Optic Measurement Analysis and Visualization using ROOT as a General Framework

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CLS Optical Metrology Lab

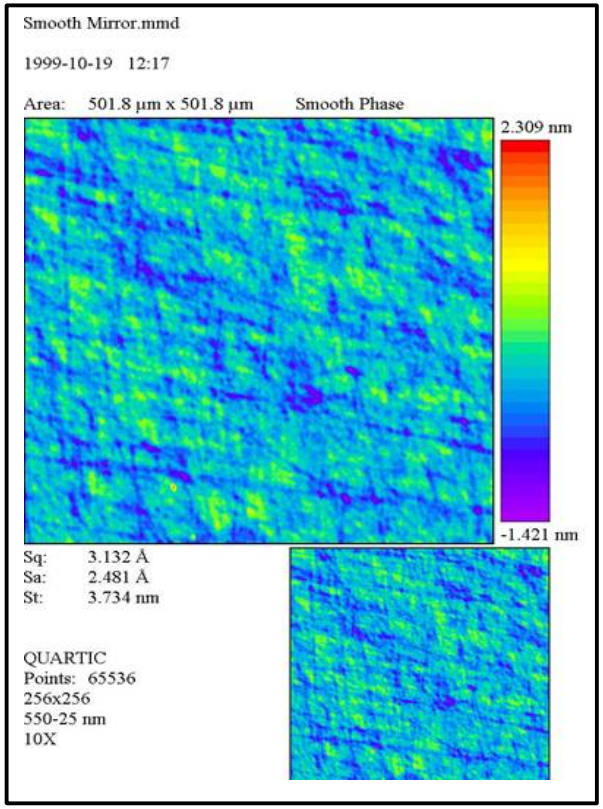
Purpose: To ensure quality of Synchrotron optics prior to their installation into a beamline. Radius of Curvature, Slope Error and Surface Roughness can be measured using the three main measurement instruments.

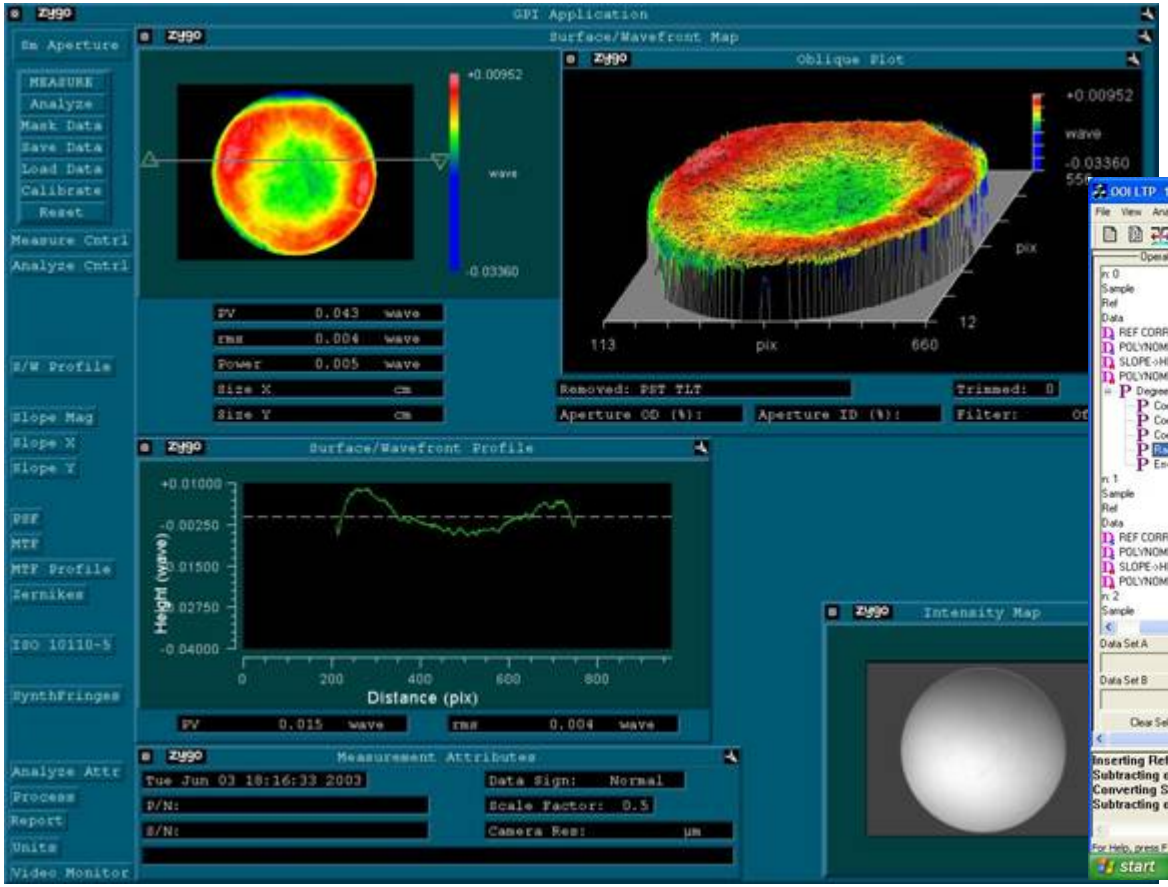
CLS Optical Metrology Lab

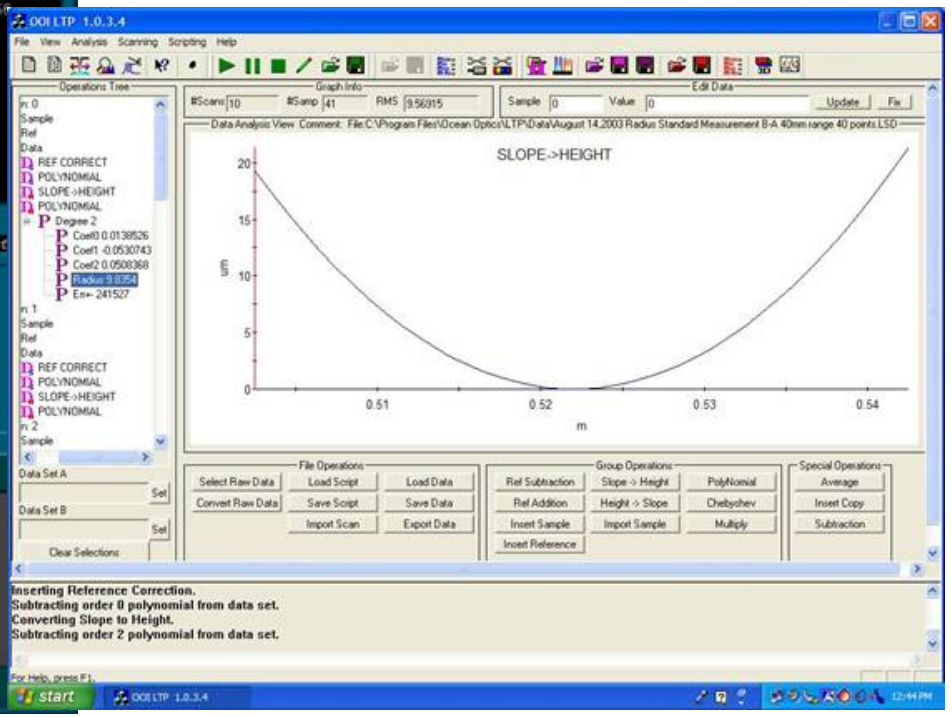
Three Main Commercial Instruments:

1) Micromap 3D Surface Profiler from Micromap Corp.
2) Long Trace Profilometer from Ocean Optics Inc.
3) Fizeau Interferometer from Zygo Corp.

Problem: Three data analysis packages that are not designed for synchrotron applications or do not have an important feature. They cannot be modified or extended because they are commercial closed-source programs.







