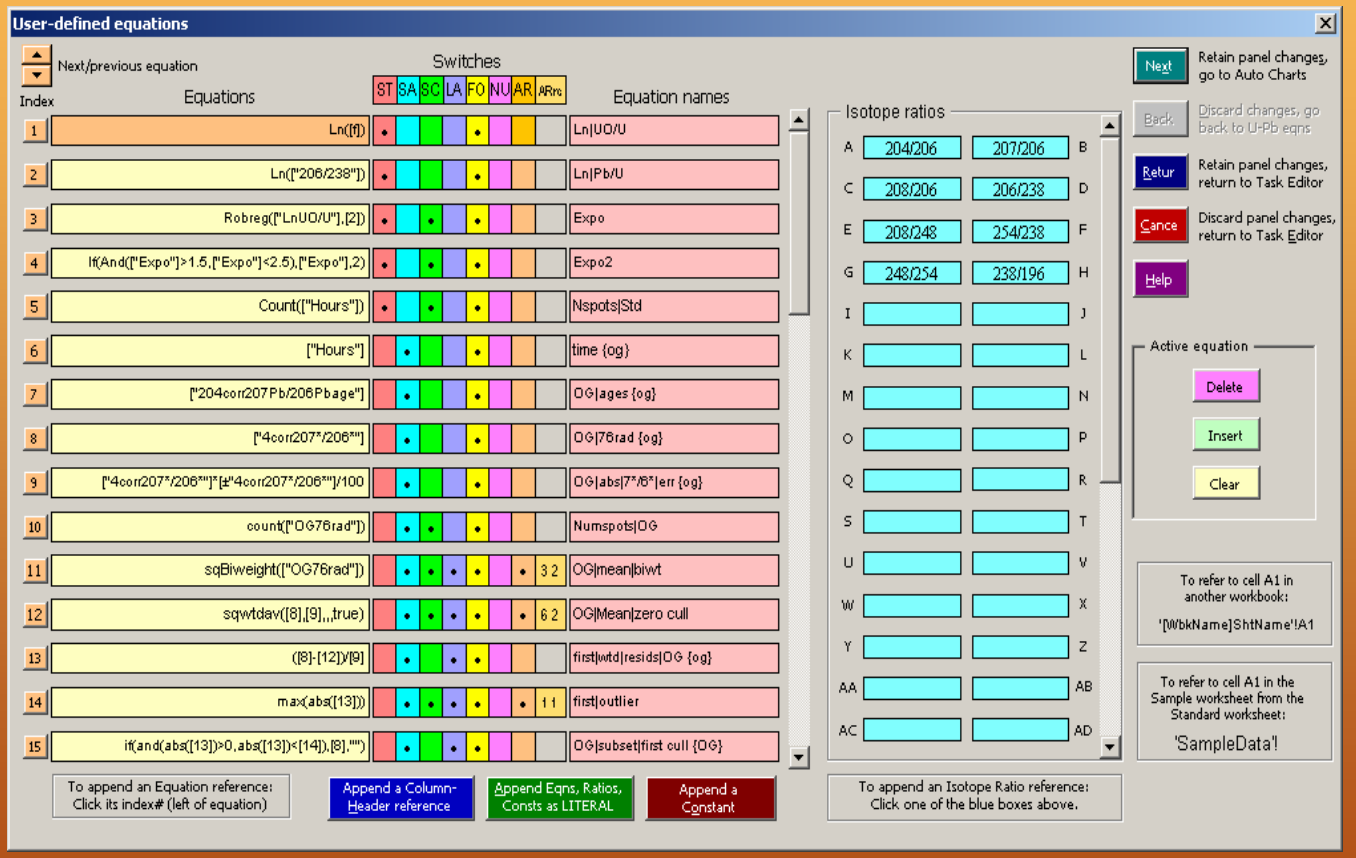
Customisation: User-defined equations



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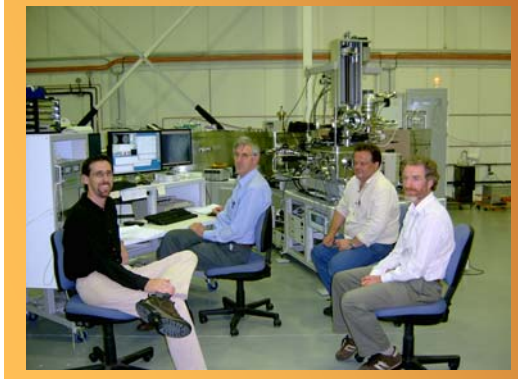
ASI-ANSTO Collaboration