Project Goals

1. Analyse data from the three metrology instruments.

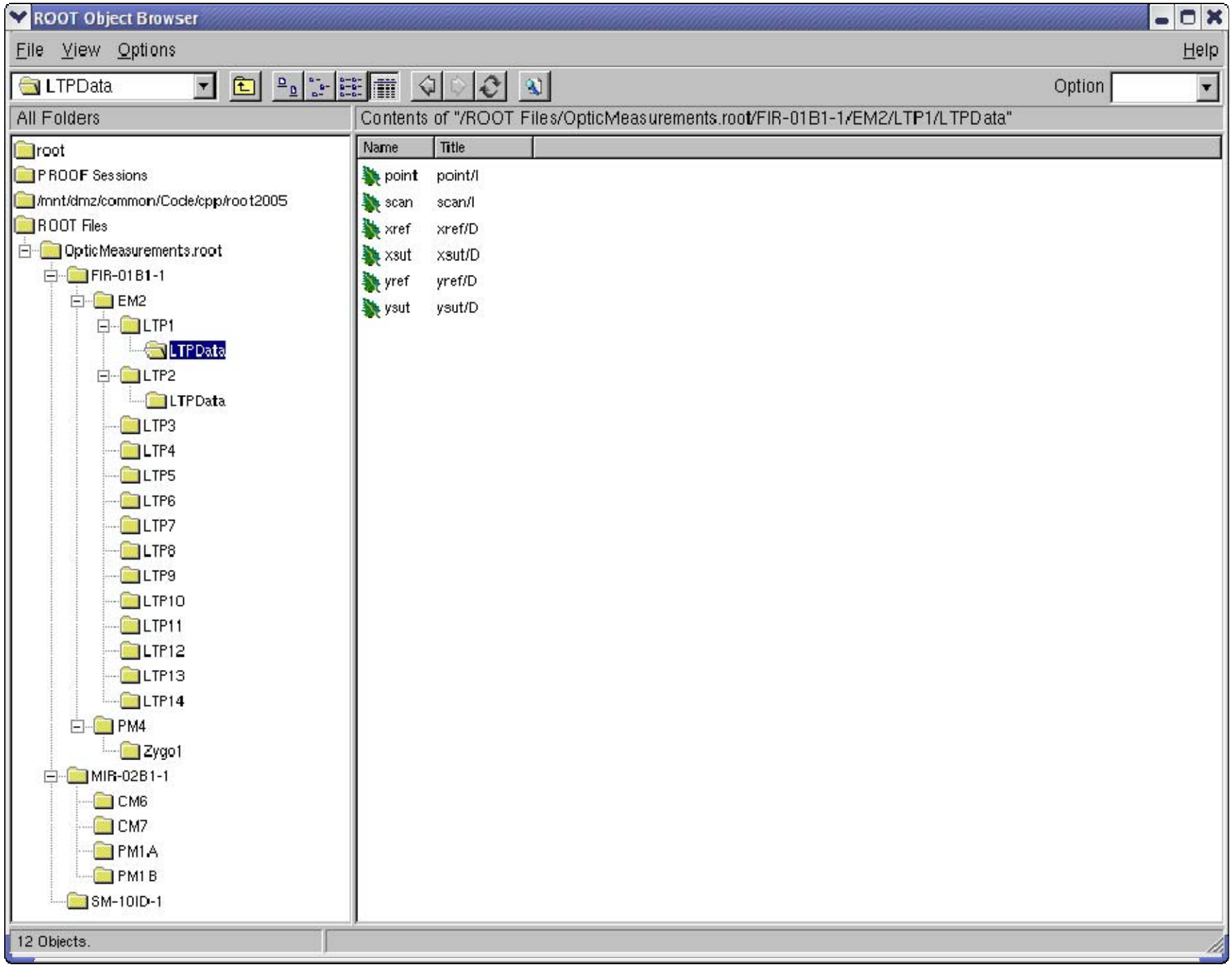
2. Display the results in a comprehensive format.

3. Print the results for easy report generation.

4. Organize both data and results for easy retrieval.

5. Easy to use graphical interface.

Browser Based Graphical Interface



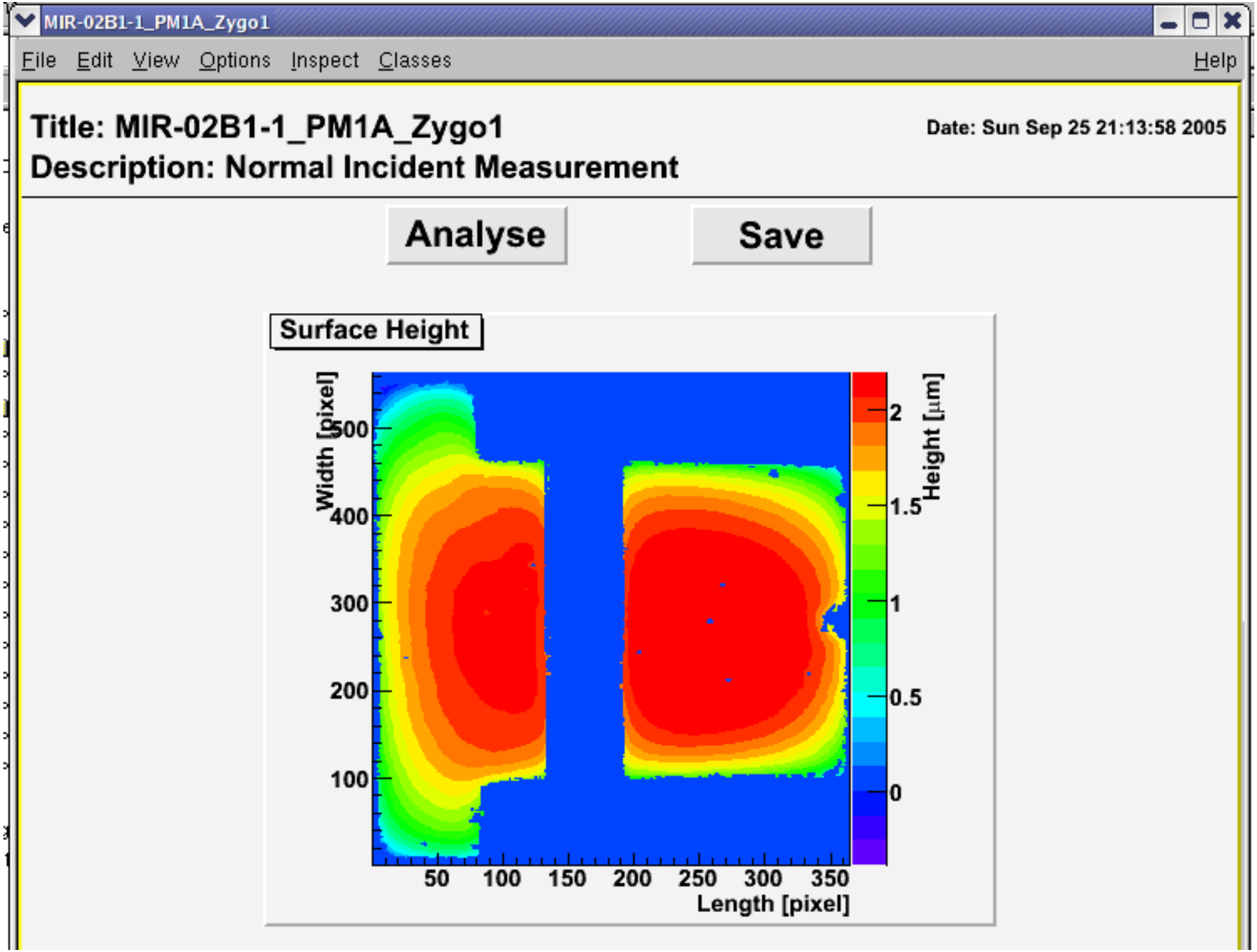
TAnalysisCanvasCLS

```
TAnalysisCanvasCLS : public TCanvas {
        protected:
                TRef fDataDir;
        public:
                TAnalysisCanvasCLS();
                TAnalysisCanvasCLS(name, title,
datadir);
                ~TAnalysisCanvasCLS()
                TDirectory* GetDataDir();
                void Store();
                virtual void Analyse();
};
```

TAnalyseButtonCLS & TStoreButtonCLS

- Inherits from TButton.
- TAnalyseButtonCLS executes the Analyse() function.
- TStoreButtonCLS executes the Store() function.

TAnalysisCanvasCLS Example



TParameterCLS

```
TParameterCLS : public TLatex {
        protected:
                TString fPrefix;
                TString fSuffix;
        public:
                TParameterCLS();
                TParameterCLS(name, prefix,
suffix);
                ~TParameterCLS()
                DrawParam(x, y, size, align);
};
```

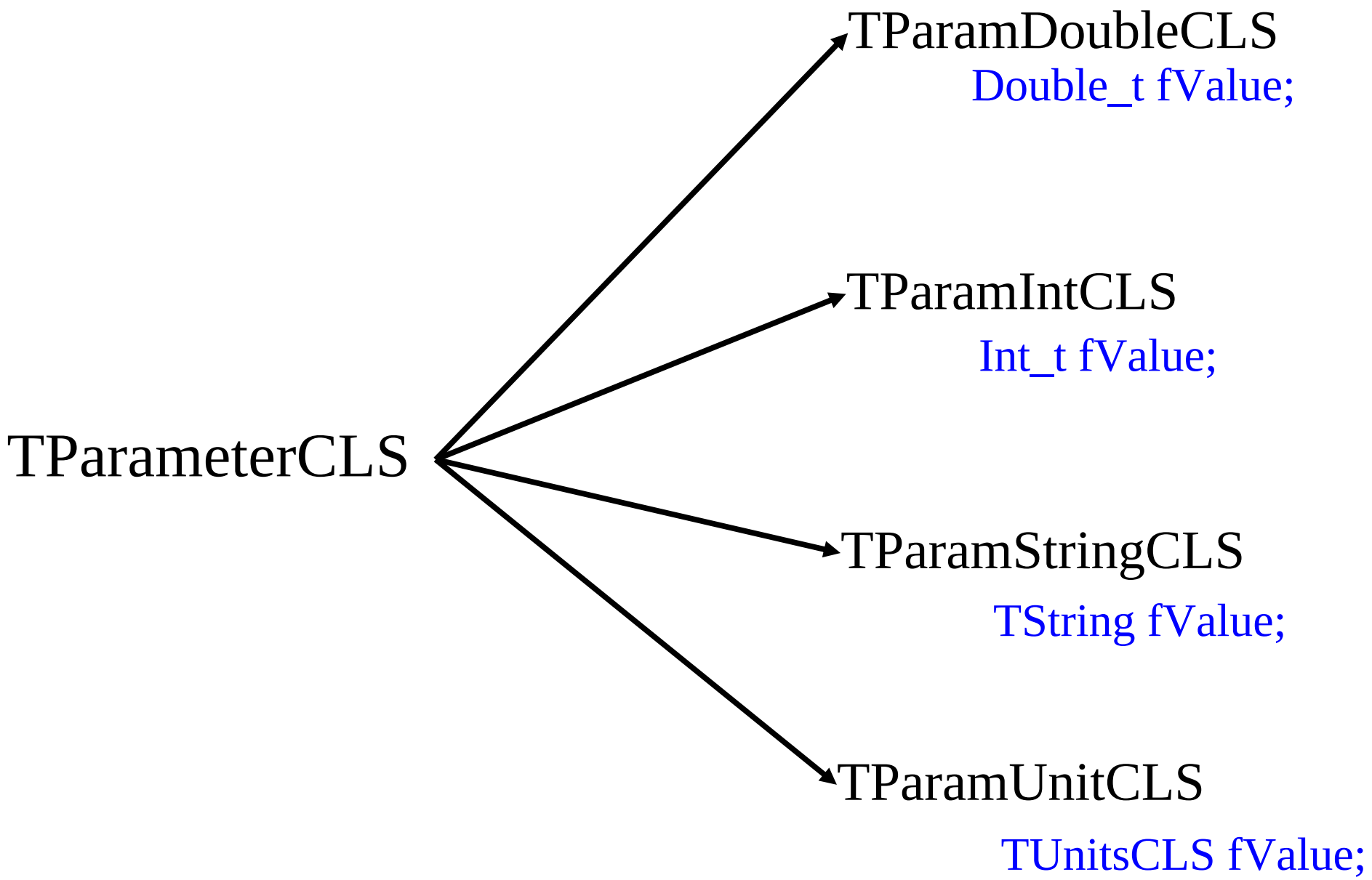
TParamDoubleCLS

```
TParaDoubleCLS : public TParameter {

        protected:
                Double_t fValue;
                TUnitsCLS fUnit;

        public:
                TParamDoubleCLS();
                TParamDoubleCLS(name, value, unit, ...);
                ~TParamDoubleCLS()

                Double_t GetValue();
                void SetValue(Double_t v);  //*MENU*
};
```


TParamDoubleCLS
Double_t fValue;
TParamIntCLS
Int_t fValue;
TParameterCLS
TParamStringCLS
TString fValue;
TParamUnitCLS
TUnitsCLS fValue;