- Australian Nuclear Science and Technology Organisation (ANSTO) is Australia's Government nuclear research body;
- ASI and ANSTO are working on development of next-generation IRMS mass spectrometers;
- ANSTO prepared representative samples of Pu/U for ASI/ANU to analyse in SHRIMP II and SHRIMP RG
- ANU and ANSTO have access to
  - Accelerator Mass Spectrometry (AMS),
  - SIMS
    - SHRIMP II,
    - SHRIMP RG and
    - Cameca 5f;
  - TIMS, to characterise nuclear materials;

ANSTO Scientists & ASI Staff, Analysing Pu/U Samples

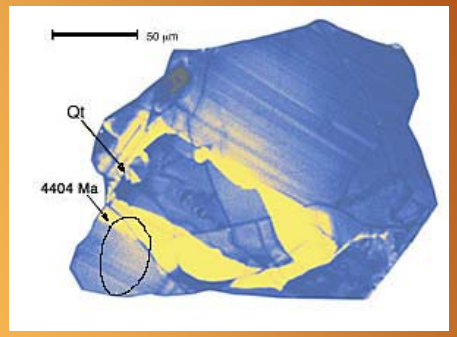


SHRIMP Workshops

Rottnest Island, venue for the most 2006 SHRIMP workshop with some of the 70 attendees from 8 countries at the workshop.

- SHRIMP community runs regular workshops to facilitate exchange of techniques and ideas
- ASI sponsors these, and acquires valuable feedback and design ideas from customers
- Next workshop is in St Petersburg in June 2008
- Previously Canberra, Hiroshima, Perth
- Next in Korea (TBC) and Brisbane (TBC)

Summary



Zircon from Acasta gneiss (top) and the Jack Hills (WA), site of the worlds oldest Zircons. These were uncovered via automated operation of ANU Shrimp-I, examining 75000 zircons.

- Strong team of Customer-ASI-ANU
- Excellent SIMS instrument
- Depth of technical and scientific support
- Excellent scope for scientific collaboration between users and Australia
- Broad SHRIMP user community with common software tools (eg SQUID)

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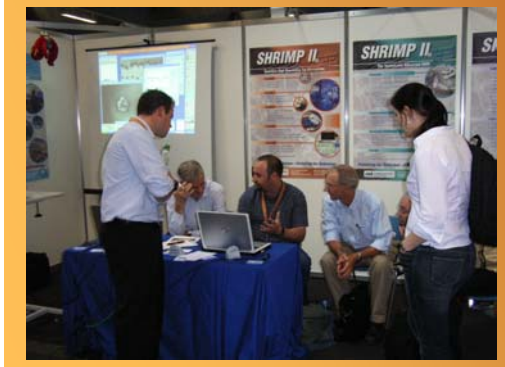
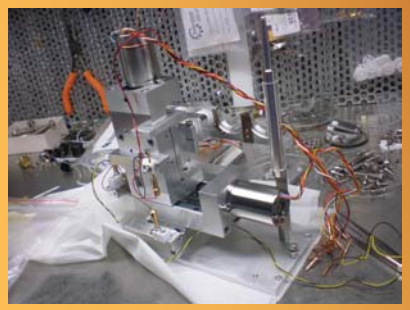
SHRIMP Utilisation



- Facilities schedule SHRIMP time in the same way as a large telescope, via a time assignment committee
- Schedule users with instrument configuration (positive or negative mode)
- Remote access allows users to ‘visit’ the machine via the web (in the same way as modern telescopes are driven remotely)
- Facilities typically allocate part of the time on a commercial access basis: cost recovery

SHRIMP Availability

Modular construction, simple geometry and computerised operation lead to high machine availability and productivity: e.g China SHRIMP II



Usage of SHRIMP II

Client	SHRIMP Running Time (Day) (1 machine day = 24h)				
	2002	2003	2004	2005	2006
CAS	50.5	58.5	56	63	58
Universities	45.5	63.5	86.5	51	58
MLR	95.5	93	151.5	149.5	126
Taiwan & Hongkong	21	14	6	9.5	13
Overseas	**33**	**41**	**-**	**26**	**26**
Others	-	1.5	1	-	-
Total	**245.5**	**271.5**	**301**	**299**	**281**

SHRIMP II/IIe Operation

Dr Allan Kennedy (right) from Curtin University, taking delivery of Multicollector for Curtin SHRIMP II(a)

- Users experience very high reliability and availability, eg > 300 days per year of 24 hour access
- Users experience stable operation for long periods of time, eg “6 days of automated operation without even needing to adjust the oxygen flow”
- Users share SHRIMP time via remote operation and bureau services
- SHRIMPs are supported by remote access for tuning and diagnostics from the Australian team
- Each SHRIMP can support > 10 serious researchers full time, or their equivalent
- The SHRIMP requires about 25% of the time of a competent electronic technician for support. Experience on a modern mass spectrometer is a good starting point.

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SHRIMP IIe/MC Running Costs

Expendable research materials	$AUD
• 600 x 36 exposure films and film processing (or equivalent colour laser printer consumables)	$10,900
• 750mm x 1mm dia. 99.999% pure gold wire for coating of samples	$5,350
• Helium line oil filter for cryocooler	$1500
• Computer paper and CDs/DVDs	$1,050
• 5 Tantalum Köhler apertures and 2 Nickel cathodes	$5,000
• 2 ETP electron multipliers (for on-axis detection)	$3,600
• 10 Sjuts continuous dynode electron multipliers (for M/C heads)	$15000

• Cleaning
  • 1000 pairs disposable gloves,
  • 50 boxes tissue,
  • 200 litres Petroleum Spirit,
  • 52 litres ethyl alcohol
	$3240

• Gas
  • 1 G size bottle high purity Helium,
  • 6 G size bottle Nitrogen,
  • 1 G size bottle medical grade Oxygen
	$1050

• Electrical power 135,000 kWhrs @ $0.12/kWhr	$16,200
• Labour costs in addition to those of an Operator (400 man hours @ $50.00/hr)	$20,000
• **TOTAL ESTIMATED ANNUAL RUNNING COST**	**$83,070**
• **TOTAL NON-LABOUR EXPENDABLES**	**$63,070**

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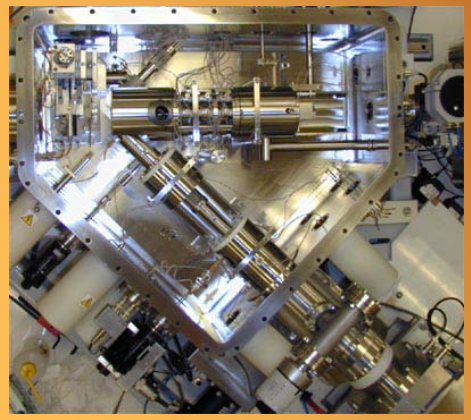
SHRIMP Delivery

- Lead time typically 18 months from order for standard machine, 22 months with multi-collector
- ASI does build continuously, so lead time can be less
- Installation takes about 6 weeks – ‘crates to dates’
- Facility needs to be set up in parallel. It has standard environmental requirements for a large instrument
- Facility requires overhead crane, air conditioning
- SHRIMPs are transported by air, about 10 crates, 16 tonnes

SHRIMP Support

- The SHRIMP IIe is a very reliable instrument providing excellent availability and ease of maintenance
- SHRIMP can be run, diagnosed and tuned remotely via a web interface
- SHRIMP is comparatively simple to repair, and spares are held in stock in Canberra
- Standard SHRIMP contract includes a comprehensive set of spares
- Three levels of support;
  - ASI – technical support by phone, e-mail, remote access (free) or site visits
  - ANU – ongoing support to the user community for development of techniques and underlying science
  - Potential for Local Support under a maintenance contract with local geochemist and ASI

Shrimp Source Chamber, with primary column (angled) and secondary column



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SHRIMP Training

- Training in both scientific use and technical support of the SHRIMP is provided, by ASI and ANU personnel as part of the sales agreement
- Training partly overlaps with the final phases of construction and testing, maximising familiarity with the instrument

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ASI-ANU Collaboration

Chief Minister at ASI (above) & KBSI Visitors meet Professor Ian Chubb, President of the ANU

- Sharing of staff, co-alignment of research, sharing of results for SHRIMP improvements
- ASI is a major contributor to the next-generation SHRIMP SI (Stable Isotope) machine
- Commercialisation of other ANU research
- Involvement of 4th year engineering students in Honors projects on SHRIMP
- ANU are the owners of ASI.
- ASI pays royalties to Research School of Earth Sciences