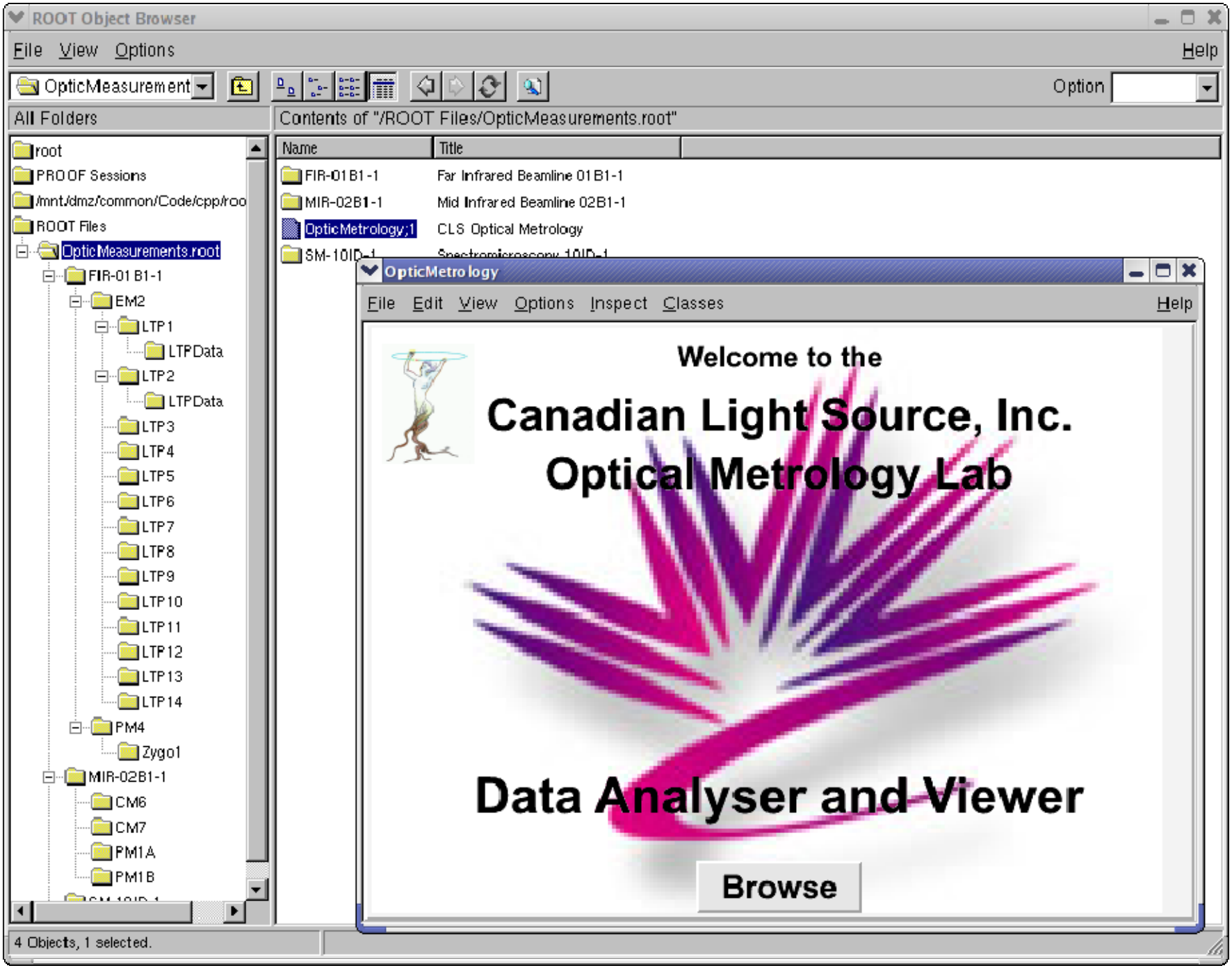
TUnitsCLS

- Contains an array of “known” units.
- Text and Latex names.
- Conversion factor and a 7-byte signature.
- Each byte is the exponent of 1 base SI unit.
- Custom units can be created using '*=' and '/=' operators.

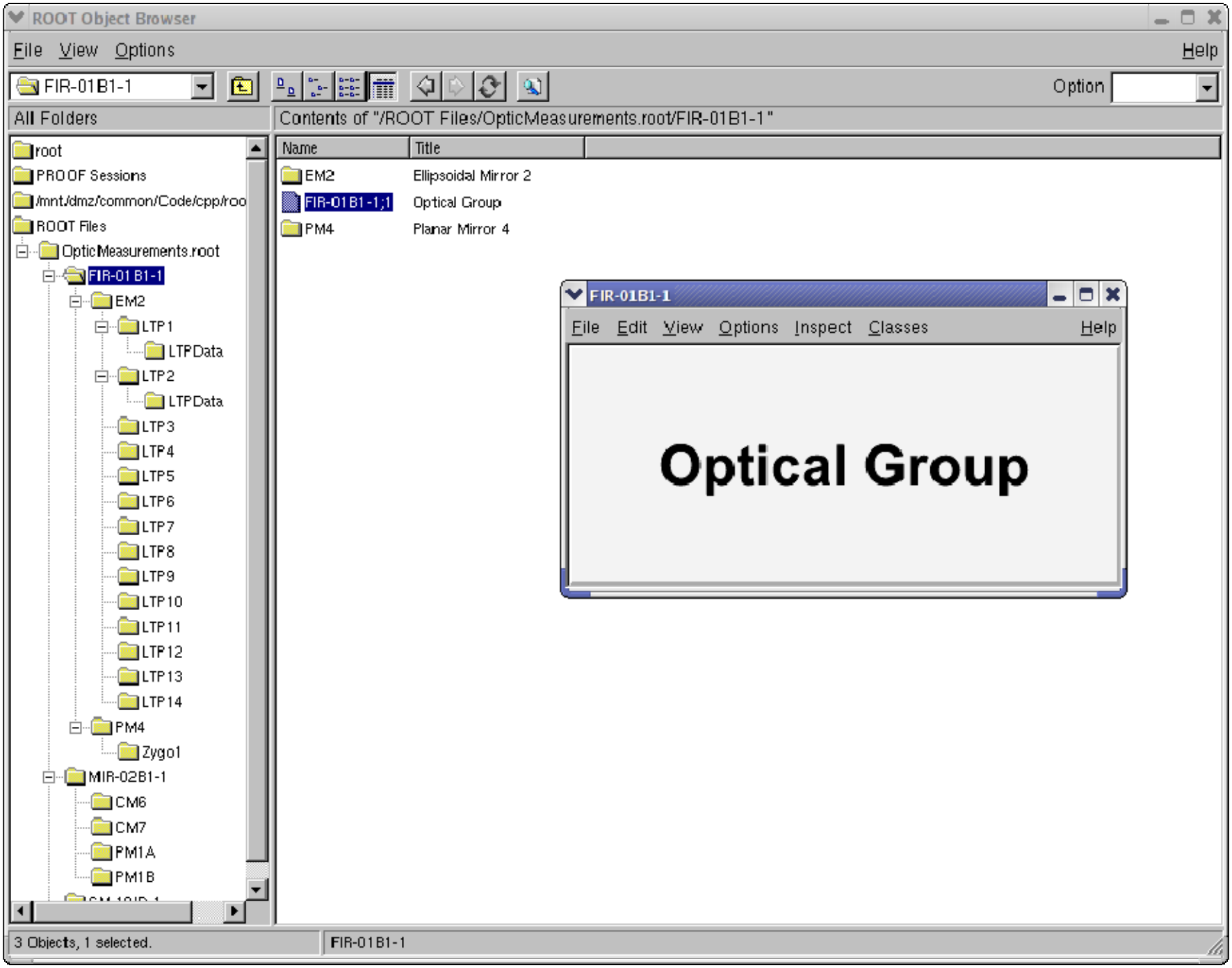
TUnitsCLS

	Meter	Kilogram	Second	Ampere	Candela	Mole	Kelvin	Factor
m	1	0	0	0	0	0	0	1.0
mm	1	0	0	0	0	0	0	0.001
mile	1	0	0	0	0	0	0	1608
N	1	1	-2	0	0	0	0	1.0
J	2	1	-2	0	0	0	0	1.0
erg	2	1	-2	0	0	0	0	1.0E-7

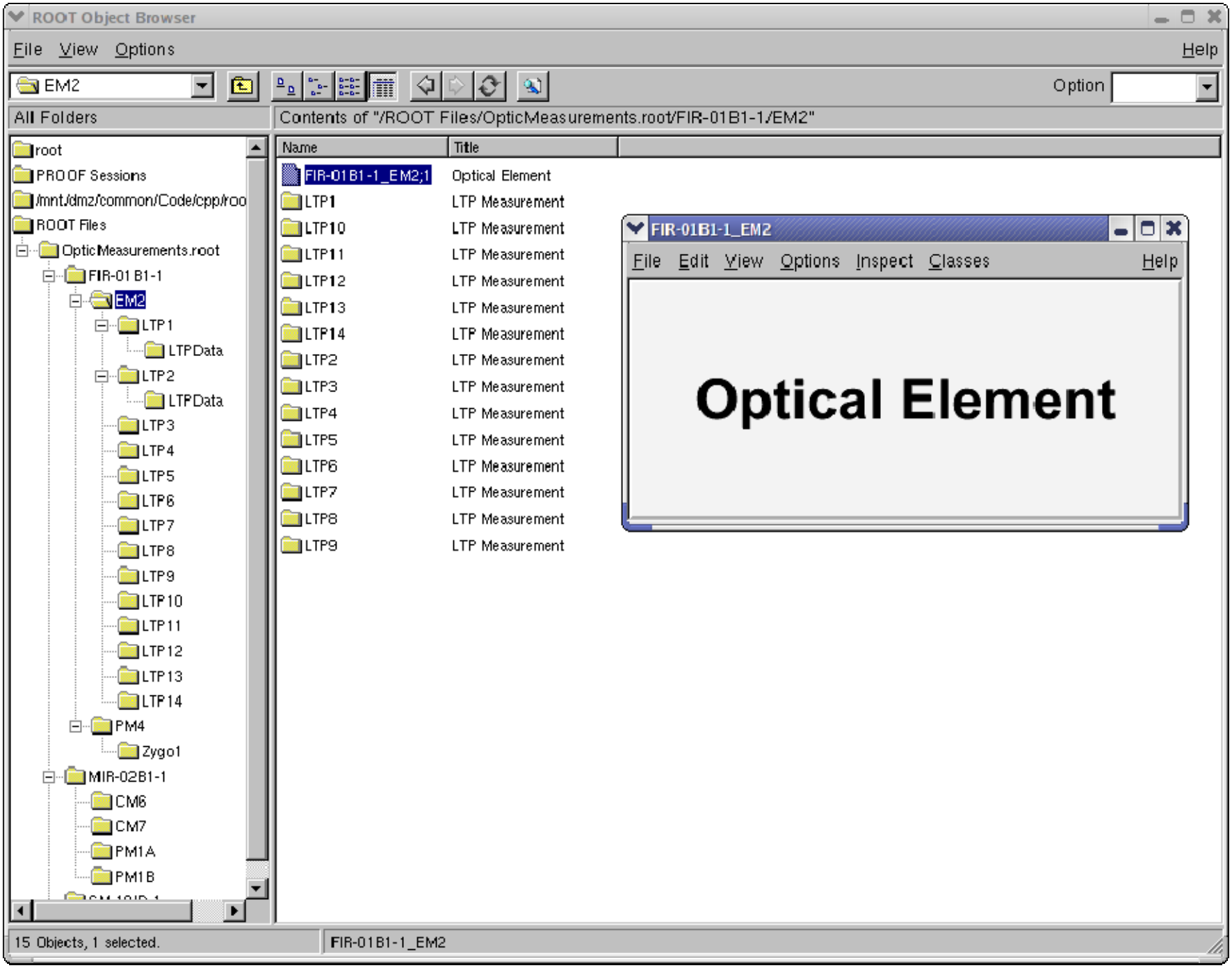
TOpticMetrologyCLS



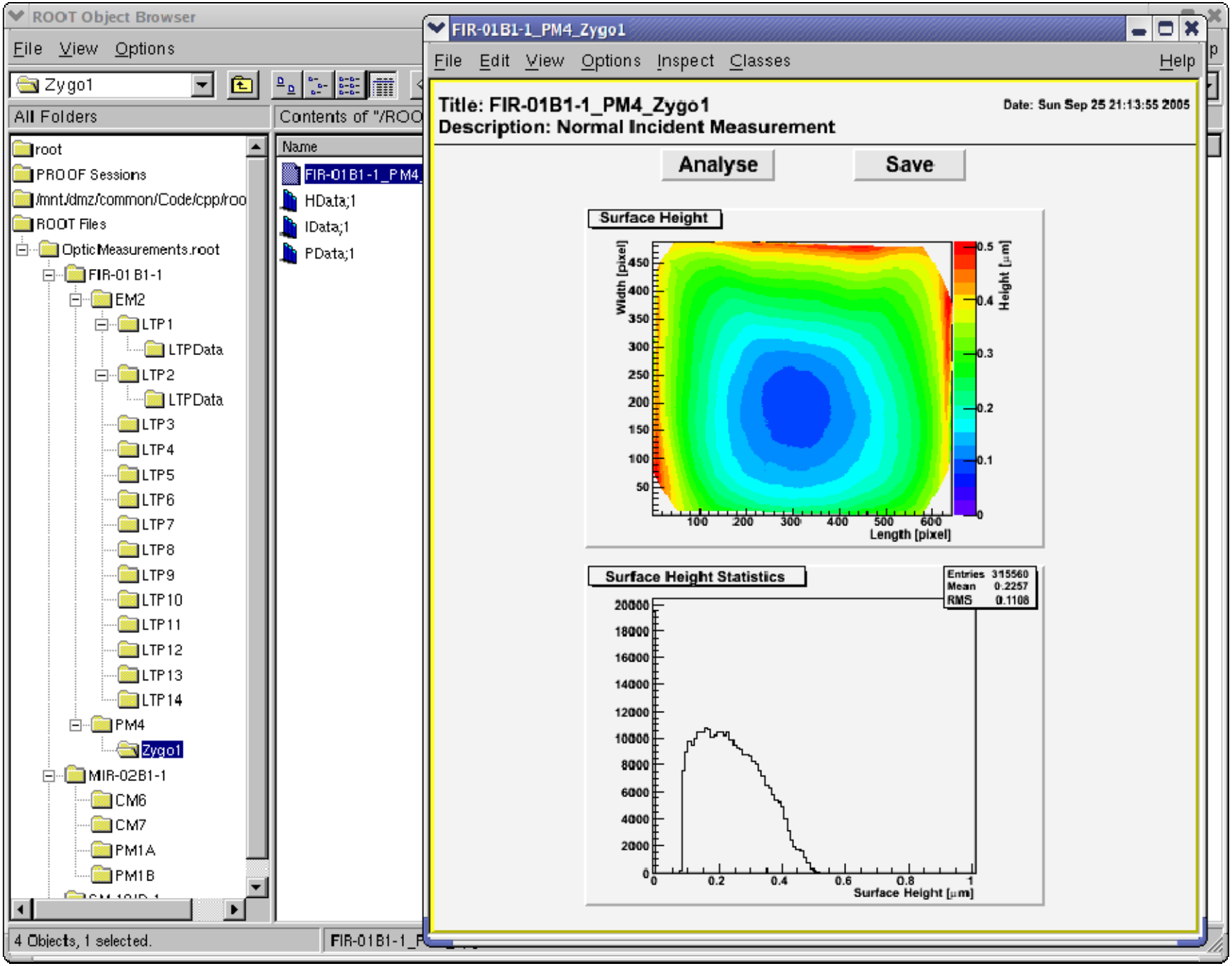
TOpticGroupCLS



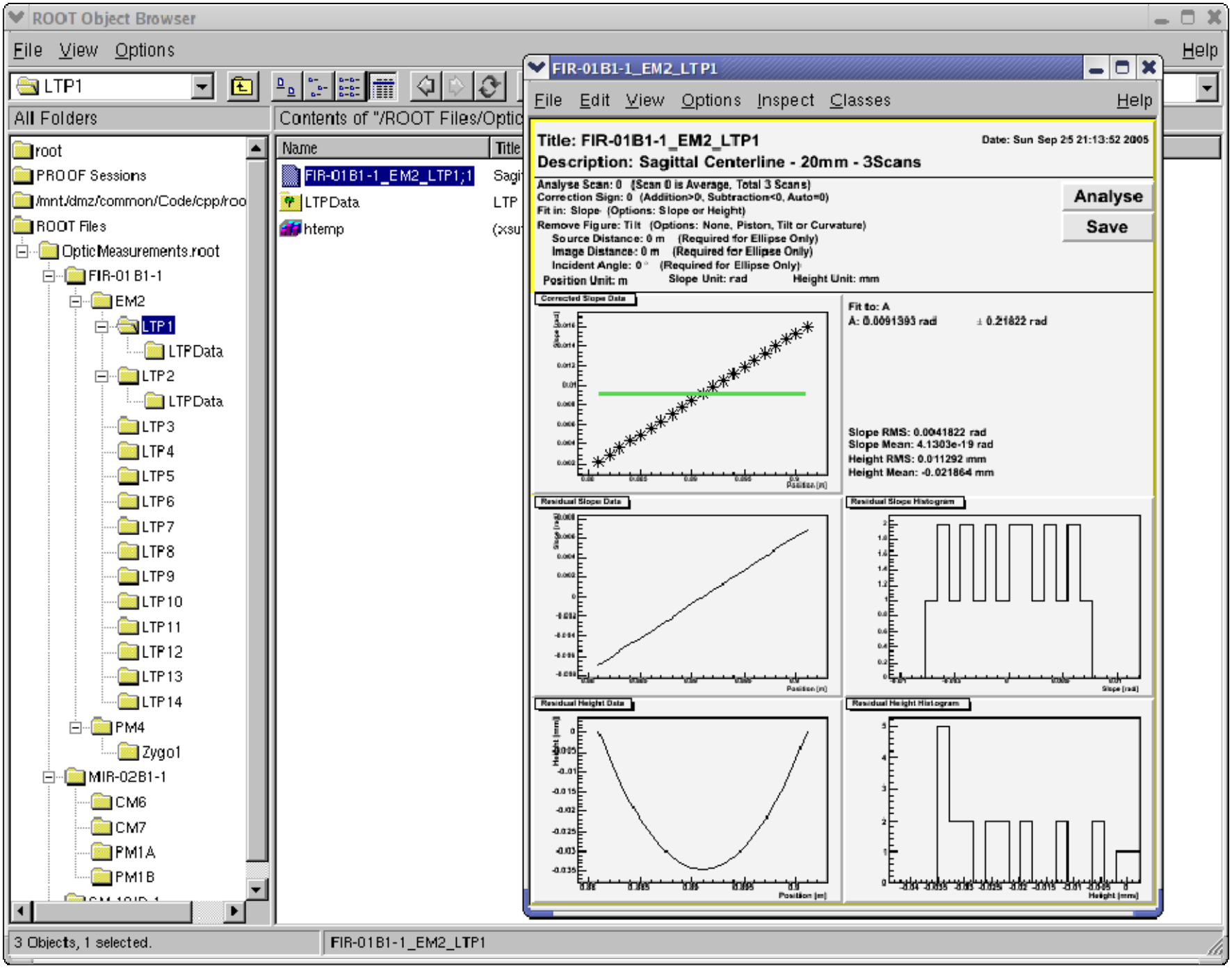
TOpticElementCLS



TOpticZygoDataCLS



TOpticLTPDataCLS



TOpticLTPDataCLS

FIR-01B1-1_EM2_LTP1

File Edit View Options Inspect Classes Help

Title: FIR-01B1-1_EM2_LTP1

Date: Sun Sep 25 21:13:52 2005

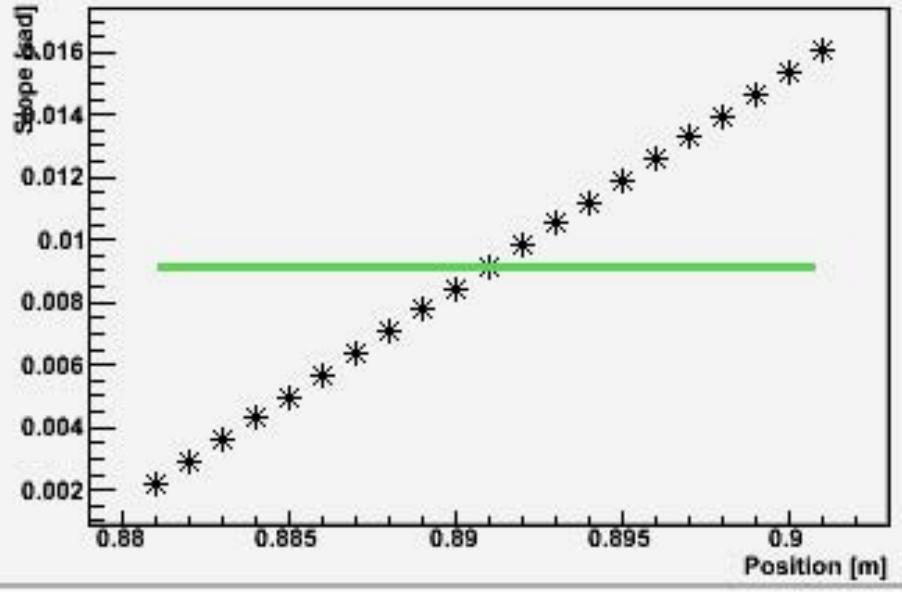
Description: Sagittal Centerline - 20mm - 3Scans

Analyse Scan: 0 (Scan 0 is Average, Total 3 Scans)
Correction Sign: 0 (Addition>0, Subtraction<0, Auto=0)
Fit in: Slope (Options: Slope or Height)
Remove Figure: Tilt (Options: None, Piston, Tilt or Curvature)
Source Distance: 0 m (Required for Ellipse Only)
Image Distance: 0 m (Required for Ellipse Only)
Incident Angle: 0 ° (Required for Ellipse Only)
Position Unit: m Slope Unit: rad Height Unit: mm

Analyse

Save

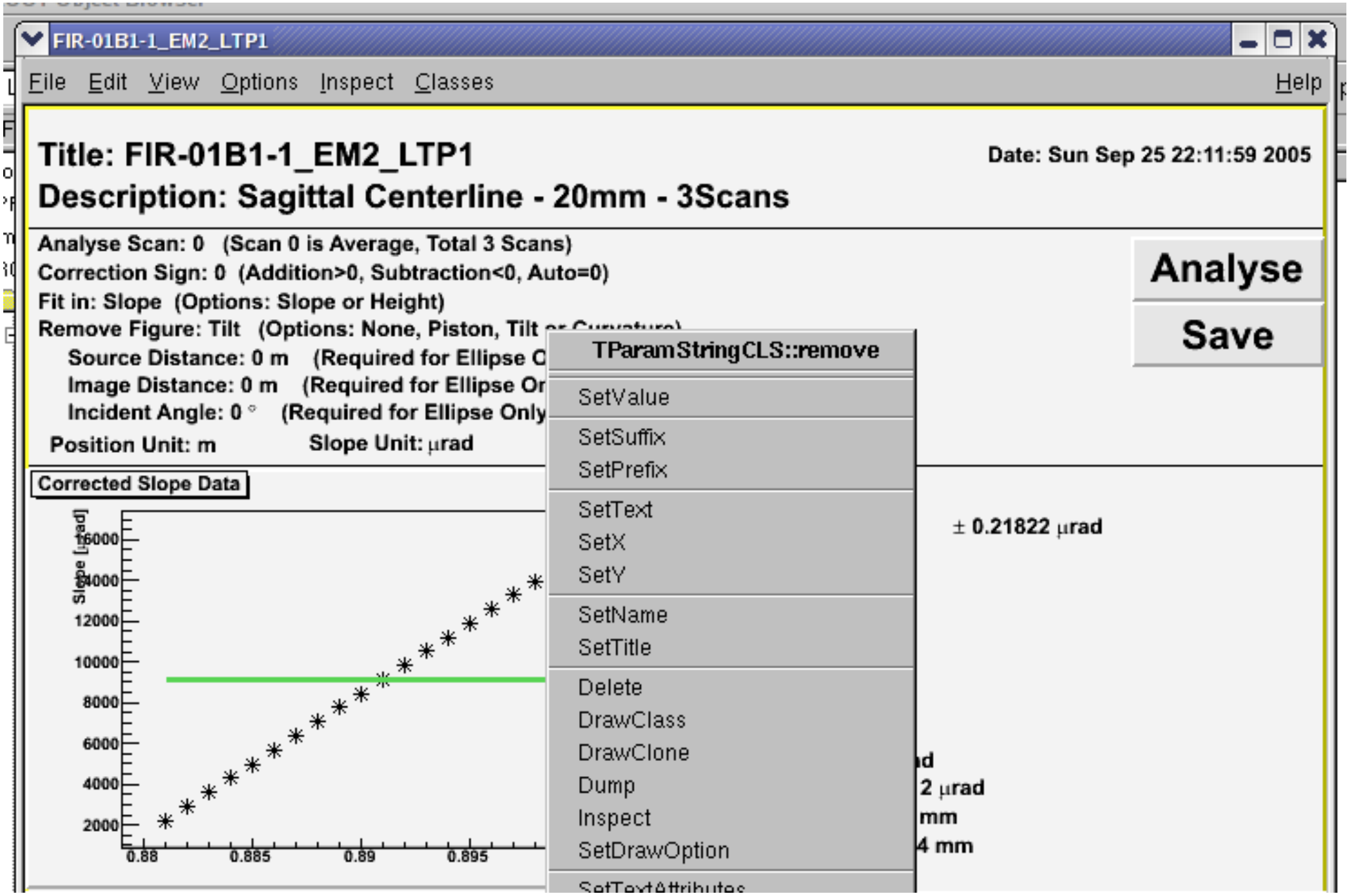
Corrected Slope Data



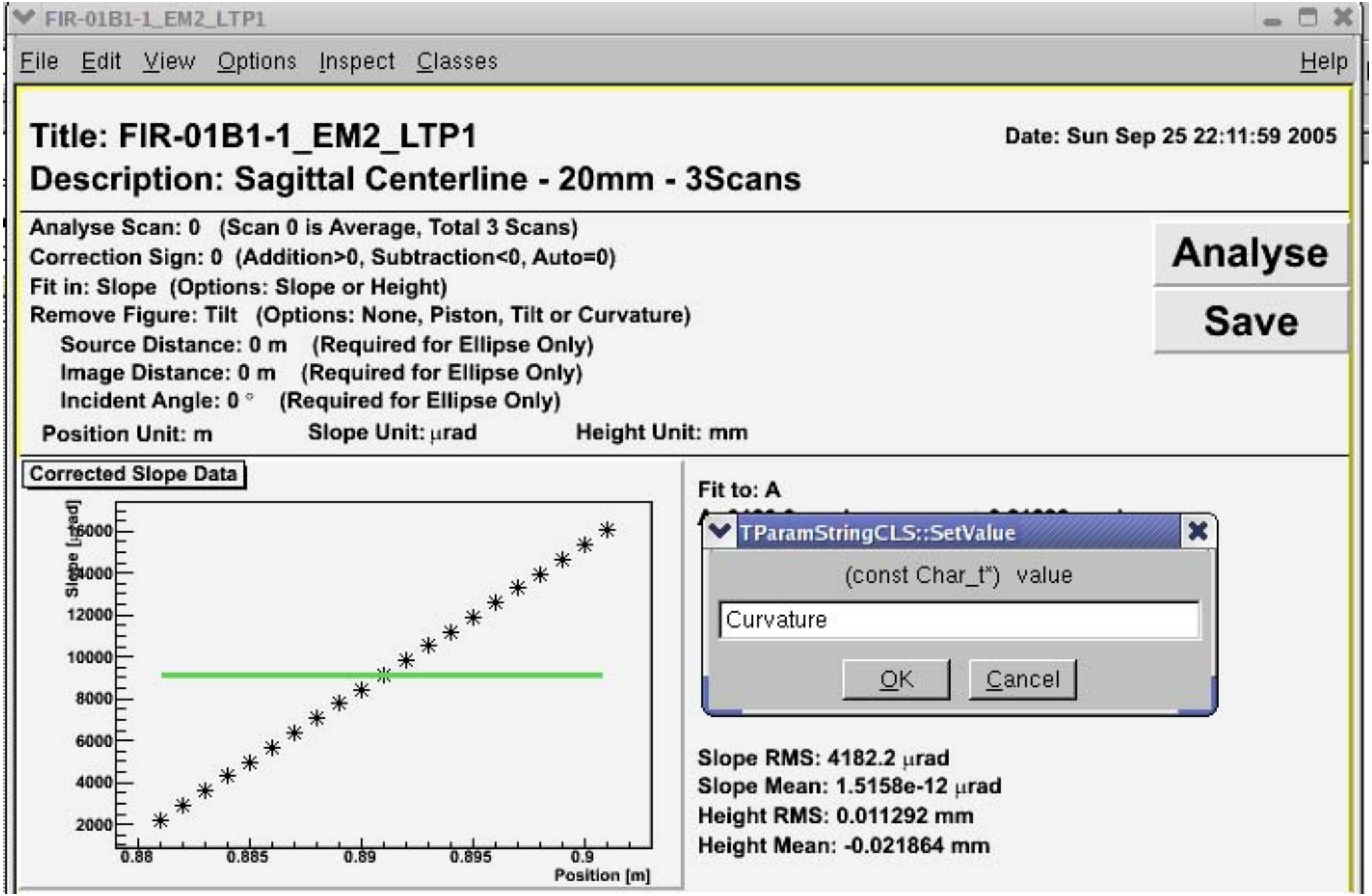
Fit to: A
A: 0.0091393 rad ± 0.21822 rad

Slope RMS: 0.0041822 rad
Slope Mean: 4.1303e-19 rad
Height RMS: 0.011292 mm
Height Mean: -0.021864 mm

TOpticLTPDataCLS



TOpticLTPDataCLS



TOpticLTPDataCLS

FIR-01B1-1_EM2_LTP1

File Edit View Options Inspect Classes Help

Title: FIR-01B1-1_EM2_LTP1

Date: Sun Sep 25 22:37:46 2005

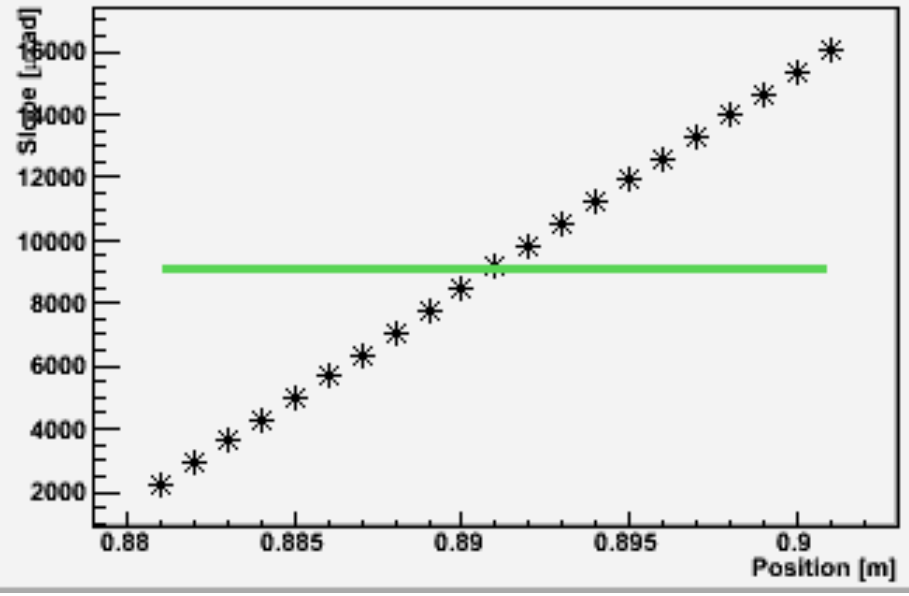
Description: Sagittal Centerline - 20mm - 3Scans

Analyse Scan: 0 (Scan 0 is Average, Total 3 Scans)
Correction Sign: 0 (Addition>0, Subtraction<0, Auto=0)
Fit in: Slope (Options: Slope or Height)
Remove Figure: Curvature (Options: None, Piston, Tilt or Curvature)
Source Distance: 0 m (Required for Ellipse Only)
Image Distance: 0 m (Required for Ellipse Only)
Incident Angle: 0 ° (Required for Ellipse Only)
Position Unit: m Slope Unit: μrad Height Unit: mm

Analyse

Save

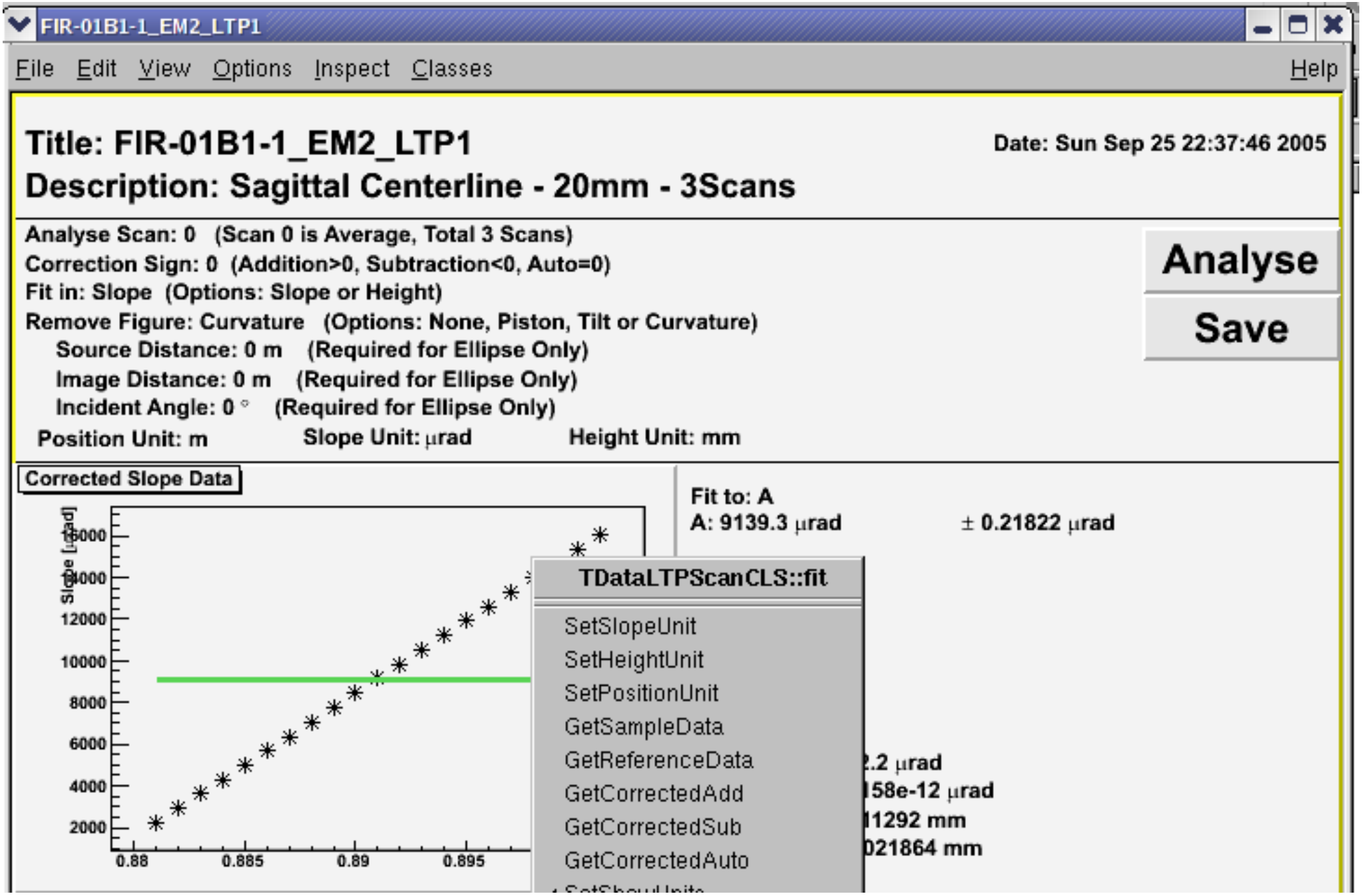
Corrected Slope Data



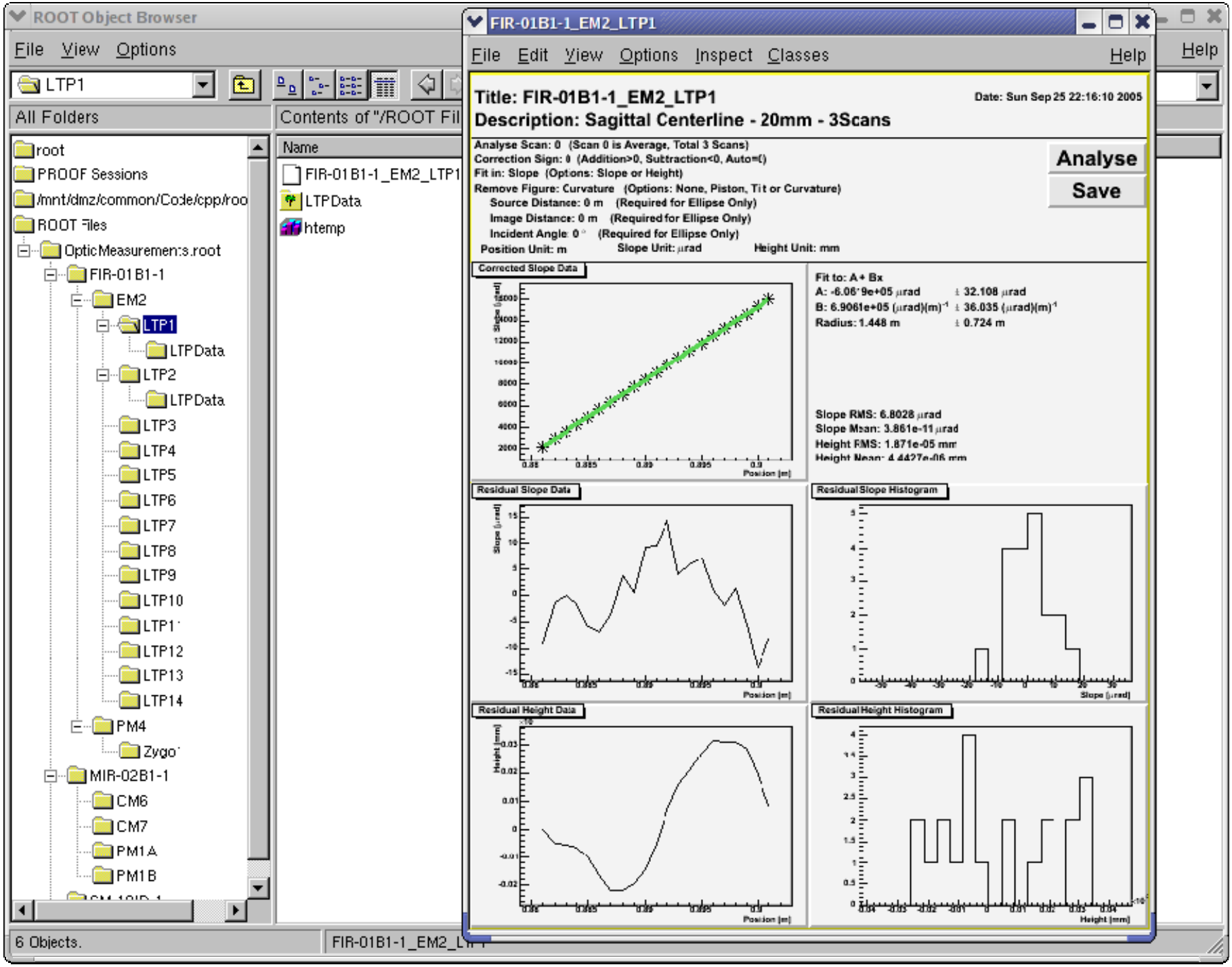
Fit to: A
A: 9139.3 μrad ± 0.21822 μrad

Slope RMS: 4182.2 μrad
Slope Mean: 1.5158e-12 μrad
Height RMS: 0.011292 mm
Height Mean: -0.021864 mm

TOpticLTPDataCLS



TOpticLTPDataCLS



Summary

TAnalysisCanvasCLS

- “Smart” Canvas
- Knows where to Find the Data
- Knows how to Analyse and Display the Data

TParameterCLS

- Used for Input or Output
- Displayed on Canvas or Browser

TUnitsCLS

- Units Conversion
- Build Custom Units

Thanks

Brian Yates
Emil Hallin
Tomas Ellis
and the
ROOT Developers